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The Developmental Response of Flesh Flies (Diptera: Sarcophagidae) to Tropical Seasons

Variation in Generation Time and Diapause in East Africa

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Summary. In a tropical environment near the equator in Nairobi, Kenya, flesh fly development is nearly continuous throughout the year with only a few individuals being channeled into pupal diapause during the coldest months. Two species reared in a field cage completed 7 generations/year. Generation time for nondiapause flies varied from 41 to 62 days.

Introduction

The harsh temperate region winter imposes a major impediment for insect growth and development. Only a few months each year can be exploited, the remaining months being non-productive periods devoted to maintenance through the inimical conditions. Like many insects of the temperate region, the flesh fly *Sarcophaga bullata* at 40° N enters pupal diapause in August, and adults do not emerge until the following May (Denlinger, 1972a). At best, the annual period of warm weather permits a turn-over of 2–3 generations.

In the tropics the dramatic seasonal variation in temperature is muted. Yet, flesh flies from tropical Africa will enter pupal diapause at low temperatures in the laboratory (Denlinger, 1974). In the present study, two species of African Sarcophagidae were reared outside in Nairobi, Kenya, to examine the impact of natural environmental conditions on generation time and to determine when, if ever, diapause occurs naturally.

Methods

Colonies of *Sarcophaga inzi* Curran and *Poecilometopa spilogaster* (Wiedemann) originated from wild females caught in Nairobi, Kenya. Rearing procedure was described by Denlinger (1972b). The field cage, a 1 × 0.4 × 0.4 m screened cage mounted on 1.2 m legs, was erected near I.C.I.P.E.

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at a site sheltered from artificial lights. Surrounding vegetation consisted of dense undergrowth 1 m high and several tall trees that partially shaded the cage late in the afternoon.

Climatic Seasonality

Nairobi is 1°18′ S at an altitude of 1700 m. Its proximity to the equator results in only a 7 min annual variation in daylength. During the 29 month experimental period, mean weekly temperature ranged from 16° to 22° C. July and August are characteristically the coldest months and January to March is the warmest period. The main rainy season from mid-March to May brings around 450 mm rainfall, and about 250 mm falls during the short rainy season between mid-October and mid-December (Anonymous, 1967). During the experimental period the short rains of 1973 were almost completely absent.

Development in Flesh Flies

From laboratory results (Denlinger, 1974) we would predict that if diapause normally occurs in the field it should appear during the coldest period. During the cold season in 1972 the overall developmental rate in *S. inzi* was 1.5× slower than during the warmest months (Fig. 1A). Although 61 days was required for completion of a generation, development was continuous throughout. There was no evidence for a developmental arrest in the pupal or any other stage.

P. spilogaster reacted similarly during the cold period in 1973 (Fig. 1B). In 1974, however, temperatures during the cold months were slightly lower than during the previous 2 years. Mean weekly temperatures between 16 and 17° C

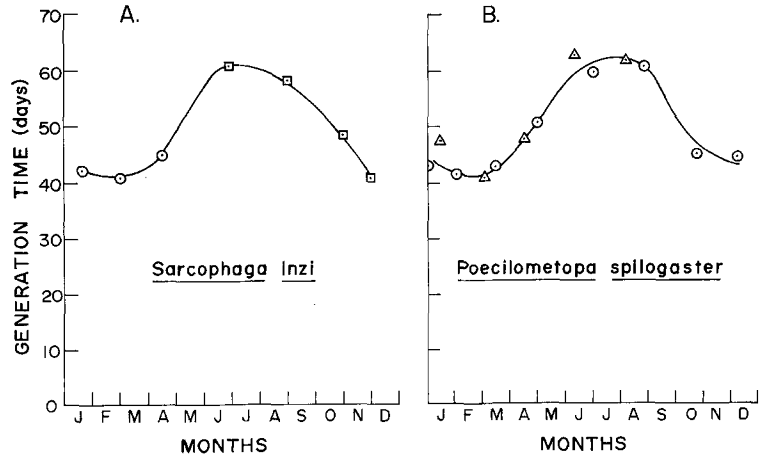

Fig. 1A and B. Seasonal variation of generation time in **A** *Sarcophaga inzi* and **B** *Poecilometopa spilogaster*. The curves are based on data compiled during 3 years: □ 1972, ○ 1973, △ 1974. Each generation was started with larvae collected from 10 females. Mean number of progeny/female was 73 in *S. inzi* and 35 in *P. spilogaster* were recorded during 7 weeks between late June and mid-August, while in both the previous years only 3 weeks had mean temperatures as low as 17° C. The lower temperatures of 1974 were sufficient to channel a few pupae into diapause in both June (4.7%, $N=127$) and August (2.2%, $N=178$). The diapausing pupae remained as undifferentiated phaenerocephalic pupae (Fraenkel and Hsiao, 1968) for 30–40 days, whereas their non-diapause siblings passed through the same developmental stage in 3–5 days. Diapausing pupae transferred to a laboratory environmental chamber at $25 \pm 1°$ C initiated adult development within 1 week, thus indicating their competence to initiate development at a higher temperature. Diapause is programmed in advance of the pupal stage: larvae must be exposed to low temperature (Denlinger, 1974). Thus, in order for diapause to be observed in the field, the temperature-sensitive larval stage must receive the appropriate temperature signals.

For most individuals diapause did not interrupt continuous development, and within one year *P. spilogaster* completed 7–1/4 and *S. inzi* 7–1/3 generations. Generation time varied from a minimum of 41 days in February and March to a maximum of 62 days in June, July and August.

In a natural population having all life stages represented simultaneously, a few pupae are likely to enter diapause each year. It is tempting to downplay the importance of diapause in the tropical flies due to the low incidence observed, but the capacity for a diapause at the fringe of ecologically relevant temperatures appears widespread among many species of flesh flies in East Africa (Denlinger, unpublished observation). It does not appear to represent a phylogenetic relic of a temperate region ancestor since evolutionary evidence (Rohdendorf, 1967) indicates a tropical origin for the Sarcophagidae. Rather, it appears to be a genetic potential actively maintained as a fail-safe device for circumventing occasional periods of unfavorable temperature.

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