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RESEARCH ARTICLE

EFFECT OF TEMPERATURE ON THE DEVELOPMENT OF CALLIPHORID FLY OF FORENSIC IMPORTANCE*, Chrysomya rufifacies* (MACQUART, 1842)

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Abstract

Chrysomya rufifacies,is one of the hairy maggot blowflies which feeds on carrion and completes its life cycle on carrion and hence is useful for PMI determination in forensic investigations.

The life cycle duration and morphological parameters of *Chrysomya rufifacies* were studied in different seasons; Life cyclein rainy season was completed in 275 ± 2.27 hrs (11.46 ± 0.45 days), when the maximum temperature was 30.1°C and the minimum temperature was 26.2°C; in summer season when the maximum temperature was 37.2°C and the minimum temperature 30.1°C, the life cycle was completed in 241± 2.17 hrs (10.04 ± 0.12 days),while in winter season life cycle was completed in 318 ± 2.45hrs (13.25 ± 0.25 days) when themaximum and minimum temperatureswere 26.4°C and 18.2°C respectively. Thus temperature plays an important role in the development of *C.rufifacies* which should be considered during PMI determination.

The morphological parameters of different stages differ from season to season. Larvae were healthy and bigger in size in rainy season but in summer were short and small sized.The size of larvae in winter season was also smaller than the size in both summer and rainy seasons.

INTRODUCTION

Blowflies of the genera *Chrysomya* (Diptera: Calliphoridae) are of considerable medical and economical importance, since they are known as myiasis producing agents in animals and humans; and they can be used to determine the post mortem interval (Gomeset al., 2003, 2005, 2006, 2009; Suri Babu et al. 2013).

The development stage of insect species helps forensic specialist to determine time since death (Byrd and Castner, 2001; Sam, 2006). Recovered insects from human cadavers, mostly blowfly and flesh flies larvae, can provide information on the conditions experienced by a body following death (Donovan et al., 2006).

To determine time since death, considerations of the critical factors affecting the rate of decomposition are important. These factors include location of the body, temperature, general climate, time of year, insect activity, animal activity in the area, and the amount of rainfall (Nafte, 2000). Temperature is the most important factor affecting developmental rate (MyskowiakandDoums,2002).Temperature and access to the cadaver are two important factors affecting insect succession and temperatures generally reduce the developmental period of Diptera (Campobasso et al., 2001).

Materials and Methods

C. rufifacies larvae were collected from dead Asian palm civet (*Paradoxurus hermaphroditus*), at botanical garden of Dr. Babasaheb Ambedkar Marathwada University campus, Aurangabad, (M.S)-India and reared in the laboratory in the rearing box by feeding daily on fresh liver of buffalo and water sweetened with honey.

Morphological identification was done in the laboratory using the identification keys (Maurice, 1971; Kitchin and Voeten, 1977; Queiroz, 1997; Spradbery, 2002; Sukontason et al., 2003, 2004, 2005, 2006, 2007, 2008; Kamal et al., 2008; Carvalho and Patiu, 2008).

About 80 eggs were collected inindifferent seasons(rainy, summer and winter)with the help of fine brush and 40 eggs each were reared at the laboratory conditionand the duration of different developmental stages and their morphological parameters (length, width and weight)were determined. The temperature and the humidity were recorded by Hygro-thermometer clock OPTILAB Model THC-20.

Observation and results

Chrysomya rufifacies, one of the blowflies known as hairy maggot blowfly, adult has face and cheeks with dense silvery hairs, anterior spiracle of the adult is open and proepisternal seta (stigmatic bristle) present, The larvae have tubercles hence called hairy maggot, these tubercles along the body segment are knobs encircling mostly half of lower surface, spines are round-knob turned spirally three times around the base of each tubercle; absence of hairy like structure at the base of tubercles in the caudal region; anterior spiracles always with10 papillae and very rear 9 papillae.

Life cycle duration of *C.rufifacies* in rainy season was completed in 275 ± 2.27 hrs (11.46 ± 0.45 days)(Table.1) when the maximum temperature was 30.1°C and the minimum temperature was 26.2°C, but in summer season when the maximum temperature was 37.2°C and the minimum temperature 30.1°C, the life cycle was completed in 241± 2.17 hrs (10.04 ± 0.12 days) (Table. 2)while in winter season cycle was completed in 318 ± 2.45hrs (13.25 ± 0.25 days) when themaximum and minimum temperatures were 26.4°C and 18.2°C respectively (Table. 3).

Size of the different developmental stages varied from season to season; in summer season, the size of different stages was smaller than same stage in rainy season and bigger than the same stage in winter season.

Table: 1) Duration of different life cycle stages of *Chrysomya rufifacies* in rainy season

Hours	Developed stage	Length (mm)	Width (mm)	Weight (mg)	Temperature (°C)			Humidity (%)		
					Max.	Min.	Average	Max.	Min.	Average
20	Eggs	1.5 ± 0.08	0.4 ± 0.07	0.32 ± 0.06	30.1	27.3	28.7	68	44	56
44	1st Instar	5.4 ± 0.11	2.2 ± 0.25	10.6 ± 0.12	30.1	27.2	28.7	68	42	55
77	2nd Instar	9.5 ± 0.15	3 ± 0.02	29.2 ± 0.10	30.1	27.2	28.7	67	43	55
109	3rd Instar	13.2 ± 0.26	3.7 ± 0.35	57.4 ± 0.37	29.6	27.4	28.5	67	41	54
155	Prepupae	11.6 ± 0.14	4.5 ± 0.13	48.4 ± 0.08	29.2	26.2	27.7	66	38	52
275	Pupae	9.3 ± 0.36	4.2 ± 0.29	41.5 ± 0.19	29.2	26.5	27.9	68	42	55
	Adult	9 ± 0.27	4 ± 0.17	36.3 ± 0.22	28.7	26.5	27.6	65	37	51

±) Indicate SD of five values

Table: 2) Duration of different life cycle stages of *Chrysomya rufifacies* in summerseason

Hours	Developed stage	Length (mm)	Width (mm)	Weight (mg)	Temperature (°C)			Humidity (%)		
					Max.	Min.	Average	Max.	Min.	Average
17	Eggs	1.43 ± 0.06	0.4 ± 0.02	0.28 ± 0.04	33.1	30.8	32.0	35	19	27
37	1st Instar	4.8 ± 0.16	1.8 ± 0.17	9.5 ± 0.11	33.1	30.8	32.0	27	17	22
59	2nd Instar	8.3 ± 0.19	2.7 ± 0.21	28.2 ± 0.14	34.2	30.1	32.2	25	19	22
89	3rd Instar	11.6 ± 0.22	3.2 ± 0.05	49.5 ± 0.27	36.5	31.8	34.2	24	18	21
123	Prepupae	9.5 ± 0.21	4.5 ± 0.14	45.1 ± 0.02	37.2	34.1	35.7	22	18	20
241	Pupae	9 ± 0.26	4 ± 0.22	37.3 ± 0.15	36.5	34.1	35.3	22	18	20
	Adult	8.7 ± 0.10	3.8 ± 0.33	29.6 ± 0.21	37.4	33.2	35.3	27	17	22

±) Indicate SD of five values

Table: 3) Duration of different life cycle stages of *Chrysomya rufifacies* in winter season

Hours	Developed stage	Length (mm)	Width (mm)	Weight (mg)	Temperature (°C)			Humidity (%)		
					Max.	Min.	Average	Max.	Min.	Average
26	Eggs	1.42 ± 0.02	0.4 ± 0.05	0.22 ± 0.01	26.4	22.1	24.3	32	26	29
54	1st Instar	4.5 ± 0.13	1.4 ± 0.16	8.2 ± 0.13	24.6	20.2	22.4	32	26	29
86	2nd Instar	7.2 ± 0.21	1.8 ± 0.12	24.3 ± 0.22	24.2	21.4	22.8	30	24	27
126	3rd Instar	9.5 ± 0.07	2.5 ± 0.26	46.7 ± 0.16	22.5	19.6	21.1	27	23	25
178	Prepupae	8.4 ± 0.21	4.4 ± 0.22	37.2 ± 0.21	22.2	18.7	20.5	25	21	23
318	Pupae	8 ± 0.32	4 ± 0.19	32.4 ± 0.34	21.5	18.6	20.1	25	21	23
	Adult	8.1 ± 0.24	3.7 ± 0.28	25.1 ± 0.03	21.4	18.2	19.8	24	10	17

±) Indicate SD of five values

Discussion

Chrysomya rufifacies is a species of medical and economic importance (Sukontason et al. 2008) and playing an important role in solving the forensic cases (Smith, 1986; Suri Babu et al. 2013). This blow fly is one of the first colonizer of the corpse.

Higher temperatures generally prop up egg hatching and accelerate maturation of larvae which can double their size in few hours. If the Calliphoridae larvae have reached maximum length at the peak of feeding, they tend to decline progressively and about 75% of the Calliphorid pre-adult cycle may be spent in post feeding and pupation (Greenberg, 1919; Campobasso et al., 2001)

The morphological parameter of different stages differs from season to season. Larvae were healthy and bigger in size in rainy season but in summer season life cycle duration was short and the size of different stages was small while in winter season the life cycle duration was longer than rainy season but the size in winter season also smaller than the size in rainy season.

Study on the effect of temperature on the different developmental stage of *Chrysomya megacephala*(Fabricius, 1794) and life cycle duration in rainy season and low constant temperature 10 ℃ reported that in rainy season life cycle duration completed in 11.04 ± 0.08 days when the maximum and minimum temperature were 29°C and 26°C respectively. But in low constant temperature 10 °C life cycle was completed in 25.38 ± 0.16 days (AbdAlgalil and Zambare, 2015), they reportedimpact of temperature on the morphological parameters in rainy season and low constant temperature.

Effect of fluctuation of temperature on development of Calliphorid flies *Protophormia terraenovae* was reported at 4-28°C and 9-23°C to their mean constant temperature, 16°C and, found that generally development at the greater fluctuation was fast and at the constant temperature was slow. The effect of summation rate is suspected to have caused this difference in development rate because fluctuations above the mean enhance the rate comparatively more than temperatures below the meancan lower the rate (Warren and Anderson, 2013).

For forensic investigations, entomological evidences found in criminal scenearound the corpse are collected and preserved according to medico-legal standardprocedures (Haskellet al., 1997).Alsomicroclimatic temperatures obtainable in the maggot's immediate environment at criminal site is established and linked retrospectively with the air temperature records. Assuming an average constant temperature, as is the case with corpses found indoors, maggots or pupae which recovered from the scene are stored at a constant temperaturetill they pupate or the first adults emerge out. Then their age can be used for PMI determination (Grassbergeand Reiter, 2002).

Conclusion

In this study the effect of temperature on the life cycle of *Chrysomya rufifacies* in different season indicate that life cycle duration in rainy season was completed in 11.46 ± 0.45 days but in summer season was 10.04 ± 0.12 days while in winter season was completed in 13.25 ± 0.25 days. The high temperature accelerated the development in summer and delayed the development in winter season by about 3 days. Larvae were healthy and bigger in size in rainy season and small in summer season, while in winter season larvae were smaller than summer and rainy season.

Temperature plays an important role in period of life cycle stages and hence correct temperature changes should be considered for PMI determination after the life cycle stages of *C.rufifacies* are collected from corpse.

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