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Sarcosaprophagous Fly Activity in Maryland

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ABSTRACT: Eighty-six successful rearings of sarcosaprophagous flies characteristic of the first successional insect wave of infestation of a corpse were conducted under field conditions in Maryland. Different species were observed to be active during spring and summer. The development times for the immature stages of each species, with the related temperatures at which the development occurred are reported for both seasons studied.

KEYWORDS: pathology and biology, entomology, flies, necrophagous flies, Maryland, time of death

The age of the larvae of sarcosaprophagous flies found on a corpse [*1–3*] can be very helpful for forensic scientists in estimating the minimum time of death of a decomposed body.

One must realize that the assemblage of carrion flies found on a corpse is determined by their geographic distribution; that is, different flies can be found during the same time period on corpses exposed in different geographic regions. Furthermore, the development of the immature stages of carrion flies is temperature related—the microclimatic conditions of the specific location where the larvae are exposed on the body have a strong influence on the larval growth [*1,3,4*]. It is essential that these two factors be evaluated before applying entomological criteria to defining the time of death.

Ecological studies of insect fauna important to forensic science, occurring in different geographic regions and during different seasons, are therefore extremely important. They represent a major point of reference by which the entomological data gathered from a body can be compared.

Recent forensic entomological studies conducted in the United States by Rodriguez and Bass [*5,6*] and by Goff and Odom [*7*] provide a useful ecological data bank for the analysis of insect fauna in specific geographic locations and habitats. A review of the literature, however, produced no equivalent ecological studies on carrion flies in Maryland. For this reason, we decided to determine which species of necrophagous flies were

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active in Maryland and what the developmental times of their immature stages were during the spring and summer seasons.

Material and Methods

The site selected for the study was a partially shaded wood adjacent to agricultural fields near Easton, Maryland. This represented typical geographical conditions for Central and Eastern Maryland. It was close to an urban area as well as to agricultural fields. It was also near the Chesapeake Bay.

The study was divided into two individual time periods: the spring period (15 April to 15 June 1988) and the summer period (1 July to 30 Aug. 1988).

The minimum and maximum daily temperatures, humidity, and general weather conditions for the selected site were continuously recorded for the two study periods using hygrothermograph.

A standard technique of observation and collection was implemented [2]. Two open glass jars containing 200 g of fresh animal liver tissue were placed on the ground each morning. When eggs or first instar larvae of carrion flies were observed, the jars were covered with a fine mesh cloth (to keep out other insects) and then placed at the same location in a screened cage (only to protect them from vertebrate animals). At the beginning of the larval migration, the jars were placed in buckets containing 10 cm of vermiculite to allow pupation.

Observations were made three times a day at 6 to 8 a.m., 1 to 3 p.m., and 6 to 8 p.m. Desiccation, total consumption of the pabulum, and rain flooding of the buckets were carefully avoided.

For each completed rearing, specimens of adult flies were killed and pinned. Samples of eggs, larvae, and pupae were preserved in 70% alcohol.

Results

More than 240 open jars were exposed at the research site during the two study periods. Of these, eggs and larvae were obtained in only 147. Forty rearings terminated at the larval stage, while 21 stopped at the pupal stage. The arrested development was due partly to parasitism and possibly to low nocturnal temperatures.

Eighty-six complete rearings were obtained. In five cases, rearings of more than one species were obtained in the same container. The results are reported in Tables 1 through 5.

The species of carrion flies consistent with the first successional insect wave active in Maryland are listed in Table 1. Calliphoridae (blowflies) were much more common than the Sarcophagidae (flesh flies). No flies of the family Muscidae were collected.

TABLE 1—*The sarcosaprophagous flies active in Maryland.*

Family Calliphoridae (blowflies)
Calliphora livida (Hall)
Calliphora vicina (Robineau-Desvoidy)
Lucilia illustris (Meigen)
Phaenicia sericata (Meigen)
Phaenicia caeruleiviridis (Macquart)
Phormia regina (Meigen)
Family Sarcophagidae (flesh flies)
Sarcophaga bullata (Parker)
Sarcophaga sarracenioides (Aldrich)

TABLE 2—*Life history of carrion flies observed in Maryland during the spring.*[a]

Species	Number of Rearings	Eggs Hatching, h		Larval Stage, days		Pupation, days		Total Immature Stages, days	
		min	max	min	max	min	max	min	max
Calliphora livida	3	24	50	8	10	13	15	23	25
Calliphora vicina	14	24	64	8	10	10	15	22	25
Lucilia illustris	6	20	54	7	10	10	14	20	24
Phaenicia caeruleiviridis	4	20	56	7	19	10	15	22	32
Phormia regina	11	20	50	8	16	10	20	20	32
Sarcophaga bullata	3	...	...	8	14	11	16	23	30

[a]Temperature range = 8 to 32°C.

TABLE 3—*Life history of carrion flies observed in Maryland during the summer.*[a]

Species	Number of Rearings	Eggs Hatching, h		Larval Stage, days		Pupation, days		Total Immature Stages, days	
		min	max	min	max	min	max	min	max
Phaenicia sericata	8	18	36	6	7	6	8	13	17
Phaenicia caeruleiviridis	14	20	48	8	14	9	16	23	26
Phormia regina	15	16	90	3	9	4	7	13	15
Sarcophaga bullata	7	...	...	6	7	13	14	19	20
Sarcophaga sarracenioides	1	...	...	7		13		20	

[a]Temperature range = 11 to 37°C.

TABLE 4—*The mean times and ranges of the developmental stages of the species of carrion flies active in Maryland in relation to the temperature, observed in the spring.*

Species	Eggs Hatching			Larval Stage			Pupation		
	Hours, mean	Temperature, °C mean	Temperature, °C min–max	Days, mean	Temperature, °C mean	Temperature, °C min–max	Days, mean	Temperature, °C mean	Temperature, °C min–max
Calliphora livida	34	17	11–25	9	20	12–26	14	18	8–27
Calliphora vicina	36	16	8–27	9	19	10–32	13	16	8–29
Lucilia illustris	30	19	13–25	8	22	15–30	11	19	8–31
Phaenicia caeruleiviridis	38	20	13–27	11	20	8–29	12	21	8–30
Phormia regina	36	21	10–25	10	21	10–32	15	19	8–31
Sarcophaga bullata	...	...	...–...	12	20	8–32	14	19	8–32

TABLE 5—*The mean times and ranges of the developmental stages of the species of carrion flies active in Maryland in relation to the temperature, observed in the summer.*

	Eggs Hatching			Larval Stage			Pupation		
		Temperature, °C			Temperature, °C			Temperature, °C	
Species	Hours, mean	mean	min–max	Days, mean	mean	min–max	Days, mean	mean	min–max
Phaenicia sericata	22	24	13–36	6	27	11–34	7	28	11–36
Phaenicia caeruleiviridis	32	24	12–32	7	26	12–37	12	29	17–37
Phormia regina	24	27	13–37	6	27	11–37	6	25	12–32
Sarcophaga bullata	...	...	...–...	7	28	16–37	13	28	13–37
Sarcophaga sarracenioides	...	...	...–...	7	24	14–37	13	24	12–37

Tables 2 and 3 list the species of flies observed and the related number of rearings obtained during the spring and summer seasons. For each species, the minimum and maximum times for egg hatching and for larval and pupal development are reported. The minimum and maximum temperatures recorded for the experimental site are listed in the footnotes to the tables.

Tables 4 and 5 list, for each study period, the mean time of each developmental stage of the species observed, with the mean values of temperature at which the development occurred.

In Table 6, the mean time necessary for each species to complete its development (from egg to adult) is compared for the two seasons studied. The time values recorded are given with the mean temperatures observed. The minimum and maximum temperatures are in parentheses.

TABLE 6—*Comparison of the spring and summer results for the time periods necessary for total development of the species of carrion flies observed, with the related temperatures.*

	Spring			Summer		
		Temperature, °C			Temperature, °C	
Species	Days, mean	mean	min–max	Days, mean	mean	min–max
Calliphora livida	24	19	8–27	...	...	...–...
Calliphora vicina	23	18	8–32	...	...	...–...
Lucilia illustris	22	20	8–31	...	...	...–...
Phaenicia sericata	...	...	...–...	14	27	11–36
Phaenicia caeruleiviridis	23	20	8–30	18	28	12–37
Phormia regina	25	20	8–32	13	26	11–37
Sarcophaga bullata	26	19	8–32	19	28	13–37
Sarcophaga sarracenioides	...	...	...–...	20	24	12–37

Discussion

The species *Calliphora livida*, *Calliphora vicina*, and *Lucilia illustris* were observed only during the springtime, while the species *Phaenicia sericata* and *Sarcophaga sarracenioides* were observed only during the summer. These results confirm previous observations [8,9].

Phaenicia ceruleiviridis, *Phormia regina*, and *Sarcophaga bullata* were active in both the spring and summer.

During the spring period, *Calliphora vicina* and *Phormia regina* were the most common species, while, in summer, *Phaenicia caeruleiviridis* and *Phormia regina* were more common (Tables 2 and 3).

With the exception of the larviporous species of the family Sarcophagidae—*Sarcophaga bullata* and *Sarcophaga sarracenioides*—all of the other flies observed laid eggs on the tissue.

In our experiments, the time between the first exposure of the organic material and observation of oviposition was between 1 and 6 h when the weather conditions included temperatures between 15 and 27°C, light winds, sunny days, and no direct continuous exposure of the organic material to the sun.

Oviposition was not observed during strong wind, rainy periods, or during the night. Temperatures below 10°C appeared to inhibit oviposition.

With the exception of *Phaenicia sericata* and *Phormia regina*, which have been observed to deposit eggs during the hottest hours of the day, all of the other species deposited eggs more frequently during the first hours of the morning, after the early morning low temperatures had risen slightly, but while the air was still cool. Some oviposition did occur in the later afternoon.

For all species observed, the eggs were deposited in protected irregularities of the exposed medium, away from direct exposure to the sun.

The time needed for the eggs to hatch appeared to be strongly influenced by the nocturnal drop in temperature. Protracted night temperatures below 10°C have delayed the egg hatching for several days (Tables 2 through 5). With the seasonal increase in temperatures, a shorter time for the egg hatching was observed. However, even in the summertime, a sudden drop in temperature delayed egg hatching for days. In one case observed in June, the nocturnal temperature dropped to 12°C for two consecutive days—delaying the egg hatching of *Phormia regina* for four days.

The duration of the larval stage was directly related to the ambient temperature. Temperatures below 10°C delayed larval development. An increase in the duration of the larval stage of up to 19 days was observed in springtime for *Phaenicia caeruleiviridis* when the temperature dropped to 8°C for two consecutive nights. Wide night/day temperature ranges appeared to be lethal for some larvae.

The larvae appeared to be more inhibited by low temperatures than the pupae of the same species. This may be attributed to their different physical locations: the larvae feeding on the organic material were more exposed to ambient temperatures than the pupae, which were protected by the vermiculite.

Only the pupae of *Phormia regina* were inhibited by low temperatures. This can be attributed to their habit of pupating on the surface of the soil, exposing themselves to the same ambient temperatures as the larvae. The same drop in temperature described above delayed the pupation time up to 20 days for *Phormia regina*.

Our results indicate that an increase of temperature speeds up the pupal development of *Phormia regina* for the reasons noted above. The pupal development of the other blowflies was relatively stable and did not show temperature-related variations.

The time for complete development of the necrophagous flies examined in Maryland was shorter in summer than in spring as a result of the influence of increased ambient temperatures on the larval development time. We observed that the higher the mean temperature, the faster the larval growth if there was not an unusually wide day/night temperature gradient.

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