Forensic Science International 242 (2014) 32–37

Contents lists available at ScienceDirect

Forensic Science International

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

Technical note

Necrophilous Staphylininae (Coleoptera: Staphylinidae) as indicators of season of death and corpse relocation

Anna Mądra [a,b,*], Szymon Konwerski [a], Szymon Matuszewski [b]

[a] Natural History Collections, Faculty of Biology, Adam Mickiewicz University, Umultowska 89, 61-614 Poznań, Poland
[b] Laboratory of Criminalistics, Adam Mickiewicz University, Św. Marcin 90, 61-809 Poznań, Poland

ARTICLE INFO

Article history:
Received 4 December 2013
Received in revised form 6 June 2014
Accepted 13 June 2014
Available online 24 June 2014

Keywords:
Forensic science
Forensic entomology
Rove beetles
Habitat preferences
Seasonal preferences
Creophilus maxillosus

ABSTRACT

Several case studies confirm that habitat and seasonal preferences of necrophilous insects are the source of valuable information about the season of death or corpse relocation. Rove beetles (Staphylinidae) are common predators found on corpses and subfamily Staphylininae includes species of the largest forensic importance. In order to evaluate usefulness of Staphylininae as indicators of season of death or corpse relocation, a pig carrion experiment was made from April to October in open and forest habitats of Central Europe. Forty species of Staphylininae were collected, with hairy rove beetle (*Creophilus maxillosus*) being the most abundant. Some species exhibited a clear preference towards particular habitats. It was found that *Philonthus lepidus* was exclusive to open habitats and therefore may be useful as indicator of corpse relocation from open to forest habitats. *Philonthus decorus* was the only species found exclusively on carcasses in forests. Clear seasonality was present in nine species. *Philonthus lepidus*, *Bisnius nitidulus*, *Philonthus concinnus* and *Gabrius osseticus* were spring – early summer species, while *Philonthus spinipes* and *Ocypus olens* were late summer – early fall species. *Bisnius fimetarius* and *Staphylinus erythropterus* were spring – summer species. *Platydracus stercorarius* was summer species. These results indicate that some Staphylininae are good candidates for indicators of season of death or corpse relocation.

1. Introduction

The knowledge of biology, phenology, biogeography and habitat preferences of necrophilous insects is fundamental to forensic entomology [1,2]. Studies of seasonal insect succession on large carrion in Europe are growing in number since the first published in 2004 [1,3–12]. Insect communities provide valuable spatial and temporal information for forensic interpretation, which often cannot be obtained otherwise [13]. Several studies were focused on habitat and seasonal preferences of necrophilous insects [2,5,12,14–20]. Some species show strong seasonality and clear habitat preference, and therefore are good potential indicators of the season of death or cadaver relocation [21–23].

Recently, the problem of postmortem body relocation has been raised. In order to reveal the primary location of the corpse, Picard and Wells [24,25] proposed genetic tests. In this paper we focus on a classical entomological approach recently expanded by Matuszewski et al. [10]. With this approach it could be possible to determine whether a body was relocated postmortem if cadaver entomofauna is atypical for the location where the corpse was found [21,26]. Case studies confirm that information of habitat preferences of some insects allow to infer the postmortem body movement [23,27,28].

While most articles emphasize the use of entomological evidence during the first few months after death, it is also possible to use insect evidence even years after death [29]. In these long PMI cases, insects with distinct seasonal occurrence may be particularly useful for the season of death determination [17,29,30]. Seasonal preferences of some taxa may however vary geographically and care is needed when inferring the season of death. For this reason local studies on composition of carrion fauna, its seasonal occurrence and patterns of succession are particularly important [1,7,13,21,31,32].

While necrophagous Diptera are usually first colonizers and primary corpse consumers, Coleoptera dominate corpses in advanced decomposition. Recently the potential of beetles for forensic investigations have been explored, as they can supplement, adjust or confirm conclusions made using Diptera [5,12,33–37].

Rove beetles (Staphylinidae) is the largest beetle family. There are over 55,000 species grouped in 32 subfamilies [38]. Despite the fact

* Corresponding author. Tel.: +48 61 829 5670.
E-mail addresses: madan@amu.edu.pl, creophilus@gmail.com (A. Mądra), szymkonw@amu.edu.pl (S. Konwerski), szymmat@amu.edu.pl (S. Matuszewski).

http://dx.doi.org/10.1016/j.forsciint.2014.06.011
0379-0738/

that they are probably the most common predators found on corpses, limited work has been done regarding staphylinid communities in forensic context. Rove beetles are highly abundant on cadavers, active throughout the year, present in various habitats and widely distributed [39,40]. For these reasons they may be useful for forensic entomology. The most commonly reported and forensically important species of Staphylinidae is hairy rove beetle – *Creophilus maxillosus* (Linnaeus, 1758). It was found to be highly useful for succession-based PMI estimations [8]. Recent developmental study indicated its usefulness for the development-based PMI estimates [41]. Moreover *C. maxillosus* and *Philonthus politus* (Linnaeus, 1758) were found highly useful for estimation of preappearance interval (PAI) from temperature [35,42]. However, the value of other Staphylinidae remains still unexplored. In many studies rove beetles were treated as a kind of curiosity, and therefore they were often identified only to the family or genus level [43–47]. Presumably this species-rich family remains forensically unused due to its taxonomic inaccessibility [48]. The only three forensically-oriented studies devoted exclusively to necrophilous rove beetles were carried out in Belgium [12], Mexico [49] and Portugal [50]. In the current analyses, we focused on the subfamily Staphylininae as it contains species of the highest forensic relevance.

In order to find species of Staphylininae which are potentially useful for the determination of the season of death or the corpse relocation, seasonal and habitat preferences of these beetles are analyzed in this article.

2. Material and methods

2.1. Design of the study

The study was conducted in 2011 in the Biedrusko military range (Western Poland, Central Europe). In each habitat (open and forest) three subtypes were selected: a typical forest (hornbeam-oak forest (hereafter HOF)), a typical open land (grassland (GRA)) and several transient habitats: alder forest (AF), birch forest (BF), grasslands at the edge of the forest (GEF) and birches in grasslands (BIG) (Table 1). The distance between open and forest habitats was at least 1000 m. Within the same type of habitat, carcasses were at least 50 m apart.

Pig carcasses of similar weight (mean – 21.3 kg) were used as a model for human cadaver. Animals were put down at about 6 a.m. with a blow to the base of the skull and were placed in the field after 1–3 h. Carcasses were placed on a metal grating and covered with welded wire mesh.

2.2. Sampling and identification of insects

The following pattern of carcass inspections was applied: 1st day – three inspections, 2nd–6th day – two inspections, from 7th day – one inspection. Inspections lasted about 15–30 min and were made by one or two observers. Beetles were collected manually and with pitfall traps. Two traps (plastic containers 16 cm in diameter and 17 cm in height) filled with 50% solution of ethylene glycol were placed at a carcass: one next to head and one next to hind legs. Insects were removed from traps at every inspection. Manual sampling was performed at every inspection and was focused on beetles present on the surface of the carcass and on the soil under and near the carcass. All samples were preserved in 70% ethanol. Determinations were made using keys for identification [51,52] and collections of authors. The nomenclature was adopted from Catalogue of Palaearctic Coleoptera [53] and Die Käfer Mitteleuropas [52]. The material was deposited in Natural History Collections, at the Faculty of Biology, Adam Mickiewicz University in Poznań.

2.3. Data analyses

Correspondence analysis was used to evaluate the habitat and seasonal preferences of necrophilous Staphylininae (Statistica 10, Statsoft). species richness was assessed using rarefaction curves (Biodiversity Pro v2). Only species with abundance over 25 individuals were included in statistical analyses.

3. Results and discussion

3.1. Species richness

In total, 4220 specimens from 10 genera and 40 species of Staphylininae were collected (Table 2). In other studies from Europe, number of Staphylininae species was clearly lower: 22 [6], 16 [54], 14 [3], 12 [11], 11 [2], 8 [40], 6 [4,55] 2 [1]. Similar number of species was found only by Dekeirsschieter et al. (36 species, of which 20 was in common with the current list) [12]. These differences probably result from differences in methods of insect sampling or differences in experimental design.

In present study the most abundant were: *C. maxillosus* (44.4%), *Ph. politus* (9.3%), *Ontholestes murinus* (Linnaeus, 1758) (7.3%), *Philonthus addendus* Sharp, 1867 (7.2%) and *Philonthus decorus* (Gravenhorst, 1802) (6.7%) (Table 2).

The species richness was higher in open habitats (32 species) as compared to forest habitats (28 species) (Fig. 1). It decreased from grassland (27 species) to birch forest (15 species) (Fig. 2) and was the highest from May to July (Fig. 3).

3.2. Spatial variability

Analysis performed for 19 species of Staphylinidae showed that the 26 cadavers are grouped almost perfectly according to the habitat type and season. First two dimensions of correspondence analysis explained respectively 44.29% and 20.46% of the total inertia (Fig. 4). The first dimension showed a clear division between forest and open habitats. The second dimension showed division in according to the season of placement.

Carcasses in spring and early summer grasslands were very similar to each other and at the same time very different from other

Table 1
Design of the study.

No.	Dates of placements	Seasons	Type of habitat						
			GRA	BIG	GEF	HOF	AF	BF	Total
1.	18th April	Spring	2			1	1		4
2.	15th June	Early summer	1	1	1	1	1	1	6
3.	4th July	Early summer	1	1	1	1	1	1	6
4.	16th August	Late summer	1	1		1		1	4
5.	30th August	Early fall	1	1	1	1	1	1	6

GRA-grasslands, BIG-birches in grasslands, GEF-grasslands at the edge of a forest, BF-birch forest, AF-alder forest, HOF-hornbeam-oak forest.