

THE LIFE CYCLE OF *METACUTEREBRA APICALIS* (DIPTERA: CUTEREBRIDAE)

ANTONIO CESAR RIOS LEITE* & PAUL WILLIAMS

Departamento de Parasitologia, Instituto de Ciências Biológicas da Universidade Federal de Minas Gerais, Caixa Postal 2486, 31270 Belo Horizonte, Minas Gerais, Brasil

The development of Metacuterebra apicalis in laboratory conditions is described. The natural host, Oryzomys subflavus, and laboratory white rats were used as experimental hosts. The life cycle, from oviposition to the deaths of adults, was completed in about 73 days. The incubation period of eggs was about 10 days; the parasitic larval phase lasted 23 days in the natural host and 26 days in white rats; pupa lived for 32 days and adults survived for six days.

Key words: Diptera – Cuterebridae – *Metacuterebra apicalis* – life cycle

The family Cuterebridae (Diptera: Cyclorapha) occurs only in the New World. The larval stages are cutaneous parasites causing myiasis in various mammals, including man. Catts (1982) recognized 83 species in the family and recorded that, by that date, the complete life cycles of 11 species of *Cuterebra* (a strictly Nearctic genus) had been described. The same author recorded that 55 species of the family occur in the Neotropical Region but the complete life cycle of only one, *Dermatobia hominis*, has been described (Neiva & Gomes, 1917). Herein, an account is given of the life cycle of *Metacuterebra apicalis*. The observations are based on the results of experiments in which infections were established in laboratory white rats (albino *Rattus norvegicus*) and in laboratory-reared *Oryzomys subflavus*, one of the natural rodent hosts of larval *M. apicalis*.

MATERIAL AND METHODS

O. subflavus (Rodentia: Cricetidae) were captured in woodland situated in the campus of the Federal University of Minas Gerais, Belo Horizonte – MG (19°55'S; 43°56'W; alt: 852 m). Additional specimens were collected by Valle et al. (1984) in the municipality of Prudente de Moraes – MG (19°28'S,

44°15'W, 732 m). The rats were captured in wire traps measuring 30 x 15 x 15 cm, each baited with a piece of a dried ear of maize, 5 cm long.

All captured rats, including those without visible bots, were brought to the laboratory and housed individually in 30 x 20 x 15 cm wooden cages fitted with wire mesh bases. Each cage was placed over a plastic tray. Mature larvae emerging from the host fell through the mesh and were collected from the tray.

Mature larvae were weighed and transferred, individually, to a glass cup containing moist sawdust. The open end of the cup was covered with nylon mesh. The cups were maintained in an incubator at 25 °C with a relative humidity of 80-90% until the pupae formed and adults emerged.

Twenty-four hours after eclosion of adults, attempts were made to mate them. As recommended by Smith (1973), all mating attempts were made in small glass tubes (Fig. 1) at a temperature of 24-25 °C and a relative humidity of 70%. Because studies on three different species of *Cuterebra* had shown that cooling enhanced copulation in laboratory conditions (Catts, 1964; Baird, 1971; Smith, 1973, 1977), some recently emerged *M. apicalis* were held at 8 °C before attempting to mate them.

Mated females were placed individually in Petri dishes with a basal lining of filter paper. Eggs were deposited on the surface of the filter paper and, after oviposition, the Petri dishes were placed in an incubator at 24-25 °C with a

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relative humidity of 80-90%. Eclosion was stimulated by gently breathing over mature eggs. Newly hatched larvae were collected with a fine paint brush and used to infect laboratory reared *O. subflavus* and white rats.

Six *O. subflavus* were each exposed to infection by introducing two first stage larvae into the nose. Each of 50 white rats were exposed to infection by placing two larvae in their eyes (Hunter & Webster, 1973). After exposure to infection, the experimental animals were kept in wire covered plastic cages until a few days before the estimated time of emergence of larvae. The rats were then transferred to the wooden cages with wire mesh bases. Throughout the experiments, the rats were provided with a balanced diet and a plentiful supply of drinking water.

Emergent larvae were examined alive and weighed. Some were killed and fixed for morphological studies. Others were kept alive to determine the duration of the pupal phase and the survival of adults.

RESULTS

Copulation – Mating attempts were made between 13 females and 16 males, and nine couples actually copulated (see Table). The shortest coupling (8th mating) lasted only 16 min; the longest (1st mating) was terminated by separating the pair after 5 hr, 20 min.

Before mating, both sexes attempted to fly and buzzed their wings within the confined space provided. In successful matings, the male genitalia expanded before he attempted to cover the female. When the legs of the male were on top of the female, alternative expansions and contractions of the female external genitalia occurred. After several unsuccessful attempts to do so, males coupled only after the females partially arched their wings. After initial congress, both partners remained at rest (Figs 2-4) but the female sometimes walked slowly.

Oviposition – One female laid 41 eggs before mating*. Four mated females died without producing eggs. One died immediately after separation from the male; the other three died 24-72 hours after copulation. One female (7th mating) began laying eggs immediately after copulation whereas another only began producing eggs 48 hr after (1st mating).

When laying eggs, a female walked slowly, depositing the eggs at more or less regular intervals in rows on the surface of the filter paper (Figs 5, 6).

Eclosion of eggs and viability – First stage larvae emerged from eggs 7-10 days after oviposition. Hatching began when a larva raised the anterior part of the operculum and the pseudocephalon appeared. Almost immediately afterwards, the larva left the egg case.

Viability of eggs seemed to be related to the duration of copulation and the interval between mating and egg laying. In the 7th mating, the pair was *in copula* for 1 hr 30 min, the female began laying eggs immediately after mating, and produced 2,507 eggs with only 0.59% hatching. In contrast, the pair of the 1st mating were coupled for 5 hr 20 min (and had to be separated), the female produced 2,921 eggs and almost 90% hatched.

Parasitic phase – Seven third stage larvae fell from experimentally infected *O. subflavus* 21-26 days after the animals had been exposed to infection. In 28 successful infections of albino rats (Figs 7-10), mature larvae fell from the hosts 22-31 days after exposure. The mean period of parasitic life of *M. apicalis* in experimentally infected *O. subflavus*, on the basis of statistical analyses, is shorter than that in white rats.

Third stage larvae (Fig. 10) – Fourteen larvae, eventually emerging as males, weighed 1.10-1.94 g ($\bar{x} = 1.32 \pm 0.26$ g) when they fell from their hosts. Another 14 specimens, which later developed into females, weighed 1.05-2.08 g ($\bar{x} = 1.49 \pm 0.28$ g). The weight differences are not statistically significant. After falling from the host, third stage larvae transformed into pupae within 24 hr.

* Pre-mating oviposition in *M. apicalis* has been previously recorded by Lutz (1917) and Mello (1978) and has been observed in four species of *Cuterebra* (Beamer et al., 1943; Dalmat, 1943; Catts, 1967; Baird, 1972).

TABLE

Relation between insects that copulated, their original host, duration of copula, beginning of oviposition, total number of eggs laid, and percentage of first instar larvae emerging

Mating	Sex of insect	Host	Duration of mating	Interval between copulation and beginning of oviposition	Total number of eggs	Percentage of first instar larvae emerging
1st	♀	<i>Rattus norvegicus</i>	5hr20min*	48hr	2921	89.42
	♂	<i>R. norvegicus</i>				
2nd	♀	<i>Oryzomys subflavus</i>	1hr23min	1hr35min	254	—
	♂	<i>R. norvegicus</i>				
3rd	♀	<i>R. norvegicus</i>	1hr22min**	22hr	947	43.57
	♂	<i>R. norvegicus</i>				
4th	♀	<i>R. norvegicus</i>	45min	***	—	—
	♂	<i>R. norvegicus</i>				
5th	♀	<i>R. norvegicus</i>	5hr10min	***	—	—
	♂	<i>R. norvegicus</i>				
6th	♀	<i>O. subflavus</i>	4hr5min	+	—	—
	♂	<i>O. subflavus</i>				
7th	♀	<i>O. subflavus</i>	1hr30min*	immediate	2507	0.59
	♂	<i>O. subflavus</i>				
8th	♀	<i>O. subflavus</i> (Exp.)	16min	?	112	7.14
	♂	<i>O. subflavus</i> (Exp.)				
9th	♀	<i>O. subflavus</i>	1hr55min	**	—	—
	♂	<i>O. subflavus</i>				

* — Couples separated at this time. ** — Copulation interrupted for 10 min during the first hr. *** — Female died 24 hr after mating. + — Female died 72 hr after mating.
 ** — Female died immediately after copulation.

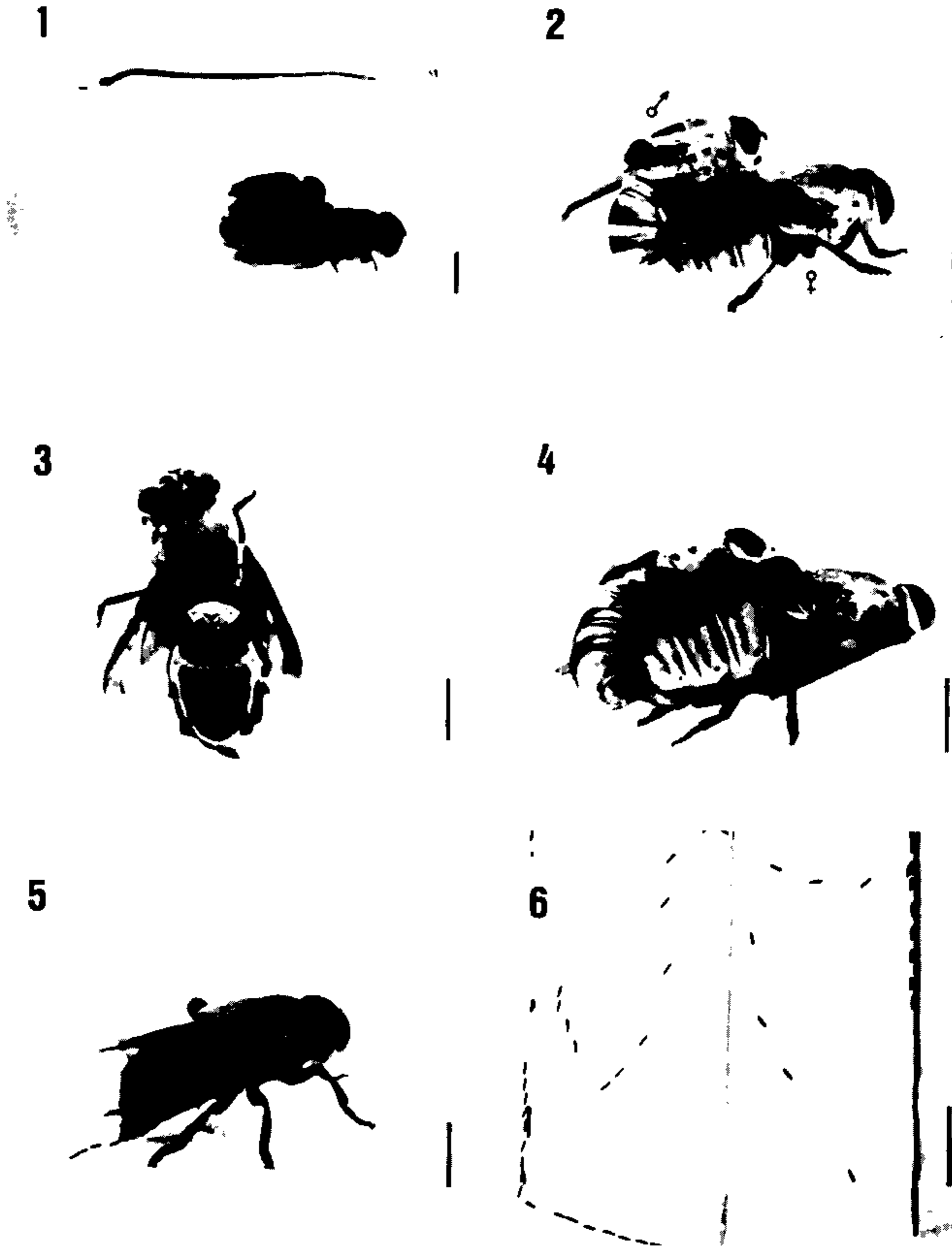


Fig. 1: mating of *Metacuterebra apicalis* in glass bottle. Fig. 2: idem, lateral view. Fig. 3: idem, dorsal view. Fig. 4: idem, latero-ventral view. Fig. 5: female laying eggs. Fig. 6: eggs laid on filter paper. Bars = 5 mm.

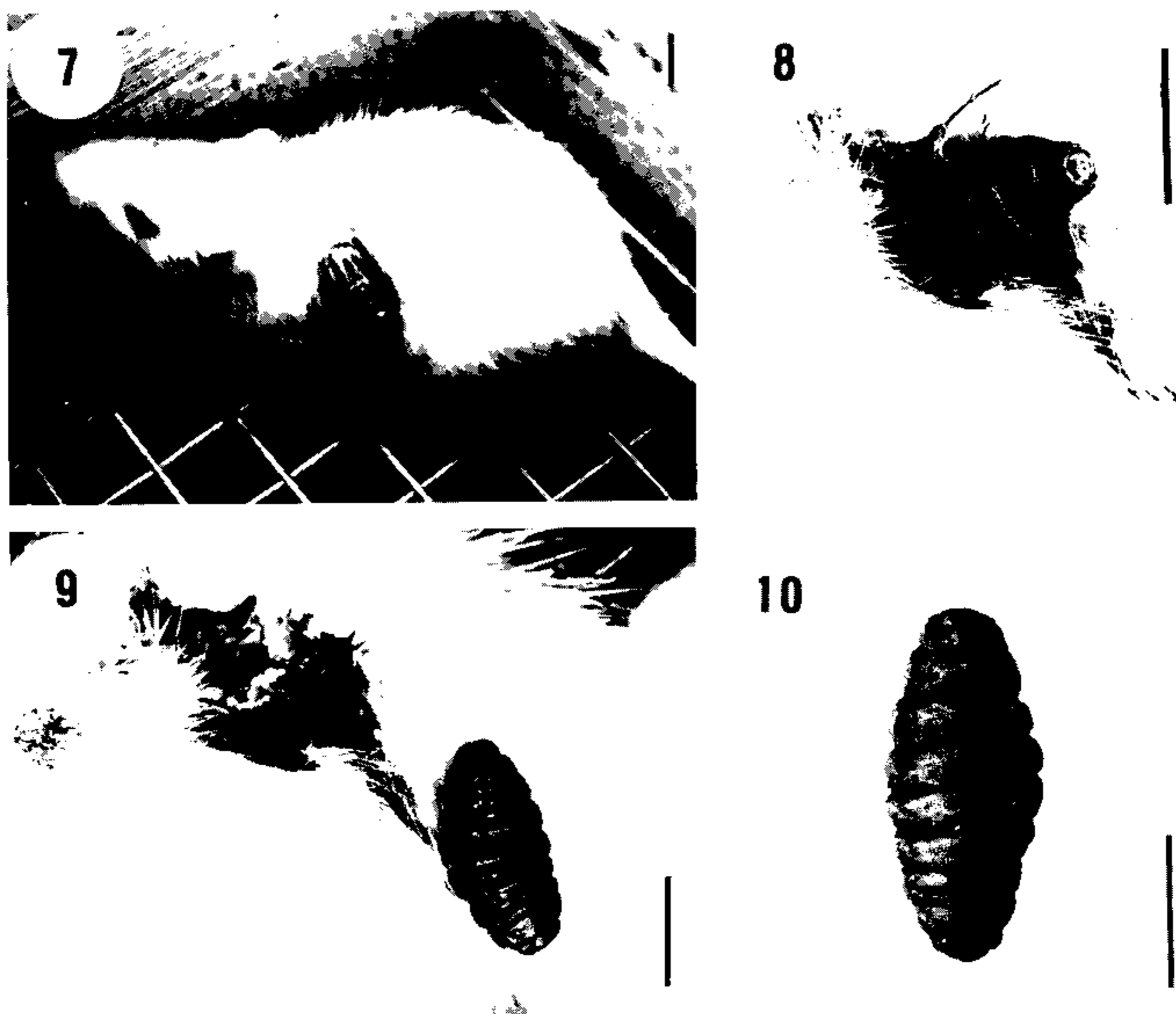


Fig. 7 to 9: third instar larva of *Metacuterebra apicalis* emerging from *Rattus norvegicus*. Fig. 10: third instar larva just emerged. Bars = 12 mm.

Pupal and adult phases — The pupal period of 14 specimens that eventually emerged as males was 29-33 ($\bar{x} = 31.22 \pm 1.39$) days whereas that of another 14 emerging as females was 31-34 ($\bar{x} = 32.40 \pm 0.77$) days. The difference in the pupal period of the two sexes is not statistically significant.

Adults emerged in a ratio (males:females) of 1:1.67. Males lived for 3-8 ($\bar{x} = 5.88 \pm 1.61$) days and females for 3-9 ($\bar{x} = 5.69 \pm 1.55$) days. The survival times of the two sexes do not differ statistically.

DISCUSSION

The method used to induce mating, previously used with success in studies on *C. approximata* (Smith, 1977) and *C. lepusculi* (Baird, 1983), cannot be considered as entirely satisfactory for *M. apicalis*. One female died immediately after copulation; three others failed to produce eggs; yet another, which

started laying immediately after copulation, produced a large number of non-viable eggs; and no eggs hatched from one batch. Further studies are needed to find better conditions for successful mating of *M. apicalis*.

The outcome of the first and third matings, however, show that *M. apicalis* can be successfully mated in the laboratory. The number of eggs by both females was much higher than the 595 recorded by D'Andretta & Jardim (1954) and considerably greater than the 188 eggs that Fonseca (1940) reported for *M. bauri*. According to Catts (1982), species of *Cuterebra* whose larvae are parasitic in rodents produce 1,000-3,000 eggs/female. If the results of the two successful laboratory matings reflect what happens in nature, the reproduction rate of *M. apicalis* is within the same range.

The egg incubation period in *M. apicalis* was similar to that recorded in *M. bauri* by Fonseca (1940) and to those of eight species of *Cutere-*

bra maintained at 20 °C or 20-22 °C (Scholten, 1964; Catts, 1964, 1967; Capelle, 1970; Baird, 1972, 1975; Jacobson et al., 1978). Eggs hatched in a way similar to that observed in *C. latifrons* (Catts, 1967) and *C. polita* (Graham & Capelle, 1970), and hatching rates of 90% and 44% are comparable with results obtained by Radovski & Catts (1960) and Catts (1967) in studies on *C. latifrons*.

The duration of parasitic life in experimentally infected *O. subflavus* was similar to that of four species of *Cuterebra* in their respective natural hosts (Sillman & Smith, 1959; Catts, 1964, 1967; Capelle, 1970; Gingrich & Barrett, 1974; Smith, 1977) and shorter than that of two other species of *Cuterebra* in natural hosts (Parker & Wells, 1919; Baird, 1975). The rate of larval development of *M. apicalis* in white rats was only slightly slower than that in a natural host (*O. subflavus*), a result paralleling what occurs when certain species of *Cuterebra* are reared in laboratory hosts (Gregson, 1950; Penner & Pocius, 1956; Catts, 1964).

Third stage larvae of *M. apicalis* pupated within 24 hr of falling from the host. The same occurs in four species of *Cuterebra* (Bennett, 1955; Catts, 1967; Baird, 1975, 1983). When they fell from the host, larvae that later became females had the same weight as those that developed into males and there was no difference in the duration of larval or pupal lives of those transforming into different sexes. This agrees with observations made on species of *Cuterebra*, though third stage larvae of prospective males of *C. approximata* are heavier than prospective females when the larvae do not diapause (Smith, 1977).

The length of pupal life was similar to that recorded for *M. apicalis* by Forattini & Lenko (1959) and Mello (1978). Much longer pupal periods have, however, been recorded in *M. apicalis*: 80 days (Lutz, 1917), 113-135 days (Fonseca, 1938/1939), 5-6 months (Henriksen (1942). These differences can be accounted for by differences in the conditions in which observations were made. Thus, the studies of Fonseca (1938/39) and Henriksen (1942) were undertaken in the cool, dry season, and those of Forattini & Lenko (1959) in the warm, wet season. The observations of Mello (1978), like those reported herein, were carried out under controlled conditions of temperature and humidity. Comparing the similar and dissimilar

results, it seems likely that *M. apicalis*, in natural conditions, undergoes pupal diapause when the weather is cool.

The adult emergence rate was higher than that recorded for *M. apicalis* by Mello (1978). The disparate sex ratio recorded in the present study agrees with observations on *D. hominis* (Moya Borja, 1966), *C. horripilum* (Haas & Dicke, 1958) and *C. buccata* (Jacobson et al., 1978). Brevity of adult life is a feature of Cuterebrids (Catts, 1982) but adult *M. apicalis* are known to survive as long as 14 or 15 days (Mello, 1978; Fonseca, 1938/1939).

The present studies were not undertaken academically but as an attempt to develop a laboratory model for studies on various aspects of myiasis, which constitute public health and veterinary/economical problems in Brazil. From the foregoing discussion, it is clear that the life cycle of *M. apicalis* is comparable with species of *Cuterebra*. Development of a *M. apicalis* laboratory model would therefore be directly comparable with similar studies in North America. Because a natural host (*O. subflavus*) for the larvae of *M. apicalis* can be reared and maintained in the laboratory without undue difficulty, and because larvae undergo complete and only slightly delayed development in white rats, the observations recorded herein show that a simple and relatively inexpensive laboratory model for experimental myiasis is feasible in Brazil.

RESUMO

Ciclo biológico de *Metacuterebra apicalis* (Diptera: Cuterebridae) – Em condições experimentais de laboratório, foi desenvolvido o ciclo biológico de *Metacuterebra apicalis*. Serviram como hospedeiros Rodentia *Oryzomys subflavus* e *Rattus norvegicus*. O ciclo foi desenvolvido em cerca de 73 dias, sendo os períodos aproximados de 10 dias para embrionia dos ovos, de 23 e 26 dias, respectivamente, para o parasitismo em *O. subflavus* e *R. norvegicus*, de 32 dias para pupa, e de seis dias para sobrevivência dos insetos adultos.

Palavras-chave: Diptera – Cuterebridae – *Metacuterebra apicalis* – ciclo biológico

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