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The classic episode of biological invasion: *Cochliomyia macellaria* (Fabricius, 1775) versus *Chrysomya megacephala* (Fabricius, 1794) (Diptera: Calliphoridae) – evaluation of the biotic potential

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ABSTRACT

The classic episode of biological invasion: *Cochliomyia macellaria* (Fabricius, 1775) versus *Chrysomya megacephala* (Fabricius, 1794) (Diptera: Calliphoridae) – evaluation of the biotic potential. The biotic of the native fly *Cochliomyia macellaria* and the exotic *Chrysomya megacephala* was compared, through the reproductive capacity and longevity. The experiment took place in a climatized chamber, with four repetitions of 15 grouped couples of each species. The posture, egg mass weight, and death of individuals were observed daily. *C. macellaria* showed an average of longevity of 27.72 days while in *C. megacephala* the average was 41.96 days. The egg mass weight average per repetition was 0.58 g and 1.22 g, respectively. These results give a better understanding about the population dynamics of these species in nature.

Key words: breed capacity, longevity, competition, caliphorids.

INTRODUCTION

Introduced species may cause negatively impact on native species in different ways, as predation, competition, biological pollution, introduction of new parasites or pathogens, among others. Alien species are recognized by the Convention on Biological Diversity as the second most important cause of global biodiversity loss, behind the habitat destruction (Jenkins 1999).

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Cochliomyia macellaria (Fabricius, 1775) is a native species, which distribution ranges from Nearctic to Neotropical regions. Its maggots are necrophagous and the adults, feed on carcasses, decaying material and also on nectar flowers (Cunha-e-Silva and Milward-de-Azevedo 1994).

Chrysomya megacephala (Fabricius, 1794) is native from New Guinea. During its invasion process it received different names based on its trophic niche, as dry-salt-fish-pest in East Asia, because of its capacity of breeding on dry salt fish (Esser 1990); “latrine-flies” due to its frequency in areas with humans feces; Indian Bazaar Bluebottle (Prins 1979), for its frequency in street popular markets and “Debulliaes” and “Iaesidebull”, palauans names that means graveyard-flies (Olsen and Sidebotton 1990). Introduced in the New World during the past 40 years (Wells 1991). *C. megacephala* was collected for the first time in Brazil in 1975, originated probably from southern Africa, later becoming established in North America (Baumgartner and Greenberg 1984).

After the introduction of the exotic *C. megacephala* in Brazil, *C. macellaria*, usually very common in urban and rural areas, has become rare in these environments (Baumgartner and Greenberg 1885, Guimarães et al. 1978, 1979, Marinho et al. 2003, 2006). Several studies suggested that the decline was due to the competition during the larval stages (Aguiar-Coelho and Milward-de-Azevedo 1996, Faria et al. 1999, Andrade et al. 2002). Although there are no studies comparing the biotic potential of these species, this understanding could bring more information about the competitive advantages of this exotic species.

Chrysomya Robineau-Desvoidy, 1830, species are very important from epidemiological aspect, being recognized as a great pathogen carrier (Greenberg 1988, Lawson and Gemmel 1990), what could be explained by its high synanthropy level, favoring human contamination (Ferreira 1978, 1979, 1983, Linhares 1981).

The objective of this study was to compare the biotic potential of *C. macellaria* with *C. megacephala*, under controlled conditions, to better understand the impact of this invasive species on the native populations of *C. macellaria*.

MATERIALS AND METHODS

Specimens of *C. macellaria* and *C. megacephala* were collected respectively in a rural area of Paracambi and in an urban area, both Rio de Janeiro (RJ, Brazil). A Van Someren-Rydon trap using as bait sardine with 48 hours decomposition (30ºC), was used to collect the material. In the Laboratório de Estudos de Dípteros of Universidade Federal do Estado do Rio de Janeiro (UNIRIO) the species were identified using the taxonomic key of Mello (2003). The colonies of *C. megacephala* and *C. macellaria* were maintained, as described in Barbosa et al. 2004, 2008.

The experiment was conducted in climate controlled chamber (Quim) set at 30ºC during the day and 28ºC during the night, 60 ± 10% relative humidity and 14 hours of light and 10 hours of dark. The light phase was initiated at 6:00 am. After the emergence of the adults, 60 couples of each species were selected and equally distributed in four cages, allowing the observation in four repetitions.

A solution of water and honey (1:1), water, and bovine meat were offered to adults daily. Meat cut into small cubes of approximately $2cm^3$ was used as substrate of egg posture for females.

The colonies were examined twice a day, in the morning, at 09:00, when the mortality of the adults was observed, and in the afternoon, at 16:00, when the postures of eggs were weighed in semi-analytical balance Gehaka BG200.

The laying period, oviposition peak and adults longevity were analyzed. The program GraphPad Instat version 2 was used, as well as the t-test, to evaluate the statistical significance of the results, considering the level of significance less than or equal to 5%.

RESULTS

The average mass of eggs for *C. macellaria* and *C. megacephala* produced per cage was respectivelly 0.58 g and 1.22 g. The average production per female/day was 0.0014 g and 0.0026 g, respectively (Table I). Extremely significant difference was observed ($P< 0.0002$).

The beginning of the oviposition occurred in the sixth day after emergence for both species. The

TABLE I
Comparison of egg mass weight of *Cochliomyia macellaria* and *Chrysomya megacephala*.

	Average/day/female*		Average/cage	
	C. macellaria	*C. megacephala*	*C. macellaria*	*C. megacephala*
Mean	0.001349[a] g	0.002605[b] g	0.5778 g	1.2208 g
SD	0.00042 g	0.00021 g	0.1697 g	0.5192 g

*Averages followed by the same letter do not differ significantly by the T test (5%).

TABLE II
Longevity of *Cochliomyia macellaria* and *Chrysomya megacephala*.

Treatments		Averages* (Day)	SD
C. macellaria	Total	27.72[a]	± 14.17
C. macellaria	Male	26.77[a]	± 14.38
C. macellaria	Female	28.67[a]	± 14.01
C. megacephala	Total	41.96[b]	± 15.61
C. megacephala	Male	45.17[c]	± 18.59
C. megacephala	Female	38.75[d]	± 11.18

*Averages followed by the same letter do not differ significantly by the T test (5%).

oviposition peak happened on the 15th day for the native species and in the 10th day for the exotic one. The native females made intermittent ovipositions until the 60th day after the emergence and the exotic until the 59th day (Figure 1a, b).

The minimum and maximum longevities observed in *C. macellaria* and *C. megacephala* were respectively 3 and 62 days and 8 and 90 days (Table II). *C. macellaria* lived, in average, 27.72 days, while *C. megacephala* lived 41.96 days. The difference found between treatments was extremely significant (P< 0.0001).

The longevity curve among males and females was similar for *C. macellaria*, while for *C. megacephala*, the male's longevity curve did not end so abruptly as in female (Figure 2a, b).

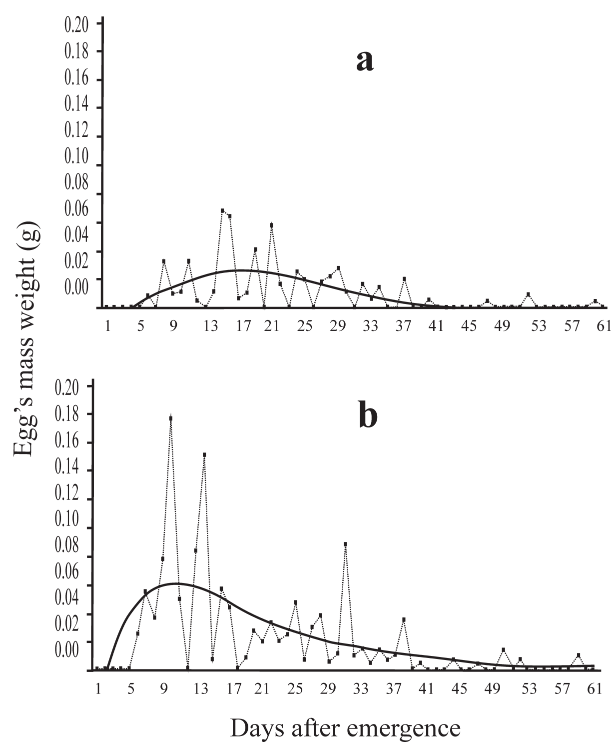

Figure 1 - a: Oviposition rhythm of *Cochliomyia macellaria*. **b:** Oviposition rhythm of *Chrysomya megacephala.*

DISCUSSION

The results of the present analysis exhibited that the exotic fly competitive advantages goes beyond

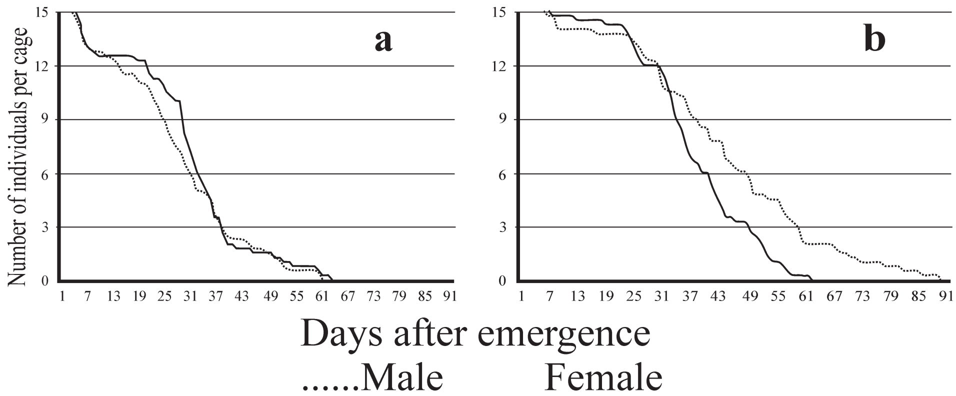

Figure 2 - a: Longevity curve of males and females of *Cochliomyia macellaria*. **b:** Longevity curve of males and females of *Chrysomya megacephala*.

the immature stage, corroborating with studies like Cunha-e-Silva and Milward-de-Azevedo (1996) and Barbosa et al. (2004) that analyzed which species independently using different methodologies.

Adults average life span of the exotic species is 34% bigger and the egg production is almost 100% bigger than the native species. Von Zuben et al. (1996) suggested that how bigger is life span, bigger the number of cicles and postures. Our results showed that the number of postures was about 29% bigger in the exotic species, although the period of time was the same in both species. Considering the egg size of both species *C. macellaria*: 1.31mm (Mendonça et al. 2014) and *C. megacephala*: 1.29mm (Sanit et al. 2013), we conclude that the egg mass production of the exotic flies was almost twice the native one. This fact could be explained by reproductive stress phenomena, where copulated females live less than virgins ones. Reproductive strees is observed in other species of *Chrysomya*, as *C. albiceps* (Wiedemann) in Queiroz and Milward-de-Azevedo 1991 and *C. megacephala* in Barbosa et al. (2004), but in *C. macellaria* the life span was similar between male and female (Figure 2a, b).

A longer life span increase the probability of finding new substrates to breading and posturing, that are ephemeral and discrete (So and Dudgeon 1989). This suggests in a higher capacity of dispersion and colonization (Roff 1977) and offspring survival (Ives 1991).

Reis et al. (1999) studying the competition between *Chrysomya putoria* (Wiedemann) and *C. macellaria* in immature stage, suggested that extinction hypothesis has low probability. Although it is important to take in consideration that it is not the only one species that impact *C. macellaria* (Aguiar-Coelho and Milward-de-Azevedo 1996, Andrade et al. 2002), and that competitive advantage goes beyond the immature stage at least to *C. megacephala*.

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REFERENCES

AGUIAR-COELHO VM AND MILWARD-DE-AZEVEDO EMV. 1996. Associação entre larvas de *Cochliomyia macellaria* (Fabricius) e *Chrysomya albiceps*

(Wiedemann), *Chrysomya megacephala* (Fabricius) e *Cochliomyia macellaria* (Fabricius) (Calliphoridae, Diptera) sob condições de laboratório. Rev Bras Entomol 41: 35-40.

ANDRADE JB, ROCHA FA, ROSA PRGS, FARIA LB, VON ZUBEN CJ, ROSSI MN AND GODOY WAC. 2002. Larval Dispersal and Predation in Experimental Populations of *Chrysomya albiceps* and *Cochliomyia macellaria* (Diptera: Calliphoridae). Mem Inst Oswaldo Cruz 97: 1137-1140.

BARBOSA LS, COURI MS AND AGUIAR-COELHO VM. 2008. Desenvolvimento de *Nasonia vitripennis* (Walker, 1836) (Hymenoptera: Pteromalidae) em pupas de *Cochliomyia macellaria* (Fabricius, 1775) (Diptera: Calliphoridae), utilizando diferentes densidades do parasitóide. Biota Neotrop 8: 49-54.

BARBOSA LS, JESUS DML AND AGUIAR-COELHO VM. 2004. Longevidade e capacidade reprodutiva de casais agrupados de *Chrysomya megacephala* (Fabricius, 1794) (Diptera: Calliphoridae) oriundos de larvas criadas em dieta natural e oligídica. Rev Bras Zoociênc 6: 207-217.

BAUMGARTNER DL AND GREENBERG B. 1985. Distribution and medical ecology of the blow flies (Diptera: Calliphoridae) of Peru. Ann Entomol Soc Am 78: 565-587.

CUNHA-E-SILVA SL AND MILWARD-DE-AZEVEDO EMV. 1994. Estudo comparado do desenvolvimento pós-embrionário de *Cochliomyia macellaria* (Fabricius) (Diptera, Calliphoridae) em duas dietas à base de carne, em laboratório. Rev Bras Zool 11: 659-668.

CUNHA-E-SILVA SL AND MILWARD-DE-AZEVEDO EMV. 1996. Aspectos da biologia da reprodução e longevidade de *Cochliomyia macellaria* (Fabricius) (Diptera, Calliphoridae) em condições experimentais. Rev Bras Zool 13: 883-889.

ESSER JR. 1990. Factors influencing oviposition, larval growth and mortality in *Chrysomya megacephala* (Diptera: Calliphoridae), a pest of salted dried fish in south-east Asia. Bull Entomol Res 80: 369-376.

FARIA LDB, ORSI L, TRINCA LA AND GODOY WAC. 1999. Larval predation by C*hrysomya albiceps* on *Cochliomyia macellaria*, *Chrysomya megacephala* and *Chrysomya putoria*. Entomol Exp Appl 90: 149-155.

FERREIRA MGM. 1978. Sinantropia de dípteros muscóideos de Curitiba, Paraná, I. Calliphoridae. Rev Bras Biol 38: 445-454.

FERREIRA MGM. 1979. Sinantropia de dípteros muscóideos de Curitiba, Paraná, II. Sarcophagidae. Rev Bras Biol 39: 773-781.

FERREIRA MGM. 1983. Sinantropia de Calliphoridae (Diptera) em Goiânia, Goiás. Rev Bras Biol 43:199-210.

GREENBERG B. 1988. *Chrysomya megacephala* (F.) (Diptera: Calliphoridae) collected in North America and notes on *Chrysomya* species present in the New World. J Med Entomol 25:199-200.

GUIMARÃES JH, PRADO AP AND BURALLI GM. 1979. Dispersal and distribution of three newly introduced species of *Chrysomya* Robineau-Desvoidy in Brazil (Diptera, Calliphoridae). Rev Bras Entomol 23: 245-255.

GUIMARÃES JH, PRADO AP AND LINHARES AX. 1978. Three newly introduced blowfly species in southern Brazil (Diptera, Calliphoridae). Rev Bras Entomol 22: 53-60.

IVES AR. 1991. Aggregation and coexistence in a carrion fly community. Ecol Monogr 61: 75-94.

JENKINS PT. 1999. Invasive Species and Biodiversity Management. In: Sandlund OT, Schei PJ and Viken A (Eds), Invasive species and biodiversity management. Based on papers presented at the Norway/United Nations (UN) Conference on Alien Species, 2nd Trondheim Conference on Biodiversity, Trondheim, Norway, 1-5 July 1996, p. 229-235.

LAWSON JR AND GEMMEL MA. 1990. Transmission of taeniid tapeworm eggs via blowflies to intermediates hosts. Parasitology 100: 143-146.

LINHARES AX. 1981. Synanthropy of Calliphoridae and Sarcophagidae (Diptera) in the city of Campinas, São Paulo, Brazil. Rev Bras Entomol 25: 189-215.

MARINHO CR, AZEVEDO ACG AND AGUIAR-COELHO VM. 2003. Diversidade de califorídeos (Diptera: Calliphoridae) em área urbana, Rio de Janeiro. Entomología y Vectores 10: 185-199.

MARINHO CR, BARBOSA LS, AZEVEDO ACG, QUEIROZ MMC, VALGODE MA AND AGUIAR-COELHO VM. 2006. Diversity of Calliphoridae (Diptera) in Brazil's Tinguá Biological Reserve. Braz J Biol 66: 95-100.

MELLO RP. 2003. Chave para identificação das formas adultas das espécies da família Calliphoridae (Diptera, Brachycera, Cyclorrhapha) encontradas no Brasil. Entomolgía y Vectores 10: 255-268.

OLSEN AR AND SIDEBOTTON TH. 1990. Biological observations on *Chrysomya megacephala* (Fabr.) (Diptera: Calliphoridae) in Los Angeles and the Palau Islands. Pan-Pac Entomol 66: 126-133.

PRINS AJ. 1979. Discovery of the oriental latrine fly *Chrysomya megacephala* (Fabricius) along the south-western coast of South Africa. Annls S Afr Mus 78: 39-47.

QUEIROZ MMC AND MILWARD-DE-AZEVEDO EMV. 1991. Técnicas de criação e alguns aspectos da biologia de *Chrysomya albiceps* (Wiedemann) (Diptera, Calliphoridae), em condições de laboratório. Rev Bras Zool 8: 75-84.

REIS SF, VON ZUBEN CJ AND GODOY WAC. 1999. Larval aggregation and competition for food in experimental populations fo *Chrysomya putoria* (Wied.) and *Cochliomyia macellaria* (F.) (Dipt., Calliphoridae). J Appl Entomol 123: 485-489.

ROFF D. 1977. Dispersal in dipterans: its costs and consequences. J Anim Ecol 46: 443-456.

SO PM AND DUDGEON D. 1989. Variation in life-history parameters of *Hemipyrellia ligurriens* (Diptera: Calliphoridae) in response to larval competition for food. Ecol Entomol 14: 109-116.

VON ZUBEN CJ, GODOY WAC AND MONTEIRO FILHO ELA. 1996. Curva de sobrevivência e estimativa de entropia em *Chrysomya megacephala* (Diptera, Calliphoridae). Rev Bras Entomol 40: 221-224.