UPDATE ON A SURVEY OF THE BLACK FLIES (DIPTERA: SIMULIIDAE) FROM THE NORTHWEST TERRITORIES AND NUNAVUT PROJECT

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Introduction

The Northwest Territories and Nunavut have been virtually unsurveyed for black flies since the completion of the Canadian "Arctic Insect Survey" (AIS) in the mid 1950s. While material collected by the AIS remains an important part of the Canadian National Collection of Insects, the sampling was haphazard and specimens are not suitable for modern analysis. For example, many nominal species of northern black flies belong to morphologically homogeneous species complexes and can be identified only through analyses of the larval polytene chromosomes. Given what is now known about sibling species in southern and northwestern North America (e.g. Adler 1986, Currie 1997), the 22 nominal species of black flies recorded from the Canadian Arctic east of the Mackenzie River (Danks 1981) is clearly underestimated.

To develop a more realistic profile of simuliid diversity east of the Mackenzie River, we undertook a survey of the remote Horton River and its tributaries during the summer of 2000. The Horton River was selected as an initial focus of study because of its close proximity to the eastern boundary of Beringia - the main source area for organisms that repopulated the Canadian north following deglaciation. The survey not only would provide valuable new insights into simuliid diversity in the northwestern Northwest Territories, but also would provide a test for the distributional patterns suggested by Currie (1997) in his account of the black flies of the Yukon.

We were accompanied by three entomologists who shared interests in other aspects of arctic-insect diversity and ecology: Donna Giberson (University of Prince Edward Island), Brian Brown (Natural History Museum of Los Angeles County) and Malcom Butler (North Dakota State University). An account of their research, and further details of the Horton River expedition, is provided by Currie et al. (2000). Because of lack of roads and the high cost of air transportation, we opted to canoe an approximately 600-km length of the Horton River between Horton Lake (just north of Great Bear Lake) and the Beaufort Sea (Figure 1). This strategy allowed us to sample numerous sites along the way and at the same time provided a south-to-north transect from the High Subarctic Ecoclimatic Region to the Low Arctic Ecoclimatic Region. No settlements are situated in the vicinity of the river, so we were compelled to bring everything we needed for the three and a half week trip. The Wilderness Adventure Company was engaged to outfit and guide the expedition, allowing us to concentrate as much as possible on our collecting activities. A chartered Twinn Otter transported our 5-member team and one river guide from Norman Wells to Horton Lake on July 16; we were retrieved from the mouth of the Horton River and returned to Inuvik on August 11.

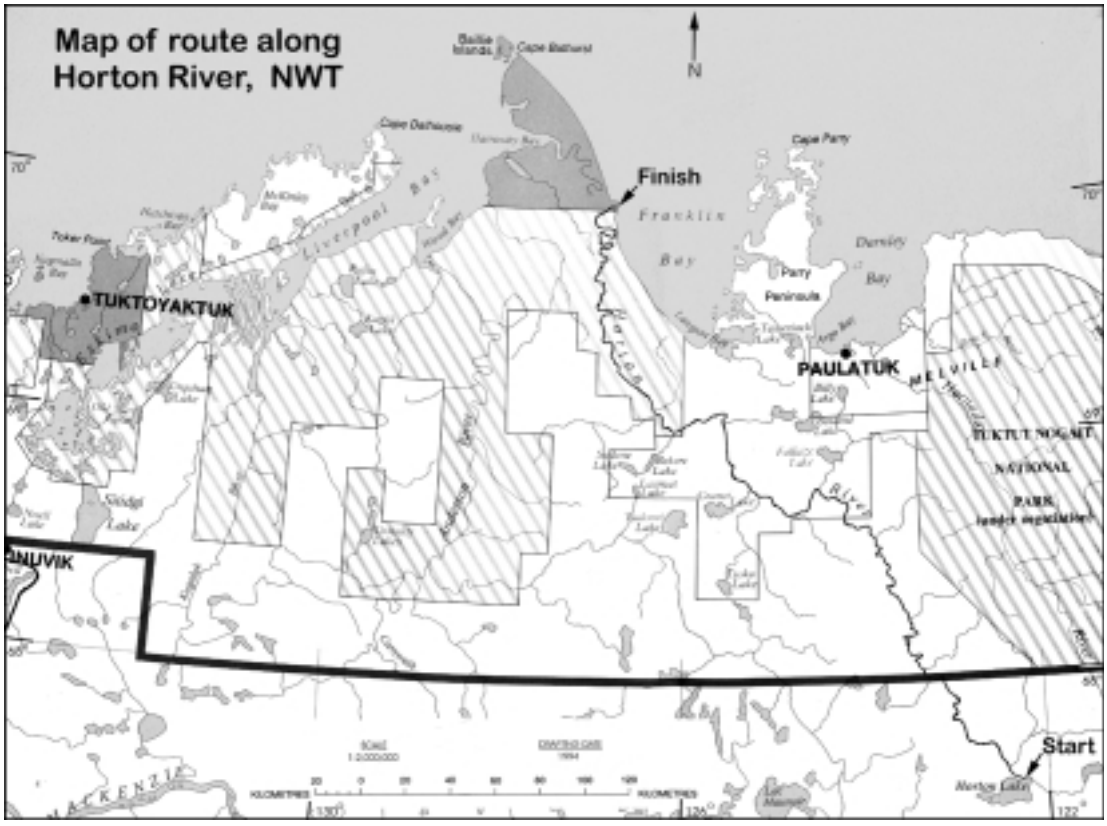
Collections of Black Flies

The Horton River Valley proved to be among the most black-fly infested regions of North America. Dense swarms of females descended on our party during the first half of the expedition, providing many fine samples of anthropophilic (i.e., human-biting) species. Despite the misery inflicted by these clouds of black flies, the anthropophilic species (mainly members of the *Simulium venustum* species complex) represented less than 15% of all species that we collected during the expedition.

The typical "early-evening" peak in biting activity was greatly prolonged because of the length of time it took for the sun to descend below the horizon. This added immeasurably to the misery suffered by team members. Fortunately, unlike mosquitoes, black flies decreased in activity perceptibly after 10:00 PM. Blood-fed anthropophilic species were frequently collected from the bodies of expedition members; numerous others were collected inside our tents, which served as effective traps. The vast majority of adults were collected in Malaise Traps that were set at most camping spots and selected lunch stops. The traps proved highly effective - even over a short period - when the weather conditions were warm and sunny. In contrast, insect activity all but ceased when the air temperature dipped into the single digits. Nonetheless, the prolonged daylight hours of the arctic summer substantially increased the efficacy of the Malaise Traps. Larvae and pupae were collected by hand from 50 sites along the Horton River and its tributaries. Most larvae were fixed in Carnoy's solution (3 parts ethanol: 1 part glacial acetic acid) for chromosomal analyses. Selected larvae and pupae were fixed in absolute ethanol to render them suitable for molecular analyses.

Species Richness

Four genera and 29 species of black flies have thus far been identified from the Horton River and its tributaries. Approximately half of these species were recognized and identified only through analyses of their polytene chromosomes, highlighting the need for cytological screening when conducting surveys of black flies. One of these species, a member of the *Simulium venustum* species complex (cytoform H/C), had been found only once before (northern Quebec). Our chromosomal analyses of the Horton River populations confirmed that this cytological entity warrants species status. The species richness in a single drainage is remarkable given that it exceeds the total number of species (22) previously recorded from all of arctic Canada east of the Mackenzie River. When we consider that more than one-third of our 29 species represented only 1% of the total number of specimens that we collected, with



some species represented by single specimens, it seems certain that numerous species were overlooked. The fact that our collecting activities were confined to the narrow corridor along the Horton River reduced the likelihood of collecting species associated with poorly drained terrain. Furthermore, the fact that our collecting was confined to a three-and-a-half week period during midsummer ensured that early-season black flies such as *Greniera* and *Stegopterna* were not collected. It is difficult to estimate the number of species that might have been encountered given a more comprehensive and thorough collecting program. Larvae in our collections were often infected with various parasites. Among the larval symbionts that we found were mermithid nematodes, oomycetes, several species of fungi, and 3 species of microsporidia. Most of these parasites are widespread in North America. Nonetheless, we found quite a number of new host associations.

Taxonomic Composition

Although the simuliid fauna of the western Northwest Territories is much richer than previously supposed, its taxonomic composition differs markedly from that of the Yukon Territory. For example, genera that are closely associated with mountainous terrain (e.g., *Gymnopais Prosimulium, Helodon, Mayacnephia*) are virtually absent (1 species) from the Horton River Valley. Collectively, species assigned to these genera account for 40% of the 55 species recorded from the Yukon (Currie 1997). Furthermore, only 2 of 14 species that Currie (loc. cit.) considered to be Beringian endemics (i.e., species assigned to his "East Beringian" and "Palaearctic-East Beringian" distributional categories) had their ranges extended eastwardly as far as the Horton River Valley. It appears, therefore, that a combination of topographical and historical factors might have shaped the present-day fauna east of the Mackenzie River. The genus *Simulium* is disproportionately represented in the Horton River Valley, contributing 25 of 29 species (86%). This percentage is strikingly higher than the 47% of species that *Simulium* contributes towards the Yukon fauna. *Helodon* and *Cnephia* were represented by 1 species each and *Metacnephia* by 2 species.

Community Structure

The Horton River Valley differs from all other regions in North America in terms of its simuliid community structure. Black flies were present in most of the watercourses we sampled, with one exception; headwater springs typically supported no black flies whatsoever. Whether groundwater characteristics rendered these streams unsuitable for habitation is not known; however, similar steams in Alaska and the Yukon support diverse and abundant assemblages of black flies. Perhaps the absence of headwater specialists reflects the lower vagility of such species and their concomitant inability to emigrate far from source areas following deglaciation.

We found an average of nearly 5 species per stream site, with the greatest densities and richness - up to 11 species - occurring at the outflows of tundra ponds. The Horton River itself contained 12 species, although its lower reaches were so heavily silted that they precluded colonization by any black flies. *Simulium tuberosum s. s.* was the dominant species at the majority of sites collected. In fact, the immature stages of this species were found at more than 80% of all sites and in a remarkable array of watercourses that ranged in width from a few centimeters to more than 100 meters.

Origins of the Black-fly Fauna of the Western Northwest Territories

The Horton River was chosen as a focus for study because of its close proximity to the eastern boundary of Beringia. Predictably, virtually all of the species (26) collected are also known from west of the Mackenzie River. This finding underscores the importance of Beringia as a source area for black flies that repopulated the north following deglaciation. However, the presence of 3 species that have not been recorded from the Yukon or Alaska suggests that glacial refugia other than Beringia might have been the source areas for these black flies.

Future Plans

Our brief foray into the Canadian Arctic reveals that there is still much to be learned about northern black flies. The difficulties associated with funding and permits notwithstanding, we

plan to mount a similar expedition along the Thelon River in the summer of 2001. Our plan is to canoe through the Thelon Wildlife Sanctuary, which straddles the border between the Northwest Territories and Nunavut. In addition to learning more about the composition and ecology of northern simuliids, we hope to recollect several enigmatic species, including *Simulium giganteum*, which is known from the Nearctic Region only from a single male collected in the vicinity of Baker Lake (MacInnes 1973).

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Paddling on the Horton River