

TECHNICAL NOTE

PATHOLOGY AND BIOLOGY

Simonetta Lambiase,¹ Ph.D. and Giuseppe Camerini,² B.D.

Spread and Habitat Selection of *Chrysomya albiceps* (Wiedemann) (Diptera Calliphoridae) in Northern Italy: Forensic Implications

ABSTRACT: Habitat selection exploited by *Chrysomya albiceps* during its initial spread in Northern Italy was analyzed in relation to landscape structure. The results of two short studies and a case report are here discussed. *C. albiceps* was not found on experimental pig carcasses in the urban area of Pavia. It was missing in the woody mountains surrounding Lecco, but it was found in the same area, at a lower altitude, within the typical “urban sprawl” landscape. It was then recorded in a natural reserve, among a rich carrion-fly population. Indications coming from habitat selection suggest that *C. albiceps* has not yet saturated its potential ecological niche in newly colonized areas of Northern Italy. Factors like temperature, altitude, and interspecific competition can act as limiting factors, affecting habitat selection and distribution in newly colonized areas; the influence of those factors has to be taken into account for forensic purposes.

KEYWORDS: forensic science, forensic entomology, *Chrysomya albiceps*, Calliphoridae, spread, forensic implications

The spread of forensically important species is of particular concern for entomologists because of the role that these insects play as indicators in diagnostic investigations. Several records demonstrate a dispersal toward higher latitudes on the part of species whose distribution area was once limited to Southern Europe. A continuous monitoring of biodiversity is therefore needed to assess changes in the composition of communities (1).

This study is concerned with the recent spread of *Chrysomya albiceps* (Wiedemann) in Northern Italy (2,3). This species is expanding its range worldwide, and its actual distribution is almost cosmopolitan (4). Expansion is due both to its spread into northern latitudes beyond the borders of its original range (5,6) and to its invasion of the New World (7). Colonization of South America was so successful that *C. albiceps* is actually one of the most important carrion-flies on that continent (8,9).

C. albiceps prefers high temperatures and humidity (10, 11). It acts generally as a secondary species in succession on corpses (12) and is a species of medical concern because it can cause myiasis in Africa and Brazil (7,13).

The results of two short studies and a case report are here discussed to obtain preliminary information about habitat selection exploited by this species during its initial spread in Northern Italy.

Materials and Methods

Experiment 1: Pig Carcass Decay in an Urban Environment

From June 2006 to July 2007, five pig carcasses (*Sus scrofa* L.) each weighing 25 kg were placed on the grounds of the Forensic Department garden, University of Pavia (45° 11' 56" N, 9° 08' 45" E, 77 m above sea level [a.s.l.]). The location chosen for exposure of the pig carcasses is located at the border of the Pavia urban area (70,900 inhabitants), in the central-western part of the Po floodplain (Northern Italy).

Carcass decay evolution, insect colonization, and succession patterns were studied by taking photographs. Air, soil, and carcass temperature were recorded. Samples (eggs, maggots, and pupae) were collected three to four times a day during the initial decomposition, not less than once a day in the late stage. Biologic samples were both fixed and reared into adults under laboratory conditions (T = 23°C; RU = 75%) and identified by stereoscopic observation.

Experiment 2: Blowfly Populations in a Nature Reserve

The blowfly community of the natural reserve “Parco Lacustre di Lungavilla” (45° 02' 36" N, 9° 04' 13" E, Northern Italy, Po floodplain, 74 m a.s.l.) was studied from June 2007 to December 2007. This protected area (60 hectares) is 12 km from Pavia (experiment 1) and lies in the Po floodplain, within an agricultural landscape. This protected area was created through the restoration of a number of abandoned clay quarries and includes ponds, woods, and uncultivated areas that are returning to woods. Blowflies were collected by means of six traps placed at the borders of ponds and woods. Each trap was made of a bottle containing a solution of 76% ethanol. A dead mouse, suspended on the bottle, was used as bait for attracting flies. Every 2 weeks, traps were emptied and baits replaced. Adult flies were then identified by

¹Dipartimento di Medicina Legale e Sanità Pubblica, Via Forlanini 12, Università di Pavia, Pavia 27100, Italy.

²Dipartimento di Scienze della Terra e dell'Ambiente, Sezione di Ecologia del Territorio, Università di Pavia, Via S. Epifanio, 14 - 27100 - Pavia, Italy.

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stereoscopic observation. Larvae found on the baits were reared under laboratory conditions ($T = 23^{\circ}\text{C}$; $\text{RU} = 75\%$).

Entomological Observations from a Case Report

Two dead young females were discovered next to each other in a mountainous wooded area in Morterone (LC, Northern Italy) ($45^{\circ} 52' 49'' \text{ N}$, $9^{\circ} 26' 39'' \text{ E}$, 936 m a.s.l.) at the end of August 2007. The corpses showed differences in decomposition and fly colonization; it was therefore hypothesized that the girls had been murdered at different times and in different places.

Entomological specimens were collected from the bodies. Eggs and a few live, first-instar larvae were collected from Corpse A. Coleoptera (*Geotrupes* sp.) and dead Diptera (adults and maggots) were taken from Corpse B, and some live blowfly specimens were recovered from Corpse B. Live specimens were reared to get adults.

C. albiceps was found only on Corpse B. As *C. albiceps* is new in Northern Italy and is known as a Mediterranean and subtropical species (14,15), it was supposed that Corpse B had been colonized by carrion-flies at a lower altitude than the wooded area where both corpses had been found.

To test such a hypothesis, two bait traps, made of a cage containing a sample of fresh pig shoulder, were placed in the wooded area where both corpses had been found. Two more traps were placed at a lower altitude, in the vicinity of Olginate ($45^{\circ} 46' 50'' \text{ N}$, $9^{\circ} 25' 29'' \text{ E}$, 217 m a.s.l.), a town (6700 inhabitants) 9 km from the place where the corpses were found. Bait traps were removed after 3 days, which was equivalent to the time between the discovery of the corpses and the collection of insects at the crime scene. Eggs and maggots collected from baits were then reared at standard conditions ($T = 23^{\circ}\text{C}$; $\text{RU} = 70\%$).

Land Cover Assessment

Landscape spatial structure and composition around experimental sites (Pavia, Lungavilla, and Olginate) and the crime scene (Lecco) were analyzed and compared. Two circular plots (500 and 1000 m radius) were drawn, centered on pigs (experiment 1) and the location of bait traps (experiment 2; case report). Plots were drawn using ARCVIEW 3.2a on Regional Technical Maps (Regione Lombardia, 1:10,000 scale). Plots were then reported on ortophotos (Google Earth, July 2007). Land cover was analyzed and classified into four categories: urban, woods, water (ponds and rivers), and terrestrial open habitats (meadows, bare ground, and cultivations). Land use comparison between plots of 500 and 1000 m radius was made by means of contingency tables. Biostat software (Analyst-Soft Inc., Vancouver, BC, Canada) was used for this purpose.

Results

Experiment 1

An urban landscape surrounds the experimental bait traps at the borders of Pavia. Land use within the 0.5-km-radius plot and 1-km-radius plot are not significantly different ($\chi^2 = 3.5 - \text{d.f.} = 3 - p > 0.05$). Urban land is largely the dominant matrix in both plots.

Twelve fly species were sampled and bred from pigs. The community includes Calliphoridae, Sarcophagidae, Muscidae, Sepsidae, and Piophilidae. The most abundant species were *Lucilia sericata* (Meigen), *Lucilia caesar* (L.), and *Phormia regina* (Meigen) during warm seasons, while *Calliphora vicina* (Robineau-Desvoidy) and *Calliphora vomitoria* (L.) were dominant species during cold seasons. The list of flies collected does not include *C. albiceps*, which

was never found, in spite of the fact that the research included summer months.

Experiment 2

The nature reserve of Lungavilla is dominated by ponds and woods. A significant difference appears from the comparison between the 500-m-radius and the 1000-m-radius plots ($\chi^2 = 68.04 - \text{d.f.} = 3 - p < 0.01$). Beyond the borders of the natural reserve, landscape features change sharply and the agricultural matrix tends to prevail. This is the common feature of the Po floodplain landscapes, scattered with seminatural areas, which survive like patches within a human-dominated landscape. *C. albiceps* adults were repeatedly trapped in the nature reserve of Lungavilla, but the species was of minor importance among the fly community, which included 76 species. Dominant species were *L. caesar*, *C. vomitoria*, *C. vicina*, *Muscina assimilis* (Fallen), *Muscina pabulorum* (Fallen), and *Fannia canicularis* (L.). The maximum abundance of *C. albiceps* was recorded in August.

Case Report

The landscape surrounding the location where the corpses were found is dominated by woods; land cover is not significantly different in compared plots ($\chi^2 = 0.23 - \text{d.f.} = 3 - p > 0.05$).

The landscape around Olginate's bait traps includes urban land (nearly 50% of the plots), open habitats, woods, and river waters, which is the typical pattern of "urban sprawl" dominating a large part of the northern Po floodplain.

Two blowfly species were bred from the exposed bait traps placed on the mountains where the corpses were found: *L. caesar* and *C. vomitoria*. In addition to those species, *L. sericata* and *C. albiceps* colonized bait traps kept in the plain (Olginate). The absence of *C. albiceps* in the baits placed at the crime site tends to suggest the hypothesis that one of the corpses was initially hidden in a location different from the wooded area where both bodies were later discovered.

Discussion

C. albiceps has recently dispersed into Northern Italy. A number of records (3) concern urban or suburban environments; these findings agree with the ecology of the species, which is classified as hemisanthropophilic (16). The absence of *C. albiceps* in the pig carcasses exposed for a year to blowflies in the urban area of Pavia is likely to be an unexpected event, given the species' adaptation to urban landscapes. A possible explanation comes from the hypothesis that the species has rapidly and widely dispersed into the Po floodplain, but it has not yet saturated all suitable habitats available in the area that it is capable of invading.

A seminatural habitat equipped with a complex food chain tends to pose stronger resistance to the establishment of a "biologic invader" owing to the degree of interspecific competition, which is likely to be higher than in human-dominated landscapes. Despite the resistance coming from the richness of the carrion-fly community found in the nature reserve of Lungavilla, *C. albiceps* was nevertheless able to colonize this habitat, even if it was not a dominant species.

C. albiceps was missing in the woody mountains surrounding Lecco, but it was found at a lower altitude, in the neighborhood. Altitude can be an important limiting factor for thermophilic species, such as *C. albiceps* (16). It is reasonable to hypothesize that a species spreading beyond the borders of its original range can be

affected by seasonal changes of temperature along an altitude gradient. Depending on seasonal climate, abundance and altitudinal distribution of a new invader could dynamically change at the borders of its range, where ecological conditions tend to be suboptimal. This factor has to be taken into account for forensic purposes.

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Additional information and reprints requests:

Giuseppe Camerini, B.D.

Dipartimento di Scienze della Terra e dell'Ambiente

Sezione di Ecologia del Territorio

Università di Pavia

Via S. Epifanio

14 - 27100 - Pavia

Italy

E-mail: giuseppe_camerini@libero.it