Journal of Archaeological Science 39 (2012) 2238–2251

Contents lists available at SciVerse ScienceDirect

Journal of Archaeological Science

journal homepage: http://www.elsevier.com/locate/jas

Chronologies in wood and resin: AMS ^{14}C dating of pre-Hispanic Caribbean wood sculpture

Joanna Ostapkowicz [a,*], Christopher Bronk Ramsey [b], Fiona Brock [b], Tom Higham [b], Alex C. Wiedenhoeft [c], Erika Ribechini [d], Jeannette J. Lucejko [d], Samuel Wilson [e]

[a] World Museum Liverpool, William Brown Street, Liverpool L3 8EN, UK
[b] Research Laboratory for Archaeology and the History of Art, University of Oxford, Dyson Perrins Building, South Parks Road, Oxford, OX1 3QY, UK
[c] Center for Wood Anatomy Research, USDA Forest Service, Forest Products Laboratory, 1 Gifford Pinchot Drive, Madison, WI 53726-2398, USA
[d] Dipartimento di Chimica e Chimica Industriale, Universita di Pisa, Via Risorgimento 35, Pisa 56126, Italy
[e] Department of Anthropology, University of Texas, Austin, TX 78712, USA

ARTICLE INFO

Article history:
Received 22 October 2011
Received in revised form
21 January 2012
Accepted 26 January 2012

Keywords:
Caribbean
Taíno
Lucayan
Wood
Resin
Radiocarbon dating

ABSTRACT

This paper establishes a chronological framework for selected pieces of Caribbean (Taíno/Lucayan) wooden sculpture, enabling previously ahistoric artefacts to fit back into the wider corpus of pre-colonial material culture. Seventy-two ^{14}C AMS determinations from 56 artefacts held in museum collections are reported, including 32 ceremonial *duhos*, or seats. Far from being constrained to the last few centuries prior to contact, the dates for these objects extend back to ca. AD 250, and include the artistic legacies of various cultures. Duhos in both low and high back styles are present from about AD 600, if not earlier, in a distribution that spans the Antillean island chain from Trinidad to Cuba. Complex, drug-related paraphernalia and elaborate ancestral reliquaries are in evidence by AD 1000, as are some distinctive regional styles – such as the unique iconography from the Bahamas and Turks and Caicos islands. This paper explores relevant methodological issues – from the challenges of working with museum pieces (e.g., uncertain provenance, discrete sampling techniques, impact of previous conservation treatments on dating results), to dealing with potential 'in-built' age in tropical hardwoods.

1. Taíno and Lucayan wooden sculpture: corpus and context

The indigenous peoples of the Caribbean's Greater Antilles, Bahamas and Turks and Caicos Islands – the Taíno and Lucayans – comprised a mosaic of various cultures when Europeans first began exploring the islands in 1492. Their sculptural arts are today recognised as among the most significant artistic achievements of the ancient Americas. This assessment is largely based on surviving large-scale wood and stone sculptures, featured prominently in museum exhibits and catalogues (Brecht et al., 1997; Kerchache, 1994). Although wood rarely survives in the archaeological record, the Caribbean has yielded some 300 carvings now held in museum and private collections (Ostapkowicz, 1998), with an additional, substantial corpus undergoing careful, long-term excavation at two major waterlogged sites: Los Buchillones, Cuba and La Aleta, Dominican Republic (Calvera Rosés et al., 1996, 2006; Conrad et al., 2001). Of the sculptures that have made their way into museum collections, some were exported as curiosities by the Spanish from the early 16th century (Martyr D'Anghera, 1970; Las Casas, 1951), while others were preserved in caves until discovered in the 18th–19th centuries, when the islands were more intensively explored and settled. A rare few have come to light more recently. Collectively, they provide an opportunity to engage with what is currently a lacuna in Caribbean material culture studies: the importance and value of wooden objects in people's day-to-day lives.

From 15–16th century *cronista* (historian) accounts, and ethnographic analogies to South and Central American indigenous cultures, it is clear that wood made up the bulk of Caribbean material culture, furnishing everything from shelter, heat, tools, canoes and weapons to highly prized valuables. But it is the absence of this material from conventional archaeological sites, which are dominated by stone and ceramics, that has hindered a study of wood as a medium of cultural expression. Despite the relative wealth of wooden material in museum collections, to date they have had little impact on wider issues in Caribbean archaeology, partly because they float outside chronologies, lacking a clear context due to often convoluted collection histories. But wood itself

* Corresponding author. Tel.: +44 (0) 151 478 4233.
E-mail address: Joanna.Ostapkowicz@liverpoolmuseums.org.uk (J. Ostapkowicz).

0305-4403/$ – see front matter © 2012 Published by Elsevier Ltd.
doi:10.1016/j.jas.2012.01.035

is a rich information source – lending itself to species identification, AMS ^{14}C dating and stable isotope analysis for provenance studies.[1] Its manufacture history can be 'read' through the presence of surface tool marks, and the addition of resin for shell or *guanin* (a gold–copper alloy) inlays. The extant corpus thus provides an opportunity to explore the stylistic range of these sculptures, their regional and temporal variation, and more broadly, their symbolism and use within the complex chiefdom-level societies that produced them.

This articles serves as an overview of the AMS ^{14}C results from 56 wooden sculptures, selected on the basis of their documented history in museum collections and their wide-ranging distribution within the Greater Antillean islands (Cuba, Jamaica, Haiti/Dominican Republic and Puerto Rico), with a particular focus on the Bahamas and Turks and Caicos Islands (Table 1; Fig. 1; all bracketed numbers in the text cross-reference with Fig. 1 and Table 1, where more detailed information about each of the artefacts can be found). While the majority of carvings discussed fall within the Taíno and Lucayan cultural spheres, four are provenanced to territories of other cultural groups – the 'Carib' (Kalinago/Eyeri/Kalipuna) of the Lesser Antilles [52; 53], the Ciboney/Guanahatebey of western Cuba [18] and the Barrancoid of Trinidad [51] (see Ostapkowicz et al., 2011b). The aims of the study were twofold: 1/ to understand the materials that were being dated and their possible implications (e.g., slow-growing woods) and 2/ to place the initial construction of both individual carvings and stylistic groupings chronologically. More detailed reports – charting the histories of each artefact, with detailed reviews of their placement in local chronologies and contexts – are in preparation, as are specific papers dedicated to resin analysis, wood identification and stable isotope studies. A parallel project on nine pieces in the collections of the British Museum will be reported separately. The results aim to contribute to the growing body of work focussing on critically refining Caribbean chronologies (e.g., Fitzpatrick, 2006).

2. Materials and methods

Within this corpus of 56 objects, by far the highest artefact concentration is in the *duho*/bench category, with 32 examples (Table 2). These ceremonial seats, well-known from early encounters between the Taíno and the Spanish, where etiquette and status demanded their use, are typically carved as a creature on all fours [e.g., 2–3] or as a slightly reclining anthropomorphic figure, its head at the top of the backrest [53]. A variety of styles were known, including high-backs featuring an extending 'tail' or backrest, and low-backs that appear more stool-like, lacking a back support (Ostapkowicz, 1997, 1998). The next largest artefact category, with eight examples, can be loosely described as *cemís*, or representations of spirits, deities or ancestors[2]: these include sculptures [20; 23; 35], reliquaries [27; 31], where the bones of revered ancestors were deposited after death, and *cohoba* stands [30; 32; 34], atop which the powdered cohoba drug (possibly involving *Anadenanthera peregrina*) was placed during the eponymous ceremony. Other *cohoba* objects, such as vomiting spatulas [54], snuff tubes [52] and spoons [37], were involved in the storage, display or ingestion of narcotic substances during the ritual. There are also five examples of platters and vessels, spanning simple, perhaps utilitarian dishes [1; 28] to elaborately carved platters [22; 33], possibly used during feasts, and storage vessels for small, precious materials [43]. A possible drum [26] and staff [18], two paddles [9; 21] and a hafted axe [12] are also included.

Samples for AMS ^{14}C dating were taken with a firm focus on the two main problems inherent in dating wood: 'in-built' age and wood reuse. In terms of in-built age, a sample from the pith may be decades to centuries older than the sapwood of the same tree, particularly for very slow-growing species. Indiscriminate sampling within a bole several centuries old could dramatically skew the results and their interpretation. Substantial delays to carving after felling, or the reuse of an older piece of wood, can also distort results. Our sampling strategy was therefore carefully devised (see Brock et al., in press), and where possible, samples were taken from the sapwood to reflect the felling date [8.1; 16; 25.1; 38.1; 47]. Where sapwood was not present, the artefact was oriented relative to its position within the original bole (there were no composite carvings), and the sample extracted from the outermost edge. Multiple samples were also collected from twelve artefacts, taken strategically at various points within each sculpture. Depending on the carving, this may include samples from 1/ the pith (central heartwood) to determine the selected tree's first years of growth; 2/ specific points within the bole to show the tree's growth rate over the course of its life and/or 3/ inlay resins, to provide an indication of the final stages of manufacture, or renewal. Sampling was dependent on the condition of the artefact, and the presence (or absence) of priority sampling areas.

These methodological requirements had to work in tandem with the preservation and curation mandates of the holding institutions: the aim was to maintain the visual integrity of the piece by working in already present fissures or damaged areas wherever possible while ensuring that the above sampling criteria were met. Project colleagues worked in close collaboration with each institution, tailoring the sampling strategy to each carving after careful review. Sample size was kept to a minimum (between 10 and 90 mg for the radiocarbon samples), and in efforts to keep the sample site as discrete as possible a scalpel was used to cut the targeted area, ideally along the wood's grain (Fig. 2).

Given the lengthy museum histories of some of the pieces, and the frequent lack of documentation for early conservation treatments, a cautious approach to processing the samples was taken. Three pieces [5–7] were known to have been treated with a mixture of lanolin and Neatsfoot oil (a preservative agent made of rendered cattle bones), and one sculpture [31] was suspected of treatment with wax. Samples submitted for GC/MS analysis also revealed the presence of other materials used for conservation/restoration purposes. Paraffin, a synthetic substance that is used on its own or in combination with beeswax, was identified in three sculptures [37; 43; 50], castor oil in one [34], and shellac – a resin of Asian origin – in three [11; 37; 38]. Any of these chemical treatments could affect the radiocarbon age of a piece if not effectively removed, resulting in an erroneous date: for example, the presence of just 1% paraffin or pitch (which, being made from petrochemical sources, contain no ^{14}C) would skew the date ~ 80 years older than the actual age of the piece. The effect of beeswax, shellac, castor oil, lanolin and Neatsfoot oil are more difficult to predict, but as they would probably all date from the time of application to a given piece, their presence may be expected to yield a younger date than the real age.

The majority of wood samples (with the exception of 5–7, 34, 36, 37, 54–55) were initially subjected to a solvent wash comprising sequential hour-long washes with acetone (45 °C),

[1] A pilot stable isotope study, which aims to clarify provenance issues by measuring various light isotope 'signatures' in the wood (strontium, nitrogen, sulphur and carbon) indicative of the specific region from which the tree originated, is nearing completion.

[2] The term *cemí* has come to refer to depictions of these spiritual forces in any form and medium – from the smallest stone trigolith (three-pointed stones, often lavishly carved) to large depictions at petroglyph sites. Cemí, however, more broadly defines the animating force, rather than its material representations (Oliver, 2009).

Table 1
AMS radiocarbon results from 56 selected artefacts involved in the 'Pre-Hispanic Caribbean Sculptural Arts in Wood' project (the British Museum collections will be reported separately). The Oxford Radiocarbon Accelerator Unit lab numbers (OxA) are provided alongside the material and sample site (e.g., terminus: sapwood or outer growth rings, to indicate when tree was felled and likely carved; pith: age of tree; growth: selected areas within the bole marking growth rates). The same system is used for the dates run by Beta Analytic on the Aboukir cemís (Manuels 2001; Allsworth-Jones 2008: 24, 99), although these are not tallied with the 72 radiocarbon dates for the project. Dates BP and calibrations at 95.4% are listed, the most likely calibration ranges highlighted in bold. All dates are calibrated using the IntCal09 dataset (Reimer et al., 2009) and OxCal v4.1.7 (Bronk Ramsey, 2009).

Island group		Artefact	Provenance	Institution/Donor/ Accession number	OxA	Material	$\delta^{13}C‰$ (VPDB)	^{14}C BP	Calibrated date range
Bahamas	1	Platter	Cave, Mortimer's, Long Island	Saint John's Abbey, Collegeville, Minnesota, USA; 89.189	OxA-19431	*Guaiacum* sp., terminus	−24.7	963 ± 27	**AD 1019–1155 (95.4%)**
	2	Duho (low-back/ 'dog')	'Bahamas'	National Museum of the American Indian, Washington, USA; 058027	OxA-19059	*Guaiacum* sp., terminus	−24.4	658 ± 25	**AD 1280–1320 (46.3%); AD 1351–1391 (49.1%)**
	3	Duho (high-back)	Cave, Mortimer's, Long Island	Saint John's Abbey, Collegeville, Minnesota, USA; 89.190	OxA-19177	*Guaiacum* sp., terminus	−24.8	636 ± 27	**AD 1285–1329 (40%); AD 1340–1396 (55.4%)**
	4	Duho (high-back)	'West Indies' Bahamas/TCI?	Peabody Museum of Natural History, New Haven, USA; 137676	OxA-19173	*Cordia* sp., terminus	−23.2	623 ± 27	**AD 1291–1400 (95.4%)**
	5	Duho (high-back/ 'dog')[a]	Cartwright Duho Cave, Mortimer's, Long Island	Antiquities, Monuments and Museums Corporation, Nassau, Bahamas; 1988-01-02	OxA-18912	*Cordia* sp., terminus	−22.4	524 ± 22	AD 1329–1341 (4.8%); **AD 1396–1439 (90.6%)**
	6	Duho (high-back/ 'bat')[a]	Cartwright Duho Cave, Mortimer's, Long Island	Antiquities, Monuments and Museums Corporation, Nassau, Bahamas; 1988-01-01	OxA-18793	*Guaiacum* sp., terminus	−24.1	454 ± 24	**AD 1418–1462 (95.4%)**
	7	Duho (high-back/ 'turtle')[a]	Cartwright Duho Cave, Mortimer's, Long Island	Antiquities, Monuments and Museums Corporation, Nassau, Bahamas; 1988-01-03	OxA-18448	*Cordia* sp., terminus	−26.5	424 ± 24	**AD 1430–1491 (93.4%);** AD 1602–1610 (2%)
	8.1	Duho (high-back)	Cat Island ('San Salvador')	Bryn Mawr College, Pennsylvania, USA; 97-1-65	OxA-20839	*Cordia* sp.; terminus (sapwood)	−23.1	409 ± 25	**AD 1435–1515 (87.3%);** AD 1600–1618 (8.1%)
	8.2				OxA-23003	*Cordia* sp.; pith	−22.0	506 ± 22	**AD 1406–1442 (95.4%)**
	9	Paddle	Cave, Mores Island, Abacos	National Museum of the American Indian, Washington, USA; 032574	OxA-19053	*Swietenia* sp., terminus	−23.4	410 ± 24	**AD 1436–1511 (88.8%);** AD 1601–1616 (6.6%)
	10	Duho (low-back)	Spring Point Cave, Acklins	National Museum of the American Indian, Washington, USA; 032575	OxA-19054	*Cordia* sp., terminus	−22.8	405 ± 25	**AD 1437–1516 (85.5%);** AD 1598–1618 (9.9%)
	11	Duho (low-back)[b]	Cat Island ('San Salvador')	Manchester Museum, Manchester, UK; 0.9323/468	OxA-18101	*Guaiacum* sp., terminus	−24.4	355 ± 25	**AD 1454–1529 (46%); AD 1544–1634 (49.4%)**
Turks and Caicos	12	Hafted axe	Cave, North Caicos	National Museum of the American Indian, Washington, USA; 060000	OxA-19172	*Guaiacum* sp., terminus	−23.0	932 ± 26	**AD 1029–1160 (95.4%)**
	13	Duho (high-back)	'Grand Turk Island'[c], Turks and Caicos (?)	National Museum of the American Indian, Washington, USA; 059385	OxA-19116	*Guaiacum* sp., terminus	−24.2	890 ± 24	**AD 1044–1101 (33.1%); AD 1119–1215 (62.3%)**
	14	Duho (high-back)	Cave, Blue Hills Settlement, Providenciales	National Museum of Natural History, Washington, USA; A030053	OxA-21854	*Carapa* sp., terminus	−24.2	498 ± 24	**AD 1407–1445 (95.4%)**
	15	Duho (low-back)	Cave, Blue Hills Settlement, Providenciales	American Museum of Natural History, New York, USA; 25/234	OxA-20843	*Carapa* sp., terminus	−22.9	475 ± 27	**AD 1411–1451 (95.4%)**
	16	Duho (high-back)	Cave, Blue Hills Settlement, Providenciales	National Museum of Natural History, Washington, USA; A030052	OxA-21894	*Guaiacum* sp., terminus (sapwood)	−25.9	464 ± 26	**AD 1413–1455 (95.4%)**
	17	Duho (high-back)	Caicos islands?	Turks and Caicos National Museum, TCI; 2003.30.1	OxA-18449	*Cordia* sp., terminus	−28.9	395 ± 25	**AD 1440–1522 (79.4%);** AD 1578–1581 (0.4%); AD 1591–1620 (15.6%)
Cuba	18	Staff/baton	Lake, Malpoton, Remates de Guane, Pinar del Rio	National Museum of the American Indian, Washington, USA; 092389	OxA-19117	*Caesalpinia sp. cf. vesicaria*, terminus	−25.0	1686 ± 24	AD 259–295 (13.6%); **AD 321–418 (81.8%)**
	19.1	Duho (high-back)	Cave ('Cueva Dujo') near Juaco, Baracoa, Guantánamo	National Museum of the American Indian, Washington, USA; 042390	OxA-18799	*Carapa* sp., terminus	−22.8	1316 ± 27	**AD 655–723 (70.8%);** AD 740–771 (24.6%)
	19.2				OxA-19057	*Carapa* sp., pith	−24.6	1371 ± 25	**AD 619–682 (95.4%)**
	20.1	Cemí (zoomorphic)	Cave near Cantillo, Monte Cristo Village, Maisí, Guantánamo	National Museum of the American Indian, Washington, USA; 042389	OxA-19056	*Guaiacum* sp., terminus	−24.6	811 ± 25	**AD 1180–1270 (95.4%)**
	20.2				OxA-19180	*Protium* or *Bursera* sp., resin	−13.7	442 ± 24	**AD 1421–1475 (95.4%)**
	21	Paddle			OxA-19342	*Carapa* sp., terminus	−24.3	545 ± 26	

			Cave near Cantillo, Maisí Guantánamo	National Museum of the American Indian, Washington, USA; 045645					**AD 1318–1353 (31.5%); AD 1389–1433 (63.9%)**
	22	Platter	Cave near La Patana, Maisí, Guantánamo	National Museum of the American Indian, Washington, USA; 042409	OxA-19058	*Guaiacum* sp., terminus	−22.5	484 ± 24	**AD 1412–1447 (95.4%)**
Dominican Republic	23.1	Cemí	'Loma de Polo' (Loma Pie de Polo?], near Barahona,	National Museum of the American Indian, Washington, USA; 058307	OxA-19060	*Guaiacum* sp., terminus	−23.6	936 ± 24	**AD 1031–1157 (95.4%)**
	23.2				OxA-19181	*Protium* or *Bursera* sp., resin	−13.7	722 ± 24	**AD 1255–1299 (94.0%);** AD 1370–1380 (1.4%)
	24	Duho (high-back)	'Santo Domingo'	National Museum of the American Indian, Washington, USA; 142434	OxA-19119	*Guaiacum* sp., terminus	−23.9	652 ± 24	**AD 1282–1320 (43.6%); AD 1350–1392 (51.8%)**
	25.1	Duho (extended)	Cave, DR	St Louis Art Museum, St Louis, USA; 168.1981	OxA-20840	*Guaiacum* sp., terminus (sapwood)	−26.0	596 ± 26	**AD 1298–1370 (70.9%);** AD 1380–1410 (24.5%)
	25.2				OxA-20841	*Protium* or *Bursera* sp., resin	−13.3	543 ± 25	AD 1319–1351 (28%); **AD 1390–1433 (67.4%)**
Haiti	26	Drum?	Cave, Isle de La Gonave	National Museum of the American Indian, Washington, USA; 198808	OxA-19171	*Guaiacum* sp., terminus	−24.6	1139 ± 27	AD 782–789 (1.5%); AD 810–848 (8.2%); **AD 856–982 (85.6%)**
	27.1	Reliquary[d]	Cave, Isle de La Gonave	National Museum of the American Indian, Washington, USA; 198807	OxA-19169	*Guaiacum* sp., terminus	−25.0	617 ± 29	**AD 1294–1400 (95.4%)**
	27.2				OxA-19170	*Protium* or *Bursera* sp., resin	−12.9	150 ± 25	AD 1667–1707 (16.3%); AD 1719–1783 (33.7%); AD 1796–1826 (11.5%); AD 1832–1885 (16.5%); **AD 1913–1950 (17.5%)**
	28	Platter	Cave, Haiti	Peabody Museum of Natural History, New Haven, USA; 237539	OxA-19175	*Guaiacum* sp., terminus	−22.6	547 ± 28	**AD 1315–1356 (35.4%); AD 1388–1434 (60%)**
	29.1	Duho (low-back)	Cave, Haiti	Peabody Museum of Natural History, New Haven, USA; 237501	OxA-19176	*Guaiacum* sp., terminus	−26.4	369 ± 28	**AD 1448–1526 (55.4%); AD 1556–1633 (40%)**
	29.2				OxA-19178	*Guaiacum* sp., pith	−26.7	491 ± 27	**AD 1408–1447 (95.4%)**
Hispaniola (DR/Haiti)	30.1	Cohoba stand[e]	Hispaniola?	Metropolitan Museum of Art, New York, USA; 1979.206.380	OxA-20626	*Guaiacum* sp., left side, terminus	−25.6	1165 ± 28	**AD 777–900 (75.9%);** AD 917–965 (19.5%)
	30.2				OxA-20627	*Guaiacum* sp., right side, terminus	−25.8	1031 ± 27	AD 902–916 (2.9%); **AD 968–1035 (92.5%)**
	30.3				OxA-20675	*Guaiacum* sp., pith	−25.9	1107 ± 26	**AD 886–993 (95.4%)**
	30.4				OxA-20676	*Guaiacum* sp., pith	−25.6	1144 ± 27	AD 781–790 (2.4%); **AD 808–977 (93%)**
	30.5				OxA-21855	*Guaiacum* sp., left side, terminus	−24.8	1093 ± 24	**AD 891–996 (93.7%);** AD 1066–1012 (1.7%)
	31.1	Reliquary[f]	Hispaniola?	Musée Barrois, Bar-le-Duc, France; 850.20.38	OxA-19399	*Guaiacum* sp., growth	−25.6	927 ± 28	**AD 1026–1170 (95.4%)**
	31.2				OxA-19398	*Guaiacum* sp., growth	−24.1	904 ± 28	**AD 1039–1208 (95.4%)**
	32	Cohoba stand	Hispaniola?	Museum of Anthropology and Ethnography, Turin, Italy; n/n	OxA-18457	Wood (ID pending) terminus	−23.2	923 ± 27	**AD 1028–1173 (95.4%)**
	33	Platter	Hispaniola?	Museum of Natural History, Florence, Italy; 308	OxA-18331	Pinaceae, resin	−21.1	383 ± 25	**AD 1445–1523 (69.5%);** AD 1573–1628 (25.9)
Jamaica	34.1	Cohoba stand ('pelican')[g]	Aboukir, Jamaica	National Gallery Jamaica, Kingston, Jamaica; n/n	OxA-23004	*Guaiacum* sp., terminus	−24.2	646 ± 22	**AD 1285–1320 (41%); AD 1350–1392 (54.4%)**
	34.2				OxA-21055	Resin (ID pending)	−13.5	536 ± 24	AD 1322–1348 (18.7%); **AD 1391–1436 (76.7%)**
	34.3				OxA-21054	*Guaiacum* sp., (pith)	−26.5	886 ± 26	AD 1044–1100 (29.5%); **AD 1119–1218 (65.9%)**
	34.4				Beta-153379	*Guaiacum* sp., (growth rate)	−25.2	820 ± 40	AD 1058–1073 (1.7%) **AD 1155–1278 (93.7%)**
	35.1	Cemí	Aboukir, Jamaica	National Gallery Jamaica, Kingston, Jamaica; n/n	OxA-21053	*Protium* or *Bursera* sp., resin	−16.4	634 ± 28	**AD 1286–1330 (39.7%); AD 1339–1397 (55.7%)**
	35.2				Beta-153380	*Swietenia* sp., terminus	−23.8	690 ± 40	**AD 1257–1325 (62.2%) AD 1344–1394 (33.2%)**
	36	Duho (high-back)	Cambridge Hill, Jamaica	Institute of Jamaica, Kingston, Jamaica; AR 60	OxA-21058	*Guaiacum* sp., terminus	−25.3	615 ± 24	**AD 1295–1400 (95.4%)**

(*continued on next page*)

Table 1 (*continued*)

Island group		Artefact	Provenance	Institution/Donor/ Accession number	OxA	Material	$\delta^{13}C‰$ (VPDB)	^{14}C BP	Calibrated date range
	37	Spoon[h]	Aboukir, Jamaica	National Gallery Jamaica, Kingston, Jamaica; n/n	OxA-21052	*Guaiacum* sp., terminus	−23.7	600 ± 24	**AD 1299–1370 (72.7%)**; AD 1380–1407 (22.7%)
	38.1	Duho (high-back)[i]	Cave, St Catherine's Parish, Jamaica	National Gallery Jamaica, Kingston, Jamaica; n/n	OxA-21056	*Guaiacum* sp., terminus (sapwood)	−23.8	384 ± 24	**AD 1445–1523 (71.7%)**; AD 1574–1625 (23.7%)
	38.2				OxA-21057	*Protium* or *Bursera* sp., resin	−29.4	396 ± 24	**AD 1440–1520 (81%)**; AD 1592–1620 (14.4%)
	38.3				Beta-153378	*Guaiacum* sp., growth rate	−26.0	970 ± 40	**AD 994–1160 (95%)**
	39	Figure	Cedar Valley, St Ann's Parish, Jamaica	National Museum of the American Indian, Washington, USA; 033300	OxA-19055	*Guaiacum* sp., terminus	−24.6	152 ± 24	AD 1666–1706 (16.3%); **AD 1720–1784 (35.9%)**; AD 1796–1819 (10.8%); AD 1832–1882 (14.4%); AD 1915–1951 (18.0%)
Puerto Rico	40	Duho (high-back)	Puerto Rico	American Museum of Natural History, New York, USA; 25/269	OxA-20842	*Guaiacum* sp., terminus	−25.3	815 ± 27	**AD 1174–1268 (95.4%)**
	41	Duho (high-back)	Condado beach (?) or Guayanilla, Puerto Rico	Museum of History, Anthropology and Art, University of Puerto Rico, Rio Piedras, Puerto Rico; 1.2008.1095	OxA-21430	*Guaiacum* sp., terminus	−26.7	811 ± 27	**AD 1176–1270 (95.4%)**
	42	Duho (low-back)	Cave, Trujillo Alto, Puerto Rico	Museum of History, Anthropology and Art, University of Puerto Rico, Rio Piedras, Puerto Rico; 1.2008.1096	OxA-21429	*Guaiacum* sp., terminus	−25.8	646 ± 27	**AD 1282–1325 (42.2%); AD 1344–1394 (53.2%)**
	43	Vessel[j]	Quebradillas, Puerto Rico	Museum of History, Anthropology and Art, University of Puerto Rico, Rio Piedras, Puerto Rico; 1.2008.0671	OxA-21431	*Guaiacum* sp., terminus	−26.0	605 ± 28	**AD 1297–1406 (95.4%)**
	44	Duho (high-back)	Cave, Jobo, Puerto Rico	National Museum of the American Indian, Washington, USA; 004687	OxA-19052	*Guaiacum* sp., terminus	−24.8	585 ± 26	**AD 1302–1367 (66.5%); AD 1382–1414 (28.9%)**
	45	Duho (high-back)	El Semil, Villalba, Puerto Rico	Tibes Indigenous Ceremonial Center, Ponce, Puerto Rico; T-193	OxA-21432	*Guaiacum* sp., terminus	−25.8	567 ± 27	**AD 1307–1363 (55.1%); AD 1385–1423 (40.3%)**
	46	Duho (high-back)	Cave, Maracayo, Puerto Rico	National Museum of the American Indian, Washington, USA; 140491	OxA-19118	*Guaiacum* sp., terminus	−25.4	479 ± 24	**AD 1413–1448 (95.4%)**
	47	Duho (low-back)	Cave, Trujillo Alto, Puerto Rico	Museum of History, Anthropology and Art, University of Puerto Rico, Rio Piedras, Puerto Rico; 1.2008.1329	OxA-21428	*Guaiacum* sp., terminus (sapwood)	−26.4	459 ± 26	**AD 1415–1461 (95.4%)**
	48	Cord	Ostiones Point, Puerto Rico	American Museum of Natural History, New York, USA; 1916-54; CRBA/0001	OxA-21433	vegetable fibre	−23.9	46 ± 26	**AD 1695–1728 (20.1%); AD 1812–1854 (17.1%); AD 1868–1919 (58.2%)**
	49	Snake sculpture	Maracayo, Puerto Rico	National Museum of the American Indian, Washington, USA; 145110	OxA-19120	*Clusia* sp., terminus	−14.9	96 ± 23	AD 1690–1730 (26.1%); **AD 1810–1926 (69.3%)**
	50	Duho[k]	South or west coast, Puerto Rico	Museum of History, Anthropology and Art, University of Puerto Rico, Rio Piedras, Puerto Rico; 1.2008.1094	P-25873	*Guaiacum* sp., terminus	/	/	Failed due to no yield
Lesser Antilles	51	Bench	Pitch Lake, Trinidad	Peabody Museum of Natural History, New Haven, USA; 145145	OxA-19174	*Andira* sp., terminus	−25.1	1538 ± 29	**AD 431–592 (95.4%)**
	52.1	Snuff tube[l]	Cave, Battowia, St Vincent and the Grenedines	National Museum of Natural History, Washington, USA; A034542	OxA-X-2345-50	*Guaiacum* sp., terminus	−25.0	775 ± 50	**AD 1159–1295 (95.4%)**
	52.2				OxA-21893	Resin (tbc)	−27.6	862 ± 28	AD 1050–1083 (9.9%); AD 1124–1137 (2.4%); **AD 1151–1254 (83%)**
	53	Duho (high-back)	Cave, Dominica		OxA-17917	*Guaiacum* sp., terminus	−23.9	556 ± 25	

				Kew Economic Botany Collection, London, UK; ECB40669					**AD 1315–1356 (43.5%); AD 1388–1427 (51.9%)**
Unproven.	54	Vomiting spatula	Unknown	SCVA, University of East Anglia, Norwich, UK; UEA 1090	OxA-21059	wood, unidentified[m]	−14.0	825 ± 25	**AD 1169–1262 (95.4%)**
	55	Duho (low-back)	Unknown	SCVA, University of East Anglia, Norwich, UK; UEA 1045	OxA-21060	*Guaiacum* sp., terminus	−22.9	556 ± 25	**AD 1315–1356 (43.5%); AD 1388–1427 (51.9%)**
	56.1	Duho (low-back)	Unknown	American Museum of Natural History, New York, USA; 25.0/3812	OxA-20844	*Guaiacum* sp., terminus	−24.4	356 ± 27	**AD 1453–1529 (45.9%); AD 1542–1635 (49.5%)**
	56.2				OxA-20845	*Guaiacum* sp., pith	−24.3	657 ± 27	**AD 1280–1320 (45.9%); AD 1350–1392 (49.5%)**

[a] All Cartwright duhos underwent conservation in 1988, which included a treatment of 40% lanolin, 7% potassium lactate, 0.25% paranitrophenol and 6% Neatsfoot oil.

[b] Shellac was identified through GC/MS on the surface samples from the Manchester duho, and may have affected the date, skewing it slightly later.

[c] The 'Grand Turk' provenance listed in the museum documents, is likely the reference to the original collector's residence (pre-Lady Blake, who donated it to the museum), rather than the find spot of the duho.

[d] Conservation treatment may have affected the resin date of the reliquary, which falls significantly after AD 1550 – the date marking the effective collapse of Taíno culture.

[e] The modelled dates for the MMA stand are *AD 975-1017*, based on the *Guaiacum* sp., growth rate model developed by colleagues at the Research Laboratory for Archaeology and the History of Art, University of Oxford (Brock et al., in press).

[f] The modelled dates for the Musée Barrois reliquary are *AD 1054-1181*, based on the *Guaiacum* sp., growth rate model developed by colleagues at the Research Laboratory for Archaeology and the History of Art, University of Oxford (Brock et al., in press; Ostapkowicz et al., 2011a).

[g] Beeswax and castor oil were identified by GC/MS in the surface samples from the Aboukir pelican cohoba stand.

[h] Paraffin and shellac were identified by GC/MS as part of the surface samples from the Aboukir spoon – the former on the wood, the latter on the resin.

[i] Beeswax and castor oil were identified by GC/MS on the surface samples from the St Catherine's duho.

[j] Paraffin was identified by GC/MS in the surface samples from the Quebradillas vessel.

[k] Paraffin and beeswax were identified by GC/MS, and the sample completely dissolved in the base wash (sodium hydroxide), suggesting that the wood was badly degraded.

[l] The wood and resin dates from the Battowia turtle snuff tube can be combined to AD 1160–1258 ($\chi^2 = df = 1, T = 2.3$ (5% 3.8)).

[m] The vomiting spatula, which had a repaired break midway through the object, was deemed too fragile for further sampling for material identification (Calvin Winner, pers com. 2011). However, the $\delta^{13}C$ value associated with the dating process identifies it as a C4 plant - all trees, and all the other pieces in the study, are by contrast C3 plants: in this sense, it is unique.

methanol (45 °C) and chloroform (room temperature) to remove any potential conservation contaminants. This was also applied as a precaution to remove oils, waxes and resins from within the wood itself that have sometimes been shown to be mobile across the bole. Radiocarbon effects from these materials are rarely documented in the literature, however, and we suspect are unlikely to make a significant contribution to any age anomalies. This is the routine solvent extraction sequence for samples treated at ORAU (Brock et al., 2010), and has been shown to effectively remove paraffin, beeswax, lanolin and Neatsfoot Oil (Dee et al., 2011). Shellac is soluble in alcohol and sodium hydroxide, and so should also have been removed by the pre-treatment processes. Castor oil has been removed using a similar solvent extraction sequence involving ethanol and hexane (Rasmussen et al., 2009). The three samples treated with lanolin [5–7] were submitted to a more thorough soxhlet extraction, involving sequential 8 h washes with petroleum ether, hexane, toluene, acetone, methanol and chloroform.

The wood samples were left to air-dry thoroughly before being subjected to a routine acid-base-acid (ABA) consisting of sequential washes with 1 M HCl (80 °C, 20 min), 0.2 M NaOH (80 °C, 20 min) and 1 M HCl (80 °C, 1 h) with thorough rinsing with ultrapure Milli-Q™ water after each step. The samples were then bleached with 5% w/v sodium chlorite solution at pH 3 for up to 30 min at 70 °C before being washed with water and freeze-dried. They were then combusted to CO_2 that was cryogenically distilled and reduced to graphite at 560 °C in the presence of an iron catalyst, as described by Brock et al. (2010) and references therein, prior to AMS dating.

While samples from the pith and sapwood, and the intervening area of growth, have secure context within the selected bole, those taken from the outer edge of the carving lacking sapwood have a degree of uncertainty associated with them, as it is unclear how close their position is to the outermost living layer (ie., bark) of the tree. It is here that wood identification plays a critical role: extremely dense woods like *Guaiacum* sp. – which was used in three quarters of the sculptures in this study – are very difficult to carve, even with modern (metal/mechanical) woodworking tools (Ostapkowicz, 1998). Given the limitations of shell and stone tools, this wood was likely best worked when it is freshly felled. Tool marks still evident in many of the sculptures suggest that they were carved when they retained a high moisture content – ie., shortly after felling (see Sands, 1997:54). Given the natural density of the wood, it seems probable that carvers selected the material with an eye to the carving's finished form, where much of the bole was retained and conservatively reduced to save labour (not only in cutting away extraneous material but also in re-sharpening tools). Further, the mature sapwood of modern *Guaiacum* sp., is classified as 'narrow' (Little and Wadsworth, 1964:212; Record and Hess, 1943:556), with estimates ranging to a maximum ca. 40 mm thick for *Guaiacum officinale* and marginally wider for *G. sanctum* (Brush, 1938:8; Rendle, 1969:104) – with the caveat that sapwood width is rarely consistent, depending on the physiology of the individual tree. Assuming that the artisans did not cut deeply into the heartwood in carvings not featuring sapwood, the age of the carving's outermost edge is quite probably within the error range of the radiocarbon determination (ca. +/− 25 years on average). As a point of comparison, this is roughly the same standard range – 10–55 years at 95% confidence – that dendrochronologists use for archaeological British oak lacking sapwood (Hillam et al., 1987; Miles, 1997).

Dendrochronology is not possible with tropical hardwoods such as *Guaiacum*, as they do not feature seasonally distinct growth rings, and their growth rates remain poorly known (but see López-Toledo et al., 2008, 2009). *Guaiacum* is often assumed to be a very slow-growing wood (see discussion in Brock et al., in press), and as

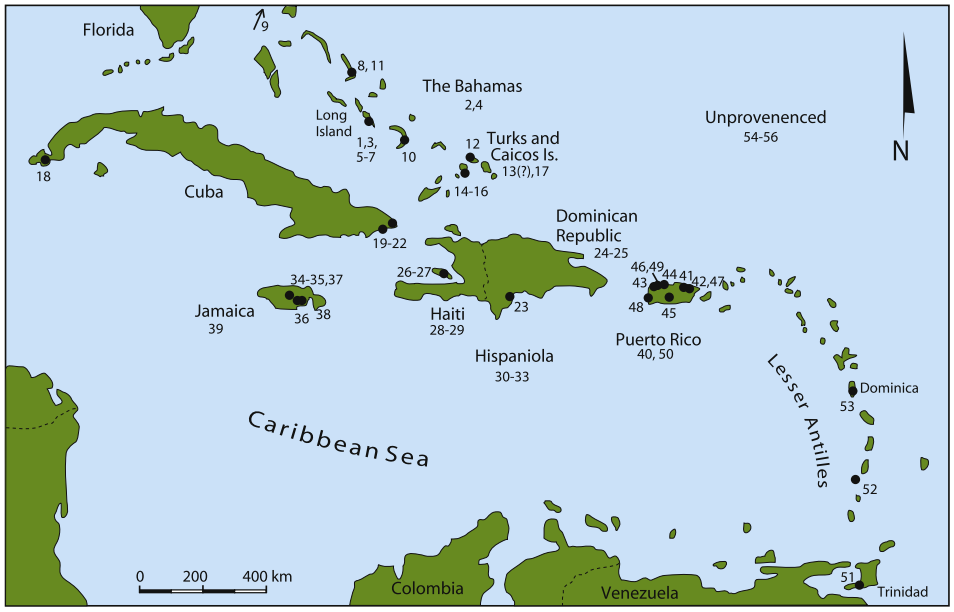

Fig. 1. Map of Caribbean showing distribution of artefacts (numbers linked to artefacts in Tables 1 and 2).

this could have significant impact on radiocarbon dating, the issue was explored by Bayesian modelling pieces with multiple AMS dates (e.g., samples from the pith and outer edge of a carving). The results from 11 *Guaiacum* carvings were incorporated into a self-consistent model for the growth rate, indicating a period of 6–13 years for 10 mm of radial growth (ibid.). This is consistent with the estimates of López-Toledo et al. (2008), which are equivalent to a period of 8–14 years for 10 mm radial growth for smaller trees or 10–13 years for larger trees (diameters of >60 cm). This model also allows us to refine the calibrated ranges for carvings with multiple dates, such as the MMA cohoba stand [30], which can be constrained to *AD 975–1017* after modelling (date ranges resulting from Bayesian models are presented in italics).

Resins are excellent materials for dating as they are generated by the metabolically active elements of the tree, and would likely be used fresh. Nine of the 56 artefacts yielded resins [20; 23; 25; 27; 33–35; 38, 52], all of which have been analysed by GC/MS, alongside reference samples from *G. officinale*, *Dacryodes excelsa* Vahl (tabonuco), and *Clusia rosea* Jacq. (cupey) – the resins of the latter two particularly well-known in the early ethnographic literature. Our procedure involved subjecting each sample (1–3 mg) to alkaline hydrolysis by adding 1 ml of hydro-alcoholic KOH and heating at 60 °C for 3 h. Neutral organic components were then extracted with *n*-hexane and, after acidification, the acidic organic components were extracted with diethyl ether. The *n*-hexane and ether fractions were evaporated to dryness under a gentle stream of nitrogen and subjected to trimethylsilylation. This was achieved by mixing the dried aliquots with 20 μl of N,O-Bis(trimethylsilyl) trifluoroacetamide (BSTFA) (at 60 °C, 30 min), using 150 μl *iso*-octane as the solvent. 2 μl of the solution were analysed by GC–MS (see Colombini et al., 2003).

The results indicate the presence of triterpenoid material in six sculptures [20.2; 23.2; 25.2; 27.2; 35.1; 38.2]: on the basis of specific chemical compounds (lupeol, β-amyrenone, β-amyrin, α-amyrenone and α-amyrin), it was possible to assign a vegetable

Table 2
Artefact categories by quantity and region.

Artefact category	Quantity	Region: artefact number
Duhos and benches	32	Bahamas: 2, 3, 4, 5, 6, 7, 8, 10, 11; Turks and Caicos: 13, 14, 15, 16, 17; Cuba: 19; Dominican Republic: 24, 25; Haiti: 29; Jamaica: 36, 38; Puerto Rico: 40, 41, 42; 44, 45, 46, 47, 50; Lesser Antilles: 51, 53; unknown provenance: 55, 56
Cemí (canopied)/ cohoba stands	3	Hispaniola: 30, 32; Jamaica: 34
Cemí	3	Cuba: 20; Dominican Republic: 23; Jamaica: 35
Cemí/Reliquaries	2	Haiti: 27; Hispaniola: 31
Platters, vessels	5	Bahamas: 1; Cuba: 22; Haiti: 28; Hispaniola: 33; Puerto Rico: 43
Cohoba paraphernalia	3	Jamaica: 37; Lesser Antilles: 52; unknown provenance: 54
Paddles	2	Bahamas: 9; Cuba: 21
Staff/baton	1	Cuba: 18
Historic sculptures	2	Jamaica: 39; Puerto Rico: 49
Drum	1	Haiti: 26
Hafted axe	1	Turks and Caicos: 12
Cord fragment	1	Puerto Rico: 48
Total	56	

Fig. 2. A ^{14}C sample being extracted from the sapwood on the right side of the St Catherine's duho [38.1]. The aim with this technique is to make the sampling site as discreet as possible, essentially indistinguishable from the surrounding surfaces by working within already damaged areas.

origin to the resinous substances, possibly indicating the use of *Protium* or *Bursera* sp. The presence of diterpenoid acids (didehydroabietic, dehydroabietic and 7-oxo-dehydroabietic acids) in the Hispaniolan platter [33] indicated the use of a resin extracted from Pinaceae. The materials from two sculptures [34.2; 52.2] are still under investigation.

The resin dating results offer a good indication of when the carvings were finished with inlays or renewed after a considerable period of use (it is possible that resin glues – depending on their composition – would dry out and need periodic replacing). However, resins are difficult to prepare and treat for dating as they are soluble in many of the chemical solvents that are routinely used in radiocarbon pre-treatment. Instead, where they remain in good condition, the outer surface can be removed, so that only the inner material is submitted for dating, and combusted to CO_2 as described above. This was our approach in objects where conservation treatments were suspected, such as with the turtle snuff tube from Battowia [52] (Ostapkowicz et al., 2011b).

3. Results

From the 56 artefacts here discussed, 73 samples were extracted and submitted for radiocarbon dating, with 72 yielding results (Table 1). A single sample, from a Puerto Rican duho [50], failed, completely dissolving in the base wash (sodium hydroxide) during pre-treatment, suggesting that the wood was badly degraded. All results were calibrated at two standard deviations using IntCal09 and OxCal v4.1.7 (Bronk Ramsey, 2009) – and throughout the following discussions the dates are presented at 95.4% confidence, unless otherwise noted.

The 72 determinations, ranging in age from AD 259–418 to AD 1695–1919, are here grouped within four distinct periods to facilitate discussion: early (AD 250–800), middle (AD 800–1300), late (AD 1300–1650) and colonial to modern (post-AD 1650). There is a small degree of overlap in the transition between the middle and late phases, especially between AD 1280–1300: a number of artefacts start from ca. AD 1280, but as the majority of their ranges fell post-AD 1300, they were included in the late phase.

Three artefacts fall within the early period, AD 250–800 (Fig. 3), with the two earliest provenanced to opposite ends of the Caribbean archipelago: a staff/baton from western Cuba (AD 259–418) [18] and a zoomorphic low-backed bench from southern Trinidad (AD 431–592) [51]. Together with the earliest high-backed duho (AD 665–771) [19] from Cuba's southeastern coast, these mark the precursors to the status objects documented among the Taíno after 1492. Contamination issues may be mitigating factors with these results: for example, pitch residues may have been deeply absorbed into the Trinidad bench, which was recovered from one of the world's largest natural asphalt deposits (Pitch Lake). Large patches of pitch still adhere to certain areas of the bench's surface, a sample of which was radiocarbon dated with a result close to background (41,300 ± 800; OxA-X-2391). Although the wood sample - taken from an area free of visible pitch adhesions – was solvent washed prior to dating, the presence of any residual pitch may have skewed the date of the bench slightly older than it should be (possibly in the region of <0.2%, or <20 ^{14}C years) (Ostapkowicz et al., 2011b). This would still place the bench within the late Cedrosan Saladoid period (AD 300/400–600/800), a period to which it had previously been attributed (Boomert and O'Brien Harris, 1984:38–39). With regard to the Cuban duho [19], its deteriorated condition and the possibility of fungal decay calls for caution, although the dates from the pith and outer wood have good overlap and there is no particular reason to discount them. In addition, any recent chemical treatments would skew the dates later rather than earlier. Accepting these early dates for the Cuban duho would place it within Rouse's Arroyo del Palo period (AD 500–800) in eastern Cuba, preceeding the Taíno settlement of the area by several centuries (from ca. 1350) (Rouse, 1992:52–53). Although all three artefacts are thus outside of the Taíno cultural sphere/period, it is clear that there is a chronological depth and a possible syncretism to certain circum-Caribbean artefacts that later emerged as diagnostic Taíno objects.

Fig. 3. Early (AD 250–800) sculptures. Left: Terminal end of ceremonial staff/baton, *Caesalpinia sp. cf. vesicaria*, AD 259–418, Remates de Guane, Pinar del Rio, Cuba [18]. L: 575 mm; W: 188 mm (max, with partial reconstruction). Courtesy, National Museum of the American Indian, Smithsonian Institution, Washington (092389). Upper right: zoomorphic bench, *Andira* sp., red pigment (?), AD 431–592, Pitch Lake, Trinidad [51]. L: 572 mm; W: 272 mm (max), H: 200 mm (max). Courtesy, Peabody Museum of Natural History, New Haven (ANT. 145145). Lower right: duho, *Carapa* sp., AD 655–771, found in cave close to Juaco, Baracoa, Guantanamo, Cuba [19]. L: 740 mm; W; 107 mm (max); H: 113 (max). Courtesy, National Museum of the American Indian, Smithsonian Institution, Washington (042390). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Thirteen artefacts are placed within the middle period (AD 800–1300), including some of the most accomplished and complex sculptures in the study – from a Hispaniolan cohoba stand (*AD 975–1017*) [30] to a duho from the Turks and Caicos Islands (AD 1044–1215) [13] (Fig. 4). This period is also marked by elaborate examples of cohoba related materials – as seen in the vomiting spatula [54], snuff tube [52] and stands [30; 32] – as well as other high status objects such as duhos [40, 41] and a reliquary [31], provenanced to Hispaniola, Puerto Rico and the Turks and Caicos. The difference between wood and resin determinations seen in some of the carvings suggest that select pieces may have been curated over a significant period of time, having their resin inlay renewed periodically (see Discussion).

The majority of the pieces, 36 in total, fall within the late period (AD 1300–1650), with examples from across the archipelago (Fig. 5). Twenty-seven duhos dominate this phase – both high- and low-backs in the full range of styles (zoomorphic, anthropomorphic and non-representational). The remaining artefacts reflect a variety of utilitarian and ritual objects – from paddles [9; 21] to elaborate vessels [22, 28, 33, 43] to a range of cohoba paraphernalia [34, 37]. Although ten date ranges for the group extend to AD 1634 at 95.4% probability, the greatest likelihood is that the majority date before AD 1530 (e.g., a Bahamian duho [7] has a 93% probability of dating to AD 1430–1491, and only a 2% probability of dating to AD 1602–1610; see Table 1 for details). Only three pieces fall within the calibration curve in such a way as to have an almost equal likelihood of dating before or after ca. AD 1530 [29, 38, 56], although the earlier part of the distribution is the more likely given an almost complete indigenous cultural dissolution within a few decades of

Fig. 4. Middle phase (AD 800–1300) cohoba stands and duho shown roughly to scale. Left: Cohoba stand, *Guaiacum* sp., shell, *AD 975–1017* (modelled dates), Dominican Republic/Haiti (?) [30]. H: 665 mm; W: 220 mm (max); D: 230 mm. The Metropolitan Museum of Art, The Michael C. Rockefeller Memorial Collection, Bequest of Nelson A. Rockefeller, (1979.206.380). Centre: Cohoba stand, wood [ID pending], AD 1028–1173, Dominican Republic/Haiti (?) [32]. H: 325 mm; W: 133 mm (max); D: 119 mm. Courtesy, Museum of Anthropology and Ethnography, Turin (no accession number). Right: Duho, *Guaiacum* sp., AD 1044–1215, Turks and Caicos islands (?) [13]. L: 855 mm; W: 158 (max), H: 203 (max). Courtesy, National Museum of the American Indian, Smithsonian Institution, Washington (059385).

European contact (Wilson, 2007:158–161).[3] In addition, there is no evidence for the inclusion of European items in these carvings, as featured in some other post-contact pieces (e.g., the cotton cemí in Rome's Pigorini Museum – Brecht et al., 1997:Fig. 127).

The final three artefacts post-date AD 1650, and are examples of local production post-Taíno collapse (Fig. 6). The date for the Jamaican anthropomorphic carving [39] ranges from AD 1666–1951 (95.4%), of which the greatest probability is AD 1720–1784 (35.9%): it may well be an example of the 18th century Afro-Jamaican grave markers described by Rev. Phillipo (in Boxer, 2008:52). A vegetable fibre cord [48] found in association with archaeological material from Ostiones Point, Puerto Rico yielded a wide range of dates between AD 1695–1919, with the greatest likelihood falling within AD 1868–1919 (58.2%) – roughly when the site was being excavated, and so suggestive of a 19th century intrusion. The coiled snake from Maracayo, Puerto Rico [49], previously included in Taíno art catalogues (e.g., Brecht et al., 1997:125) but atypical of the stylised conventions of 'Taíno' iconography, proved to be modern (AD 1810–1926, 69.3%). It may be an example of *campesino* sculpture, or perhaps a piece made specifically for sale for the growing tourist and/or antiquarian market that was emerging in Puerto Rico after the mid-19th century.

4. Discussion

There is broad consensus that the development of complex, stratified societies in the Caribbean emerged from about AD 600

[3] While elements of Taíno culture (and certainly genetics) may have persisted for far longer (e.g., Vega, 2007), these are unlikely to have included the elite objects that required an intact indigenous socio-political system for their meaning and relevance.

Fig. 5. Late phase (AD 1300–1650) duho and platters, shown roughly to scale. Left: Ceremonial platter, *Guaiacum* sp., AD 1412–1447, found in a cave near La Patana, Cuba [22]. L: 390 mm; W: 187 mm; H: 38 mm (max). Courtesy, National Museum of the American Indian, Smithsonian Institution, Washington (042409). Center: Duho, *Guaiacum* sp., AD. 1415–1461, found in a cave near Trujillo Alto, Puerto Rico [47]. L: 357 mm; W: 175 mm; H: 118 (max). Courtesy of the Museum of History, Anthropology and Art, University of Puerto Rico, Rio Piedras, Puerto Rico (1.2008.1329). Right: Ceremonial platter, *Guaiacum* sp., AD 1445–1523 (69.5% probability), Dominican Republic/Haiti (?) [33]. L: 506 mm; W: 222 mm (max); H: 63 mm. Courtesy, Museum of Natural History, Section of Anthropology and Ethnology, Florence, Italy (308).

(Oliver, 2009:25; Petersen et al., 2004:17). This was a critical time in the region, with population expansion and large-scale settlements, complete with ceremonial plazas and ball courts on some of the larger islands, as well as the colonisation of the Bahamas/Turks and Caicos Islands, Cuba and Jamaica. The corpus suggests that wood carving was an important component during this period: objects

Fig. 6. Two historic (AD 1650–1950) artefacts, shown roughly to scale. Left and centre: Two views of anthropomorphic figure, St. Ann's Parish, Jamaica [39], *Guaiacum* sp., AD 1666–1951 (95.4%; within this range, the most likely date is AD 1720–1784 – 35.9%). L: 770 mm; W: 135 mm. Courtesy, National Museum of the American Indian, Smithsonian Institution, Washington (033300). Right: Snake carving, Maracayo, Puerto Rico [49], *Clusia* sp., AD 1810–1926 (69.3% probability). L: 550 mm; W: 500 mm; H: 178 (max). Courtesy, National Museum of the American Indian, Smithsonian Institution, Washington (145110).

that were associated with high status at the time of European contact – such as ceremonial seats – were present in the Greater Antilles by AD 600, if not earlier, and complex cohoba paraphernalia was in evidence by AD 1000, as were reliquaries – suggesting ancestral veneration had developed into a major artistic expression. The following discussion explores three critical areas that highlight the value of wood carvings within Taíno culture – caching, stylistic chronologies and curation.

4.1. Cached artefacts

Dating objects in grouped cave deposits provides an opportunity to explore whether they were placed in the cave at the same time. There are ten such artefacts: three carvings from Aboukir, Jamaica [34–35, 37] (Aarons, 1994; Saunders and Gray, 1996), five carvings, in two separate groups, from Mortimer's, Long Island, Bahamas [1, 3, 5–7] (Aarons, 1989; Granberry, 1955), and two from Trujillo Alto, Puerto Rico [42, 47] (Hostos, 1941). A further example – from Cambridge Hill, Jamaica [36] – provides the first date for the eponymous cave site where it was found, and where the remains of reportedly some 40 individuals were recovered during C.B. Lewis' excavations in 1946 (Allsworth-Jones, 2008:125). Although it is unclear whether there was any association between the burials and the duho, this is one of only a handful of Greater Antillean sites to yield both, and as such is of significance given the cronista accounts of duhos being interred with burials (Oviedo, 1992:I:119).

The first group, from a series of caves at Mortimer's, Long Island, consists of a duho and platter, although it is unclear whether the objects were found directly associated or in separate areas of the same large cave. The platter (AD 1019–1155) [1] is at least a century earlier than the duho (AD 1285–1396) [3]. This could suggest two periods of deposition or, alternatively, that the platter may have been curated for a considerable time before being deposited in the cave with the duho. It is equally likely that the duho itself had some years of use before it was finally placed in the cave – so the later part of the 14th century should be viewed as the *terminus post quem* for its deposition.

The three duhos from another cave at Mortimer's, form the largest duho group recovered *in situ* (Aarons et al., 1988) [5–7]. Their date ranges, while broadly similar (and overlapping in the period AD 1419–1438), fail the Ward and Wilson (1978) test (χ^2, df = 2, T = 101.6 (5%, 6.0)). The duho carved in the form of a dog is the outlier of the group [5], with a slightly earlier date of AD 1329–1439. While this suggests that the three duhos were not made at the same time, they may still have shared histories, and may have been deposited together as a group, as suggested by their close association in the small cave (Aarons et al., 1988). As with the platter discussed above, the dog duho may have been curated for some time before being deposited with the two other duhos at some point after the mid-15th century – if we accept that they formed a coherent group.

A slightly different scenario is suggested by three Jamaican Aboukir carvings [34–35, 37]. Although there is some overlap between the five terminus dates for this group (both wood and resin), they fail to combine (χ^2, df = 4, T = 17.0 (5%, 9.5)) (Fig. 7). The clear outlier is the resin date from the Pelican cohoba stand (AD 1391–1436, 76.7%), suggesting that the inlays may have been renewed after some use. The wood dates, in contrast, overlap between AD 1292–1392 (95.4%; χ^2, df = 3, T = 4.3 (5%, 7.8)) and are consistent with the proposition that the pieces were made as a set, or at least brought together within a short span of time. Even if the date of the spoon [37] is affected by paraffin contamination (subsequently found on its surface) making it slightly older, it is still likely to overlap with the other pieces.

The final group, from Trujillo Alto, Puerto Rico, consists of two stylistically different low-backed duhos: one bears elaborate two-dimensional designs on its terminal ends (Fig. 5, centre) [47] and the other is carved in the form of a reclining man [42]. Each represents a subcategory of low-backed duho (Ostapkowicz, 1998:136), other examples of which have been found in both Puerto Rico and Hispaniola. Although both fall within the late period (AD 1300–1650), one predates the other by a minimum of several decades to a maximum of nearly 180 years. Again, accepting their contemporary deposition, it could be suggested that the older duho was curated for some time before being placed in the cave with the younger duho, which itself shows some wear. Hence, both were likely used for several generations prior to their deposition.

4.2. Duho chronologies and styles

The corpus of 32 seats enable a finer-grained assessment of this category of artefact. The study has highlighted their presence in the Caribbean earlier than previously expected, and provides insights into stylistic developments in the insular Caribbean. Although an object strongly associated with the Taíno, it is not the Taíno heartland – Hispaniola or Puerto Rico – that has yielded the earliest seats in the Caribbean, but rather Trinidad, Cuba and the Turks and Caicos. The earliest surviving wooden duhos from Puerto Rico and Dominican Republic – both high- and low-backs – fall predominantly after AD 1200 [40–42; 24], confirming that both were contemporaneous through the following centuries. This indicates that their divergent styles reflected specific design choices made by artisans or perhaps were dictated by the specific

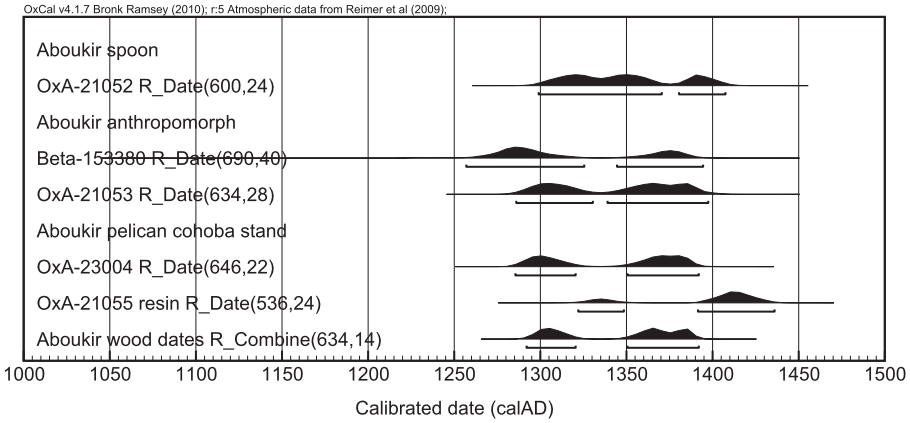

Fig. 7. Summary plot of the dates for the Aboukir artefact cluster, with a combined range at bottom, suggesting that while the wood dates for all three artefacts overlap well, the resin date for the Pelican cohoba stand (OxA-21055) is the slight outlier, and may indicate a later renewal of the inlays, with the highest probability ca. AD 1391–1436 (76.7%).

contexts in which they were used, or the status of the individuals for whom they were carved. Equally, they could be the unique stylistic conventions of different regions – and peoples – subsumed within the Taíno 'supra-cultural entity' (Rodríguez Ramos, 2010:200–201). The forthcoming stable isotope results may help distinguish between these possibilities.

Given that stools are a ubiquitous category of material culture among many lowland South American groups, both archaeologically and ethnographically (Marcos and de Manrique, 1988:43; McEwan, 2001:179; Zerries, 1970; Saville, 1910), it is reasonable to suggest that the ancestors of the Taíno, migrating from the mainland into the Greater Antilles by 500 BC and intermingling with the local populations there (who may have had their own versions), carried with them stool prototypes – perhaps physically, but more importantly as mental templates – that would eventually develop into the Greater Antillean duho. The bench from Trinidad (AD 431–592) [51] may be an example of an early style – or at least an example that helps us explore this possibility: assuming that the date is broadly correct (Ostapkowicz et al., 2011b), it falls towards the end of the Saladoid period, a time of considerable South American influence on Trinidad and the Caribbean as a whole (Hofman and Hoogland, 2004:49; Allaire, 1997:23; Boomert, 2003:153). In its scale and style it echoes South American benches, suggesting that such styles may have been possible antecedents to those that would later emerge in the Greater Antilles. It may have been preceded by centuries of other examples taken as heirlooms – or remembered templates – on journeys across the island chains, and was likely followed by many others – all of which cumulatively refined the design of the small chair to one that would eventually emerge as the Taíno cacical duho.

If the Trinidad bench provides insight into the styles of low-backed stools that were present in the Lesser Antilles post-AD 430, then the earliest duho from Cuba [19], dating to AD 655–771, indicates the use of high-backs in the Greater Antilles. Thus, both low- and high-backs chair styles appear much earlier than expected: prior to this study, the duho was thought to be restricted to the Chican Ostionoid period (post-AD 1200), as it was considered a key accoutrement of Taíno caciques, reflecting the emergence of complex chiefdoms during this late period (Curet, 1996:126). The dates in this study suggest that the stool has greater chronological depth in the Caribbean, perhaps equal to other artefacts that would later emerge as diagnostic 'Taíno' artefacts – such as trigoliths, which appear in the Antilles by 200 BC (Walker, 1993:44).

By ~ AD 1050, the characteristics that have come to be associated with the 'classic' duho category (ie., post-AD 1200) had emerged: high-backed, anthropo/zoomorphic features and complex, two-dimensional art. The earliest piece that showcases these elements – dating to AD 1044–1215 – is reportedly from the Turks and Caicos [13]. Although indigenous exploration of these islands began, conservatively, ca. AD 700 – mainly by peoples from Hispaniola – permanent settlements were only established by about AD 1000–1100, when a uniquely Lucayan material culture began to emerge (Keegan, 2007:182). If the duho is indeed from the Turks and Caicos Islands, the date would suggest that although the Lucayans may have based their duhos on the high-backed styles they knew from Hispaniola, within a short span of time they had transformed them into something uniquely their own. This duho not only features among the most accomplished two-dimensional carving in the entire Caribbean region, but heralds the stylistic conventions that were to dominate Lucayan duhos over the next 300–500 years: a low extending tail, large size and fleshy features (Ostapkowicz, 2008). The speed with which this uniquely Lucayan duho style emerged, and its elaborate nature, hints at the importance of duhos early on in the settlement of the islands.

Some insight into the possible reasons for this importance is given by three duhos of a slightly later date – ca. AD 1400–1450 [14–16] – all provenanced to the Blue Hills Settlement on Providenciales, TCI, close to the site of P-1. This site appears to have been an important trade centre, especially with communities in western Hispaniola, whence much of its Meillacan-style ceramics are thought to have derived (Sullivan, 1981:332). Economic prosperity and links to cacicazgos in the south likely spurred increasing social hierarchy and differentiation, and it is here that elite accoutrements – duhos among them – may have came to reinforce rank and position. They could have served to cement links between distant trade partners: the Lucayan hospitality of honouring guests – especially when important economic transactions were being negotiated – may well have involved inviting them to sit on duhos, as was the practice in the south. The use of duhos was something that these regional partners had in common, and understood in terms of value – hence they functioned to reconfirm mores of status and hospitality, while at the same time proffering the correct protocols during important negotiations.

In Jamaica, the dating of the Cambridge Hill duho (AD 1295–1400) [36] confirms the presence of ceremonial seats on the island by at least ca. AD 1300. The duho's very small size suggests that it may have been intended as a miniature, which also implies that larger examples were present as models in a variety of styles. The latter is confirmed by the much larger St Catherine duho, which dates slightly later to AD 1440–1523 [38] (resin, 81% probability; wood, 71.7%). It is stylistically different to the miniature, featuring an anthropomorphic head at the top of the backrest, large projecting front feet with protruding ankle bones and skeletal imagery – characteristics shared with only six other duhos from the entire Caribbean (Ostapkowicz, 1998). The majority of these anthropomorphic duhos appear to come from the Dominican Republic, which may have been the centre for this particular style (Ostapkowicz et al., 2011b). If so, this raises interesting questions about the origin of the duho (whether local or an import), and possible contacts between Jamaica and the Dominican Republic – something currently being explored via stable isotope analysis.

Perhaps the most unusual duho style features a reclining anthropomorphic body with the head supported by tightly flexed arms, naturally carved legs, and the chest or back serving as the platform. Only two examples survive: one recovered from the site of Isabella, thirty miles from Puerto Plata and now in the collections of the British Museum and the other tentatively provenanced to the Puerto Plata area and in the collections of the St Louis Museum of Art [25] (Ostapkowicz et al., 2011a). The strong similarities in style and their clear chronological overlap in the 14th century would suggest that the two may have been made by the same artist working on the north coast of the Dominican Republic.

4.3. Curation

Another insight that has emerged through the dating programme is the likelihood that some of the artefacts were curated, something supported by the ethnographic record. The Jeronomite friar and ethnohistorian Ramon Pané, who lived among the Macorix and Taíno/Arawak speakers in northern Hispaniola between 1494 and 1498, remarked that the 'ownership' of a specific cemí ('Corocote') had passed through the hands of three separate custodians (Oliver, 2009; Walker, 1993:158). Given that these were elaborate, carefully made artefacts, imbued with animated forces, it stands to reason that they were safeguarded over potentially lengthy periods of time, being inherited by subsequent generations – or transferred by other means (Pané noted that some were stolen).

Several artefacts that provided both wood and resin dates indicate a lengthy gap between the felling, and likely carving, of the

Fig. 8. Vessel, Quebradillas, Puerto Rico, *Guaiacum* sp., AD 1297–1406, [43]. L: 122; W: 80 mm; H: 70 mm (max). Courtesy of the Museum of History, Anthropology and Art, University of Puerto Rico, San Juan, 1.2008.0671.

tree and the inlay of the resins. The zoomorphic sculpture from Cantillo, Cuba [20], for example, provides a terminus wood date of AD 1180–1270 and a resin date of AD 1421–1475, suggesting that the resin eye inlays were refreshed more than a century after it was first carved. Another example is a cemí from 'Loma de Polo', Barahona region, Dominican Republic [23] (Ostapkowicz et al., 2011a): even factoring the error ranges due to the less than ideal sample site and the sapwood estimates, the gap between the dates (wood: AD 1031–1157; resin: AD 1255–1299 at 94%) suggests, at minimum, a span of 50 years between the harvesting (and likely carving of the wood) and the resin inlay.[4] Both pieces suggest valued heirlooms being periodically refreshed with new inlays over the span of several generations.

Similarly, the substantial pelican cohoba stand from Aboukir, Jamaica [34] provides a wood terminus date of AD 1285–1392, but a resin date of AD 1322–1436. Although there is a degree of overlap, the two dates fail to combine (χ^2, df = 1, T = 11.401 (5%, 3.8)), suggesting that the carving and inlay were separate events spaced over a period of time.

As discussed above, some artefacts suggest curation by association: the Quebradillas vessel [43] was attributed to the early colonial period (AD 1508–1520) due to its association with a group of 52 small, glass beads, which were intermixed with indigenous shell, stone and canine teeth beads (Méndez Bonilla, 2006:26) (Fig. 8). However, the small sample (19.23 mg) extracted from the left side of the bowl, the area furthest from the pith within the carving, returned a date range that is, at minimum, a century earlier: AD 1297–1406. Paraffin contamination – identified through GC/MS analysis – may be a mitigating factor, which would skew the date older, and so caution is necessary in our consideration of the date. However, Dee et al. (2011) demonstrated that the solvent treatment applied to the sample should have been capable of removing the paraffin. A further complication is that the sample site was not within sapwood, and an additional error range of ca. four decades (based on 1 cm = 6–13 years and an average 40 mm sapwood estimate for *Guaiacum* – see above, Brock et al., in press) should be factored in, but the resulting range of ca. AD 1337–1446 is still at least half a century prior to Columbus' first visit to the island (1493), and its first European settlement (1508). This may suggest that there is an element of curation to this fine vessel that spans several decades, if not centuries, but further analysis is required given the possibility of paraffin contamination.

[4] Due to the size of the figure, and it being carved in the round, the most discrete sampling location was <10 mm from the outermost area of the sculpture, which was estimated to be within a few growth rings of the ideal sampling site. Factoring in sapwood (a maximum 40 mm for *G. officinale* – Brush, 1938:8; Rendle, 1969:104) suggests the sampling area was ca. 50 mm from the outermost part of the selected branch. Based on the growth rate model developed specifically for this project, where 1 cm is equivalent to 6–13 years, a maximum error of roughly 50 years should be added to the radiocarbon date.

5. Conclusions

Museum collections hold some of the most celebrated examples of Taíno and Lucayan art, many carved in wood, yet, with little to anchor them in time, this corpus has largely remained on the periphery of Caribbean archaeological studies. The dating programme discussed here, with a methodology specifically targeting the construction date of select examples of Caribbean wood sculpture, and assessing issues of 'in-built' wood age, is beginning to highlight the potential of these pieces to inform on a wide variety of issues – from stylistic changes over time and variability between islands to their inherent value to the people who invested in their creation and curation.

This research has demonstrated that, not surprisingly, wood sculpture has a long history in the Caribbean: from at least AD 400 the inhabitants of the island archipelago were creating a wide variety of material culture that combined function and aesthetics, potentially also underscoring status and power. The earliest seats [51; 19] foreshadow the duhos that were later documented as Taíno elite regalia (Colón, 1992:69) by nearly a millennium. Whether such restricted, elite use stretches back in time is difficult to know, but given the importance of stools in the ancestral heartland (South America) both archaeologically and ethnohistorically, and given the waves of South American (Saladoid) migrants into the Caribbean since 500 BC, there are some grounds to indicate a broad syncretism and an emerging complexity. Duhos in both low and high back styles are present from about AD 600, if not earlier, stretching in distribution across the island chain from Trinidad to Cuba. Their history in certain regions – such as the Turks and Caicos – emerges shortly after the earliest permanent settlements were established (ca. AD 1000), suggesting that their use was likely an inheritance that 'migrated' with initial colonists. Hence, the categories of objects documented by the cronistas in the late 15th to early 16th centuries have a deeper history than previously thought, and their potential use as status markers may have a greater time-depth.

Equally, some iconic sculptures long considered the apogee of late period Taíno artistic fluorescence (post-AD 1200), can now be placed as early as AD 1000. Large compositions featuring elaborate two-dimensional art are clearly well established by this time, as seen in such fine examples as the MMA cohoba stand [30] and the Musée Barrois reliquary [31]. Carved specifically for ritual and mortuary contexts, respectively, the scale of these objects suggests that they had an impact on the wider community, not only reflecting the skills of the artisans who created them, but the affluence of those who otherwise brought them into 'being' – their human trustees who commissioned their material form.

These were investment pieces, not only in terms of being carved in dense, tropical hardwoods, but in their long-term curation: some results suggest that pieces were used over long periods of time – in some cases centuries. These were not ephemeral objects – but may have accrued greater value and importance over a much longer history of use than has previously been acknowledged. This implies a succession of trustees who safeguarded the objects, something supported by the ethnographic record, which mentions the circulation of important, named cemís (Pané, 1999:28; see also Oliver, 2009:74). Some group deposits also suggest that objects with different histories – some longer than others – were placed together [42, 47].

Although there are still outstanding issues (e.g., pitch/paraffin contamination), overall the chronologies presented here enable previously atemporal objects to be re-inserted into the histories of the islands they came from, and into Caribbean culture history more broadly. There is now the potential for expanding the discussion to consider other elements of Taíno material culture that lack chronological contexts, for example the trigoliths, stone collars and shell vomiting spatulas that share stylistic affinities with the wooden sculptures. There is also scope to begin exploring specific regional carving styles, and potentially of identifying the work of specific communities, or perhaps even the hands of individual artists. The results of the dating programme presented here provide a platform upon which to address these and other issues.

Acknowledgements

This work was part of the 'Pre-Hispanic Caribbean Sculptural Arts in Wood' project funded by the Getty Foundation and British Academy, with administrative support by National Museums Liverpool (NML). The authors would like to thank the following museums for their involvement and for permissions to sample: **Caribbean**: Antiquities, Monuments and Museums Corporation, Nassau, Bahamas; Turks and Caicos National Museum, Grand Turk, TCI; National Gallery Jamaica, Kingston, Jamaica; Institute of Jamaica, Kingston, Jamaica; Museum of History, Anthropology and Art, University of Puerto Rico, Rio Piedras, Puerto Rico; Tibes Indigenous Ceremonial Center, Ponce, Puerto Rico; **Europe**: Musée Barrois, Bar-le-Duc, and Musée du Quai Branly, Paris, France; Museum of Anthropology and Ethnography, Turin and Museum of Natural History, Anthropology and Ethnology section, Florence, Italy; **UK**: Kew Economic Botany Collection, London; Sainsbury Centre for the Visual Arts, University of East Anglia, Norwich; Manchester Museum, Manchester, UK; **USA:** American Museum of Natural History, New York; Bryn Mawr College, Pennsylvania; Metropolitan Museum of Art, New York; National Museum of the American Indian and National Museum of Natural History, Washington; Peabody Museum of Natural History, New Haven; Saint John's Abbey, Collegeville, Minnesota; St Louis Art Museum, Missouri. Tracey Seddon and Graham Usher, NML, assisted in the sampling and study of the Manchester and Kew Duhos. Rick Schulting, Lee Newsom and an anonymous reviewer all made insightful comments on an earlier version of this paper.

Unless otherwise noted, all photographs and illustrations by Joanna Ostapkowicz.

References

Aarons, G.A., Outten, K., Turner, G., Cartwright, C., 1988. Report on Long Island Expedition: Cartwright Duho Cave Excavation (LN-37), 22nd–28th September, 1988. Unpublished report on file at the Department of Archives, Nassau, New Providence.

Aarons, G.A., 1989. The Lucayan Duhos: 1828–1988. Journal of the Bahaman Historical Society 11 (1), 3–11.

Aarons, G.A., 1994. The Jamaican Taíno: the Aboukir Zemis: symbols of Taíno philosophy, mysticism and religion. Jamaica Journal 25 (1), 11–17.

Allaire, L., 1997. The Lesser Antilles before Columbus. In: Wilson, S. (Ed.), The Indigenous People of the Caribbean. University of Florida Press, Gainesville, pp. 20–28.

Allsworth-Jones, P., 2008. Pre-Columbian Jamaica. The University of Alabama Press, Tuscaloosa.

Boomert, A., O'Brien Harris, P., 1984. The pitch lake in archaeology. Naturalist 5 (11), 34–47.

Boomert, A., 2003. Agricultural societies in the continental Caribbean. In: Sued-Badillo, J. (Ed.), General History of the Caribbean. Autochthonous Societies, vol. 1. Unesco Publishing, Paris, pp. 134–194.

Boxer, D., 2008. Isaac Mendes Belisario: Art and Emancipation in Jamaica. National Gallery of Jamaica, Kingston.

Brecht, F., Brodsky, E., Farmer, J.A., Taylor, D. (Eds.), 1997. Taíno: Pre-Columbian Art and Culture from the Caribbean. El Museo del Barrio and The Monacelli Press, New York.

Brock, F., Higham, T., Ditchfield, P., Bronk Ramsey, C., 2010. Current pretreatment methods for AMS radiocarbon dating at the Oxford Radiocarbon Accelerator Unit (ORAU). Radiocarbon 52, 103–112.

Brock, F., Ostapkowicz, J., Bronk Ramsey, C., Wiedenhoeft, A., Higham, T., Cartwright, C., in press. Paired dating of pith and other edge (terminus) samples from Pre-Hispanic Caribbean wooden sculptures. Radiocarbon.

Bronk Ramsey, C., 2009. Bayesian analysis of radiocarbon dates. Radiocarbon 51 (1), 337–360.

Brush, W.D., 1938. Lignum vitae (Guauacum species). Foreign Woods, Forest Service. United States Department of Agriculture, Washington.

Calvera Rosés, J., Manuel Rey, E.S., Yudelsy Yparraguirre, Y.P., 1996. El sitio arqueológico Los Buchillones. El Caribe Arquelógico 1, 59–67.

Calvera Rosés, J., Valcárcel Rojas, R., Cooper, J., 2006. Los Buchillones: Universo de Madera. Revista de Ciencias Sociales: ACRD, 9–16.

Colombini, M.P., Giachi, G., Modugno, F., Pallecchi, P., Ribechini, E., 2003. Characterisation of paints and waterproofing materials of the shipwrecks found in the archaeological site of the Etruscan and Roman harbour of Pisa (Italy). Archaeometry 45, 649–664.

Colón, F., 1992. The Life of the Admiral Christopher Columbus by His Son Ferdinand. Translated by Benjamin Keen, second ed. Rutgers University Press, New Brunswick, N.J.

Conrad, G.W., Foster, J.W., Beeker, C.D., 2001. Organic artifacts from the Manantial de la Aleta, dominican republic: preliminary observations and interpretations. Journal of Caribbean Archaeology 2, 1–20.

Curet, A., 1996. Ideology, chiefly power, and material culture: an example from the greater antilles. Latin American Antiquity 7 (2), 114–131.

Dee, M.W., Brock, F., Bowles, A.D., Bronk Ramsey, C., 2011. Using a silica substrate to monitor the effectiveness of radiocarbon pretreatment. Radiocarbon 53 (4), 705–711.

Fitzpatrick, S.M., 2006. A critical approach to ^{14}C dating in the Caribbean: using chronometric hygiene to evacuate chronological control and prehistoric settlement. Latin American Antiquity 17 (4), 389–418.

Granberry, J., 1955. A Survey of Bahamian Archaeology. Unpublished MA Thesis, University of Florida, Gainesville.

Hillam, J., Morgan, R.A., Tyers, I., 1987. Sapwood estimates and the dating of short ring sequences. In: Ward, R.G.W. (Ed.), Applications of Tree-ring Studies: Current Research in Dendrochronology and Related Areas. British Archaeological Reports International Series, S333, pp. 165–185.

Hofman, C.L., Hoogland, M.L.P., 2004. Social dynamics and change in the Northern Lesser Antilles. In: Delpuech, A., Hofman, C.L. (Eds.), Late Ceramic Age Societies in the Eastern Caribbean. BAR International Series 1273 and Paris Monographs in American Archaeology 14, Oxford.

Hostos, A. de, 1941. The 'Duho' and other wooden objects from the West Indies. In: de Hostos, A. (Ed.), Anthropological Papers, Based Principally on Studies of the Prehistoric Archaeology and Ethnology of the Greater Antilles. Government of Puerto Rico, Office of the Historian, San Juan, pp. 77–84.

Keegan, W., 2007. Taíno Indian Myth and Practice: The Arrival of the Stranger King. University Press of Florida, Gainesville.

Kerchache, J. (Ed.), 1994. L'art des sculpteurs Taïnos: Chefs-d'œvre des Grandes Antiles précolombiennes. Musee du Petit Palais, Paris.

Las Casas, B. de, 1951. Historia de las Indias. Biblioteca Americana 1-3, Fondo de Cultura Economica, Mexico.

Little, E.L., Wadsworth, F.H., 1964. Common Trees of Puerto Rico and the Virgin Islands. Agriculture Handbook No. 249. U.S. Department of Agriculture, Forest Service, Washington, D.C.

López-Toledo, L., Burslem, D.F.R.P., Martínz-Ramos, M., García-Naranjo, A., 2008. Non-Detriment Findings Report on *Guaiacum sanctum* in Mexico. NDF Workshop case studies; WG1 Trees, Case Study 7.

López-Toledo, L., 2009. A conservation assessment of endangered tropical tree species: *Guiaiacum sanctum* and *G. coulteri* in Mexico. PhD Thesis. University of Aberdeen, UK.

Manuels, M., 2001. Condition and Analysis Report of Four Taíno Carvings at the National Gallery of Jamaica. Unpublished report. The Sherman Fairchild Center for Objects Conservation, Metropolitan Museum of Museum of Art, New York.

Marcos, J.G., Manrique, M. de, 1988. De la Dualidad Fertilidad-Virilidad a lo explicitamente femenino o masculine: La relacion de las figurinas con los cambios en la organizacion social Valdivia, Real-Alto, Ecuador. In: Miller, V.E. (Ed.), The Role of Gender in Precolumbian Art and Architecture. University Press of America, Lanham, pp. 35–51.

Martyr D'Anghera, P., 1970. De orbe novo: the eight decades of Peter Martyr D'Anghera. Translated by Francis August MacNutt. Burt Franklin, New York.

McEwan, C., 2001. Seats of power: axiality and access to invisible worlds. In: McEwan, C., Barreto, C., Neves, E. (Eds.), Unknown Amazon: Culture in Nature in Ancient Brazil. British Museum Press, London, pp. 176–197.

Méndez Bonilla, I.F., 2006. Culturas Indígenas de Puerto Rico. Museo de Historia, Antropología y Arte, Universidad de Puerto Rico, San Juan.

Miles, D., 1997. The interpretation, presentation and use of tree-ring dates. Vernacular Architecture 28, 40–56.

Oliver, J., 2009. Caciques and Cemí Idols: The Web Spun by Taíno Rulers Between Hispaniola and Puerto Rico. The University of Alabama Press, Tuscaloosa.

Ostapkowicz, J., Wiedenhoeft, A., Bronk Ramsey, C., Ribechini, E., Wilson, S., Brock, F., Higham, T., 2011a. 'Treasures… of black wood, brilliantly polished': five examples of Taíno sculpture from the tenth-sixteenth century Caribbean. Antiquity 85, 942–959.

Ostapkowicz, J., Bronk Ramsey, C., Wiedenhoeft, A., Brock, F., Higham, T., Wilson, S., 2011b. In: Hofman, C., van Duijvenbode, A. (Eds.), 'This Relic of Antiquity': 5th–15th Century Wood Carvings from the Southern Lesser Antilles. Communities on Contact Sidestone Press, Leiden, pp. 137–170.

Ostapkowicz, J., 1997. To be seated 'with great courtesy and veneration': contextual aspects of the Taíno Duho. In: Brecht, F., Brodsky, E., Farmer, J.A., Taylor, D. (Eds.), Taíno: Pre-Columbian Art and Culture from the Caribbean. Monacelli Press and Museo del Barrio, New York, pp. 55–67.

Ostapkowicz, J., 1998. Taíno Wooden Sculpture: Duhos, Rulership and the Visual Arts in the 12th–16th Century Caribbean. Unpublished PhD Thesis. Sainsbury Research Unit, University of East Anglia, Norwich.

Ostapkowicz, J., 2008. Carved histories: ceremonial *duhos* from the Turks and Caicos islands. Astrolobe: Times of the Islands, Fall 2008, 103–108.

Oviedo, G.F. de, 1992. Historia General y Natural de las Indias. In: Tudela Bueso, J.P. (Ed.), 1992. Biblioteca de Autores Espanoles, vol. 1–5. Ediciones Atlas, Madrid.

Pané, R., 1999. In: Arrom, J.J. (Ed.), An Account of the Antiquities of the Indians. Duke University Press, Durham (S.C. Griswold, Trans.).

Petersen, J.B., Hofman, C.L., Curet, L.A., 2004. Time and culture: chronology and taxonomy in the Eastern Caribbean and the Guaianas. In: Delpueche, A., Hofman, C.L. (Eds.), Late Ceramic Age Societies in the Eastern Caribbean. BAR International Series, 1273, Paris Monographs in American Archaeology, 14. Archaeopress, Oxford.

Rasmussen, K.L., van der Plicht, J., Doudna, G., Nielsen, F., Højrup, P., Stenby, E.H., Pedersen, C.T., 2009. The effects of possible contamination on the radiocarbon dating of the Dead Sea Scrolls II: empirical methods to remove castor oil and suggestions for redating. Radiocarbon 51 (3), 1005–1022.

Record, S.J., Hess, R.W., 1943. Timbers of the New World. Yale University Press, New Haven.

Reimer, P.J., Baillie, M.G.L., Bard, E., Bayliss, A., Beck, J.W., Blackwell, P.G., Bronk Ramsey, C., Buck, C.E., Burr, G.S., Edwards, R.L., Friedrich, M., Grootes, P.M., Guilderson, T.P., Hajdas, I., Heaton, T.J., Hogg, A.G., Hughen, K.A., Kaiser, K.F., Kromer, B., McCormac, F.G., Manning, S.W., Reimer, R.W., Richards, D.A., Southon, J.R., Talamo, S., Turney, C.S.M., Van der Plicht, J., Weyhenmeyer, C.E., 2009. IntCal09 and Marine09 radiocarbon age calibration curves, 0–50,000 years cal BP. Radiocarbon 51 (4), 1111–1150.

Rendle, B.J., 1969. World Timbers: North and South America. Ernest Benn Limited, London.

Rodríguez Ramos, R., 2010. Rethinking Puerto Rican Precolonial History. University of Alabama Press, Tuscaloosa.

Rouse, I., 1992. The Taínos: Rise and Decline of the People Who Greeted Columbus. Yale University Press, New Haven.

Sands, R., 1997. Prehistoric Woodworking: The Analysis and Interpretation of Bronze and Iron Age Toolmarks. Institute of Archaeology, London.

Saunders, N., Gray, D., 1996. Zemis, trees and symbolic landscapes: three Taíno carvings from Jamaica. Antiquity 70 (270), 801–812.

Saville, M.H., 1910. The antiquities of Manabi, Ecuador: final report. In: Heye Foundation Contributions to South American Archaeology, vol. 2. New York.

Sullivan, S.D., 1981. The Colonization and Exploitation of the Turks and Caicos Islands. PhD Dissertation. University of Illiniois at Urbana-Champaign.

Vega, B., 2007. The indigenous inheritance in dominican culture. In: Vega, B. (Ed.), Dominican Cultures: The Making of a Caribbean Society. Markus Wiener Publishers, Princeton, pp. 1–28 (C. Ayorinde, Trans.).

Walker, J.B., 1993. Stone Collars, Elbow Stones and Three Pointers, and the Nature of Taíno Ritual and Myth. PhD Dissertation. Washington State University, Pullman.

Ward, G.K., Wilson, S.R., 1978. Procedures for comparing and combining radiocarbon age determinations: a critique. Archaeometry 20 (1), 19–31.

Wilson, S., 2007. The Archaeology of the Caribbean. Cambridge University Press, Cambridge.

Zerries, O., 1970. Bancos zoomorfos y asientos de los espíritus en la América del Sur. Suplemento Antropologico 5 (1–2), 289–314.