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Association of *Oxelytrum cayennense* (Silphidae, Coleoptera) with Pig Carcasses (*Sus scrofa*, Suidae) in Terra Firme Areas in Manaus, Amazonas, Brazil

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Abstract. Colonization aspects of the carrion beetle *Oxelytrum cayennense* (Sturm) in man-size pig carcasses (~60 kg) are presented at Adolpho Ducke Forest Reserve, Manaus, Brazil. This species colonized pig carcasses from bloated to skeletonized stages. Adults were eventually observed preying on fly larvae from the second day postmortem and their larvae were observed from the fifth day postmortem feeding on skeletonized areas, probably cleaning the bones of the remaining soft tissues. Adult beetles with predatory behavior on the oldest Diptera larvae can impact their populations and thereby complicate the estimation of the time of death as these larvae are frequently used as a postmortem indicator. In addition, both larvae and adult developmental stages have potential use as a postmortem interval (PMI) indicator because the adult can colonizes carcasses from the second postmortem day onward and the larvae from the fifth day onward.

Keywords: Forensic Entomology; Silphids; Central Amazonia

Associação de *Oxelytrum cayennense* (Silphidae, Coleoptera) com Carcaças de Porcos (*Sus scrofa*, Suidae) em Áreas de Terra Firme em Manaus, Amazonas, Brasil

Resumo. Aspectos da colonização do silfídeo *Oxelytrum cayennense* (Sturm) em carcaças de porcos do tamanho de um homem adulto na Reserva Florestal Adolpho Ducke são apresentados. Esta espécie colonizou as carcaças de porcos do estágio enfisematoso à esqueletização. Adultos foram observados eventualmente predando larvas de moscas a partir do segundo dia de intervalo pós-morte e suas larvas foram observadas a partir do quinto dia se alimentando em áreas esqueletizadas, provavelmente limpando os ossos dos tecidos moles remanescentes. O comportamento predatório dos adultos nas larvas de dípteros mais velhas podem impactar suas populações e complicar estimativas de intervalo pós-morte, uma vez que estas são freqüentemente usadas para esta estimativa. Além disso, adultos e larvas têm potencial uso como indicadores de intervalo pós-morte (IPM) porque o adulto pode colonizar carcaças do segundo dia em diante e as larvas do quinto dia em diante.

Palavras-Chave: Entomologia Forense; Silfídeos; Amazônia Central

The Silphidae (Coleoptera) or "carrion beetles" are represented by 175 species distributed in 15 genera worldwide (Peck 2001). Immature stages are necrophagous and the adults are predators principally on fly maggots (Catts & Haskel 1990; Mise *et al.* 2007). This predation can impact the population of dipterous larvae frequently used as a minimal postmortem indicator and complicate estimations of time since death, by preying on the oldest dipterans larvae. Many studies have described silphids linked to the decomposition of human corpses or animal carcasses, however the genera and the species are varied (Oliveira-Costa 2007). In the Neotropical region, *Oxelytrum* Gistel, originally described as a subgenus of *Silpha* Linnaeus, is the most common silphid reported in association with decomposition of animal carcasses (Mise *et al.* 2007; Moura *et al.* 1997; Moura *et al.* 1998; Carvalho *et al.* 2000; Moura 2004). In South America, three species have been cited: *Oxelytrum cayennense* (Sturm), *Oxelytrum discicolle* (Brullé) and *Oxelytrum erythrurum* (Blanchard) (Almeida & Mise 2009). In Brazil, two species were cited in association with carcasses, *O. discicolle* and *O. cayennense*. The latter species has few geographical distribution registries available for Brazil (Almeida & Mise 2009; Luederwaldt 1911).

Here we report the relation between *O. cayennense* and the decomposition processes of domestic pig models (*Sus scrofa* Linnaeus). The main objectives of this study were to: 1) describe some aspects of the beetle species behavior on carcasses and the arrival patterns for adults and larvae in central Amazonia, Manaus, Amazonas, Brazil, and 2) discuss the species potential as a forensic indicator.

MATERIAL AND METHODS

This work was carried out in the Adolpho Ducke Forest Reserve (100km2) of the Instituto Nacional de Pesquisas da Amazônia (INPA), Manaus, Brazil, in terra firme primary forest (2055'51"S, 59058'59"W). Six large domestic pigs (~60 kg) were killed by a shot with .38 caliber gun in the frontal region of the head and placed undressed in metal cages of 4 m2 with 2" mesh. Three experiments with two pigs each were set up and observed for 30 days: the first experiment was conducted from 30 June 2005 to 30 July 2005 (low rainfall/dry season); the second, from 18 October 2005 to 17 November 2005 (mid rainy season), and the third from 15 March 2006 to 14 April 2006, during the main rainy season. Daily visits between 5:00 – 6:30 pm were

made to the site for observation and collections of abiotic data (temperature, air relative humidity) with a thermo-hygrometer and rainfall data were taken from meteorological station of INPA on Adolpho Ducke reservation. Photographs and presence or absence of the beetles and some general behavioral and only qualitative notes were taken. The terminology used to describe the physical changes in the appearance of carcasses, as well as for determining and quantifying the stages of decomposition, was taken from Catts & Haskell (1990). The adipocere-like stage was based on the description by Moura *et al.* (1997). The analysis of photos and the classification of the stages of decomposition were assisted by a forensic examiner of Criminalists Institute of Brasília, Brazil. Twenty-nine voucher specimens of *O. cayennense* were collected and are deposited at the Invertebrates Collection of INPA. It is important to record that notes and observations were taken during a major experiment designed to evaluate the temporal distribution of calliphorid flies that resulted in a Ph.D. doctoral dissertation. However, some relevant notes of behavior and arrival patterns of others forensically important species were take and have since been published (Ururahy-Rodrigues *et al.* 2008).

RESULTS AND DISCUSSIONS

Table 1 illustrates the presence and absence of adult and immature Silphidae collected along the time line of the different decomposition stages during the three experiments conducted. It shows the arrival patterns for this species and the frequency and temporal variation in the decomposition process. We observed five decomposition stages: fresh, bloated, decay, adipocere-like and skeletonized. In thirty days the models don't reached the stage of remains (Table 1).

The temperature did not change significantly in the three periods studied (N = 90; Min = 22.2; Max= 29.8; Sum = 2331.8; Mean = 25.9089; Std. error = 0.155552; Variance = 2.17767; Stand. Dev = 1.47569). In the dry season temperatures reached the minimum of 24.1ºC and a maximum of 29.3ºC, with an average of 26.10C. In the transition period between the two stations, the minimum value was 23.0ºC, the maximum value of 29.80C, and average 26.4ºC. Finally, in the rainy season the minimum value was 22.2ºC, the maximum value of 27.6ºC, and average of 25.2ºC. The same occurred with the air humidity (N = 90; Min = 63; Max = 99; Sum = 7650; Mean = 85; Std. error = 1,01253; Variance = 92.2697; Stand. Dev = 9.60571) that reached the minimum of 63% and a maximum of 93%, with an average of 79.4%. In the transition period between the two stations, the minimum value was 69%, the maximum value of 98%, and average 80.8%. Finally, in the rainy season the minimum value was 83%, the maximum value of 99% and average 95.4%.

Regarding precipitation, the results demonstrated that this is the only variable that has fluctuated significantly during the experimental period and therefore temporally (N = 90; Min = 0; Max = 81.5; Sum = 804.4; Mean = 8.93778; Std. error = 1.77629; Variance = 283.968; Stand. Dev = 16.8514). In the dry season reached the minimum of 0.0 mm, the maximum of 68.3 mm, and average 4.2 mm. In the transition period between the two stations, the minimum value was 0.0 mm, the maximum value of 78.2 mm, and average 9.9 mm. Finally, in the rainy season the minimum value was 0.0 mm, the maximum value of 81.5 mm and average 11.8 mm.

In the first two experiments, adult *O. cayennense* appeared on the pig carcasses from the second day following death, during the bloated stage, when the first colonizing flies' eggs had hatched, and during the time when the early instars were active. The adults remained in the decay, adipocere-like, and skeletonized stages. In the rainy season, the adipocere-like stage did not occur.

Adults feed on fly eggs, fly larvae (Figure 1) or carcass tissues were observed at last once time in the three experiments. Some times exploring the postmortem lesions caused by another beetle of forensic importance in the region: *Coprophanaeus lancifer* (Linnaeus) (Scarabaeidae) (Ururahy-Rodrigues *et al.* 2008). These results are in partial agreement with behavioral observations made by other investigators (Moura *et al.* 1997; Moura *et al.* 1998; Carvalho *et al.* 2000; Moura 2004) who mainly found the adults of these beetles as only predators.

Figure 1. Adult of *O. cayennense* preying on a muscoid fly maggot the 8th postmortem day.

Immature stages of *O. cayennense* were observed in the first and second experiments from the fifth postmortem day (adipocerous-like stage) on and in the third experiment from the sixth postmortem day (skeletonized stage). Larvae were present from these times forward throughout the rest of the decomposition processes in all three pseudo-replicates. Silphid larvae appeared to show a preference for skeletonized area of the head and extremities, probably feeding on remains of soft tissues (Figure 2) and were not observed preying on fly larvae.

The first case involving a human corpse in Brazil (Roquette-Pinto 1908), where the PMI was estimated to be eight days, was based on body physical changes. In this study the author reported the occurrence of two (one adult and one immature) silphid specimens, both identified as *Oxelytrum* (*Silpha*) sp. With that time period, and according to the successional pattern proposed by (Mégnin 1894), the presence of silphids is generally associated with older corpses. Therefore, in the latter case it could suggest an overestimated PMI and point out that the succession patterns could be different depending on geographical variation, climatic and faunal differences as would occur in the tropics.

Figure 2. Larvae of *O. cayennense* feeding on skeletonized areas of the head.

Table 1. Date of observations, presence or absence of the adults and larvae of *O. cayennense*, decomposition stages and postmortem interval, in the three experiments. Sta= decomposition stage; PMI= postmortem interval; FR= fresh; BL= bloated; DE= decay; AL= adipocere-like; SK= skeletonized.

Date	Adult	Larvae	Sta	PMI	Date	Adult	Larvae	Sta	PMI	Date	Adult	Larvae	Sta	PMI
1/7/2005	0	0	FR	24	19/10/2005	0	0	FR	24	16/3/2006	0	0	FR	24
2/7/2005	1	0	BL	48	20/10/2005	1	0	BL	48	17/3/2006	1	0	BL	48
3/7/2005	1	0	BL	72	21/10/2005	1	0	BL	72	18/3/2006	1	0	DE	72
4/7/2005	1	0	DE	96	22/10/2005	1	0	DE	96	19/3/2006	1	0	SK	96
5/7/2005	1	1	AL	120	23/10/2005	1	1	AL	120	20/3/2006	1	0	SK	120
6/7/2005	1	1	AL	144	24/10/2005	1	1	AL	144	21/3/2006	1	1	SK	144
7/7/2005	1	1	AL	168	25/10/2005	1	1	AL	168	22/3/2006	1	1	SK	168
8/7/2005	1	1	AL	192	26/10/2005	1	1	AL	192	23/3/2006	1	1	SK	192
9/7/2005	1	1	AL	216	27/10/2005	1	1	AL	216	24/3/2006	1	1	SK	216
10/7/2005	1	1	AL	240	28/10/2005	1	1	AL	240	25/3/2006	1	1	SK	240
11/7/2005	1	1	AL	264	29/10/2005	1	1	AL	264	26/3/2006	1	1	SK	264
12/7/2005	1	1	AL	288	30/10/2005	1	1	AL	288	27/3/2006	1	1	SK	288
13/7/2005	1	1	SK	312	31/10/2005	1	1	SK	312	28/3/2006	1	1	SK	312
14/7/2005	1	1	SK	336	1/11/2005	1	1	SK	336	29/3/2006	1	1	SK	336
15/7/2005	1	1	SK	360	2/11/2005	1	1	SK	360	30/3/2006	1	1	SK	360
16/7/2005	1	1	SK	384	3/11/2005	1	1	SK	384	31/3/2006	1	1	SK	384
17/7/2005	1	1	SK	408	4/11/2005	1	1	SK	408	1/4/2006	1	1	SK	408
18/7/2005	1	1	SK	432	5/11/2005	1	1	SK	432	2/4/2006	1	1	SK	432
19/7/2005	1	1	SK	456	6/11/2005	1	1	SK	456	3/4/2006	1	1	SK	456
20/7/2005	1	1	SK	480	7/11/2005	1	1	SK	480	4/4/2006	1	1	SK	480
21/7/2005	1	1	SK	504	8/11/2005	1	1	SK	504	5/4/2006	1	1	SK	504
22/7/2005	1	1	SK	528	9/11/2005	1	1	SK	528	6/4/2006	1	1	SK	528
23/7/2005	1	1	SK	552	10/11/2005	1	1	SK	552	7/4/2006	1	1	SK	552
24/7/2005	1	1	SK	576	11/11/2005	1	1	SK	576	8/4/2006	1	1	SK	576
25/7/2005	1	1	SK	600	12/11/2005	1	1	SK	600	9/4/2006	1	1	SK	600
26/7/2005	1	1	SK	624	13/11/2005	1	1	SK	624	10/4/2006	1	1	SK	624
27/7/2005	1	1	SK	648	14/11/2005	1	1	SK	648	11/4/2006	1	1	SK	648
28/7/2005	1	1	SK	672	15/11/2005	1	1	SK	672	12/4/2006	1	1	SK	672
29/7/2005	1	1	SK	696	16/11/2005	1	1	SK	696	13/4/2006	1	1	SK	696
30/7/2005	1	1	SK	720	17/11/2005	1	1	SK	720	14/4/2006	1	1	SK	720

In this work, *O. cayennense* adults were present and copulating at the bloated stage, one day after death, followed by the appearance of their larvae five to six days after death. This occurred subsequent to the decay stage and during the adipocerous-like stage, suggesting that oviposition occurred during the bloated stage. In Paraná state, Brazil, a study using pigs as models (Moura 2004), found adults of *O. discicolle* preying on fly larvae, but not feeding on the animal tissues. Additional work carried out in Paraná, Brazil, but using rats as a model (Moura *et al.* 1997), reported that *O. discicolle* arrived on the carcass during the decay stage in all four seasons studied, showing a pattern and indicating that the life cycle of this species was approximately 30 days. These arrival patterns, in addition to a relatively short life cycle, demonstrated the importance of this species as an indicator of postmortem interval (PMI). In addition, a recent paper found a life cycle from egg to adult took 20.33 ± 0.89 days at 28ºC (Velásquez & Viloria 2009). This temperature is close to mean found on the three experiments in this study (26.7ºC).

It is possible that *O. cayennense* has a short life cycle like *O. discicolle* in the study area and their early arrival on carcasses suggested the species could play an important role as a minimal PMI indicator. Our results highlighted the importance for ecological and biological studies of the Amazonian carrion beetle *O. cayennense* succession which could contribute to a better use of it as a PMI indicator in Central Amazonia. Its predatory behavior on fly larvae could impact the population of dipterous larvae frequently used as a postmortem indicator and could complicate estimations of the time of death, by preying on the oldest dipterans larvae. However, this occurrence also can be used as a minimal postmortem indicator because adults occur on carcasses from the second day, and the larvae from the fifth postmortem day. This study also provides little known data on the development of larvae and adults of forensically important Coleoptera, a major void in most of the forensic literature.

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