Comunicação Científica

Blackfly Oviposition on Riparian Vegetation of Waterfalls in an Atlantic Rain Forest Stream

Gilson R.P. Moreira[1,2] and Gosuke Sato[1]

[1]EPAGRI/Estação Experimental de Itajaí, Caixa postal 277, 88301-970, Itajaí, SC.
[2]Current address: Departamento de Zoologia, Instituto de Biociências, UFRGS, Av. Paulo Gama, 40, 90040-046, Porto Alegre, RS.

An. Soc. Entomol. Brasil 25(3): 557-562 (1996)

Oviposição de um Simulídeo sobre a Vegetação Ribeirinha em Cachoeiras de um Córrego da Mata Atlântica

RESUMO - São apresentadas informações preliminares sobre um hábito de oviposição incomum de *Simulium nogueirai* D'Andretta & González (Diptera: Simuliidae), no Córrego Tromn, município de Joinville, SC. Descreve-se a postura, identifica-se os substratos utilizados e determina-se a periodicidade diária da atividade de oviposição. Ao contrário do observado na maioria dos simulídeos, a oviposição nesta espécie foi efetuada externamente à coluna d'água. Folhas, ramos e raízes finas de ervas e arbustos, localizados nas margens das cachoeiras, sob a área de incidência dos respingos, foram utilizados como substrato. A oviposição ocorreu no período da tarde, intensificando-se ao anoitecer. As fêmeas ovipositaram isoladamente ou em grupos, podendo resultar em massas de posturas compostas de milhares de ovos.

PALAVRAS-CHAVE: Insecta, Diptera, simulídeos, comportamento, oviposição.

Simulids breed typically in running waters. Their egg-laying sites are mostly associated with substrate either submerged or located at the water surface, such as trailing vegetation (Golini & Davies 1987, Crosskey 1990). Terrestrial mass-oviposition has been recorded for a few blackfly species (*e.g.*, Ladle *et al.* 1985, Zwick & Zwick 1990). In this scientific note, we describe under preliminary basis one such oviposition behavior for *Simulium nogueirai* D'Andretta & González. The distribution of this little known blackfly is apparently restricted to southeastern Brazil (Py-Daniel & Moreira 1989). Its immature stages are commonly collected in streams located at the steeps of Serra do Mar mountains of northeastern Santa Catarina State (SC), where this species breeds continuously throughout the year (Moreira *et al.* 1994). This study is based upon a census carried out along Tromn Creek, Joinville County, SC, during December 1987. We describe the egg-laying site, characterize the oviposition substrate and egg-masses, and determine the diel oviposition activity of *S. nogueirai*. Tromn Creek has been described in detail elsewhere (Moreira *et al.* 1994). It is an undisturbed, first order stream, with steep profile, whose upper section is covered by the Atlantic Rain Forest.

Laying Sites and Substrates. Eggs of *S. nogueirai* are laid above the water surface, on riparian vegetation located under the spray incidence area of waterfalls. In general, oviposition substrates are composed of young leaves, thin branches and roots of herbs and shrubs that grow along the stream banks (Fig. 1A). At Tromn Creek, egg-clusters were collected from the following plants, in density order: *Calathea* sp. (Marantaceae), *Aphelandra mirabilis* (Acanthaceae), *Impatiens sultani* (Balsaminaceae), *Sechium edule* (Cucurbitaceae), *Boehmeria caudata* (Urticaceae), *Polypodium phyllitidis* (Polypodiaceae) e *Piper* sp. (Piperaceae), and from unidentified pteridophytes. There was no indication females had selected the oviposition substrate primarily according to the plant species. Since riparian vegetation of Tromn Creek is mostly composed of the above plant species, this could indirectly determine their use as the oviposition substrate by *S. nogueirai*.

Although boulders and cobbles are abundant throughout the stream profile, we did not find eggs of *S. nogueirai* on these substrates. Also, eggs were never collected from any dried or submerged plant substrates. At small waterfalls (less than 0.5m in height), they were found on wet plants near the water surface. At higher waterfalls, however, they were laid at any distance from the water column, depending on the availability of a suitable plant substrate. Clusters were collected up to 2.1m from the stream surface at a 4.6m

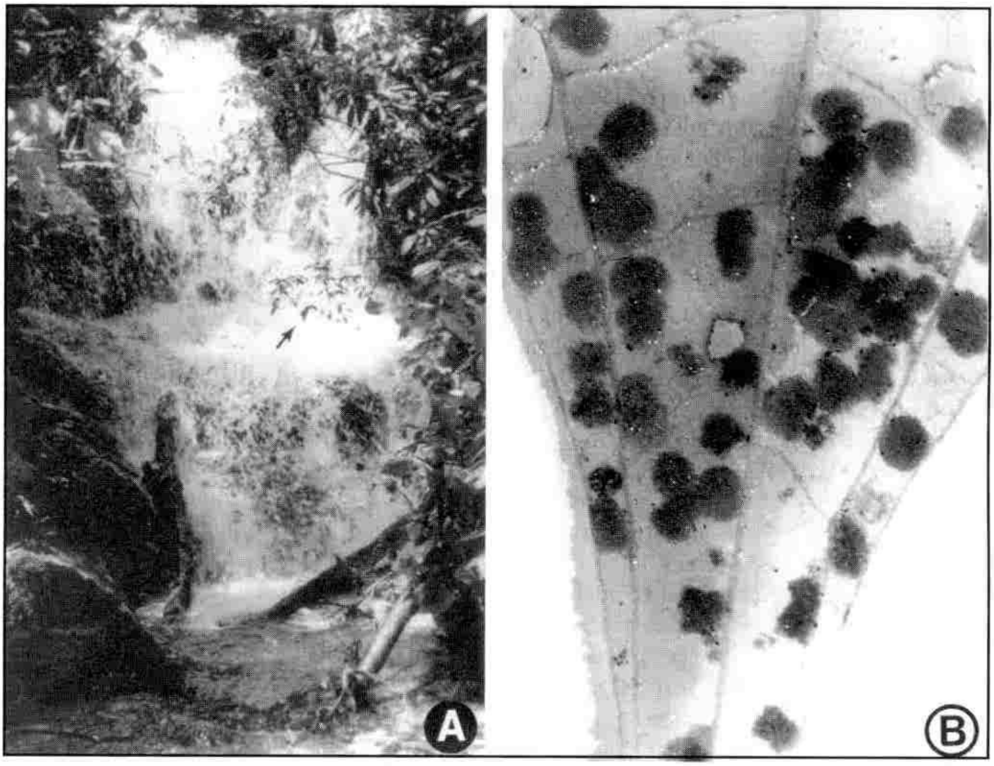

Figure 1. A = a 4.6m high waterfall, located at 220m of Tromn Creek profile. Arrow indicates riparian vegetation bearing egg-clusters of *Simulium nogueirai*. B = egg-masses of *S. nogueirai* on leaf .

high waterfall (Fig. 1A). Results obtained from an oviposition site selection study (G.R.P. Moreira, unpublished data) suggest females choose the oviposition substrate as a function of spray intensity. High waterfalls when in association with substantial discharge produce large amounts of spray. Thus, the riparian vegetation at such waterfalls tends to show the highest density of eggs, and also the greatest variation in spatial distribution of eggs in relation to the stream bed.

First instar larvae of *S. nogueirai* were abundantly collected in the water column near the waterfalls where eggs were found. Additional studies on the ecological consequences of *S. nogueirai* oviposition behavior (G.R.P. Moreira, unpublished data) have shown that variation in density of both last instar larvae and pupae along the stream profile correlates with the abundance of egg-laying sites of this torrenticolous blackfly. We have no information concerning the way first instar larvae reach the water surface after eclosion. We suppose they simply fall into the stream by gravity action, using as vehicle either the falling water spots, or less likely, the gelatinous substance that covers the eggs (after liquefaction). The latter mechanism was documented by Gullefors (1989) for a limnephilid caddisfly with similar egg-laying behavior.

Egg-Clusters and Masses. Eggs of *S. nogueirai* were laid in clusters (Fig. 1B), while the female was settled on the substrate. The eggs exhibited an eccentric shape and undergone the embryonic developmental color changes generally observed among simulids (for a description, see Crosskey 1990). They were covered by a fine layer of a translucent, apparently gelatinous matrix, which attached them to each other and to the substrate. When laid on flat surfaces (*e.g.* leaves), the clusters showed a saucer-like shape, and were composed of up to three layers of eggs (Fig. 2). They may vary in shape as a function of substrate type. For example, when laid around fine branches and roots, they assumed a cylindrical format.

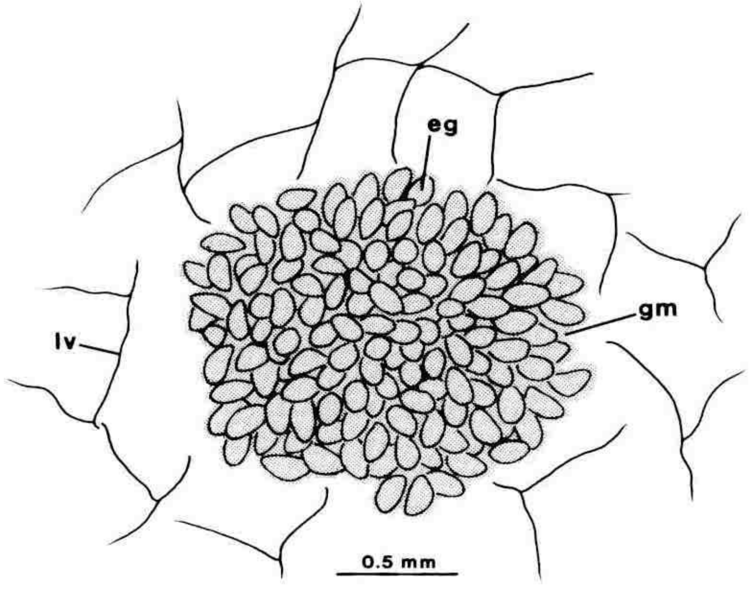

Figure 2. Egg-cluster of *Simulium nogueirai*. eg = egg; gm = gelatinous matrix; lv = leaf vein.

In most waterfalls of Tromn Creek, *S. nogueirai* clusters were laid in irregularly arranged groups, resulting from mass-oviposition. Although we have not attempted to quantify their number, eggs may amounted to thousands in such egg-agglomerations. More than 45 thousand eggs were massively deposited on individual plastic strings that were daily offered as artificial substrates in oviposition site selection studies (G.R.P. Moreira, unpublished data). Egg-clusters could not be individualized in mass-oviposition, except through differences in color produced by embryonic development changes, when egg-clusters were laid in different times.

There was considerable variation in the number of eggs within clusters of *S. nogueirai*. The number of eggs in 200 field collected clusters ranged from 45 to 567 eggs (average of 234.8 eggs/cluster). This analysis was based upon isolated, fresh egg-clusters. The number of mature eggs in the ovaries of 27 dissected females, which were netted on egg-laying activity, ranged from 79 to 353 (average of 241.5 eggs per female). The egg batch size estimated in these counts matched the size range assessed for several *Simulium* species (Crosskey 1990).

Egg-Laying Activity. Diel oviposition activity of *S. nogueirai* was quantified during four consecutive days (December 9-12), at a 4.6m high waterfall located under the forest canopy, at an altitude of 220m (Fig. 1A). Egg-laying activity was observed on a grid placed horizontally on stakes (0.5m in height), at a distance of 0.2m from the waterfall base. The grid frame was composed of a 2.2 x 1 m wood rectangle matching approximately the dimensions of the waterfall spray incidence area. The frame was crossed by fine plastic strings (0.5 mm in diameter) at 0.3m intervals. The strings were promptly used by females as oviposition substrates. The number of ovipositing females on the plastic strings was counted at 15-minute intervals throughout daylight time. At the same sampling interval, air temperature, humidity and luminosity were measured with a termohygrograph and a luximeter. These were positioned on a 1m high support placed in an open area, approximately 50 m from the waterfall. For the analysis, both oviposition and weather data were grouped into 30-minute intervals.

On the four consecutive days of observations, oviposition activity on the grid started

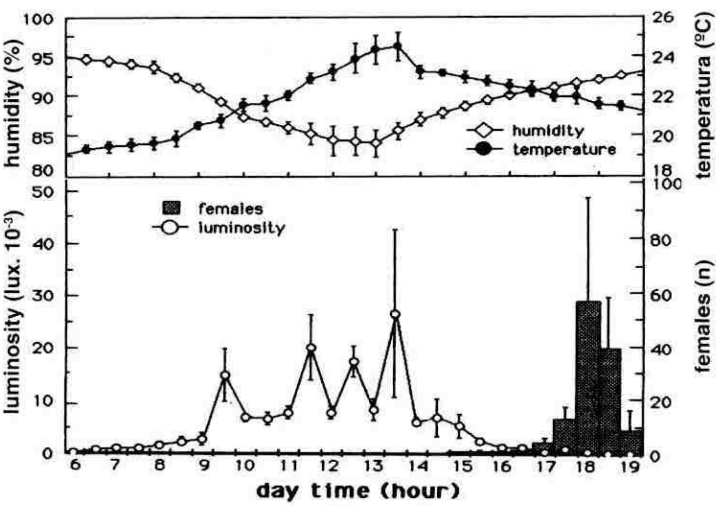

Figure 3. Average diel oviposition activity of *Simulium nogueirai* at Tromn Creek, Joinville County, December 9-12, 1987. Bars = standard errors.

in the middle afternoon, then increased progressively, and culminated near the sunset (Fig. 3). Up to 98 females were observed on simultaneous oviposition at this time. Females disappeared from the egg-laying site soon after sunset; none was seen during nocturnal inspection of egg masses. Such a diel-oviposition pattern is commonly found among simulids (Golini & Davies 1987, Crosskey 1990). The increase in *S. nogueirai* egg-laying activity during late afternoon was concurrent to a progressive increase in air humidity and a decrease in both temperature and luminosity (Fig. 3). Winds were negligible during the experimental period. Although it is accepted that weather may influence the diel oviposition patterns of blackflies (*e.g.*, Gorayeb 1981, Coupland 1991, Moor 1991), little is known concerning the mechanisms by which such abiotic factors affect their ovipositing behavior.

Aggregations followed by communal oviposition are not uncommon among simulids (Crosskey 1990). The biological significance and precise mechanisms that determine this ovipositing behavior are still not clear (Davies 1962, Crosskey 1990, Coupland 1991). To our knowledge, the first record on terrestrial oviposition among blackflies was given by Ladle *et al.* (1985) for *S. posticatum*, which lays eggs into crevices of stream banks in England. Mass-terrestrial oviposition on moist moss was also reported by Zwick & Zwick (1991) for three *Prosimulium* species in Germany. However, we are not acquainted with records concerning this oviposition strategy in *Simulium* species. During four years of intensive research in Joinville County, we frequently observed the egg-laying behavior of other blackfly species, but never upon sites located above the water surface, as here described for *S. nogueirai*. For example, *S. inaequale* oviposited on trailing vegetation (mainly leaves) at small, open streams and lake outlets. Females laid eggs continuously while settled, the eggs being layered on the substrate. On the other hand, *S. acarayensis* and *S. dinnellii* laid eggs on inclined substrates, mainly on bedrock covered by a thin film of running water. In this case, females oviposited uninterruptedly onto the substrate, while in flight, by dipping their abdomen through the water column, which was also called dabbing oviposition technique by Crosskey (1990).

Acknowledgments

Thanks to Edval Tromn for allowing to carry out the study in his property. The "25 de Julho" Foundation, Joinville County, provided facilities for field work. Renato Pegoraro and Ingomar Seidel (EPAGRI) helped in the field. The late Raulino Reitz (Herbário Barbosa Rodrigues) identified the plants. Armando J. Aguilera did the final photographic work. Comments by Nicoleta T.N. Sabetzki (EPAGRI) and Helena P. Romanowski (UFRGS) improved earlier versions of the manuscript.

Literature Cited

Coupland, J.B. 1991. Oviposition response of *Simulium reptans* (Diptera: Simuliidae) to the presence of conspecific eggs. Ecol. Entomol. 16: 11-15.

Crosskey, R.W. 1990. The natural history of blackflies. Chichester, Wiley, 711p.

Davies, J.B. 1962. Egg-laying habits of *Simulium damnosum* Theobald and *Simulium medusaeforme* form *hargrevesi* [sic] Gibbins in Northern Nigeria. Nature 196: 149-150.

Golini, V.I. & D.M. Davies. 1987. Oviposition of black flies. p. 261-275. In: K.C. Kim & R.W. Merritt (eds.). Black flies: ecology, population management, and annotated world list. University Park, Penn. Sta. Univ.

Gorayeb, I.S. 1981. Comportamento de oviposição e ciclo evolutivo de *Simulium fulvinotum* Cerq. e Melo 1968 (Diptera, Nematocera). Acta Amazonica 11: 595-604.

Gullefors, B. 1989. The egg-laying behaviour of *Glyphotaelius pellucidus* (Retzius) (Trichoptera: Limnephilidae). Fauna Norv. Ser. B 36: 59-63.

Ladle, M., J.A.B. Bass & L.J. Cannicott. 1985. A unique strategy of blackfly oviposition (Diptera: Simuliidae). Entomol. Gaz. 36: 147-149.

Moor, F.C. de. 1991. Description of ovipositing behavior in the torrenticolous *Simulium (Anasolen) dentulosum* Roubaud, 1915 (Diptera: Simuliidae). Aquat. Insects 13: 201-208.

Moreira, G.R.P., R.A. Pegoraro & G. Sato. 1994. Influência de fatôres abióticos sobre o desenvolvimento de *Simulium nogueirai* D'Andretta & González em um córrego da Mata Atlântica. An. Soc. En- tomol. Brasil 23: 525-542.

Py-Daniel, V. & G.R.P. Moreira. 1989. Simuliidae (Diptera: Culicomorpha) no Brasil. IX. Sobre o *Simulium (Inaequa lium) nogueirai* D'Andretta & González, 1964. Iheringia, Sér. Zool. 69: 85-95.

Zwick, H. & P. Zwick. 1990. Terrestrial mass-oviposition of *Prosimulium*-species (Diptera: Simuliidae). Aquat. Insects 12: 33-46.

Received 18/I/96. Accepted 16/X/96.