

The taxonomy and distribution in eastern Canada of *Polygonum arenastrum* ($4x = 40$) and *P. monspeliense* ($6x = 60$), introduced members of the *P. aviculare* complex

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The introduced nonmaritime knotweeds have generally been regarded in North America as comprising a single species called *P. aviculare* L. In recent years cytological and morphological studies have suggested that at least two chromosome races are present and that certain morphological features are correlated with chromosome number. There have been, however, discrepancies in the reports of the distribution and relative abundance of the two races. Studies of the morphology and cytology of introduced knotweeds in eastern Canada confirm the existence of two groups that are recognizable at species rank, and establish that the most common knotweeds in open habitats, e.g., along roadsides and sidewalks, are tetraploid plants distinguishable from their hexaploid relatives by the relatively uniform size of their leaves, the short and narrow free portion of the perianth segments, and by one side of the fruit being very much narrower than the other two. These plants are referable to *P. arenastrum* Boreau. This species is compared with the heterophyllous hexaploid, usually called *P. aviculare* sensu stricto, or, if that is considered a *nomen ambiguum*, *P. monspeliense* Pers. A table of distinguishing features, illustrations of the two species, and maps of their distribution in eastern Canada are provided.

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Les *Polygonum* introduits et non maritimes de la section *Avicularia* ont généralement été considérés en Amérique du Nord comme une seule espèce nommée *P. aviculare* L. Au cours des dernières années, des études cytologiques et morphologiques ont révélé que ces plantes comprennent au moins deux races chromosomiques et que certains caractères morphologiques sont en corrélation avec les nombres chromosomiques. Cependant, il existe des divergences entre les auteurs quant à la distribution et à l'abondance relative des deux races. Des études morphologiques et cytologiques de ces *Polygonum* introduits dans l'est du Canada confirment la présence de deux groupes, qui peuvent être reconnus au niveau spécifique, et démontrent que les individus les plus fréquents dans les habitats ouverts, par exemple au bord des routes et le long des trottoirs, sont des plantes tétraploïdes. On peut les distinguer des plantes hexaploïdes apparentées par les caractères suivants: la dimension de leurs feuilles est relativement uniforme, la partie libre des segments du périanthe est courte et étroite, et un côté du fruit est beaucoup plus étroit que les deux autres. Ces plantes tétraploïdes peuvent être rapportées au *P. arenastrum* Boreau. Cette espèce est comparée à l'espèce hexaploïde hétérophylle habituellement nommée *P. aviculare* sensu stricto ou, si ce nom est considéré comme un *nomen ambiguum*, *P. monspeliense* Pers. On présente un tableau des caractères distinctifs, des illustrations des deux espèces et des cartes de leur répartition dans l'est du Canada.

[Traduit par le journal]

Introduction

Most North American manuals (e.g., Fernald 1950; Gleason and Cronquist 1963; Hitchcock and Cronquist 1964) recognize only one species among the introduced weedy or ruderal knotweeds growing on the continent. This goes under the name *Polygonum aviculare* L. On the basis of cytological and morphological studies that extend the work of Styles (1962) in Britain, Mertens and Raven (1965) concluded that two species of the "*Polygonum aviculare* complex" exist in North America. One has a chromosome number of $2n = 6x = 60$, notably longer leaves on the main stems than on the branches, a deeply divided perianth, and fruits with three more or less equal concave sides; they called this species *P. aviculare* sensu stricto. The other species *P. arenastrum*

Boreau, has a chromosome number of $2n = 4x = 40$, is more homophyllous, has shorter perianth segments, and one concave side of the fruit much narrower than the other two, usually convex, sides. Mertens and Raven claimed that most North American collections referred to "*P. aviculare*" are really *P. arenastrum* and that plants referable to this species occur throughout the temperate United States and southern Canada and are occasionally found further north.

In his treatment of *Polygonum* in the *Flora of Canada*, Scoggan (1978) adopts Mertens and Raven's (1965) treatment so far as the key is concerned, but suggests that *P. aviculare* sensu stricto is restricted in Canada to one locality in the Yukon and one in Alberta. Scoggan lists a large number of synonyms under *P. arenastrum*, including not only distinctive native species such as *P. caurianum* Robinson, but also *P. heterophyllum* Lindm. and *P. monspeliense* Pers. which

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are considered to apply to the heterophyllous hexaploid by European workers (Styles 1962; Tsvelev 1979).

The purpose of the present study was to assess the status of *P. arenastrum* in eastern Canada, particularly in the light of Mertens and Raven's (1965) claim that it is more abundant than *P. aviculare* s.s., and of Scoggan's (1978) implication that it occurs almost to the exclusion of that species. The investigation was designed, therefore, to determine whether *P. arenastrum* can be distinguished from other knotweeds in eastern Canada and, if so, to provide an account of its distribution, relative abundance, and any habitat preferences. Coastal plants, including species such as *P. oxyspermum* Meyer & Bunge ex Ledeb. and *P. fowleri* Robinson, were not included in this study.

Materials and methods

About 250 herbarium specimens of the *Polygonum aviculare* complex from eastern Canada, representing the entire collections at ACAD and DAO (for explanation of abbreviations see Holmgren and Keuken 1974) were examined. This selection provided good representation from throughout eastern Canada. Critical observations were made of those characteristics of the leaves, flower clusters, perianth, stamens, and fruit that have been used in the classification of the group (Mertens and Raven 1965; Scholz 1959a, 1959b, 1960, 1977; Styles 1962; Tsvelev 1979). In addition, observations were made on pollen grains mounted in glycerine jelly.

Between 1976 and 1980 over 100 field collections of members of the complex were made in Ontario, Quebec, and the Atlantic provinces; both herbarium specimens and seed were collected. Observations were made on variation in association with habitat. After cold treatment (5°C) and scarification, where necessary, seed was germinated from a number of these collections; germination was in petri dishes in the light at 20–25°C. The plants were then grown in a greenhouse at the Central Experimental Farm, Ottawa. Chromosome counts were made on mitotic preparations from root tips using the modified acetocarmine squash method described by Tsuchiya and Nakamura (1979).

Results

Examination of morphological features of herbarium specimens and field collections of members of the *Polygonum aviculare* complex from eastern Canada, revealed the existence, within the overall variation, of one very distinctive and relatively uniform group of plants. At time of flowering and fruiting these characteristically have numerous, more or less prostrate, stems that appear uniformly leafy; this appearance is a combination of more or less equal-sized leaves and their rather regular spacing along the stems (Fig. 1A). Plants of this type are also characterized by narrow perianth segments that do not overlap in fruit and which are scarcely longer than the fused portion of the perianth (Fig. 1B); although variation occurs, this perianth tube is characteristically cuneate at the base, even in fruit. The nuts are trigonous,

but with very unequal sides, one being concave and about half as wide as the other two, which are generally convex (Fig. 1D). These are the characteristics ascribed to *P. arenastrum* Boreau by European botanists (e.g., Styles 1962; Webb and Chater 1964) and by Mertens and Raven (1965).

Chromosome counts on roots tips of progeny of plants with these characteristics from seven populations (Table 1) were found to be $2n = 40$, the number reported for *P. arenastrum* by other workers (Styles 1962; Mertens and Raven 1965; Moore et al. 1970). These plants, that seem, therefore, to be referable to *P. arenastrum*, are widespread in eastern Canada (Fig. 3) and are nearly always found in open, sandy or gravelly habitats particularly along roadsides and paths. They have generally been identified as "*P. aviculare* L."

The morphological studies showed, however, that although *P. arenastrum* was common in eastern Canada, there was an even larger number of specimens of the *P. aviculare* group in the herbaria examined, that were not referable to that species. Some of these were from coastal habitats (e.g., beaches and sand dunes) and appear to represent native populations with different characters or character combinations from the weeds of inland locations; the morphology, cytology and taxonomy of these plants will be reported elsewhere (J. McNeill, in preparation).

Almost all the plants from inland habitats that were not referable to *P. arenastrum* differed in being less prostrate and in having markedly heterophyllous leaves, with the uppermost leaves being very small compared with those at the base of the plant (Fig. 2A). Moreover, the perianth was divided at least two-thirds way to the broad base, and the segments overlapped even in fruit (Figs. 2B, 2C). The nut had almost equal, usually concave, sides (Fig. 2D) and was more distinctively patterned than in *P. arenastrum*. Although flower and nut sizes were sometimes less than those reported for the British plants that Styles (1962) called *P. aviculare* L. (sensu stricto), they match this taxon in all other details and seem best referred to it; other European workers (e.g., Scholz 1959a, 1959b, 1960; Tsvelev 1979) apply the name *P. monspeliense* Pers. to this species (see Conclusions). Chromosome counts of $2n = 60$ were obtained from root tips of progeny from two collections of plants of this taxon (Table 1). From the herbarium specimens examined, plants of this species are more widely distributed in eastern Canada than are those of *P. arenastrum* (Fig. 3). Like those of *P. arenastrum*, plants of *P. aviculare* (*P. monspeliense*) are found in waste places and along roadsides; they are common along railroads and are also found as weeds in gardens and cultivated fields, habitats into which *P. arenastrum* does not usually penetrate.

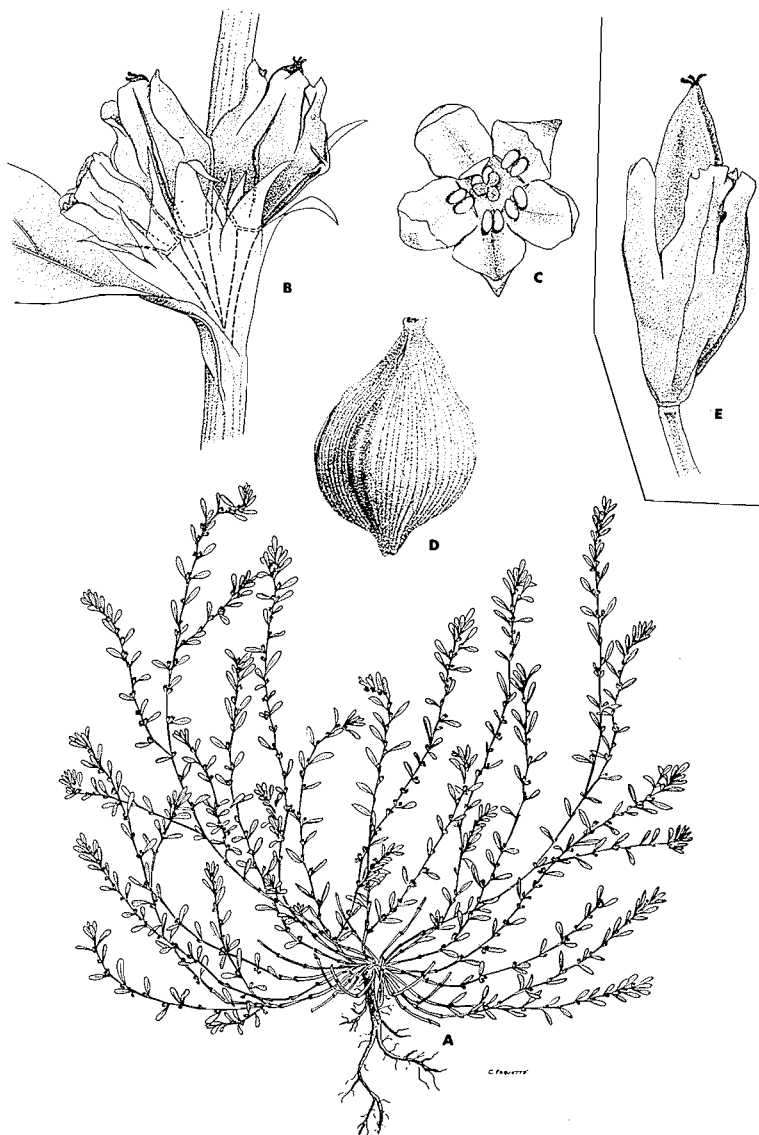


FIG. 1. *Polygonum arenastrum*. (A) Habit. $\times 1/3$. (B) Flowering and fruiting cluster. $\times 9$. (C) Open flower. $\times 12$. (D) Nut. $\times 15$. (E) Late season fruiting condition. $\times 12$. A–D are based on specimens collected 12 September 1939 at Shirley Bay, Ottawa-Carleton Regional Municipality, Ont. W. H. Minshall 1929. DAO 277827; E from a specimen collected 3 October 1963 between St. Vincent de Paul and Riviere des Prairies, Hochelaga Co., Quebec, Carol Shaw. DAO 606102.

The distinguishing features of the two species are enumerated in Table 2. These data were obtained from the herbarium material examined. The most reliable characters for identification are (a) the degree of heterophylly (especially in young plants), (b) the shape and relative length of the perianth segments, and (c) the relative width of the sides of the nut.

Measurements were made of pollen grain diameter on plants of *P. arenastrum* and *P. aviculare* (*P. monspeliense*) from both Canada and Europe but no significant differences were found. In *P. arenastrum*, how-

ever, grains were invariably tricolpate, whereas in most samples of *P. aviculare* (*P. monspeliense*) 20–80% of the grains had four furrows and in some samples a few had five or even six furrows.

Conclusions

These morphological and cytological studies establish that *P. arenastrum* is widespread and common in eastern Canada, confirming Mertens and Raven's (1965) reports of the occurrence of this species in North America. Plants that Mertens and Raven would refer to

TABLE 1. Origin of seed from which plants were grown for chromosome counts on root tips undergoing mitosis. Four digit numbers represent field collections; those prefixed C, cultivated vouchers; all specimens are preserved in DAO

Species	Locality
<i>Polygonum arenastrum</i> $2n = 40$	<ol style="list-style-type: none"> (1) Newfoundland: St. Johns: Science Building, Memorial University; cracks in sidewalk. <i>J. McNeill</i> 6108 (voucher: <i>McN</i> C78-76) (2) Nova Scotia: Cape Breton Co.: S shore of East Bay, ca. 1 km E of Big Pond on highway 4; gravel shoulder of road. <i>J. McNeill</i> & <i>M. E. Barkworth</i> (<i>McN</i> 6204) (voucher: <i>McN</i> C78-79) (3 and 4) Nova Scotia: Victoria Co.: South Ingonish; sandy shoulder of road. <i>J. McNeill</i> 5105 (robust plants), 5106 (slender plants) (vouchers: <i>McN</i> C80-37 and C80-38) (5) Nova Scotia: Colchester Co.: Truro: Robie Street; gravel outside Hoyt and Paterson's garage. <i>J. McNeill</i> 5058 (voucher <i>McN</i> C80-20) (6) Nova Scotia: Lunenburg Co.: Lunenburg: cracks in sidewalk opposite Bluenose Lodge. <i>J. McNeill</i> 5132 (voucher <i>McN</i> C80-35) (7) New Brunswick: Charlotte Co.: ca. 4 km N of St. Andrews on highway 127 to St. George; waste ground by road and roadside gravel. <i>J. McNeill</i> 5191 (vouchers <i>McN</i> C80-42, C80-43, C80-44, C80-45, C80-46, C80-48) (8) New Brunswick: Northumberland Co.: Escuminac Provincial Park; gravel between car park and edge of dunes. <i>J. McNeill</i> 5037 (voucher <i>McN</i> C80-15) (9) New Brunswick: Restigouche Co.: Jacquet River Provincial Park; grassy edge of toilets. <i>J. McNeill</i> 5025 (voucher <i>McN</i> C80-18)
<i>Polygonum monspeliense</i> (= <i>P. aviculare</i> sensu stricto) $2n = 60$	<ol style="list-style-type: none"> (1) Nova Scotia: Kings Co.: Wolfville: 3 Braemar Drive; weed in backyard. <i>P. J. Vander Kloet</i>, <i>M. E. Barkworth</i>, and <i>J. McNeill</i> (<i>McN</i> 6216) (voucher <i>McN</i> C78-81) (2) Quebec: Frontenac Co.: Shenley and Forsyth township line: ca. halfway from La Guadelope on road to St.-Hilaire-de-Dorset; muddy pasture at gate. <i>J. McNeill</i> 6255 (voucher <i>McN</i> C78-27)

P. aviculare sensu stricto, are however, much more abundant and widely distributed than these authors suggest. The distribution of the two species in eastern Canada is compatible with that reported for New York state by Mitchell and Dean (1978) and for Indiana by Savage and Mertens (1968).

The material examined suggested that *P. arenastrum* is more common than *P. aviculare* (*P. monspeliense*) in eastern Ontario and in parts of Nova Scotia, whereas it was less well represented in New Brunswick and Quebec (Fig. 3). Field observations confirm that *P. arenastrum* is less widely distributed in parts of New

Brunswick and eastern Quebec than elsewhere, but the concentration of records in eastern Ontario and Nova Scotia is due to the better representation from these areas in the herbaria used for the study. *Polygonum arenastrum* is the common species of roadsides, paths, and parking lots; it is rarely found in more natural habitats or associated with native species and it is not generally a field weed. As a result it tends to be passed over as unworthy of preservation, except where very intensive collecting has occurred.

The only previous study on *Polygonum* in eastern Canada is that by Löve and Löve (1956). Although some

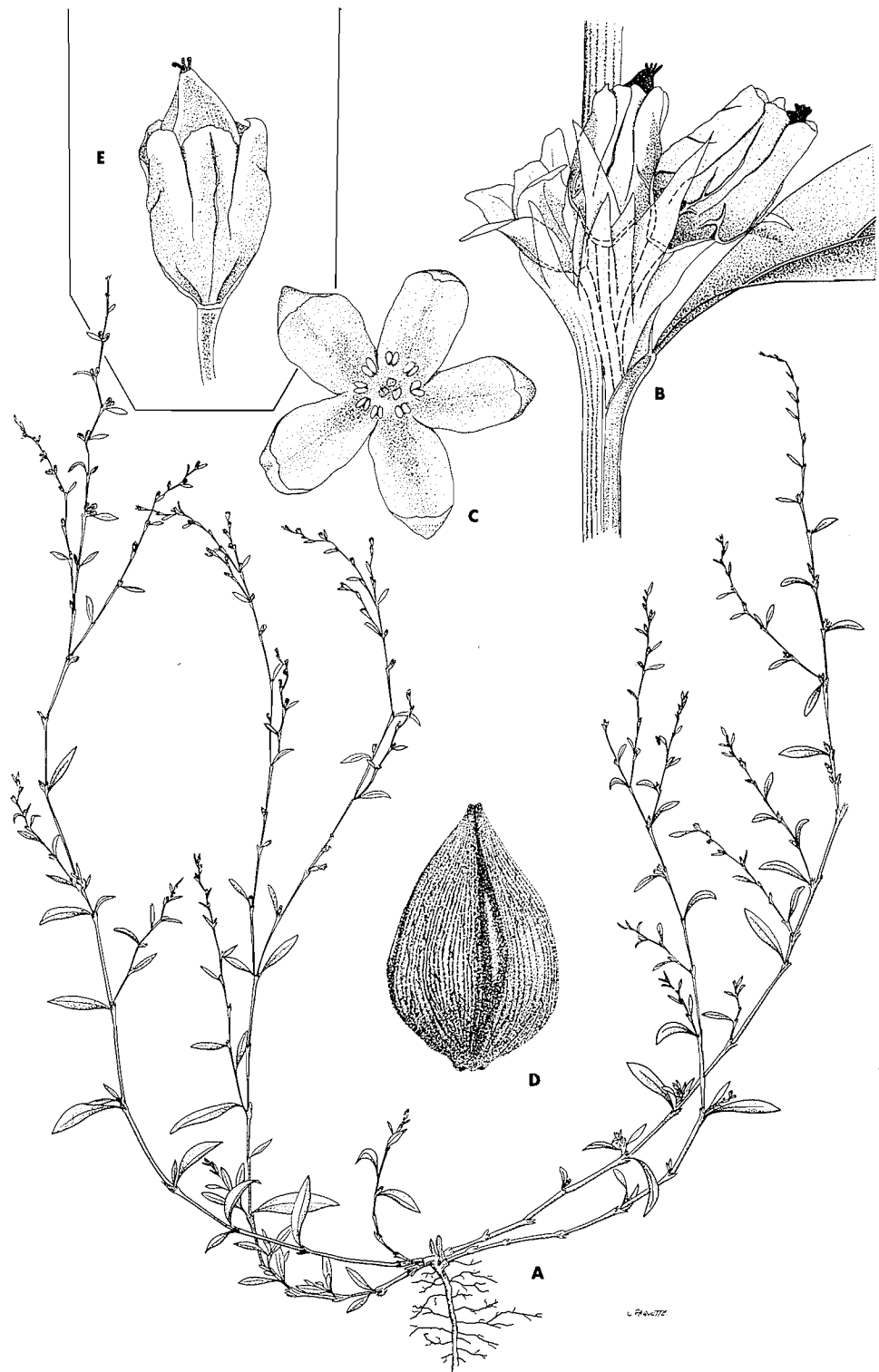


FIG. 2. *Polygonum monspeliense* (*P. aviculare* sensu stricto). (A) Habit. $\times 4/9$. (B) Flowering and fruiting cluster. $\times 9$. (C) Open flower. $\times 12$. (D) Nut. $\times 15$. (E) Late season fruiting condition. $\times 11$. A–D are based on specimens collected 9 August 1969 at Camp Hermosa, 6 miles N of Goderich, Huron Co., Ontario. W. H. Minshall 4819. DAO 612913; E from a specimen collected 4 October 1960, 4 miles N of Prescott, Grenville Co., Ont. W. G. Dore 1835. DAO 277828.

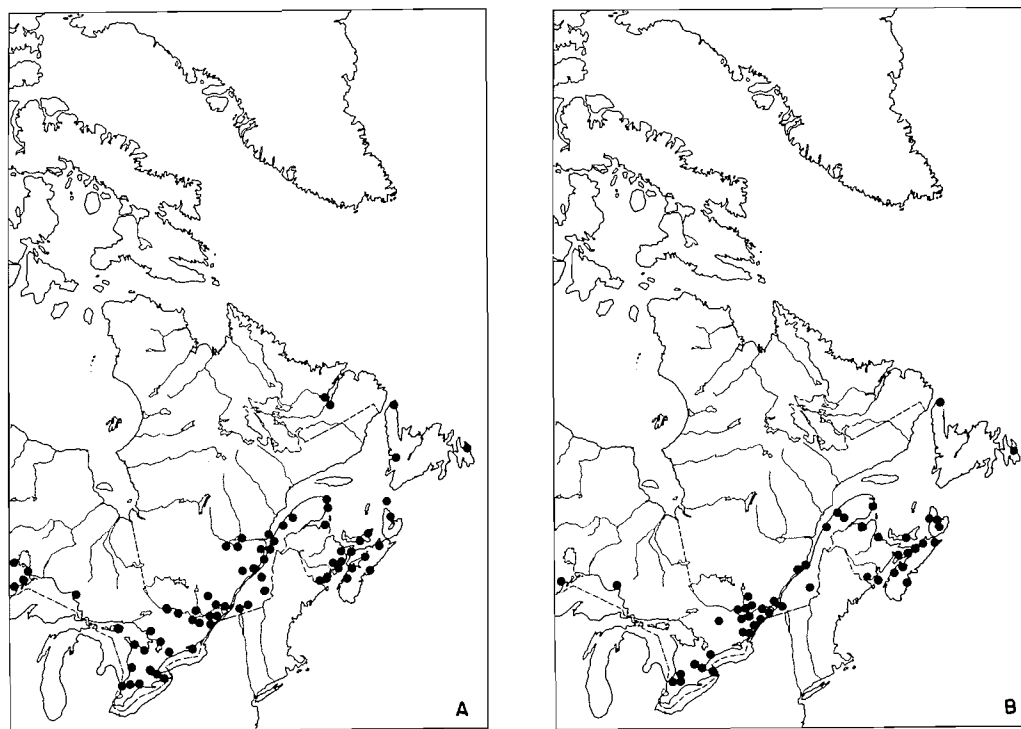


FIG. 3. Distribution of *P. arenastrum* (A) and *P. monspeliense* (*P. aviculare* sensu stricto) (B) in eastern Canada. Based on collections in DAO and ACAD.

of the taxa that they name and to which they attribute characteristic chromosome numbers are difficult to interpret in the light of the findings of other workers (cf. comments in Styles (1962, pp. 200–202) and in Mertens and Raven (1965)), Löve and Löve do clearly recognize the homophyllous tetraploid and heterophyllous hexaploid that are distinguished here. Following workers such as Komarov (1936) and Voroshilov (1954), Löve and Löve (1956) apply the name *P. aviculare* to the species called *P. arenastrum* here and in other recent works, including their own (e.g., Löve and Löve 1975); Löve and Löve (1956) use the name *P. heterophyllum* Lindman for the heterophyllous hexaploid.

Because of the widespread confusion in the precise application of the name *P. aviculare*, some authors (e.g., Marek 1954; Soó 1970; Scholz 1977) have abandoned it as a “*nomen ambiguum*.” The ambiguity has been intensified by the recent claim by Tsvelev (1979) that the previous lectotypification of *P. aviculare* L. by a heterophyllous specimen (Styles 1962) is incorrect; instead Tsvelev proposes typification by a homophyllous specimen referable to *P. arenastrum*. I have established elsewhere (McNeill 1981) that Tsvelev’s challenge to Styles’s lectotypification is unfounded under the *International code of botanical nomenclature* (ICBN) (Stafleu 1978). Nevertheless, because of the widespread and continuing incorrect use of the name for

the species correctly called *P. arenastrum*, I have proposed that *P. aviculare* be listed as a rejected name under Article 69 of the ICBN. The next available name for the heterophyllous hexaploid that is widespread in eastern Canada appears to be *P. monspeliense*. The application of an earlier name, *P. bellardii*, is uncertain; from his illustration, Small (1895) appears to have applied it to plants of this species, but European authors (e.g., Webb and Chater 1964; Tsvelev 1979) have referred it to one of two smaller-flowered species not apparently found in eastern Canada. The original description and illustration, although inadequate for critical identification, suggest that Allioni had material different from both *P. monspeliense* and *P. arenastrum*.

In McNeill (1981) a suggestion is made for amendment to the ICBN that would allow the continued use of *P. aviculare* in an “aggregate” sense by those who do not regard *P. arenastrum* and *P. monspeliense* (= *P. aviculare* sensu stricto) as specifically distinct.

Scoggan’s (1978) treatment of the *P. aviculare* group is now seen to be unsatisfactory. His key, based on that in Mertens and Raven (1965), does distinguish the tetraploid homophyllous *P. arenastrum* from the hexaploid heterophyllous plants, to be called *P. monspeliense* if *P. aviculare* is rejected, but his account of these species in the text is seriously in error. Both species are common and widespread. Moreover, *P. arenastrum* is

TABLE 2. Distinguishing features of *P. arenastrum* and *P. monspeliense* (*P. aviculare* s.s.)

	<i>P. arenastrum</i>	<i>P. monspeliense</i> (<i>P. aviculare</i> s.s.)
Subtending stem leaves	Usually slightly longer than lowest leaf of a lateral branch; length ratio 1–1.5(–1.6)	Usually much longer than lowest leaf of a lateral branch; length ratio (1.2–)1.5–2.0
Leaves on a single stem or branch	All approximately equal	Usually becoming progressively smaller towards apex
Lower leaves	0.9–2.0 × 0.2–0.6 cm, often elliptical to oblanceolate, 3–4 times as long as wide	2.3–4.5 × 0.4–1.2 cm, often narrowly elliptical, 4–5 times as long as wide
Leaf apex	Acute to obtuse	Acute
Perianth tube	Usually gradually narrowed to base	Often rather abruptly contracted below the nut
Perianth segments	About 0.5–0.6 times as long as perianth, rounded oblong, scarcely overlapping in fruit	About 0.6–0.75 times as long as perianth, ovate-oblong, generally overlapping even in fruit
Fruiting perianth	1.9–3.0 mm long	(2.5–)2.9–4.0 mm long
Stamens	Usually 5, occasionally up to 8	Often 8, sometimes 5, occasionally 6 or 7
Pollen	Always tricolpate	Usually at least some grains tetracolpate
Nut ("normal" summer fruit)	1.8–2.5 × 1.2–1.6 mm, medium to dark brown, finely pitted, the two widest sides subequal, convex, 1.5–2 times third side	(2.0–)2.2–3.0 × 1.5–1.8 mm dark brown, strongly pitted, the sides subequal, but successively less wide, usually concave, the widest less than 1.5 times the narrowest
Exserted nuts in late season fruit	Commonly produced, very narrowly ovoid, up to 4 mm long, olivaceous to medium brown, smooth to shiny, prominently exserted from perianth	Rarely produced, similar to those in <i>P. arenastrum</i> , but not as long and less prominently exserted

not the broad, heterogeneous taxon that Scoggan implies by his distributional data and synonymy; rather it is a distinctive and relatively uniform segregate of the *P. aviculare* complex, that is found abundantly in open habitats, and can withstand trampling, drought, and the relatively high salt concentrations associated with roadsides in eastern Canada. Details of the publication of the accepted names and of the unequivocal synonymy are as follows.

P. arenastrum Boreau, Flora Centre Fr. ed. 3, 2: 559. 1857. Type: apparently not extant; post-1857 Boreau collections named by him at ANG, cf. Styles (1962, p. 205).

Syn.: *P. calcatum* Lindman, Bot. Not. 1904: 144. 1904. Type: not designated; Plate: op. cit. p. 140!

P. aequale Lindman, Svensk Bot. Tidskr. 6: 692. 1912. Type: not designated; Plates: op. cit. t. 23, f. 10–13; t. 26, f. 1–3, 5!

P. aviculare sensu Löve & Löve, Can. J. Bot. 34: 515, 519. 1956, et sensu Tsvelev, Nov. Sist. Vyssh. Rast. 15: 137. 1979, non L.

P. monspeliense Pers., Syn. Plant. 1: 439. 1805. Type: "Monspeli", Thiebaud. G-DC (fiche!).

Syn: *P. aviculare* L., Sp. Plant. 362. 1753, nom. rejic. sub Article 69 (cf. McNeill 1981). Lectotype (Styles 1962, p. 205): "15 aviculare," LINN 510.23!

P. heterophyllum sensu Lindman (quoad descr.), Svensk Bot. Tidskr. 6: 690. 1912, et auct. plur., non *P. heterophyllum* Lindman quoad typ. (nom. illeg. = *P. rurivagum* Jordan ex Boreau: ICBN Article 63, 7.11).

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