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COMPARISON OF THE REPRODUCTIVE BEHAVIOR BETWEEN ISOLATED *PECKIA CHRYSOSTOMA* (WIEDEMANN, 1830) AND *ADISCOCHAETA INGENS* (WALKER, 1849) (DIPTERA: SARCOPHAGIDAE) FEMALES REARED IN LABORATORY

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In both species, maintained under laboratory environmental conditions, anautogeny was comproved and all females that had free access to proteic source were fertiles.

We obtained the following average values for Peckia chrysostoma: *59.7 ± 15.6 and 81.8 ± 15.4 days of longevity in the respective cases of free access and no access to proteic source, 21.4 ± 4.3 days of pre-larviposition period and 35.2 ± 16.5 days of larviposition period, 5.3 ± 1.8 larvipositions per female with 7.0 ± 1.1 days of periodicity, 35.7 ± 6.1 larvae per larviposition leading to a total number of 183.8 ± 69.2 viable larvae per female and 94.8% ± 5.3% of productivity. The mean number of ovarioles per female was 56.4 ± 9.8, resulting in a reproductive potential of 63.3%.*

For Adiscochaeta ingens, *the obtained average values were: 41.3 ± 6.3 and 52 ± 13.1 days of longevity in the respective cases of free access and no access to proteic source, 15.3 ± 1.7 days of pre-larviposition period and 21.5 ± 7.5 days of larviposition period, 3 ± 0.7 larvipositions per female with 10.4 ± 0.8 days of periodicity, 30.3 ± 8.2 larvae per larviposition leading to a total number of 78.5 ± 21.7 viable larvae per female and 90.1% ± 16% of productivity. The mean number of ovarioles per female was 54.6 ± 5.2, resulting in a reproductive potential of 55.5%.*

Within the applied parameters, the values obtained for P. chrysostoma *demonstrate its superior productivity in comparison with* A. ingens.

Key words: Diptera – Sarcophagidae – *Peckia chrysostoma* – *Adiscochaeta ingens* – reproductive behaviour – larviposition – productivity

Peckia chrysostoma is a widely spread species in Rio de Janeiro. D'Almeida (1984) observed an abundance of 26.66% from the total dipterous collected by him. This species demonstrated, in Rio de Janeiro, preference for environments inhabited by man and the bait that attracted it more was raw fish. In Minas Gerais, in contrast, it was found more in forest area (Dias et al., 1984). *Adiscochaeta ingens* is a species characteristic from the Brazilian "Campos Cerrados", where it was collected, but is also found in Rio de Janeiro, although in a smaller frequency, as observed by D'Almeida (1984). In Minas Gerais, Dias et al. (1984) observed the same. Lopes (1973) had done an extensive work during 40 years in which he studied the distribution and density of the Sarcophagidae; his observations proved the constant numerical superiority of *P. chrysostoma* over *A. ingens*. Also in Campinas, Linhares (1981) collected only 4 individuals of *A. ingens* against 283 of *P. chrysostoma*. In Ceará, however, Lopes (1974) observed only 0.15% of *P. chrysostoma* and 0.1% of *A. ingens* in the total of species collected by him with baits of bananas and brown sugar. In Mato Grósso, Lopes & Tibana (1982) also found only 0.23% and 0.77% of individuals from *P. chrysostoma* and *A. ingens*, respectively. In this way, one of the goals of this study is to compare the reproductive behaviour of an autochthonal species with that of a non autochthon, introduced and colonised in the laboratory.

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With the purpose of optimising the maintenance of dipterous colonies for studies in the laboratory, one observes the necessity of checking the reproductive individual behaviour of isolated females reared with males. The results of this study allow us to estimate the interpretation of data obtained in colonies, evaluating better some biological parameters, such as: the number of larvipositant females, pre-larviposition and larviposition periods, the larviposition number, the larviposition periodicity, the mean number of viable larvae per female, the mean number of larvae per larviposition, the percentage of viable larvae per female and female longevity. The reproductive potential may be determined comparing the mean number of larvae per larviposition with the mean number of ovarioles presented by the females. The productivity is given by the percentage of viable larvae in relation to the total number of laid eggs/larvae.

MATERIALS AND METHODS

We used, in the *P. chrysostoma* study, descendent strains of native populations captured in the *campus* of Instituto Oswaldo Cruz (RJ) in March, 1990. Since then, 3 additional collects were done (the approximate interval between 2 consecutive ones being 3 months) for the inclusion of new individuals in the initial colony with the purpose of not interfering in the genetic potential of the considered population. In the case of *A. ingens,* all the used descendents are originated from larvae collected in the expedition done at "Campos Cerrados" of Brasília (DF) in July, 1990. Since then the colonies are kept isolated, being then prevented to crossing with native populations.

The breedings established in the Diptera Caliptrata Laboratory of the Department of Biology, Instituto Oswaldo Cruz (RJ), are maintained in wired cages of 30 x 30 x 30 cm which contain water, brown sugar and the proteic source and/or larviposition substrate (in this case, raw fish). The larviposition substrate was kept during 24 h in the cages and changed daily. Observations were, then, done aiming at the determination of the larviposition occurence and of the layed larvae number until the death of all females. At it is known the role of bacterial odours in the stimulus of oviposition in many flies (Emmens & Murray, 1982), control-groups, with proteic substrate in containers isolated with a piece of bride, were observed for the determination of a possible autogeny in both species.

For each species, 2 repetitions were performed, one with 8 and the other with 7 samples, with a total of 15 samples, each one with 1 female and 2 males newly emerged. The same parameters were used for the control-groups with no access to proteic sources. The 1st repetition was done under average temperature of 28.4 °C (the average of the minima was 26.5 °C and that of the maxima was 30.3 °C) and 69.3% of relative humidity (minimum of 56% and maximum of 81%). The 2nd repetition was performed under average temperature of 28.5 °C (the average of the minima was 26.5 °C and that of the maxima was 30.5 °C) and 68.5% of relative humidity (minimum of 56% and maximum of 82%).

In order to determine the average number of ovarioles per female, we dissected 25 females of each species which were approximately one week old since, according to Anderson (1964) and Gillies (1958), the number of functional ovarioles decreases with an increasing number of gonotrophic cycles. However, the number of layed eggs/larvae may not diminish with the sucession of gonotrophic cycles. Gravid females can retain eggs after the maturation in a previous gonotrophic cycle and be still able to lay this eggs/larvae in the 2 next cycles. Besides that, it can also occur a small variation of this number between the 2 ovaries of a same individual.

There were selected only females which obtained a maximum of larval development (which had received satisfactory proteic food) since the number of ovarioles seems to be definitely related with the size of the insect and, therefore, depends directly on the food amount obtained during the larval stage (Williams & Richardson, 1983; Vogt & Walker, 1987a, b).

In order to count the ovarioles of each ovary, the females had their abdomes detached in the base and dissected in a salted solution of 0.85%. For the dissection, the abdomens were laterally attached with entomological pins in a plate of Petri with paraffin and longitudinally cut, with thin scissors, in the ventral part. After removing the ovarioles, they were immersed in Acetic Carmin solution for approximately 5 h and assembled in slides with glycerin.

TABLE I

Values, per female, of the various biological parameters of 15 females of *Peckia chrysostoma* maintained under environmental conditions of laboratory

Females	Variables								
	a	b	c	d	e	f	g	h	i
1	24	55	8	7.7	32.6	325	287 (88.3%)	81	69
2	20	51	6	8.8	43.2	259	246 (95.0%)	75	67
3	18	57	7	8.5	36.1	253	220 (87.0%)	72	89
4	26	34	5	6.5	39.8	199	184 (92.5%)	62	89
5	26	33	5	6.7	30.4	152	152 (100%)	63	70
6	18	27	4	8.3	33.0	132	126 (95.4%)	46	81
7	21	22	4	6.0	29.2	117	105 (90.0%)	49	81
8	29	20	4	5.6	36.7	147	147 (100%)	50	87
9	24	12	3	5.0	48.0	144	144 (100%)	42	70
10	24	50	8	6.3	34.7	278	242 (87.0%)	79	72
11	23	30	5	6.5	36.0	180	180 (100%)	53	70
12	16	15	3	7.0	22.0	66	66 (100%)	32	61
13	14	28	5	6.2	34.4	172	172 (100%)	53	116
14	23	25	4	7.7	37.2	149	148 (99.3%)	51	97
15	15	69	9	7.9	42.9	386	338 (87.6%)	88	108
min.	14	12	3	5.0	22.0	66	66 (87.0%)	32	61
max.	29	69	9	8.8	48.0	386	338 (100%)	88	116
mean	21.4	35.2	5.3	7.0	35.7	197.3	183.8 (94.8%)	59.7	81.8
S.D.	4.3	16.5	1.8	1.1	6.1	83.3	69.2 (5.3%)	15.6	15.4
P.	20%	46.9%	34%	15.7%	17.1%	42.2%	37.6%	26.1%	18.8%

Variables:
a: pre-larviposition period (in days).
b: larviposition period (in days).
c: number of larvipositions.
d: mean periodicity of larvipositions (in days).
e: mean number of larvae per larviposition.
f: total number of larvae.
g: number of viable larvae.
h: longevity of females with access to protein source (in days).
i: longevity of females without access to protein source (in days).

S.D.: standard deviation. P.: percentual standard deviation.

RESULTS

Fertility – We verified that, in both species, 100% of the isolated females with the proteic source were fertiles, i. e., effected larviposition. But no female laid larvae with the isolated proteic source.

Longevity – With access to the proteic source, *P. chrysostoma* females (Table I) obtained an average longevity of 59.7 ± 15.6 days (minimum of 32 and maximum of 88 days) whereas with the isolated proteic source, the average longevity increased up to 81.8 ± 15.4 days (minimum of 61 and maximum of 116 days). With access to the proteic source, the average longevity of *A. ingens* females (Table II) was smaller than that of *P. chrysostoma:* 41.3 ± 6.5 days (minimum of 29 and maximum of 57 days), whereas, with the isolated proteic source, the average longevity increased up to 52 ± 13.1 days (minimum of 30 and maximum of 69 days).

Pre-larviposition and larviposition periods – The results which we obtained show that *P. chrysostoma* (Table I) had a bigger pre-larviposition period (which varied between 14 and 29 days with an average of 21.4 ± 4.3 days) than that of *A. ingens* (Table II) (which varied between 13 and 19 days, with an average of 15.3 ± 1.7 days). In spite of the reproductive period had started earlier for *A. ingens,* it endured less, varying between 10 and 33

TABLE II

Values, per female, of the various biological parameters of 15 females of *Adiscochaeta ingens* maintained under environmental conditions of laboratory

Females	Variables								
	a	b	c	d	e	f	g	h	i
1	15	12	2	11.0	27.5	55	55 (100%)	39	43
2	15	12	3	10.0	28.0	84	84 (100%)	40	58
3	13	25	4	8.7	26.5	106	105 (99.0%)	39	66
4	15	13	2	11.0	38.0	76	76 (100%)	30	38
5	14	26	3	11.5	22.0	66	66 (100%)	43	40
6	15	22	3	10.5	40.3	121	83 (68.6%)	40	66
7	16	31	4	10.3	27.5	110	106 (96.4%)	48	30
8	16	24	3	11.5	32.0	96	96 (100%)	41	43
9	16	24	3	11.0	19.7	59	43 (72.9%)	41	43
10	13	33	4	10.0	26.0	104	44 (42.3%)	48	60
11	14	23	3	10.5	26.7	80	78 (97.5%)	41	60
12	15	13	2	11.0	52.0	104	95 (91.3%)	29	34
13	19	23	3	10.5	22.3	67	59 (88.0%)	43	64
14	14	10	2	9.0	37.5	75	72 (96.0%)	41	69
15	19	32	4	10.0	29.0	116	116 (100%)	57	66
min.	13	10	2	8.7	19.7	55	43 (42.3%)	29	30
max.	19	33	4	11.5	52.0	121	116 (100%)	57	69
mean	15.3	21.5	3	10.4	30.3	87.9	78.5 (90.1%)	41.3	52
S.D.	1.7	7.5	0.7	0.8	8.2	20.8	21.7 (16%)	6.5	13.1
P.	11.1%	34.9%	23.3%	7.7%	27.1%	23.7%	27.6%	15.7%	25.2%

Variables:
a: pre-larviposition period (in days).
b: larviposition period (in days).
c: number of larvipositions.
d: mean periodicity of larvipositions (in days).
e: mean number of larvae per larviposition.
f: total number of larvae.
g: number of viable larvae.
h: longevity of females with access to protein source (in days).
i: longevity of females without access to protein source (in days).

S.D.: standard deviation; P.: percentual standard deviation.

days (average of 21.5 ± 7.5 days), whereas, for *P. chrysostoma,* it varied between 12 and 69 days (average of 35.2 ± 16.5 days).

Number of larvipositions – As the larviposition period of *A. ingens* was smaller, the number of larvipositions per female, consequently, was smaller, varying between 2 to 4 larvipositions (average of 3 ± 0.7) (Table II, Fig. 2), whereas in the *P. chrysostoma* it varied from 3 to 9 larvipositions (average of 5.3 ± 1.8 larvipositions) (Table I, Fig. 1).

Productivity – P. chrysostoma was able to lay up to 338 viable larvae per female and a minimum of 66 (an average of 183.8 ± 69.2 viable larvae per female from a total average of 197.3 ± 83.3). The average productivity of viable larvae per female, then, was 94.8 ± 5.3%. *A. ingens* laid only a maximum number of 116 viable larvae per female and a minimum one of 43 (an average of 78.5 ± 21.7 viable larvae per female from a total average of 87.9 ± 20.8). However, the mean productivity of viable larvae per female was relatively high: 90.1 ± 16%.

Reproductive potential – The mean number of larvae per larviposition, per female of *P. chrysostoma,* remained between 22 and 48 (Table I), with an average of 35.7 ± 6.1 larvae per larviposition, in spite of the mean number of ovarioles presented by á female was 56.4 ± 9.8 (Table IV). This shows a reproductive potential of only 63.3%. The average number of larvae per larviposition, per female of *A.*

TABLE III

Comparison among the minimum, maximum and total average values obtained for the biological parameters of *Peckia chrysostoma* (P) and *Adiscochaeta ingens* (A), under environmental conditions of laboratory

	Minimum values		Maximum values		Total average	
Variables	P	A	P	A	P	A
a	14	13	29	19	21.4 ± 4.3	15.3 ± 1.7
b	12	10	69	33	35.2 ± 16.5	21.5 ± 7.5
c	3	2	9	4	5.3 ± 1.8	3.0 ± 0.7
d	5.0	8.7	8.8	11.5	7.0 ± 1.1	10.4 ± 0.8
e	22.0	19.7	48.0	52.0	35.7 ± 6.1	30.3 ± 8.2
f	66	55	386	121	197.3 ± 83.3	87.9 ± 20.8
g	87%	42.3%	100%	100%	94.8% ± 5.3%	90.1% ± 16%
h	32	29	88	57	59.7 ± 15.6	41.3 ± 6.5
i	61	30	116	69	81.8 ± 15.4	52 ± 13.1

Variables:
a: pre-larviposition period (in days).
b: larviposition period (in days).
c: number of larvipositions.
d: mean periodicity of larvipositions (in days).
e: mean number of larvae per larviposition.
f: total number of larvae.
g: number of viable larvae.
h: longevity of females with access to protein source (in days).
i: longevity of females without access to protein source (in days).

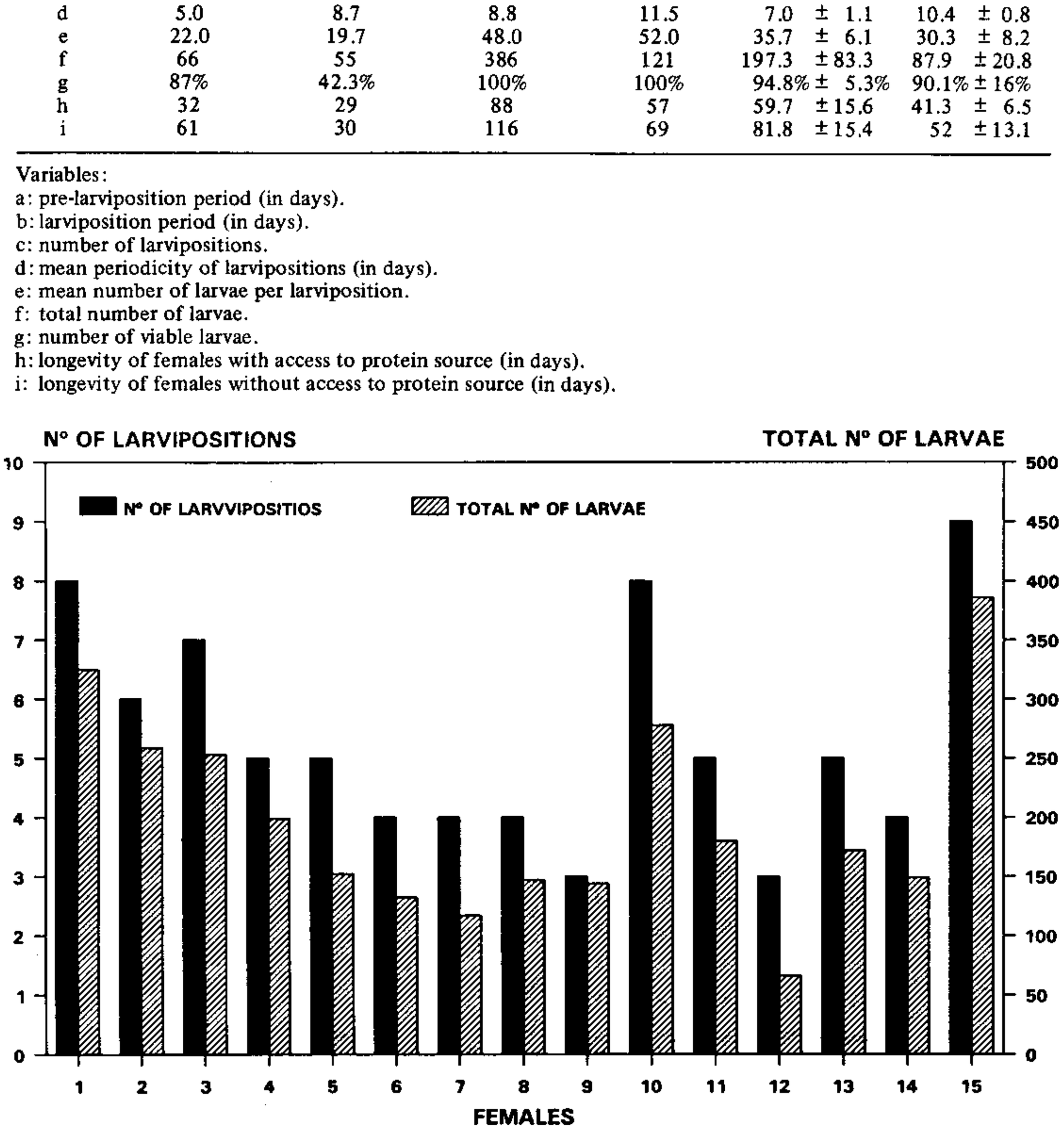

Fig. 1: individual productivity of females of *Peckia chrysostoma* reared isolately and maintained under environmental conditions of laboratory.

ingens, remained between 19.7 and 52, with an average of 30.3 ± 8.2 larvae per larviposition. The mean number of ovarioles per female was 54.6 ± 5.2, which leads to an even smaller reproductive potential: 55.5%. For both species, one of the ovaries of the same indi-

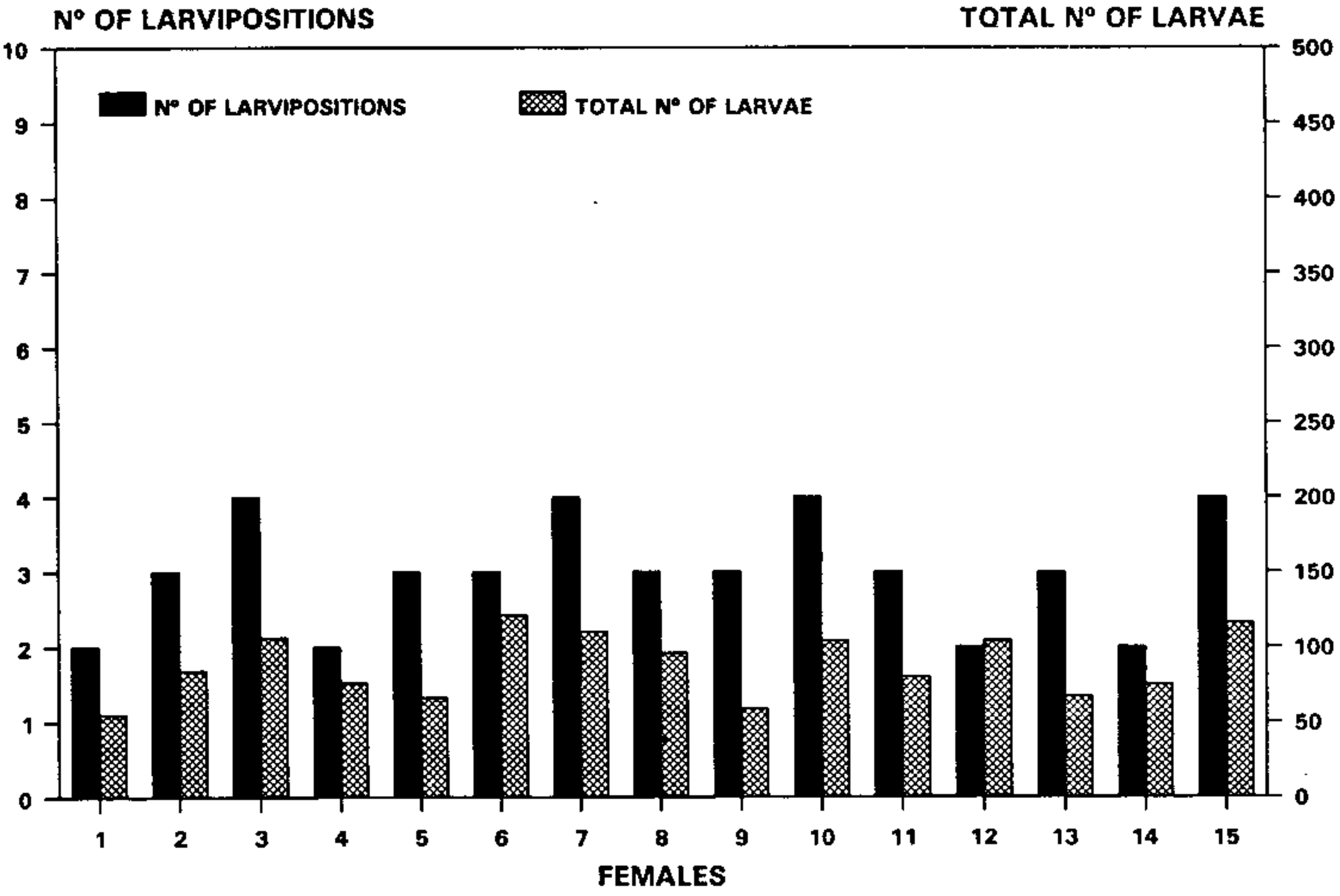

Fig. 2: individual productivity of females of *Adiscochaeta ingens* reared isolately and maintained under environmental conditions of laboratory.

vidual had frequently 1 and, occasionaly, 2 or 3 ovarioles more than the other member of the pair.

Periodicity – The mean periodicity between the larvipositions was 7.0 ± 1.1 days for *P. chrysostoma* (varying between 5 to 8.8 days) and 10.4 ± 0.8 days for *A. ingens* (varying between 8.7 to 11.5 days). Therefore we conclude that the maturation time of the various gonotrophic cycles of *P. chrysostoma* is smaller. Kuramochi & Nishijima (1984) observed that *Haematobia irritans,* however, needs only an average of 5.4 days for the sucessive maturation of gonotrophic cycles.

DISCUSSION

The females of many diptera are anautogenics, i. e., need a proteic food to develop their ovarian folicles. The occurence of autogeny may vary considerably with the species, strain, larval rearing and adult condition. Chadha & Denlinger (1976) studied its occurence in the tropical flesh flies. Pappas & Fraenkel (1977) observed that in *Phormia regina,* for instance, feeded only with sugar, produced no yolk deposition. In *Neobellieria bullata* the same diet led to the beginning of yolk deposition (incipient autogeny). For the two species here studied, we comproved the anautogeny or, at least, the necessity of stimuli or a convenient local for the larviposition, since no female with isolated proteic source laid larvae. Zvereva (1984) observed the important role of taste stimuli for triggering the behaviourial act of egg laying in *Musca domestica.* In case of their absence, the eggs remain in the ovary and are reabsorbed. According to Chapman (1982), the lack of convenient locals to eggs laying or larviposition leads to oosorption of terminal oocytes. Taking into account the various factors that can lead to an inibition of the egg laying or larviposition, we cannot conclude that the protein reserves laid down in the larval state could not be mobilized for egg formation in *P. chrysostoma* and *A. ingens.*

Mello & Garcia (1988) observed, in *Stomoxys calcitrans,* that only 10 among 27 (37%) of the analyzed females laid eggs. The fact that 100% of the *P. chrysostoma* and *A. ingens* females have laid larvae shows a high level of fertility and adaptability of the species to the laboratory conditions.

TABLE IV

Comparison between the number of ovarioles, per female, and the reproductive potential of *Peckia chrysostoma* and *Adiscochaeta ingens*, under environmental conditions of laboratory

	P. chrysostoma	*A. ingens*
Females	Ovarioles	Ovarioles
1	24/25	27/28
2	29/29	27/27
3	38/40	27/28
4	17/18	23/23
5	33/34	28/29
6	32/33	26/28
7	22/22	24/24
8	23/24	27/27
9	27/29	29/32
10	31/30	26/28
11	18/20	31/32
12	29/31	27/28
13	28/29	26/27
14	28/28	27/27
15	24/25	31/31
16	22/24	29/30
17	29/29	24/24
18	26/26	25/26
19	30/30	31/31
20	29/30	29/30
21	35/37	26/27
22	30/31	29/32
23	32/33	22/23
24	30/31	24/24
25	26/28	26/28
Average per ovary	28.2 ± 4.9	27.3 ± 2.6
Average per female	56.4 ± 9.8	54.6 ± 5.2
Larvae no. per larviposition	35.7 ± 6.1	30.3 ± 8.2
Reproductive potential	63.3%	55.5%

In 1940, Fraenkel had already observed that many species of flies can be maintained alives and healthy with a diet consisting only of sugar and water. In this way they were able to live their maximum period of timelife. The addition of protein in the diet was essential only for the eggs development and it did not occur an increase in the longevity, existing even evidence that this could have an opposite effect, a fact which was verified for the two species studied herein.

It is a known fact that the muscoid Diptera usually have a relatively short gonotrophic cycle. This occurs because these flies have a polytrophic-type ovary. Our results, however, diverged a lot from those for other studied species where the initial groups of eggs became mature with less than 300 h. For *C. megacephala*, for example, the maximum time was 240 h and the minimum was 132 h (Linhares, 1988). Trepte (1979) observed, for *M. domestica*, 145 h. In *Haematobia irritans* the first larviposition occurs 3 or 4 days after the birth (Krafsur & Ernst, 1983). *Dermatobia hominis* develop their gonads during the pupal period: the ovaries become formed around the eighth day of pupa; the vitellogenesis begins around the 25th day of pupa and becomes completed in the birth of the adult (Lello et al., 1985). For *Stomoxys calcitrans*, Glaser (1923) observed that the mean period of pre-larviposition was 10 days. The results most similar to ours was obtained for *S. calcitrans* by Mello & Garcia (1988) who observed a pre-oviposition average period of 16 days, whereas the mean oviposition period was only of 10.2 days.

As far as it is known in the ovoviparous species, the maturation divisions of the oocyte are completed in the vitellarium and the embryologic development occurs while the oocyte is still in the uterus. The chorions of the eggs break during the larviposition and the females lay directly the first stage larvae, instead of eggs. Besides that, as the larvae of the same gonotrophic cycle are not all laid simultaneously, each larviposition herein refers to all the larvae laid in each mature gonotrophic cycle, this because for the same cycle it can happen from 1 to 3 larvipositions.

The number of ovipositions/larvipositions varies a lot according to the species. Smith (1968), for example, observed 4 or more ovipositions for the *M. domestica*. Mello & Garcia (1988) observed from 1 to 7 ovipositions per female of *S. calcitrans*.

It is known that the number of functional ovarioles existent in the ovaries of Diptera varies widely according to the species, type of food and environmental conditions. According to Lopes (1941) and Vogt (1987), ovarian development rates and female fecundity are dependent on fly size. We observed, in both studied species, that the number of ovarioles

can be reduced up to 46% in females of small size originated from larvae with deficient nourishment.

The results obtained through comparison between the mean number of larvae per larviposition and the mean number of ovarioles presented by the females seem to agree with observations done by some authors, in spite of the absence of quantitative information about the reproductive potential. Vogt et al. (1985), for instance, observed that *Lucilia cuprina* females rarely mature all their eggs, i. e., most females reabsorb some of them in the ovary. Bell & Bohm (1975) also observed that oosorption occurs, at a low frequency, in seemingly normal females. According to Browne et al. (1981), however, *L. cuprina* females matured virtually all their primary oocytes.

Comparing, in both species, the respective averages of periodicity among the larvipositions and the averages of the periods of prelarviposition, we conclude that gravid females have secondary follicles which are well developed in the vitellogenesis, a fact already observed by Krafsur & Ernst (1983).

Within the applied parameters, the values obtained for *P. chrysostoma* demonstrate its superior productivity in comparison with *A. ingens* (Table III). This confirms our previous observations during the period of adaptation of the native colonies. Unlike the *P. chrysostoma* case, we must, however, take into account the grade of genetic interference that the *A. ingens* rearings must have had for being isolated from crossings with native populations.

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