DIAHELIOTAXIS AND OMBROPHOBIA IN AN ANTHOPHILOUS HIGH ARCTIC MIDGE, *SMITTIA VELUTINA* (LUNDBECK, 1898) (CHIRONOMIDAE)

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Records of Chironomidae as flower visitors are few (Larson et al. 2001), and explanations of their anthophilous activities even fewer. In the Arctic, several species are known as flower visitors and nectariphages (McApline, 1965; Oliver, 1968; Hocking, 1968; Kevan, 1970; 1973; Larson et al. 2001), but none so abundant and conspicuous as *Smittia velutina*.

Smittia velutina is a common, early emerging species of Chironomidae in the High Arctic (Danks 1981). It seems to be parthenogenetic. Males are so far not recorded and females I kept in vials oviposited on the inside walls. One of the interesting features of this insect is its anthophily, or flower visiting habits. Oliver (1968) also recorded this species (of only two Chironomidae in the High Arctic) as nectariphagous. Large numbers can be found on the first summer blooms of *Saxifraga oppositifolia* L. (Saxifragaceae) and of *Salix arctica* Pall. (Salicaceae). I found them with their mouthparts at the nectaries of flowers of both species of plants, and few on a few others (Kevan 1970). My observations were almost exclusively from staminate catkins *S. arctica*, but both McAlpine (1965) and Hocking (1968) recorded them from pistillate catkins.

During my studies in insect and flower relations in the Canadian High Arctic (Kevan 1970; 1972; 1973), I was able to collect large numbers of *S. velutina* from flowers and made the following discoveries. All findings reported herein are from Hazen Camp, Ellesmere Island, Nunavut (89 49’ N., 71 18’ W).

Between 31 May and 23 July, 1967 I collected 337 females from flowers. They were dissected to examine their gut contents and the state of their ovarian development (Harlow 1956). Almost all had guts distended with clear, syrupy liquid. None had ingested pollen grains. Two thirds (65%) of those dissected had well developed ovaries, with ovarioles at Stage 3 of development. Ten percent had ovaries at Stage 2, and 16% at Stage 4. Those with Stage 1 and spent ovaries numbered only 3 and 4% respectively.

Oliver (1968) noted that 9 of the species he studied emerged with ovaries almost mature (Stage 3) or mature. He did not report on *S. velutina*, but indicated that in the species he studies that ovarian maturation from almost to fully mature (Stage 4) takes about 3 days. Given the duration of anthophily I recorded, with a peak from 1 to 15 June, I postulate that the cohorts of midges I observed in the flowers were constantly changing. That idea was strengthened by observations on the daily pattern of abundances of *S. velutina* on the flowers of *S. oppositifolia*.

From combined observations from 1966 and 1968, I determined that about 64% of the midges were in flowers on the insolated sides of clumps of *S. oppositifolia* (Figure 1). That observation suggests strongly that the insects were continually changing their orientation and following the warmth of the sun (i.e. were exhibiting diaheliotaxis). I did not make precise measurements of the shapes of the clumps of flowers, nor of the insolated proportion of the clumps from which the observation came. Thus, a complete statistical analysis can not be made to test the hypothesis implied in the above. I leave that to someone else.

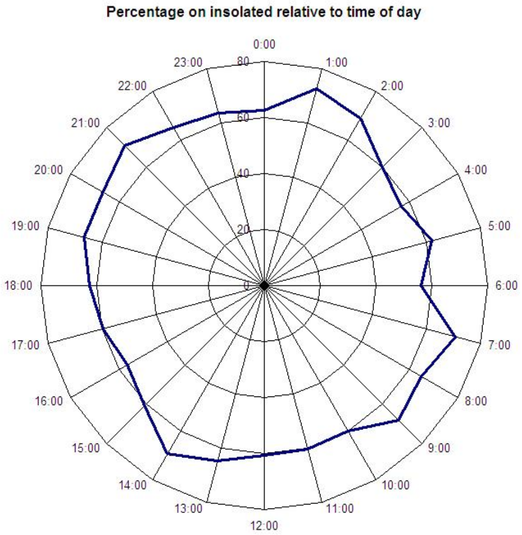

Figure 1. The percentage of the observed population of *Smittia velutina* within fully insolated flowers of *Saxifraga oppositifolia* throughout a composite day of 24 hours of sunshine (Data summarized from summers 1966 to 1968 at Hazen Camp, Ellesmere Island, Nunavut)

In respect of the benefits of arctic insects' basking in flowers, the most studies have been made on temperature regimes in the diaheliotropic flowers of *Dryas integrifolia* (Vahl.) (Rosaceae) and *Papaver radicatum* Rottb. (Papaveraceae) (Hocking and Sharplin, 1965; Kevan 1975). Those studies indicate two-fold benefits, one to the insects (warmth and protection) and the other to the plants (pollinator attraction, increased speed of pollen tube growth following pollination, more rapid fertilization of the ovules and growth of the seeds and fruits). Although *S. oppositifolia* is not diaheliotropic, its flowers become warmed by insolation. Figure 2 shows the amount of warmth (temperature above ambient air in the vicinity of the flowers) within its flowers according to the angle of insolation. Small insects, such as *S. velutina*, would assume the temperature of the environment within the flowers in which they rested. Thus, the two-fold benefit of insolational warming of the flowers of *S. oppositifolia* would be the same as for *D. integrifolia* and *P. radicatum*, but for shorter durations. The insects could extend the duration of their benefit by circumnavigating the clumps and so remaining insolated and warm. Using the same approach as in Kevan (1975) one can calculate roughly that the adult midges might gain as much as 25% more heat units by this behaviour. Such thermally advantageous circumnavigation (Kevan 1989) is known for mosquito larvae in tundra ponds (Haufe, 1957), woolly bear caterpillars on hummocks of vegetation (Kevan et al. 1981; Kukal et al. 1988) and diaheliotropic flowers (Kevan 1975).

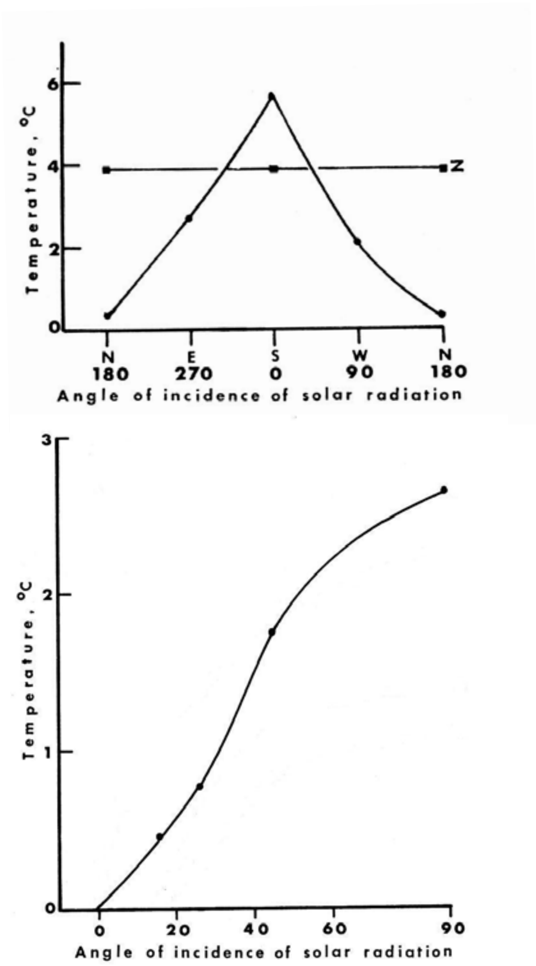

Figure 2. Top: Temperature within and at the bases of the flowers of *Saxifraga oppositifolia* (where *Smittia velutina* was observed feeding on nectar) above ambient air temperature with respect to the direction of the sun on a still sunny day at solar noon. Flowers at S (0) were open directly to incoming insolation, at N (180) open directly away from the sun, Z is for temperatures of flowers open directly to the Zenith.
Bottom: Temperature within and at the base of flowers of *Saxifraga oppositifolia* (where *Smittia velutina* was observed feeding on nectar) above

ambient air temperature with respect to the direction of the sun as they were tipped from facing directly into the sun (90 equivalent to 0 in the left-hand graph) to a position so that the sun's rays glanced across the top of the open flowers.

Although rain is uncommon around Lake Hazen, from 22 to 24 June, 1966 light rains fell and observations on the insects in *S. oppositifolia* were made. At each observation between 104 and 127 midges were counted. Close inspection revealed that *S. velutina* used the flowers as umbrellas. Only one hour after the rain had started, many flowers were empty, but 65% of the midges had taken refuge beneath the flowers. Thirteen hours later, 80% of the midges associated with the flowers were underneath them. Thus, the midges were exhibiting avoidance of rain, or ombrophobia. After the rain ceased and the sun had shone, the midges slowly resumed their positions in the flowers, so that after 14 hours of sunshine 89% of the midges were within the corollas, and only 11% still beneath them.

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