

# Taphonomy at two contiguous coastal rockshelters in Panama: Preliminary observations focusing on fishing and curing fish

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## Abstract

The scarcity of animal products negatively influences nutrition in tropical inland areas, which lack large rivers. Consuming cured marine fish mitigates this deficiency. In Panama, trading cured fish from coastal to inland sites is documented ethnohistorically and can be inferred from the current archaeozoological record. Very large numbers of marine fish remains have been recovered at pre-Columbian sites located on and around Parita Bay, a mangrove-fringed estuary on the central Pacific coast. At Sitio Sierra, a farming village 12 km inland from the active marine shore, more than 70% of fish remains deposited between ca. 1800 and 1500 uncalibrated radiocarbon years BP proved to be of marine origin. Two small rock-shelters located downriver from Sitio Sierra and now 2.6 km from the marine shore (Vampiros-1 and Vampiros-2) show evidence for having been used intensively for fishing and preparing fish between ca. 2200 and 1900 BP. A prior model based on air photograph interpretation and sedimentological analyses of marine and terrigenous sediments suggest that these shelters would have been on or very near the active marine shore at this time. A much earlier occupation at Vampiros-1 dating to ca. 11,500–7700 BP corresponds to pre-agricultural (Paleoindian) and early agricultural (Early Preceramic) people who camped occasionally in this shelter when the transgressing ocean was in the process of flooding Parita Bay. No shell or bone was recovered in this earlier cultural component. In the more recent (2200–1900 BP), component abundant remains of marine mollusks and crustaceans and vertebrate bones (mostly fish) are in excellent condition. A synopsis of the geological and cultural history of the Vampiros shelters is followed by preliminary observations on the relationship between pre-Columbian human activities and these sites' formation processes, soil chemistry, bone integrity and animal species. Evidence is accruing for human impacts on fish skeletons resulting from the in situ preparation of fish (i.e., gutting, cutting and smoking) providing the opportunity to compare our archaeofaunal data with the results of Irit Zohar's ethno-archaeological research, which identified how preparing fish for salting and sun-drying at present-day Panamanian fishing villages around Parita Bay affects the fish skeleton physically and proportionally. There is a strong possibility that the Vampiros shelters were used to provision inland sites like Sitio Sierra with inshore marine fish although we cannot yet ascertain the means by which coastal foodstuffs may have arrived at the latter site.

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## 1. Introduction

Living on or near coasts affords nutritional advantages to human societies especially when protein and fat from marine animals complement carbohydrate-rich plant foods. The availability of salt, an essential nutrient, is also of considerable importance. Hypotheses advocating that coastal resources were a catalyst for population growth,

sedentism and cultural complexity in the Americas (e.g., Moseley, 1975; Yesner, 1980; Sandweiss et al., 1998; Erlandson, 2001; Erlandson and Fitzpatrick, 2006) have been palliated by the discovery that pre-Columbian peoples cultivated plants and developed agriculture far earlier than formerly believed often at very great distances from marine coasts (e.g., Piperno, 1988; Piperno and Pearsall, 1998; Smith, 1998; Smith, 2001). Even so, it is clear that some of the earliest manifestations of village life and complex societies in the New World developed in proximity to coastal wetlands and/or nutrient-enriched upwelling zones whose resources not only enhanced diet breadth and nutrition, but also injected valuable commodities into

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exchange networks, i.e., colorful marine shells, fish and marine mammal bones and teeth, sea salt, and cured fish and shrimp (Smith, 1993; Drennan, 1996).

The geographic focus of this research is Parita Bay on the central Pacific coast of the Isthmus of Panama, the first area of the New World tropics to provide evidence for the mid-Holocene exploitation of coastal resources (Willey and McGimsey, 1954; McGimsey, 1956) (Fig. 1). The sites we consider are the Vampiros rockshelters (1 and 2), which are located on a small rocky hill (Cerro Tigre), 2.6 km from the present-day shoreline of the bay (Figs. 2 and 3). The position of these sites vis-à-vis sea level, a major river (the Santa María) and landforms related to the rapidly changing meanders and delta of the latter has changed constantly through time. One of the rock-shelters (Vampiros-1, formerly ‘Cueva de los Vampiros’ (Cooke and Ranere, 1984, Fig. 5)) was first used by humans during the Late Glacial (after 11,500 BP) when people possessing a Paleoindian stone tool kit (including fluted points) camped

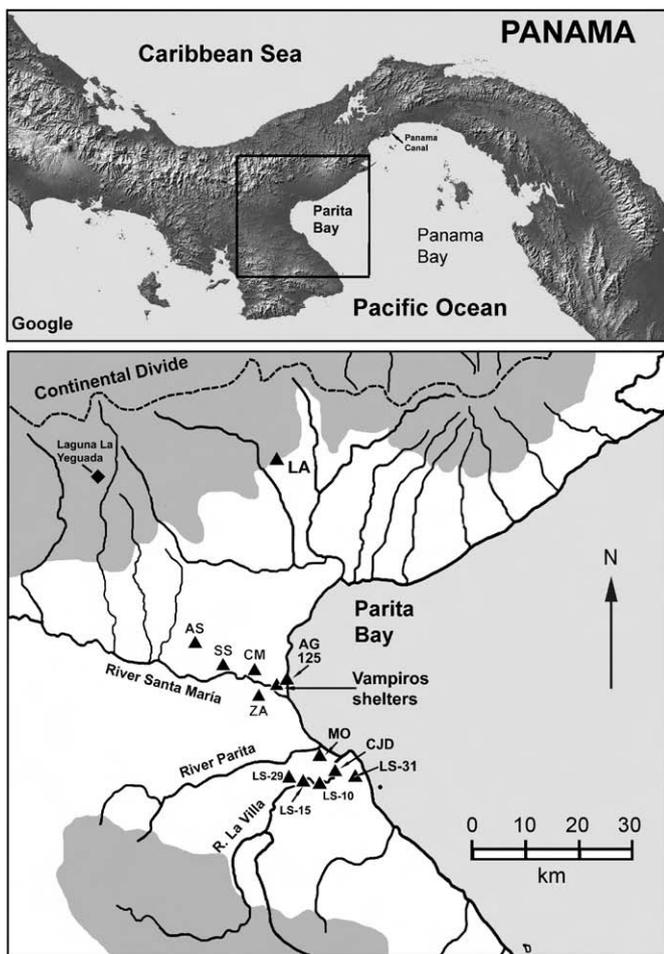


Fig. 1. Maps showing the location of the Vampiros-1 and Vampiros-2 shelters with respect to other pre-Columbian sites around Parita Bay, which have provided data on fishing practices (Upper map: Google, lower map: R.G. Cooke). *Named sites:* AS—Aguadulce Shelter, CJD—Cerro Juan Diaz, CM—Cerro Mangote, LA—Cueva de los Ladrones, LS-10—Las Huertas, LS-15—La Isleta, LA-29—La Chilonga, MO—Monagrillo, SS—Sitio Sierra, VA—Vampiros shelters and ZA—Zapotal.

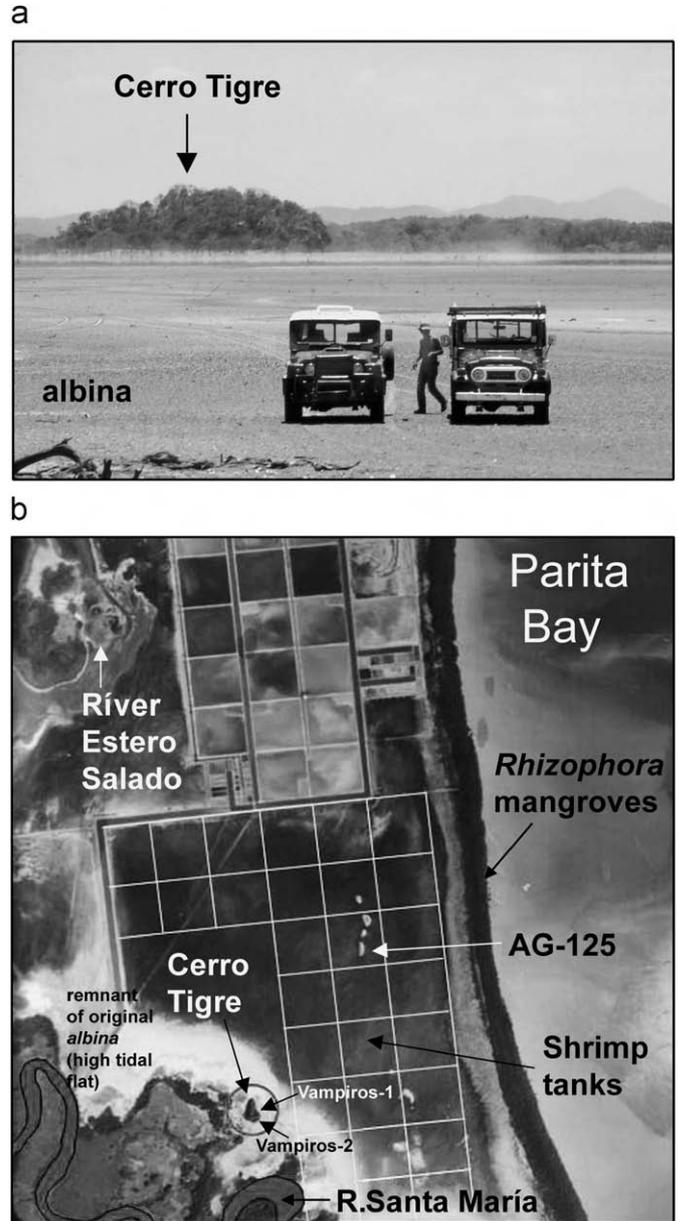


Fig. 2. (a) View of Cerro Tigre from the north-east, dry season, 1982, when it was landward of an extensive high tidal flat or *albina*. (Photo: R.G. Cooke). (b) Air photograph of Parita Bay (2002) showing the location of Cerro Tigre, adjacent shrimp tanks (which have cut through the natural high tidal flats or *albinas*) and prominent landforms.

here occasionally. At this time the marine shoreline was still distant. Vampiros-1 continued to be occupied sporadically and lightly until ca. 7700 BP after which it appears to have been abandoned as the ocean encroached and probably drowned the immediate environs of Cerro Tigre (Pearson, 2002; Pearson and Cooke, 2002, in press; Pearson et al., 2003). After ca. 2200 BP both shelters were re-occupied. They were used intensively for the next 300 years and thereupon less frequently until ca. 1100 BP. By this time it appears that their increasing distance from the active marine shore had favored the establishment of new fishing stations, such as a linear group of sites (including

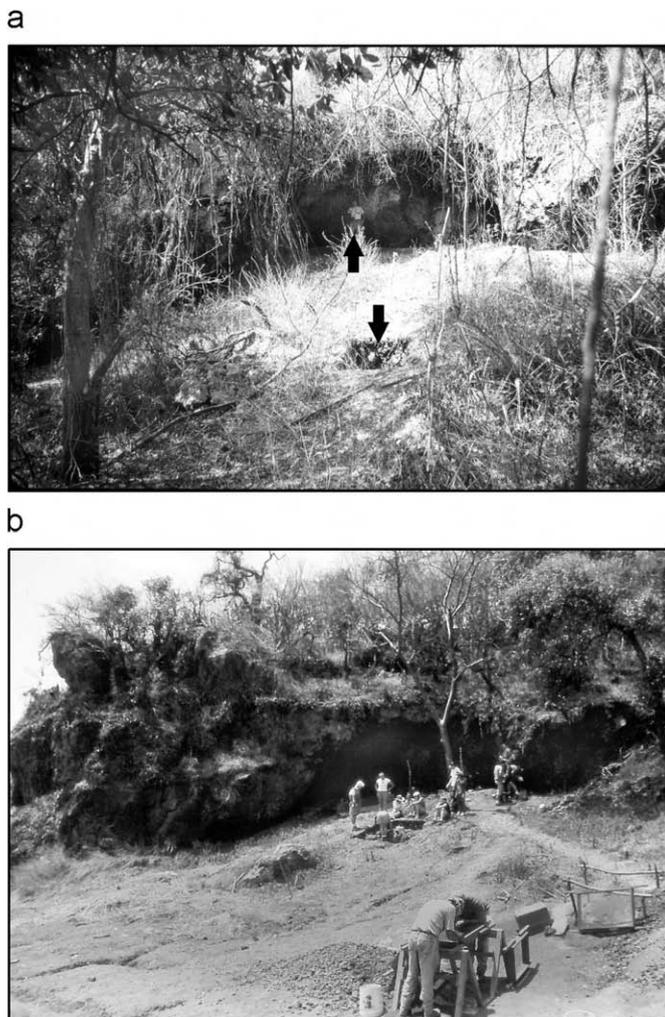


Fig. 3. (a) View of Vampiros-1 in 1982. The up arrow points to a person standing under the overhang. The down arrow shows the location of test pit 1 dug “Proyecto Santa María” archeologists (Cooke and Ranere, 1984). (Photo: D. Weiland). (b) View of Vampiros-1 in 2004 during a Princeton University field course. The talus was scraped by a bulldozer in 2000 resulting in the removal of 0.5m of cultural sediments (Photo: M. Guerra).

AG-125) identified by archeologists ca. 1 km to the east (see air photograph in Fig. 2b).

The predominance of fish remains in the variegated upper deposits of both Vampiros shelters (our D2), their physical state, and evidence for many kinds of features made of perishable materials, suggest that fishing and the curing of fish were the principal activities at these small overhangs between 2200 and 1900 BP (Fig. 4). The presence of other vertebrate classes, however, suggests that people stayed long enough at the shelters to engage in other activities.

Carvajal-Contreras is analyzing fish remains recovered in three 0.5 m column samples in 2005. She aims to test the hypothesis that between ca. 2200 and 1900 BP the Vampiros shelters were used to cure fish obtained in nearby inshore and river-mouth habitats in order to provision coeval communities located further inland. One

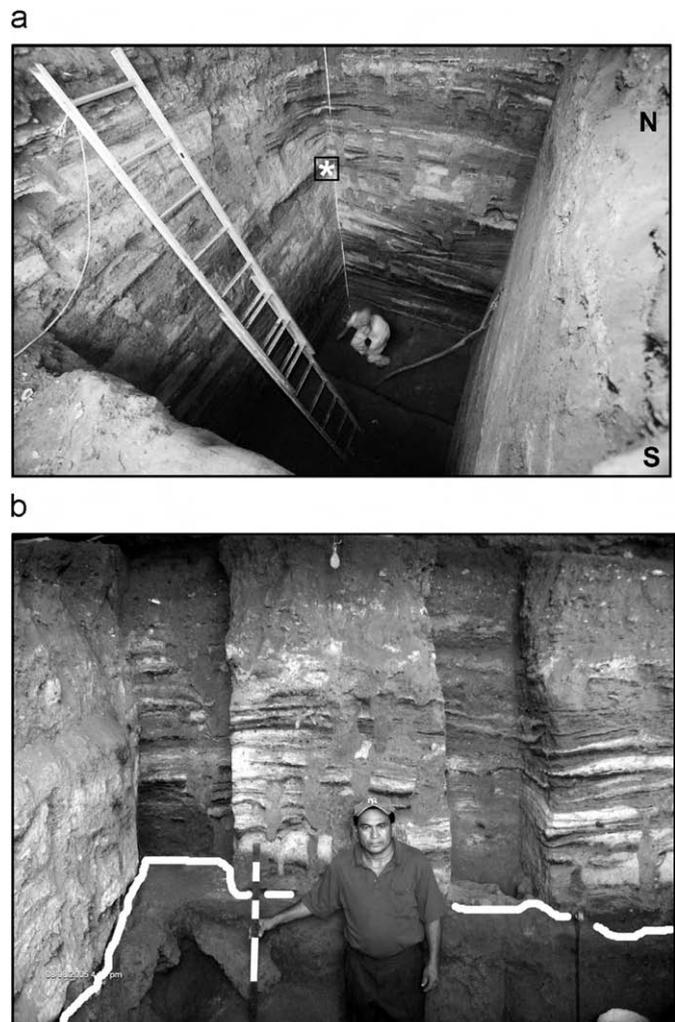


Fig. 4. (a) Vampiros-2, test pit (2 × 1 m), 2005. The person is sitting on the lowest level excavated. The asterisk (\*) relates this photo to the drawing in Fig. 5. Carvajal-Contreras excavated a 0.5 m column on the western edge of the north wall (Photo: M. Guerra). (b) Vampiros-1, south wall, 2005, showing the position of the two columns taken by Carvajal Contreras through depositional units (D) 1 and 2. The white line highlights the division between the variegated post-2200 BP deposits (D 1 and 2) and the earlier, more homogeneous deposits lacking shell and bone (D 3–5) (Photo: Carvajal-Contreras).

of these is Sitio Sierra, an inland village where there is evidence for the consumption of many species of marine fish albeit at a slightly later time period (1800–1500 BP) (Cooke and Ranere, 1999). Carvajal-Contreras is referring to observations on bone damage, proportionality and survivability provided by Irit Zohar’s prior ethno-archeological study of two men from the present-day village of Boca de Parita who prepare fish of different species and sizes for brining and sun-drying (Zohar and Cooke, 1997).

## 2. Cultural and geological setting

Soon after the Second World War archeologists found sites containing abundant marine mollusks and crustaceans

located near geological features, which air photograph interpretation suggested were related to marine shorelines that had changed through time in response to sea-level rise, marine transgression and (during the past ~7000 years) coastal progradation (the seaward expansion of terrigenous sediments). One of these sites (Cerro Mangote) (CM in Fig. 1b) lacked pottery while others (e.g., Monagrillo [MO] and Zapotal [ZA]) contained a very simple ceramic ware (“Monagrillo”) (Willey and McGimsey, 1954; McGimsey, 1956). It was assumed that these sites were considerably older than others located further inland along sizable rivers whose cultural inventory and mortuary remains represented sedentary farming communities belonging to fairly complex societies, i.e., chiefdoms (Lothrop, 1937, 1942). By 1960 the age of the Parita Bay coastal sites (ca. 7000–3500 BP) had been elucidated by radiocarbon dating (McGimsey, 1957; Deevey et al., 1959). Since then their occupation history has been fine-tuned by additional excavations and  $^{14}\text{C}$  dates (Ranere and Hansell, 1978; Cooke and Ranere, 1992b; Piperno et al., 2000).

The excavations in the 1950s were conducted without sieving and by using horizontal arbitrary levels that cut across irregularly accumulated natural strata. These techniques led to the recovery of far more invertebrate than vertebrate remains. Even so the abundance of marine shell and locations on past shore lines suggested to Willey (1971) that shellfishing and fishing were the primary subsistence activities at Cerro Mangote (7000–5000 BP) and at Monagrillo and other coeval ceramic sites (4500–3200 BP). Hence he assigned them to his North-west South American Littoral Tradition proposing that their inhabitants were non- or “incipiently” agricultural peoples confined to the marine shore whose strongest cultural links were with other littoral cultures between Ecuador and Panama.

Subsequent research has shown that the early coastal sites of Parita Bay were in fact coeval with and culturally related to many other small settlements dispersed across both watersheds of central Panama (Cooke and Ranere, 1992a–c; Cooke, 2005; Griggs, 2005). Multi-proxy analyses of lake sediments at La Yeguada (see Fig. 1b) show that people were felling and burning forests in the Pacific foothills and plains at this time (summarized in Piperno and Pearsall, 1998, pp. 175–179). Studies of phytoliths and starch grains embedded on stone tools point to the widespread use of domesticated plants, i.e., maize, manioc, sweet potatoes, squashes and arrowroot (Piperno and Pearsall, 1998, pp. 209–227; Dickau, 2005; Dickau et al., 2007). For example, the inhabitants of the Monagrillo site prepared maize, manioc and palm fruits with their abundant grinding stones (Piperno and Holst, 1998). An edge-ground cobble found at Zapotal produced pepper (*Capsicum*) starch (Perry et al., 2007).

It has not yet been established whether the Parita Bay coastal sites were occupied seasonally by people who lived inland at other times of the year (i.e., during the planting

season) or year-round by groups who exchanged coastal resources with communities located in other ecosystems and habitats (Cooke, 2005). Nonetheless it is clear that their inhabitants were not just strandloopers who subsisted mainly on marine mollusks (Willey, 1971). They participated in a regional economy exchanging non-perishable and perishable goods obtained in many different terrestrial and coastal habitats (Cooke and Ranere 1992c; Cooke, 2005; Griggs, 2005). One important perishable commodity was fish.

### 3. Model for marine transgression and coastal progradation

Between 1979 and 1982, geologists from Temple University conducted a survey of the Parita Bay littoral with a view to determining the antiquity, nature and inter-relations of coastal landforms and their relation to known pre-Columbian sites. This research was presented in two unpublished master’s theses (Barber, 1981; Dere, 1981) and summarized by Clary et al. (1984). Sediments were sampled with a Vibracore in different littoral habitats around the bay. A facies model proposed that the ocean transgressed Panama and Parita bays rapidly until about 7000 BP, at which time the active shoreline would have coincided approximately with the landward edge of the high tidal flat illustrated in Fig. 2b. As sea level rise diminished the Santa María River delta began to accumulate sediments and prograde seawards. The Temple University geologists estimated from sediment analysis that from ca. 4000 BP to the Present, progradation has advanced in the central zone of Parita Bay (i.e., the mouth of the Santa María River) at about  $1\text{ mm yr}^{-1}$  or 1 km every 1000 years.

We are still ignorant of many geological details that impinge upon the accuracy of this facies model. For example, the present-day outlet of the Santa María river, which currently runs just to the south of the Cerro Tigre, was not necessarily the outlet when, according to archeological data, the Vampiros shelters were used as fishing stations. Infrared and standard air photographs suggest that at one time the River Santa María would have flowed to the north of Cerro Tigre entering the sea where the River Estero Salado now runs (Fig. 2b; Cooke and Ranere, 1999, Fig. 1). It is probable that it was still flowing in this direction between ca. 2200 and 1900 BP when fishing-related activities were most intense in the Vampiros shelters. Another impediment to the facies model is deficient knowledge about the influence of coastal uplift for which there is some field evidence (Clary et al., 1984). Even so, the occupation sequence which Pearson’s and our research proposes is harmonious with the timing of marine transgression proposed by the facies model and also with a post-4000 BP progradation rate in the order of  $1000\text{ m yr}^{-1}$ . It is hoped that future geomorphological field research coupled with sedimentological and biological analyses of the Vampiros deposits will enhance or modify the current model.

#### 4. Coast-inland transport of fish

Although the first excavations at Cerro Mangote, Monagrillo and Zapotal produced very few fish bones because sieves were not used, subsequent analyses of screened archaeofaunal samples at these sites demonstrated that their inhabitants captured many inshore marine fish species, some in considerable quantities. These remains and those recovered at the Vampiros shelters were identified with the comparative fish skeleton collection housed at the Smithsonian Tropical Research Institute in Panama. This currently contains 1570 prepared skeletons belonging to 91 families, 221 genera and 356 species, mostly from the tropical eastern Pacific and Panamanian freshwater bodies. Many of the marine fish families most commonly encountered at Parita Bay sites (e.g., marine catfish [Ariidae], croakers and allies [Sciaenidae], jacks and allies [Carangidae] and grunts [Haemulidae]), contain many species. Although most species in these four families and others reported in Parita Bay archaeofaunas frequent shallow inshore waters, they exhibit variable preferences for specific coastal habitats (Cooke, 1992, 1996; Robertson and Allen, 2004). Therefore, identifying the *species* exploited by prehistoric fisherfolk enhances our understanding of fishing with the important proviso that we are only referring the marine fish bones in our samples to *species that have been recorded in eastern tropical Pacific waters* (Cooke and Jiménez, 2004).

At Monagrillo (4500–3200 BP) and Zapotal (4000–3500 BP), which were located on or very near the marine shore during their major occupations, the most abundant species frequent sandy beaches, estuaries and shallow lagoons, e.g., Pacific moonfish (*Selene peruviana*), thread-herrings (*Opisthonema* spp.), marine catfish (e.g., *Ariopsis seemanni* and *Cathorops furthii*), Pacific bumpers (*Chloroscombrus orqueta*) and threadfins (*Polydactylus* spp.) (Cooke, 1992, 1995; Jiménez and Cooke, 2001; Peres, 2001). The Aguadulce Shelter, partially coeval with these sites (AS in Fig. 1), is now located 18 km from the present-day coastline. Thirty-two genera and 41 species of marine fish were identified here including the common species we have just mentioned. At Cueva de los Ladrones site (CL), now 25 km from the coast, four genera and three species of marine fish were recovered from the Early Ceramic levels (4500–2500 BP). These are thread-herring, point-nosed croaker (*Ophisocion typicus*), Pacific ilisha (*Ilisha fuerthii*) and Pacific bumper (Cooke, 2001; Cooke and Jiménez, 2004). These kinds of small shoaling fish used to be caught in large numbers in intertidal traps around Parita Bay (Cooke and Tapia-Rodríguez, 1994b). (English names are from FishBase <[www.fishbase.org](http://www.fishbase.org)>).

Another somewhat later site providing substantive data for use of marine fish at inland sites is Sitio Sierra, a large (maximum: 45 ha.) nucleated village. Cooke and Ranere (1999) studied fish remains from a large refuse lens deposited 1800–1500 BP. They determined that 70% of fish bones recovered by water-screening over a 1/8" (4 mm)

mesh are of marine origin (55 genera and 78 species were identified). A few of these marine species have been recorded in freshwater sections of the River Santa María and could have been caught from the river bank in front of Sitio Sierra (Cooke and Tapia-Rodríguez, 1994a). Others frequent the middle estuary, i.e., the turbid mixing zone (*sensu* Day et al., 1989), whose inner margin is about 5 km down the River Santa María as the crow flies. By far the most frequent marine species in this sample, however, are thread-herrings, Pacific moonfish and brassy grunt (*Orthopristis chalceus*). Adults of these species avoid turbid water being most abundant in clear water currents over sand-rubble bottoms or near sandy beaches. Such habitats would have been more than 12 km distant from Sitio Sierra as the crow flies.

Two modes of acquisition stand out as alternatives: either, the inhabitants of Sitio Sierra and other earlier inland sites traveled themselves to coastal habitats to procure fish, or they acquired them through exchange with coastal communities (cf. Reitz and Masucci, 2004). That the latter pattern is a viable alternative is suggested by a 1516 Spanish document, which describes people from the coast of Parita Bay coming into the Spanish camp at Natá to “exchange fish and crabs for maize” (Espinosa, in Jopling, 1994, p. 49). Colonial documents written at the moment of Spanish contact in the early sixteenth century AD describe the inland transport of marine fish. For example, a chieftain called Comogre whose head village was probably in the headwaters of the Chucunaque valley on the Pacific slopes of Panama, was supplied with fish from the *opposite* (Caribbean) coast (Andagoya, in Jopling, 1994, p. 24; Cooke and Sánchez-Herrera, 2004). This is a straight-line distance of over 40 km over extremely rough terrain. Although different cultural groups exhibit markedly variable degrees of tolerance of putrefying meat and fish, it is reasonable to assume that fish moving through Comogre’s chiefdom was cured in some way. Around the Gulf of San Miguel on the Pacific coast of Panama, Spanish chronicler Fernández de Oviedo (1535) saw people curing fish for “5 or 6 days” in shallow holes covered with earth. Although salt was not used, the finished product was dehydrated (the word he used is: *enjuto*, “dried out”). Fernández de Oviedo (1853, p. 140) does mention “salt fish,” however, when making a general comment about the Cuevan people of the Darién remarking that this commodity was carried on slaves’ backs.

Salting fish in brine and sun-drying them for transport to inland communities is a traditional if fast-disappearing practice at present-day communities located around Parita Bay (Zohar and Cooke, 1997; Cooke, 2001). Since the native people of this part of Panama were exterminated or acculturated extremely quickly after conquest in the early sixteenth century AD (Cooke et al., 2003; Cooke and Sánchez-Herrera, 2004) it is imprudent to assume continuity between pre-Columbian and historic practices. (One obvious difference, of course, is that metal tools replaced stone tools.) But since the Spanish describe salt-pans and

salt in natural “lagoons” during the dry season (e.g., Andagoya, in Jopling, 1994, p. 32), it is reasonable to assume that fish consumed at some distance from the Pacific coast in pre-Columbian times was prepared at coastline communities by using salt in some way and by taking advantage of the long period of sunny and windy days that characterize the dry season (December–May) in this part of Panama.

## 5. The Vampiros shelters

Carvajal-Contreras is evaluating the relationship between fish remains, fishing and fish curing methods at the Vampiros shelters. In 2005, she took two 0.5 m columns from the south wall of Vampiros-1 and one 0.5 m column from the wall of Vampiros-2 (Figs. 4 and 5). These columns samples depositional units (D) 2 and 1, which date between ca 2200 and 1150 BP (see below). She sieved all sediments through a metal 1/8” mesh (4 mm) in the field and subsequently with water over graded geological sieves down to 0.0625 mm. Her study is addressing: (1) how fish preparation methods physically impacted fish skeletons;

(2) how these methods affected the intra-site distribution of butchering units; and (3) whether fish consumed at inland sites exhibit body part proportions or physical damage consistent with human intervention at processing sites (e.g., Sitio Sierra).

We present some preliminary results from this study. We also make comments on the presence and use of other vertebrates at these sites concentrating on the relationship between taphonomy and site formation processes. We refer to bones retrieved from the column samples and to others recovered by Pearson using 1/4” sieves during the larger-scale excavations of 2002–2006. Our intent is to provide an overview for guiding future research on these and other processes. We rely on published data and our own field observations. Additional osteological and soil analyses will probably force us to modify or change some of our current inferences.

## 6. Summary of environmental setting and occupation history

The two Vampiros shelters are located at the edge of a small rocky hill (Cerro El Tigre), 2.6 km inland from the

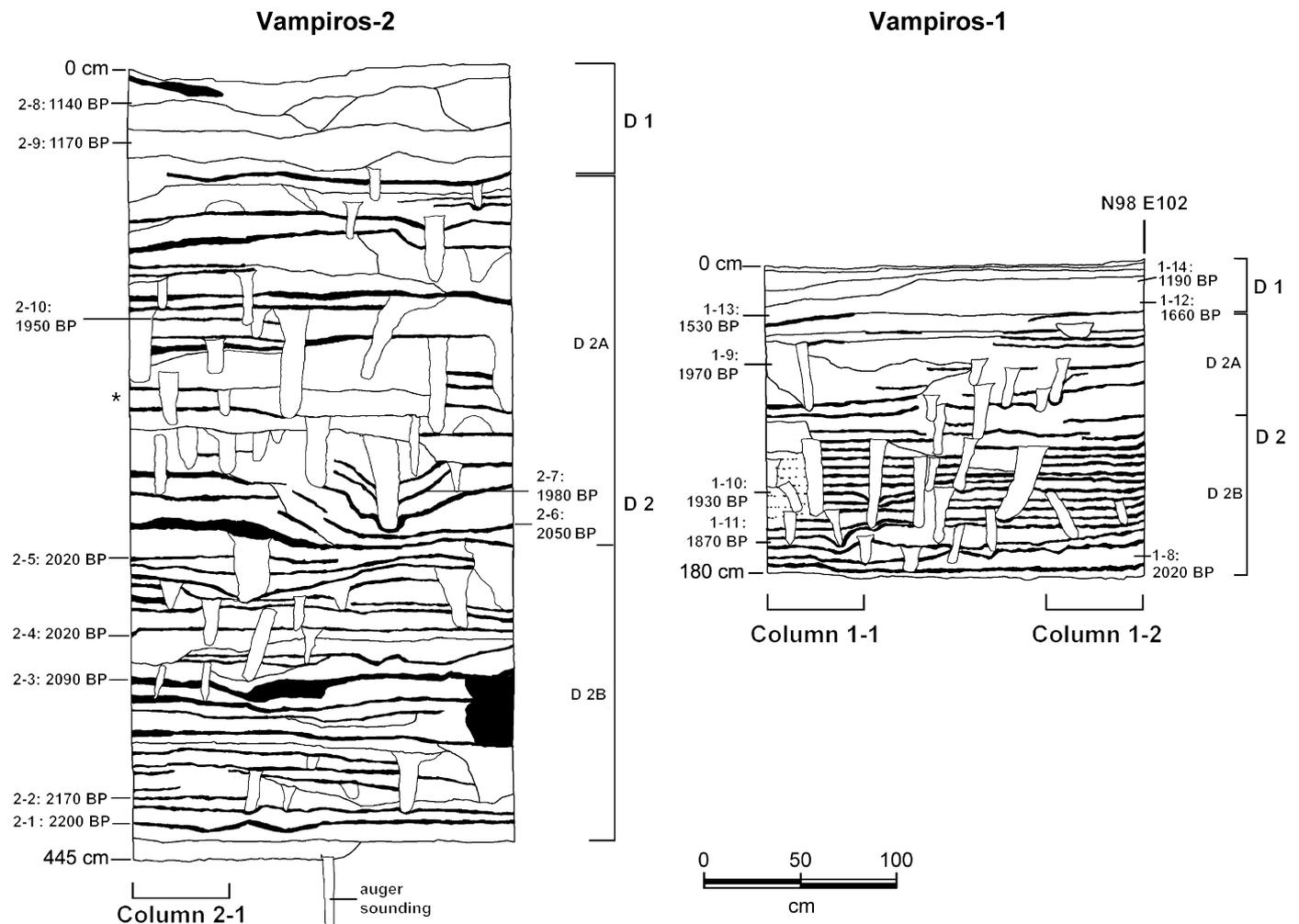


Fig. 5. Profiles of depositional units (D) 1 and 2 taken from part of the south wall of Vampiros-1 and the north wall of Vampiros-2. The location of  $^{14}\text{C}$ -dated charcoal and sediment samples is shown (see Table 1) (Drawing: Carvajal-Contreras).

present-day coastline of Parita Bay and 0.7 km north of the current channel of the River Santa María (Fig. 1). They were discovered in 1982 when two test pits (2 × 1 m and 1 × 1 m) were excavated on the floor and talus of the larger shelter, Vampiros-1 (then called “Cueva de los Vampiros” [AG-145]) (Cooke and Ranere, 1984). These excavations demonstrated the existence of two cultural components widely separated in time and deposited under dissimilar environmental conditions. Artifacts in the earlier component consisted entirely of chipped stone. The later component contained potsherds, chipped stone, polished axe flakes and abundant invertebrate and vertebrate remains. A charcoal date of 8560 ± 160 BP was associated with the early component (Cooke and Ranere, 1984, Fig. 6). Phytoliths from a cultigen—arrowroot (*Maranta arundinacea*)— sponge spicules and a few marine shells and fish remains were recovered in the same level leading to the assumption that the shelter’s inhabitants at this early date were planting crops nearby and also collecting marine resources (Piperno and Pearsall, 1998, p. 213).

Between 2002 and 2006 more extensive excavations in Vampiros-1 (Pearson, 2002; Pearson and Cooke, in press) and a 2 × 1 m test pit dug into the floor of Vampiros-2, identified five depositional macro-units (see ‘D’ in Figs. 5 and 6). Three (D1, D2 and D4) contained evidence for human activities and two (D3 and D5) lacked such evidence.

Although Pearson (2002) reported a date of 15,190 ± 60 BP from near the bottom of Vampiros-1

(Fig. 6), the basal depositional unit (D5) shows no obvious evidence for human activities (carbon dates from the 2002–2006 excavations and one from 1982 ( $\beta$ -5101) are listed in Table 1; other dates from 1982 are given in Cooke and Ranere, 1992b). Pearson interpreted a thin anthropogenic soil as the initial occupation floor (bulk sediment date: 11,550 ± 140 BP). Stone tools characteristic of the Paleoindian technological tradition, including fragments of two fluted points and a spurred end-scraper, were deposited on top of the initial occupation floor and beneath a charcoal date of 8970 ± 40 BP. Occasional occupation followed during the Early Preceramic until about 7700 BP. *No bone or shell was found in D4*. This is important because it contradicts the results of the 1982 excavation into the lower occupation of Vampiros-1 (D4) (“dark brown silt with rock” in Cooke and Ranere, 1984; Fig. 6) because it indicates that shell, fish bone and perhaps also sponge spicules and arrowroot phytoliths entered these deposits through animal burrows (“krotovinas”) many of which were identified and carefully cleared by Pearson and his team.

Cultural material in D4 consists entirely of stone tools and the products of their use and in situ manufacture and curation. The remains of a hearth were found in the upper levels associated with a date of 7690 ± 40 ( $\beta$ -166504) (Fig. 2; for additional details see: Pearson, 2002; Pearson and Cooke, 2002; Pearson et al., 2003).

Above D4 in Vampiros-1 lies a band of brown soils (D3) of variable thickness (0.1–0.5 m). No cultural materials

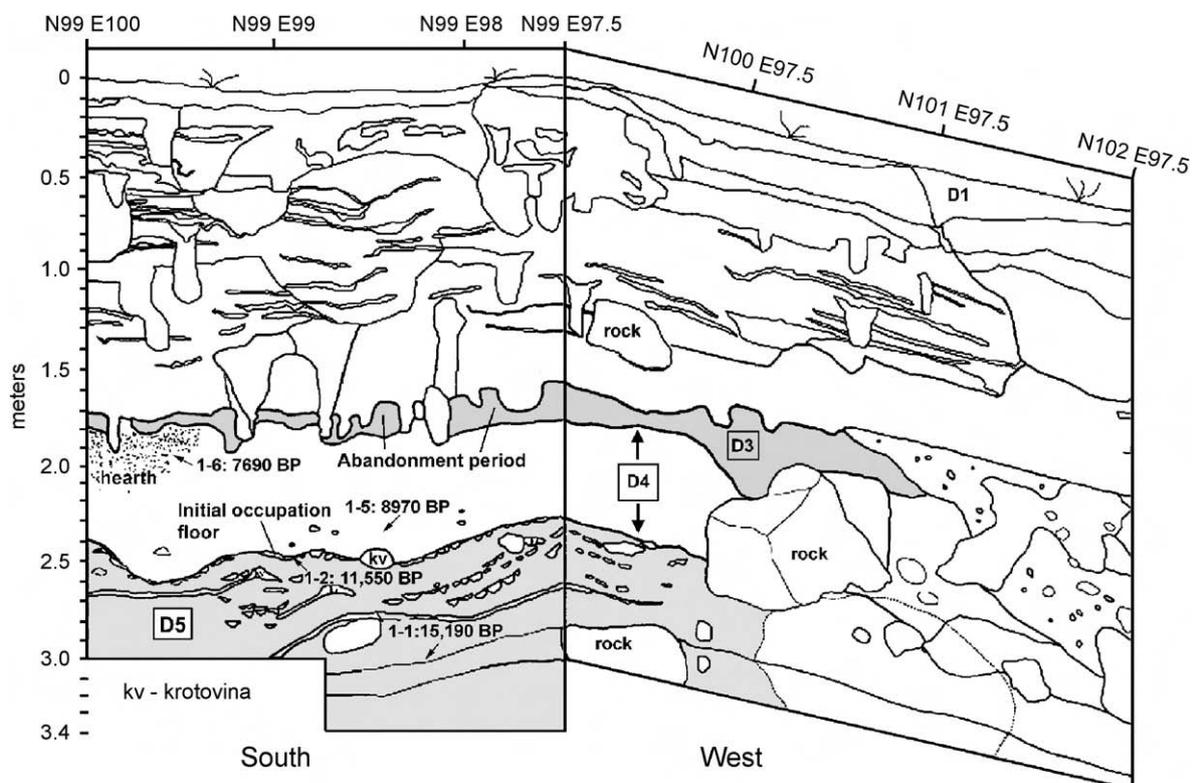


Fig. 6. Profiles of part of the south and the west walls at Vampiros-1 showing the relationship between depositional units (D) 1 and 2 (“fishing camps”) and D 3–5 (Drawing: G.A. Pearson).

Table 1  
Radiocarbon dates from Vampiros

Site	Field specimen	Lab. sample	n method	Material	Conventional age BP	d13CPDB	2 sigma calibration, 96% probability	Intercept
Vampiros 2	Vamp 001	$\beta$ -195180	AMS	Charcoal	2200	-24.6	cal BC 380–160	cal BC 350, 310, 210
Vampiros 2	Vamp 003	$\beta$ -195181	AMS	Charcoal	2170	-24	cal BC 370–100	cal BC 200
Vampiros 2	Vamp 011	$\beta$ -195182	AMS	Charcoal	2090	-25.4	cal BC 200–20	cal BC 100
Vampiros 2	Vamp 104	$\beta$ -195183	AMS	Charcoal	2020	-22.9	cal BC 110–70	cal BC 30
Vampiros 2	Vamp 020	$\beta$ -195184	AMS	Charcoal	2020	-24.9	cal BC 110–70	cal BC 30
Vampiros 2	Vamp 022	$\beta$ -195185	AMS	Charcoal	2050	-24	cal BC 170–40	cal BC 50
Vampiros 2	Vamp 024	$\beta$ -195186	AMS	Charcoal	1980	-21.2	cal BC 50–cal AD 100	cal AD 30
Vampiros 1	Vp 10106	$\beta$ -217522	AMS	Charcoal	1870	-24.2	cal AD 60 to 240	cal AD 130
Vampiros 1	Vp 10110	$\beta$ -217523	AMS	Charcoal	1970	-23.5	cal BC 50–cal AD 110	cal AD 40
Vampiros 1	Vp 10118	$\beta$ -217525	AMS	Charcoal	1530	-27.6	cal AD 430–620	cal AD 540
Vampiros 1	Vp 10223	$\beta$ -217526	AMS	Charcoal	1660	-26.8	cal AD 260–290 & cal AD 320–450	cal AD 400
Vampiros 1	Vp 10236	$\beta$ -217527	AMS	Charcoal	1190	-22.7	cal AD 720–740 & cal AD 760–960	cal AD 870
Vampiros 1	Vp 10391	$\beta$ -217528	AMS	Charcoal	2020	-25.9	cal BC 110–cal AD 70	cal BC 30
Vampiros 2	Vp 20072	$\beta$ -217529	AMS	Charcoal	1140	-24.2	cal AD 790–990	cal AD 900
Vampiros 2	Vp 20074	$\beta$ -217530	AMS	Charcoal	1170	-25.4	cal AD 770–980	cal AD 880
Vampiros 2	Vp 2105	$\beta$ -217531	AMS	Charcoal	1950	-24.5	cal BC 40–cal AD 130	cal AD 60
Vampiros 2	VP 2107	$\beta$ -217532	AMS	Charcoal	1940	-23.7	cal BC 30–cal AD 130	cal AD 70
Vampiros 2	Vp 20108	$\beta$ -217533	AMS	Charcoal	1930	-24.5	cal BC 10–cal AD 140	cal AD 70
Vampiros 1	Vp 10113&101	$\beta$ -217524	AMS	Charcoal	1930	-27	cal BC 10–cal AD 140	cal AD 20
Vampiros 1	VAMP 30-SED	$\beta$ -166594	AMS	Sediment	15070	-17.4	cal BC 16640–15820	cal BC 16210
Vampiros 1	VAMP-21	$\beta$ -166505	AMS	Charred material	8850	-17.4	cal BC 8260–8180 & 8110–8000	cal BC 8230
Vampiros 1		$\beta$ -165620	AMS	Charred material	8690	-25.6	cal BC 7780–7595	cal BC 7630
Vampiros 1	VAMP-02	$\beta$ -166504	AMS	Charred material	7690	-24.9	cal BC 6600–6450	cal BC 6480
Vampiros 1	VAMP-23	$\beta$ -166506	AMS	Charred material	9090	-24.4	cal BC 8310–8250	cal BC 8280

have yet been found within it. We follow [Cooke and Ranere \(1984\)](#) and [Pearson \(2002\)](#) in interpreting this soil as evidence for the abandonment of this shelter after about 7700 BP and before ca. 2200 BP when D2 began to form. We also propose that the non-use of Vampiros-1 between ~7700 and 2200 BP was due to its being in or very near the sub-tidal zone following the transgression of the ocean over Parita Bay at a time when the Santa María delta was in early stages of formation.

Depositional unit 2, present in both Vampiros-1 and -2, accreted between  $2200 \pm 40$  BP and  $1930 \pm 40$  BP. Its sediments differ radically from those of D4. (The excavation at Vampiros-2 was not taken below D2 because the water table reached this level during the wet season of 2004 when Pearson dug the test pit.) Fourteen  $^{14}\text{C}$  dates run on charcoal are internally consistent (with the exception of one date [ $\beta$ -217522]) ([Fig. 5](#), [Table 1](#)). Sediments are strongly laminated containing charcoal, ash, marine

mollusk and fish remains, shell artifacts, stone flakes and pottery. Several post-molds, hearths, pits, floors and other anthropogenic features were recorded (Figs. 4–6).

We have sub-divided D2 into two episodes in both shelters. D2b accumulated fairly slowly between 2200 and 2050 BP: its sediments are more compact and have a higher carbonate content than those in D2a (P. Botero, pers. commun., 2007). Cultural materials are also more fragmented and sediments more clearly laminated (with many features cutting through former levels). Deposition during D2a was very rapid between ca. 2050 and 1920 BP (more rapid in Vampiros-2 than in Vampiros-1).

Cooke (1988) and Cooke and Jiménez (2004) analyzed one-sixth of a sample of vertebrate bones recovered from a 10 cm-thick floor (VII) in the 2 × 1 m test pit 1 dug in Vampiros-1 in 1982. This corresponds to the very bottom of D2a (Cooke and Ranere, 1984). All but one of the ~6800 bones recovered over a 1/8" (4 mm) mesh were fish of marine origin. 4130 fish bones (61%) were taxonomically diagnostic representing 25 families, 57 genera and 84 species. Only one element was from a freshwater taxon (a knife-eel [*Sternopygus*] sp.) (Cooke and Jiménez, 2004) suggesting that fishing concentrated on habitats along the marine littoral.

Sedimentation at the top of both shelters (D1) was considerably slower than in D2. This unit is a little more than 0.5 m deep in Vampiros-2 and ca. 0.3 m deep in Vampiros-1. The latest dates from D1 are 1140 ± 40 BP ( $\beta$ -217529) and 1170 ± 70 BP ( $\beta$ -217530), in Vampiros-2, and 1190 ± 40 BP ( $\beta$ -217527) in Vampiros-2.

We propose that the diminishing intensity of fishing-related activities at the Vampiros shelters between ca. 1900 and 1150 BP was influenced by local geomorphological changes related to rapid coastal progradation, which would have favored the adoption of other shoreline localities to the east of Cerro Tigre. About 1 km eastwards, a row of shell-bearing sites is visible in the air photograph presented in Fig. 2b. A test pit dug in one locality in 1982 (AG-125) contained many fish bones, which Carvajal-Contreras is currently comparing with the Vampiros samples. A radiocarbon date of 930 ± 55 BP obtained at AG-125 suggests that by ca. 1000–900 BP the linear coastal settlement had replaced the Vampiros shelters as the primary fishing station in this sector of the bay (Weiland, 1984; Cooke and Ranere, 1992b; Cooke et al., in press). This hypothesis is consistent with a sedimentation rate in the order of 1 km per 1000 years (Clary et al., 1984). Probably other sites used as fishing stations between ca. 1900 and 1000 BP lie buried and between Cerro Tigre and AG-125 under the sediments of the high tidal flats (Cooke et al., in press).

To sum up, when Paleoindian people camped in the shelters after ca. 11,500 BP, the coastline would have been located as much as 60 km to the east. According to the Clary et al. (1984) facies model, at ca. 7000 BP the active marine shore would have been about 1.2 km eastwards of Cerro Mangote and ca. 4 km west of Cerro Tigre (Cooke and Ranere, 1999, Fig. 1). Since we do not know where the

River Santa María's main channel ran at this time we cannot be sure of the precise relationship of Cerro Tigre to specific features of the ancient delta. It is reasonable to assume, however, that for all or some of the period 7700–2200 BP, it would have been located in the sub-tidal and inter-tidal zones. If a sedimentation rate of 1 mm yr<sup>-1</sup> (Clary et al., 1984) is correct, the Vampiros shelters, now 2.6 km from the active marine shore, would have been on or very near the active marine shore between ca. 2200 and 1900 BP and therefore in an ideal location for a fishing station. This is when human activities were most intense.

Preliminary archaeozoological data support this scenario. The fish bone sample recovered at the base of D2 by Cooke and Ranere in 1982 (Cooke and Jiménez, 2004) and other samples provided by the lowest levels of Carvajal-Contreras' 2005 column samples (Fig. 4), which are under analysis, include some fish species that habitually frequent clear water columns, not necessarily far from the coast, i.e., green jack (*Caranx caballus*), Paloma pompano (*Trachinotus paitensis*), bonefish (*Albula* sp.) and needle fish (*Tylosurus* spp.). These fish are most frequent in these lowest levels of D2 in both shelters. Under present-day conditions they do not frequent the turbid middle and upper zones of the Parita Bay estuary complex (Cooke, 1992; Cooke and Tapia-Rodríguez, 1994a, b; see Cooke and Ranere, 1999, for a discussion of estuary zonation). We reiterate the need for knowing whether the River Santa María flowed north through the Estero Salado outlet at this time, as is suggested by air photographs (Fig. 2b). Notwithstanding, the frequency of green jack, pompano, bonefish and needlefish in fish bone samples deposited ca. 2200–2050 BP suggests, either that they were obtained at some distance from Cerro El Tigre—towards the outer margins of the mixing plume (Cooke, 1992)—or that water columns in the immediate vicinity of Cerro Tigre received less direct influence from wet season run off than under present-day conditions.

Carvajal-Contreras' ongoing analysis of the mollusks deposited as food remains in D2 and D1 at both shelters also show diachronic changes in abundance, which are harmonious with changing sedimentary conditions in a prograding coastal regime. She used a comparative collection of modern mollusks housed at the Smithsonian Tropical Research Institute and Panamic Province literature to guide her identifications (Keen, 1971; Cruz-Soto and Jiménez, 1994; Skoglund, 2001, 2002) (Table 2). In D1 and the upper deposits of D2 the most frequent mollusks are intertidal: *Grandiarca grandis* (low inter-tidal/sub-tidal mudflats), *Protothaca asperrima* (mud-sand-rubble), *Natica unifasciata* (exposed mud-flat and mud-sand) and *Anadara tuberculosa* (mangrove/high inter-tidal mud-flat). In contrast, at the bottom of D2, mussels (*Mytella* sp.) and scallops (*Argopecten ventricosus*) are more frequent, suggesting a clearer water environment. A rocky shoreline in front of Cerro Tigre would have been particularly attractive to *Mytella* mussels, which settle on this kind of substrate.

Table 2  
Preliminary quantification of mollusk samples at Vampiros

	<i>Natica unifasciata</i> <sup>a</sup>	<i>Grandiarca grandis</i>	<i>Argopecten ventricosus</i>	<i>Thais kiosquiformis</i>	<i>Protothaca asperrima</i>	<i>Anadara tuberculosa</i>
Vampiros 1	2334	204	146	34	322	93
Vampiros 2	1160	235	147	11	166	212
Talus	1514	233	22	27	160	46
Total	4908	672	315	72	648	161

<sup>a</sup>This counting included the opercula.

## 7. Taphonomy and site formation processes: preliminary observations

### 7.1. Natural processes

#### 7.1.1. Eolian processes

When Vampiros-1 was first discovered in 1982 Cerro Tigre lay to the west of an extensive high tidal flat (*albina* in local parlance) (Fig. 2a). In 2000, commercial shrimp tanks were constructed destroying all but small remnants of the original high tidal flat (Fig. 2b). Before 2000 this flat would dry out during the season as brisk northerly to easterly winds whipped up the desiccated salt-laden surface sediments driving them inland (Cooke and Ranere, 1984).

Eolian deposition is not obvious during the most intensive period of occupation (2200–1900 BP), in our opinion because the high tidal flat had not yet formed. In the uppermost 50 cm of both shelters (D1), however, marine shells show scaling and lamination symptomatic of exfoliation through the degradation of carbonates. We interpret this as the deleterious effect of salt-laden eolian sediments after the high tidal flat had formed and when the shelters were used little or had been abandoned by the pre-Columbian occupants. These deposits are thicker in Vampiros-2 than Vampiros-1 (Fig. 5).

#### 7.1.2. Faunalurbation

Many kinds of animals live in caves both above and below ground. Archeologists recognize that these animals are an important cause of physical disturbances (Stahl, 1996; Mello-Araujo and Marcelino, 2003). Their naturally deposited remains can confuse analyses of human animal use.

Frog and bat bones were found in the Vampiros shelters being most frequent in D1 and the uppermost layers of D2. Four anuran species have been recorded at pre-Columbian sites around Parita Bay. Cooke (1989) argued that all of them including the toxic marine toad (*Bufo marinus*) were manipulated by humans, probably for food. Thirty-three marine toad bones in the Vampiros shelters include four isolated specimens, which may be food refuse. Twenty-nine others, however, are not discolored and show no evidence for burning. They were recovered together in column sample 2 in Vampiros-1, 5 cm below surface. They should belong to a single individual since they represent half the

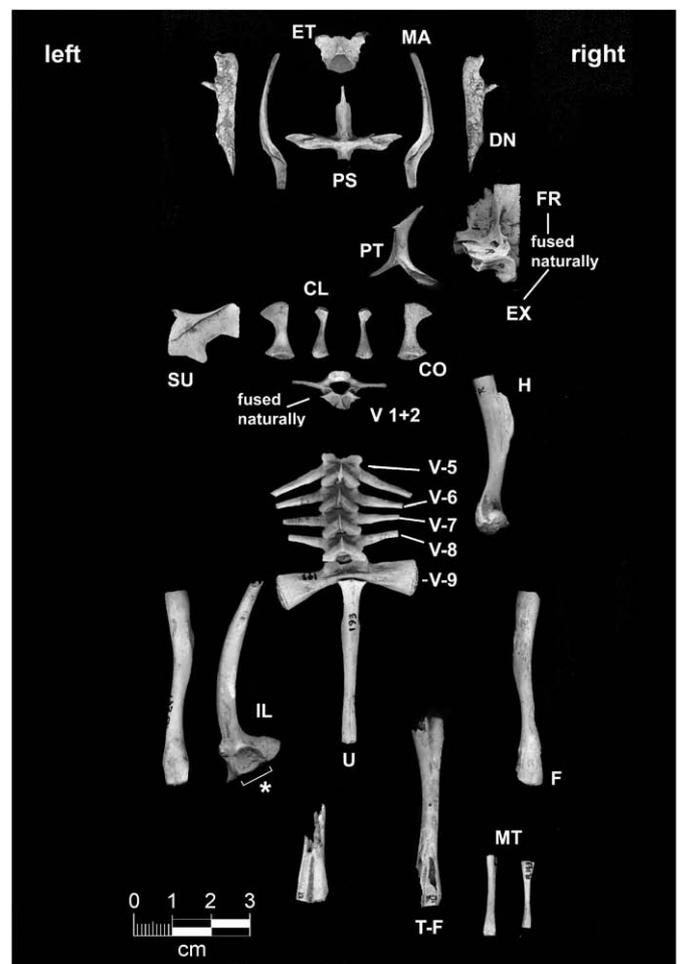


Fig. 7. Partial skeleton of a marine toad (*Bufo marinus*), Vampiros-1. Maximum acetabular width (\*) predicts an estimated body mass of 408 g, and a snout-vent length of 166 mm (Cooke, 1989) (Photo: R.G. Cooke). CL—clavicle, CO—coracoid, DN—dentary, ET—ethmoid, EX—exoccipital, FE—femur, FR—frontal, H—humerus, IL—ilium, MA—maxilla, MT—metatarsal, PS—parasphenoid, PT—pterygoid, SU—suprascapular, TF—tibio-fibula, U—urostyle and V—vertebra.

total number of bones (56) that one would expect from a single marine toad (excluding foot bones) (Fig. 7). Measurement of the maximum acetabular width predicts a body mass of 408 g and a snout-vent length of 160 mm (Cooke, 1989). Marine toads do not burrow but seek out damp nooks and crannies. They often succumb to

desiccation in the dry season. Forty-five snake bones found in a group probably represent a single boa constrictor that died of natural causes or was killed and discarded by the human inhabitants (Fig. 8b and c).

Bats currently use Vampiros-1 to roost in large numbers. The species (probably more than one) have not been identified but their dung suggests they are hematophagous (hence the popular name ‘Vampire Cave’). Seventy-four chiropteran specimens belonging to at least 20 individuals were recorded in Pearson’s and Carvajal-Contreras’ excavations and column samples (Fig. 8h, j and k). The sizes and morphology of 21 humeri suggest the presence of four different species, including a large species with a

humerus length of 35 mm (proximal epiphysis absent, unfused). This is the only stained bat bone. Neither this nor any other bat bones showed evidence for burning. Several bat bones were found in clusters suggesting that individual animals had died from natural causes or were killed by the shelters’ occupants and discarded whole.

The fact that 13 out of a total of 24 bird bones belong to young individuals (some very young) suggests, either than birds used the shelters for nesting or that predators discarded these bones there. Cathartid vultures are known to seek out rocky places for nesting—but not when people are near. Two bones of an adult black vulture (*Coragyps atratus*) were found (Fig. 9d). The activities of these heavy birds would displace materials in the surface deposits of the shelters. Other bird bones, which have been identified to species, are unlikely to have nested in or taken refuge in the

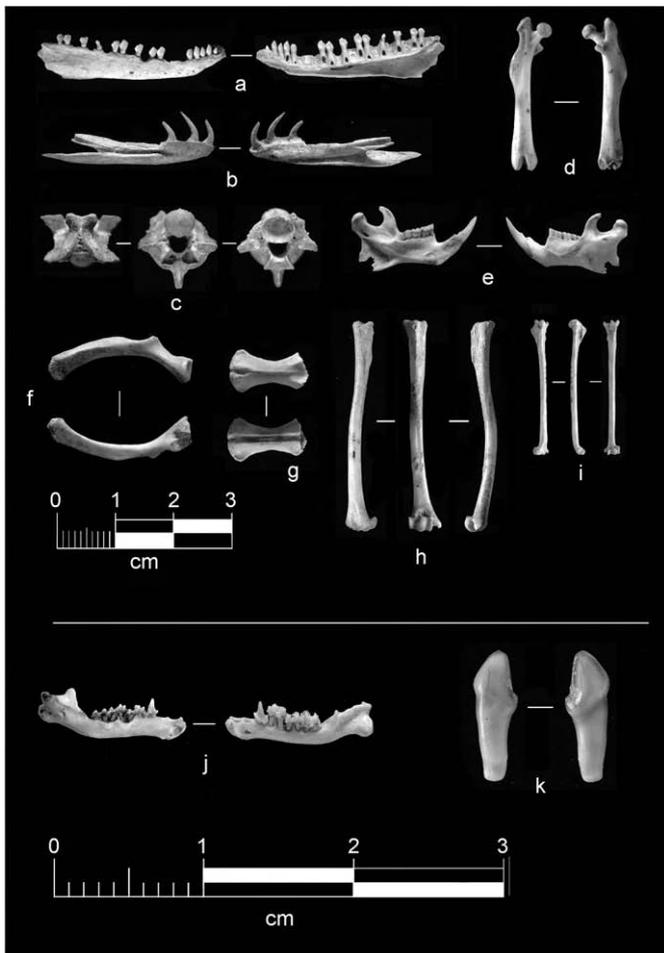


Fig. 8. Mammal and reptile bones and teeth from the Vampiros shelters, Cerro Tigre, Coclé, Panamá (Photos: Tara Hornung). (a) Black iguana (*Ctenosaura* sp.), anterior right dentary (split longitudinally), (b) snake (cf. *Boa constrictor*), right dentary, Vampiros-2, (c) snake (cf. *Boa constrictor*), vertebra, probably same individual as (b), Vampiros-2, (d) hispid cotton rat (*Sigmodon hispidus*), right femur, distal epiphysis absent (unfused), Vampiros-1, (e) hispid cotton rat (*Sigmodon hispidus*), left mandible, probably same individual as (c), Vampiros-1, (g) opossum (*Didelphidae*, probably *Didelphis marsupialis*), caudal vertebra, Vampiros-1, surface, (f) mud turtle (*Kinosternon scorpioides*), left ilium, Vampiros-2, (h) bat (*Chiroptera*), right humerus, proximal epiphysis absent (unfused), Vampiros-2, (j) bat (*Chiroptera*), unidentified species, left humerus, Vampiros-1, (k) bat (*Chiroptera*), left mandible, Vampiros-1 and (l) gray fox (*Urocyon cinereoargenteus*), left mandibular premolar 1.

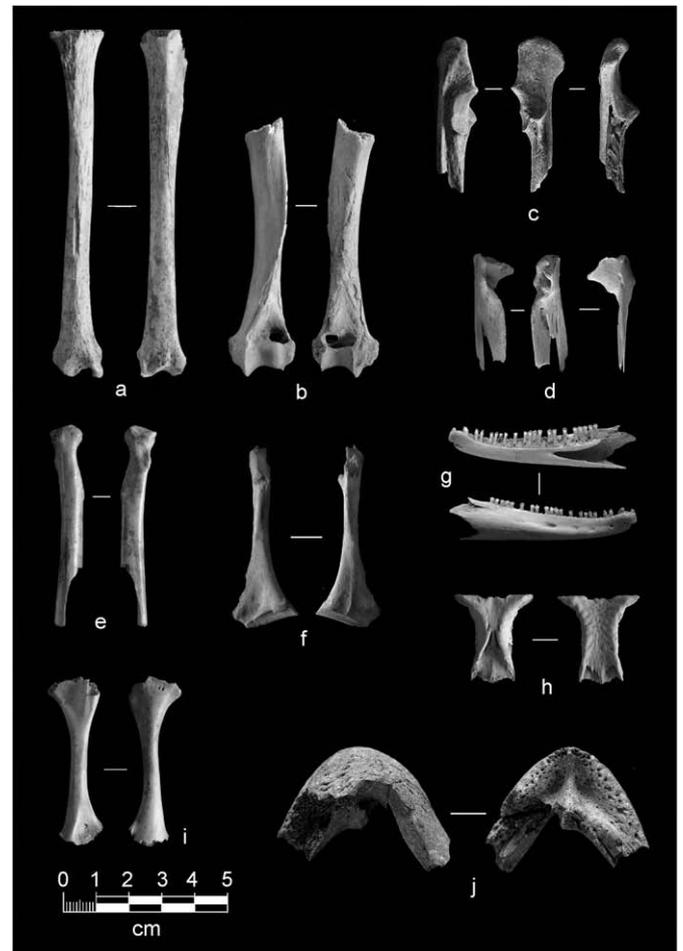


Fig. 9. Mammal, bird and reptile bones from the Vampiros shelters, Cerro Tigre, Coclé, Panamá (Photos: Tara Hornung). (a) Raccoon (*Procyon cf. lotor*), right tibia, Vampiros-2, (b) paca (*Agouti paca*), distal left humerus, Vampiros-2, (c) anteater (*Tamandua cf. mexicana*), proximal left ulna, Vampiros-1, (d) black vulture (*Coragyps atratus*), right articular, Vampiros-1, (e) brown pelican (*Pelecanus occidentalis*), proximal left radius, Vampiros-2, (f) cormorant (*Phalacrocorax cf. olivaceus*), left coracoid, Vampiros-2; (g) green iguana (*Iguana iguana*), right dentary, Vampiros-1, (h) black iguana (*Ctenosaura* sp.), frontal, Vampiros-1, (j) green iguana (*Iguana iguana*), left humerus, Vampiros-2 and (k) green turtle (*Chelonia mydas*), anterior dentary, Vampiros-1.

shelters, e.g., brown pelican (*Pelecanus occidentalis*) (Fig. 9e) and cormorant (*Phalacrocorax cf. olivaceus*) (Fig. 9f). They were probably food items. Both species were recorded in middens at other Parita Bay sites (Cerro Juan Díaz and Sitio Sierra) (Cooke and Ranere, 1992a; Cooke et al., 2007, in press).

Wasps, crabs, iguanas and rodents burrow into the Vampiros shelter sediments today. Most of the burrows identified during the excavations were produced by wasps (Sphecidae) burying their offspring. Although these burrows are relatively small in size (5 cm or less in diameter), they probably caused vertical displacement of cultural materials (W. Wcislo, pers. commun., 2007).

#### 7.1.3. Bones of three small rodent species were found

Pocket rat (*Liomys* sp.), rice rat (*Oryzomys* sp.) and hispid cotton rat (*Sigmodon hispidus*) (Fig. 8d and e). Rice and hispid cotton rat activities may have caused some displacement of materials. But we did not record any evidence for rodent or carnivore gnawing of bones. This suggests that small rodents that engage in this behavior rarely entered the shelters. On the contrary, rodent-gnawed bones are frequent at large village sites around Parita Bay where the three genera reported at the Vampiros shelters and the cane rat (*Zygodontomys*) are frequent (Cooke et al., 2007, in press).

Over 100 lizard bones were found. Four represent an as yet unidentified taxon. The remainder belongs to the two iguanid species that frequent coastal habitats in Panama: green iguana (*Iguana iguana*) and black iguana (*Ctenosaura* sp.) (Figs. 8a, 9g,h and j). Twelve iguana in bones are burnt. It is likely that these lizards were consumed by the shelters' inhabitants as they were elsewhere around Parita Bay (Cooke et al., 2007, in press). The terrestrial and fossorial black iguana may be responsible for some of the larger burrows identified during the excavation.

We mentioned above that fish bones and marine shell were reported as being found in 1982 in D4, i.e., before 7700 BP. The 2002–2006 excavations identified several animal burrows penetrating the soils of this depositional unit. Some of these contained sediments from the ashy deposits of D2, as well as bat and rodent bones. We now propose that all bone and shell formerly identified in D4 is intrusive. Therefore, contrary to earlier reports (Cooke and Ranere, 1984, 1992a–c), we can no longer argue on the basis of the Vampiros shelter data that coastal resources were exploited in Pacific Panama during the Paleoindian and Early Pre-ceramic periods (i.e., 11,500–7000 BP) (Cooke, 2005). (Of course, coastal sites belonging to this period may be submerged.)

#### 7.1.4. Floral turbation

Other archeological studies have documented the mixing of cultural materials caused by the growth and decay of trees and other plants, which often form root casts or bring materials to the surface when they are uprooted (Buck et al., 2002; Peacock and Fant, 2002). Before the beginning of

the excavations the talus slopes of both shelters were heavily vegetated. We observed disturbances caused by this vegetation in D1. We argued above that D3 was deposited in Vampiros-1 when this shelter was located in sub-tidal or inter-tidal zones. The irregular surface of D3 may be the result of disturbance caused by vegetation that colonized the shelters during their long abandonment. Also influential is the differential hardening of the surface by iron-rich water filtering down the back wall (P. Botero, personal observation, 2007).

## 7.2. Cultural processes

### 7.2.1. Ancient human disturbances

The activities of ancient people who reoccupy the same area have a profound post-depositional impact on the integrity, preservation, and disturbance of older deposits. The profiles illustrated in Figs. 4–6 demonstrate that human activities at the Vampiros shelters during the existence of the fishing station constantly penetrated earlier strata. These include hearths, pits and holes dug for inserting perishable materials, such as wooden posts, presumably for furniture or awnings. Although we made every attempt to identify such disturbances, it is obvious that subsequent activities have compromised the integrity and contemporaneity of materials found in most features. Nevertheless, the fact that the radiocarbon chronology based on charcoal is internally consistent (except for  $\beta$ -217522), suggests that the effects of human disturbances were localized.

### 7.2.2. Differential preservation

No shell and bones were recovered in the 2003–2006 excavations in D4, deposited between ca. 11,500 and 7700 BP. These materials are frequent, however, in D2 and D1. Preliminary geo-chemical analyses show that sediments deposited in D4 have slightly more acidic soils and lower organic material and phosphorus levels than the deposits in D2 and D1 (Tables 3a and b). Predictably the levels of organic matter are higher in D2 and D1 because of the great quantity of shell and vertebrate (mostly fish) remains. They are lower in D4. D1 and D2 soils are only slightly acidic probably because leaching is more intense than in the deeper deposits (D4). On the other hand, soil texture in D1, and D2 is similar to that of D4 (all units have sandy loam matrices). The sand proportion in all these depositional units is quite uniform. This suggests that soils deposited on the surface of each unit, which normal erosive processes would have made sandy, were constantly transported downwards by human and animal activities (Tables 3a and b).

### 7.2.3. Human impacts on shellfish

Since the Vampiros shelters were occupied intensively or regularly by a small group of humans over a period of about 300 years (2200–1900 BP), it is feasible that they impacted locally available mollusks through intensive

Table 3a  
Geo-chemical analyses from Paleo-Indian deposits at Vampiros

% Sand	% Silt	% Clay	% Organic M.	pH	P (Ug ml <sup>-1</sup> )	K (Ug ml <sup>-1</sup> )	Ca (Ug ml <sup>-1</sup> )	Mg (Ug ml <sup>-1</sup> )	Al (Ug ml <sup>-1</sup> )
60	28	12	1.34	6.8	210	755	0.24	1.32	0.2

Table 3b  
Geo-chemical analyses from ceramic deposits at Vampiros

Context	Texture sandy	% Organic M.	pH	P (Ug ml <sup>-1</sup> )	K (Ug ml <sup>-1</sup> )	Ca (Ug ml <sup>-1</sup> )	Mg (Ug ml <sup>-1</sup> )	Al (Ug ml <sup>-1</sup> )
VP1-0151	Sandy loam	1.28	6.4	318	782	16.8	6.2	.1
VP1-267	Loam sandy	4.56	6.4	324	762	9.1	8.1	.1
VP2-0094	Loam sandy	5.19	6.2	1476	586	73.0	8.5	.1
VP2- 130	Loam sandy	2.40	6.6	324	250	6.0	7.5	.1

collection. Admittedly, in a coastal environment that experienced frequent changes and spatial re-arrangement of land-forms and marine substrates, it is difficult to separate human over-exploitation from natural changes in shellfish populations due to environmental change. Nonetheless we are investigating the possibility that the apparent diminution in the sizes of the shells of a marine snail (*Natica unifasciata*) from the bottom of D2 to the top of D1 may be attributable to human impact.

#### 7.2.4. Butchering

We are studying fish bones in order to identify the physical effects of butchering on individual skeletal elements and on body part survivability and distribution paying close attention to empirical data provided by a study of modern brining and sun-drying practices at Boca de Parita, at the southern edge of the bay (Zohar and Cooke, 1997). The fish remains from D2 differ from samples acquired at previously studied sites around Parita Bay in three ways: (1) scales and cartilaginous elasmobranch mouth parts are occasionally preserved, (2) several articulated sections of vertebral columns and fins were found (for example, the tail-sections of grunts [Haemulidae]) and (3) branchial bones are abundant (ceratobranchial, epibranchial and hypobranchial). These features undoubtedly constitute evidence for the in situ preparation of fish, although, pending more detailed analyses, they do not permit distinguishing between curing and direct consumption.

Physical damage to bones that we have identified so far includes: (1) cut dorsal spines of marine catfish (Ariidae), (2) cut-marks on the cleithrum, urohyal, quadrate and premaxilla of marine catfish and also jack-pompano (Carangidae), Sciaenidae (croaker-weakfish) and puffer-fish (Tetraodontidae), (3) frequent transverse cut-marks on the dorsal surface of puffer-fish supra-cleithra. This last feature is so striking and frequent that it will allow inferences about how these fish were butchered when the samples have been completely analyzed. Although one of

the puffer-fish genera present at the Vampiros shelters (*Sphoeroides*) is known to have toxic and in some cases dangerously toxic viscera, another genera (*Guentheridia*), which is the most abundant puffer-fish in this and other Parita Bay tetraodontid samples was once sold in Panama City markets (Cooke, 1992; Jiménez and Cooke, 2001).

The ethnoarcheological research conducted by Zohar and Cooke (1997) suggests that fish butchering is size-dependent. They observed that large fish (>325 mm) are butchered by a longitudinal dorsal cut, starting at the base of the caudal fin and extending to the anterior part of the skull; in the case of large marine catfish, the first dorsal spine is removed and later a ventral cut is performed through the skull. In the Vampiros shelter fish bone samples we observed that several marine catfish first dorsal spines were cut or damaged. Damage to some neurocranial bones of mainly large catfish is also visible, especially to the ethmoid, vomer and frontals.

Zohar and Cooke also demonstrated that small fish (<325 mm) are today butchered with a different method: they are gutted, but damage to cranial bones is far less frequent than in the case of large fish. We are finding that many skull bones of abundant small fish, such as the Pacific moonfish (the commonest marine fish species in the shelters) are intact and that they do not present signs of damage.

#### 7.2.5. Features ostensibly related to fish preparation activities

The pre-Columbian inhabitants placed many small and sometimes quite deep holes on the floors of the Vampiros shelters. They also buried their dead occasionally during the fishing-station occupation. We are investigating the possibility that some arrangements of post-holes represent furniture, i.e., drying racks, beds and seats. In D2 at Vampiros 1, especially well-preserved fish bones are associated with dark brown soils, which we believe represent the intensive disposal of fish remains during fish preparation activities.

Table 4  
Preliminary quantification of fish bones samples over 1/8" mesh at Vampiros 2006

	NISP	Burnt bones
Vampiros 1	8469	3043
Vampiros 2	1132	815
Total	9601	3858

It appears that different activities were carried out in the two shelters. The fishing-station deposits are twice as deep in Vampiros-2 as in Vampiros-1 (Fig. 5). In Vampiros-1 fewer bones show evidence of heat and their general state of preservation is notably better than in Vampiros-2. Fish scales and possible chitinised shrimp skin are more frequent at Vampiros-1 than at Vampiros-2. On the other hand, the very high proportion of fish bones impacted by differential heat exposure in Vampiros-2 is striking (Table 4). Bones range in color from light gray to black, and many are extremely eroded. Pending more detailed osteological and distributional analyses, our working hypothesis is that Vampiros-1 was used mostly for scaling, gutting and drying fish, while smoking was carried out at Vampiros-2. This is consistent with topographic differences between the two shelters. Vampiros-1 is exposed to dry season winds and also to wet season rain storms moving in from Parita Bay. The leeward Vampiros-2 is a better locale for smoking and a more comfortable place to live in both seasons (Fig. 2b).

#### 7.2.6. Other vertebrates

In addition to the species that we mentioned above in the context of disturbance, we note the presence of marine turtles (Cheloniidae), river turtles (*Trachemys* and *Kinosternon*) (Fig. 8f), anteater (*Tamandua*) (Fig. 9c), opossum (including probable *Didelphis marsupialis* and a smaller species [cf. *Caluromys*]) (Fig. 8g, paca (*Agouti paca*) (Fig. 9b), raccoon (*Procyon cf. lotor*) (Fig. 9a), gray fox (*Urocyon cinereoargenteus*) (Fig. 8l and white-tailed deer (*Odocoileus virginianus*). Some of these bones show evidence of butchering, i.e., cut marks and fractures.

Particularly striking is the number of marine turtle bones (118), of which most are post-cranial bones. Sixteen show evidence for burning. The green turtle (*Chelonia mydas*) is definitely present (Fig. 9k). The only other Parita Bay sites at which marine turtle have been reported are Cerro Mangote (*Eretmochelys imbricata*), Zapotal (*Lepidochelys olivacea*) and Cerro Juan Díaz (located at the southern edge of Parita Bay) (Cooke et al., 2007, in press). All the turtle bones found at Cerro Juan Díaz were carapace fragments. None was found at Sitio Sierra. This situation led Cooke (2004) to propose that turtles may have been tabooed as food items in later prehistoric times around Parita Bay. The Vampiros data suggest the contrary. Cooke and Tapia-Rodríguez (1994b) reported that green turtles are occasionally trapped in inter-tidal traps around

Parita Bay. It is possible, therefore, firstly, that the people who lived at the Vampiros shelters also caught fish and turtles with these simple but effective artifacts and, secondly, that cured turtle meat was another coastal resource that the inhabitants of the Vampiros shelters inserted into the regional economy.

*Historical impacts:* In 2000, the Panamanian government gave concessions to private companies to use the high tidal flats located in front of Cerro El Tigre for commercial shrimp tanks (Fig. 2b). This resulted in the entire flat's being excavated and filled with water. Construction works disturbed 0.5–1 m of the talus deposits in front of the Vampiros-1, but not the drier deposits on the shelter floor (Fig. 3b). Fortunately, these talus deposits were sampled in 1982 (Cooke and Ranere, 1984). Therefore the faunal materials contained in them will be studied.

## 8. Discussion and conclusions

Although our data analysis is in a preliminary stage, it sheds light on the regional use of marine fish in pre-Columbian times. For a period of about 300 years (2200–1900 BP) people used the Vampiros shelters frequently for fishing-related activities, and also for collecting shellfish in nearby habitats, capturing marine turtles and, occasionally, hunting and collecting other vertebrate species that frequent habitats along and just landward of the marine littoral. Although we cannot yet distinguish satisfactorily between simple in situ consumption and the curing of fish (i.e., by smoking and/or dehydration with or without salt), evidence is accruing for the latter activities: very large numbers of burnt fish bones especially in the leeward shelter (Vampiros-2), frequent cut marks in some cases anatomically patterned (i.e., puffer-fish supra-cleithra), frequent furniture probably made of wood, many hearths and pits, and an unusually high proportion of fish branchial bones. Since the Vampiros shelters were located near the mouth or mouths of the River Santa María in pre-Columbian times, it is reasonable to suppose that a village located upstream, and partially coeval with the fishing-station deposits (D2), was one of the recipients of fish obtained there. This site is Sitio Sierra. In spite of being 12 km from the marine shore ca. 1800 and 1500 BP the most frequently consumed animal foods were marine fish (70% of the fish bone sample). The high rank of species such as the Pacific moonfish, brassy grunt, thread-herrings and Pacific bumpers at Sitio Sierra allude to capture seaward of the estuarine mixing plume. In this case, one can infer that they were obtained a straight-line distance of more than 15 km (considerably further if travel and transport was by canoe following the River Meanders). We cannot objectively distinguish between people from Sitio Sierra using the Vampiros shelters to acquire fish themselves from people living at the shelters providing the fish. The very diversity of the fish fauna at this site, however, in addition to the fact that the representative species occupy a considerable variety of inshore habitats,

suggests that people with special knowledge and skills were doing the fishing. Today, one could probably walk from the Vampiros shelters to Sitio Sierra in a few hours. Therefore, it is rash to advocate that fish arrived at this village in a cured state. The ethnohistoric record, however, refers to long-distance transport of fish, some of it salted. Markets where fish and crabs were exchanged are also described. Salting and drying fish around Parita Bay and the transport of the finished product to communities in the foothills and highlands is a now-dying activity that in recent living memory was much more important. We feel therefore that it is reasonable to suppose that the Vampiros shelters represent stations that were used to cure fish for inland consumption at a specific moment in the physical evolution of the Parita Bay littoral. Monagrillo, occupied 2000 years earlier, probably served the same function, as did AG-125 and the other localities in the linear settlement located seaward of Cerro Tigre after coastal progradation had lessened the fishing potential of the Vampiros shelters. A similar pattern of coast-inland movement of marine fish was recently described by Isaza-Aizpurúa (2007) along the neighboring River La Villa. Isaza-Aizpurúa proposed that pre-Columbian inhabitants used a station located close to the Pacific coast (LS-31) for capturing and preparing fish, which was then distributed to villages and hamlets further inland, such as Cerro Juan Diaz, LA-29 (La Chilonga), LS-15 (La Isleta), and Las Huertas (LS-10) (Fig. 1).

Fernández de Oviedo (1853) remarked that when the Cueva people of the Darién were not at war, “they spent the whole time dealing with each other, and trading anything they find useful. They transport merchandise on their slaves’ backs, some carrying salt, and others maize...blankets ... hammocks ...spun and un-spun cotton ...and salt fish”. In our opinion, the relationship we are postulating between the Vampiros shelters and Sitio Sierra, and between LS-31 and inland sites up the River La Villa, exemplifies a similar and very ancient relationship between coastal purveyors and inland consumers of cured fish.

We admit that our taphonomic analysis of fish remains at the Vampiros shelters is in a preliminary stage. We believe nonetheless that it is highly probable that these sites were used for curing fish between 2200 and 1900 BP. Referring to prior geological models, we propose that this was the time when local geomorphological conditions favored these activities making them profitable for small human groups whose specialized activities were part of a wider probably chiefdom-wide economic system.

In a wider context, the pattern of faunal exploitation observed at the Vampiros Shelters confirms the importance of the animals that frequent Neotropical estuaries for pre-Columbian subsistence and trade. The estuaries of the tropical eastern Pacific are especially productive and harbor a diverse nektonic fauna. Many species or species groups are widely distributed occurring from the Gulf of California to northernmost Peru. The speciose nature of the most important food fish families—over 40 species in

the case of the Sciaenidae—reflects habitat and/or trophic differentiation among closely related species. High tidal range and heavy riverine discharge favor the formation of mangrove swamps, tidal channels and mudflats, which are ideal habitats for humans to exploit large biomasses of marine animals without sophisticated watercraft or fishing tackle. Since estuarine influences often penetrate far inland communities located some distance inland are in a good position to exploit marine fish amphidromy. Plentiful supplies of sea salt confer additional advantages because they permit the use of surpluses for exchange activities. The inland consumption of salted fish enhances nutritional quality. It is probably significant that no evidence for fishing tackle, such as net weights, harpoons and hooks, has been recovered at Vampiros, nor indeed at any other sites at the mouth of the Santa Maria River. This situation makes it likely that intertidal traps were the primary mode of capture as they were in historic and recent times around Parita Bay and elsewhere along the coast of the tropical eastern Pacific (Cooke, 1992; Cooke and Tapia-Rodríguez, 1994b).

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