Chapter 19

The First Human Settlers on the Yucatan Peninsula: Evidence from Drowned Caves in the State of Quintana Roo (South Mexico)

Arturo H. González, Alejandro Terrazas, Wolfgang Stinnesbeck, Martha E. Benavente, Jerónimo Avilés, Carmen Rojas, José Manuel Padilla, Adriana Velásquez, Eugenio Acevez, and Eberhard Frey

ABSTRACT

Prehistoric evidence from submerged caves and sinkholes (cenotes) on the Yucatan peninsula provides strong evidence for the existence of an early preceramic human settlement in southern Mexico. During our ongoing paleoanthropological research we have already documented three well-preserved human skeletons as old as 13,000 and 9000 years from these sites in Quintana Roo (Gonzalez et al. 2008a, Gonzalez et al. 2008b). The findings were associated with hearths and a diverse megafaunal assemblage of late-Pleistocene age. A fourth human skeleton was discovered in 2009, two more in 2010, and two others in 2011. Here we provide a first register of these additional five skeletons, bringing the total assemblage to eight. A ninth skeleton was informally reported from the same area by INAH researchers. These findings thus constitute one of the largest databases on bones of early humans in Mexico.

KEYWORDS: Cenotes, Mexico, Quintana Roo, Karst, Human settlement, Paleoamericans, Pleistocene, Holocene, Underwater archaeology

Introduction

The northern part of the Yucatan Peninsula in Southeast Mexico is a flat landscape where no surface rivers flow because the rain quickly disappears into the limestone of a kilometers-thick carbonate platform and runs subsurface to the sea. The ground is pierced by vine-draped sinkholes—cenotes, as they are called locally—where the roofs of underground caverns have collapsed (Lopez Ramos 1975; Smart et al. 2006; Ward et al. 1985). Phreatic levels are reached only a few meters below surface. From here the discharge of groundwater is rapid and directed towards the coast. The enormous degree of karstification and limestone permeability in the subsurface of the northern Yucatan led to the formation of one of the most extensive active cave systems worldwide, with an explored length of approximately 700 km and a presumed extension of 7,000 km (Quintana Roo Speleological Survey (QRSS), www.caves.org/project/qrss).
This enormous subterranean karst labyrinth was formed during the last two to three million years, mostly during the Pleistocene (Ward et al. 1985). During the glacial stages of this geological period, precipitation in the northern Yucatan peninsula was likely higher and sea level 100 m and more below the level of today (Blanchon and Shaw 1995; Moseley et al. 2013). Sea-level rise at the end of the Pleistocene and early Holocene was caused by the global deglaciation, between 13,000 and 7,600 before present. This eustatic rise of the sea level was considered “catastrophic” by Blanchon and Shaw (1995). The present-day sea-level was reached about 6600 cal yr BP (Gabriel et al. 2009).

Without the sinkholes and caves with groundwater, much of northern Yucatan would be a waterless plain and one of the most inhospitable regions in the world because of paucity of fertile soil, the scarcity of drinking water, and shortage of other natural resources (Ward et al. 1985).

Nevertheless, one of the most sophisticated pre-Columbian civilizations, the Maya, did indeed cope with these adverse environmental conditions. Recent archaeological discoveries in the Mexican state of Quintana Roo suggest, however, that the arrival of humans to this region was much earlier and dates back to the end of the Pleistocene, thousands of years prior to the classic Mayan civilization. (Gonzalez et al. 2008a, Gonzalez et al. 2008b).

In 2008 we documented paleontological and anthropological evidence from about a dozen sites in the Tulum area of Quintana Roo. The fossil assemblage is of late-Pleistocene to early-Holocene age (Gonzalez et al. 2008a, Gonzalez et al. 2008b). The association includes horses, foxes, agoutis, peccaries, bats, elephants, tapirs, llamas, ground sloths, and glyptodonts. Some of these animals are widely known from North America as characteristic of shrub-type vegetation. At or near the Pleistocene/Holocene boundary, however, the dominant vegetation of thorny shrubs disappeared and tropical forests arose. They quickly became dominant at approx. 9000 years BP (Leyden 1995; Brenner et al. 2002; Leyden et al. 1993).

Among the most important discoveries (reported by Gonzalez et al. 2008a, Gonzalez et al. 2008b) were three human skeletons called Naharon, Las Palmas, and El Templo, which are almost complete (>80%) and anatomically articulated (Tables 19.1, 19.2). They were recovered from depths of 23 m, 24 m, and 9 m, respectively, in the submerged cave systems, which must have been flooded during early stages of the Holocene sea-level rise.

The taphonomic circumstances suggest that at least two skeletons, Las Palmas and Naharon, were intentionally deposited. The position of El Templo individual suggests an accidental death. We assume that these skeletons are of latest-Pleistocene/early-Holocene age based on radiometric dating (Tables 19.1, 19.2). The Naharon individual, also known as “Naharon Woman,” was discovered by G. Walten and J. Coke and subsequently reported to one of us (JA). Her age at death was estimated at 20–30 years. Her death was dated on bone collagen to 11,570 ± 65 14C yr BP (UGA-6828) using 14 C, and to 12,000–10,000 BP using U/Th techniques (Gonzalez et al. 2008a, Gonzalez et al. 2008b). Nevertheless, these ages must be considered with caution, because the amount of organic matter detected in the bones is extremely low (Taylor 2009). The Las Palmas individual (Tables 19.1, 19.2), also known as “Mujer de las Palmas,” a female discovered by J. Coke and reported to one of us (JA), reached an age of 44–50 years and was dated to 8050 ± 130 14C yr BP (UGA-6828) using 14 C, and to 12,000–10,000 BP using U/Th techniques (Gonzalez et al. 2008a, Gonzalez et al. 2008b). The El Templo individual (Tables 19.1, 19.2) was a male 25–30 years old at the time of death. It was discovered by S. Gerrard, G. Klag and D. Martin, and reported to one of us (JA). Bone tissue was too much degraded and collagen contents too low to get reliable radiometric 14 C ages. Criteria for identifying sex and age of the El Templo male were already reported by Gonzalez et al. (2008a).

The discovery of human skeletons associated with hearths and a diverse faunal assemblage of latest-Pleistocene age clearly indicates an early human settlement on the Yucatan peninsula reaching back to the late Pleistocene or early Holocene.

Here we present new anthropological evidence from our ongoing research and report on five additional human skeletons from the cave systems of Quintana Roo state. These skeletons, here referred to as Chanhol I, Chanhol II, Muknal, Pit I, and Pit II (compare Tables 19.1 and 19.2) were discovered since 2008. A ninth individual was recently reported from the same area at Cenote Black Hole by Instituto Nacional de

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**Table 19.1** Complete list of human skeletons.

<table>
<thead>
<tr>
<th>Site</th>
<th>Cave system</th>
<th>Cave subsystem</th>
<th>Cenote entrance</th>
<th>Distance from entrance (m)</th>
<th>Depth (m)</th>
<th>Discoverer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naharon</td>
<td>Ox Bel Ha</td>
<td>Naranjal</td>
<td>Naharon</td>
<td>368</td>
<td>23</td>
<td>G. Walten and J. Coke</td>
</tr>
<tr>
<td>Las Palmas</td>
<td>Ox Bel Ha</td>
<td>Muknal</td>
<td>Palmas</td>
<td>174</td>
<td>24</td>
<td>J. Coke</td>
</tr>
<tr>
<td>El Templo</td>
<td>Templo</td>
<td>Palmas</td>
<td>ElTemplo</td>
<td>185</td>
<td>24</td>
<td>S. Gerrard, G. Klag, and D. Martin</td>
</tr>
<tr>
<td>Chan Hol I</td>
<td>Toh Ha</td>
<td>Chan Hol</td>
<td>547</td>
<td>8</td>
<td>A. Kampe and E. Kampe</td>
<td></td>
</tr>
<tr>
<td>Chan Hol II</td>
<td>Toh Ha</td>
<td>Chan Hol</td>
<td>1240</td>
<td>8</td>
<td>H. Gust</td>
<td></td>
</tr>
<tr>
<td>Muknal</td>
<td>Ox Bel Ha</td>
<td>Muknal</td>
<td>Palmas</td>
<td>210</td>
<td>33</td>
<td>J. Aviles</td>
</tr>
<tr>
<td>El Pit I</td>
<td>Sac Actun</td>
<td>Dos Ojos</td>
<td>Pat Jacinto</td>
<td>47</td>
<td>30</td>
<td>Unknown</td>
</tr>
<tr>
<td>El Pit II</td>
<td>Sac Actun</td>
<td>Dos Ojos</td>
<td>Pat Jacinto</td>
<td>12</td>
<td>45</td>
<td>Unknown</td>
</tr>
</tbody>
</table>
Antropología e Historia (INAH) researchers. The assemblage now represents the largest database on bones of early humans in Mexico.

Table 19.1 shows the complete list of human skeletons.

**New Discoveries about Early Human Settlement in Yucatan**

Figure 19.1 shows the coast of the Mexican state of Quintana Roo with the location of cenotes and caves containing sites with human skeletons and associated Pleistocene to early-Holocene fauna. The area of study stretches from Tulum toward Playa del Carmen. All sites are between a few hundred meters to a maximum of 10 km from the actual coastline. Black dots mark sites that contain human evidence; white dots represent sites that contain animal evidence; black-and-white dots indicate sites that contain both human and animal evidence.

Here we document several new locations in the Tulum area. At Chan Hol cave, two human skeletons were recently discovered, but one of them (Chan Hol II) was subsequently stolen from the submerged cave and only about 10% of this skeleton could be recovered. Two skeletons discovered at Pat Jacinto (formerly known as "El Pit") as well as one at Muknal cave were saved from potential vandalism. Both localities are visited by an increasing number of recreational cenote and cave divers via newly constructed roads to these cenotes.

**Chan Hol**

The Chan Hol cave, which forms part of the Toh ha system, was first explored by Kim Davidson in 2005. The known extension of the cave system is estimated today at more than 5000 m. The main entrance, known as Chan Hol cenote, is located approximately 15 km south of Tulum close to highway 307, which connects Tulum with Playa del Carmen. The...
entrance is semilunar in shape, 3–4 m wide, and partially covered by a natural roof of limestone. Water level at this entrance is shallow, only about 0.5–0.8 m deep, but deepens gradually to a cave 8–10 m deep. Two human skeletons discovered in the Chan Hol cave were named by us Chan Hol I, also known as “El Joven” (Figure 19.2) and Chan Hol II, also known as “La Niña” (Figure 19.3).

**27 Chan Hol I**

The Chan Hol I skeleton was discovered in 2006 by cave explorers Alexandra and Thorsten Kampe and reported to us by Robbie Schmittner. It is located approximately 530 m northeast from the entrance. Depth at the site is 8 m. The skeleton was found partially articulated and in a lateral position, resting on its left side, with legs flexed to the body at an angle of about 90 degrees. The right arm was stretched out. A stalactite, about 1.2 m in length, had collapsed on the arm and may have caused the fracture of the diaphysis of the right humerus in its distal third (Figure 19.4).

Unrelenting contact with slowly flowing fresh water resulted in poor preservation of the skeleton. Bones are exceedingly fractured and fragmented and spongy bone is mostly dissolved. Despite the poor preservation, anatomical relationships are clearly recognized and indicate that an overall original anatomical position is preserved, including even tiny segments of extremities such as phalanges (Figure 19.5).

The Chan Hol I skeleton is about 90% complete, but only 60% of the bones were sufficiently well preserved to be collected, owing to dissolution of the bone substance. The flexed position of both legs, and the fact that even the smallest bones of hands and feet maintain their anatomical position, clearly indicate that skeletonization occurred on site, at a time when the cave was still dry and not yet filled with water.

![Figure 19.2](image1)  The Chan Hol I skeleton.

![Figure 19.3](image2)  Chan Hol II individual before looting of the skull and other bones. Photo courtesy of Liquid Jungle.
The strong dissolution observed in most diagnostic elements of the Chan Hol I skeleton prevents our determining reliable data regarding the sex or age at the time of death of this individual.

**Chan Hol II**

The Chan Hol II skeleton is located in a small cave tunnel approximately 1,200 m west of the Chan Hol cenote, at a water depth of only 8 m and thus at a similar depth as the Chan Hol I individual. The tunnel is reached via the same cenote entrance. The skeleton was discovered in early 2009 by Harry Gust and reported to one of us (JA). Subsequently the site was vandalized by an unknown cave diver during the summer of 2012. At present, only a few photographs exist from the site prior to vandalism (Figures 19.6, 19.7). These photos indicate that the Chan Hol II individual was likely >80% complete, including the skull, and that decay and skeletonization occurred in situ.

After the looting of the Chan Hol II site and robbery of the skull and numerous large bone elements, we returned to the location in October 2012 to collect all bone fragments, which remained dispersed on the cave ground or were adhering to an aragonite layer covering the cave bedrock limestone. Even though the majority of these bone fragments were small, less than 50 mm in size, they represent approxi-
approximately 10% of the skeleton. We collected 51 fragments which correspond to ribs, 6 vertebrae, fragments of feet and hands, one patella, 6 fragments of tibiae, 2 of the left humerus, 3 of the left radius, one of the clavicle, 4 teeth, various fragments of the pelvis, 3 of the scapula, as well as single fragments of the temporal and occipital condyle.

The arms and legs of the skeleton were articulated and preserved in an anatomical position. In addition, a large stalagmite grew on the pelvis of the skeleton.

Incisive teeth recovered from both the Chan Hol I and Chan Hol II individuals present a “sinodont,” shovel-shaped, morphology, and thus provide an important source regarding the biological affiliation of these early settlers and their origin in relation to the populations in East and North Asia (cf. Turner 1990).

39 Ox Bel Ha System

Ox Bel Ha is located in the Tulum area. This huge system extends from the jungle and mangroves south of Tulum to the Caribbean Ocean. With 243,031 km of explored caves and tunnels, it has absorbed all neighboring systems. At least 140 different cenotes lead to this huge system, many of them very popular among cave divers. Maximum depth recorded in the system is 34.7 m at the Muknal archaeological site, from which a human skeleton is reported here. The ongoing exploration and mapping of caves in the Tulum area has shown that the Ox Bel Ha system is connected to other systems in the area, including the Naranjal and other systems as well as the Muknal cave. In these cases the larger system (Ox Bel Ha) swallows up the smaller ones and only the name of the larger system is retained. Following this nomenclature, the Naranjal system has recently been absorbed by the Ox Bel Ha system. For a better understanding of terms already introduced to the anthropological literature (e.g. Gonzalez et al. 2008a, Gonzalez et al. 2008b), we here maintain the term Naranjal sub-system, as well as Naharon and Muknal remote siphon areas which are part of the Naranjal system (“QRSS” 1989–2001).
Prior to the discovery of its connection with the Ox Bel Ha cave system, the Naranjal system had a mapped length of 24.5 km, with 8 known entrances (Figure 19.8). Two preceramic human skeletons, Naharon and Palmas, have already been documented from Naranjal system by Gonzalez et al. (2008a, Gonzalez et al. 2008 b; Tables 19.1 and 19.2). The Naharon Woman was 20–30 years old at death. The skeleton was discovered in an articulated condition, indicating decay occurred in situ (Gonzalez et al. 2008a, Gonzalez et al. 2008b). The “Señora de Las Palmas” was discovered about 1 km distant from the Naharon individual in an area of the same cave system known as Muknal remote siphon, at a depth of 24 m and a distance of 174 m from the nearest entrance. This individual had reached an age of 44–50 years. The skeleton was articulated, with the legs flexed to the body, suggesting an intentional deposition, likely a funeral. Figures 19.9, 19.9A, and 19.9B show the reconstruction of the Las Palmas female, completed in 2010 at the Atelier Daynes Studios at Paris, France, by Elisabeth Daynes.

Subsequent to the findings of the Naharon and Las Palmas individuals, further reconnaissance and exploration of the Naranjal system led to the discovery by one of us (JA) of a new skeleton only 60 m from the Las Palmas individual in an area of the same cave system known as Muknal remote siphon, at a depth of 24 m and a distance of 174 m from the nearest entrance. This individual had reached an age of 44–50 years. The skeleton was articulated, with the legs flexed to the body, suggesting an intentional deposition, likely a funeral. Figures 19.9, 19.9A, and 19.9B show the reconstruction of the Las Palmas female, completed in 2010 at the Atelier Daynes Studios at Paris, France, by Elisabeth Daynes.

The Muknal skeleton is approximately 50% complete, including skull, mandible, cervical bones, and some long bones. The skeleton was not found articulated; instead, bones were distributed randomly (Figure 19.11). It is unclear whether they were transported to the site by water run-off, which appears unlikely from its location in an elevated location on the Muknal cave floor adjacent to the charcoal accumulation as well as the absence of transport marks on the bones. Alternatively, prehistoric settlers may have deposited some skeletal parts at the Muknal site. This latter interpretation appears to be more likely based on the evidence.

**Osteology of the Muknal individual**

**Skull**  As a result of post-mortem fractures and superficial dissolution of the ethmoid and the internal portion of the orbits, only the wings and spines of the sphenoid are preserved.
A post-mortem fracture is identified in the inferior portion of the malar. The zygomatic arches are fractured; margins are clearly recognized, suggesting that the fracture is recent. In the maxillae, the entire portion adjacent to the sphenoid is lost, including the posterior alveolar region from the first molar in the right side and all teeth from the third molar on the left side. The upper anterior portion of the right maxilla is also missing, as well as the plate of the ethmoid, the infraorbital margin, and inferior margin of the maxilar. Almost the entire base of the cranium is lost, with only the posterior margin of the foramen magnum preserved. Fractures on the cranial base preserve black rims indicating that they
are considerably older than fractures, which affected the facial region.

Most teeth were lost ante mortem, among them the right lateral incisive, the second right premolar, the left canine, and the first left premolar and first left molar. A possible left premolar of the upper jaw and badly preserved roots of other unidentified teeth are preserved.

Skullcap and the right orbit are unfractured, but part of the left malar and the central portion of the maxillar were integrated into their original anatomical position in the lab.

Sex of the Muknal individual
To determine sex in a fossil human cranium, the following characters need to be considered:
1) morphology of mastoid apophyses,
2) occipital condyles,
3) muscular incertation of the occipital
4) frontal protuberances,
5) the width of the zygomatic arcs,
6) the supraorbital margin,
7) orbital delimitations,
8) the form of palatinal bones, and
9) the mandible architecture (Brothwell 1987 in White and Folkens 2000).

The interpretation of sex follows the propositions of Buiskra and Ubelaker (1994): Superciliar arches are medially marked. They fuse with the glabella to form a robust bulge, associated to grade 4 in the scale of Buiskra and Ubelaker (1994).

The nucal crest is little accentuated, reaching grade 3 in this scale, whereas the mastoid process is medium-sized, anteriorly inclined, in the range of grade 3. The supraorbital margin is fine, slightly rounded, and elevated grade 4 in this scale (op.
cit.). Chin morphology is modified due to alveolar absorption caused by the loss of teeth; a marked triangular chin is present and in the range of grade 3 to grade 4. These criteria indicate that the Muknal skeleton represents a male individual.

Age
The following criteria were used to estimate the age of the Muknal individual: Despite the fact that the individual lost all molars during life, the eruption of the third inferior and superior molars was completed. The few teeth that are preserved in the mandible show extreme abrasion, reaching grade I of dental attrition in the scale of Lovejoy (1985 in White and Folkens 2000), whereas the maxillary teeth abrasion reaches grade H. This suggests that the age of the individual may range between 45 to 55 years, considering the mandible, and between 40 and 50, based on the maxilla.

Cranial sutures were analyzed following the methodology established by Lovejoy and Mendl (1984 in White and Folkens 2000), suggesting an age of 48.5 (SD 10.5) for the first sutures group, and 56 (SD 8.5) for the second. However, these standard techniques are known to present a wide range of error and the Muknal individual shows little bone-tissue degeneration. The age at death may therefore be lower than proposed above and may actually range between 40 and 45 years.

Pathologies
The Muknal individual shows evidence for pathological processes, principally based on dentition. The ante-mortem loss, in the maxilla, of the two central incisors, the left lateral incisor, the second left premolar, the left molar, and all three right molars is indicated by alveolar reabsorption. The remaining first right premolar and second left molar show evidence of alveolar retraction and severe periodontal abrasion reaching the pulp chambers, as well as occlusal caries in the distal portion of the right premolar. Dental calculus is absent. In the
mandible all left molars, the second left premolar, left canine, all incisives, both right premolars, and the second and third right molars were lost during the life of the individual. The remaining first left premolar and first right molar are worn down and show occlusal caries in the right molar, extending into the pulp chamber.

The temporomandibular joints present arthrosis with bone tissue reaction, principally on the left side. There is a slight supra-inion injury on the left side with reaction on the occipital. The right orbital roof presents a marked criba orbitalia, including remodeling of the bone tissue. A healed porotic hyperostosis is registered in the bregma region, while another reaction of the bone tissue was detected on the superior margins of both auditory conduct, but primarily on the left side.

Comments on the osteology

The cranium of the Muknal individual is ovoid in shape and thus corresponds to a mesocranial (for a definition of the craniometric indexes see Comas, 1966) morphology (78.48), with a narrow nose (leptorrin, 40.81) and low orbits (camæconc, 82.92). In general terms, the cranium is bigger than those of Naharon and Las Palmas, but within the range of the El Templo individual that was attributed to a male. On the other hand, the facial region, i.e., the narrow nose, resembles the Naharon female, whereas the Las Palmas female has a wider nose. The low orbits are a common feature in all the submerged cave individuals where this character is preserved in Muknal, Las Palmas and possibly Naharon.

Sac Actun system

In 2012, the 82.291-km-long Dos Ojos system was reported by Peter Sprouse as forming part of the Sac Actun great system, known to be 222.673 km long. The two systems are connected by swamps, dry land, and partially water filled caves. However, Sac Aktun and Dos Ojos are flooded caves, separated, but technically “connected,” by partially water filled caves. The total length of both caves (wet and dry) reaches 308.487 km (QRSS 2013: http://www.caves.org/project/qrss/qrdry.htm).

With a maximum depth of 130 m, Dos Ojos is one of the deepest cave systems on the Yucatan peninsula and the deepest known in Quintana Roo; it is therefore popular for deep diving. Here we report on two partially preserved human skeletons from the Pat Jacinto cenote, also known as El Pit (Figure 19.12). The cenote was first explored in 1994 by Kay Walten and Dan Lins. This cenote is located 4 km south of the Xel Ha inlet. It is reached from highway 307 via a dirt road at Dos Ojos Cenotes Park entrance that connects Cancun and Tulum.

Cenote Pat Jacinto (Previously Known as El Pit)

The dispersed bones of at least two human individuals were discovered by unknown cave divers in the Pat Jacinto cenote and reported to us by cave-diving instructor Luis Leal. Both remains form part of the debris mound of the cenote and were found in water depths of 30 to > 45 m.

Bones as well as the taphonomic context have been degraded by sulfuric acid in the water of Pat Jacinto cave, which forms clouds at depths below approximately 35 m. Dissolution is strongest in the deep parts of the cenote, where cave sediment is in contact with water. Bone color is brown-yellow on the coronal part, which was covered by sediment, and lightly colored in parts exposed to the cave water.

El Pit I

The El Pit I individual consists of a fragmentary cranium discovered at a depth of 30 m. Postcranial material, which likely belongs to the same individual, is also included in the present preliminary description (Figure 19.13).
Sex
The nucal crest is well developed, reaching grade 4 on the scale developed by Buikstra and Ubelaker (1994). Even though no other diagnostic elements are preserved, this character suggests that the Pit I individual is a male.

Age
In the absence of other characters, the low degree of fusion of the cranial sutures suggests that the Pit I human was a young adult. The mandible, which likely belonged to the same individual, shows the complete eruption of the third molar, even though dental abrasion is not very pronounced. This reinforces the idea that the Pit I skeleton belonged to a young adult.

Pathology
We determined a small traumatic lesion recovered in life in the frontal bone immediately above the left superciliary arch and a slight exostosis affecting the upper margin of the right auditory canal.

Conservation
The encephalic portion of the cranium is preserved, but the total facial region and base are lost. The squama frontalis is preserved above the glabella, but this is not enough to measure the maximum length of the cranium. The sphenoid is majorly lost, but small fractions adhering to the temporal are preserved and indicate that the sphenotemporal sutures were not fused yet. The temporal preserves mandibular pits, the auditive conducts, and the mastoid region up to the mastoid holes. The mastoid apophyses are fractured. The occipital is broken in a paracoronal direction and at the height of the insertion of the Rect. Cap. Post Major and Minor, thus preserving the external protuberance and a portion of the occipital crest.

Commentaries
The Pit I cranium was discovered close to the entrance of the Pat Jacinto cave and forms part of the debris mound of the cenote. In addition to the radiometric dating (see Table 19.2) of some of the human bones from this cenote, the cranial morphology, even though incomplete, suggests that the Pit I skull differs from that of Mayan settlers by the absence of intentional cephalic deformation, a common character seen in about 80% of pre-Hispanic crania (Tiesler 2012), and by its overall mesocranial shape, even though this interpretation needs to be substantiated by more detailed research.

El Pit II
The El Pit II individual is composed of a parietal partially articulated with the occipital, as well as on postcranial parts that were discovered covering the debris mound of the El Jacinto cenote in water depths of 44–45 m deep. These remains are presently under study, and only a preliminary description is given here.

Osteology
A fragment of the left parietal preserves an almost complete occipital margin. In the lower edge the posterior region of the squamous border is preserved although the medium por-
tion is missing, including the articulation with the sphenoids. Anteriorly, the coronal suture and the anterior half of the saggital suture are lost, even though the latter is well conserved in its posterior half. The external diploe is little eroded, but its inner portion is majorly dissolved, as is the major part of the trabecular tissue.

The second fragment corresponds to the occipital and conserves the left lambdoid suture, from Lambda to the lateral angle and the superior part of the mastoid portion. From here, a fracture connects with the inferior curved line, raising the medial portion and running vertically to Lambda. Consequently, the entire lower right portion of the occipital is missing, including the region around foramen magnum.

The left parietal and the occipital articulate along the lambdoid suture, even though alignment is imprecise owing to marginal dissolution in both bones.

The sex of the individual is yet undetermined, but some characteristics suggest its age at the moment of death: Cranial sutures are widely open and preserve sharp margins, without any evidence of a fusion. The parietal is more rounded than in adult individuals of the research area. Inferior and superior temporal lines are undeveloped, and in the occipital, muscular incisions are shallow. We therefore preliminarily interpret the Pit II individual as an infant, or juvenile.

100 Discussion and Conclusions
The database for human remains of Preceramic age in the submerged caves of Quintana Roo, South Mexico, is steadily increasing and presently comprises eight individuals. Bone material is majorly affected by post-depositional dissolution processes, which modified the compact surface and spongy bone and nearly completely degraded collagen, especially in shallow cave settings where the bone is exposed to fresh water. This dissolution debilitates the cohesion of organic and inorganic portions of the bone and makes it vulnerable to fragmenting. It also hampers the use of radiometric C-14 dating methods because of widespread dissolution of a measurable organic component (Taylor 2009) (Table 19.2).

Even in cases when radiometric data are absent, or suspect owing to insufficient collagen, the cranial morphology of the cenote individuals is observably considerably different from pre- and post-Hispanic Maya. In addition, intentional cephalic deformation seen in the majority of Mesoamerican pre-Hispanic crania is absent (Tiesler 2012).

In a few cases, our research suggests that humans coexisted with Pleistocene animals. At La Chimenea (Figure 19.14), discovered by Steve Gerrard and Nancy de Rosa and reported to one of us (J.A.), fossil bones of the camellid Hemiauchenia macrocephala had been partially burned as a result of...
of roasting in an ancient hearth. The final extinction of *Hemi-
auchenia* in North America has been dated to 13,300–12,900
cal yr BP (e.g., Haynes 2006; Fiedel and Haynes 2004), a pe-
riod consistent with the extinction of other large mammals
found in the caves. The collapse of megafaunal populations
may even have occurred between 14,800 and 13,700 cal yr
BP (Gill et al. 2009).

Charcoal concentrations interpreted by us as hearths are
also found in water depths of up to 30 m and were dated by
$^{14}$C to 8941 ± 39 yr BP and 7740 ± 39 yr BP at Las Palmas.
At Aktun Ha, discovered by J. Coke and reported to us by O.
Río, a small cavity in an isolated rock about 0.9 m above the
cave ground had been used as a hearth. Charcoal samples
from this niche were dated by $^{14}$C to 9139 ± 23 yr BP and
9180 ± 60 yr BP. Hearths clearly required a dry cave.

The cenote humans thus populated the area at a time
when caves reaching to 30 m and more below present water
level were still dry and unaffected by the post-Pleistocene
rise of sea level. It is known that present-day water levels
were reached about 6600 yr BP (Blanchon and Shaw 1995; Ga-
Gabriel et al. 2009). The corpses of these individuals could have
floated to their present locations, but this latter scenario ap-
pears unlikely for the following reasons:

1) Human skeletons are found in deep parts of the caves,
hundreds of meters from the nearest entrance. If the
caves were water filled the corpses would have to drift
several hundreds of meters, through a cave system
of tunnels and open galleries decorated with spel-
themes, and be subsequently deposited almost com-
plete (> 80% of bones were recovered).

2) Four of the eight (El Templo, Las Palmas, Chan Hol I,
and Chan Hol II) were found almost fully articulated,
without major bone displacement, with even with the
anatomical connections of carpals and tarsals intact.
These structures are the first to disintegrate and slough
off a body floating in water for a long time (Haglund
and Sorg 2002). This situation clearly indicates the bod-
ies decayed in situ, which only could have occurred in
a dry cave. Moreover, the flexed positions of the Nahar-
on, Las Palmas, Chan Hol I, and Chan Hol II, and pos-
sibly Muknal individuals were intentionally deposited,
likely in a funeral, which would also require a place that
was dry at the time. At El Pit I and El Templo this situ-
tion is less clear. The final disposition of the skeletons
appears to be the result of accidental death in the case
of El Templo, and water-run-off for El Pit I.

Human skeletons from the drowned caves of the Yucatan
peninsula are dated to the Pleistocene-Holocene transition
and are thus among the earliest settlers of the American con-
tinent known from bone material. The physical morphology
of their crania should give evidence for their evolutionary re-
relationship with subsequent settlers in the area such as the
pre-Hispanic cultures that populated Mesoamerica during the
middle and late Holocene.

In this context, the so-called Paleoamerican morphol-
ogy is characterized by a narrow and low neurocranium,
low orbits, and a wide nasal region (Neves and Hubbe 2005).
The face is generally low relative to the height of the neuro-
 cranium, and the upper face region is unflattened. In the fos-
record this morphology is present in extensive collections
from the Lagoa Santa region of Brazil, in the oldest human
remains from the Sabana de Bogotá region in Colombia, and
in crania from the Mexican basin (González-José et al. 2005;
Neves et al. 2007). Populations with these characteristics are
known to exist up to the late Holocene in isolated regions of
Patagonia and on southern Baja California (González-José et
al. 2003).

The Amerindian morphology, on the other hand, is de-
 fined by bulged crania (brachicranial) and a wide and flat-
tened face, principally in the medium and upper region
(Pucciarelli 2004). These characters are found in almost all
modern indigenous groups in the Americas (Pucciarelli 2004)
and in mongoloid populations from China and other regions
of northern Asia (Cunningham and Jantz 2003).

The dichotomous recognition of Paleoamerican and Am-
erindian morphologies in ancient cultures of the American
continent has led some authors to postulate a “two-compo-
nent model” (Pucciarelli 2004), in which the continent was
first colonized by groups emigrating from southern Asia.
They would be the ancestors of modern “Australomelanesian”
groups and could have migrated to America along the Bering
passage, approximately 12,000 years ago. Their craniofacial
shape changed little and their demographic growth rate in
America remained low. According to this model, the Paleo-
americans were replaced about 9000 years ago by a second
migration wave of Amerindian groups. The replacement was
exceedingly fast and apparently occurred without genetic
 interchange between the two cultural groups (Pucciarelli
2004). The model thus postulates that a clear discontinuity
exists between the fossil remains of two distinct but homog-
 enous human groups populating the same territories within
the Americas: the Paleoamericans with a minimum age of
9000 years, and the Amerindians, which are younger.

Following this model, the Las Palmas, Naharon, Muknal
and El Pit individuals would be of Paleoamerican genetic stock
and thus should resemble fossil humans from the Mexican
basin, Lagoa Santa, as well as modern Australomelanesian
 groups, and they should differ from historic and modern Ma-
yan populations. This is only partially the case: Even though
cranially diverse, the preceramic individuals from the Yucatan
submerged caves are indeed characterized by mesocrania
with low orbits, narrow faces and variable nose apertures,
whereas Maya populations from the same region present a
marked hyperbrachycephaly (very rounded skulls), hypso-
to orthocrania hi pertapeinocrania (wide, short and low skulls),
and facial regions eurienas (broad), mesorrinas (intermedi-
ate nose width), hipsoconcs (low orbits) and mesognats (flat
faces) (Tiesler 2012). These differences, however, are not suf-
iciently pronounced to exclude the possibility that the late-
Pleistocene individuals may indeed be ancestors of the pre-
Hispanic Maya.
As a minimum, although the Las Palmas, Naharon and Muknal individuals show important inconsistencies within the so-called "Paleoamerican" morphology, nonetheless they do not coincide with Amerindians either. The individuals from submerged caves have mesocranial skulls, with an overall shape and size outside the dimensions of the Lagoa Santa, Sabana de Bogotá, and Basin of Mexico collections. They rather resemble other early-Holocene skulls from North America, such as those from Pelican Rapids, Florida; Gordon Creek, Colorado; Marmes, Washington (Young and Steele 1987); and Buhl, Idaho (Herrmann et al. 2006), all of which are mesocranial and show a greater variability than their counterparts from South America (multivariate analysis shows clearly the variability of “Paleoamerican” individuals from North America; Terrazas et al. in preparation).

These preliminary results suggest that near the end of the Pleistocene a notable morphological diversity must already have existed, which was likely the result of local micro-evolution. The early colonization of North and South America must have been a highly complex process in which dispersion and adaptation to local environments are not fully understood.

The latest-Pleistocene to early-Holocene ages of the Quintana Roo individuals and their marked cranial diversity, combined with the diversity known to date for other North American “Paleoamerican” skulls, provide evidence for an early colonization of the Americas, which likely occurred prior to the appearance of the Clovis culture in the Great Plains. Likely, this diversity is the result of an earlier migration wave and subsequent microevolution of these settlers in, and selective adaptation to, different environmental conditions of the North American continent. In that case models based mostly on migration as the driving genetic force are insufficient to explain the detailed process of settlement of the Americas.

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