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Case report

Syritta pipiens (Diptera: Syrphidae), a new species associated with human cadavers

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ABSTRACT

The analyses of necrophagous insects feeding on a corpse can be successfully used to estimate the minimum time since death. A minimum time frame is sometimes an underestimate, but it is actually the only method that can provide such information when decomposed remains are found at a crime scene. Many insects are known to be colonisers of a corpse, but because there is an endless spectrum of crime scene environments, the development data bases for necrophagous insects is incomplete. The two cases detailed in this paper show different entomological patterns due to the different environments (well and burial) and locations (south and central Italy) where the two cadavers were found. Common to both of these cases' was the discovery of the corpse in the same period of the year (January) and the presence of *Syritta pipiens* (Diptera: Syrphidae), a species that has never been associated with deceased humans. The ecological information concerning this insect was used in combination with the more typical entomofauna found on the corpse to provide a minimum post mortem interval.

1. Introduction

Forensic entomology is the study of insects and other arthropods found on a corpse and are used to help solve crime especially in medico-legal cases. The presence of a deceased person is an appealing resource to many species of necrophagous, opportunistic and occasional insects [1,2]. The identification of insects associated with a corpse and their specific insect biology in the context of a crime scene can provide useful data for the best estimation of the minimum post mortem interval (PMI). Since 1884, when Mégnin [3] provided the first list of insects associated with a cadaver during the different stages of decomposition in France, many authors involved in this research discipline have replicated such trials in different localities in many countries [4,5]. In many situations, the behaviour and arrival pattern of some species involved in the decomposition process varies across geographical locations and seasons [1,2,6]. Moreover, the movement of goods and people and climate change can easily modify the distribution of insects around the world [7]. In forensic entomology studies, the most common insects found on a corpse at a crime scene belong to the order Diptera, mainly from the families Calliphoridae, Muscidae, Sarcophagidae, Fanniidae and Piophilidae.

Adults of many species belonging to the family Syrphidae (hover-flies) display Batesian mimicry, resembling either wasps or bees [8], while the larvae are typically somewhat dorsoventrally flattened with a distinct posterior respiratory tube, which is normally short but can be very long and telescopic in some aquatic forms such as *Eristalis*.

Historically, the popular belief was that the carcasses of noble animals produced bees, while flies were produced by less noble animals. For example, in the Bible it is written that Samson found a beehive in the lion a few days after he killed it using his hands [9]. In the opera "I Fasti" written by Ovidio (Roman poet 43 B.C.–17 A.D.) the swarming coming from a dead bull is thought to be produced by bees ("*from the dead bull something is swarming: a single life gave birth to millions*") [10]. In all likehood the popular belief was based on an actual observation as many adult Syrphid species resemble honey-bees. An example is *Eristalis tenax* (Linnaeus) (rat-tailed maggot), which has been recorded on carrion in a semi-liquid state [11] and in cases of intestinal myasis [12]. Currently, in the literature *E. tenax* and *Brachyopa* sp. are the only Syrphid species recorded from a corpse [11,13].

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However, this paper deals with the collection for the first time of another syrphid, *Syritta pipiens* (Linnaeus) from two very different forensic cases located in central and southern Italy during the winter season. *S. pipiens* (known as the "thick-legged hoverfly" because it has a distinctively enlarged hind femur) is one of the 23 species of the genus *Syritta* present in the Palearctic, Afrotropical, and the Australasian-Oceania regions. *S. pipiens* is widespread throughout Europe and it is also distributed in Nearctic and Oriental regions [14–20]. The adult abdomen is narrow with paired orange or grey spots on tergites 2 and 3 and it can be found in habitats such as gardens, meadows and fields. The larvae have been found on various kinds of organic matter including rotting bulbs [19,21], but their biology is still poorly known. The importance of this species colonising a corpse will add to the body of information which may help calculate a more accurate PMI.

2. Case 1

The body of a murdered person was found dismembered and floating in the water of a well used for the collection of rainwater in January 2010 on the island of Sicily. The site was in a field in the countryside.

The pelvis and lower limbs were partially skeletonised and some adipocere was present. The corpse was floating in the water and it was still wearing trousers, socks and shoes. The day after when the well was drained the remainder of the body which was completely skeletonised was recovered. Unfortunately, no entomologist was involved at the time of discovery, recovery and autopsy of the corpse to collect insect specimens. Also no environmental data was recorded at the scene.

At the end of September 2011 the case was reopened. During this new post mortem examination insect evidence was identified and collected by the anthropologist from between the sacrum and the lowest lumbar vertebrae which appeared to be still articulated with the pelvis by adipocere. Insects were fixed in 80% ethanol. Subsequently the insect specimens were sent to an entomologist for identification and an interpretation of the minimum PMI was requested.

Meteorological data (maximum, minimum, average daily temperature and rainfall) were taken from the closest weather station (9.5 km) which was then correlated with the entomological data in order to calculate the time since death.

All the information from entomological studies was provided to the court but at present the case remains unsolved.

3. Case 2

A deceased female was found partially buried in a wood. The discovery took place on January 2011, in central Italy. The body was curled up in a hole with part of the shoulder blade and part of the pelvis and femur exposed on the surface. The maximum depth of the burial was approximately 70 cm. The body was fully dressed and partially skeletonised. Parts of the corpse were highly decomposed and some adipocere formation was present. The woman was identified by her personal effects and the DNA analysis determined that this was a person who went missing in May 2010. The police at the crime scene reported the presence of insects around the woman's exposed shoulder blade and these were collected. Some samples were preserved in ethanol and an attempt was made to rear some larvae to adult without success. During the first investigation the species of insect found were not identified, but they were measured ("length around 1 cm or a little more", however no information was supplied about the measurement tool used or the number of larvae measured). The pathologist reported that because of the low temperature observed at the crime scene insects were active on the exposed part of corpse for no more than a week. The pathologist's report concluded that the time since death based on the decomposition state of the body was when the woman disappeared.

In 2012 when the case went to trial a forensic entomologist and a pathologist were nominated by the defence to determine the PMI. The identification of the insect species collected and then compared with the meteorological and environmental data provided a minimum PMI. The pathologist provided an independent PMI based on the decomposed state of the corpse which matched the entomological time frame. When this new information was presented to the court a new inquest was initiated and a second team of experts were nominated by the prosecutor.

4. Discussion

The entomological pattern identified in each case was different. Although both bodies where discovered during the same period of the year (January), each corpse was located in very different environmental situations; one in a well in southern Italy and the other partially buried in central Italy.

Concerning Case 1, *Chrysomya albiceps* (Wiedemann) (Diptera: Calliphoridae) is known to be a carrion and faeces breeder and involved in human and livestock myiasis [12,22]. It is widespread in Africa and ranges northwards to southern Europe and the Middle East, and has recently become established in parts of South America [22–26]. The larva is recognised to be a predator of other dipteran larvae and is canibalistic [11,22,27]. In Italy this is a primary species mainly present on fresh carcasses and corpses during the summer season [28]. *C. albiceps* is not able to complete its life cycle when temperature is less than 15 °C, but it is generally still active at 35 °C [22]. Puparia of *C. albiceps* found in this case determined that the corpse had been in the well prior to winter but since the water environment slows down the decomposition process and the body is subjected to sinking and floating [29] a more accurate colonisation interval was unable to be concluded.

The genus *Ophyra* (Diptera: Muscidae), often synonymised with the larger genus *Hydrotaea*, comprises approximately 20 species of small, typically shining black flies, which occur world wide but most commonly in warm climates [30]. Several *Ophyra* species have been found associated with both decaying matter and corpses in late stages of decay and decomposition, and their larvae are predators feeding mainly on the larvae of other Diptera [11,31,32]. For these reasons it is considered an insect of forensic importance [33–36]. In the present case pupae and empty puparia of *Ophyra* were found, but since the samples were already dead, we were not able to rear these insects to identify the species by their adult characteristics. As well adult clerids (Coleptera: Cleridae) are known to be predators of dipteran larvae [4]. These insects can be found on bodies at different stages of decomposition but are more common when the corpse is in a state of dry decay or skeletonised.

In Case 2, larvae of *Hermetia illucens* (Linnaeus) (Diptera: Stratiomyidae) were collected. This species is known to associate with both exposed and buried corpses. It is considered a late coloniser (20–30 days after death) [37–39] although it has been reported on a corpse a week after death [40]. Oviposition by this insect occurs when the environmental temperature is between 27.5 and 37.5 °C and the eggs are able to survive in temperatures above 24 °C. In some situations it can enter a diapause phase. There is only a short period during the time after the woman went missing when conditions would have been suitable for oviposition by this species (15th to 20th July), and from this the minimum PMI would be between 7 and 30 days before this, which would be between the middle of June and early July

Adult Heleomyzidae (Diptera) and mites (Acarina) have been found associated with both buried and exposed corpses. Larvae of