Forensic Science International 252 (2015) 1–10

Contents lists available at ScienceDirect

Forensic Science International

journal homepage: www.elsevier.com/locate/forsciint

Long-term study of pig carrion entomofauna

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ARTICLE INFO

Article history:
Received 12 December 2014
Received in revised form 16 March 2015
Accepted 10 April 2015
Available online 20 April 2015

Keywords:
Forensic entomology
Long PMI
Advanced decomposition
Carrion insects
Recolonization
Insect succession

ABSTRACT

Long-term changes of carrion entomofauna are poorly understood. No single carrion study lasted longer than one year. We studied entomofauna of large pig carcasses in the second and the third year postmortem. Ten carcasses were exposed in xerothermic grasslands of Western Poland in spring, early and late summer of 2012. Entomofauna was monitored until September of 2014. 72 species were found in the second year, and six in the third year. In the second or the third year carcasses from the late summer block revealed larger number of taxa compared to carcasses from the spring or the early summer block. Taxa differed in pattern of multiple larval colonizations. Only necrophagous taxa breeding in long-lasting carrion parts as well as predators feeding on arthropods present in these parts were found to recolonize. Recolonizations were always recorded in the second or the third year after death. Patterns of multiple colonization depended on the time of carcass exposure in the first year. Residencies of larvae were unexpectedly long in the second year. Several forensically important flies overwintered on carcasses in the larval stage. Current results support the view that insect fauna of cadavers with long post-mortem interval (PMI) may be used for PMI estimation.

1. Introduction

Estimating time of death in cases of long post-mortem interval (PMI) is a challenging task. Long-term studies of carrion decomposition are rare, and there are only few decompositional phenomena useful for PMI estimation in long PMI cases. Although several techniques were proposed and used in casework [1–4], there is still an urgent need for basic research and new methods. When a cadaver is discovered weeks, months or years after death, PMI may frequently be estimated using entomological methods [5].

Generally, there are two entomological methods for PMI estimation [6,7]. In short PMI cases a developmental approach may be used, in which the age of immature insects sampled from a cadaver is estimated by using species-specific temperature models for development and case-specific temperature data [6]. This approach is problematic if a cadaver is discovered long after death, as immature insects sampled may come from the second or even the third generation. Accordingly, in long PMI cases a succession-based approach is more useful. It involves an analysis of insect community recorded on a cadaver and its comparison with results of relevant pig carcass study. The baseline data should contain information on local carrion entomofauna, seasonal patterns of its succession and residency times for particular taxa [8]. This approach was successfully used for PMI estimation in death investigations [9,10].

Cadavers are sometimes discovered several months or years after death [11,12]. Unfortunately, no single study on succession provides the time of carrion exposure longer than one year [13–38] (Table 1). Consequently, most successional data have limited usefulness for the estimation of long PMI. In particular, upper limits for the presence of late arriving insects may be unknown or underestimated. Moreover, some taxa may reappear on large cadavers after winter [38]. Decrease of temperature during winter in temperate climate inhibits decomposition and activity of insects. Consequently, some species present on a cadaver before winter may reappear after winter, as was demonstrated for adult *Necrobia violacea* (Linnaeus, 1758), *Necrobia rufipes* (DeGeer, 1775), *Nitidula flavomaculata* Rossi, 1790 and *Thanatophilus ferrugatus* (Solsky, 1874) [38]. Contrary, some species colonizing cadavers exclusively in the first year of decomposition may indicate that PMI is shorter than one year. Unfortunately, successional studies with overwintering cadavers are very rare, so all these patterns are poorly studied.

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http://dx.doi.org/10.1016/j.forsciint.2015.04.013
0379-0738/

Table 1
Selected studies of pig carrion entomofauna according to the duration of sampling.

Duration of sampling [days]	Number of carcasses	Carcass mass [kg]	Habitat	Country	Reference
14	53	13.5–18.5	Woodlot	USA	Pérez et al. [13]
21	8	23–45	Open/forest	USA	Tabor et al. [14]
24	4	15	Semi-urban	Chile	Ortloff et al. [15]
36	3	10	Urban	Colombia	Pérez et al. [16]
38	8	23	Island	USA	Davis and Goff [17]
40	9	45	Forest	Australia	Voss et al. [18]
42	6	43–65	Indoor/outdoor	Canada	Anderson [19]
49	8	10	Forest	Brazil	Carvalho and Linhares [20]
50	8	23–39	Field	South Africa	Kelly et al. [21]
60	3	25–30	Urban	Canada	Bygarski and LeBlanc [22]
60	2	37;44	Urban	Austria	Grassberger and Frank [23]
63	18	42–79	Grassland	Canada	Sharanowski et al. [24]
71	7	22	Open urban	Mexico	Valdes-Perezgasga et al. [25]
76	4	7.5–8	Woodland	Portugal	Prado e Castro et al. [26]
77	8	8	Rural	Argentina	Battán Horenstein et al. [27]
78	18	36–67	Forest, grassland	China	Wang et al. [28]
83	3	10	Andes	Colombia	Martinez et al. [29]
97	4	12	Semi-rural	Colombia	Segura et al. [30]
98	10	40–45	Bushland	Australia	Voss et al. [31]
105	36	14–39	Forest	Poland	Matuszewski et al. [32]
125	10	49–55	Forest	Australia	Archer [33]
128	9	14.5–29	Grassland, sand dune, bush	New Zealand	Eberhardt and Elliot [34]
133	8	25	Rural	Germany	Anton et al. [35]
155	15	14–18	Forest	USA	Benbow et al. [36]
271	7	22	Open, rural	Canada	Anderson and VanLaerhoven [37]
365	12	100–150	Forest	Turkey	Özdemir and Sert [38]

Long period of carrion exposure favors occurrence of insects associated with late portion of decomposition. This group consists mainly of beetles: Dermestidae, Cleridae, Trogidae, Nitidulidae, Histeridae, Staphylinidae, flies: Piophilidae, Phoridae, Psychodidae and moths i.e. Tineidae [39]. Species from these families were reported in most pig carrion studies from Europe [23,35,38, 40,41]. However, all these studies lasted no longer than one year. Supposedly, it results from the fact that most researchers used carcasses of ca. 25 kg, which have short periods of decomposition [42,43]. Only in few studies larger carcasses were used [19,24,28,38], however sampling was usually terminated when insects were still present. Therefore, entomofauna of cadavers with long PMI is rather poorly studied.

The aim of the present study was to investigate long-term changes of carrion entomofauna on large pig carcasses in Central Europe. Several predictions were formulated based on our experience in field carrion studies. First, some species recolonize carcasses in the second year of decomposition. Second, the time of carcass exposure in the first year affects number of taxa visiting and breeding in the second year. Third, some forensically relevant taxa reside on large carcasses for a very long time.

2. Materials and methods

Present results come from the experiment on the effect of body mass and clothing on decomposition and entomofauna of pig carcasses [42,44]. Here we report long-term changes of entomofauna (as recorded in the second and third year of decomposition) from just 10 carcasses. These were carcasses of large (54.8–64 kg) or medium/large (34–49.8 kg) mass, which decomposed longer than one year. Short-term changes of entomofauna on these carcasses (as recorded in the first year of decomposition) were reported in the article with main body of results from the above experiment [44].

Pig carcasses of large and medium/large mass were bought from the local pig farm (Table 2). As we bought and used carcasses, no approval was necessary from the Ethics Commission on the Animal Experiments. Pigs were killed by a butcher (a blow to the base of the skull) at about 6 a.m. and afterwards were transported in plastic bags by car to the study site. One to three hours elapsed between the moment of death and the moment of carcass exposure in the field. The study was conducted in 2012 (May–November), 2013 (March–September) and 2014 (June–October). Carcasses were exposed in the Biedrusko Military Range (Western Poland) on xerothermic grasslands. The area was flat, without trees or bushes. Carcasses were placed in a direct sunlight, without wind or sun barriers, at least 50 m from each other. Two carcasses were exposed in spring (17 May, thereafter 'spring block'), four in the early summer (16 July, thereafter 'early summer block') and four in the late summer (27 August, thereafter 'late summer block'). Average daily ground level temperatures in the study area in 2012 ranged between 10 °C and 25 °C in the late spring, 16 °C and 28 °C in the early summer, 14 °C and 22.0 °C in the late summer and 4 °C and 16 °C in the early autumn. Temperatures were similar in 2013 and 2014. Temperatures were logged hourly with HOBO U23 Pro v2 2× External Temperature Data Loggers (Onset Computer Corporation, MA, USA).

During the first year inspections were performed daily until 20th day and less frequently afterwards. The last inspection in 2012 was made on all carcasses on 19 November. Insect fauna was monitored for 175 days on the spring carcasses, 127 days on the early summer carcasses and 86 days on the late summer carcasses. Due to the minimal insect activity, it was decided not to take samples during the winter. In the second year of the study (2013) inspections started on 7 March and lasted until 16 September. In March and September one insect sample was taken, whereas from April until August insects were sampled thrice or twice a month. Entomofauna was monitored on all carcasses for 194 days. In the third year of the study (2014) three inspections were made (in June, August and September). In order to prevent scavenging, each carcass was placed on a metal grating, covered with welded wire mesh and staked to the ground. At every inspection carcasses were moved to the side to enable searching the ground below and were weighed with the hanging scale (KERN HCB 99 K50; KERN & Sohn, Balingen, Germany).