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RESEARCH ARTICLE

EFFECT OF SEASONAL TEMPERATURE VARIATION ON THE DURATION OF LIFE CYCLE STAGES OF THE FLY OF FORENSIC IMPORTANCE, *PARASARCOPHGA DUX* (THOMSON) (DIPTERA: SARCOPHAGIDAE).

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Abstract

Sarcophagid flies belonging to carrion insect communities provide the information about the corps. *Parasarcophaga dux* (Thomson) (Diptera: Sarcophagidae) collected from Latur district of Maharashtra (India) has been studied for the duration of different life cycle stages in three different seasons i.e. rainy, winter and summer seasons under the room temperature. The female released Ist instar larvae which after two larval mounts undergo prepupation and then pupation in the soil. The adult emerged out from pupae.

During rainy season the life cycle duration from larvaeposite to emergence of adult was 315.15 ± 3.28 hrs, during winter season in 359.56 ± 2.44 hrs, while in summer season it took 265.51 ± 6.28 hrs, under the fluctuating diurnal temperature and humidity of the laboratory.

The time durations of life cycle stages of *P. dux* in the different seasons can be used to determine the PMI using the meterological data and *P. dux* life cycle stages collected from the cadaver.

Introduction:-

The more than 2600 species [1] of flesh flies (Family – Sarcophagidae) reported belongs to 1000 genera all around the world. In India the family Sarcophagidae represents 117 species and 38 genera of three subfamilies. The genus Sarcophaga includes more than 22 recorded species belonging to 6 subgenera. Most flesh flies are parasites or predators with relatively small numbers of species with a true preference for vertebrate carrion [2-3]. Flesh flies are usually considered as a taxon of high forensic importance [4-5]. However their participation in carrion insect community was tasted almost exclusively in experiments with small sized carrion [6-11].

Sarcophagidae are considered to be unimpeded by rain and to fly despite the weather [12]. The females deposit the larvae in the safe nutritious location [13]. As a result flesh flies may be the initial colonizers of the body outdoors, if there is long period of rainy weather. Despite this, many flesh flies prefer sunlight rather than shaded condition [4] although *Sarcophaga* (Subgenus – *Robineauella) caerulescens* is considered a shade lover [14].

The time taken by Sarcophaga larvae to emerge as an adult is considered to be between 8 – 15 days [15]. Kamal (1958) provide an indications of life cycle duration of various stages of American Sarcophagid species. Development time to adult emergence varied by as much as 252 hours [16] depending on the temperature.

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Therefore, this provides a source of variation and limitations in the use of this species to calculate the time since death.

The present research work was carried in the laboratory in Latur district, Maharashtra, India to study the time duration of different stages of the life cycle of *Parasarcophga dux* (Thomson) in different seasons.

Material and method:-

The maggots were collected from dead dog from Latur district (MS), India and were reared in laboratory in rearing chamber on fresh chopped buffalow liver and sugar syrup on cotton. These chambers were covered with a fine muslin cloth in order to facilitate fresh air and to prevent the entry of parasites. These chambers were maintained under natural temperature and humidity condition. Soil was also supplied for pupation. The maggots were observed throughout their developmental stages at different time interval on hourly basis. After adult emergence the flesh flies were identified and were to be *P. dux* and some Calliphorids. Adult male and female *P. dux* were maintained in insect cages with fresh liver every day. The I^{st} instar larvae released on liver were monitored on hourly basis to find the duration with reporting of temperature. This experiment was repeated in three times in three different seasons i.e. rainy season, winter season and summer season.

Observation and result:-

In the present study the life cycle stages of *Parasarcophga dux* (Thomson) are larvae (i.e. I^{st} instar, II^{nd} instar and III^{rd} instar), pre-pupa, pupa and adult. The female releases the I^{st} instar larvae directly on the liver. The duration of life cycle stages changed as per the temperature variations in different seasons.

1. Rainy season:

In rainy season it has been observed that the time duration of different life cycle stages of *Parasarcophga dux* (Thomson) was completed in 315.15 ± 3.28 hours from larviposite up to emergence of adult fly at the average temperature ranging from 23 – 26.7 ^{0}C and average humidity ranging from 28.5 – 58.6%. It was observed that the time duration of different life cycle stages of *Parasarcophga dux* (Thomson) was 25.10 ± 1.13 hours, 27.45 ± 1.22 hours, 43.28 ± 5.25 hours, 23.47 ± 3.10 hours and 195.05 ± 6.39 hours forI^{st} instar, II^{nd} instar, III^{rd} instar, pre-pupa and pupa respectively (Table 1).

Table 1:- Time duration of different life cycle stages of *Parasarcophaga dux* (Thomson) during rainy season

life stages		PMI (H:MM)	Average temperature (^{0}C)	Average humidity (%)
Larva	I^{st} instar	25:10 ± 1:13	25.5±1.1	33.5±1.1
	II^{nd} instar	27:45 ± 1:22	26±1.04	28.5±2.1
	III^{rd} instar	43:28 ± 5:25	26.7±0.7	41.1±1.3
Pre-pupa		23:47 ± 3:10	23±0.9	51.5±1.03
Pupa		195:05 ± 6: 39	23.4±1.2	58.6±1.4
Total duration		315:15 ± 3:28		

(± indicates standard deviation of three values)

2. Winter season:

In winter season the time duration of different life cycle stages of *Parasarcophga dux* (Thomson) was completed in 359.56 ± 2.44 hours from larviposite to emergence of adult fly at the average temperature ranging from 18 – 22.7 ^{0}C and average humidity ranging from 44 – 68.8%. The time duration of different life cycle stages of *Parasarcophga dux* (Thomson) was 26.50 ± 2.04 hours, 28 ± 4.12 hours, 45.55 ± 3.21 hours, 24.05 ± 2.19 hours and 235.06 ± 3.02 hours of I^{st} instar, II^{nd} instar, III^{rd} instar, pre-pupa and pupa respectively (Table 2).

Table 2:- Time duration of different life cycle stages of *Parasarcophaga dux* (Thomson) during winter season

life stages		PMI (H:MM)	Average temperature (^{0}C)	Average humidity (%)
Larva	I^{st} instar	26:50 ± 2:05	18.5± 1.7	68.8± 1.1
	II^{nd} instar	28:00 ± 4:12	18± 1.4	62± 0.4
	III^{rd} instar	45:55 ± 3:21	22.7± 2.2	51.7± 0.2
Pre-pupa		24:05 ± 2:19	20.5± 1.5	66.5± 0.2
Pupa		235:06 ± 3:02	20.3± 1.8	44± 1.2
Total duration		359:56 ± 2:44		

(± indicates standard deviation of three values)

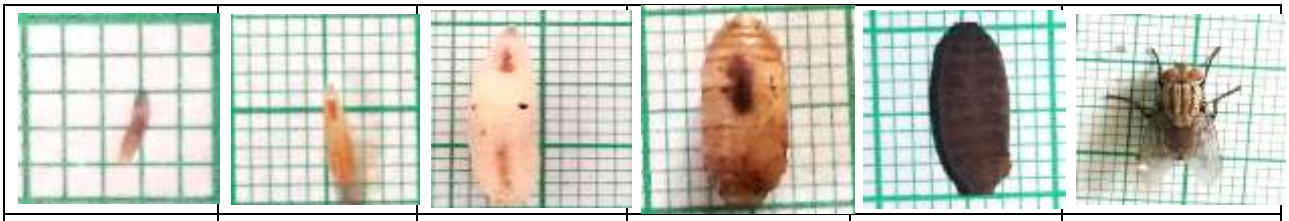
3. Summer season:

In summer season, the time duration of different life cycle stages of *Parasarcophga dux* (Thomson) was completed 260.51 ± 6.28 hours from the larviposite to emergence of adult fly at the average temperature ranging from 31.5 to 33.7ºC and average humidity 13.6 – 20.5 %. The time duration of different lifecycle stages of *Parasarcophga dux* was 22.51 ± 1.52 hours, 24.30 ± 1.71 hours, 26.45 ± 4.43 hours, 18.39 ± 2.52 hours and 168 06 ± 2.17 hours of Ist instar, IInd instar, IIIrd instar, pre-pupa and pupa respectively (Table 3)

Table 3:- Time duration of different life cycle stages of *Parasarcophaga dux* (Thomson) during summer season

life stages		**PMI (H:MM)**	**Average temperature (^{0}C)**	**Average humidity (%)**
Larva	Ist instar	22:51 ± 1:52	31.5±0.8	13.6±0.4
	IInd instar	24:30 ± 1:17	31.7±1.1	14.5±0.3
	IIIrd instar	26:45 ± 4:48	31.6±1.1	18.7±1.1
Pre-pupa		18:39 ± 2:52	33±0.5	20.5±0.5
Pupa		168:06 ± 2:17	33.7±0.7	17.7±0.7
Total duration		260:51 ± 6:28		

(± indicates standard deviation of three values)



a b c d e f

Fig.1:- Life cycle stages of *Parasarcophaga dux* (Thomson). a. Ist instar larvae; b. IInd instar larvae; c. IIIrd instar larvae; d. Pre-pupa; e. Pupa; f. Adult fly.

Discussion:-

Species of flesh flies larvae are very similar in appearance and traditionally have been difficult to identify [4]. Therefore accurate identification of either larvae or adults has had to be made by taxonomic specialists [17]. Taxonomically *P. dux* has been confused with *Parasarcophaga misera* by many previous authors [4], but more recent research has a clarified classification of these two species as distinct species and separated them based on adult males [18-20].

It was observed that at higher temperature and humidity the maggots emerged faster than lower temperature and higher humidity and increase in temperature will increase the rate of metabolism [21]. An earlier study done on *P. terraenovae* it was found that fluctuating temperature actually lade to significant faster rate of development [22]. In present study it was observed that IIIrd instar larvae took higher time period than Ist and IInd instar larvae. It was also recorded that IInd and IIIrd instars took prolonged time for development as compare to first instar larvae [23-24].

The time taken by *Sarcophaga* (Subgenus Robineaulla) c*aerulescens* larvae to emerge as an adult is considered to be between 8-12 days [15]. An indication was also provided on the lifecycle duration of various stages of the American *Sarcophagid* species [25]. However different observations have been reported for the developmental rates of the *S. dux*. Life cycle of *Sarcophaga dux* from the first instar to the adult was 312.0 ±3.0 h under uncontrolled indoor temperature in Malaysia [26]. Report from study in north Thailand in the year 2002-2003 under natural temperature indicates seasonal variation in development of fly with rapid larval development in summer at around 72 hrs, while it took 72-96 hrs.in rainy season and 96 hrs.in winter [27-28]. The life cycle of *Sarcophaga cultellata* at 25^{0}C and 50% humidity showed a total development time from larvae position to first adult emergence was 330 ± 12 hr [29]. The only report from India on the development of larvae of S*arcophaga(L) tibialis* raised on chicken liver indicated maximum development between 15-30^{0}C [30-35].

The present results are similar with the developmental duration of *Chrysomya megacephala* (Diptera: Calliphoridae), in rainy season and low constant temperature of 10°C and humidity 19%, the total life cycle duration in rainy season was completed in 265 h ± 2 h(11.04 days ± 0.08 days) when the temperature ranged between 26°Cand 29°C and humidity ranged between 35% and 50%, while in the low constant temperature 10°C ± 0.5°C the life cycle was completed in 609h ± 4 h (25.38 days ± 0.16 days) indicating a delay in the life cycle by14.37 days ± 0.13 days [36]. Similarly our current results are in agreement with another study on the effect of different temperature and humidity on the lifecycle duration and morphological parameters of *Chrysomya rufifacies* (Diptera: Calliphoridae) in different seasons It was reported that the life cycle of *Chrysomya rufifacies* in summer was completed in 241 ±2.17 h (10.04 days ± 0.12 days) when the temperature ranged between30.1°C and 37.2°C, but in the rainy season it was completed in 275 h ±2.27 h (11.46 days ± 0.45 days), when the temperature ranged between26.2°C and 30.1°C, while in winter the life cycle was completed in 318h ± 2.45 h (13.25 days ± 0.25 days) when the temperatures ranged between 26.4°C and 18.2°C respectively [37].

In previous study in laboratory, at the fluctuating temperature during rainy season, winter season and summer season, *Chrysomya megacephala* took 237 hours 47 minutes, 263 hours 51 minutes and 211 hours 13 minutes respectively. Whereas the *Chrysomya rufifacies* took 239 hours 14 minutes, 286 hours 02 minutes and 216 hours 26 minutes during rainy season, winter season and summer season respectively [38].

Conclusion:-

It is observed that developmental time of different stages of life cycle of *Parasarcophga dux* from larviposite to emergence of adult differ in various seasons. On the basis of result it was clearly seen that a changes in temperature and humidity bring about a significant changes in developmental rate of the larval stages. In the condition with the higher temperature, larvae developed quickly and matured into pupa as compared to that grown in cooler temperature.

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