Chapter 16

PRE-COLUMBIAN EXPLOITATION OF BIRDS AROUND PANAMA BAY

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This paper presents a summary of avifaunas found at residential and mortuary sites from two areas of Panama: Parita Bay and the Pearl Islands Archipelago. Despite relying on samples often few in number, the taxonomic diversity of birds recorded in contexts belonging to 10 archaeological sites is much greater than that of other vertebrate classes (except fish). Although a considerable number of Neotropical bird orders and families share the problem that it is impossible to separate their members osteologically, our analysis concentrates on data pertaining to the taxonomic levels of genera and species. Results show that pre-Columbian people from both areas did not go very far to obtain most of the bird taxa they utilized. The exceptions to this rule are a few species that frequent extensive forests or marine habitats well offshore. Whereas most bird taxa were destined for human consumption, some nonlocal and/or less abundant species were captured for ritual and ceremonial, decorative, affective, and crafting purposes.

Bird Remains in Pre-Columbian Panama

Not many areas of Panama have produced pre-Columbian vertebrate archaeofaunas. Those that have are located in coastal zones, on islands where middens contain abundant marine molluscs, or in the central Pacific lowlands and foothills where a combination of long dry seasons and favorable soil chemistry enhance bone survival in archaeological sediments even when marine shell is absent (Cooke, Jiménez, and Ranere 2007, 2008; Cooke and Ranere 1989, 1992a; Linares and White 1980; Ranere and Hansell 1978; Wing 1980a). Bird remains were not recovered at all sites with vertebrate archaeofauna, however. For example, at Cerro Brujo, on the western Caribbean coast (Figure 1), a cluster of houses occupied between 600 and 1250 cal CE provided zooarchaeological data on fishing, turtling, and hunting manatees and terrestrial mammals; but no bird specimens were reported in extensive excavations. Since fish bones

and other fragile remains were recovered, this situation presumably reflects the dietary preferences or the discard behavior of this particular human group rather than a preservation environment inimical only to bird remains (Linares 1976).

The samples we discuss here refer to the littoral and islands of Panama Bay. Pre-Columbian bird remains from 10 sites have been formally analyzed (Table 1). Seven sites are located on and just inland of Parita Bay, in the northwestern corner of Panama Bay where the Azuero Peninsula joins the major axis of the isthmus. These range in age from ca. 4200 cal BCE to Spanish contact (1515 CE). Three sites are located on the Pearl Islands. One of these (Playa Don Bernardo) is the first Preceramic settlement reported on Central American land-bridge islands.

Two other sites on the mainland have produced bird remains. One is Sitio Conte, a mortuary precinct where large numbers of bird-bone artifacts were found in graves dating between ca. 700 and 1000 cal CE during the apogee of Panama chiefly societies (Briggs 1989; Cooke and Jiménez 2010; Lothrop 1937). The other is Panamá Viejo where a pre-Columbian village lies underneath the ruins of the colonial town. Copious faunal samples have been recovered here although only fish remains have been reported until now (e.g., see now Jiménez and Cooke 2001).

Our evaluation concentrates on genus and species. We have taken some liberties making species-level identifications. For example, we attribute ibis bones to the white ibis (*Eudocimus albus*) rather than to the scarlet ibis (*E. ruber*) even though separating these two species osteologically is impossible. The scarlet ibis, however, has been recorded only once in Panama (Angehr 2005) whereas the white ibis is widespread. Therefore it is most likely that all archaeological *Eudocimus* bones belong to the white ibis. From the standpoint of human ecology, it does not matter much: both species frequent similar habitats. The difficulty of separating similar-sized doves in the genera *Leptotila, Geotrygon*, and *Zenaida* prompted us to list together specimens that refer to these genera but cannot objectively be assigned to species.

The 10 sites located around Parita Bay and on the Pearl Islands produced 1,319 bird specimens from 77 genera and at least 82 species (Table 2). The same sites reported four species of amphibians, 13 species of reptiles, and 31 species of mammals (Carvajal Contreras, Jiménez, and Cooke 2008; Cooke and Jiménez 2008, 2009; Cooke, Jiménez, and Ranere 2007). The avian archaeofauna, however, underestimates the diversity of the bird communities that would have been available to pre-Columbian peoples

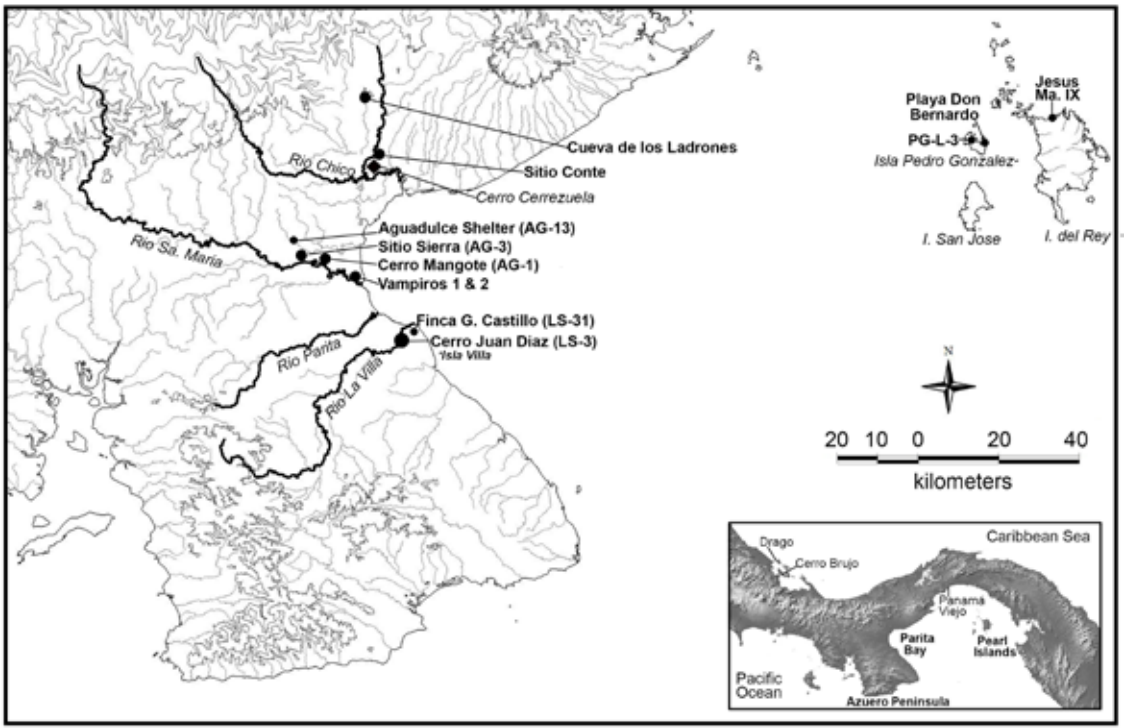

Figure 1. Geographical location of archaeological sites around Parita Bay and in the Pearl Islands, Panama, which have provided bird archaeofaunas. Inset: map of Panama showing the location of other pre-Columbian sites with archaeofaunas, and prominent geographical features.

Table 1. Archaeological sites around Parita Bay and on the Pearl Island archipelago, Panama, where taxonomically significant bird remains have been reported.

Site	Region	Area	Year(s) studied	Type of site	Date of occupation	Distance from sea (km)	Current nonagricultural vegetation in vicinity
Playa Don Bernardo	Pearl Islands (P. González)	1.3 ha	2008–2010	Small farming open settlement, preceramic	4240–3600 cal BCE	0	Dry forest, second-growth, coastal scrub
Cerro Mangote (AG-1)	Parita Bay	1.75 ha	1956, 1979	Small farming open settlement, preceramic	5900–3020 cal BCE	1.5–5	Dry forest, second growth, salt flats, mangroves
Aguadulce Shelter (AG-13)	Parita Bay	~120 m^2	1973–1975, 1998	Rockshelter occupied by farmers	5400–800 cal BCE	15–18	Dry forest, wooded savannas, freshwater swamps
Cueva de los Ladrones (LP-1)	Parita Bay	~625 m^2	1974	Rockshelter occupied by farmers	5900–2100 cal BCE	20–25	Dry forest, wooded savannas, grasslands
Cerro Juan Díaz (LS-3)	Parita Bay	150 ha	1991–2001	Nucleated farming village and mortuary center	200 cal BCE–1600 cal CE	2–4	Dry forest, wooded savannas, mangroves, salt flats
Sitio Sierra (AG-3)	Parita Bay	45 ha	1971–1975	Nucleated farming village with burials	200 cal BCE–1520 cal CE	12–13	Dry forest, wooded savannas, gallery forest, swamps

Finca Germán Castillo (LS-31)	Parita Bay	17 ha	2001–2002	Nucleated farming village	550–750 cal CE	1–2	Dry forest, wooded savannas, mangroves, salt flats
Vampiros Shelters (AG-145)	Parita Bay	~50 m^2	1982, 2002–2006	Rockshelter; hunting & fishing camp or station	200 cal BCE–1000 cal CE	0-2	Mangroves, coastal scrub, salt flats, dry forest
Jesús María IX	Pearl Islands (Isla del Rey)	0.5 ha	2007	Midden area with marine shell	1000–1515 cal CE	0.5	Coastal scrub, dry forest
PG- L-3	Pearl Islands (P. González)	0.5 ha	2007	Midden area with marine shell	640–780 cal CE	0.5	Dry forest

Table 2. Bird taxa exploited by pre-Columbian humans around Parita Bay and in the Pearl Island Archipelago, Panama, with observations on habitat and current status on the isthmus (synthesized from Angehr and Dean 2010).

Family	Genus	Species	English name	Habitat (general)	Current status (Panama)
ANATIDAE	*Dendrocygna*	indet.	whistling-duck	freshwater	varies by species
ANATIDAE	*Dendrocygna*	*autumnalis*	black-bellied whistling duck	freshwater, estuaries	breeding
ANATIDAE	*Dendrocygna*	*viduata*	white-faced whistling-duck	freshwater	vagrant
ANATIDAE	*Cairina*	*moschata*	muscovy duck	freshwater, estuaries	breeding; domestic
ANATIDAE	*Anas*	indet.	dabbling duck	freshwater	varies by species
ANATIDAE	*Anas*	*bahamensis*	white-cheeked pintail	freshwater, estuaries	vagrant
ANATIDAE	*Aythya*	*affinis*	lesser scaup	freshwater	migrant, Nov.–Mar.
ANATIDAE	*Aythya*	*collaris*	ring-necked duck	freshwater	migrant, Dec.–Feb.
CRACIDAE	*Crax*	*rubra*	great curassow	remote forests	breeding, rare and local
CRACIDAE	*Ortalis*	*cinereiceps*	gray-headed chachalaca	woods, second growth	breeding, common
CRACIDAE	*Penelope*	*purpurascens*	crested guan	forests	breeding, uncommon
PHASIANIDAE	*Gallus*	*gallus*	domestic chicken	domestic	introduced, domestic
ODONTOPHORIDAE	*Colinus*	*cristatus*	crested bobwhite	scrub with grassy areas	breeding, common
PROCELLARIIDAE	*Puffinus*	*griseus*	sooty shearwater	marine	offshore, June–Sept.

SULIDAE	*Sula*	indet.	booby	marine	varies by species
SULIDAE	*Sula*	*dactylatra / granti*	masked or Grant's booby	marine	offshore, *granti:* uncommon
SULIDAE	*Sula*	*leucogaster*	brown booby	marine	breeding, common
SULIDAE	*Sula*	*nebouxii*	blue-footed booby	marine	breeding, common at nests
PELECANIDAE	*Pelecanus*	*occidentalis*	brown pelican	marine	breeding, very common
PHALACROCORACIDAE	*Phalacrocorax*	*brasilianus*	neotropic cormorant	marine, coastal, freshwater	breeding, common
FREGATIDAE	*Fregata*	*magnificens*	magnificent frigatebird	marine, strays inland	breeding, very common
ARDEIDAE	*Egretta*	indet.	egret	freshwater, coasts	varies by species
ARDEIDAE	*Ardea*	indet.	heron	freshwater, coasts	varies by species
ARDEIDAE	*Ardea*	*alba*	great egret	freshwater, coasts	breeding & migrant, common
ARDEIDAE	*Ardea*	*herodias*	great blue heron	freshwater, coasts	mostly migrant (Sept.–Apr.)
ARDEIDAE	*Butorides*	indet.	green and/or striped heron	freshwater, coasts	breeding & migrant, common
ARDEIDAE	*Nyctanassa*	*violacea*	yellow-crowned night-heron	freshwater, coasts	breeding & migrant, common
ARDEIDAE	*Nycticorax*	*nycticorax*	black-crowned night-heron	freshwater, coasts	breeding & migrant, common

Table 2 (continued).

Family	Genus	Species	English name	Habitat (general)	Current status (Panama)
CICONIIDAE	*Mycteria*	*americana*	wood stork	freshwater	breeding, uncommon
THRESKIORNITHIDAE	*Platalea*	*ajaja*	roseate spoonbill	freshwater, coasts	perhaps breeds, uncommon
THRESKIORNITHIDAE	*Eudocimus*	*albus*	white ibis	freshwater, coasts	breeding, common
CATHARTIDAE	*Coragyps*	*atratus*	black vulture	ubiquitous	breeding, abundant
ACCIPITRIDAE	*Pandion*	*haliaetus*	osprey	coasts, freshwater	migrant, some all year
ACCIPITRIDAE	*Buteogallus*	indet.	hawk	varies by species	varies byspecies
ACCIPITRIDAE	*Buteogallus*	*anthracinus*	common black hawk	coasts, adjacent woodlands	breeding, common
ACCIPITRIDAE	*Buteo*	indet.	hawk	varies by species	varies by species
ACCIPITRIDAE	*Buteo*	*magnirostris*	roadside hawk	second growth, scrubby areas	breeding, common
FALCONIDAE	*Micrastur*	*semitorquatus*	collared forest-falcon	forest including gallery	breeding, uncommon
FALCONIDAE	*Caracara*	*cheriway*	crested caracara	open areas	breeding, common
FALCONIDAE	*Milvago*	*chimichima*	yellow-headed caracara	open areas	breeding, common
FALCONIDAE	*Falco*	indet.	falcon	varies by species	varies by species
FALCONIDAE	*Falco*	*deiroleucus*	orange-breasted falcon	forest and woods, seeks cliffs	breeding, very rare

FALCONIDAE	*Falco*	*femoralis*	aplomado falcon	open areas	breeding, uncommon & local
RALLIDAE	*Aramides*	*cajanea*	gray-necked woodrail	woods near water	breeding, common
RALLIDAE	*Amaurollimnas*	*concolor*	uniform crake	woods near water	breeding, very rare
RALLIDAE	*Fulica*	*americana*	American coot	freshwater	migrant, Oct.–Apr., uncommon
RALLIDAE	*Porphyrio*	*martinicus*	purple gallinule	freshwater, marshes	breeding, common
RALLIDAE	*Porzana*	*carolina*	sora	freshwater, marshes	migrant, Sept.–Apr., common
CHARADRIIDAE	*Charadrius*	*vociferus*	killdeer	areas with short grass	migrant, Oct.–Mar., local breeder
JACANIDAE	*Jacana*	indet.	jacana	freshwater with floating vegetation	breeding, common
SCOLOPACIDAE	*Tringa*	indet.	tringine sandpiper	freshwater, coasts	migrant, winter
SCOLOPACIDAE	*Tringa*	*solitaria*	solitary sandpiper	freshwater, occasionally coasts	migrant, Aug.–Apr., common
SCOLOPACIDAE	*Catoptrophorus*	*semipalmatus*	willet	coasts	migrant, some all year
SCOLOPACIDAE	*Numenius*	*phaeopus*	whimbrel	coasts	migrant, some all year
SCOLOPACIDAE	*Numenius*	*americanus*	long-billed curlew	coasts	migrant, Aug.–Dec., very rare
SCOLOPACIDAE	*Arenaria*	*interpres*	ruddy turnstone	coasts	migrant, some all year
SCOLOPACIDAE	*Calidris*	indet.	sandpiper	coasts	migrant

Table 2 (continued).

Family	Genus	Species	English name	Habitat (general)	Current status (Panama)
SCOLOPACIDAE	*Calidris*	*canutus*	knot	coasts	migrant, Sept.–Apr., rare
SCOLOPACIDAE	*Calidris*	*mauri* or *pusilla*	western/s-palmated sandpiper	coasts	migrant, Aug.–Apr., few all year
SCOLOPACIDAE	*Calidris*	*melanotos*	pectoral sandpiper	wet grassy areas, coasts	migrant, Aug.–.Nov & Mar.-Apr.
SCOLOPACIDAE	*Limnodromus*	indet.	dowitcher	freshwater, coasts	migrant, Aug.–Apr., few all year
LARIDAE	*Leucophaeus*	*atricilla*	laughing gull	freshwater, coasts, offshore	migrant, Oct.–Apr., some all year
LARIDAE	*Onychroprion*	*fuscatus*	sooty tern	marine, mostly well offshore	breeds islets (Los Frailes)
LARIDAE	*Sterna*	*forsteri*	Forster's tern	marine	migrant, rare
LARIDAE	*Chlidonias*	*niger*	black tern	freshwater, coasts, offshore	migrant, Oct.–Apr., some, all year
COLUMBIDAE	*Patagioenas*	indet.	pigeon	varies by species	varies by species
COLUMBIDAE	*Columbina*	indet.	ground-dove	varies by species	breeding
COLUMBIDAE	*Columbina*	*minuta*	plain-breasted ground-dove	dry, open areas	breeding
COLUMBIDAE	*Columbina*	*talpacoti*	ruddy ground-dove	ubiquitous,, open areas, towns	breeding

COLUMBIDAE	*Lept/Zen/Geo* [D]	indet.	small dove	varies by species	breeding
COLUMBIDAE	*Leptotila*	indet.	white-tipped doves	varies by species	breeding
COLUMBIDAE	*Zenaida*	indet.	mourning doves	varies by species	breeding
COLUMBIDAE	*Zenaida*	*asiatica*	white-winged dove	second growth near coasts	breeding, local on Pacific
COLUMBIDAE	*Zenaida*	*macroura*	mourning dove	open and grassy areas	breeding, migrant
COLUMBIDAE	*Geotrygon*	*montana*	ruddy quail-dove	on ground in forests	breeding, fairly common
PSITTACIDAE	*Ara*	indet. [E]	macaws	varies by species	varies by species
PSITTACIDAE	*Ara*	*macao*	scarlet macaw	forest, open areas with trees	breeding, commo only on Coiba I.
PSITTACIDAE	*Aratinga*	indet.	parakeet	varies by species	varies by species
PSITTACIDAE	*Aratinga*	*finschi*	crimson-fronted parakeet	forest, open areas with trees	breeding, common but local
PSITTACIDAE	*Aratinga*	*pertinax*	brown-throated parakeet	open areas with trees	breeding, common but local
PSITTACIDAE	*Brotogeris*	*jugularis*	orange-chinned parakeet	forests, open areas with trees	breeding, widespread
PSITTACIDAE	*Pionus*	*menstruus*	blue-headed amazon	forests, woods, open areas	breeding, common
PSITTACIDAE	*Amazona*	indet.	amazons	varies by species	breeding
PSITTACIDAE	*Amazona*	*autumnalis*	red-lored amazon	forest and woods	breeding, common
PSITTACIDAE	*Amazona*	*ochrocephala*	yellow-crowned amazon	woods, often coastal	breeding, fairly common

Table 2 (continued).

Family	Genus	Species	English name	Habitat (general)	Current status (Panama)
CUCULIDAE	*Coccyzus*	*minor*	mangrove cuckoo	forest edges, scubby areas	possibly breeding
CUCULIDAE	*Crotophaga*	indet.	ani	varies by species	varies by species
CUCULIDAE	*Crotophaga*	*ani*	smooth-billed ani	open areas, especially fields	breeding, common
CUCULIDAE	*Crotophaga*	*sulcirostris*	groove-billed ani	open areas, especially fields	breeding, common
TYTONIDAE	*Tyto*	*alba*	barn owl	open areas, especially fields	breeding, fairly common
STRIGIDAE	*Megascops*	indet.	screech owl	forest, second growth	varies by species
STRIGIDAE	*Pulsatrix*	*perspicillata*	spectacled owl	forests	breeding, uncommon
STRIGIDAE	*Glaucidium*	indet.	pygmy owl	forest, second growth, open areas	varies by species
STRIGIDAE	*Pseudoscops*	*clamator*	striped owl	scrubby and grassy areas	breeding, uncommon
STRIGIDAE	*Ciccaba*	*virgata*	mottled owl	forest, second growth	breeding, common
CAPRIMULGIDAE	*Chordeiles*	*minor*	common nighthawk	aerial, likes open areas	breeding & migrant
CAPRIMULGIDAE	*Nyctidromus*	*albicollis*	pauraque	forest edges, second growth, scrub	breeding, common
CAPRIMULGIDAE	*Caprimulgus*	*cayannensis*	white-tailed nightjar	dry grassy areas	breeding, rare and local

ALCEDINIDAE	*Megaceryle*	*torquata*	ringed kingfisher	freshwater and coastal	breeding, common
PICIDAE	*Campephilus*	*guatemalensis*	pale-billed woodpecker	forest, clearings with trees	breeding, rare, w. Panama
PASSERIFORMES	indet.		passerines	varies by species	varies by species
TYRANNIDAE	*Megarhynchus*	*pitangua*	boat-billed flycatcher	second growth, clearings	breeding, common
CARDINALIDAE	*Pheucticus*	*ludovicianus*	rose-breasted grosbeak	forest, second growth, open areas	migrant, Oct.–April, common
Incertae sedis	*Saltator*	*striatipectus*	streaked saltator	second growth, open areas	breeding, common
ICTERIDAE	*Sturnella*	indet.	meadowlarks and blackbirds	open areas with grass	varies by species
ICTERIDAE	*Quiscalus*	*mexicanus*	great-tailed grackle	ubiquitous, commensal	breeding, very common
ICTERIDAE	*Molothrus*	*oryzivorus*	giant cowbird	open areas, nr. oropendola colonies	breeding, fairly common
ICTERIDAE	*Icterus*	indet.	oriole	varies by species	varies by species
ICTERIDAE	*Icterus*	*galbula*	Baltimore oriole	open areas with trees	migrant, Oct.–Apr., common
ICTERIDAE	*Psarocolius*	indet.	oropendolas	forest edge, second growth	varies by species

in the vicinity. This is because we cannot objectively assign many specimens to genus and species in a number of Neotropical bird orders and families. For example, Passeriformes (songbirds) comprise 49 percent of the present-day Panamanian avifauna of 978 bird species (Angehr 2006). We identified 162 passerine bones—but only 61 of these were referable with confidence to eight genera and six species (Table 3). In some cases, we can guess which song bird species in a given genus are most likely to have been present on ecological and zoogeographical grounds (Cooke, Jiménez, and Ranere 2007, 2008).

We shall see that the people who lived near Parita Bay and in the Pearl Islands did not go very far to obtain most of the bird taxa they utilized. Non- or lightly forested and aquatic habitats (coastal, freshwater, and marine) account for most of the species recorded. The exceptions are a few species that frequent extensive forests or marine habitats well off-shore. It is likely that some bird species were captured for use in ritual, to use their bones as ornaments (e.g., boobies [*Sula* spp]), to be kept as pets or curiosities, or for using their skins, feathers, and talons for decoration and ceremony (e.g., macaws, parakeets, and parrots [Psittacidae spp] and raptors [Falconiformes spp]). A few species are now vagrants to Panama. Others are no longer found in the study areas, either because humans have extirpated them or because some habitats, for example, riverine gallery forests around Parita Bay, were in better ecological health than they are today.

Our samples refer to a small percentage of Panama's territory. Around Parita Bay, the natural vegetation has been affected by the seasonally dry and windy climate in conjunction with unbroken human occupation since the Late Glacial (Cooke, Norr, and Piperno 1996; Cooke, Jiménez, and Ranere 2007, 2008). The Pearl Islands also experience an intense seasonal drought, which favors slash-and-burn agriculture and rapid forest removal. Pre-Columbian bird exploitation in hilly, mountain, and perennially humid regions of Panama is likely to have been quite different from the patterns that we infer from the avifaunas recovered at this geographically restricted group of sites.

Geographic and Cultural Setting

Parita Bay

Parita Bay is a small mangrove-fringed embayment on the central Pacific coast. This is one of the driest zones of lower Central America. An-

nual precipitation is as low as 1,200 mm near the coast. Dry seasons are long, windy, and intense (4–5 months; Figure 1).

Archaeological field data and vegetation history confirm a continuous human presence since the beginning of the Clovis technological horizon ca. 12,000 cal BCE (Pearson and Cooke 2007; Piperno 2009; Ranere 2006). The oldest bird remains were deposited during the Late Preceramic period of the Gran Coclé culture area (6000–3500 cal BCE; Cooke and Sánchez Herrera 2004b). By this time local communities practiced a mixed economy of farming, fishing, hunting, and tree-crop gathering, having already adopted several cultigens, among them maize (*Zea mays*), manioc (*Manihot esculenta*), and squash (*Cucurbita* spp; Dickau 2010; Piperno 2006, 2009).

By the beginning of the Common Era, nucleated farming villages had been established along the banks of the major rivers that discharge into Parita Bay. Cerro Juan Diaz (LS-3) and Sitio Sierra (AG-3) epitomize this development. During the last few centuries before Spanish contact (ca. 500–1515 CE) villages were organized into populous chiefdoms (Cooke and Sánchez Herrera 2004b; 2004c; Haller 2008; Isaza Aizpurúa 2007; Linné 1929; Sauer 1966; Weiland 1984). Smaller culturally related communities existed in the mountains and on the Caribbean slopes (Griggs 2005). When the Spanish appeared on this landscape with their cattle and horses, the vegetation adjacent to Parita Bay was a patchwork of fields, grassy areas, riverine woods, remnants of dry forest (especially on hill tops) and—along the marine littoral—scrubby xerophytic vegetation and mangroves interspersed with barren high tidal flats (Clary et al. 1984, Cooke, Norr, and Piperno 1996; Cooke, Jimenez, and Ranere 2008; Sauer 1966).

The seven Parita Bay sites whose features contain bird remains are residential or residential-cum-funerary. They were investigated over a period of 40 years (1970–2010) by several archaeologists (Cooke and Sánchez Herrera 2004a). The most recent summary of the vertebrate assemblages from them can be consulted in Cooke, Jiménez, and Ranere (2007, 2008). Jiménez and Steadman have since identified new bird material and revised earlier identifications. Steadman has paid particular attention to ducks (Anatidae), boobies (*Sula* spp), quail (Odontophoridae), parrots (Psittacidae), and passerines (Passeriformes).

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Table 3. Distribution of bird genera and species at nine archaeological sites around Panama Bay by NISP (Sp) and MNI (I).

SITE	PDB		CM		AG		LA		LS-3		AG-3		LS-31		AG-145		JM-9		PG-L3		**All sites**	
Sp-NISP, I-MNI by feature	Sp	I	Sp	I	Sp	I	Sp	I	Sp	I	Sp	I	Sp	I	Sp	I	Sp	I	Sp	I	Sp	I
TAXON																						
Dendrocygna indet.									**5**	5	**11**	4									**16**	9
D. autumnalis									**2**	2											**2**	2
D. viduata									**2**	2	**24**	1									**26**	3
Cairina moschata									**27**	16	**21**	5									**48**	21
Anas indet.					**1**	1					**4**	2									**5**	3
Anas bahamensis									**1**	1											**1**	1
Aythya affinis											**1**	1									**1**	1
A. collaris									**1**	1											**1**	1
Crax rubra									**3**	3											**3**	3
Ortalis cinereiceps									**1**	1											**1**	1
Penelope purpurascans									**23**	3											**23**	3
Gallus gallus									**1**	1											**1**	1
Colinus cristatus									**90**	47	**22**	9	**1**	1					**1**	1	**114**	58
Puffinus griseus	**1**	1																			**1**	1
Sula indet.									**32**	2											**32**	2
S. dactylatra or *granti*									**13**	5											**13**	5

S. leucogaster									**21**	9											**21**	9
S. nebouxii									**6**	6											**6**	6
Pelecanus occidentalis									**5**	4	**1**	1			**1**	1	**3**	1			**10**	7
Phalacrocorax brasiliensis	**18**	3							**22**	9	**15**	2			**1**	1					**56**	15
Fregata magnificens									**8**	5											**8**	5
Egretta indet.			**2**	1					**7**	4	**2**	2									**11**	7
Ardea indet.									**1**	0											**1**	0
A. alba	**1**	1	**4**	2					**102**	29	**30**	9									**137**	41
A. herodias									**5**	4	**10**	2									**15**	6
Butorides striatus/ virescens									**3**	3	**3**	2									**6**	5
Nyctanassa violacea	**2**	1							**9**	4											**11**	5
Nycticorax nycticorax									**1**	1											**1**	1
Mycteria americana									**8**	4	**3**	2									**11**	6
Eudocimus albus			**19**	9					**19**	10	**1**	1									**39**	20
Coragyps atratus					**3**	2			**18**	10					**2**	1					**23**	13
Pandion haliaetus			**1**	1					**12**	7											**13**	8
Buteogallus indet.									**5**	2											**5**	2
B. anthracinus									**2**	2											**2**	2
Buteo indet.							**1**	1	**2**	2											**3**	3
B. magnirostris									**6**	1											**6**	1

Table 3 (continued).

Micrastur semitorquatus									**8**	2											**8**	2
Caracara cheriway									**1**	1											**1**	1
Milvago chimichima									**1**	1											**1**	1
Falco indet.									**2**	2	**4**	1									**6**	3
F. deiroleucus									**1**	1											**1**	1
F. femoralis									**1**	1											**1**	1
Aramides cajanea									**13**	3											**13**	3
Amaurolimnas concolor											**1**	1									**1**	1
Fulica americana									**2**	2											**2**	2
Porphyrio martinica									**1**	1											**1**	1
Porzana carolina											**1**	1									**1**	1
Charadrius vociferus									**1**	1											**1**	1
Jacana indet.									**1**	1											**1**	1
Tringa indet.			**1**	1					**1**	1											**2**	2
T. solitaria									**1**	1			**1**	1							**2**	2
T. semipalmatus			**8**	6					**3**	2											**11**	8
Numerius phaeopus			**1**	1					**2**	2											**3**	3
N. americanus									**1**	1											**1**	1
Arenaria interpres					**1**	1															**1**	1
Calidris indet.			**2**	0																	**2**	0

C. canutus			**1**	1																	**1**	1
C. mauri or *pusilla*			**2**	1																	**2**	1
C. melanotos									**1**	1											**1**	1
Limnodromus indet.									**1**	1											**1**	1
Leucophaeus atricilla									**1**	1											**1**	1
Onychoprion fuscatus									**2**	1											**2**	1
Sterna forsteri													**1**	1							**1**	1
Chlidonias niger									**4**	3											**4**	3
Patagioenas indet.									**3**	2	**3**	1									**6**	3
Columbina indet.			**1**	1					**16**	11	**1**	1	**1**	1							**19**	14
C. minuta											**1**	1									**1**	1
C. talpacoti			**1**	1					**6**	6											**7**	7
Leptotila/Zenaida/ Geotrygon	**1**	1	**1**	1					**43**	9	**3**	2									**48**	13
Leptotila indet.									**18**	14									**1**	1	**19**	15
Zenaida indet.									**8**	5	**1**	1									**9**	6
Z. asiatica									**4**	3											**4**	3
Z. macroura									**5**	2	**1**	1									**6**	3
Geotrygon montana			**4**	1					**3**	1											**7**	2
Ara indet.									**110**	27	**1**	1									**111**	28
Ara macao									3	2	**34**	1									**37**	3

Table 3 (continued).

Aratinga indet.									**17**	7											**17**	7
A. finschi									**2**	2											**2**	2
A. pertinax									**10**	4											**10**	4
Brotogeris jugularis									**4**	2	**3**	3									**7**	5
Pionus menstruus									**1**	1											**1**	1
Amazona indet.					**1**	1			**31**	15	**1**	1							**1**	1	**34**	18
A. autumnalis											**1**	1									**1**	1
A. ochrocephala			**1**	1																	**1**	1
Coccyzus minor											**1**	1									**1**	1
Crotophaga indet.									**8**	3	**3**	1									**11**	4
C. ani											**1**	1									**1**	1
C. sulcirostris									**6**	6	**2**	1									**8**	7
Tyto alba									**3**	2	**7**	1									**10**	3
Megascops indet.					**1**	1			**9**	5											**10**	6
Pulsatrix perspicillata									**2**	2											**2**	2
Glaucidium indet.									**7**	5											**7**	5
Pseudoscops clamator					**1**	1			**4**	3	**2**	1									**7**	5
Ciccaba virgata															**1**	1					**1**	1
Chordeiles minor									**1**	1											**1**	1
Nyctidromus albicollis									**2**	2											**2**	2

Caprimulgus cayennenis											**1**	1									**1**	1
Megaceryle torquata									**1**	1											**1**	1
Campephilus guatemalensis									**1**	1											**1**	1
Passeriformes indet.	**1**	*							**85**	*	**15**	*									**101**	0
Megarynchus pitangua									**8**	2											**8**	2
Pheucticus ludovicianus									**1**	1											**1**	1
Saltator stratipectus									**1**	1											**1**	1
Sturnella indet.									**2**	2											**2**	2
Quiscalus mexicanus									**40**	29	**1**	1									**41**	30
Molothrus oryzivorus									**3**	3											**3**	3
Icterus indet.									**2**	1											**2**	1
I. galbula									**1**	1											**1**	1
Psarocolius indet.									**2**	2											**2**	2
TOTAL:	**24**	7	**49**	28	**8**	7	**1**	1	**985**	421	**237**	68	**4**	4	**5**	4	**3**	1	**3**	3	**1319**	544

Pearl Island Archipelago

This large group of different-sized islands is located in Panama Bay 50–80 km from Panama City, but closer to the Darién coast. An ongoing study of sea level in Panama Bay suggests that between 10,000 and 9000 BP a marine strait had formed between a single large island and the Darién coast. By 6200 cal BCE when people first arrived there by sea the archipelago was similar to that of today (Redwood, personal communication; see also González, Urrego, and Martinez 2006; Milne, Long, and Bassett 2005; Peltier 2002). At Spanish contact (1515 CE), the largest island, Isla del Rey (~250 km^2), was under the sway of a powerful chieftain who raided Darién coastal villages with flotillas of canoes (Mártir de Anglería 1965:375–378). His power was probably related to control of the marine-shell trade (*Spondylus* spp and *Pinctada* spp; Cooke and Sánchez Herrera 2001).

Linné (1929) surveyed six islands in 1927 and found many shell-bearing middens. Since 2007 archaeologists have conducted surveys and test excavations on several islands where tourist projects are planned or in progress. Over 100 pre-Columbian sites have been found. All date to after ca. 200 cal BCE except one: Playa Don Bernardo whose occupation is Preceramic (4240–3600 cal BCE). This site provides evidence for depletion of the terrestrial mammal and reptile faunas by the Preceramic settlers: >60 percent of the mammal bones belong to opossums (*Didelphis marsupialis*) and a species of very small deer (Cervidae sp). These taxa have disappeared from Pedro González Island although populations of *D. marsupialis* and a deer attributed to *Mazama gouazoubira* or *M. nemorivaga* (probably erroneously), survive on Isla del Rey and San José Island, respectively (Handley 1966; www.iucnredlist.org/details/136708/0). Mud turtles (*Kinosternon* spp), paca (*Cuniculus paca*), and a cebid monkey (cf *Cebus capucinus*)—also recorded in the Preceramic middens—are not present today anywhere on the archipelago (Cooke and Jiménez 2009). The prehistoric vulnerability of pacas and monkeys on continental islands was discussed by Steadman and Jones (2006).

The other two sites where bird bones have been reported (Jesús María IX [Isla del Rey] and PG-L-3 [Pedro González]) represent the period 500–1515 CE, by which time pre-Hispanic communities were widely distributed across the archipelago.

Bird Exploitation at Individual Sites

All the bird-bone samples we consider, except one, were recovered using the same mesh size (⅛ inch, 3.2 mm). The exception is Cueva de los Ladrones where a ¼-inch mesh was used (Cooke 1984b).

By far the largest and most diverse bird-bone assemblages were recorded at the two largest and most completely excavated sites, namely, Cerro Juan Díaz (~160 ha), where extensive excavations spanned a 10-year period, and Sitio Sierra (~45 ha), also investigated with areal excavation (Table 3; Cooke 1979, 1984b; Isaza Aizpurúa 1993).

Preceramic and Early Ceramic open sites and rock-shelters and all sites on the Pearl Islands were investigated by much smaller excavations, which have produced correspondingly smaller samples of bird remains (Cooke 1984b; Cooke and Jiménez 2009; Piperno et al. 2000; Ranere and Hansell 1978).

Preceramic: Playa Don Bernardo (Isla Pedro González, Pearl Islands; 4240–3600 cal BCE)

The Preceramic site on Isla Pedro González is located on a sandy beach. Three test excavations have been opened here. Eight radiocarbon dates are available. The oldest, taken from a depth of 4.1 m from present-day land surface, is 5330±40 BP (4240–3890 cal BCE; Beta-278902). The most recent was obtained 0.8 m from the surface, 4880±40 BP (3710–3630 cal BCE; Beta-256751; Cooke and Jiménez 2009).

Predictably, the vertebrate faunal samples at Playa Don Bernardo are dominated by fish. In one 1 × 2 m test cut taken to 2.6 m below the surface (PG-L-20), 19,766 bones were recovered over 3.2 mm mesh: 19,065 (96.5%) are fish, 163 (0.8%) reptiles, 531 (2.7%) mammals, and only 15 (0.08%) birds.

Only five bird taxa have been identified so far: Sooty shearwater, Neotropical cormorant, great egret, yellow-crowned night-heron, and dove (cf *Leptotila verreauxi*). The most unusual species is the sooty shearwater, which has not been recorded in other Panama avifaunas. The closest islands used by sooty shearwaters for breeding lie at 43°S, off the south Chile coast. Post-breeding birds disperse widely through the Atlantic and Pacific oceans. Systematic field observations show that several sooty shearwaters are likely to be seen during the course of a day in Panamanian waters at the peak of migration (Angehr, personal communication, 2010).

Except for one second-hand February record (Wetmore 1965; fide R.C. Murphy) all sightings fall between June and September and peak in August (Angehr 2006; Loftin 1991). Sooty shearwaters on migration do not often come close to shore but will settle on the sea during calm periods. Canoe-borne seafarers would be able to catch them.

Eighteen cormorant elements belong to a minimum of two adults and one juvenile. Neotropical cormorants visit the Pearl Islands in enormous flocks. The fish-bone sample at Playa Don Bernardo includes bonito (*Euthynnus lineatus*) and green jack (*Caranx caballus*)—shoaling piscivores that swim in clear currents not necessarily far from the shore. Several bones of dolphins (*Tursiops truncatus, Delphinus delphis,* and an unidentified species of *Stenella*) were found in the midden suggesting that these marine mammals may have been enmeshed as they pursued schools of fish around the small bay in front of the settlement (Cooke and Jiménez 2009; also T. A. Wake, personal communication). Today, cormorants are often drowned in gill nets. It is possible that cormorants were "fished" this way in the past as well.

Capturing cormorants and other sea birds at breeding colonies is inferred at pre-Columbian sites elsewhere (e.g., Chile [Simeone and Navarro 2002] and California [Broughton 2002]). The Maori harvested the sooty shearwater ("mutton bird") in the past (Anderson 1995), and still do (Kitson 2002; Lyver 2000). Cormorant nesting in the Pearl Islands begins in February and is over by June (Angehr and Kushlan 2007; Montgomery and Martínez 1984). Brown-pelican breeding is likewise synchronized with dry season upwelling (January–April). Loftin (1991) observed brown-booby breeding activity on the Pearl Islands between October and April, and peak frigatebird breeding in February and March. Angehr and Kushlan (2007) counted 233 brown booby and 281 blue-footed booby nests in the Gulf of Panama in April 2005 "probably late in the breeding season."

It is surprising, therefore, that we have not yet found specimens of frigatebirds, pelicans, and boobies at Playa Don Bernardo. Occupation when these marine birds were not at their nesting colonies (July–September) is confirmed by the presence of the sooty shearwater. Therefore it is possible that people only lived on this island during the dry (nonfarming) season. If so the maize that was processed with small grinding stones according to starch and phytolith evidence (Holst, personal communication) could have been grown nearby. Another possible explanation is dietary prefer-

ence: marine birds were less-attractive food sources than fish and naïve mammals on a previously uninhabited island.

Preceramic: Cerro Mangote (5900–3020 cal BCE)

Cerro Mangote was investigated in 1955–1956 and 1979 (Cooke and Ranere 1992a, 1992b; McGimsey 1956). McGimsey described it as a hunting, fishing, and shell-fishing station with some evidence for "incipient agriculture." It is now known that the local population was practicing agriculture during this site's Preceramic occupation (5800–3300 cal BCE; Cooke 2005; Piperno 2009).

The many shell-bearing middens at Cerro Mangote cover ~1.75 hectares. They are located on the level summit of a 48 m hill, which looks eastwards over high-tidal flats (*albinas*), mangroves, and riverine gallery forests. The River Santa María now runs immediately south of the site, but it probably entered the sea elsewhere during all or part of Cerro Mangote's Preceramic history (Cooke and Ranere 1999).

Cerro Mangote's location vis-à-vis the active marine shore of Parita Bay has changed since the middle Holocene in response to marine transgression and delta build-up. It is now ~8 km from shore but would have been closer during the Preceramic occupation, perhaps as little as 1.2 km when the site was first settled (Clary et al. 1984; Cooke and Ranere 1992a, 1999).

The bird taxa recorded at the site are consistent with mangrove-estuary habitats and dry-vegetation formations landward of the high-tidal flats. White ibis and willet are the most frequent species. Other wading birds (Scolopacidae) comprise whimbrel, knot, a large *Tringa* (probably greater yellowlegs), and "peep" sandpipers (*Calidris mauri* or *C. pusilla*). Whimbrel, willet, yellowlegs, and "peeps" still congregate in the intertidal zone of Parita Bay in very large numbers. At high tide the larger species shelter in mangroves and the smaller ones in supra-tidal areas where water is impounded (Buehler 2002). Great egrets, smaller egrets, and osprey (*Pandion haliaetus*) frequent the same habitats. (*Egretta* spp) frequent the same habitats. Dove remains represent three species: 1) ruddy quail-dove, 2) another species in the *Leptotila-Zenaida-Geotrygon* group (probably white-winged dove), and 3) ruddy ground dove. The yellow-crowned parrot is locally the most abundant species of *Amazona* along the central Pacific littoral. It often roosts in mangroves.

These taxa would have been available within an hour's walk or so from the site, either in marine coastal habitats or in scrubby and riverine woodlands. The high rank of raccoons (*Procyon lotor*), white-tailed deer (*Odocoileus virginianus*), and iguanas (*Iguana iguana* and *Ctenosaura similis*) in the middens is consistent with this foraging scenario and with the inferred middle estuary habitat preferences of the fish species deposited in Cerro Mangote's middens (Cooke and Jiménez 2004; Cooke, Jiménez, and Ranere 2008; Cooke and Ranere 1989, 1992a, 1999).

Preceramic and Early Ceramic: Aguadulce Shelter (5400–800 cal BCE)

This rock shelter is now located 15 km inshore from Cerro Mangote at the inland edge of the narrow coastal plain that extends northwestwards from Parita Bay. It was occupied as early as 12,000 cal BCE by Paleoindians who made bifacial chalcedony tools (Piperno et al. 2000) Vertebrate archaeofaunas are preserved only under the 10 × 12 m overhang in midden deposits, which accumulated slowly between ca. 5400–800 cal BCE (Ranere and Hansell 1978) "Monagrillo" pottery (Cooke 1995), Panama's first ceramic ware, appears here about 3400 cal BCE (Piperno et al. 2000). Phytoliths and starch grains found on grinding stones distributed throughout these levels include maize (*Zea mays*), squash (*Cucurbita* spp), and manioc (*Manihot esculenta*; Piperno et al. 2000). Large numbers of carbonized palm fruits (mostly American oil palm [*Elaeis oleifera*]) bear witness to the dietary importance of locally obtained tree crops (Dickau 2010).

Only 17 bird bones were recovered—less than frog with 24 specimens (Cooke, Jiménez, and Ranere 2008:Figure 6-3). Eight specimens preserved anatomical features diagnostic of genus or species: duck (*Anas* sp), black vulture, ruddy turnstone, amazon parrot (*Amazona* sp), tropical screech owl, and striped owl. The presence of vulture and owl bones in middens inside rockshelters is not necessarily evidence for their being exploited by humans, since these birds frequently roost and nest in such shelters. They could have been killed by human occupants returning to the site after a hiatus. The presence of the ruddy turnstone, however, suggests that the shelter's inhabitants made excursions to rocky habitats on the coast. This idea is consistent with the fact that about 30 percent of the >1,300 fish bones recovered in the middens belong to marine taxa, some of which would have been obtained in coastal (rather than tidal river) habitats (Cooke, Jimenez, and Ranere 2008).

Preceramic and Early Ceramic: Cueva de los Ladrones (5900–2100 cal BCE)

Located at ~300 m on the southern slopes of Cerro Guacamayo and now 25 km from the shore of Parita Bay, Cueva de los Ladrones was home to a small group of farmers during the Late Preceramic and Early Ceramic (5100–2100 cal BCE; Dickau 2010; Piperno et al. 1985) The taphonomic situation here is like that of the Aguadulce Shelter: no bones were found downslope from the drip line where midden deposits are much deeper than on the dry, shelter floor. Sediments were screened with a dump sifter with ¼″ mesh (Cooke 1984b). Differential preservation in addition to large mesh size may explain why only one taxonomically diagnostic bird bone was recovered: a distal pedal digit of a hawk (*Buteo* sp).

Preceramic: Sitio Sierra (250 cal BCE–1520 cal CE)

Pre-Hispanic cultural material covers 45 hectares at this nucleated village on the north bank of the River Santa María (Weiland 1984). It was investigated between 1970 and 1975 by Cooke who uncovered dwellings, refuse lenses, pits, and two burial grounds. Marine and river fish and deer provided the majority of animal food. Hunting iguanas and collecting small freshwater turtles were also important activities (Cooke 1979, 1984b; Cooke, Norr, and Piperno 1996; Cooke and Ranere 1989, 1999; Isaza Aizpurúa 1993). Bird NISP and MNI estimated by feature have been aggregated. Most of the bird specimens were found around clay-floored houses radiocarbon dated between 250 cal BCE and 550 cal CE (Cooke and Ranere 1992a).

The most frequent bird species are crested bobwhite and great egret (each 13.2% MNI). A bobwhite partial skeleton found alongside an extended burial may be an intentional offering (Cooke 1984a:Figure 9). Twenty-one elements from probably five muscovy-duck individuals were found. Distinguishing wild from domesticated muscovy ducks is confounded by the fact there is size overlap between female domesticated and male wild individuals; the bones of adult domesticated males do not overlap with those of wild females (Stahl 2005). Twelve burnt bones from a midden deposited between ca. 300 and 500 CE belong to a single large individual. Its complete right humerus falls within the size range of Stahl's domesticated males. Norr's carbon and nitrogen isotope analysis of a bone

from this individual points to a diet similar to that of humans at this village (Cooke, Norr, and Piperno 1996), although we do not have isotopic data from wild muscovies with which to compare Norr's data.

Whistling duck remains at Sitio Sierra refer to the black-bellied and white-faced species. In 1975 a partial skeleton of a white-faced whistling duck was recovered in the midden where the domesticated muscovy duck was found (Cooke and Olson 1984). One bone is an orbital that clinches the identification. (In this species it is incomplete while in the black-bellied and fulvous whistling ducks it forms an unbroken ring.) The white-faced whistling duck is no longer present in central and western Panama. Seven bones at Sitio Sierra are referable to either the white-faced or fulvous whistling duck (*D. bicolor*). The latter species had not been recorded in Panama when Cooke and Olson wrote their article. It has since reestablished itself as a breeding bird in Herrera province on the Azuero Peninsula, midway between Sitio Sierra and Cerro Juan Díaz (Angehr 2005), and may have been present before Spanish contact. The migratory lesser scaup is present. Other duck bones may refer to additional migratory species, for example, shoveller (cf *Anas platyrhincus*), blue-winged teal (cf *Anas discors*), and pintail (cf *Anas acuta*; Cooke and Ranere 1992a). Neotropic cormorant, great blue heron, smaller egrets, green heron, roseate spoonbill, white ibis, wood-stork, sora, and an unidentified rail (larger than purple gallinule) make up the aquatic bird sample, which represents 53 percent NISP and 50 percent MNI. Present-day habitat distribution predicts this situation. Sitio Sierra is on the banks of the River Santa María where almost annual floods result in large expanses of freshwater that slowly recede during the dry season. The Neotropic cormorant is the only marine species at Sitio Sierra, although it is commonly encountered along freshwater stretches of the River Santa Maria. The absence of other marine species indicates that the villagers did not make excursions to the coast 12–13 km away to hunt birds. A flute made of a pelican humerus found in a grave could have been traded in (Cooke 1984a:Figure 9).

In addition to crested bobwhite the terrestrial avifauna at Sitio Sierra comprises species now characteristic of the wooded savannas of central Panama and elsewhere along the Pacific side of Central America: 1) aplomado falcon, 2) plain-breasted ground dove, 3) doves (*Geotrygon/Leptotila/Zenaida*) including mourning dove, 4) orange-chinned parakeet, 6) groove-billed and smooth-billed ani, 7) mangrove cuckoo, 8) barn owl, 9) striped owl, 10) white-tailed nightjar and 11) great-tailed

grackle. The grackle is the only passerine species identified in a sample that probably also includes fork-tailed flycatcher (cf *Tyrannus savanna*), oropendola (cf *Psarocolius decumanus*) and pale-faced spinetail (*Synallaxis albescens*). These species are widespread today in local pastures and woodland edges (Cooke, Jiménez, and Ranere 2008; Cooke and Ranere 1992a). The uniform crake and red-lored amazon have not been recorded in formal ornithological surveys conducted around Parita Bay (Angehr, Engleman, and Engleman 2008; Lasky and Keitt 2010).

Preceramic and Early Ceramic: Finca Germán Castillo (LS-31; 550–750 cal CE)

This 17 hectare coastal settlement near Cerro Juan Díaz, occupied during the Cubitá phase (550–750 CE), is described by Isaza Aizpurúa (2007:208–288) as a "fishing village"—a term that reflects the large numbers of marine fish bones and marine shells deposited in four mounded middens on an ancient beach ridge adjacent to paleo-meanders. Four diagnostic bird bones were recovered: crested bobwhite, solitary sandpiper, Forster's tern, and a ground dove (*Columbina* sp). Forster's tern is a vagrant in Panama with six records from both coasts of the Canal Area (Angehr 2005).

Preceramic and Early to Late Ceramic: Vampiros 1 and 2 (380 cal BCE–990 cal CE)

The Vampiros-1 rock shelter is located on a hill (Cerro Tigre) in the high tidal flats at the mouth of the River Santa María. It was first tested in 1982 (Cooke and Ranere 1984, 1992b), and reexcavated in 2002–2006 by Pearson who found and tested a second rock shelter nearby (Vampiros-2). Vampiros-1 was first occupied in the Paleoindian and Early Preceramic periods (12,000–6500 cal BCE). A long hiatus ensued during which Cerro Tigre was probably isolated from the mainland by the transgressing sea. Both shelters were reoccupied between 380 cal BCE–990 cal CE, and used intensively between 200 BCE and cal 250 CE when they would have been near or on the active marine shore (Pearson 2002a; Pearson and Cooke 2007). Carvajal excavated three columns, two in Vampiros-1 and one in Vampiros-2, with a view to evaluating the hypothesis that the most recent occupants of these shelters dried and salted fish for inland communities (Carvajal Contreras 2010; Carvajal Contreras, Jiménez, and Cooke 2008; see also Carvajal Contreras this volume).

Twenty-four bird bones were discovered in the upper (ceramic) deposits of Vampiros-1 and 2. Thirteen bones belonged to young birds. One is a mottled owl metatarsal. Adult specimens were identified as black vulture, brown pelican, and Neotropic cormorant (Carvajal Contreras, Jiménez, and Cooke 2008).

Ceramic Period: PG-L3, Pedro González Island, Pearl Island Archipelago

Two sites belonging to pottery-using communities in the Pearl Islands have yielded bird bones. At PG-L3 on Pedro González Island, a 2 × 1 m test pit was excavated in a 0.6-m-deep shell-bearing midden (640–780 cal CE; Beta-23080-02). Three taxa were identified from five bird bones: crested bobwhite, amazon parrot (*Amazona* sp), and dove (*Leptotila* sp). Amazons and the white-tipped dove (*Leptotila verreauxi*) are conspicuous members of the Pearl Island avifauna today. The crested bobwhite has not been recorded there in modern bird inventories. A single bone does not prove that bobwhites once resided on this island. Caged quails may have been moved from community to community. We note, however, that two crested bobwhite specimens were identified by Steadman at Panamá Viejo. They were found around dwellings occupied between ca. 1000 and 1200 cal CE (Parque Morelos; Martín Rincón 2003) The crested bobwhite has not been reported in the savannas east of the Panama Canal since modern ornithological records began more than a century ago (Ridgely and Gwynne 1993). It is possible, therefore, that bobwhites occurred naturally in this area before Spanish contact and that post-Columbian reforestation influenced their decline.

Another ceramic site on the north coast of Isla del Rey (Jesús María IX) produced three bone tubes fashioned from brown pelican ulnae.

Ceramic Period: Cerro Juan Díaz (200 cal BCE–1600 cal CE)

The largest and taxonomically most diverse sample of bird bones from Parita Bay was recovered at Cerro Juan Díaz (LS-3), located near the northeastern coast of the Azuero Peninsula at the mouth of the perennial River Parita: 857 specimens identifiable to genus and species are attributable to 410 individuals (Table 4). This residential-cum-mortuary site is now 4.3 km inland from the active marine shore, but it would have been closer to the sea when first occupied ca. 200 cal BCE because the River Santa María delta has expanded seawards in response to coastal progradation (Clary et al. 1984; Willey, McGimsey, and Greengo 1954). Excava-

Table 4. Taxonomically significant bird bones reported at Cerro Juan Diaz (LS-3), Azuero Peninsula, Panama, showing their distribution in nine "operations" (excavation units) across the site. MNI are aggregated from individual features within each operation.

CERRO JUAN DIAZ (LS-3)																		
Sp: NISP; I: MNI by feature	Sp	I	Sp	I	Sp	I	Sp	I	Sp	I	Sp	I	Sp	I	Sp	I	Sp	I
TAXON	Op. 1		Op. 2		Op. 3		Op. 4		Op. 5		Op. 6		Op. 7		Op. 8		Op. 31		Op. 19		*TOTAL*	
Dendrocygna indet.	**1**	1	**1**	1	**1**	1			**2**	2											**5**	5
D. autumnalis																	**2**	2			**2**	2
D. viduata	**1**	1															**1**	1			**2**	2
Cairina moschata	**1**	1			**1**	1	**3**	2	**11**	7							**11**	5			**27**	16
Anas bahamensis																	**1**	1			**1**	1
A. collaris									**1**	1											**1**	1
Crax rubra																	**3**	3			**3**	3
Ortalis cinereiceps																	**1**	1			**1**	1
Penelope purpurascans	**22**	2															**1**	1			**23**	3
Gallus gallus									**1**	1											**1**	1
Colinus cristatus	**12**	3	**6**	2	**7**	6	**10**	8	**21**	7	**2**	1	**3**	1			**28**	18	**1**	1	**90**	47
Sula indet.	**9**	0	**1**	1	**1**	1			**4**	0							**17**	0			**32**	2
S. dactylatra or *granti*	**7**	2							**1**	1			**2**	1			**3**	1			**13**	5
S. leucogaster	**5**	2			**1**	1	**1**	1	**1**	1			**1**	1			**12**	3			**21**	9
S. nebouxii	**2**	2					**1**	1	**1**	1							**2**	2			**6**	6

Table 4 (continued).

Sp: NISP; I: MNI by feature	Sp	I	Sp	I	Sp	I	Sp	I	Sp	I	Sp	I	Sp	I	Sp	I	Sp	I	Sp	I
TAXON	Op. 1		Op. 2		Op. 3		Op. 4		Op. 5		Op. 6		Op. 7		Op. 8		Op. 31		Op. 19		*TOTAL*	
Pelecanus occidentalis	**1**	1															**4**	3			**5**	4
Phalacrocorax brasiliensis					**2**	2			**18**	5			**1**	1			**1**	1			**22**	9
Fregata magnificens									**4**	3			**3**	1			**1**	1			**8**	5
Egretta indet.	**2**	1							**1**	1							**4**	2			**7**	4
Ardea indet.									1	0											**1**	0
A. alba	**4**	2	**9**	1			**1**	1	**11**	5			**3**	1			**74**	19			**102**	29
A. herodias			**1**	1					**1**	1							**3**	2			**5**	4
Butorides striatus/virescens	**1**	1															**2**	2			**3**	3
Nyctanassa violacea					**1**	1			**6**	1							**2**	2			**9**	4
Nycticorax nycticorax					**1**	1															**1**	1
Platalea ajaja																	**1**	1			**1**	1
Eudocimus albus									**14**	6			**2**	1			**3**	3			**19**	10
Mycteria americana			**5**	1			**1**	1	**1**	1							**1**	1			**8**	4
Coragyps atratus			**5**	2	**2**	2	**1**	1	**1**	1			**1**	1			**8**	3			**18**	10
Pandion haliaetus					**2**	1	**6**	3	**1**	1	**2**	1					**1**	1			**12**	7
Buteogallus indet.									**4**	1							**1**	1			**5**	2
B. anthracinus							**1**	1									**1**	1			**2**	2
Buteo indet.							**1**	1											**1**	1	**2**	2

B. magnirostris					**6**	1						**6** 1
Micrastur semitorquatus		**7**	1							**1**	1	**8** 2
Caracara cheriway					**1**	1						**1** 1
Milvago chimichima					**1**	1						**1** 1
Falco indet.					**1**	1				**1**	1	**2** 2
F. deiroleucus					**1**	1						**1** 1
F. femoralis					**1**	1						**1** 1
Aramides cajanea	**1**	1								**12**	2	**13** 3
Fulica americana										**2**	2	**2** 2
Porphyrio martinica		**1**	1									**1** 1
Charadrius vociferus	**1**	1										**1** 1
Jacana indet.											**1**	1 **1** 1
Tringa indet.										**1**	1	**1** 1
T. solitaria				**1**	1							**1** 1
T. semipalmatus					**1**	1				**2**	1	**3** 2
Numerius phaeopus										**2**	2	**2** 2
N. americanus										**1**	1	**1** 1
Calidris melanotos			**1**	1								**1** 1
Limnodromus indet.					**1**	1						**1** 1
Leucophaeus atricilla										**1**	1	**1** 1

Table 4 (continued).

Sp: NISP; I: MNI by feature	Sp	I	Sp	I	Sp	I	Sp	I	Sp	I	Sp	I	Sp	I	Sp	I	Sp	I	Sp	I
TAXON	Op. 1		Op. 2		Op. 3		Op. 4		Op. 5		Op. 6		Op. 7		Op. 8		Op. 31		Op. 19		*TOTAL*	
Onychoprion fuscatus																	**2**	1			**2**	1
Chlidonias niger					**2**	1			**1**	1					**1**	1					**4**	3
Patagioenas indet.					**2**	1									1	1					**3**	2
Columbina indet.	**6**	2	**1**	1	**3**	3	**1**	1									**5**	4			**16**	11
C. talpacoti			**1**	1									**1**	1	1	1	**3**	3			**6**	6
Leptotila/Zenaida/ Geotrygon	**16**	2	**2**	0	**2**	1	**4**	3	**10**	0							**9**	3			**43**	9
Leptotila indet.	**1**	1			**2**	1	**3**	3	**10**	7							**2**	2			**18**	14
Zenaida indet.			**4**	1	**1**	1											**3**	3			**8**	5
Z. asiatica					**1**	1			**2**	1							**1**	1			**4**	3
Z. macroura	**1**	1							**4**	1											**5**	2
Geotrygon montana									3	1											**3**	1
Ara indet.					**13**	6	**9**	5	**8**	4							**80**	12			**110**	27
Ara macao									**1**	1							**2**	1			**3**	2
Aratinga indet.			**1**	1			**4**	3	**8**	0							**4**	3			**17**	7
A. finschi									**1**	1							**1**	1			**2**	2
A. pertinax	**1**	1					**1**	1	8	2											**10**	4
Brotogeris jugularis									**3**	1							**1**	1			**4**	2

Pionus menstruus	**1**	1																					**1**	1
Amazona indet.					**13**	5	**12**	6	**4**	3							**2**	1					**31**	15
C. sulcirostris					**3**	3											**3**	3					**6**	6
Tyto alba	**1**	1															**2**	1					**3**	2
Megascops indet.	**5**	1							**1**	1							**3**	3					**9**	5
Pulsatrix perspicillata													**1**	1			**1**	1					**2**	2
Glaucidium indet.			**3**	1					**1**	1							**3**	3					**7**	5
Pseudoscops clamator																	**4**	3					**4**	3
Chordeiles minor																	**1**	1					**1**	1
Nyctidromus albicollis																	**2**	2					**2**	2
Megaceryle torquata					**1**	1																	**1**	1
Campephilus guatemalensis							1	1													1		1	
Passeriformes indet.	**10**		**21**		**6**		**11**		**10**				**1**				**26**						**85**	
Megarynchus pitangua									**8**	2													**8**	2
Pheucticus ludovicianus									**1**	1													**1**	1
Saltator stratipectus									**1**	1													**1**	1
Sturnella indet.	**1**	1					**1**	1															**2**	2
Quiscalus mexicanus	**7**	2	**1**	1	**11**	8	**3**	3	**3**	3			**1**	1			**14**	11					**40**	29
Molothrus oryzivorus	**1**	1							**1**	1							**1**	1					**3**	3
Icterus indet.									**2**	1													**2**	1

Table 4 (continued).

Sp: NISP; I: MNI by feature	Sp	I	Sp	I	Sp	I	Sp	I	Sp	I	Sp	I	Sp	I	Sp	I	Sp	I	Sp	I
TAXON	Op. 1		Op. 2		Op. 3		Op. 4		Op. 5		Op. 6		Op. 7		Op. 8		Op. 31		Op. 19		*TOTAL*	
I. galbula																	**1**	1			**1**	1
Psarocolius indet.					**1**	1											**1**	1			**2**	2
TOTAL:	**126**	37	**70**	17	**81**	51	**77**	48	**210**	89	**4**	2	**20**	11	**3**	3	**391**	160	**4**	4	**985**	421

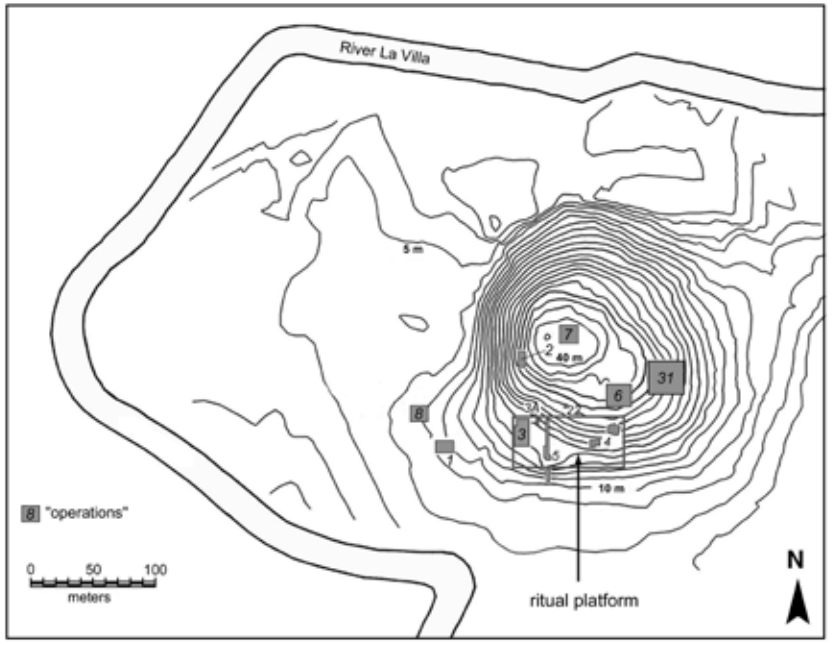

Figure 2. Map of Cerro Juan Díaz, within site LS-3, Los Santos, Panama, showing the location of excavation units ("operations") excavated from 1992 to 2001. Above 10 m contour intervals are at 2 m. Map by Cooke and Isaza.

tions undertaken here continuously from 1992 to 2001 concentrated on the 42 m-high hill at the center of the settlement (Cerro Juan Diaz). Eleven field "operations" varied in size from 2×1 m test pits (Ops-3A and 22) to Op-31, which covered ~800 m^2 (Figure 2). Each excavation revealed floors, kitchen middens, graves, and pits. Features varied greatly in each operation with regard to depth, complexity, and cultural and biological content. All the operations except Op-2 showed evidence for some kind of mortuary activity (Cooke 2001; Cooke et al. 1998; Cooke, Sánchez Herrera, and Udagawa 2000; Díaz 1999; Sánchez Herrera 1995).

Isaza Aizpurúa's foot survey demonstrated that cultural material covers ~160 hectares on both banks of the River La Villa. The size of the settlement waxed and waned through time. It started as two small hamlets during the local La Mula Phase (200 BCE–250 CE). These coalesced into a larger, more continuous settlement, which reached its apogee during the Cubitá Phase (550–750 CE). The site then contracted, but it was still used for habitation and burying the dead during the last two centuries of the

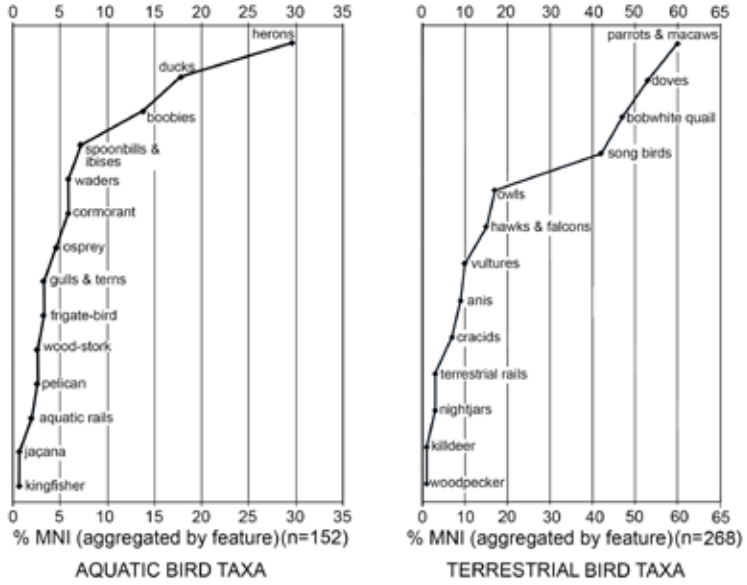

Figure 3. Frequency of aquatic and terrestrial bird taxa present in archaeofaunal samples from Cerro Juan Díaz based on minimum numbers of individuals (MNI) in each category, aggregated by feature.

pre-Columbian period. One small test pit (Op-19) was excavated on the northern side of the River La Villa (Isaza Aizpurúa 2007:154–174).

At Spanish contact, Cerro Juan Díaz would have been within the territory of a chieftain whom the Spanish named Parita. He had acquired prestige as a successful warrior beyond his territory (Cooke, Isaza Aizpurúa et al. 2003; Haller 2008; Lothrop 1937). Archaeological and documentary evidence suggest that a *pueblo de indios* called Cubitá had been established at Cerro Juan Díaz by 1575 CE. The Church promoted these "Indian towns" as a palliative to Spanish settlers' mistreatment of conquered peoples, and as a convenient means of indoctrinating the few surviving (and culturally admixed) Native Americans. A small scatter of colonial artifacts, including Spanish wheel-thrown pottery, occupied the area around and between Ops-6, 7 and 31. In Op-7 a child burial placed in an atypical stone-lined grave is of colonial age (360±40 BP; 1440–1660 cal CE]), and is likely to correspond to the 'pueblo de indios' (Carvajal Contreras et al. 2006; Cooke and Sánchez Herrera et al. 2003). This ephemeral settlement is probably the source of a chicken (*Gallus gallus*) radius from Op-5. This specimen was

found at 67–72 cm below the present-day ground surface in association with exclusively pre-Columbian cultural materials. It was stained identically to other unburned bones. It is most unlikely that domestic chickens were present on the isthmus before Spanish contact. The discovery of a chicken bone at the Arenal-1 site in central Chile—directly dated to 622±35 BP (1304–1424 CE cal at 2σ; A. A. Storey et al. 2007)—has been firmly questioned by more recent genetic studies (Gongora et al. 2008).

Minimum number of individuals (MNI) was calculated at Cerro Juan Diaz by aggregating bird MNIs estimated for individual features in each "operation." In some operations, for example, Op-3, Op-4, and Op-31, the stratigraphy and spatial relationship among features were extremely complex. Severe looting activity has interfered with many features (Cooke 1997). The MNI estimations are still preliminary and are likely to change when this site's depositional history is satisfactorily evaluated.

Aquatic Species: Three hundred and thirty-four specimens (34% NISP) at Cerro Juan Díaz are from aquatic birds representing 152 individuals (37% MNI; Figure 3). The high input of aquatic birds is expected given the site's location near the coast, a major river, and a narrow plain that regularly floods in the rainy season. (Although the killdeer is a wading bird, it is invariably found in Panama in terrestrial habitats often far from water. The gray-necked wood-rail frequents second-growth woodland. We have classified both species as "terrestrial.")

Marine species (boobies, cormorant, brown pelican, frigate-bird, laughing gull, sooty tern, and black tern) comprise 111 specimens (33% of the aquatic bird sample) and 45 individuals (30%). Some species within this group, however, occur around freshwater bodies where they may have been captured, for example, black tern, and Neotropic cormorant.

Eleven wader (Scolopacidae) individuals at Cerro Juan Díaz represent at least five species. Three are common-to-abundant today in the wetlands of Parita Bay: dowitcher, willet, and whimbrel. The solitary and pectoral sandpipers—"fairly common" today (Angehr 2005)—are more likely to be found in freshwater than in marine littoral habitats. The long-billed curlew is listed by Angehr (2005: 88) as a "rare migrant" (transient and winter resident) to coastal and nearby grassy areas.

The white ibis is represented by 10 individuals. This species frequents mudflats at low tide but can also be found around agricultural fields in the coastal plain. The roseate spoonbill, represented by one individual at Cerro Juan Díaz and also present at Sitio Sierra, is today rarer than herons, ibises, and the wood stork. Its breeding has not been proven in Panama

(Angehr 2005). Small flocks can still be seen in the vicinity. It frequents freshwater and brackish habitats near the coast.

The great egret is the second most-abundant species at Cerro Juan Díaz. This is predictable since it is the most widespread and visible heron in Panama, being found anywhere there is water (fresh, brackish, or marine) and in habitats as dissimilar as downtown Panama and Pearl Island beaches. Large breeding colonies are known in the Azuero Peninsula, some quite close to Cerro Juan Díaz (Angehr and Kushlan 2007). Wood storks, represented by four individuals, congregate locally in large numbers especially at the end of the rainy season when wide expanses of the coastal plains are flooded. Other aquatic birds in the sample include resident jacanas and purple gallinule and the migratory American coot.

The most frequent duck species at Cerro Juan Díaz is the muscovy duck. Twenty-seven bones belong to at least 16 individuals. Most of the archaeological specimens are incomplete. Steadman proposes, however, that nine elements at Cerro Juan Díaz are from domesticated birds. The black-bellied tree duck is abundant today, congregating wherever there is water, often in flooded agricultural fields. The white-faced whistling duck is also present, confirming data from Sitio Sierra that this species was a component of the local avifauna in precontact times. The migrant ring-necked duck requires fairly deep water. It is now an uncommon transient (Angehr 2005). The white-cheeked pintail is now a rare vagrant in Panama.

Terrestrial species: Macaws, parrots, and parakeets contributed 176 specimens belonging to 60 individuals from five genera. The 110 macaw specimens represent at least 27 individuals. All macaw bones at Cerro Juan Díaz are either clearly referable to the scarlet macaw (*A. macao*) or cannot be distinguished from bones of this species. A partial skeleton recovered in a grave at Sitio Sierra is a scarlet macaw (Cooke 1984a). This species is now absent from the lowlands around Parita Bay, but it preferentially frequents seasonally dry forests and is likely to have belonged to the prehuman avifauna of the region. The orange-chinned parakeet, brown-throated parakeet, blue-headed amazon, and yellow-crowned amazon are still prominent members of the avifauna of the lowlands and foothills adjacent to Parita Bay. This is not so for the crimson-fronted parakeet, represented at Cerro Juan Díaz by two specimens belonging to two individuals. This species has not been recorded in ornithological surveys around Parita Bay (Angehr, Engleman, and Engleman 2008; Lasky and Keitt 2010).

Crimson-fronted parakeets and scarlet macaws may have arrived at Cerro Juan Díaz through exchange because of their value as pets or, as we point out below, for their feathers. Both species survive in the submontane and montane forests that persist at the southwestern tip of the Azuero Peninsula (Cooke 1984a, 2004a; Cooke, Jiménez, and Ranere 2008; Ridgely and Gwynne 1989:172–174; 1993:175–176). This region was connected culturally to sites around Parita Bay to judge from the archaeological record (Ichon 1980).

Another species reported at Cerro Juan Díaz, which is now absent in the vicinity, is the pale-billed woodpecker. It occurs today only in far-western Panama in forests and forest edges up to 1200 m elevation (Ridgely and Gwynne 1989:249; 1993:269). Further east it is replaced by the crimson-crested woodpecker (*Campephilus melanoleucos*). This suggests that it arrived at Cerro Juan Díaz as an exotic trade item, perhaps a dried skin or a curiosity for caging. This species is still present, however, in lowland habitats on the Burica Peninsula and around the city of David (G. Angehr, personal communication). Therefore its natural range may once have extended further to the east in the lowlands when appropriate habitats were more widespread and interconnected.

Pigeons and doves present considerable difficulties for intra- and subgeneric differentiation. The *Leptotila* species present at Cerro Juan Díaz is likely to be the white-tipped dove (*L. verreauxi*), a widespread denizen of dry woods, open areas, and gardens. The three other Panama species in this genus (*L. battyi, L. cassini*, and *L. plumbeiceps*) have not been formally recorded around Parita Bay. The ruddy ground dove and mourning dove are also widespread on the present-day landscape. The white-winged dove, however, is restricted to habitats adjacent to the marine littoral where it is common. The ruddy quail dove—also recorded at Cerro Mangote—is not present in the area today (Angehr, Engleman, and Engleman 2008; Lasky and Keitt 2010). Since doves are mainly frugivores (*Patagioenas*) and granivores (the other four genera), their abundance and tendency to aggregate are enhanced by agricultural activities. The Spanish encamped at Natá on the northern side of Parita Bay between 1516 and 1520 CE found "turtle doves" ("tórtolas") so abundant and easy to shoot with crossbows that they felt "stuffed full" from eating so many (Espinosa 1517, cited in Jopling 1994:55)!

Birds kept in captivity for food: The crested bobwhite is the most abundant bird species at Cerro Juan Díaz (11.2% MNI). Coveys of this small quail are commonly encountered today in the grassy savannas around

Parita Bay. Bobwhites are easy to capture in fall traps baited with grain. Modern country folk take fledglings from terrestrial nests and keep them in cages. The presence of some young quail bones, as well as pathological specimens, suggest that this custom was also practiced at Cerro Juan Díaz and Sitio Sierra. This hypothesis accords with ethnohistoric data. We have pointed out elsewhere (Cooke, Jiménez, and Ranere 2007, 2008; Cooke and Ranere 1992a) that the "partridges" (*perdices*) seen by Spanish soldiers in cages at Parita Bay villages are likely to have been bobwhite quail; the "geese" (*ánsares*), muscovy duck; the "peacocks" (*pavas*), great curassow and crested guan; and the "turtle doves" (*tórtolas*), long-tailed doves similar to the European turtle dove (*Streptopelia turtur*), that is, mourning dove (*Zenaida macroura*). "Pheasants" (*faisanes*) were perhaps gray-headed chachalaca. Country folk today often keep gray-necked wood rails *(cocalecas*) in captivity.

We have already mentioned evidence for the presence of domesticated muscovy duck at Cerro Juan Diaz and Sitio Sierra. Duck bones from very young individuals were found at both sites. Some are likely to be muscovy duck and others whistling ducks (*Dendrocygna* spp).

Remains of great curassow, crested guan, and gray-headed chachalaca were recovered at Cerro Juan Díaz. Three great curassow bones appeared in Op-31 in three different features suggesting that three individuals are represented. This large species is not present in the vicinity but it still frequents forests on the western side of the Azuero Peninsula (Ridgely and Gwynne 1993: 105). Cooke (2004b) has queried Helms's (2000) insistence that a standardized image of stripe-tailed and crested birds, which is frequently painted on Gran Coclé-style pottery made ca. 700–1000 CE, invariably depict curassows. Some painted and modeled images, however, do appear to represent this species. This suggests that local artisans were familiar with it (Cooke 1984a:Figure 10; Linares 1977)

In Op-1, 22 crested guan specimens refer to an adult and a juvenile. Single bones of crested guan and gray-headed chachalaca were found in Op-31. This guan is a shy forest bird. The gregarious chachalaca shows little fear of humans and is still abundant locally in second-growth woods.

Nonculinary uses of birds: In his summary of ethnohistoric evidence for human-avian relations in New Spain at the eve of conquest, Corona-Martínez (2002) identifies four nonculinary uses for birds: (1) medicinal, (2) relevance to myths and legends, (3) adornment and pleasure, and (4) feather work. We propose that some groups of bird taxa found at Cerro Juan Díaz are likely to have been captured for nonculinary purposes.

Raptors: Seven hawk and falcon species were recorded at Cerro Juan Díaz. Black hawks (*Buteogallus* spp) are confined to the coast. The roadside hawk is generally encountered at forest edges or in second growth. The crested caracara and yellow-headed caracara are ubiquitous scavengers. The aplomado falcon is a fast-flying, bird-eating species that inhabits savannas. The orange-breasted falcon, extremely rare in Panama today, nests on cliffs in dry or humid forests. The collared forest-falcon, not present in the immediate vicinity today (Angehr, Engleman, and Engleman 2008; Lasky and Keitt 2010), may have been more abundant in the past if riverine gallery forests were more exuberant and less patchy than they are today.

Ospreys are today frequently seen singly or in pairs near coasts, along rivers and around large lakes especially in the dry season (December–April). Two osprey distal pedal digits (claws) were found in Feature 51 (Op-4), a complex tomb containing primary burials and burials in urns (Cooke 2004b:Figure 8c). Two osprey phalanges and a tarsometatarsus were recovered inside a burial urn in Feature 48 (Op-4). A tibiotarsus and femur appeared alongside a disturbed burial urn in Feature 81 in Op-3. These associations point to the use of osprey claws and talons for ritual or decorative purposes.

The two *Buteogallu*s elements found in Op-31 are pedal distal phalanges. Four other accipitrid specimens, which could not be identified to genus, are also phalanges. The *Buteo* specimen in Op-19-2 is a pedal distal phalanx. At Sitio Sierra an accipitrid pedal distal phalanx the size of that in a common black hawk was found. The *Buteo* element at Cueva de los Ladrones also is a claw. A hawk distal pedal phalanx (size of *Buteo magnirostris*) was reported at the Aguadulce Shelter. These occurrences suggest that raptor claws were intentionally saved in order to make amulets or other decorations. Some appear to have been polished by use.

Eighteen specimens of the black vulture representing at least 10 individuals were recovered at Cerro Juan Díaz. This vulture is so ubiquitous around human settlements in Panama that it can become a nuisance. It may have been killed for this reason alone. Archaeologists propose that vultures provide the model for many avian images modeled in gold, stone and pottery in Central America. In Panama, the king vulture (*Sarcoramphus papa*) is certainly represented on polychrome pottery from around Parita Bay (Cooke 1998a:Figure 2a). This species figures prominently in the myths of the present-day Bribri of Costa Rica and Panama (summarized in Cooke 1984a; see also, Bonatti González 2003; Melendez 1971).

Figure 4. Left: Effigy vase depicting an owl. Cerro Juan Díaz. Operation 6 (grave). Charred material on this vessel's interior rim gave an AMS date of 1120±40 BP (cal 810–840 CE and cal 860–1000 CE at 2σ; Beta-154373). Right: two tropical screech owls (*Megascops choliba*) at the archaeological site of El Caño, 2009. Photos: R. G. Cooke.

The distinctive crest and facial disk of the harpy eagle (*Harpia harpyja*) is apparent in some metal and stone artifacts (Benson 1997: 69–92). We cautioned elsewhere, however, that it is imprudent to attribute all images of birds with curved beaks and outstretched wings and tails to raptors (Cooke 1986). Hummingbirds are clearly depicted on polychrome pottery made around Parita Bay (e.g., Cooke 2004a:117–118 and Figure 116).

Owls are prominent in the iconography of Gran Coclé pottery. A common vessel type in graves at Cerro Juan Diaz is a chalice with legs or short pedestal, bearing the face of an owl (Figure 4). Charred material from the interior of the depicted vessel was AMS-dated to 1120±40 BP (cal 810–1000 CE; Beta-154373). It is possible therefore that the diversity of owls at Cerro Juan Díaz—six of the 10 owl genera recorded in Panama are present—reflects their importance in medicine, myths, and legends. Pygmy owls (*Glaucidium* spp) are considered to be "mysterious" by modern country folk who associate them with ghosts and spirits. On zoogeographic grounds the species of pygmy owl most likely to be present at Cerro Juan Díaz is the ferruginous pygmy owl (*G. brasilianum*) and the

Megascops species, the tropical screech owl (*M. choliba*; Figure 4) whose call is a prominent nocturnal sound in dry forests and second growth around Parita Bay. The barn owl and striped owl are larger owls that hunt in open land. The spectacled owl, however, prefers tall forest. It has not been recorded in modern ornithological surveys around the Parita Bay littoral (Angehr, Engleman, and Engleman 2008; Lasky and Keitt 2010).

Ritual or decorative use of boobies and other aquatic birds: A striking archaeological feature at Cerro Juan Díaz is a refuse lens in Op-8, which was deposited during the Cubitá phase (550–750 cal CE). It is full of debris from the production of shell beads fashioned mostly from a marine gastropod (*Strombus galeatus*; Mayo Torné 2004; Mayo Torné and Cooke 2005). Several whole and broken bone artifacts were found in this feature (e.g., Mayo Torné, Mayo, and Karas 2010:Figure 12c). It is curious, however, that none of these was made of bird bone. On the other hand, coeval Op-1—located 15 meters to the southeast and excavated six years before Op-8—produced 19 cut booby bones. All modified specimens are wing bones (1 carpometacarpus, 12 ulnae, 4 humeri, and 1 radius). One purpose of the cuts was to obtain lengths of diaphyses for making tubes. Nevertheless it is apparent from the Sitio Conte artifacts studied briefly by Cooke that the proximal and distal ends were themselves used for decoration (some have been drilled intentionally for stringing; Cooke and Jiménez 2010:Figure 3.7). This intriguing find suggests that the people responsible for depositing the refuse lens in Op-1 worked bird bone whereas those who left behind the workshop in debris in nearby Op-8, did not.

Steadman recently restudied the 72 *Sula* specimens recovered at Cerro Juan Díaz. He identified brown booby (*S. leucogaster*; 21, 9), blue-footed booby (*Sula nebouxii*; 6, 6), and masked booby (*S. dactylatra*) or Nazca booby (*S. granti*; 13, 5). (NISP and MNI are given in parentheses.) The brown booby is the most in-shore of the species found in Panama waters (Nelson 1978). Blue-footed boobies once nested on Isla Villa, a rocky islet located only 12 km south of Cerro Juan Díaz (Figure 1), but they no longer breed there (Olson 1997). Isla Villa may well have provided some of the boobies exploited by the pre-Columbian inhabitants of Cerro Juan Díaz (Cooke and Jiménez 2010).

Steadman cannot distinguish masked booby bones from those of the recently recognized Nazca booby because the two species are distinguished on the basis of bill and leg color. They are also genetically differentiated. Neither species has been recorded breeding in Panama in recent times. The Nazca booby breeds between the Isla de Afuera islands (Peru), Cocos

Island (Costa Rica), and Malpelo Island (Colombia). In the eastern Pacific, the masked booby nests on the Alijos and Revillagigedos islands (Mexico), Clipperton Island (France), the Galápagos islands (Ecuador), and Juan Fernández Island (Chile; Figueroa 2004; Friesen et al. 2002; Pitman and Jehl 1998). Angehr (2006) lists the Nazca booby as an uncommon migrant in Pacific Panama, and the masked booby as a vagrant—but only in Atlantic waters. Present-day zoogeography suggests, then, that large booby bones from Cerro Juan Díaz are more likely to refer to the Nazca than to the masked booby.

Fish were the most reliable and prolific animal food source for the inhabitants of Cerro Juan Díaz and other communities around Parita and Panama bays. Fishing was a well organized and productive activity concentrating on the tidal river, intertidal mudflats, sandy beaches, and deeper waters seaward of the turbid water plume (Cooke, Jiménez, and Ranere 2008:Figure 6–3; Jiménez and Cooke 2001). The arrival of people at Pedro González Island in the Pearl Islands before 4000 cal BCE, and the fishing practiced there, indicate that canoe travel across choppy Panama Bay is at least as ancient as this date. Veneration of boobies seems to have been widespread around Panama Bay: Mendizábal (2004: 149) found the rostrum of a blue-footed booby (*S. nebouxii*) in a pre-Columbian grave at Panama Viejo. Boobies' spectacular fishing abilities may be one reason for their widespread importance in display and, presumably, ritual. Displaying osprey claws and talons is likely to reflect this association as well.

We mentioned above a flute fashioned out of a pelican-bone humerus from a Sitio Sierra grave (the same one that received a scarlet macaw as an offering). Jesús María IX, on Isla del Rey (Pearl Islands), produced three bone tubes fashioned from brown pelican ulnae. The only other bird-bone artifacts from Cerro Juan Díaz, which retained taxonomically diagnostic anatomical features, comprised (1) a cut and polished brown pelican ulna (Op-31); (2) a tube fashioned from the tibiotarsus of a great blue heron (Op-5); and (3) two frigate-bird radii and one ulna cut below the articulations (Op-7).

Admittedly, the sample of identifiable bird-bone artifacts is small. Practical considerations, such as size, sheen, and durability, may explain the selection of pelican and other large aquatic bird bones. Nevertheless, the prevalence of sharks, ray, and sea turtle images in Gran Coclé art vouches for the importance of marine species in the regional imagery (Cooke 2004a: 116–117; Linares 1977). Evidence from Sitio Conte suggests that high-rank individuals possessed showy artifacts fashioned from hundreds

of booby bone tubes (Cooke and Jiménez 2010). It remains to be seen whether future analyses of taxonomically diagnostic bird bones, for example, from Julia Mayo's ongoing excavations at a high status burial ground at El Caño, will confirm an intentional emphasis on piscivorous birds for fashioning costume artifacts.

Feather-work for ritual, ceremony and trade: Brightly colored feathers were widely used for decoration, ritual, and ceremony in native societies across the Neotropics. They were an important component of tribute demanded by the Aztec from conquered nations (Corona Martínez 2002; Peterson and Peterson 1992; Reina and Kensiger 1991). Macaws were a primary commodity for trade and ceremony commodity for trade and ceremony in Mexico. They were bred at Paquimé (Chihuahua), which was probably the distribution center for macaws to the American southwest where they were also bred (Minnis et al. 1993; Somerville, Nelson, and Knudson 2010).

It is likely that some bird species with bright plumages, including macaws, amazons, and parakeets, were hunted or kept for their feathers at Cerro Juan Díaz. Macaw remains are not evenly distributed across the site. They are only found in four operations (3, 4, 5, and 31). Ops. 3, 4, and 5 were placed on an intentionally leveled area to the south of the central hill. Each operation contained abundant graves (Cooke, Sánchez Herrera, and Udagawa 2000; Díaz 1999). Eighty macaw specimens from at least 12 individuals were found in Op.-31 where several funerary and ceremonial features were recorded. Macaw bones were not recorded in Op-1 where the primary feature was a refuse lens replete with human food remains, or in Op-2, which contained midden deposits.

A cluster of 26 *Ara* specimens belonging to a single individual was found in Feature 16 of Op-31, which contained secondary human burials. It is likely that this macaw was intentionally deposited in this feature. Nearby, 24 macaw specimens belonging to a single individual were recovered. These are in the same stratum as a prominent ritual feature consisting of 28 upturned vessels whose only offerings were human maxillae and mandibles whose teeth had been extracted postmortem. This feature was deposited between 1165 and 1450 cal CE (Carvajal Contreras et al. 2006; Cooke 2001). The macaw may be an offering related to this feature.

Feature 16 of Op-31 also contained 28 bones from a single great egret, which suggests intentional placement within this feature. Great egrets are another candidate for feather use. So are passerines with bright plumages: rose-breasted grosbeak (males), boat-billed flycatcher, Baltimore

oriole, and the two *Sturnella* species found in this area of Panama—eastern meadowlark and red-breasted blackbird (males). These species were found in Op-5 where there is evidence for a specially prepared surface, which may have had a ritual function.

There is no evidence in Op-31 for the existence of structures, which may have served as aviaries for housing curious birds or others that were used for their feathers and bones or for ritual, medicinal, or symbolic purposes. But it is worth bearing this possibility in mind when other ceremonial sites like Cerro Juan Díaz are subjected to areal excavations. We suspect that the western section of Op-31 may have housed such a structure on the basis of the bird-bone distributions we have just summarized.

Conclusion

We have summarized the avifaunas found at pre-Columbian residential and funerary sites in two areas of Panama: Parita Bay on the Pacific mainland and the Pearl Island archipelago. Bird specimens are well-preserved in contexts with appropriate soil chemistry, but are scarcer than mammal and reptile bones and, at some sites, even frog bones (Cooke, Jiménez, and Ranere 2008). Since birds are considerably more diverse than terrestrial mammals, reptiles, amphibians, and reptiles, large décapage-type excavations are required adequately to sample classes, considerable excavation is needed to sample adequately the avifauna that would have been available around each site. This was amply demonstrated at Cerro Juan Díaz. Nonetheless, the ability of the research team to relate bird remains to individual features as they were being uncovered would have been enhanced by having a trained zooarchaeologist permanently on the site. Had this been the case, the intriguing possibility that structures for keeping birds may have been present there could have been investigated immediately and *in situ* rather than pondered *a posteriori* when the bird-bone identifications had terminated!

The low numbers of bird bones on the Pearl Island archipelago are a scientific disappointment. These islands have played an important part in theoretical discussions of island biogeography (MacArthur, Diamond, and Karr 1972; MacArthur and Wilson 1967; Wright, Faaborg, and Campbell 1985). The Preceramic settlement at Playa Don Bernardo appears to represent the initial human colonization of the archipelago after postglacial sea level rise had isolated it from the mainland. Therefore it

would be illuminating to identify more components of the avifaunas present on individual islands when humans first arrived. Areal excavations are required to augment the bird-bone sample.

Nine bird species recorded in the Parita Bay archaeofaunas have not been recorded in formal ornithological surveys conducted in the coastal lowlands between Cerro Cerrezuela and the environs of the modern town of Chitré (Figure 1; Angehr, Engleman, and Engleman 2008; Lasky and Keitt 2010): great curassow, crested guan, collared forest-falcon, orange-breasted falcon, uniform crake, ruddy quail-dove, red-lored amazon, spectacled owl, and pale-billed woodpecker. It is impossible to determine objectively whether these birds were obtained locally or from distant regions. We propose, however, that all these species (except, arguably, the pale-billed woodpecker) could have been present around Parita Bay before Spanish contact *if dry woods and riverine gallery forests were more continuous, interconnected, and ecologically healthy than they are today.* This seems likely in view of the fact that pre-European Native American technology and the lack of domesticated ruminants would have been less deleterious to these vegetation formations than modern land modification practices. On the other hand, our data show that the bird community now characteristic of the wooded savannas of central Panama and elsewhere in Pacific Central America was in place in the coastal lowlands around Parita Bay by the beginning of the Common Era. This community is epitomized by such species as crested bobwhite, crested caracara, yellow-headed caracara, aplomado falcon, ruddy ground-dove, plain-breasted ground-dove, white-winged dove, mourning dove, brown-throated parakeet, barn owl, striped owl, white-tailed nightjar, eastern meadowlark, and red-breasted blackbird.

With regard to human hunting endeavors and strategies at individual sites, the distribution and frequency of bird genera and species in the archaeofaunas are largely predictable in terms of the most likely distribution of nearby habitats (when diachronic changes in local topography are taken into consideration). The best candidates for having been food items are species that would have been *locally* abundant. For example, at Late Preceramic Cerro Mangote, the small-bird sample emphasizes coastal wading birds. This is consistent with the topography inferred by prior geomorphological studies for the environs of this site between 5930 and 3020 cal BCE (Cooke and Ranere 1992a).

Hundreds of people probably lived at Cerro Juan Díaz and Sitio Sierra during the final 2000–1500 years of the pre-Columbian era. The high

frequency of herons and egrets, ducks, bobwhite quail, doves, and grackles in midden deposits is harmonious with a patchwork of active and abandoned agricultural fields, seasonal swamps, ox-bow lakes, second growth, riverine forests and dry forest remnants on hills—the landscape that the invading Spaniards described in considerable detail between 1515 and 1530 CE (Cooke, Norr, and Piperno 1996; Cooke, Jiménez, and Ranere 2008; Sauer 1966). Bobwhites and doves are particularly attracted to fields and residential areas, and are relatively easy to capture with traps that can be monitored while people are engaged in other activities, such as tending to fields. It is likely that villagers obtained all or most of their avian food items quite close to their settlements thus avoiding conflict with people from nearby chiefdoms during a period of constant social tension (Cooke and Sánchez Herrera 2004a, 2004b; Haller 2008; Helms 1979; Isaza Aizpurúa 2007; Linares 1977).

That birds were obtained for reasons other than or in addition to human sustenance is exemplified by the large proportion of intentionally modified booby bones at Cerro Juan Díaz; the finds of hundreds of cut booby bones used to make aprons and bracelets at the Sitio Conte mortuary precinct; and the intriguing discovery of a blue-footed booby rostrum in a grave at pre-Columbian Panama Viejo. These marine birds must have been imbued with a special symbolic significance during the last 1,000 years of the pre-Columbian period. The one-hulled dug-out canoes documented ethnohistorically probably would have enabled people to navigate considerable distances offshore to find boobies—perhaps including the Nazca booby, which does not breed in Panama. At the same time, we warn that boobies are known to have nested on islands quite close to shore, such as Isla Villa located, a mere 12 km from Cerro Juan Díaz and 7 km from Finca Germán Castillo. These are likely to have been brown and blue-footed boobies.

Macaws, parrots, and parakeets recorded at Cerro Juan Díaz may have been kept as pets or for using their feathers. Great egrets and colorful passerines are other candidates for these behaviors. Macaws and the crimson-fronted parakeet are no longer found within 100 km of Cerro Juan Díaz and Sitio Sierra, but they once may have been *natural* components of the local avifauna. Steadman was unable unequivocally to attribute macaw bones to species other than the scarlet macaw. This is known to be the species best adapted to the strongly seasonal climate and dry woodlands of the Parita Bay littoral. The white-faced whistling duck presumably dis-

appeared from this area due to human hunting pressure although we cannot know whether this happened before or after Spanish contact.

Other birds that are likely to have been kept in captivity for food are curassows, guans, quail, ducks, and rails. Ethnohistoric data give credence to this hypothesis. The size of at least one muscovy duck individual at Sitio Sierra is typical of a modern domesticated male. Several individuals at Cerro Juan Díaz were probably domesticated, too. The presence of young duck bones, which appear to be muscovies and whistling ducks on morphological grounds, is further evidence for domestication or for the widespread Native American custom of bringing young birds back to settlements and keeping them until needed for food or other purposes.

Trade may explain the presence of the crested bobwhite at Panama Viejo and on Pearl Island archipelago where this species no longer occurs. Isotopic and trace element analyses may help resolve this problem since *Colinus* quails have small home ranges (Johnsgard 1973). They should also be applied to macaw bones to determine whether they received a nonnatural diet, for example, C4 plants, as they did at Paquimé in Mexco (Somerville, Nelson, and Knudson 2010)

The bird-bone samples we have considered were found in two small areas of Panama, which have long and windy dry seasons that exacerbate human burning and forest clearance. These practices can be traced back to the Preceramic. It is unlikely that bird-bone assemblages from sites located in other isthmian regions would replicate the avian distributions and human cultural emphases we have summarized. Bird remains are being recovered at Sitio Drago (Isla Colón, Bocas del Toro), which was considerably larger than Cerro Brujo—a nearby site that reported no bird bones—and socioeconomically more diverse (Wake and Mendizábal in revision). These samples have not yet been analyzed; but they promise to amplify the interpretations presented herein since they represent a region where year-long rainfall curtails burning and favors the survival of forested habitats.

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Key Words

Panama, pre-Columbian, birds, Cerro Juan Diaz, Sitio Sierra, Pearl Islands, bone tools, macaw, booby, quail

Digital Companion

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