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AN ANCIENT ASSEMBLAGE OF SCAVENGER INSECTS IN PATAGONIA (ARGENTINA)

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Abstract.—The study of a carrion fauna from a forensic perspective provides insight into cadaveric succession during vertebrate decomposition and contributes to documentation of taphonomic processes. The insects associated with sea lion bones of 1290 ± 100 years BP found in Puerto Madryn (Argentina) were examined. The recorded species were: *Cochliomyia macellaria* and *Fannia* sp. (Diptera), *Dermestes maculatus* and *Necrobia rufipes* (Coleoptera), and *Tineola cf. biselliella* (Lepidoptera). The succession of insect species occurred at the end of spring or the beginning of summer, on carrion exposed to the open air for approximately 50 days. Decomposition was apparently interrupted by mass wasting that buried the carcasses.

Key words: carrion fauna, taphonomy, forensic entomology, cadaveric succession, Argentina.

Resúmen.—El estudio de la fauna carroñera desde una perspectiva forense permite conocer el proceso de descomposición de los vertebrados (aún en una sucesión cadavérica antigua) y contribuye con los estudios fafonómicos. En esta investigación, fueron examinados los insectos asociados a restos de lobos marinos de 1290 ± 100 ^{14}C años AP hallados en Puerto Madryn (Argentina). Las especies registradas fueron: *Cochliomyia macellaria* y *Fannia* sp. (Diptera), *Dermestes maculatus* y *Necrobia rufipes* (Coleoptera) y *Tineola cf. biselliella* (Lepidoptera). Fue determinado que la sucesión se desarrolló a fines de la primavera o comienzos del verano y los restos estuvieron expuestos al aire abierto por aproximadamente 50 días, cuando la descomposición aparentemente fue interrumpida por fenómenos de remoción en masa que enterraron los restos.

Key words: fauna cadavérica, tafonomía, entomología forense, sucesión cadavérica, Argentina.

Vertebrate carcass decomposition implies a heterotrophic succession where, throughout relatively discrete diverse stages, various arthropod groups colonize the carrion as a resource for feeding and breeding (Goff, 1993; Centeno *et al.* 2002). From the succession of the carrion fauna it is possible to obtain information about circumstances associated with and following the death of the animal(s), which is helpful in forensic investigations (Goff 1993; Benecke, 2001).

Different body parts of insects and other arthropods can be preserved unaltered for thousands of years [e.g., 24,550 ± 600 years BP (Coope, 1986; Petrulevicius, 2001)] or can become fossilized. For example, fossilized Diptera of the family Calliphoridae have been found in association with Pleistocene mammals from Argentina, and represent an example of an ancient cadaveric decay assemblage (Petrulevicius, 2001). No fossilized scavenger insects were found associated with Egyptian or Peruvian mummies dating to several thousands years B.P. (Panagiotakopulu 2001). The study of assemblages of insects found in archeological sites from the Middle Ages provides knowledge about environment utilization, displacements, and behavior of ancient populations (Hellqvist & Lemdahl, 1996; Carrott & Kenward, 2001). The knowledge of cadaver fauna from a specific time can be helpful in the study of circumstances associated with past events such as animal death and decay, graves, mummies, or other sites of archaeological interest. The study of this fauna from a forensic perspective can contribute information valuable to reconstructing past events (Panagiotakopulu, 2004). Our study of carrion insects was carried out in conjunction with an archaeological investigation in Patagonia, Argentina.

Materials and Methods

Insect remains were collected from the site of a taphonomic event at the site called "Sitio Lobos", located at Punta Dorado, on the Golfo Nuevo coast, 12 km northeast of Puerto Madryn (Serrán

Table 1. Species and body parts of arthropod remains from Sitio Lobos.

Order	Family	Species	Remains
Diptera	Calliphoridae	*Cochliomyia macellaria* F.	pupae, empty puparia and puparia containing other puparia or an adult
Diptera	Fannidae	*Fannia* sp.	pupa inside *C. macellaria* puparium, empty puparia
Coleoptera	Dermestidae	*Dermestes maculatus* De Geer	exuvia
	Cleridae	*Necrobia rufipes* De Geer	head, thorax, elytra, abdomen
Lepidoptera	Tineidae	*Tineola* sp. *cf. biselliella* Hummel	cocoon

et al. 2007). This site was found by members of the archaeology laboratory of the Centro Nacional Patagónico (Patagonia, Argentina), who discovered bones arising within the walls of a gully aligned perpendicular to the coast. The bone remains were buried at depths ranging from 40–70 cm, in a continuous layer that extended 13 m, located 44 m inland from the high tide line and 1.85 m above present sea level. The bones were identified as those of at least 22 individual sea lions (*Otaria flavescens* (Shaw)) of both sexes and varying ages (i. e., pups, juveniles, subadults and adults). A radiocarbonic age of 1290 ± 100 C-14 B.P. was reported (Serrán *et al* 2007). Taphonomic analyses indicated a mass mortality event of the sea lions. No evidence of human activity or catastrophic event was recognized in the site; thus an acute illness was proposed as the cause of death (Serrán *et al.*, 2007).

Remains of several arthropods, some of them well preserved, were collected in association with the sea lion bones. Taxonomic analysis of the insects and their context within the site allowed establishment of the cadaver-inhabiting nature of the fauna. We analyzed the insects from a forensic perspective, trying to determine the incidence of different processes at the site.

The insect remains and the associated sediment were transferred to the laboratory where they were cleaned, using minutens, brushes and other instruments in order to prepare them for taxonomic determination. Insect remains were stored in the Laboratory of the Centro de Estudios e Investigaciones at the Universidad Nacional de Quilmes. Table 1 lists the identified species and includes some details about the life stages represented in the fauna.

Results and Discussion

The discovery of several puparia of Calliphoridae containing other calliphorid puparia inside is evidence of more than a single generational cohort. The larvae of the second generation entered empty puparia from the first generation in order to pupate. Something similar would have happened with pupae of *Fannia* sp. which were found inside *Cochliomyia macellaria* F. puparia, indicating that at least some of the *Fannia* arrived after the Calliphoridae. This observation is consistent with results obtained from Santa Catalina (Buenos Aires province, Argentina) where Calliphoridae arrived relatively early, followed by *Fannia* sp. during the more advanced stages of decay (Centeno *et al.*, 2002).

The Cleridae are represented by *Necrobia rufipes* De Geer, an omnivorous species that, once the succession started, likely came to the carrion in order to feed on dipterous eggs or larvae. It is also conjectured that this clerid might feed on fat from the corpses (Payne & King, 1970). The rest of the coleopterous larval exuviae are from *Dermestes maculatus* De Geer, indicating that this succession proceeded to an advanced decay stage, close to skeletonization and/or mummification, where only bony tissue, dried skin and hair are preserved. This interpretation is reinforced by the presence of a Lepidopteran cocoon, probably a representative of the family Tineidae, and very similar to *Tineola biselliella* Hummel. Larvae of this species are known to feed on hair and other dried tissues (Payne & King, 1969; Oliva, 1997).

With respect to the estimation of event seasonality, palaeoclimatic studies indicate that current weather conditions in the plateau of north Patagonia extrandina began about 2500–2000 years BP (Páez 1993; Schäbitz & Liebricht 1998). That allows us to infer that at the time of death of the sea lions, climatic conditions in the area were similar to the present arid temperate environment. Referring to Calliphoridae seasonality in a temperate climate like that NW of Buenos Aires province (Centeno *et al.*, 2004), *Calliphora macel-*

laria are most abundant during the late spring and early summer. Thus, the abundance of puparia of *C. macellaria* indicates that decomposition would have taken place during the warm season of the year, probably the end of spring or the beginning of summer. The absence here of other Calliphoridae species that are common during other seasons of the year reinforces this prediction. These results are supported by thin-section analysis of the pup and adult sea lion teeth, which corroborate the summer as the most probable season of their demise.

Geomorphological analyses show that the layer containing the pinneped bones is composed of small gravel (coming from the palaeocliff) mixed with coarse sand and small scattered mollusc valves. This indicates that the corpses were buried by a mass wasting event, possibly due to torrential rain. Under semiarid climatic conditions with cool temperatures, severe droughts commonly alternate with violent pluviometric episodes that can move a great amount of detritus. Coronato & Del Valle (1993) calculated that the 63% of the hydric erosion that occurred in the northeast of Chubut during a sixteen month period was due to only two intense pluviometric summer episodes. (see Serrán *et al.*, 2007 for further information).

To calculate the length of time the corpses were exposed prior to burial, it is important to take into account the development rates of *C. macellaria* in the laboratory, which vary between 13 and 14 days at temperatures between 16° C and 29° C (Greenberg, 1991). The added time of overlapping generations extends the estimated duration of exposure somewhat. The minimum development time for a *C. macellaria* larva to reach stage III is estimated to be two days (under the previously described conditions); at this time, the larva entered into an empty puparium left behind by the previous generation in order to pupate (Byrd & Butler, 1996). This indicates that the carcasses were unburied until at least the 10^{th} or 11^{th} day of succession, being able to attract *C. macellaria* and be colonized with new eggs, from which arose the larvae that pupated in empty puparia.

Cadaveric decomposition studies conducted in Buenos Aires province during the summer showed that dermestid beetles were captured 10 days after the beginning of succession, when remains were in an advanced decomposition stage (Centeno *et al.*, 2002). This span coincides with the estimated time that the corpses remained exposed based on the remains of *C. macellaria*. These data allow us to conclude that the first stages of decomposition would have been reached by at least 10 or 11 days post-mortem. Then, the remains were unburied until reaching a dry stage (mummification/skeletonization), providing suitable habitat for beetles such as *D. maculatus* and eventually, sarcophagous moths such as *T. biselliella*. The interval length of this final stage is hard to estimate, considering that *T. biselliella* takes almost 40 days to reach the pupa stage. From this, it can be assumed that approximately 40 days passed following the initial stages of decomposition.

The post-mortem interval thus can be estimated as 50 days, this being the time interval in which the cadaveric succession developed before reaching a stage of near-skeletonization. Then the sea lion carcasses would have been buried by a mass wasting episode, possibly due to torrential rain.

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