



Flies, Mochicas and burial practices: a case study from Huaca de la Luna, Peru

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ABSTRACT

Study of a specific insect fauna from a pre-Columbian Moche grave, on the north coast of Peru, reveals burial practices, notably an estimation of the corpse's exposure time prior to burial, and compares New and Old World beliefs concerning flies and death.

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1. Introduction

The use of forensic entomology in archaeological investigations is relatively recent and the literature on this topic remains scarce. Nevertheless, such studies could be especially valuable in the following ways: understanding mortuary practices (Gilbert and Bass, 1967; Faulkner, 1986; Dirrigl and Greenberg, 1995; Bourget, 1998; Nystrom et al., 2005; Huchet, 2010); taphonomy of the cadavers (Wood, 1976; Wylie et al., 1987; Huchet et al., 2009); human parasites in past civilisations (Ewing, 1924; Capasso and Di Tota, 1998; Rick et al., 2002; Reinhard and Buikstra, 2003); and, lastly, as a mode of disease transmission among the ancients (Raoult et al., 2006).

The *post-mortem* interval (PMI) is the time since death. It may be hours, days, months, etc. During that period cultural practices have a direct influence on the way the body is treated; biotic factors play a role as well. Although it is obviously impossible to estimate the PMI in an archaeological context, the faunal combinations associated with a burial, and the biology of the recovered species, might provide valuable information on the "history" of the cadaver. The specificity and possible relevance of the associated specimens and distinct protocols implemented during archaeological investigations (sifting at 300 µm; flotation, etc.) led one of us (Huchet, 1996)

to propose a distinct terminology for this specific field of research: "Funerary Archaeoentomology" (l'Archéoentomologie funéraire).

The *Huacas de Moche* site is located on the northern coast of Peru, in the vicinity of Trujillo, 550 km north of Lima. The archaeological complex includes two monumental pyramids built as a series of platforms: *Huaca del Sol* (Temple of the Sun) and *Huaca de la Luna* (Temple of the Moon), separated by a vast urban centre. This site is regarded as the "capital" of the Southern Moche region.

Archaeological excavations carried out by Dr C. Chauchat and his team since 1999 on the Uhle Platform, located at the foot of "Huaca de la Luna" (Fig. 1) have recovered many well-preserved insect remains from graves that were directly associated with human skeletons or from inside ceramic vessels placed as offerings. The presence of necrophagous insects in Moche graves has been reported (Donnan and Mackey, 1978; Verano, 1995; Donnan and McClelland, 1997; Franco et al., 1998; Bourget, 1998, 2001; Millaire, 2004), and archaeologists have suggested that, in some cases, the corpses may have been exposed prior to burial to satisfy an as yet unexplained ritual. The present study of insect remains found in a Moche simple burial (Burial 45) focuses on the possible duration of exposure and the significance of flies in Moche culture.

2. Historical context

The Mochica (or Moche) culture is one of the pre-Columbian civilisations in Peru. It flourished from about AD 100 to 750 (Bawden, 1996) on a narrow desert coastal strip of northern Peru,

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Fig. 1. Pyramid of the Moon. At the base, on the right, is the Uhle platform excavated by the Franco-Peruvian archaeological team. Cerro Blanco mountain in background (photo C. Chauchat, 2004).

between the Andes and the Pacific. The name “Moche” was suggested in the 1920s by the Peruvian archaeologist Julio C. Tello after an ancient language spoken in that region, the *Muchik*. This pre-Inca culture had been characterised previously as proto-Chimú by the German archaeologist Max Uhle, the first to conduct excavations at a Moche site (*Huacas of Moche*) in 1899 (Uhle, 1913). Toward the middle of the XXth century, the Peruvian scholar Rafael Larco Hoyle (1946, 1948), considered the founder of “Mochicology”, established the first stylistic chronology based upon the Mochica stirrup-spout vessels (Quilter, 2002). Recent archaeological investigations show that Larco’s sequence must be re-examined because Mochica society, during its seven hundred years, was not as homogeneous as he had assumed (Castillo and Uceda, 2008).

The Mochica civilisation developed a sophisticated art and technology that did not exist in preceramic times. Peruvian and foreign archaeological teams since the 1980s have broadened our knowledge of Moche contributions revealed in their mastery of metallurgy, fine textiles, technological skill in their irrigation systems, and monumental adobe temples called huacas. Not least are the brilliant painted ceramics and vessels with complex realistic and mythological scenes. The study of fine-drawn Mochica ceramics, mural paintings, and jewellery has revealed a rich corpus of iconographic themes, including scenes of warriors in battle, decapitation, and sacrifice. Recent investigations conducted by the Canadian archaeologist S. Bourget (1997, 1998, 2001, 2006) at Huaca de la Luna, show that some of these horrific scenes are realistic portrayals. His excavations reveal the temple as a very important ceremonial centre which included a funerary platform as well as a huge sacrificial area. The archaeological evidence from this sector indicates that the bodies of the victims were often dismembered or decapitated, and were sacrificed during distinct episodes of torrential rains, possibly coinciding with an El Niño event.

3. Moche burial patterns

In recent decades, archaeological excavations conducted at many Moche sites have provided important data on Moche funeral practices (Donnan and Mackey, 1978; Bourget, 1998; Tello et al., 2003; Millaire, 2004). Undoubtedly, human remains were a central component of the Moche religious system evidenced by complex mortuary practices as delayed burials, grave reopenings, and secondary offerings of human remains (Nelson, 1998; Millaire, 2004; Gutierrez, 2008). Donnan (1995; Donnan and McClelland,

1997) accurately described and illustrated a wide range of funerary treatments and burial patterns of the Mochica, that were generally linked with the social rank of the deceased. The corpse was initially prepared and then placed in a sort of coffin made of canes tied together. The body was traditionally buried lying on its back in a fully extended position, head to the south, the upper limbs extended along either side of the body. In graves of high-ranking persons, copper elements, either simple plates or recycled objects, are usually found in the mouth, hands, and under the feet. Three kinds of funerary structures have been noted: a burial chamber made of adobe; a simple pit burial; or a “boot tomb” that refers to its peculiar shape in cross-section (Nelson, 1998). Grave goods are always present, including personal artifacts, e.g. disc-shaped ear ornaments, headgear with metal elements, copper spatulae, ceramic vessels, gourd containers, and bones of sacrificed animals (mostly llama) (Goepfert, 2008). In some cases, red pigment on the facial bones of the skull indicates that the face of the deceased was painted at the time of burial (Donnan, 1995). Insect remains such as fly puparia have been found in many graves between the mats and textiles, directly associated with buried skeletons, or even inside ceramic vessels placed as offerings (Donnan and Mackey, 1978). In some cases, the cadaver may have been exposed in the open for some time prior to burial, suggested by the state of decomposition (Nelson, 1998), and by the presence of a specific necrophagous entomofauna (Faulkner, 1986).

4. Archaeological context

Since 1999, a Franco-Peruvian team, headed by the French archaeologist Claude Chauchat, has been excavating at the foot of Huaca de la Luna, in a sector approximating the area formerly investigated by Max Uhle at the end of the XIXth century (Chauchat, 2000; Chauchat and Gutierrez, 2007, 2008a,b; Chauchat et al., 2008). Between 1999 and 2009, 57 graves were discovered and excavated on the eastern half of the platform,¹ and at the foot of the Huaca. Depending on their location, the tombs present two distinct patterns: burial chambers, including a variable number of lateral niches on the platform; or pits dug in sand at the foot of the Huaca.

The hyper-arid environment of the north coast of Peru fosters the remarkable preservation of archaeological materials, e.g. organic remains and textiles, which are perishable in other climates. These conditions favoured the recovery of a particularly well-preserved entomofauna intimately connected with the decomposition processes of the individual in grave 45.

5. Material and methods

5.1. Excavation of grave 45

Excavated in 2006, grave 45 was located in the southern part of the northern sector of the Uhle Platform, close to another grave (T47); the grave was in a single pit at the top of a wall of adobe belonging to an adjacent pre-existing funerary chamber. The numerous insect remains were located around the skeleton, somewhat more concentrated at the four cardinal points of the pit.

5.2. Physical anthropology

Grave 45 contains a young adult male (20–30 years old), originally placed in a funerary bundle. The skeleton lies on its back, oriented north-south, head to the south. The skull has distinct spots

¹ Named “Uhle platform” in reference to the German archaeologist.

of red mineral pigment identified as cinnabar (Fig. 2). Five pieces of copper were recovered, one laid on the mouth, four others placed inside the mouth.

The anthropological study conducted by D. Deverly showed that the skeleton was incomplete and had been disturbed prior to excavation: the left forearm and lower legs were entirely missing; and the right humerus had been put back on the wrong side. In all likelihood, these disturbances were caused by the Moche reopening the grave, and not by tomb plunderers (Huaqueros) who would have removed the grave goods to sell, and not bothered with the skeleton.

The remaining articulations of the skeleton with many intact ligaments suggest that the bundle was moved when the body was in an advanced stage of decomposition but before it was completely skeletonised. The bone disarticulations might have been enhanced by the south-north soil incline (the skull was located 10 cm higher than the pelvis).

5.3. Associated grave goods

Four ceramic vessels (three stirrup-spout vessels and a single *cántaro*) were recovered from grave 45. These correspond to “Moche I” style in Larco Hoyle’s chronology. One of the vessels presents an exceptionally realistic scene showing a condor, the wings widely spread, attacked by a feline perched on its back. It is noteworthy that the head of the feline is missing. According to Chauchat et al. (unpublished 2006 archaeological report), the intentional decapitation of the feline, probably performed with a *Tumi* (sacrificial knife), is highly symbolic since feline and condor, in Moche mythology, were considered supernatural creatures commanding earth and air, respectively.

5.4. Insect remains from grave 45

Adult beetles generally have a particularly hard exoskeleton, whereas adult flies are relatively fragile and are poorly preserved in archaeological contexts. During pupariation, the maggot contracts and its skin hardens into a rigid barrel-shaped case (puparium), inside which the adult fly develops. The sclerotized puparium can survive thousands or even millions of years (Handschin, 1944; Gautier and Schumann, 1973; Germonpré and Leclercq, 1994). The forensic entomologist often relies on living fly larvae on cadavers

but the archaeoentomologist depends, in most cases, on the puparium, the “fossil witness”, to calculate the time of death.

Grave 45 contained about two hundred fly puparia (Fig. 3). Their identification was aided with a scanning electron microscope (SEM) (JEOL 5600LV), after the specimens were gold/palladium coated to a thickness of approximately 275 Å with a Denton Desk IV sputter coater.

Because the anterior portion of the puparium is lost during adult emergence, the diagnosis was based on the posterior segments, e.g. the relative position of the tubercles and features of the posterior spiracles: their shape and distance apart; the contours of the spiracular slits; the thickness, shape, and completeness of the peritreme; and the location of the scar and button (Fig. 4a,b,c,d,f). SEM photos of the puparia from the tomb were compared with photos of puparia from known species collected and reared from egg to adult at various Peruvian sites (Greenberg and Szyska, 1984). The recovered fly puparia belong to three families: Calliphoridae, Muscidae and Sarcophagidae. In addition, the remains of a wing case fragment (elytron) of the hide beetle, *Omorgus suberosus* (F.) (Coleoptera: Trogidae), as well as many pupal cells attributed to the same species were recovered in the sediment subjacent to the skeleton (Fig. 5b,c,d). Although no parasitoid wasps were recovered, their presence is evidenced by the characteristic exit holes visible on most of the sarcophagid puparia (Fig. 5a). Investigations performed in 2009 by one of us (J.B.H.), using traps with meat bait on the site of Huaca de la Luna, yielded two species of adult *Brachymeria* (*B. podagrica* (F.) and *B. n. sp.*) (Chalcididae). The reduced size of the exit holes on the puparia, suggest that the buried sarcophagids might have been parasitized by a wasp belonging to the Pteromalidae (Table 1).

6. Results

6.1. Diptera

6.1.1. Calliphoridae

Calliphorids (blowflies) are very often involved in forensic investigations due to their ability to locate and colonize a cadaver soon after death (Greenberg, 1991; Greenberg and Kunich, 2002).



Fig. 2. Moche, young adult, at grave 45. Skull with distinct areas of red pigment (cinnabar) (photo B. Guttierrez León, 2007). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)



Fig. 3. Fly puparia from grave 45. In the centre, an elytral fragment of the skin-beetle *Omorgus suberosus* (Fabricius) (Coleoptera: Trogidae). Photo C. Chauchat/J.B. Huchet, 2008.

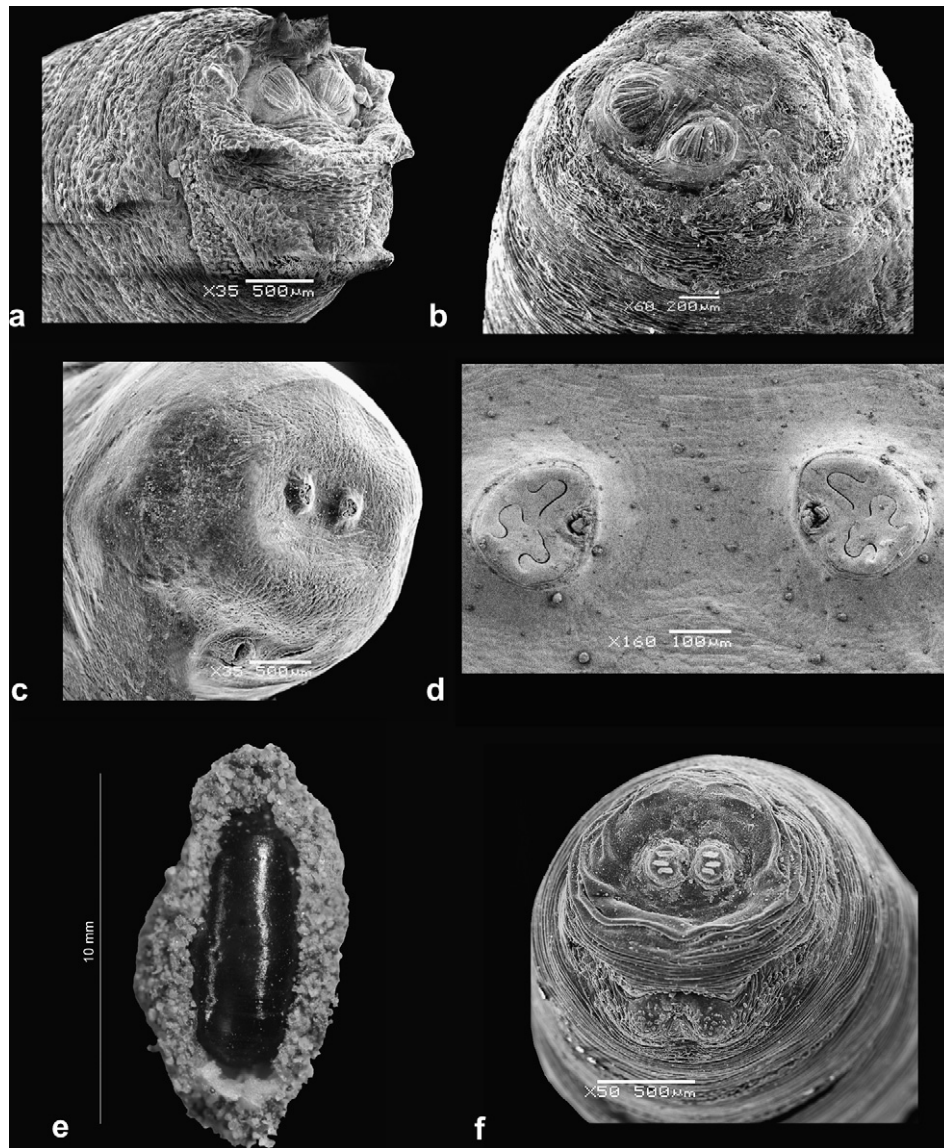


Fig. 4. a. SEM photos of puparia. a. *Compsomyiops verena* (Mello) (Calliphoridae, Chrysomyinae), caudal segment of subfossil puparium (lateral view) showing the pair of posterior spiracles surrounded by distinct sharp tubercles. b. *Cochliomyia macellaria* (F.), idem (posterior view). c. *Synthesiomyia nudiseta* van der Wulp (Muscidae, Reinwardtiinae), idem (lateral view). d. idem, close-up of sinuous anal spiracular slits. e. *S. nudiseta*, recent trapped specimen from the same archaeological site showing the puparium enclosed in a sandy cocoon. f. *Ophyra aenescens* (Wiedemann) (Muscidae, Azeliinae), caudal segment of subfossil puparium (posterior view). (Photos a, b, c, d, f: Dept of Biological Sciences, University of Illinois at Chicago, 2009; photo e: J.B. Huchet, 2009).

The Peruvian calliphorid fauna is relatively well known on the basis of several recent taxonomic and biological studies. Greenberg and Szyska (1984) reared and described the life cycles of twelve calliphorid species for the first time (see also Flores and Dale, 1984; Dale, 1985; Prudot and Dale, 1985; and Dale and Prudot, 1986). Baumgartner and Greenberg (1985) provide bionomic and ecological data on a number of Peruvian blowflies.

6.1.1.1. *Cochliomyia macellaria* (F.) (Fig. 4b). Puparia of this fly were recovered from two pre-Columbian Peruvian mummies (Riddle and Vreeland, 1982). In Peru, it is among the most common fly frequenting carrion (Iannacone, 2003; Baumgartner and Greenberg, 1985), and it colonizes cadavers soon after death. Its prevalence in pre-Columbian archaeological contexts indicates that it is undoubtedly a native species. A population decline of this species was first noted with the concurrent expansion of the recently introduced invasive species *Chrysomya albiceps* (Wiedemann) (Baumgartner and Greenberg, 1984). According to the forensic

observations of A. Oliva (2008, pers. comm.), *Cochliomyia macellaria* now behaves as a “backward primary fly”, colonizing corpses 24 to 72 h after death. *C. macellaria* is a synanthropic fly (Greenberg, 1971) and is considered to be of primary forensic importance (Velásquez, 2008). Based on the biological data concerning *C. macellaria*, this species was probably among the first flies to colonize the corpse.

6.1.1.2. *Compsomyiops verena* (Mello) (Fig. 4a). The puparia recovered from grave 45 were compared with those of *Compsomyiops verena* (Mello) and *C. boliviana* (Mello), collected and reared in San Ramon, Junin Province, 1550 m (VI, 1980) and Montaro Valley, Junin Province, 3500 m (XII, 1979), respectively (Greenberg and Szyska, 1984). Immature stages of the two reared species are difficult to distinguish. Both species have similar food preferences but different habitat distributions. *C. boliviana* is a montane species while *C. verena* occurs at lower elevations (1200 m) in the upper rain forest. It overlaps *C. boliviana* at approximately 2500–3000 m.

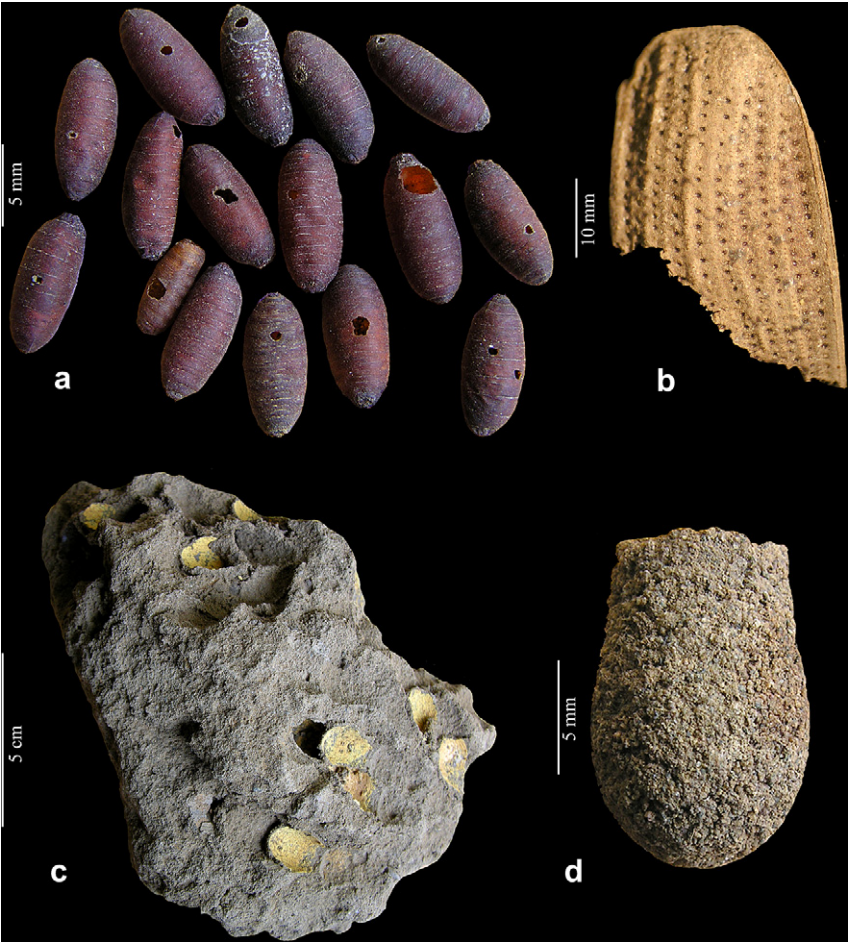


Fig. 5. a. Parasitized puparia of Sarcophagidae from grave 45 with wasp emergence holes. b. Right elytral fragment of *Omorgus suberosus* (Fabricius) (Coleoptera: Trogidae) from grave 45. c. Sediment from T45 containing numerous Trogid pupal cells. d. Close-up of a complete pupal cell from the grave (Photos C. Chauchat/J.B. Huchet, 2008).

On the basis of altitude preference the Huaca de la Luna specimens are attributed to *C. verena*. According to Segura et al. (2009) in Colombia, this species colonizes pig cadavers soon after death (first wave).

6.1.2. Muscidae

6.1.2.1. *Ophyra aenescens* (Wiedemann) (Fig. 4f). *Ophyra* species (dump flies) are frequently recorded from buried corpses (Méglin, 1894; Smith, 1986; Bourel et al., 2004; Huchet, unpublished) or corpses kept indoors, inaccessible to blowflies for several months. Several authors recovered puparia or adult remains belonging to this genus in graves from archaeological contexts (Huchet, 1996; Huchet and Gallis, 1996; Scharrer-Liška and Grassberger, 2005), or associated with mummified bodies (Couri et al., 2008).

The species identified here as *Ophyra aenescens* is a New World native (D’Almeida et al., 1999), with widespread distribution in Central and South America and parts of North America. Since the

1960s, it has spread from Italy throughout Western Europe (Hogsette and Washington, 1995). Carrion is the primary food source for the larvae (Greenberg and Miggiano, 1963) though the larvae are predatory, as well. The complete development of *O. aenescens* ranges between 17 days at $24 \pm 1^\circ\text{C}$ and 37 days at $17^\circ\text{C} \pm 1^\circ\text{C}$ (Lefebvre and Pasquerault, 2004a,b). Comparable results were obtained by D’Almeida et al. (1999) (14–15 days at $27 \pm 1^\circ\text{C}$). *Ophyra* species usually appear during the stage of ammoniacal fermentation (Turchetto and Vanin, 2004; Couri et al., 2008). According to Byrd and Castner (2001), *O. aenescens* may be recovered on human cadavers during the late or active decay stage. Given the range between these two accounts, we chose not to use this species in our estimation (Fig. 8) of the time of colonization in T45.

6.1.2.2. *Synthesiomyia nudiseta* van der Wulp (Fig. 4c, d, e). According to Skidmore (1984), *Synthesiomyia nudiseta* usually colonizes carrion after the first wave of necrophilous flies. In

Table 1
Summary of insect remains recovered from grave 45.

Order	Family	Taxa	Archaeological remains
Diptera	Calliphoridae	<i>Cochliomyia macellaria</i> (F.)	Puparia
Diptera	Calliphoridae	<i>Comptosyriops verena</i> (Mello)	Puparia
Diptera	Muscidae	<i>Ophyra aenescens</i> (Wied.)	Puparia
Diptera	Muscidae	<i>Synthesiomyia nudiseta</i> van der Wulp	Puparia
Diptera	Sarcophagidae	Genus?	Puparia (mostly parasitized)
Coleoptera	Trogidae	<i>Omorgus suberosus</i> (F.)	Elytron fragment/pupal cells
Hymenoptera	Pteromalidae?	<i>Muscidifurax</i> or <i>Spalangia</i> sp.?	Exit holes on puparia

Hawaii, Buxton and Hopkins (1927) found that *S. nudiseta* invades carrion at the “sarcophagid stage” (second wave according to Easton and Smith, 1970). Recent investigations conducted by Kumara et al. (2009) showed that the life cycle duration of *S. nudiseta* took 13.4 ± 0.8 days (average temperatures and relative humidity were respectively 28.5 ± 1.5 °C and 67–85%). The third instar larvae were collected from a decomposed human corpse (active decay stage) then reared on beef meat. These data accord with the field observations of one of us (J.-B. H, 2009) at the Huaca de la Luna, where this species began to oviposit on meat-bait (pork, in pieces of 50 g each) on the 13th day. The total life cycle took 15–16 days (average temperature and relative humidity were 23.1 °C and 69%, respectively). At the postfeeding stage, the mature larvae burrowed into the ground and exuded a frothy fluid which solidified to form a cocoon upon which sand grains adhered (Fig. 4e). No trace of these sandy cocoons were recovered from the grave. This species seems to be frequently associated with human cadavers in archaeological context. One of the authors (J.-B. H, unpublished) recovered remains of puparia within a funerary bundle (mortuary cave of Candelaria, Coahuila, Mexico, XVth century AD). The unidentified muscid quoted by Faulkner (1986: Fig. 4) from exposed human skeletons at Pacatnamu might be attributed to this species.

6.1.3. Sarcophagidae

The sarcophagid (fleshflies) puparia from grave T45 remain unidentified. The family includes nearly 2600 species worldwide (Pape et al., 2009). The Neotropical species are poorly known although probably richer than in other regions (Pape, 1989). Unlike calliphorids, the sarcophagids are larviparous and the first instar larvae are deposited directly on the corpse. Females usually colonize corpses slightly later than the pioneer blowflies. Most of the studied puparia were parasitized by parasitoid wasps (Pteromalidae or Chalcidae) which produce characteristic circular emergence holes (Fig. 5a).

6.2. Coleoptera

6.2.1. Trogidae

6.2.1.1. *Omorgus suberosus* (F.) (Fig. 5b). The Trogidae or “carcass beetles” include nearly 300 species worldwide (Scholtz, 1986). Most members of this family have necrophilous habits and usually exploit carrion in the last stages of decomposition, feeding on the desiccated remains (skin, ligaments). Among the thirteen South American *Omorgus* species, *O. suberosus* is one of the most common and widely distributed (Vaurie, 1962; Scholtz, 1990). Identification was based on an elytron fragment and on numerous pupal cells found in the sediment under the skeleton. Trogids, like dermestids, feed on desiccated carcasses that are subaerially exposed. *Omorgus* females deposit their eggs in the sediment subjacent to the primary food source up to a depth of about 15–25 cm, depending on the species (Baker, 1968). The presence of numerous pupal cells beneath T45 skeleton (Fig. 5c,d) indicate that the corpse was temporarily exposed to these insects. Similar evidence of corpse exposure prior to burial based on trogid beetles recovered from Native American graves (Arikara tribes, South Dakota) was reported by Ubelaker and Willey (1978).

6.3. Hymenoptera

Parasitic wasps (e.g. Chalcidae, Pteromalidae) pierce the fly puparium to deposit their eggs on the developing pupa. The wasp larvae feed, complete their development, and adults chew their way out, leaving a characteristic circular hole in the puparium, similar to those present on the sarcophagid puparia recovered from

T45 (Fig. 5a). The size of the emergence hole in the T45 puparia is a possible indicator that pteromalid species (e.g. *Muscidifurax* sp. or *Spalangia* sp.) were involved. *Muscidifurax* includes one species from coastal Peru (*Muscidifurax raptorellus* Kogan and Legner) (Legner, 1988) whose development (egg to adult) takes about 14 days at 27 °C (C. Geden, pers. comm., 2010). The *Spalangia* are widespread parasitoids of sarcosaprophagous flies, and include 12 Neotropical species (Marchiori et al., 2000). According to Geden (2006), development of most pteromalid species is completed in 2–4 weeks. Previous experiments (Geden, 2002) showed that some pteromalid and chalcid species (genera *Muscidifurax*, *Spalangia* and *Dirhinus*) can't oviposit on puparia buried in sandy soil at a depth of 1–6 cm. This indicates that T45 Sarcophagid puparia were directly accessible to these wasps.

7. Flies and death: parallel beliefs in the old and new worlds

Meaningful associations of arthropods in human thought and culture go back millennia to the rock inscriptions of honeybee harvesters in Spain (Hernández-Pacheco, 1921, 1924), rock carvings of spiders and other arthropods by the Anasazi in the southwest United States, the bees and scarab beetles of Egypt (Latreille, 1819; Cherry, 1985; Cambefort, 1987; Kritsky, 1991, 1993; Huchet, 1995), the flies and grasshoppers on Mesopotamian cylinder seals (Greenberg and Kunich, 2002), and to the Bible. Of 120 insects mentioned in the Bible, 34 refer to locusts and grasshoppers (food), 11 refer to moths (food and clothing), and 9 to flies (20 refer to “worms”, most of which would be fly larvae). Flies were associated with pestilence, disease, and death. In warm weather maggots can destroy more than fifty per cent of a corpse in a few days. This awesome biotic potential did not go unnoticed by the ancients and is best expressed in the saying: “Three flies can eat more than a lion”. In the ancient Near East this force of nature permeated thoughts of life and death.

The fly association with gods and priests goes back to the beginning of recorded history. A 5000 year old Mesopotamian cylinder seal carved in stone accurately depicts a typical fly. A Babylonian cylinder seal (1700–1400 BCE) shows the god Nergal with a fly. In the Near Eastern pantheon, gods and flies were sometimes interchangeable and comparison of gods with flies carried no stigma. For example, in Bible lands, Baalzebub, Lord of Flies, could change into a fly to ward off the plague, or send legions of these insects as punishment. The bravest Egyptian soldiers were rewarded with a necklace made of flies of pure gold. Egyptians wore and were buried with necklaces of stone-carved flies to ward off the ravages of maggots to prevent their remains from turning into flies that would carry off their guardian spirit or *Ka*. These symbols – given as death-defying rewards, or buried with the dead – speak eloquently of the power bestowed upon the common fly. Even today, people, in parts of rural Egypt, believe that shiny metallic-colored flies (blowflies) may be carrying the spirit of departed ancestors (Kritsky, 1985; Greenberg and Kunich, 2002).

Given their omnipresence it is not surprising that their necrophagous habits would have parallel impacts on New and Old World cultures, despite their separation by an ocean. In ancestral Andean cultures the soul is frequently depicted as a flying insect (Hocquenghem, 1981; Robin Azevedo, 2008). This evocation is clearly reported in seventeenth-century Quechuan texts such as the *Huarochirí* manuscript (Taylor, 1987; Salomon and Urioste, 1991), and the *Cajatambo* trial for idolatry (Duviols, 2003). Popson (2002) states “...art showcasing flies suggests the insects held symbolic meaning for the Moche”.

In the compilation of myths, rites and customs from the Huarochirí region recorded by Avila between 1597 and 1609 (Arguedas, 1966; Taylor, 1980), flies are intimately linked with the dead and

merged with the soul of the deceased: "... when a person died (...), people used to wait, saying, "Our dead will return in five days. Let's wait for him". They used to keep nightly vigil until the dawn of the fifth day after his death. On the fifth day, a woman would put on her fine clothing and go to Yaru Tini, saying "I'll bring him back from there" (...). At Yaru Tini, as the sun was rising, the dead spirit would arrive. In the old times, two or three big flies—people call them *llacsa anapalla*—would light on the garment she brought. She'd sit there for a long while. As soon as those maggots, called "Huancoy worms" left the corpse, the woman would say, "Come on, let's go to the village".

According to [Hocquenghem \(1981\)](#), the term "*llacsa*" could be related to the "verdigris" color or else to the awful and terrifying nature of those flies. [Taylor \(1980\)](#) suggested that it could be linked with the brilliant color of the first flies that colonize a cadaver (bluebottle and greenbottle flies), and the term "*anapalla*" may be related to "*ayapaura*", "a big fly that dirties the flesh". Finally, the mention of "*huancoy*" ("*huancoy curo*" in the original seventeenth-century Quechuan text) states that "*the cadaver must be left long enough to breed worms so its anima can emerge and escape in the form of flies*".

There is a major difference between the Moche view of flies and that of the ancient Near East, typified by the Egyptians. The latter did everything in their power to prevent flies from destroying the corpse, including enclosing written prayers with the body and embalming. The Egyptians hoped the *ka* would accompany the body of the deceased into eternity, whereas the Moche deliberately exposed the body to the flies with the hope that the anima or spirit of the deceased would be carried from the maggots into adult flies and through close contact with people, complete the human cycle.

8. Flies and death in Moche iconography

Flies and death in Mochica iconography are dramatically depicted on Moche ceramics. One stirrup-spout bottle depicts flies "waiting in anticipation" for the right moment to lay eggs on the bodies of prisoners being led to their execution ([Donnan and McClelland, 1999](#)) (Fig. 6). Blowflies do not normally lay eggs on the living, but respond with surprising promptness and remarkable sensitivity to odors of the newly deceased ([Greenberg, 1973](#)). Maggots and other insects have feasted on the bodies and reduced them to skeletons, shown in another stirrup bottle (Fig. 7). This depicts a lone fly in a "welcoming party" among dancing skeletons celebrating the arrival of the deceased souls ([Hocquenghem, 1981](#)). It is a kind of "dance macabre". To quote [Bourget \(2001, 2006\)](#) "*the departure of hundreds of new flies would have signalled the end of the sacrificial ceremony*". The same author suggests that the band of oval-shaped motifs figured on most of the lower jaws of the clay



Fig. 7. Skeletons dancing in the presence of a single fly. Mochica III, Valle de Chicama. Ethnologisches Museum, Berlin. Collection Gildemeister, VA 62199 (drawing by Donna McClelland).

effigies from the sacrificial area at Huaca de la Luna (Plaza 3A) could represent flies emerging from their puparia. There is also evidence from Moche burial sites of ritual disinterment, and sacrificed bodies decaying in the open. Clearly, flies and other such insects flourished among the Moche despite the region's aridity.

9. From forensic entomology to funerary archaeoentomology

It was not until some time in the 10th century in China that flies were linked to solving murders ([Greenberg and Kunich, 2002](#)). Forensic entomology and archaeoentomology exploit the attraction that certain insects and other arthropods have to a cadaver to feed, copulate, and oviposit. Timetables for the arrival, development, and departure of this necrofauna, when available, and now recognized by the courts, as useful and sometimes determinative in estimating the time of death in suicides, murders, and questionable deaths ([Anderson, 2001](#); [Tantawi et al., 1996](#); [Greenberg and Kunich, 2002](#)). Insects, like all arthropods, are poikilothermic (cold-blooded) and their timetable is primarily temperature driven. Rate of development may be species specific and is influenced by biotic factors, e.g. maggot mass that can significantly accelerate rate of development; and state of the body (clothed or naked, mutilated, etc.). Abiotic factors that influence rate of development include exposure of the body in sunlight or shade, and weather (rain, wind,



Fig. 6. Mochica warriors accompanying naked prisoners with flies staring down at the scene (from: [Donnan and McClelland, 1999](#): 71, Fig. 3.51). Colchagua Museum, Chile.

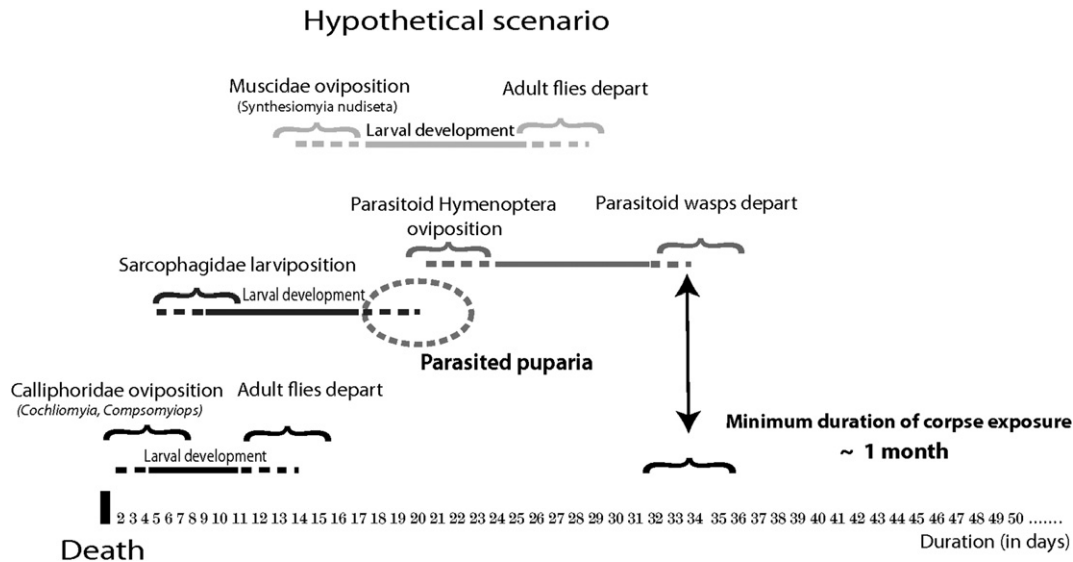


Fig. 8. Estimates of the time line of insect succession in T45 individual grave and duration of corpse exposure.

temperature). Forensic entomologists usually deal with *post-mortem* intervals of a few days or weeks, optimally within the first generation of the key insect, usually a fly. It follows that estimates of the PMI are less accurate the longer the interval between the fatal event and discovery of the body. Peruvian archaeoentomology relies on a detailed knowledge of the indicator species, then and now. In addition, there are such variables as long-term weather cycles (El Nino), disturbance of the burial site by post-ritual activity, plunderers, or animals, all of which may be significant factors.

Studies have shown that fly access to deep burials may not be limited to smaller flies, e.g. phorids. Loose or sandy soil with cracks, or blood-soaked soil, can facilitate deeper penetration by larger flies as well. In blood-soaked soil, eggs will hatch and larvae can develop into 2nd instar larvae that can penetrate to the corpse. In Canada, maggots of various flies, including calliphorids (bluebottle and greenbottle flies), were recovered from pigs buried 30 cm deep (VanLoerhoven and Anderson, 1999). Grave 45 was 1 m deep and thus beyond fly accessibility. Reopening a grave invites re-infestation and possible altering of the normal entomofaunal succession. For example, a partly decomposed body that is re-moistened by rain could re-engender putrefactive odors and initiate a new wave of oviposition by the “primary” flies. Therefore, the empty fly puparia recovered from the grave, indicate only one thing – the larval development of this wave was completed *in situ*.

The puparium’s predetermined cuticular lines of weakness and the pulsating ptilinum of the emerging fly are fine adaptations to facilitate eclosion of the adult fly. The teneral fly must then push its way from carcass and through soil up to the surface. Until then, the adult is soft-bodied, with crumpled wings held flat against the body, powerful hind legs, and the pulsating ptilinum between the compound eyes acting like a bulldozer. When the surface is reached the ptilinum is permanently withdrawn into the head, the wings are expanded and the body hardens. The absence of adult structures, if the sifting process was carefully done, indicates the successful escape of the flies from the burial site and into the air.

The biology and habits of the adult flies may be relevant to the burial practices of the Moche. Although tagged flies can disperse up to 20 miles in response to a food source (Greenberg, 1973), such trips would have been unnecessary because the Moche culture, if not the climate, fostered a resident fly population. We know that flies do not fly in heavy rain or strong winds. In Peru they are generally most abundant in the wet season but the seasonal mix of

fly species has not been adequately studied in Peru, and particularly, in the subtropical desert scrub environment of the Moche site.

Seasonality of flies is pronounced in regions with cold or freezing winters. Even in Alexandria, Egypt with a moderate, Mediterranean climate, Tantawi et al. (1996) found definite seasonal changes in the mix of fly species breeding in rabbits. In winter, the calliphorids, *Calliphora vicina* and *Phaenicia sericata*, were present on the carcasses, and several sarcophagid species which had been present in the fall were strangely absent. It is worth noting that one of us (J.-B. H) trapped numerous species of sarcophagids and the muscid *S. nudisetata*, at the Moche site but no calliphorids were recovered on meat baits in the month of May. If we knew the seasonality of the fly species at the Moche site we might, by comparison with the buried species, be able to infer the time of year when death came to the individual in grave 45.

Generally, fly activity is restricted or ceases at night. In field studies elsewhere in Peru flight activity sharply declined, or may have ceased at dusk, even in the presence of a carcass, and an ambient temperature suitable for flight (Baumgartner and Greenberg, 1985). Field studies in various regions give mixed results. Blowflies oviposited, albeit in smaller batches, on meat bait during the darkest hours of summer nights in Illinois (Greenberg, 1990a) and in Punjab, India (D. Singh, pers. comm.), but did not oviposit in Alexandria, Egypt (T. Tantawi, pers. comm.). Given the above, and what has come down to us concerning pre-hispanic burial practices, there is little reason to assume a rapid or nocturnal burial.

10. Conclusion

The life cycles and habits of the relevant flies preclude an early burial and point to a period above ground, or in a temporarily unfilled grave (open tomb), of at least 3 or 4 weeks (Fig. 8). In warm weather, oviposition by flies would begin within one or two days following death. A few days later, the body would be swarming with maggots of various species and ages. Within a week at least 50% of a corpse (including the brain and viscera) would be consumed. *C. macellaria* and *C. verana*, were probably among the first to exploit the corpse. *C. macellaria* provides some relevant biology. In this species, egg hatch to cessation of larval feeding takes about five days. About 40% of postfeeding larvae remain at or close to the corpse, and about 50% disperse no farther than 2.4 m to

pupariate (Greenberg, 1990b). Despite the huge numbers of maggots and puparia one normally encounters on a corpse in outdoor situations, a relatively small number of empty fly puparia were recovered from grave T45. Furthermore, the average depth of 1 m of Moche graves at Huaca de la Luna exceeds the ability of blowflies to reach the cadaver. It is reasonable to conclude that oviposition and the bulk of maggot activity – feeding, dispersion, and pupariation – occurred above ground before burial. The muscids, *S. nudiseta* and *O. aenescens*, would probably have arrived later, perhaps during preparation of the corpse for burial. The sarcophagid pupae recovered with the remains were most likely parasitized above ground and buried with the corpse (Geden, 2002).

The presence of many empty pupal cases of the trogid beetle, *O. suberosus*, together with fragments of adults in the sediment indicate an even longer exposure period since this species generally visits a corpse above ground during the dry decay stage, attracted by skin and ligaments. However, the presence of these insects might be the result of a subsequent reopening of the tomb by the Moche, suggested by absence of the legs and misplacement of several bones.

As discussed here, knowledge of the biology and habits of the relevant entomofauna of the grave can cast light on the funerary practices of ancient civilisations. Flies proved their value in modern forensics only after such knowledge, particularly life cycle data, was available. Exploration of the biology of the flies at the Moche site might fine-tune our insight into the life and death of the Moche.

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