OBSERVATIONS ON THE POLLINATION BIOLOGY OF PLANTS ON MELVILLE ISLAND, N.W.T., CANADA

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WHILE COLLECTING PLANTS and insects on Melville Island, N.W.T., Canada from July 19 to July 31, 1965, we made some observations on the occurrence and behavior of flower-visiting insects as well as on the scent and other target characteristics of flowers. These observations were made about two miles north of Bailey Point in an area where a deep river valley bisects an otherwise rolling topography (75°N 114°58'W). A paper dealing with chromosomal and taxonomic characteristics of the flora at this locality has already been published (Mosquin and Hayley, 1966). The present account includes only those species of plants which had well-developed open flowers at the time of our visit to the site.

All Diptera listed in Table 1 were collected individually with an aspirator and placed in separate vials together with a note identifying the plant on which the collection was made. Only those Diptera which were actually probing into the flower are listed in the table. The Lepidoptera and the bumblebees were collected using a conventional butterfly net.

Most of the insect collections listed in the Table were made during the three days, July 22, 23 and 24 when the sky was clear, the winds relatively calm and the temperature in the warm fifties. Several of the Diptera visitors are shown in Figure 1.

SPECIES WITH SCENTED FLOWERS

Astragalus alpinus L. This species occurred in colonies up to many meters in diameter. The sweet, honey-like scent from such colonies was often detected from a distance of several yards or more.

Parrya arctica R. Br. This species occurred usually as scattered individuals although the species is often locally abundant. In seemingly sterile environments the plants had small inflorescences and these were scentless. However, plants growing in more favorable sites had well-developed and lush inflorescences. Such inflorescences, if bunched together, had a distinctive pungent sweet-mustard aroma.

Petasites frigidus (L.) Fries. This species, although very abundant in the area was just beginning to flower during the last few days of our visit. The flowers had a very sweet and pungent fragrance. The flowers of this species are apparently fragrant throughout its arctic range (see Porsild, 1957, p. 150).

In addition to these three species, two others, *Epilobium latifolium* L. and *Senecio congestus* (R. Br.) DC., since they have showy flowers, may well have been scented but they had not yet started flowering by the end of our visit.

SPECIES WITH APPARENTLY SCENTLESS FLOWERS

Salix arctica Pall.
Oxyria digyna (L.) Hill
Polygonum viviparum L.
Stellaria longipes Goldie
Stellaria humifusa Rottb.
Cerastium alpinum L.
Melandrium apetalum (L.) Fenzl.
Caltha palustris L. var. *arctica* (R. Br.) Huth. This species may have had a very slight aroma at this locality.
Ranunculus hyperboreus Rottb.
Ranunculus sabinei R. Br.
Ranunculus sulphureus Sol.
Papaver radicatum Rottb.
Cochlearia officinalis L.
Draba spp.
Erysimum pallasii (Pursh) Fern.
Saxifraga caespitosa L.
S. cernua L.
S. flagellaris Willd.
S. foliolosa R. Br.
S. hirculus L.
S. nivalis L.
S. oppositifolia L.
S. tricuspidata Rottb.
Dryas integrifolia M. Vahl
Geum rossii (R. Br.) Ser.
Potentilla hyparctica Malte
P. pulchella Pursh
Oxytropis arctica R. Br.
Cassiope tetragona (L.) D. Don
Pedicularis arctica R. Br.
P. sudetica Willd.
Antennaria angustata Greene
Arnica alpina (L.) Olin
Erigeron compositus Pursh
E. eriocephalus J. Vahl
Taraxacum arctogenum Dahlst.
T. phymatocarpum J. Vahl
T. pumilum Dahlst.

DISCUSSION

Our observations support the general hypothesis dealing with evolutionary patterns of the arctic flora proposed in detail in an earlier paper (Mosquin, 1966). This hypothesis is that in the arctic, genetic uniformity is at a selective advantage. Therefore nearly every species has one or more reproductive devices for promoting population uniformity. Further, features of arctic plants which appear to promote variability, are, in fact, vestigial. For example, features such as showy flowers, nectar production, zygomorphic corollas, and perhaps genetic variability itself are not to be interpreted as evidence that outcrossing has adaptive function to-day but rather these features are evidence of outcrossing in the ancestry. Their presence in the arctic flora is due mainly to the fact that adaptation in the arctic flora is mainly physiological rather than morphological. The evidence is strong to indicate that nearly all arctic species are derived from temperate-zone ancestors (Mosquin, 1966) and that these ancestors are ones that have a preponderance of features which promote variability. The arctic flora of today therefore contains numerous species which carry the morphological vestiges of their outcrossing ancestry. Following are some interpretative comments on our observations.

The absence of pollinators on the two species of *Pedicularis* will be considered first. Both species were very common in the area and are showy-flowered. The flowers are, however, scentless and as far as we could determine, are not visited by the bumblebees which were very common in the area. Pre-

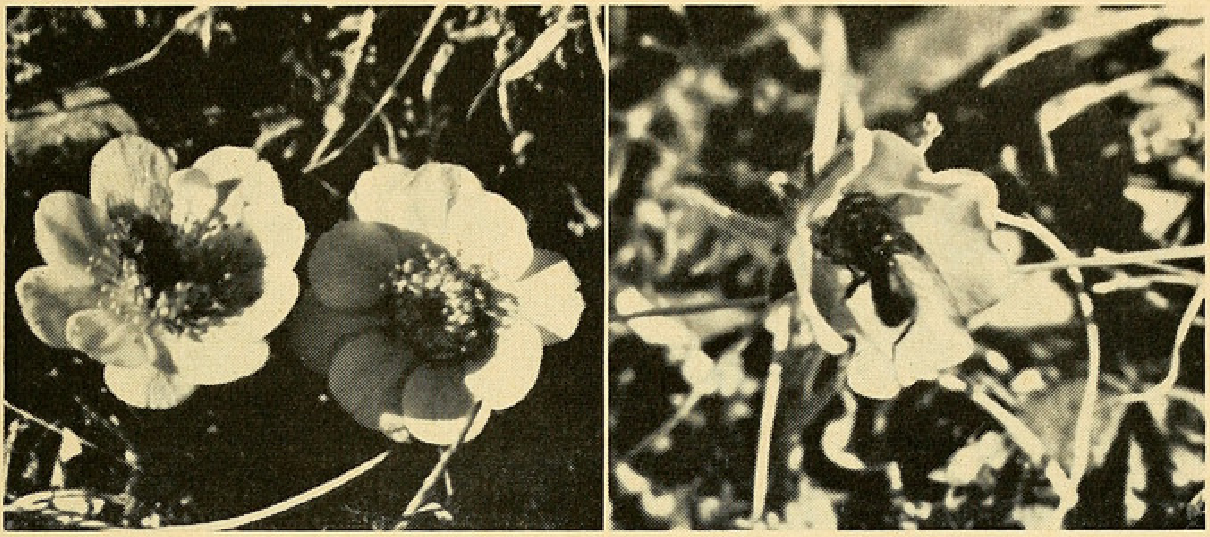

FIGURE 1. Left, an anthomyiid fly, *Pogonomyiodes segnis* Holmgren, feeding on pollen grains of *Dryas integrifolia* M. Vahl. Right, a blow fly, *Boreelus artriceps* (Zetterstedt), presumably taking nectar from flower of *Potentilla vahliana* Lehm. Photographs adapted from kodachrome slides.

sumably, both species have lost their capacity to produce scent such as occurs in many of their temperate-zone ancestors (Sprague, 1962). It is of interest, however, to note that on Somerset Island, where leguminous plants are absent, the bumblebees occasionally did visit *Pedicularis arctica* (Savile, 1959). It seems clear that the remarkable success of the two species of *Pedicularis* at Melville Island does not depend on visits from the bumblebees. Presumably the plants are strongly self-pollinated, since seed-set is high (Savile, personal communication). Self-pollination would ensure a relatively high degree of genetic uniformity through homozygosity.

The two species of Leguminosae provide another interesting example in support of the above hypothesis. Thus *Astragalus alpinus* was, by far, the most bumblebee-visited plant species in the area. Obviously nectar was being produced abundantly. However, whether the presence of the bees is of any value to the plants is questionable. This statement seems justified because another legume species, *Oxytropis arctica*, which occurs in the same general area, and has much larger and more showy flowers, is apparently completely scentless and is not visited by bees as far as we could determine. It is clear that bumblebees are not required in the arctic for the success of *Oxytropis arctica*. Perennial legumes of more southern latitudes are normally self-incompatible and strongly insect pollinated (Fryxell, 1957). A scented legume like *Astragalus alpinus* may not yet have lost its capacity to produce nectar. The visiting insects are presumably only utilizing an available food supply. It is important to determine whether *A. alpinus* is self-incompatible because if it is, it would be an exception to the above hypothesis.

Salix arctica can be considered as another example of an arctic species that has lost its capacity to produce scent. It would be worthwhile to determine whether more southern populations of this species are scented. Certainly nearly

TABLE 1.—Flowering plant species and their insect visitors

	Boloria improba (Nymphalidae)	Colias hecla (Pieridae)	Colias nastes (Pieridae)	Anarta richardsoni (Noctuidae)	Rhamphomyia sp. (Empididae)	Boreellus atriceps (Calliphoridae)	Protocalliphora sp. (Calliphoridae)	Spilogona aesturium (Muscidae)	Spilogona almquistii (Muscidae)	Spilogona dorsata (Muscidae)	Spilogona hurdiana (Muscidae)	Spilogona latilamina (Muscidae)	Spilogona melanosoma (Muscidae)	Spilogona projecta (Muscidae)	Spilogona sanctipauli (Muscidae)	Eupogonomyia probilofensis (Muscidae)	Pogonomyiodes segnis (Muscidae)	Bombus polaris (Bombidae)
Cerastium alpinum (Caryophyllacae)														1 ♂ 1 ♀	2 ♂ 1 ♀			
Caltha palustris (Ranunculaceae)									1 ♀	1 ♂	1 ♀		1 ♀		1 ♂ 2 ♀			
Papaver radicatum (Papaveraceae)									1 ♂								1 ♀	
Potentilla vahliana (Rosaceae)						1 ♂ 2 ♀	1 ♂		2 ♂ 3 ♀	2 ♀		5 ♀	1 ♀		6 ♂ 13 ♀	3 ♂ 4 ♀	1 ♂	
Dryas integrifolia (Rosaceae)	8								3 ♀					1 ♀	11 ♂ 4 ♀	2 ♀	2 ♂ 3 ♀	
Geum rossii (Rosaceae)									1 ♀									
Astragalus alpinus (Leguminosae)		11	1															15
Oxytropis arctica (Leguminosae)				1														
Petasites frigidus (Compositae)																		1
Arnica alpina (Compositae)									1 ♀						2 ♀	1 ♂		
Taraxacum spp. (Compositae)					1 ♀	1 ♂		2 ♀	1 ♂ 2 ♀						1 ♀			

all willows of the temperate areas are strongly insect-pollinated. Arctic willows may well be losing a dependence on insect pollination and evolving toward wind-pollination. A loss of scent might be expected to be associated with such a trend. Evolution in *Salix* from entomophily toward anemophily is suggested by Wodehouse (1935, p. 348) on the basis of various kinds of evidence. The distribution and occurrence of scent in northern willows would be worthy of detailed study.

It is clear from Table 1 and from the papers by McAlpine (1965a, 1965b) that the Diptera are very important flower visitors in the arctic. Many species have strong preferences for the flowers of certain plants. These preferences seem to be closely related to the size of the visual target. Thus plant species like *Dryas integrifolia* and *Potentilla vahliana*, which have very showy flowers were much-visited by the flies. In contrast, we failed to capture any flies on the sweet-scented *Astragalus alpinus*, probably because its purple flowers have about the same reflectivity as adjacent greenery. Likewise the Cruciferae, the various Saxifragaceae, and Caryophyllaceae, since they provide relatively non-conspicuous visual targets are apparently rarely visted by flies.

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REFERENCES

McALPINE, J. F. 1965a. Insects and related terrestrial invertebrates of Ellef Ringnes Island. Arctic 18: 73-103.

———, 1965b. Observations on anthophilous dipetra at Lake Hazen, Ellesmere Island, The Canadian Field-Naturalist 79: 247-252.

FRYXELL, P. A. 1957. Mode of reproduction in higher plants. Botanical Review 23: 135-233.

MOSQUIN, T. 1966. Reproductive specialization as a factor in the evolution of the Canadian flora. *In* The Evolution of Canada's Flora, edited by R. L. Taylor and R. A. Ludwig, University of Toronto Press, 137 pp.

MOSQUIN, T. and D. E. HAYLEY. 1966. Chromosome numbers and taxonomy of some Canadian Arctic Plants. Canadian Journal Botany 44: 1209-1208.

PORSILD, A. E. 1957. Illustrated flora of the Canadian Arctic Archipelago. National Museum of Canada, Bulletin 146.

SAVILE, D. B. O. 1959. The botany of Somerset Island, District of Franklin. Canadian Journal Botany 37: 959-1002.

SPRAGUE, E. F. 1962. Pollination and evolution in *Pedicularis* (Scrophulariaceae). Aliso 5: 181-209.

Wodehouse, R. P. 1935. Pollen Grains. McGraw-Hill Book Co., New York. 574 pp.

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