

Phoretic association of blackflies (Diptera: Simuliidae) with heptageniid mayflies (Ephemeroptera: Heptageniidae) in South Africa

F.C. de Moor

Albany Museum, Somerset Street, Grahamstown, 6139 South Africa

The phoretic or epizootic association of blackfly (Diptera: Simuliidae) larvae and pupae with other aquatic arthropods has been documented for a number of tropical African species (Grenier & Mouchet 1959; Corbet 1961, 1962; Germain *et al.* 1966; Disney 1969, 1971a–d, 1973; also references in Crosskey 1990). The significance of these associations has led to much speculation, although no scientific conclusions regarding the origin and purposes of the associations have been reached (Corbet 1961; Crosskey 1990).

Attachment of simuliid larvae and pupae to other aquatic arthropods could be fortuitous, especially where dense populations of simuliid larvae occur, and where they may encounter difficulties in locating suitable substrates on which to attach. There are, however, a number of blackfly species that have developed obligatory associations with specific arthropod hosts and these simuliids manifest a range of unique morphological adaptations. In the larvae, these include a modified abdominal cuticle, structurally modified or reduced cephalic feeding fans, the ventral position of the terminal abdominal proleg with its attachment hooks and, in the pupae, the development of additional abdominal hooks that secure them in their reduced 'half slipper-shaped cocoon' (Crosskey 1990).

The distribution of obligate phoretic associations between blackflies and other arthropods is recorded as being restricted to central Asia and tropical Africa. In central Asia only mayflies of the family Heptageniidae (Ephemeroptera) are involved in the association, and the blackfly larvae and pupae do not manifest any striking morphological adaptations. In tropical Africa there are phoretic associations of blackflies with Decapoda (Potamonautidae and Atyidae) and Ephemeroptera (Heptageniidae, Oligoneuriidae and Baetidae). These obligatory phoretic blackfly larvae and pupae have many specialized morphological modifications. In Africa the most widespread records of phoretic associations are those between Simuliidae and Potamonautidae. These extend from Liberia and Kenya to Malawi (Crosskey

1990). The association between Simuliidae and Ephemeroptera range from Liberia and Uganda to Tanzania and southern Democratic Republic of the Congo, with a recent record in northern Namibia (Palmer & de Moor 1998).

Surveys conducted by staff of the Albany Museum in 1990 and 1991 recorded larvae and pupae of *Simulium* (*Phoretomyia*) *lumbwanum* de Meillon together with large numbers of nymphs of heptageniid mayflies belonging to *Afronurus scotti* Schoonbee and a *Compsoeuria* species. One mature nymph of *Compsoeuria* supported a penultimate instar larva of *S. lumbwanum* (Figs 1, 2). The specific identification of the *Compsoeuria* nymph could not be confirmed as several nymphs of known African species have not yet been de-



Fig. 1. Dorsal view of a *Compsoeuria* sp. nymph with phoretic *Simulium lumbwanum* larva attached to the right wing bud (Catalogue LIM 59J). Length of *Compsoeuria* nymph = 9 mm.



Fig. 2. Lateral view of *Simulium lumbwanum* larva attached to the right wing bud of *Compso-neuria* sp. nymph (Catalogue LIM 59J). Note ventral positioning and attachment of posterior proleg leading to streamlined attachment. Notice the extended cephalic fans in feeding posture.

scribed or correlated with adults. Six species of *Afronurus* and two of *Compso-neuria* have been recorded from South Africa (McCafferty & de Moor 1995). The nymph of *Compso-neuria njalensis* (Kimmings) was described by Schoonbee (1967) and the nymph of *Compso-neuria bequaerti* (Navás) is unknown. Although closely resembling *C. njalensis* nymphs, there are some minor morphological and colour pattern differences that make it likely that the nymph of the phoretic mayfly host represents either an undescribed species or the nymph of another unassociated adult species. This observation presents the first record of phoresis between blackflies and the mayfly genus *Compso-neuria*.

The body of the *Compso-neuria* nymph excluding cerci is 9 mm long and the *S. lumbwanum* larva is 6 mm long (Fig. 1). The posteriorly orientated positioning of the simuliid larva on the wing bud of the mayfly would presumably be the feeding position of the larva. Heptageniid nymphs normally position themselves with heads facing the current, hence the streamlined posterior-facing

positioning of the blackfly larva would optimize feeding. The extreme ventral placement of the posterior abdominal proleg of the *S. lumbwanum* larva means that it would be able to maintain its position on the mayfly nymph in a near-parallel position to the mayfly's body with minimal increase in friction (Fig. 2). The larvae can furthermore place its cephalic fans facing into the current directly from a horizontal position with minimal effort. If the posterior proleg was situated in a more terminal position there would be a greater resistance to the body of the blackfly as well as more drag on the wing bud of the mayfly (Fig. 2). The ventral positioning of the posterior proleg is bioenergetically less efficient and the larva would use more energy to constantly change position than it would with a terminal proleg. Terminal positioning of the proleg would allow for greater mobility of larvae than ventral positioning. Attachment by *S. lumbwanum* larvae to the wing buds of *Compso-neuria* nymphs would be of a fairly sedentary nature from an energetic perspective.

There were large populations of heptageniid mayflies in the rivers where *S. lumbwanum* were found. In such situations, sedentary populations of blackflies would be continually disturbed by the feeding activity and movement of these mayflies. The phoretic behaviour of *S. lumbwanum* may therefore be a strategy for avoiding such a disturbance. It is also significant that *S. lumbwanum* was only found on *Compso-neuria* sp. nymphs and not on *A. scotti*, which was also common in the rivers where the phoretic association occurred. This would signify that there is a distinct microhabitat preference shared by *Compso-neuria* nymphs and *S. lumbwanum* larvae. Gillies (1984) stated that nymphs of *Compso-neuria* species preferred slow-flowing water conditions whereas *Afronurus* species preferred fast-flowing water. The *Compso-neuria* nymphs with phoretic *S. lumbwanum* larvae were found on stones in riffles and on marginal vegetation in slow-flowing to moderately fast-flowing water, during this study.

Although there is a record of a single pupa of *S. lumbwanum* from the Victoria Falls, (Freeman & de Meillon 1953), Crosskey & Howard (1997) did not include this in their recent species inventory of the world's blackflies. Extension of the distribution of *S. lumbwanum* from Kenya and Uganda to Mpumalanga, South Africa (*i.e.* by more than 2500 km) is considerable. It extends the distribution of this species beyond the tropical realm to

which it appeared to be restricted. Palmer & de Moor (1998) also record this species from Swaziland and the Okavango River, Caprivi Strip, Namibia.

Simulium lumbwanum has been recorded from the following localities in South Africa: Mpumalanga, LIM 59J, 20.x.1990, Sabie River, Sabie-Sand Reserve at Londolozi, 315 m, 24.47S 31.31E, F.C. de Moor, H.M. Barber & W.P. McCafferty; LIM 2I, 5.xi.1991, Crocodile River, 25.26S 30.45E, H.M. Barber & N.P.E. James; LIM 4I,

5.xi.1991, Crocodile River, near Montrose Falls, 25.27S 30.42E, H.M. Barber & N.P.E. James.

The National Research Foundation is thanked for making funds available that enabled the research to be undertaken. The Directorate of Museums and Heritage, Eastern Cape, are thanked for providing research facilities. H. Barber-James checked mayfly identifications and R. Palmer and I. de Moor read and commented on the manuscript.

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