

CYTOTAXONOMIC STUDIES OF THE TRIBE NEPETEAE (LABIATAE) IN CANADA¹

L.S. GILL

Department of Biological Sciences, University of Benin, P.M.B. 1154, Benin City, Nigeria

Received November 30, 1977/Accepted January 1, 1979

The chromosome numbers of four genera and eight species have been determined from the Canadian material and the diploid cytotype ($n = 9$) in *Glechoma hederacea* has been reported for the first time from North America. Reproductive biology and the variational patterns have been studied. The distribution maps of all taxa of this tribe known to occur in Canada are given.

Introduction

The family *Labiatae* comprises about 3500 species and 180 genera (Willis, 1966). It is almost worldwide in distribution with its chief centre in the Mediterranean region. Whilst it is abundant in the tropics, the family has no true arctic representatives. Sixty eight species and nine hybrids of *Labiatae* are recognized to occur in Canada, out of these 33 species and two hybrids are native and the remainder are introduced (Gill, 1971b).

The tribe *Nepeteae* contains 393 species in nine genera, of which the genus *Nepeta* is the largest with 250 species (Willis, 1966). The tribe is recognized by the 15-nerved calyx, and by the outer pair of stamens being shorter than the inner. The chief centre of distribution is subtropical and temperate Asia. In Canada, it is represented by four genera and eight species, two of these genera and four species are native. The base numbers for the tribe are 5, 6, 7, 8, 9 and 17.

The purpose of this investigation was to study the cytology, variational patterns and to determine the

current taxonomic and distributional status of this tribe in Canada.

Material and methods

Living material of all the known taxa of this tribe was brought into cultivation at Waterloo either by transplanting root stock or by raising plants from seeds. Their accession numbers and sources are listed in Table 1. In addition specimens from the major Canadian herbaria* were examined in order to ascertain the extent of variation and range of distribution. Meiotic and mitotic preparations were made using techniques outlined by Gill (1970, 1971a). Pollen fertility was determined from the ability of pollen to stain with glyceracetocarmine. Mature anthers were squashed in a mixture of equal parts acetocarmine and 50% glycerine for about 12 hours. Grains which were well formed and filled with stained protoplasm were regarded as fertile.

Pollination experiments were carried out in t¹ experimental garden at Waterloo. Prior to the opening of the flower of each taxon, the inflorescence was bagged. The bags were left intact until the last corolla had withered. For purpose of comparison, unbagged plants of the same species were grown alongside the bagged ones and were left to be open-pollinated. Seed production from both bagged and open pollinated plants was estimated by counting the number of well formed seeds in at least 50 fruiting calyces from each plant.

* ACAD, ALTA, CAN, DAO, HAM, MCM, MT, MTJB, MTMG, NFLD, OAC, QK, QMP, QPH, QFA, QUE, SASK, TRT, USAS, UWO, UBC, V, WIN, WINF, CM, PFES, VC, WLU, Lakehead and University of Waterloo.

1 Part of Ph.D. Thesis at Department of Biology, University of Waterloo, Waterloo, Ontario, Canada.

Results and Discussion

Agastache Clayton.

A small genus of 20 species (Lint & Epling, 1945), distributed in the United States and Mexico. Also represented in Japan by a single species, *A. rugosa*. The genus is characterized by 15 nerved tubular campanulate calyx, flowers crowded in interrupted terminal spike and the exerted stamens. Three species occur in Canada. The base number for the genus is 9.

Key to the Canadian species of *Agastache*

- 1 Lower leaf surface silver-grey with minute appressed felt-like hair, calyx teeth 1-2 mm, violet tinged *foeniculum*
- Lower leaf surface glabrous (excluding the nerves) and not silver grey 2
- 2 Corolla yellowish, calyx teeth 1 mm long, ovate with prominent veins *nepetoides*
- Corolla rose or violet, calyx teeth 2.5-3.5 mm long; acuminate with dense pubescence *urticifolia*

A. foeniculum (Pursh) Kuntze

A haploid number of 9 (Fig. 1) was obtained for this species, and agrees with the earlier recorded number of $2n = 18$ (Löve & Löve 1964). Meiosis and pollen formation are normal with 100% good pollen. Normally outbreeding and insect pollinated but bagged plants produced a small number of seeds (29 from 76 flowers). Under open pollination each flower produces 3 to 4 seeds.

Variation.

Canadian material shows little variation in nature and under cultivation.

Distribution and Ecology (Map 1)

Occurs on the borders of woods and thickets and in rough grassland and prairie. The range extends from New Brunswick to British Columbia and northwards across the prairies to lat. 56° . In the United States it ranges southwards to Iowa and Colorado. Its northern limit coincides with the 65°F July isotherm and the -10°F January isotherm. This is primarily a prairie species, favouring a continental climate with its hot dry summers and severe winters. It flowers from July to August.

A. nepetoides (L.) Kuntze

A haploid number of 9 (Fig. 2) was determined from 2 populations. This confirms a previous report by Smith (1966). Meiosis and pollen formation are normal with 100% pollen fertility. Self compatible

Table 1

Accessions of material used

Species	Acc. No.	Source
<i>Agastache foeniculum</i> (Pursh.) Kuntze	N.A. 2291	East of Winnipeg, Manitoba.
<i>A. nepetoides</i> Kuntze	Can. 177	Rondea Park, Ontario.
	Can. 306	Kettle point, Ontario.
<i>A. urticifolia</i> (Bth.) Kuntze	Can. 322	Klamath falls, Oregon.
<i>Glechoma hederacea</i> L.	N.A. 3024	Douglas; Gaspe, Quebec.
	N.A. 2700	Fergus – Qutario.
	Can. 49	Horningmills, Ontario.
	Can. 42	Woodstock, Ontario.
<i>Moldavica parviflora</i> (Nutt.) Britt.	Can. 84	Sibly Peninsula, Ontario.
	Can. 86	Lakehead University Campus, Ontario.
	Can. 103	Kakabeka falls, Ontario.
<i>M. thymiflora</i> Rydb.	N.A. 2304	East of Winnipeg, Manitoba.
	N.A. 3813	Fort Saskatchewan, Alberta.
<i>Nepeta cataria</i> L.	Mulligan 2518 (DAO)	Berwick, Ontario.
	Can. 2	Waterloo – Ontario.
	Can. 33	Belwood Lake, Ontario.
	Can. 44	Warwich, Ontario.
	Can. 48	Belleville, Ontario.
	Can. 119	Elmira, Ontario.
	Can. 159	Horning mills, Ontario.
J.K. Morton S.n.	Innsville, Ontario.	
<i>N. mussini</i> Spreng.	L.S. Gill	Park seed company of South Carolina.
	S.n.	

* Vouchers are housed in the herbarium of the Department of Biology, University of Waterloo, Ontario, Canada. The designations Can. & N.A. refer to the material collected by L.S. Gill and Prof. J.K. Morton respectively.

and self pollinating. The flowers in this species are yellowish green in colour and smaller than in the other two species which have conspicuously coloured flowers and are outbreeders.

Distribution and Ecology (Map 2)

A plant of low moist rich woods and thickets. In Canada, confined to southern Ontario and the St. Lawrence lowlands. In the United States it extends from Massachusetts to South Dakota and southwards to Georgia, Tennessee, Kansas and Arkansas. Its northern limit follows the July isotherm of 65°F. Flowering from July to September.

A. urticifolia (Benth.) Kuntze

The present haploid count of 9 (Fig. 3) was obtained from plants collected at Klamath falls, Oregon. This confirms the previously recorded number of $2n = 18$ (Wedberg, 1959). The species occurs in British Columbia, but I was unable to obtain living material from this region. Meiosis and pollen formation are normal with 100% good pollen. An outbreeder which produced no seed in bagged plants. Among open pollinated plants at Waterloo, seed production was very low and only 22 viable seeds were obtained from 100 fruiting calyces, but this is probably because suitable pollinators do not occur in the Waterloo area. The flower structure, in which the stamens are much exerted from the corolla, suggests that in nature this plant is insect pollinated.

Distribution and Ecology (Map 3)

Occurs in the foothills and wooded slopes of southeastern British Columbia, east of the Rockies. Its range in the United States extends from west Montana through Washington and Oregon to California and Colorado. Flowers in July to August.

A. scrophulariaefolia (Willd.) Kuntze (Map 3)

Once collected from Thamesville, Kent County, Ontario by John Dearness in 1892. There is no mention whether this material was of cultivated or wild origin. Macoun (1884) mentioned it from Queenston Heights, Ontario, a record taken up by Soper (1949). An American species whose range extends from New York, New Jersey; southwards to North Carolina and westwards to Illinois, Iowa and Wisconsin. Probably a chance and temporary introduction into Canada and apparently not seen in this century.

Glechoma L.

A small Old World genus of 6 perennial species characterized by 15-nerved, tubular somewhat 2-lipped calyx, upper lip of corolla flat and tube narrowly obconic and straight. Represented in Canada by a single introduced species. The base number for this genus is 9.

G. hederacea L.

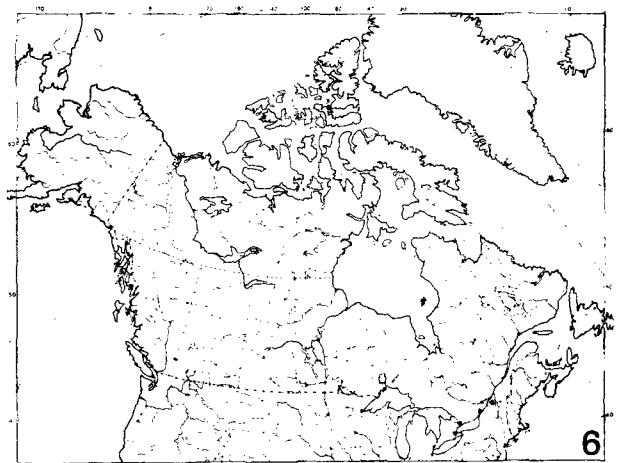
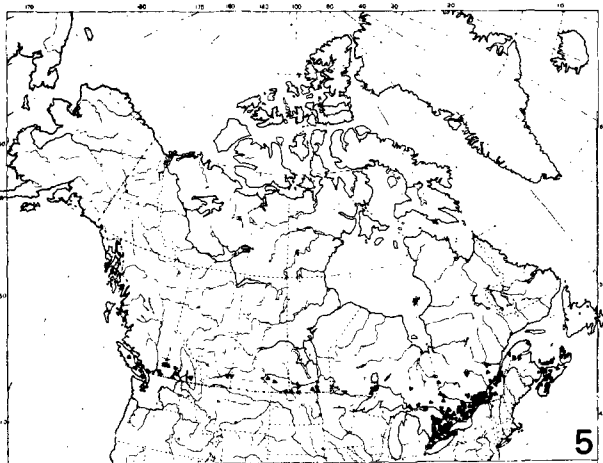
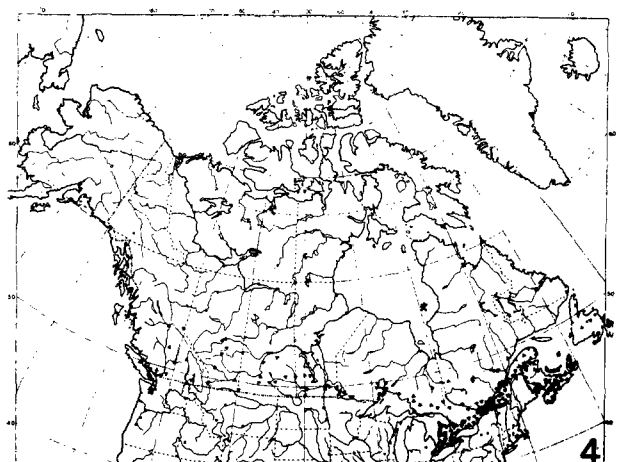
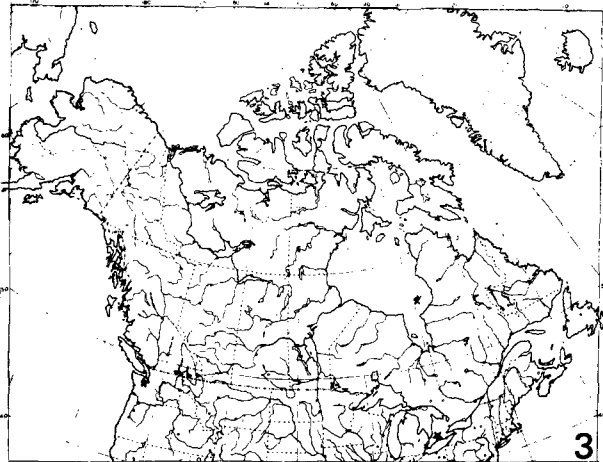
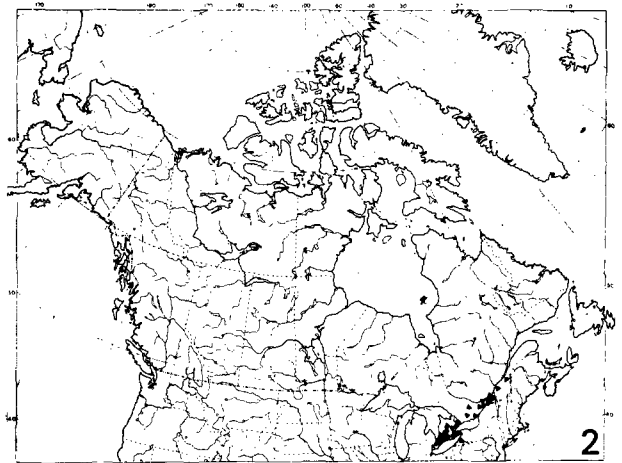
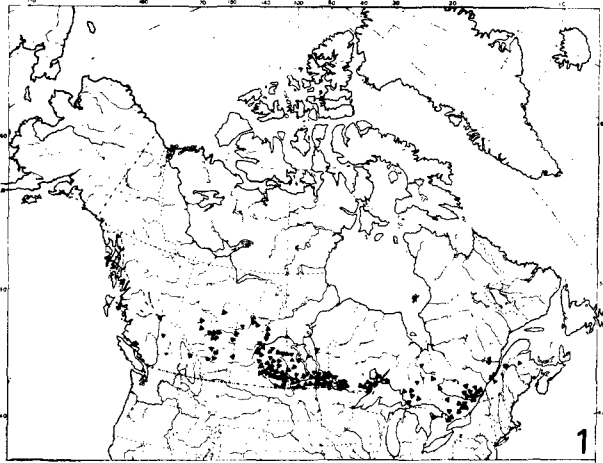
A haploid number of 18 (Fig. 4) was obtained from 4 populations of this species and of 9 (Fig. 5) for another population. Diploid numbers of 18, 24, 36 are reported in the literature for material from various parts of Europe. Meiosis and pollen formation are normal in both the cytotypes. Self-incompatible and no seeds were obtained from bagged plants. Under open pollination where the flowers were freely visited by insects seed setting was normal with 3 to 4 seeds produced per flower.

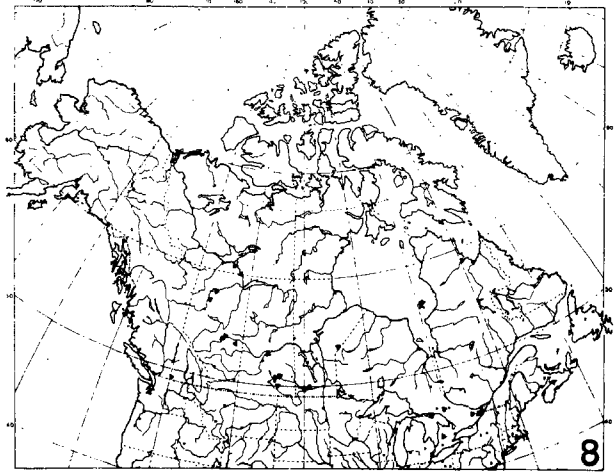
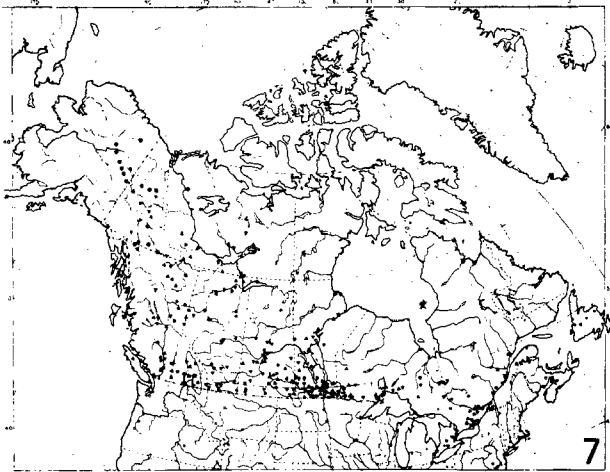
Variation

Shows variation in pubescence and size of leaf and flower. Under cultivation the differences in pubescence and leaf size are not retained, but flower size remains constant. The species is gynodioecious. In hermaphrodite plants the leaves are larger and dark green; the corolla size varies from 14-18 mm; the corolla tube is much exerted from the calyx and has a large lower lip; the stamens are exerted. In male sterile plants the leaves are generally bronze tinged and smaller; the corolla size varies from 7-10 mm and its tube is slightly exerted from the calyx with a short (4-5 mm) slightly inrolled lower lip; the stamens are reduced to small staminodes included in the tube. In the literature (e.g., Gleason, 1963) the male sterile form is referred to variety *parviflora* (Benth.) Druce. It seems inappropriate to me that these different sexual phases should be given taxonomic recognition. There are no morphological differences between these 2 cytotypes.

Distribution and ecology (Map 4)

Native of Europe, naturalized in North America and often abundant in moist shady waste places, lawns, cemeteries, around buildings and along river banks and fence lines. The statement in several floras and manuals (e.g., Steyermark, 1963) that its range extends from Ontario to Newfoundland, is incomplete. The map shows that it ranges from Newfoundland (lat. 47°, long. 53°W) to British Columbia (lat. 54°, long. 123°W). In the United States, it extends





Maps 1-8. Distribution of Canadian *Nepeteae*: (1) *Agastache foeniculum*; – (2) *A. nepetoides*; – (3) *A. urticifolia*, triangles, *A. scrophulariaefolia*, stars; – (4) *Glechoma hederacea*; – (5) *Nepeta cataria*; – (6) *N. mussonii*; – (7) *Moldavica parviflora*; – (8) *M. thymiflora*.

southwards to Georgia, Tennessee, Kansas and Colorado. In Canada, its northern limit follows the July isotherm of 55°F and the 10°F January isotherm. Perring & Walters (1962) also obtained a similar correlation with the July isotherm in the British Isles.

Nepeta L.

Annual or perennial herbs and shrubs, mainly distributed in temperate Eurasia and North Africa. Characterized by the curved tabular, 15-nerved calyx; flowers in many-flowered axillary whorls forming a terminal spike; and the upper lip of the corolla being flat. Represented in North America by a single naturalized species and another which occasionally escapes from cultivation. The base numbers are 9 to 17 (Darlington & Wylie, 1955). However, the report of $2n = 16$ in *N. teydea* (Larson, 1960) suggests a new base number of 8. The higher base number of 17 is probably of secondary origin.

N. cataria L.

Cytological investigations were carried out on 7 populations of this species and in all cases the haploid number of 17 (Fig. 6) was observed. This agrees with the previous count of $2n = 34$ (Mulligan, 1959), but differs from that of Suigura (1940), who obtained $2n = 36$. Meiosis and pollen formation are normal with 100% pollen fertility.

Apparently partially self-compatible and self pollinating. Under natural conditions, the flowers are frequently visited by bees (Clapham et al., 1962), which presumably bring about pollination. Under open pollination 4 seeds per calyx are usually observed but in bagged plants the number is reduced to 2 or 3.

Variation

In North America, showing little variation. A variety named *citriodora* Becker is sometimes cultivated and differs in having a strong lemon smell. Morphologically it is indistinguishable from the type variety and proved to have the same chromosome number.

Distribution and Ecology (Map 5)

Native of Eurasia, completely naturalized in North America and now a commonly occurring weed of waste land and roadsides. It ranges from Nova Scotia (lat. 46°N, long. 60°W) to British Columbia (lat. 50°N, long. 126°W) and southwards in the United States to Oregon, Georgia, Kansas and Utah. Steyermark (1963) also records it from Newfoundland, but no specimen has been found in Canadian herbaria to substantiate this record. Its northern limit in Canada and in the British Isles (Perring & Walters, 1962) coincides with the 60°F July isotherm. It is particularly abundant in southern Ontario and Quebec, but much rarer westwards. The possible reasons for its rarity in the west may be low precipitation and severe winters.

N. mussini Spreng

The haploid number of 9 (Fig. 7) confirms the previous reports of $2n = 18$ (vide Federov, 1969). Meiosis and pollen formation are normal with 75-80% fertile pollen. I was unable to obtain living material of Canadian origin, but seeds of this species were supplied by the Park Seed Company of South Carolina.

Distribution and Ecology (Map 6)

Commonly cultivated in gardens and rarely encountered as a relic of cultivation and a garden throw-out in southern Ontario and Quebec.

N. camphorata

An occasional garden plant which has escaped from cultivation on Mont Royal, Montreal and persisted for many years. First collected there by Cleonique (8133 in DAO, MT.) in 1934 and is still growing there. Dr. Wolf Jr. of the Arnold Arboretum comments on this material that it could be a hybrid with *N. mussini*.

Moldavica Adans.

A genus of annual, biennial or perennial herbs, composed of 50 species (Gleason, 1963), distributed across the northern hemisphere. Recognized by the 13-15-nerved, 2-lipped calyx, which has the upper lobe wider than the lower ones. Represented in North America by 2 species one of which is native. The base number is 7.

Key to the Canadian species of *Moldavica*

- 1 Annual, flowers in dense terminal clusters, calyx long-ciliate, bracts spinescent *parviflora*
- Perennial, flowers in whorls, forming a loose elongated interrupted raceme; calyx shortly pubescent, purple tinged; bracts not spinescent *thymiflora*

M. parviflora (Nutt.) Britt.

(Syn. *Dracocephalum parviflorum* Gray)

Four populations were examined cytologically and all had a haploid number of 7 (Fig. 8). This agrees with the report of Mulligan (1957). Meiosis and pollen formation are normal with 100% good pollen. Self compatible and self pollinating.

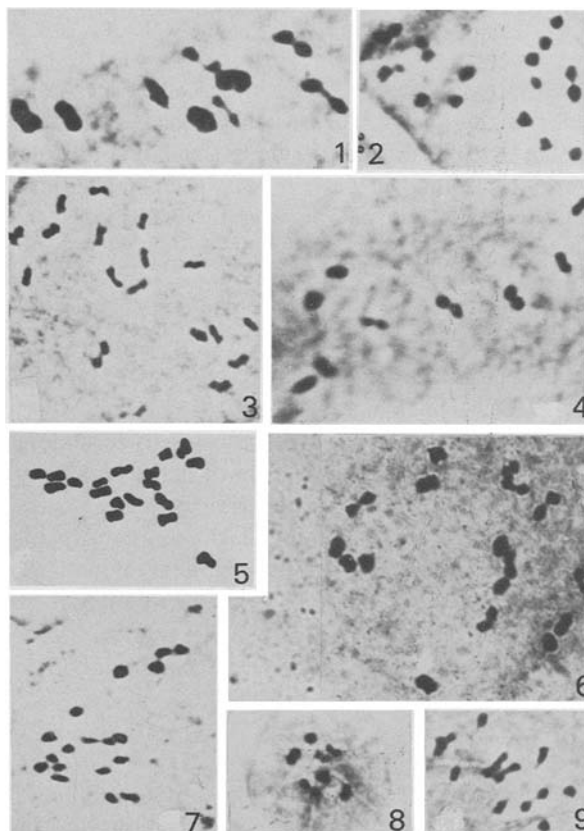
Distribution and Ecology (Map 7)

A weed of open and disturbed dry places, widely distributed across most of Canada and Alaska though

less frequent in the east. In the United States, it extends southwards to Nebraska, New Mexico, Arizona and Mississippi. Macoun (1884) gave Ottawa as its eastern limit. Its present distribution, further to the east, may be the result of recent dispersal into disturbed localities created by man. The northern limit (lat. 66°N, long. 129°W) follows the 60°F July and 20°F. January isotherms. The continental type of climate with dry hot summers and severe winters seem to favour this plant. Flowers from June to August.

M. thymiflora (L.) Rydb.

The haploid number of 7 (Fig. 9) was counted from 2 Canadian populations. This is in accordance with the report of $2n = c.14$ by Sorsa (1962). How-



Figs. 1-9. Meiotic chromosomes of *Nepeteae*, X 1800: (1) *Agastache foeniculum*, $n = 9$; - (2) *A. nepetoides*, $n = 9$; - (3) *A. urticifolia*, $n = 9$; - (4) *Glechoma hederacea*, $n = 9$; - (5) *G. hederacea*, $n = 18$; - (6) *Nepeta cataria*, $n = 17$; - (7) *N. mussini*, $n = 9$; - (8) *Moldavica parviflora*, $n = 7$; - (9) *M. thymiflora*, $n = 7$.

ever, Mulligan (1961) obtained $2n = 20$ from Canadian material. Seeds were grown from Mulligan's voucher specimen (2518) and a diploid number of 14 was obtained. Meiosis and pollen formation are normal with 100% good pollen.

Distribution and Ecology (Map 8)

Introduced from Eurasia and now of widespread but infrequent occurrence on open stony grazed ground along roadsides and in fields. Probably not persisting for more than a few years in most localities away from the prairies. Flowers from May to August.

I am indebted to Professor J.K. Morton for valuable guidance during the course of this study and also to the Curators of various herbaria for providing the specimens. This work was supported by a Canadian National Research Council grant in aid of research No AL1897 to Professor J.K. Morton. This is gratefully acknowledged.

References

- Clapham, A.R., T.G. Tutin & E.F. Warburg (1962). Flora of the British Isles. Cambridge Univ. Press, London. p. 1269.
- Darlington, C.D. & A.P. Wylie (1955). Chromosome atlas of flowering plants. London. p. 519 p. 926.
- Federov, A.A. (1969). Khromosomme Chisla tsvetkovykh rastery. Leningrad.
- Gill, L.S. (1970). Cytological observations on West Himalayan Labiatae: Tribe Stachydeae. *Phyton, B. Aires* 17(2): 177-184.
- Gill, L.S. (1971a). Chromosome number of *Lysimachia ciliata* L. *Rhodora* 73 (796): 556-557.
- Gill, L.S. (1971b). A biosystematic survey of the Canadian Labiatae. Ph.D. thesis, University of Waterloo, p. 313.
- Gleason, H.A. (1963). Illustrated flora of the Northeastern United States and adjacent Canada – Vol 3., p. 595. Lancaster Press Inc., Lancaster.
- Larsen, K. (1960). Cytological and experimental studies on the flowering plants of Canary Islands. *Biol. Skr.* 11 (3): 1-60.
- Lint, H. & Epling, C. (1945). A revision of Agastache. *Amer. Mid. Nat.* 33(1): 207-230.
- Löve, A. & D. Löve (1964). In: IOPB Chromosome number reports I. *Taxon* 13: 100-110.
- Macoun, J. (1884). Catalogue of Canadian plants. Geological survey of Canada. Part II. Gamopetalae. Dawson Brother, Montreal.
- Mulligan, G.A. (1957). Chromosome numbers in Canadian Weeds. I. *Can. J. Bot.* 35: 779-789.
- Mulligan, G.A. (1959). Chromosome numbers of Canadian weeds. II. *Can. J. Bot.* 37: 81-82.
- Mulligan, G.A. (1961). Chromosome numbers of Canadian weeds. III. *Can. J. Bot.* 39: 1057-1066.
- Perring, F.H. & S.M. Walters (Eds.) (1962). Atlas of the British flora. London & Edinburgh.
- Smith, E.B. (1966). In: IOPB Chromosome number reports. VII. *Taxon* 15: 155-163.
- Soper, J.J. (1949). The vascular plants of southern Ontario. Thesis, Univ. of Toronto. *J. Fed. Ont. Naturalist*: 95.
- Sorsa, V. (1962). Chromosomenzahlen Finnischer Kormophyten I. *Annls Acad. scientiarum fennicae ser. A* IV. Biol. 58: 1-14.
- Steysmark, J.A. (1963). Flora of Missouri. Iowa State Univ. Press. Ames, Iowa. 1728.
- Sugiura, T. (1940). Studies on the chromosome numbers in higher plants. IV. *Cytologia* 10: 324-333.
- Wedburg, H.L. (1959). In: Documented chromosome numbers of plants. *Madroño* 15: 51.
- Willis, J.C. (1966). A dictionary of the flowering plants and ferns. 7th ed. Cambridge University Press, London, p. 1214.