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# EFFECTS OF FOOD AND MEDIA ON EGG PRODUCTION, GROWTH AND SURVIVORSHIP OF FLIES (DIPTERA : CALLIPHORIDAE, MUSCIDAE AND SARCOPHAGIDAE)

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**Abstract**

*The effects of three types of food: mixed synthetic medium, fresh meat soaked in water, and mixed synthetic medium with fresh meat soaked in water, were tested on egg production, growth and survivorship of three species of synanthropic flies (Chrysomyia megacephala Fabr, Musca domestica L. and Parasarcophaga ruficornis Fabr.) under laboratory conditions (27 ± 4°C and 78 ± 4% RH). Egg production by females, growth, and survivorship of developmental stages and adults varied significantly between groups raised on different foods. Growth and reproduction were highest in flies fed with combined mixed synthetic medium and fresh meat soaked in water. The combined medium appears to be best for rearing large numbers of flies for experimental purposes.*

## Introduction

Synanthropic flies, i.e. the blow flies *(Chrysomyia megacephala* Fabricius, Calliphoridae), the house flies (*Musca domestica* Linnaeus, Muscidae) and the flesh flies (*Parasarcophaga ruficornis* Fabricius, Sarcophagidae) serve as vectors and carriers of pathogenic organisms causing acute and chronic diseases of man and animals. They can be found in unsanitary human habitats and in animal sheds. The flies are eusynanthropic, and their distribution and migration are cosmopolitan. Tumrasvin *et al.* (1978) and Sucharit and Tumrasvin (1981) found these flies to be common in Thailand. At present, chemical insecticides are used as the major method of insect control (Greenberg, 1973 ; Peonvit *et al.*, 1969), but rapid evolution of resistance to chemical pesticides by pests has caused failure in many vector control campaigns (Keiding, 1980 ; Sucharit and Tumrasvin, 1981). Thus, studies on their life history and biology may provide knowledge regarding the most vulnerable developmental stages, which may be useful for devising better and safer means

of controlling them. However, such studies require large numbers of flies, and the larvae must be reared on economical and reliable growth medium. We report on egg production, growth and survivorship of three species of synanthropic flies on two types of media given separately and in combination.

## Materials and Methods

All three species of synanthropic flies *(Chrysomyia megacephala, Musca domestica* and *Parasarcophaga ruficornis)* used in this study were collected from garbage piles at Bangkhen market, Bangkok, Thailand. Voucher specimens were deposited in the Center for Applied Malacology and Entomology's Museum, Faculty of Science, Mahidol University, Bangkok.

The following types of media were used to feed the flies and larvae: (1) mixed synthetic medium (100 g rice bran and husk, 350 g dry, low fat powder milk, 75 g icing sugar, 15 g Baker's yeast, and 200 ml of 2% KOH in normal saline solution), (2) fresh cow meat soaked in water (the meat was moistened with a few drops of water daily until pupation), and (3) the combination of media types (1) and (2).

Flies were raised in l-cu.ft. cages, each containing 10 males and 10 females. Each cage contained a Petri dish filled with medium. Five cages of each species were used for each type of medium, making 15 cages (total 150 male and 150 female flies) of each species.

Larvae were raised to first, second or third instar stages in 300 ml glass bottles covered with fine-mesh nylon netting in groups of 20 larvae per bottle. Five bottles of flies were raised to each stage per type of medium for each species, giving 900 larvae in 45 bottles per species (45 bottles = 3 types of medium $\times$ 3 larval stages $\times$ 5 trials). 10 g. of food were given per bottle. To provide moisture, cotton pads soaked with water were placed in the cages and bottles. They were cleaned and observed daily. The temperature was 27° $\pm$ 4°C and relative humidity 78 $\pm$ 4%.

The eggs, larvae, pupae and adults were measured individually under a dissecting microscope fitted with a micrometer, and were weighed individually with a Qeartling balance.

## Results and Discussion

The results in Table 1 indicate very clearly that type of food is a very important factor in determining fecundity and survivorship in all three species of flies. Analysis of variance (Table 2) showed that type of food significantly affected egg production of adult females, growth and survivorship of first, second and third instar larvae of *Chrysomyia megacephala, Musca domestica* and *Parasarcophaga ruficornis.* The combination of

synthetic medium and fresh meat soaked in water rendered the best results in terms of egg production by adult females, growth and survivorship of developmental stages and adults of the flies, followed by fresh meat soaked in water. Hence, the mixed synthetic medium with fresh meat soaked in water could be useful for mass production of flies when large numbers are required for experimental purposes.

Tables 3, 4, and 5 exhibit life durations of various developmental stages of *C. megacephala, M. domestica,* and *P. ruficornis,* while Figure 1 summarizes them. The mean life cycles of *C. megacephala, M. domestica,* and *P. ruficornis* were 11.2 ± 1.32, 10.7 ± 1.19, and 17.7 ± 1.08 days, respectively, for males, and 16.1 ± 3.24, 15.1 ± 2.28, and 22.5 ± 3.07 days, respectively, for females.

**TABLE 1.** Effects of food on egg production, growth and survivorship of *Chrysomyia megacephala, Musca domestica* and *Parasarcophaga ruficornis.*

| Egg production and survivorship of developmental stages | | Type of food | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Mixed synthetic medium | | | Meat soaked in water | | | Mixed synthetic medium and meat soaked in water | | |
| | | C. | M. | P. | C. | M. | P. | C. | M. | P. |
| Females laying eggs | (%) | 72.0 | 68.0 | 57.0 | 75.0 | 72.0 | 67.0 | 79.0 | 81.0 | 74.0 |
| First instar larvae | (%) | 82.4 | 80.6 | 86.2 | 89.3 | 87.5 | 91.5 | 93.8 | 93.7 | 94.0 |
| Second instar larvae | (%) | 78.3 | 75.1 | 81.6 | 85.5 | 84.1 | 87.3 | 89.8 | 89.1 | 90.4 |
| Third instar larvae | (%) | 74.3 | 71.6 | 77.1 | 83.2 | 80.3 | 84.0 | 87.1 | 86.3 | 87.1 |
| Puparia | (%) | 70.4 | 68.3 | 73.3 | 80.1 | 75.4 | 78.1 | 85.7 | 83.7 | 83.6 |
| Adults (emergence to ovoposition) | (%) | 64.2 | 65.6 | 70.1 | 78.1 | 72.1 | 75.0 | 83.5 | 83.7 | 81.6 |

C. = *Chrysomyia megacephala ;* M. = *Musca domestica ;* P. = *Parasarcophaga ruficornis.*

**TABLE 2.** Analysis of variance (3 × 3 Factorial) on survival of five different stages of the life cycle, for *Chrysomyia megacephala, Musca domestica,* and *Parasarcophaga ruficornis*. Variation between species has been removed: significant effects exist within each species in overall survival.

| Instar | SOURCE | d.f. | SS | MS | F |
|---|---|---|---|---|---|
| Egg laid per female | Month | 9 | 557.08 | 61.90 | 10.36** |
| | Media | 2 | 1506.93 | 753.93 | 126.12** |
| | Residual | 78 | 465.97 | 5.79 | |
| | Corrected total | 89 | 2529.98 | | |
| First instar (survival from egg to hatching) | Month | 9 | 559.56 | 62.17 | 12.36** |
| | Media | 2 | 1287.73 | 643.86 | 128.05** |
| | Residual | 78 | 392.21 | 5.02 | |
| | Corrected total | 89 | 2239.50 | | |
| Second instar (survival of $1^{st}$ to $2^{nd}$ instar) | Month | 9 | 560.54 | 62.28 | 14.71** |
| | Media | 2 | 1302.16 | 651.08 | 153.74 |
| | Residual | 78 | 330.31 | 4.23 | |
| | Corrected total | 89 | 2193.02 | | |
| Third instar (survival of $2^{nd}$ to $3^{rd}$ instar and puparia) | Month | 9 | 583.79 | 64.86 | 18.41** |
| | Media | 2 | 1331.02 | 665.50 | 188.89** |
| | Residual | 78 | 274.81 | 3.52 | |
| | Corrected total | 89 | 2189.61 | | |
| Adult (survival of $3^{rd}$ instar to puparia and adult stage) | Month | 9 | 830.40 | 92.27 | 17.45** |
| | Media | 2 | 1786.41 | 893.20 | 168.92** |
| | Residual | 78 | 412.45 | 5.29 | |
| | Corrected total | 89 | 3029.26 | | |

** = significant at the 1% level of probability.

**TABLE 3.** Life duration of various developmental stages of *Chrysomyia megacephala* reared at 27° ± 4°C and 78 ± 4 % RH.

| Stage of development | Number of specimens | Range | Mean ± SD |
|---|---|---|---|
| Egg (days) | 1000 | 0.75 – 2.00 | 0.88 ± 0.09 |
| Larva | | | |
| First instar (days) | 938 | 1.50 – 2.75 | 2.13 ± 0.96 |
| Second instar (days) | 898 | 1.75 – 2.50 | 2.09 ± 0.31 |
| Third instar (days) | 871 | 2.00 – 5.00 | 3.50 ± 0.97 |
| Total | | 5.25 – 10.25 | 7.72 ± 2.24 |
| Pupa (days) | 851 | 3.00 – 4.00 | 3.50 ± 0.71 |
| Sex matured adult | | | |
| Male (days) | 348 | 3.00 – 6.25 | 4.85 ± 1.36 |
| Female (days) | 487 | 3.75 – 7.00 | 5.25 ± 1.27 |
| Total life cycle | | | |
| Male (days) | 100 | 9.95 – 13.00 | 11.19 ± 1.32 |
| Female (days) | 100 | 11.50 – 21.25 | 16.05 ± 3.24 |
| Adult longevity (sex matured) | | | |
| Male (days) | 50 | 9.05 – 24.00 | 16.81 ± 4.34 |
| Female (days) | 50 | 7.50 – 11.75 | 8.22 ± 3.07 |
| Sex ratio, male : female = 5:7 | | | |
| No. of egg laid/batch | 50 | 12 – 405 | 161.62 ± 119.27 |
| No. of egg batch/fly | 50 | 4 – 15 | 10.00 ± 3.89 |
| Egg hatchability (%) | 100 | 90 – 96 | 93.80 ± 1.87 |
| Oviposition period (days) | 50 | 1 – 12 | 6.50 ± 3.60 |

**TABLE 4.** Life duration of various developmental stages of *Musca domestica* reared at 27° ± 4°C and 78 ± 4% RH.

| Stage of development | Number of specimens | Range | Mean ± SD |
|---|---|---|---|
| Egg (days) | 1000 | 0.25 – 1.25 | 0.75 ± 0.40 |
| Larva | | | |
| First instar (days) | 937 | 1.30 – 1.75 | 1.54 ± 0.17 |
| Second instar (days) | 891 | 1.50 – 2.00 | 1.75 ± 0.35 |
| Third instar (days) | 863 | 2.00 – 3.00 | 2.50 ± 0.71 |
| Total | | 4.80 – 6.75 | 5.79 ± 1.23 |
| Pupa (days) | 837 | 3.50 – 5.00 | 4.25 ± 1.06 |
| Sex matured adult | | | |
| Male (days) | 327 | 3.00 – 5.00 | 4.00 ± 1.41 |
| Female (days) | 490 | 2.75 – 6.50 | 4.65 ± 1.36 |
| Total life cycle | | | |
| Male (days) | 100 | 9.55 – 12.25 | 10.70 ± 1.19 |
| Female (days) | 100 | 12.00 – 18.50 | 15.07 ± 2.28 |
| Adult longevity (sex matured) | | | |
| Male (days) | 50 | 18.45 – 51.75 | 35.43 ± 9.70 |
| Female (days) | 50 | 16.00 – 45.50 | 30.98 ± 9.06 |
| Sex ratio, male : female = 2:3 | | | |
| No. of egg laid/batch | 50 | 36 – 623 | 177.25 ± 137.77 |
| No. of egg batch/fly | 50 | 8 – 18 | 13.00 ± 3.31 |
| Egg hatchability (%) | 100 | 91 – 97 | 93.70 ± 2.05 |
| Oviposition period (days) | 50 | 8 – 18 | 13.00 ± 3.31 |

**TABLE 5.** Life duration of various developmental stages of *Parasarcophaga ruficornis* reared at 27° ± 4°C and 78 ± 4% RH.

| Stage of development | Number of specimens | Range | Mean ± SD |
|---|---|---|---|
| Egg (days) | 1000 | 0.30 – 1.25 | 0.76 ± 0.34 |
| Larva | | | |
| First instar (days) | 940 | 1.00 – 2.50 | 1.75 ± 0.50 |
| Second instar (days) | 904 | 2.00 – 3.50 | 2.83 ± 0.76 |
| Third instar (days) | 871 | 2.75 – 4.00 | 3.40 ± 0.52 |
| Total | | 5.75 – 10.00 | 7.98 ± 1.78 |
| Pupa (days) | 836 | 5.50 – 7.00 | 6.25 ± 0.54 |
| Sex matured adult | | | |
| Male (days) | 330 | 5.50 – 13.75 | 9.25 ± 2.38 |
| Female (days) | '496 | 4.50 – 7.55 | 5.98 ± 0.96 |
| Total life cycle | | | |
| Male (days) | 100 | 16.55 – 20.00 | 17.65 ± 1.08 |
| Female (days) | 100 | 18.00 – 27.25 | 22.53 ± 3.07 |
| Adult longevity (sex matured) | | | |
| Male (days) | 50 | 3.45 – 39.00 | 21.90 ±10.61 |
| Female (days) | 50 | 2.00 – 31.75 | 17.88 ± 8.62 |
| Sex ratio, male : female = 2:3 | | | |
| No. of egg laid/batch | 50 | 3 – 36 | 19.10 ± 11.05 |
| No. of egg batch/fly | 50 | 4 – 5 | 4.50 ± 0.70 |
| Egg hatchability (%) | 100 | 90 – 98 | 94.00 ± 2.40 |
| Oviposition period (days) | 50 | 4 – 5 | 4.50 ± 0.70 |

The females of *C. megacephala* laid eggs 5.3 ± 1.27 days after their emergence, while 4.7 ± 1.36 days were required for *M. domestica,* and 6.0 ± 0.95 days for *P. ruficornis*. *M. domestica* laid the highest mean number of eggs per batch (177.3 ± 137.77), followed by *C. megacephala* (161.6 ± 119.27) and *P. ruficornis* (19.1 ± 11.05). The larval development took 7.7 ± 2.24 days for *C. megacephala,* 5.8 ± 1.23 days for *M. domestica,* and 8.0 ± 1.78 days for *P. ruficornis*. The pupae of *C. megacephala* took 3.5 ± 0.71 days to develop, whereas those of *M. domestica* and *P. ruficornis* took 4.3 ± 1.06 and 6.3 ± 0.54 days, respectively. The larviparous females of *P. ruficornis* were occasionally found in this experiment, the occurrence of which is possibly due to the sudden change of high temperature. Their offspring varied from 3 to 11 in number with an average length of 1.9 ± 0.55 mm. (Table 6). The body length and weight of various developmental stages of *C. megacephala, M. domestica* and *P. ruficornis* are recorded in Table 6.

**TABLE 6.** Body length and weight of various developmental stages of *Chrysomyia megacephala, Musca domestica* and *Parasarcophaga ruficornis,* reared at 27° ± 4°C and 78 ± 4% RH.

| Developmental stages | Average body length (mm) and weight (mg) | | | | | |
|---|---|---|---|---|---|---|
| | *C. megacephala* | | *M. domestica* | | *P. ruficornis* | |
| | length | weight | length | weight | length | weight |
| Egg | 1.2± 0.10 | 0.001±0.0002 | 1.1±0.04 | 0.0003±0.00001 | 1.6±0.33 | 0.001±0.0002 |
| Larva | — | — | — | — | 1.9±0.55 | 0.002±0.0004 |
| First instar | 4.0±0.30 | 0.002±0.0007 | 2.4±0.19 | 0.0004±0.00009 | 6.8±0.45 | 0.009±0.0007 |
| Second instar | 7.9±0.80 | 0.007±0.001 | 5.0±0.12 | 0.002 ±0.0001 | 11.8 ±0.07 | 0.053±0.007 |
| Third instar | 12.8±0.30 | 0.040±0.002 | 8.7±0.34 | 0.020 ±0.009 | 16.9±0.08 | 0.073±0.005 |
| Pupa | 6.8±0.60 | 0.040±0.001 | 4.9±0.13 | 0.020 ±0.001 | 11.7±0.14 | 0.063±0.004 |
| Adult | | | | | | |
| Male | 10.7±0.20 | 0.060±0.001 | 5.7±0.12 | 0.050 ±0.002 | 13.8±0.16 | 0.090±0.002 |
| Female | 8.1±0.20 | 0.050±0.001 | 5.2±0.27 | 0.040 ±0.001 | 13.2±0.01 | 0.730±0.003 |

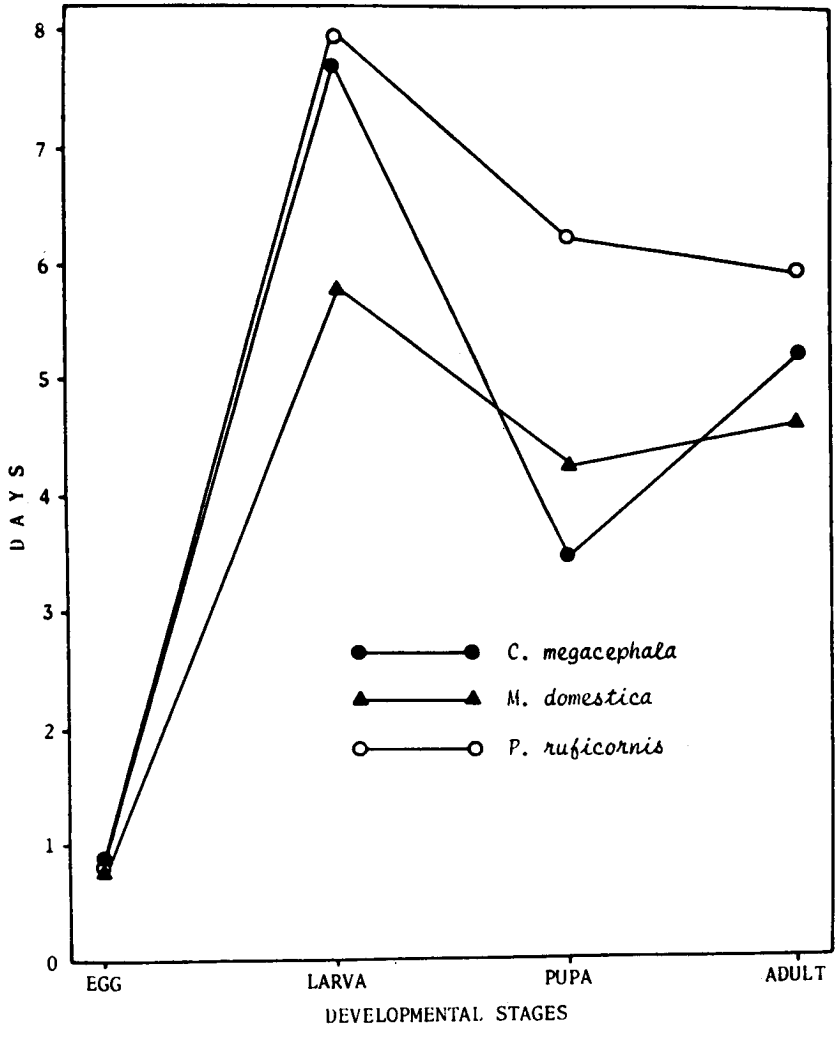


**Figure 1.** The mean survivorship of different stages of *Chrysomyia megacephala, Musca domestica, and Parasarcophaga ruficornis* reared with mixed synthetic medium and meat soaked in water, at 27° ± 4°C and 78 ± 4% RH.

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**บทคัดย่อ**

การเลี้ยงแมลงวัน synanthropic flies 3 ชนิด คือแมลงวันหัวเขียว *Chrysomyia megacephala* Fabr., แมลงวันบ้าน *Musca domestica* L., และแมลงวันหลังลาย *Parasarcophaga ruficornis* Fabr. ในห้องปฏิบัติการที่มีอุณหภูมิ 27 ± 4 องศาเซลเซียส ความชื้นสัมพัทธ์ 78 ± 4 เปอร์เซนต์ ด้วยอาหาร 3 ชนิดคือ อาหารผสม, เนื้อวัวสดแช่น้ำ และอาหารผสม + เนื้อวัวสดแช่น้ำ นั้นพบว่าอาหารที่มีคุณค่าที่ดีที่สุดที่มีผลต่อการเจริญเติบโตของแมลงวันทั้ง 3 ชนิด เป็นอาหารผสม + เนื้อวัวสดแช่น้ำในอัตราส่วน 1:1 มีผลทำให้แมลงวันตัวเมียมีเปอร์เซนต์การวางไข่สูง และจำนวนไข่แต่ละครั้งมากที่สุด เปอร์เซนต์การอยู่รอดตั้งแต่ไข่จนเป็นตัวเต็มวัยมีปริมาณสูงสุด การเจริญเติบโตของตัวหนอนเข้าดักแด้ และฟักเป็นตัวเต็มวัยได้สูง ซึ่งมีความเชื่อมั่นทางสถิติที่ระดับ ($p < 0.01$) ไข่ฟักเป็นตัวหนอนได้ภายใน 1 วัน ตลอดวงจรชีวิตเป็นแบบ complete matamorphosis ดังนั้นจึงเชื่อว่า อาหารผสม + เนื้อวัวสดแช่น้ำเหมาะที่สุดสำหรับการเลี้ยงแมลงเป็นจำนวนมากเพื่อใช้ในการทำการทดลอง