A STUDY OF THE GENUS ANEMONE

AS FOUND IN MANITOBA.

by

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THE ANEMONES OF MANITOBA.

The genus Anemone, although represented by only six species in this province, well deserves our careful consideration, if only for the reason that one of its most widespread members, Anemone patens, commonly known as the prairie crocus, has very fittingly been chosen as the floral emblem of Manitoba. While winter's snow yet lingers in the valleys, and not a green blade of grass can be found, this hardy little flower emerges from its furry coat, disregarding the chilling wind, and clothes every sunny hillside with lilac, encouraging us to believe that it is really Spring.

The white wood anemones, A.canadensis and A.quinquefolia, though more retiring than their predecessor, have, by the size, purity and profusion of their blossoms, been rendered very attractive, and are well worth a detailed study.

The remaining three species, A.cylindrica, A.multifida, and A.virginiana, while their flowers are not so large or conspicuously colored, are noticeable to the most casual observer, and intensely interesting to a botanist, by reason of their curiously woolly fruits, which often remain on the plant over the winter.

The position of the anemones in the systematic order of plants is as follows:

Division II	Spermatophyta.
Subdivision II	Angiospermae.
Class 2	Dicotyledonae.

Sub-class 1.	Archichlamydeae.
Order,	Ranunculales.
Family,	Ranunculaceae.
Tribe,	Anemoneae.
Genus,	Anemone.

(Gray's Manual of Botany, 7th edition, 1908.)

According to the chart devised by Mez and Ziegenspeck (1926) in which plants are classified and related in reference to their serum reactions, all plant life may be represented as branching from one main stem, which has its roots in autotrophic bacteria, and progresses upward through algae, fungi, mosses, ferns, gymnosperms, and angiosperms, till at its apex we find the Compositae. Among the lowest of the dicotyledons is the Ranunculaceae, shown as a short branch with no offshoots, and at the same height as the Rosaceae, which has many families related to it. The Ranunculaceae family, therefore, is primitive, but not so much so as the Menispermaceae, Ceratophyllaceae, Nymphaceae and Magnoliaceae, which all appear below it on the chart.

The family Ranunculaceae, to which the anemones belong, is considered by recent authors (e.g.Hutchinson, 1926[1]), Clements[2],), to contain the most primitive of the herbaceous

1. Families of Flowering Plants, (Hutchinson,(1926)
2. Flower Families and Ancestors, Clements, (1928.)

Dicotyledons. This opinion is based on several characteristics, among which are the following:-

1.- They are nearly all perennials with alternate leaves.

2.- The flowers are predominately hypogynous, actinomorphic and hemicyclic to rarely completely cyclic.

3.- All the parts of the flower are free, as a rule, the sepals and petals (if present) are often numerous, while the stamens and pistils are usually so.

4.- The seeds contain a copious endosperm surrounding a very small embryo.

The tribe Anemoneae (Gray, 1908), comprises the genera Ranunculus, Myosurus, Adonis, Thalictrum, Anemone, Trautvetteria, Anemonella and Hepatica, of which the first five occur in Manitoba.

The foregoing are similar in that they are all herbs; the sepals, which may number from 3 to 20, are imbricated in the bud; the stamens are numerous; the carpels are one-ovuled; the fruit is an akhene; the leaves may be basal or alternate, and are usually divided. Anemone resembles Hepatica in the fact that it has no petals, and possesses an involucre, remote from the flower in the former genus, but close to it and resembling a floral envelope in the latter. Ranunculus and Adonis have petals, but no involucre, while Thalictrum has neither. The ovule in Ranunculus is erect, but in all the other related genera it is suspended. The Anemones are, with the exception of A. patens, without nectaries, while Ranunculus and Myosurus have nectariferous pits at the base of the petals. The above-mentioned and other characteristics of these genera are set forth in the accompanying table.

TRIBE ANEMONEAE.

	Ranunculus	Bactrachium	Thalictrum	Adonis
Duration	Annual or perennial	perennial (aquatic)	herbaceous perennial	annual
Roots or Rootstocks	Fleshy fibrous	fibrous	short perenn nial rootstock	
Leaves	alternate, simple, entire, divided or dissected	alternate, dissected or palmately lobed	ternately decompound, basal and cauline, alternate petioles dilated at base.	alternate, pinnately dissected, segments linear.
Involucre	absent	absent	absent	absent
Inflorescence	solitary or corymbed yellow or white	solitary small white	racemed or panicled, dioecious, purplish or greenish	solitary, red or yellow.
Sepals	usually 5, imbricate in bud, spurless deciduous	usually 5, imbricate in bud, spurless	4 or 5 small imbricate in bud, spurless	5 - 8 imbricate in bud, spurless
Petals	often more than 5, with nectariferous pit	usually 5, with nectariferous pit	absent	5-16, with no nectariferous pit
Stamens	numerous, occasionally few all anther bearing	numerous occasionally few; all anther bearing	numerous exserted, filaments often dilated	numerous; all anther bearing
Pistils	several or many, one-ovuled	many in a globular head	4 - 15 few	numerous in a head
Styles	Subulate long, & filiform		Subulate	persistent
Stigmas			unilateral or sessile & elongate	
Achenes	capitate or spicate, generally flattened, smooth or echinate, ovule ascending or erect	oblique, compressed, not margined; transversely wrinkled, beakless, or short beaked; ovule ascending or erect	one seeded, ribbed or nerved, stipitate or sessile (inflated in some species; ovule suspended	1 seeded, capitate or spicate, rugose reticulated, tipped with the persistent styles ovule suspended

TRIBE ANEMONEAE

	Anemone	Pulsatilla	Hepatica	Myosurus
ration duration	herbaceous perennial	herbaceous perennial	perennial	annual
oots or ots or otstocks Rootstocks	horizontal rootstocks	tap root	fibrous	fibrous
aves leaves.	basal, lobed divided or dissected	basal, long petioled ternately divided central division stalked, lateral divisions 2-parted	basal, evergreen purplish red beneath 3 lobed	basal, linear tufted
volucre Involucre	remote, sessile or short petioled	remote sessile 3-leaved	close under flower, sessile 3-leaved	absent
flores- cence	solitary or cymose, white greenish, red or yellow	solitary purple or white	solitary white or purple	solitary greenish-yellow, small
pals Sepals.	4-20, petioled, imbricate in bud, spurless	5-7 imbricate in bud spurless	imbricate in bud spurless	5, imbricate in bud, spurred
tals Petals	absent	absent	absent	absent or when present, with nectariferous pit
amens Stamens	numerous, all anther bearing	numerous outer ones sterile functioning as nectaries	numerous all anther-bearing	5 - 25 all anther-bearing
stils Pistils	usually numerous	numerous	several in a small head	numerous, borne at maturity on elongated receptacle
rles styles	short subulate	elongated densely plumose, persistent	short subulate	minute or elongated
igmas stigmas	introrse unilateral	introrse unilateral	introrse unilateral	

TRIBE ANEMONEAE (cont'd).

	Anemone	Pulsatilla	Hepatica	Myosurus
Achenes	compressed one-seeded, pointed or woolly, ovule suspended	with long, persistent styles, ovule suspended	short-beaked pubescent	somewhat 3-sided apiculate or aristate, in a long spike, ovule attached near top

KEY TO THE ANEMONES OF MANITOBA.

(Compiled partly from Gray and Britton and Brown, and partly from the author's observations.)

Anemone.

Erect perennial herbs. Radical leaves lobed, divided or dissected, those of the stem 2 or 3 together, opposite or whorled, sessile or petiolate, forming an involucre remote from the flower. Peduncles one-flowered, solitary or umbellate. Sepals 4-20 petaloid. Petals 0. Stamens ∞, shorter than the sepals. Carpels ∞. Achenes pointed or with long feathery tails, compressed, one-seeded, ovule anatropous, suspended.

I. Pulsatilla.

Achenes with long persistent plumose styles. Inner stamens anther-bearing, outer ones often small, abortive, and answering to petals.

Anemone patens.

II. Anemone proper.

Styles short, not plumose. Staminodia none. Sepals 5 - 8.

A. Achenia densely woolly, compressed. Involucre far below the flower. Stem commonly branching above. Tall, generally 2 - several flowered.

(1) leaves of involucre short-petioled. Sepals usually red. Head of fruit globose or oval.

A. multifida.

(2) Taller. Involucral leaves long-petioled. Sepals white or green, silky downy beneath. Head cylindrical, oval or oblong. Style subulate.

(a) Head of fruit oblong or oval. Divisions of the leaves ovate broad. Secondary involucre present on lateral peduncles.

A. virginiana.

(b) Head of fruit cylindric. Divisions of the leaves wedge-shaped, narrow. Secondary involucre usually wanting.

A. cylindrica.

B. Achenia pubescent or nearly glabrous.

(1) Stout, 1^0 - 2^0 high, branching and bearing several flowers. The lateral peduncles involucellate. Leaves of involucre sessile. Sepals 5, obovate, white. Head of fruit globose. Carpels nearly orbicular, naked, wing-margined.

A. canadensis.

(2) Stems slender, one flowered. Plant 4' - 9' high. Involucral leaf divisions lobed or incised. One radical leaf occurring later than the flower, white or tinged with purple outside. Achenes rather few, ovate, oblong.

A. quinquefolia.

I. (ANEMONE, L. SP. PL., 538, (1753).)

The genus Anemone derives its name from the Greek, meaning "to be shaken by the wind", because growing in windy places, or blossoming at the windy season. Its members, commonly called windflowers, are widely distributed in temperate, sub-arctic or alpine regions, and comprise, according to the Index Kewensis, 1929, about 140 species, six of which occur in Manitoba, viz:- A.patens, A. canadensis, A. cylindrica, A. multifida, and A. quinquefolia. The various authors disagree as to the limits of the genus; in fact, the same writer at different times contradicts himself, e.g. "Linneaus in the earlier edition of his Genera Plantarium has Hepatica, Pulsatilla and Anemone, but united them in the first edition of his Species Plantarium"[1]. Also Gray, in the first four editions of his manual, recognized Anemone and Pulsatilla as distinct, but united them in the fifth and subsequent editions. As there seems to be considerable difference of opinion amongst authors, it is difficult to know which one to follow, but as Gray is the most generally accepted authority in this province, it has been deemed advisable in this paper, to unite Pulsatilla and Anemone, as has been done in the most recent editions of his manual.

1. Britton, Ann., N.Y. Acad. Sci. VI, 215, 1891.

ANEMONE PATENS, L. VAR. WOLFGANGIANA (BESS) KOCH.

Pulsatilla patens, Mill. Gard. Dist. Ed. 8, No. 4 (1768).
Clematis hirsutissima, Pursh Fl. Am. Sept. 385 (1814).
A. Nuttalliana, D.C. Syst. 1: 193, (1818).
Pulsatilla Nuttalliana, Spreng. Syst., 11, 663 (1825).
Pulsatilla patens, A. Gray, Gen. III, 1, 18 t. 3 (1848).
A. patens, var. Nuttalliana, A. Gray, Man. Ed. 5, 36, (1867).
A. patens, var. hirsutissima, Hitch. Trans. St. Louis, Ac., V, 482, (1891).
P. hirsutissima Britton, Ann. N.Y. Acad. Sc. 6,217 (1891).
A. patens, Hook, Fl. Bor. Am. 1, 4, (1830). (should be no. 5.)

Life History.

Anemone patens, the prairie crocus, or pasque flower, is a perennial commonly found throughout Manitoba, though there are a few districts where it has not yet obtained a foothold. A gravelly hillside facing south is an ideal location for these flowers, which may be found there early in April, and have occasionally been known to bloom in March. The flower buds break through the soil usually in clumps of five or more, each bud being covered with a grayish-green furry involucre, which protects it from the cold, and also renders it very difficult to discern, being almost the same colour as the surrounding grass. The first flowers open when their petioles are quite short and at first resemble crocuses,

having a bell-shaped, half-open calyx, surrounded by the bracts forming the involucre. See Fig. 1. (c & d.).

Later the petiole lengthens rapidly, both above and below the involucre, and the sepals, now paler in colour, spread out widely, (see Fig. 1, 3), while the first leaves appear folded and doubled back, superficially resembling those of a fern, and covered with grayish down. After the flower has been fertilised (usually by insects) the sepals wither and fall, the petiole continues its growth to a height of six inches or more, while the feathery styles elongate to nearly an inch and a half in length, (see Fig. 1 e), and finally the fruits are carried away by the wind.

The leaves are, by this time, fully developed, and are four or five inches across, ternately divided, dark green and covered, like the rest of the plant, with silky hairs. They wither early in the fall, but remain attached to the rootstock, and can readily be found the next year.

Importance to Man.

The prairie Anemone possesses an acrid poisonous sap, which irritates the skin. This acridity is due (according to Pammel) to the presence of a crystalline substance called anemonine, the vapours from which inflame the eyes to a very great degree, even closing them temporarily. Sheep have been known to die from the effects of eating anemones, not, however, from poison, but by having their digestion

impaired by the presence in their stomachs of felt-like balls of epidermal hairs. A.patens was used by the Omaha Indians as a medicine in cases of rheumatism and neuralgia, when the fresh leaves were crushed and applied to the surface over the affected part. The juice from the bruised leaves acted as a counter-irritant, causing a blister if left on long enough.

DESCRIPTION IN DETAIL.

Root.

The root is a shallow taproot often branching into two, and bearing numerous tough brown rootlets. In structure it is a triarch root, with three bundles of strongly lignified vessels in the central cylinder, (see Fig. 4). The cortex is composed of large hexagonal cells with a starchy content, the latter being more in evidence as fall approaches. The outer layer of the epidermis is of a brown colour and suberised, especially in the older roots.

Stem:

The stem, or caudex, is so short as to be barely discernible as such, and is not distinguishable from the root proper except by the fact that the old leaf bases are to be

1. Gilmore, Eth. Ann. 33, 82, (1919).

found there, also the buds of the next year's flowering shoots, each in the axil of a leaf. The stem is really a sympodial rhizome, and the superposed branches can quite readily be seen, giving the stem a furrowed appearance, (see Fig. 2). The three bundles of the root have divided radially, forming six in the stem, as shown in transverse section.

Leaves.

The leaves are few in number (usually three surrounding a flower stalk), with long, slender, hairy petioles, the average length being four to five inches. Ther are grayish-green in colour, owing to the long unicellular hairs with which the laminae, as well as the petioles, are covered, and are slightly lighter on the lower side. The compound leaf is composed of three leaflets, the centre one having a petiole which may be three quarters of an inch long, while the lateral leaflets are often without petioles, or with very short ones, rarely exceeding one quarter of an inch in length. Each leaflet is ternately divided in a somewhat irregular fashion, the segments being linear in shape, with a blunt point at the tip. (See Fig. 7).

The venation is multicostate reticulate, there being an indistinct midrib in each division of the leaf, and two or more veins parallel to it connected laterally, giving a cellular appearance resembling that of a butterfly's wing. (See Fig 7) A cross section of the leaf shows that it has on the upper surface a very thick cuticle, an epidermis one cell in depth

and a few stomata. Beneath this is one layer of palisade cells, then several spongy parenchymatous cells. The lower epidermis is similar to the upper except in the larger number of stomata. A peculiarity of the latter is the very small size of the guard cells compared to that of the other epidermal cells. The epidermal hairs are very long, unicellular, and have very thick walls, the lumen occupying about one third of the width of the hair. There are small raised epidermal cells surrounding the base of each hair, which is not appreciably swollen.

Inflorescence.

The inflorescence is solitary, borne on a long hairy scapiform stem, which is hollow except where the grayish-green involucre is attached, the latter being sessile, whorled and multifid, apparently formed by the union of three finely-dissected leaves. (See Fig. 6.). The flower-stalk is very short at first, elongating considerably during anthesis, and up to the time when the seeds are ripe, mature specimens varying from six inches to a foot in height. This elongation takes place both above and below the involucre, which by this means becomes gradually separated from the flower. There is but one floral envelope, purple outside and paler within, covered with long silky hairs, which give it a grayish tinge. The flower does not open fully at first which accounts for the name "crocus" having been applied to it, although Anemone is not even distantly related to the family to which the genus

Crocus belongs.

Receptacle.

The receptacle is hollow, convex and covered with shallow pits into which the bases of the seeds are inserted, (see Fig. 6). As the achenes mature, the receptacle becomes even more convex, thus spreading out the plumose styles to catch the wind, and also loosening the fruits in their tiny depressions.

Perianth.

There is only one floral envelope, which is therefore called a calyx. The sepals are separate, hypogynous, usually six in number, and arranged in two whorls, similarly to the perianth of a lily. They are ovate to oblong in shape, 25-35 mm. long, and usually 10 mm. wide, truncate at the base and pointed at the tip. They are lilac in colour, shading to purple at the base, and gradually fade as the flower matures, finally withering to a light brown, and dropping off.
The outer side of the sepals is the darker, and is covered with whitish unicellular hairs about five millimeters in length, while the inner surface is without hairs and almost white in colour. The sepals are prominently marked with purple vascular bundles, which run from base to apex in parallel lines about a millimeter apart and are connected by numerous cross bundles or veins.

Androecium.

The stamens are numerous, separate and hypogynous, and are attached to the receptacle above the sepals, (see Fig. 6). They gradually decrease in size from the centre outwards, the outermost circle being composed of staminodes with very short filaments and ovate or spatulate heads. (See Fig 8 The filaments are pale yellow in colour, long and slender, tapering from the base upwards, with a vascular bundle in the centre. The anthers are two-celled, basifixed, and extrorse, opening along the sides to discharge the pollen, which is creamy white, spherical, dry, and has the extine marked with a network of ridges.

Gynaecium.

The pistils are numerous, separate, and protogynous, massed together on the apex of the receptacle, (see Fig. 6). The ovary is superior and one- celled, containing one anatropous pendulous ovule. The style is pale green in colour, long, slender and hairy. Its epidermal cells are oblong in shape, and are interspersed with raised stomata. There is one vascular bundle in the centre, in which the spiral vessels can be easily seen. The style elongates considerably after fertilisation, attaining a length af one and a half inches. The stigma is slightly curved and cannot be easily differentiated from the style, except by the presence of the stigmatic papillae on the convex surface.

Nectaries.

The nectaries are represented by the staminodes, previously mentioned, which form the outer whorl of the androecium, (see Figs.6.8). They have very short, wide tapering stalks with an aborted anther attached at the apex of each, but not differentiated in structure, seeming to be merely a continuation of the filaments. The staminodes are uniformly yellow in colour, but vary in shape and size, being oval as a general rule.

SPECIAL MECHANISM FOR POLLINATION.

The gynaecium ripens first, and as the pistils are taller than any of the stamens, the flowers are more than likely to be cross-pollinated by insects which alight on the stigmas after crawling over the androecium of another flower.

The stamens are at first entirely erect, but as they ripen they turn outwards and downwards away from the pistils. The outer short stamens dehisce first, and the stigmas are receptive until the last innermost circle of anthers are mature. These stamens are also the tallest and their pollen can easily be transferred to the stigmas, if these have not already been fertilized. The massing of the pistils and stamens in the centre of the flower makes a convenient landing-stage for insects of which several species, mainly small beetles and bees, have

been noticed crawling over the flowers, thus distributing the pollen. As the flower matures, the peduncle lengthens, and the wind bends it over, thus facilitating self-pollination.

FRUIT AND SEED.

The fruit is an achene with a plumose style which is usually over an inch in length and extremely hairy, especially at the lower end, thus enabling the seed to anchor itself when it reaches the ground, (see Fig. 5). The seeds require a period of rest, as has been shown by planting fresh seeds, which do not germinate. The pericarp is thin, brown and hard, is hairy on the outside, and has a sharp point at the basal end, while the apex tapers off into the long style.

The seeds are pale brown oval bodies, slightly flattened and with a distinct longitudinal ridge along one side. (see Fig. 9.). They are usually two and a half millimetres long and one millimetre wide at the broadest part which is nearer to the upper end of the seed. There is a short beak terminating this wider end, while at the lower narrower end is a rough semi-circular patch. The embryo is less than a millimetre in length, and is to be found in the upper end of the seed, the remainder of which is composed of endosperm containing both starch and oil.

VARIATIONS.

The principal variations are in the number of sepals, flowers with seven, eight and occasionally five having been

found. Out of five hundred specimens counted, one had five sepals, five had seven, and two had eight, the remainder having six. There may also be an occasional variation in colour, in which case the flowers instead of being lilac, are creamy white, but these are rather rare.

CONCLUSION.

This brings to an end the part of this paper dealing with Anemone patens, which has been shown to be a simple type, well adapted to serve as an introduction to the study of Angiosperms in general, and the family Ranunculaceae in particular. The inclusion of A. patens in the above family is due to its primitive construction, which it has been the writer's aim to elucidate.

ANEMONE PATENS.

Fig. 1. a, b, c, d, e. Series of photographs of A. patens showing progressive development at daily intervals.

Fig. 2. Plants of A. patens showing the sympodial rhizome.

Fig. 3. Flowers at different stages of development.

Fig. 4. Microphotograph of a hand-cut section of root.

Fig. 5. Pistil just after pollination, and a mature achene drawn to the same scale.

Fig. 6. Sectional elevation of a flower of A. patens, note;

(a) The hypogyny of the flower.

(b) The hollow peduncle.

(c) The solid partition in the peduncle at the point of the attachment of the involucre.

(d) The convexity of the receptacle.

(e) The varying sizes of the stamens.

(f) The staminodes.

Fig. 7. Leaf of A. patens to show the general morphology.

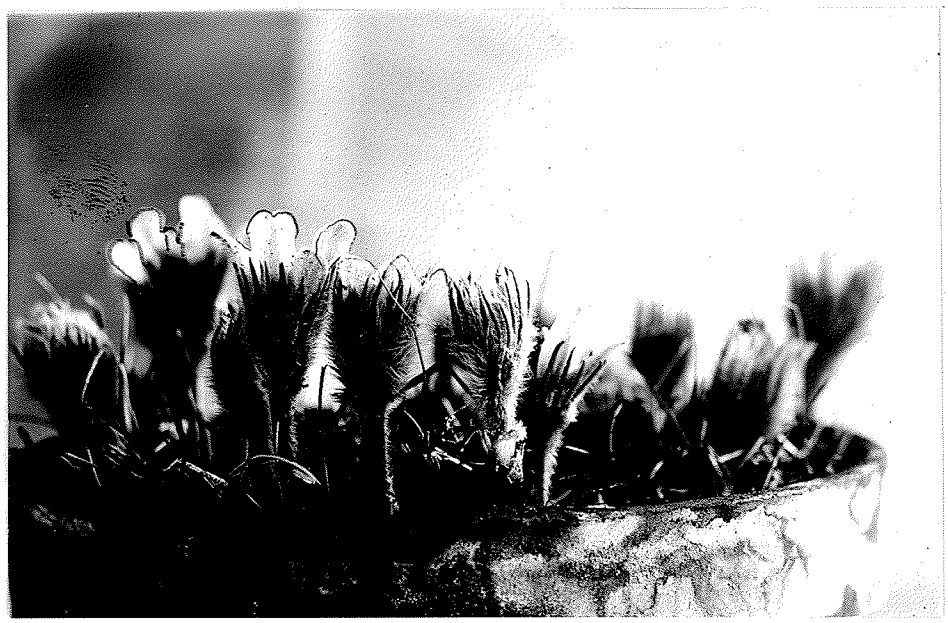
Fig. 8. Series of stamens and staminodes from the same flower drawn to scale.

Fig. 9. Seeds of A. patens showing the groove.

Fig I.

a.

b.



c.

Fig I.

(d)

(e) (10 days later)

Fig 2.

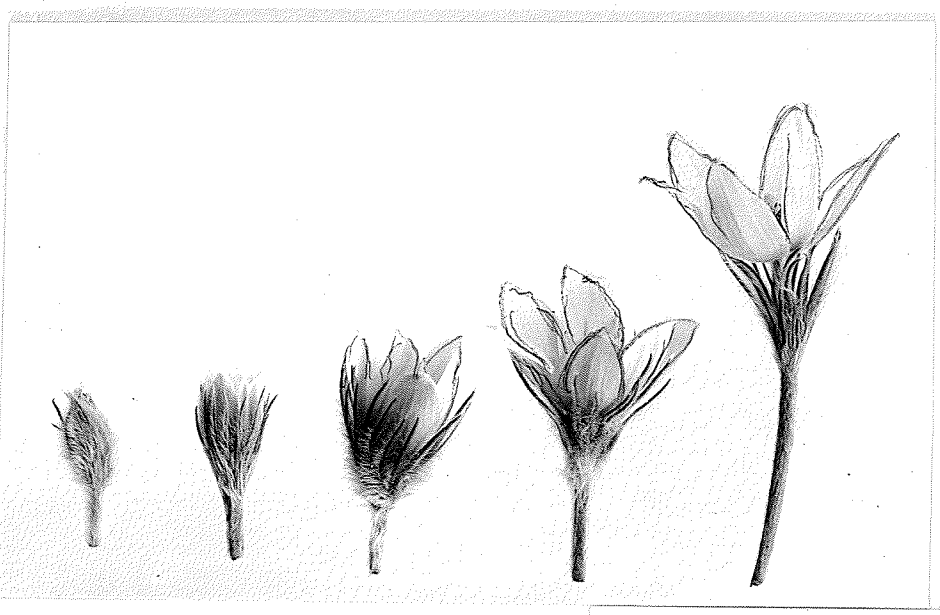


Fig 3.

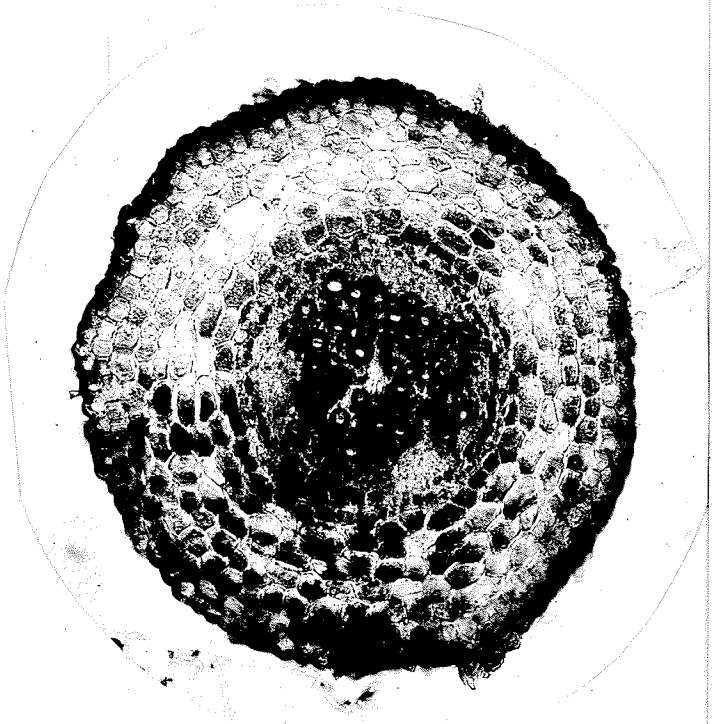


Fig 4. (x 75)

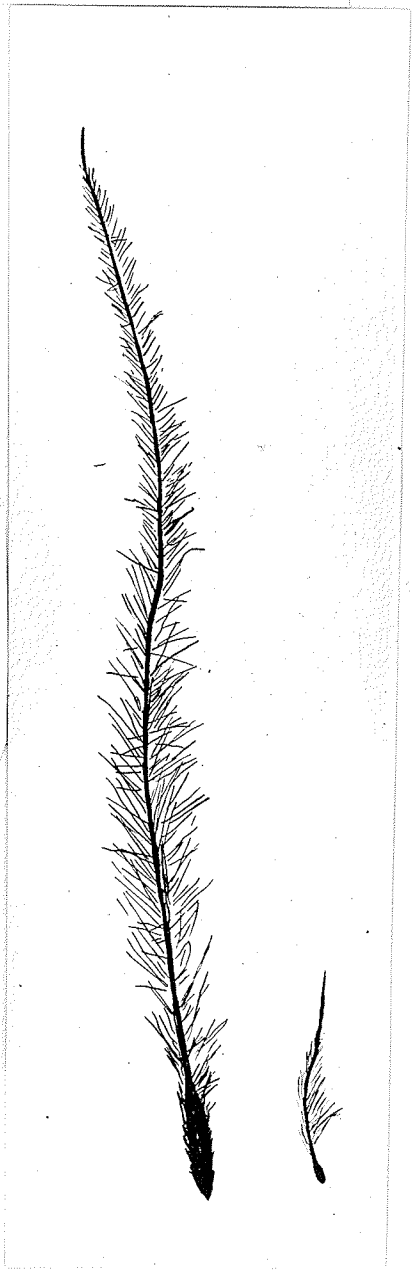


Fig. 5 (x 4)

Fig. 6. (× 2½)

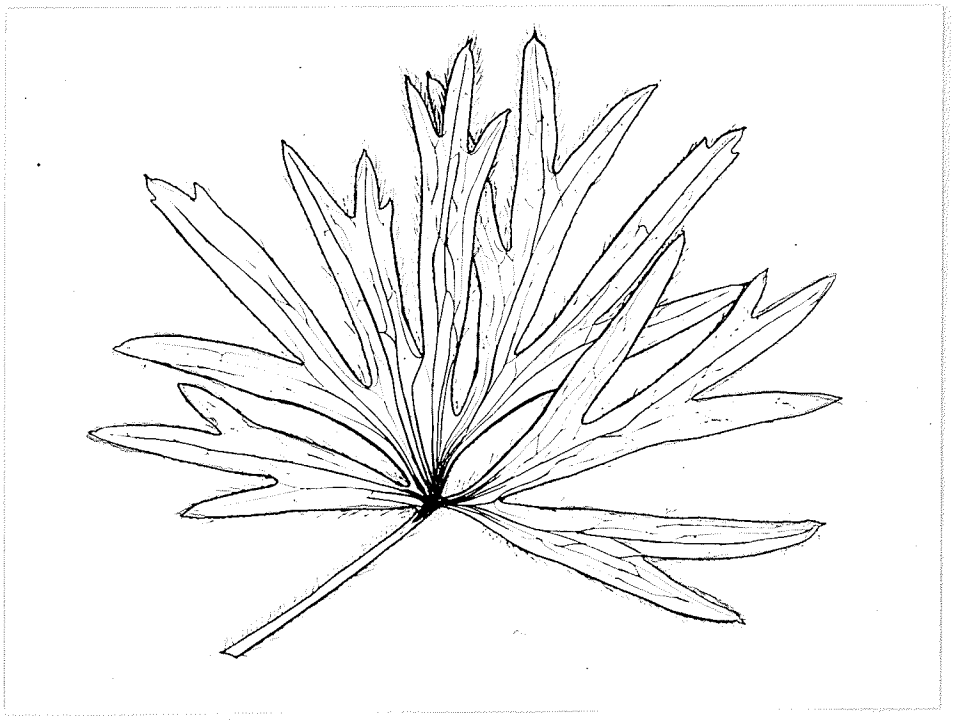


Fig. 7. (natural size)

Fig. 8. (X 15)

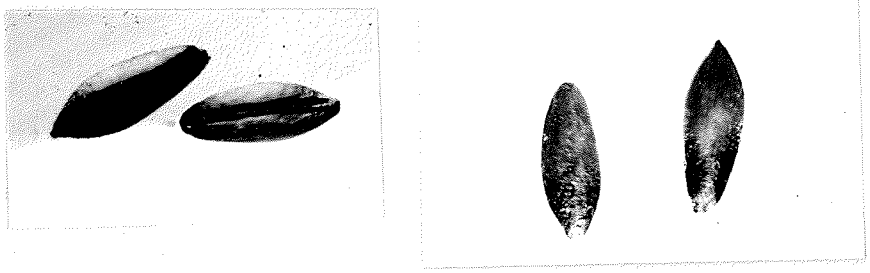


Fig. 9.

ANEMONE MULTIFIDA, Poir.

A. multifida, Poir, Suppl. Lam. Encycl., i, 364 (1810).
A. Hudsoniana, Richards, Frank. Journ., Ed. 2, App. 22 (1823).
A. Commersoniana, D.C. ex Deless., Ic. i, 4, t, 17. (1820).
A. globosa, Nutt. ex Pritz., Linnaea, xv, 673 (1841).
A. lanigera, Gay, Fl. Chil., i, 22 (1845).
A. sanguinea, Pursh. ex Pritz., Linnaea, 1841, 672.
A. narcissiflora, H. & A. Bot. Beechey, 121, not. L.
A. multifida, Cat. Can. Plants, I, Macoun, (1883).
A. multifida, Am. N.Y. Acad. Sc. 222, (1891).
A. multifida, Poir, Gray Man. Ed. 7, (1908).
A. hudsoniana, Richards, B. & B., 1913.

The history of the specific name of this Anemone is a rather confusing one, and apparently its real name is still a debatable point. It was first named as above in 1810, then in 1923 as A. hudsoniana. Macoun (1883) and Gray (1908) both inclined to the former name, giving A. hudsoniana as a synonym, while Britton and Brown (1913) definitely state that multifida and hudsoniana are two distinct species, though frequently confused, our Manitoba one being the latter. Here, as elsewhere in this paper, Gray's nomenclature has been followed.

ANEMONE MULTIFIDA, Poir.

Anemone multifida, or the red windflower, grows locally in many districts in southern Manitoba, coming out into bloom late in June or early in July, and often associated with A. cylindrica on grassy hillside or prairie. It is generally from 12 to 18 inches in height, and somewhat bushy in habit, having a number of long-petioled radical leaves, from amongst which rise involucrate flowering stems, each bearing three solitary dull purplish-red blossoms ½ to 1 inch in diameter. The two lateral pedicels usually have a secondary two-parted involucre, while the centre one is naked.

The fruiting head is globose, and the achenia are copiously covered by silky white hairs, which facilitate transportation by the wind.

DESCRIPTION IN DETAIL.

Root.

The root has three or four main branches, which go straight downwards, and each bear a few tough, coarse rootlets. In structure it is very similar to the one already described, and, therefore, does not merit a separate discussion.

Stem.

The plant grows from a multicipital caudex, and there are in consequence several flowering shoots from the same root, similarly to the condition found in A. patens. These stems

differ greatly from those of the latter plant, being very woody, and having a number of vascular bundles in the form of a ring near the outside of the stem. There is a group of woody sclerenchyma cells corresponding to each vascular bundle and appearing to be a continuation of the bundle towards the cortex which is a cylinder of five or six rows of thick-walled cells. The cells inside the ring of vascular tissue become successively larger and thinner walled till the centre is reached, where they are very large and irregular in shape. The stem is of a very loose texture in the centre, but is not actually hollow, as is that of A. patens.

Leaves.

The root leaves are usually three or four to each flowering stem, and have petioles from 4 to 8 inches long, and which are narrow and ribbed throughout their length, except toward the base, where they are broad, flat and clasping. The laminae bear a strong resemblance to those of A. patens, being 2-3 ternately divided into linear or lanceolate lobes, multicostate and clothed with unicellular hairs, the latter, however, not being so numerous as those of the previously mentioned species, (see Fig. /.).

In Anemone multifida the leaves appear before the inflorescence, while in A. patens, there are no leaves visible until the flowers are fully opened.

Inflorescence.

The flowering stem bears a whorled involucre, composed of three leaves similar to those found at the root and previously described, their petioles varying in length from ½ inch to 2 inches, though the former length is the more usual one. From this involucre commonly spring three peduncles, one of which is naked, while the other two each bear a two-leaved secondary involucre. The flower is purplish-red to pink in colour, occasionally whitish, and is similar in structure to that of A. patens, but considerably smaller, being only from ½ inch to 1 inch wide when fully opened.

Receptacle.

The receptacle is ovoid in shape, and taller than that of A. patens. It is hairy, and has a honeycombed appearance due to the close-set hexagonal depressions with which it is covered.

Perianth.

The calyx consists of six or more reddish, oblong sepals ¼ to 1/8 inch long and similar to those of A. patens in structure and arrangement.

Androecium and Gynaecium.

The androecium is similar to that of the previously men-

tioned species, except that the stamens are smaller and there are no staminodes. The gynaecium, however, differs markedly from that of A. patens, for the style is not plumose, but spiny, turning dark brown with age. The pistils average 1.7 mm. in length, the stigmatic papillae occupying .2 mm., and the style .8 mm. The ovary is closely covered with appressed silky white hairs. There are no nectaries in this species, nor in any of those subsequently mentioned.

Fruit and Seed.

The fruiting head is globose when young (see Fig. 2) and consists of a large number of achenes, differing from those of A. patens in that each has, instead of a long feathery persistent style, a short subulate one. The ripened receptacle and the achenia themselves are all closely covered with silky hairs which expand as the fruits ripen, pushing the seeds apart and giving to them a woolly appearance. The former is lanceolate in shape, usually a centimeter in length and 4 mm. in greatest width. ✓ The achenia are flattened and tipped with the subulate styles.

see Fig 5. A. cylindrica

ANEMONE MULTIFIDA.

Fig. 1. Leaf showing general shape and venation.

Fig. 2. Immature fruiting head to show shape.

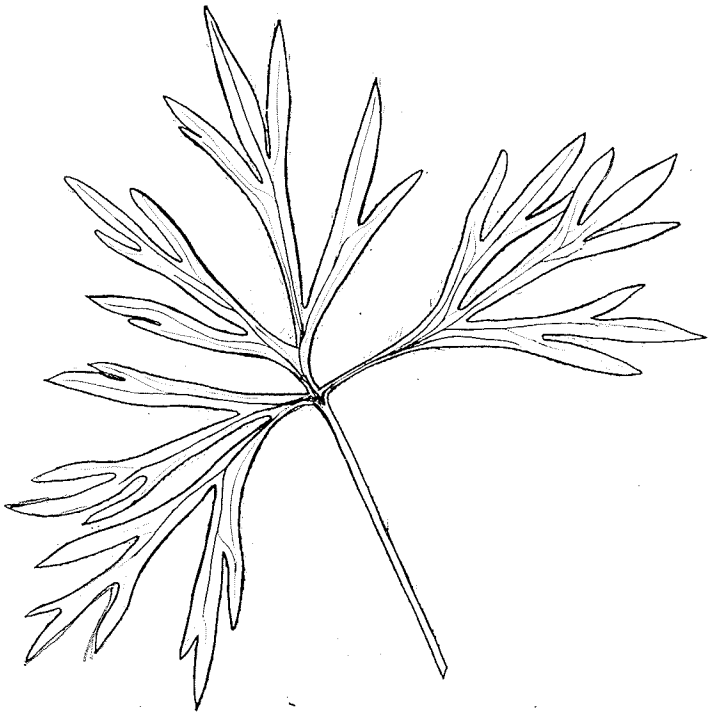


Fig 1. (slightly enlarged)

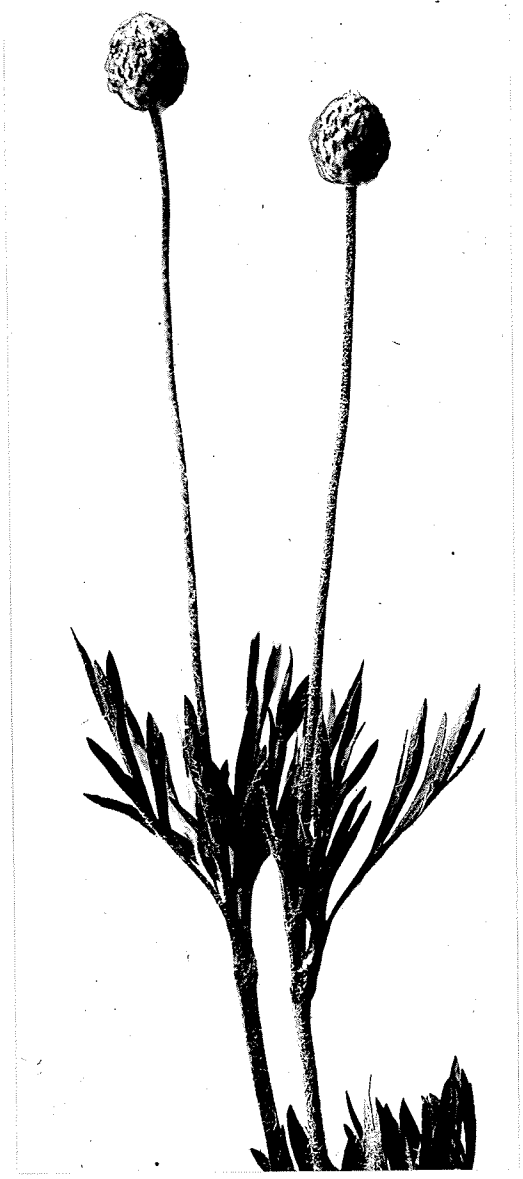


Fig. 2.

ANEMONE VIRGINIANA L.

A. virginiana L, Sp. Pl., 540 (1753).

A. hirsuta, Moench., Meth. Suppl., 105 (1802).

This plant has often been confused with A. riparia Fernald, in fact Britton and Brown give the latter name as a synonym. According to Gray, however, they are two very distinct species, A. riparia having large white or reddish petals, while those of A. virginiana are small and greenish.

A. virginiana is a tall plant found in the shady woods of southern Manitoba, but it is rather rare, and in consequence of the inconspicuousness of its flowers may easily be overlooked. It is somewhat leafy in habit, and the leaves are larger, thinner, and of a darker green than those belonging to the species mentioned heretofore. The plant grows to a height of almost 3 feet, and is topped by the small greenish flowers, which occur in June, July and August, and later develop into woolly fruits very similar in appearance to those already described.

DESCRIPTION IN DETAIL.

Root.

The root is a fibrous-branching tap root, the main portion being short and stout, and having a large number of approximately equal branches coming off from it at right angles, and spreading out in all directions parallel to the surface of the soil. Occasionally on some of the older plants, one of the lateral branches is larger than the others, and bears adven-

(See Fig. 1.)

titious buds, but all the roots are comparatively shallow, showing that the plant is a surface feeder. The structure of the root is of the triarch type, typical of the genus.

Stem and Leaves.

There is a multicipital caudex as in A. multifida, with two or three flowering stems arising from it, each surrounded by two or four radical leaves, which have petioles varying in length from 6 to 15 inches. The latter are slightly hairy, especially towards the apex, and are not quite circular in cross-section, being slightly concave on one side, similarly to a corn stem. They are hollow and have a ring of vascular tissue, consisting of 6 large bundles alternating with smaller ones, and having a group of sclerenchyma cells outside the phloem of each. There are several rows of cortical cells, the outer ones being rich in chloroplasts.

The laminae are broader than long, being 5-7 inches wide and a little less in length. They are ternately cleft into ovate-lanceolate leaf-divisions, cuneate at the base and acute-pointed at the apex, with serrate margins. (See Fig 4)

The laminae are somewhat thinner than those of the foregoing species, and the hairs are shorter and less in number. They are only .3 to .5 mm. long on the lamina itself, and .5 to 1 mm. long on the veins and petiole, where they are also more numerous.

The upper surface of the leaf is dark green, sparsely

dotted with short hairs, while the lower side is lighter in colour and has a large number of longer hairs on all the veins. The venation differs from that of the two preceding species, being digitately reticulate and having as a rule five main diverging veins.

The flowering stems each bear an involucre composed of three leaves similar to those at the base, but with shorter petioles (2 - 3 inches in length), from the centre of which rises a naked pedicel from 6 to 10 inches long, accompanied by one or two proliferous ones, each bearing an involucel, or secondary involucre, consisting of two short petioled leaves like those of the primary involucre mentioned above.

The flower and its parts.

The flower is greenish in colour, usually not being over three quarters of an inch in diameter.

The receptacle is almost identical with that of A. cylindrica, being the same shape, but a little shorter and wider, covered with short hairs, and honeycombed with depressions for the achenes.

The sepals, usually five in number, are acute, light green on the inside, but whitish outside owing to their being thickly covered with hairs, and they turn back and fall off as the receptacle enlarges. (see Fig. 3). In some localities a variety of A. virginiana occurs having large white sepals[1] and apparently this variation is found in

(1) Gray. Man. Ed. VII, 402, (1908).

Manitoba since Hales lists A. riparia in his "Selected Western Flora", doubtless confusing it with A. virginiana, since he does not mention the latter at all.

The androecium and gynaecium do not differ materially from those of A. multifida, except that the styles are longer and more divergent.

Fruit and Seed.

The fruit is very similar in structure and general appearance to that of A. multifida, but is slightly different in form owing to a corresponding difference in the shape of the receptacle, that of A. virginiana being almost cylindrical and rounded at both ends. (see Fig. 5). The styles are more in evidence than they are in A. multifida, but the hairs are just as numerous and expansible making it almost impossible to distinguish between the two species except by an examination of the receptacle. See Fig. 5, A cylindrica.

ANEMONE VIRGINIANA.

Fig. 1. Root system showing adventitious buds.

Fig. 2. Plant of A. virginiana showing first flower bud with naked pedicel, also a later involucellate one.

Fig. 3. Flower of A. virginiana.

Fig. 4. Leaf showing general morphology.

Fig. 5. Plant with immature fruiting heads.

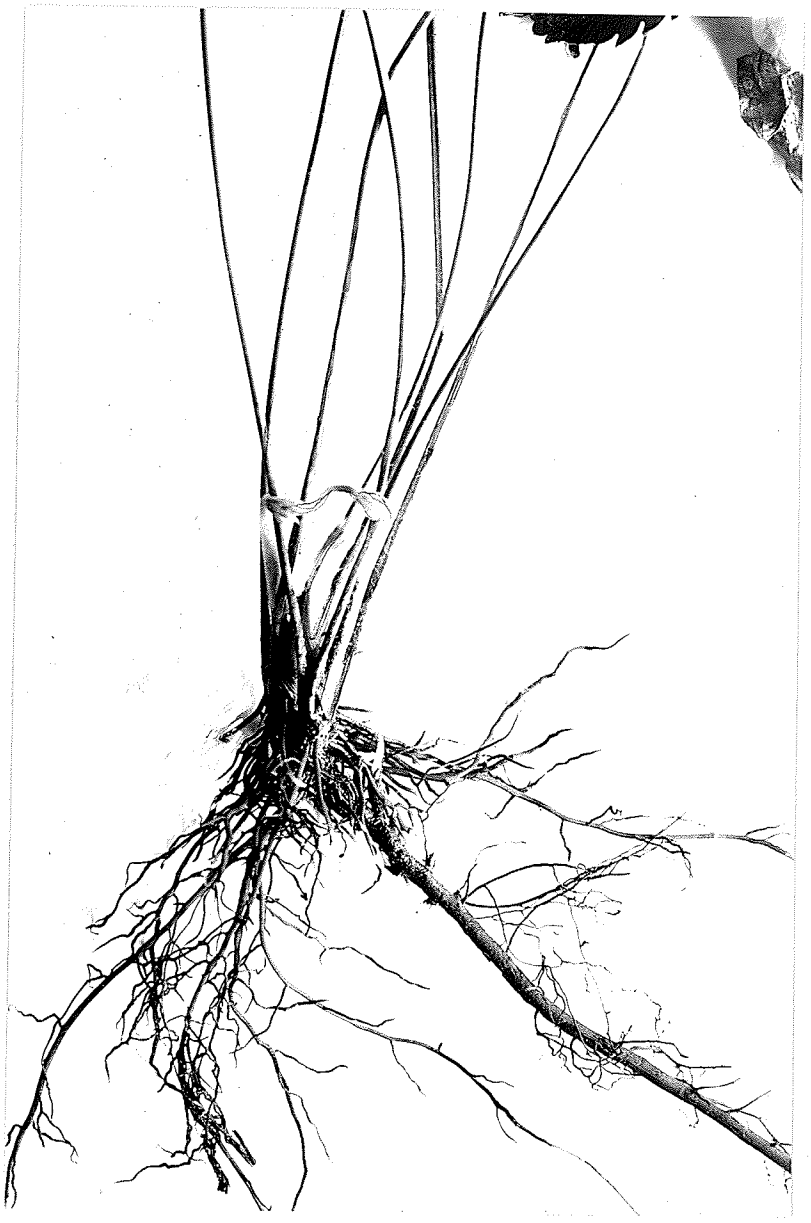


Fig. 1.

Fig 2.

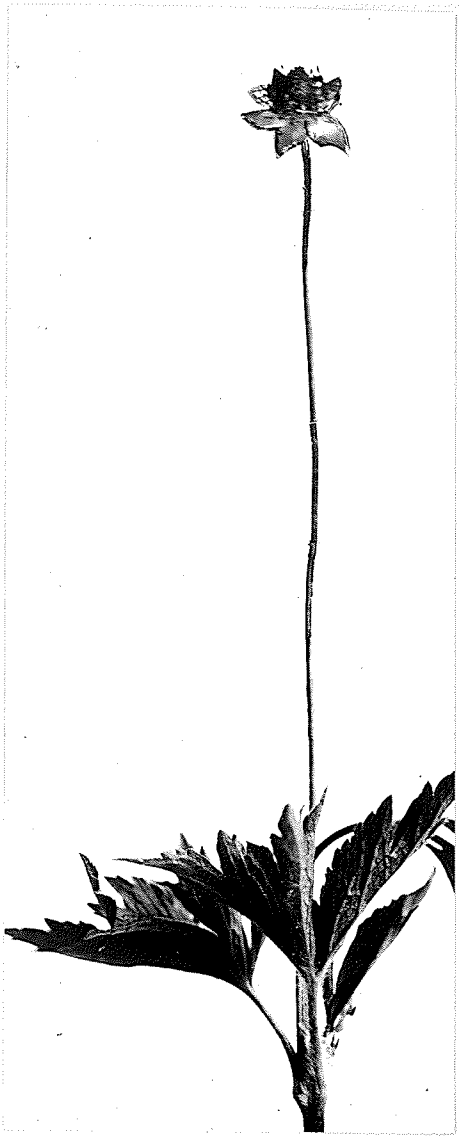


Fig 3.

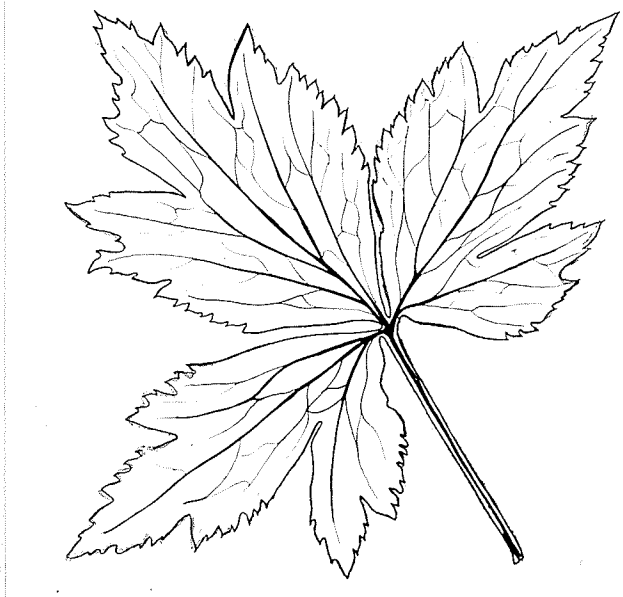


Fig 4 natural size)

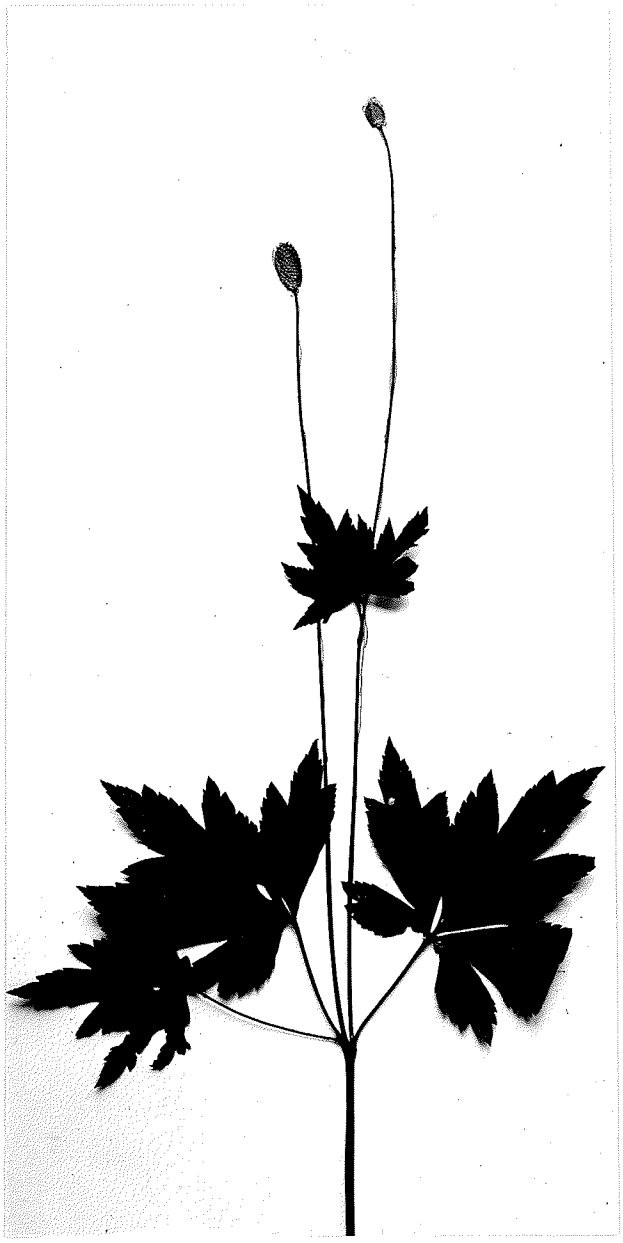


Fig 5.

ANEMONE CYLINDRICA. A. Gray.

A. cylindrica, A. Gray, Am. Lyc. N.Y., iii, 221, (1836).

This species is commonly found on the dry prairies and hillsides of Manitoba, and is in bloom from June till August, but is not generally noticed until the seeds are mature, as the flower itself is inconspicuous. The plant grows to a height of from 10 to 18 inches, and the fruits, borne on long naked pedicels, persist well on into the autumn, and are then plainly to be seen protruding above the dead grass and herbage. At this season ofthe year it is easily confused with A. multifida, which is often found in association with it, and the two species may only be distinguished by a careful examination of the fruiting pedicels. The specific name is an indication of the shape of the immature fruit, which is one of the best means of identification. (See Fig. 2.).

DESCRIPTION IN DETAIL.

Root and Stem.

The root is almost identical with that of A. virginiana but the secondary roots, instead of being parallel to the surface of the ground, travel downward, which is to be expected, as A. cylindrica grows in dry situations. Each plant has three or four flowering stems arising from the caudex, and surrounded by several long-petioled basal leaves. The flow-

ering stems each bear an involucre composed of short-petioled leaves similar to the radical ones, and numbering about twice as many as the 2-4 naked pedicels arising therefrom. Occasionally as one of the latter may be surrounded by a secondary two-leaved involucre, which is formed just above the primary one, and appearing to be a part of it. The usual absence of this involucre is one of the important points to be noted in the identification of the species. In structure the flowering stem is woody and solid, containing numerous vascular bundles arranged in a ring around the central pith, and surrounded by six rows of thick walled cortical cells. Between the cortex and the phloem of each bundle lies a mass of scherenchymatous fibres, which is almost as large as the vascular tissue.

Leaves.

The radical leaves have petioles averaging three inches in length and rarely exceeding four. These are shield-shaped in cross-section, not hollow, contain six large vascular bundles, and have a number of silky epidermal hairs. The laminae of the basal leaves are usually the same size as those of A. multifida, and are broader than long, being on the average 2½ to 3 inches wide, and 1½ to 2 inches in length. They are also 2 - 3 ternately divided, but the lobes are shorter and wider than those of A. multifida and A. patens, and the divisions are rhombic-cuneate in shape. (See Fig 3.) The leaves are silky hairy throughout, similarly to those of A. patens, but the

hairs are shorter and not so numerous, though longer than those of A. virginiana.

Flower.

The flower is very similar to that of A. virginiana, but is a little larger. There are five greenish-white oblong or obtuse sepals, usually 3/8 inch in length and extremely hairy on the outside. (See Fig. /.).

The androecium and gynaecium are the prominent parts of the flower, and are very similar to those of A. virginiana, except that the filaments are not so long, and the androecium therefore does not cover so much of the calyx. The styles are about the same length as those of A. virginiana, but longer than those of A. multifida, and are slightly curved outward and downward at the apex.

Fruit and seed.

The shape of the fruiting head is one of the characteristic features of this species, and must therefore be carefully noted. As its name implies, the fruit is cylindrical in shape, and is from 3/4 to 1¼ inches long and ¼ inch wide before the seeds ripen. (See Fig. 2). At maturity the seeds separate, owing to the expansion of their epidermal hairs, (as has already been mentioned in connection with A. virginiana and A. multifida) forming a fluffy ball around the elongated receptacle, and which may remain there for some time, perhaps over winter. (See Fig. 4). When the fruits

are eventually carried away by the wind, the naked receptacle is left as a straight stalk, approximately equal in diameter to the pedicel. (See Fig. 4). Thus, even after the seeds have matured, the plant may be distinguished from the two species which it most resembles (A. multifida and A. virginiana) by the length anf shape of the receptacle, as well as by the absence of a secondary involucre. (See Fig. 5)

ANEMONE CYLINDRICA.

Fig. 1. Flower and buds.

Fig. 2. Immature fruiting heads showing characteristic shape.

Fig. 3. Leaf showing general morphology.

Fig. 4. Series of mature fruiting heads.

Fig. 5. Drawing showing comparison of mature receptacles of A. multifida, A. virginiana, and A. cylindrica.

Fig 1.

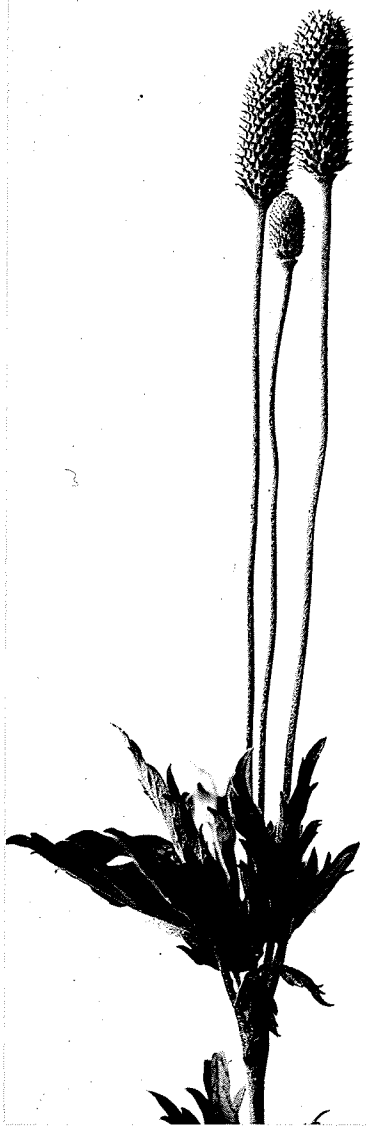


Fig 2

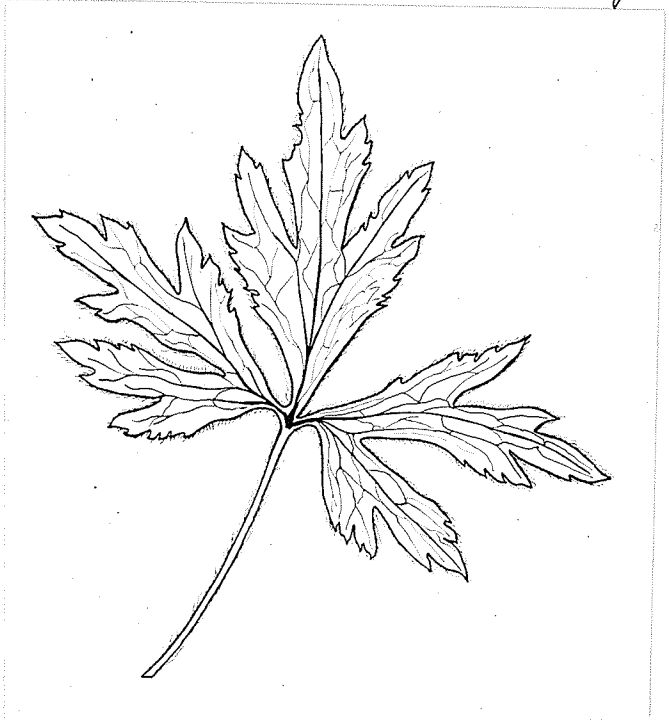


Fig 3. slightly enlarged

Fig 4.

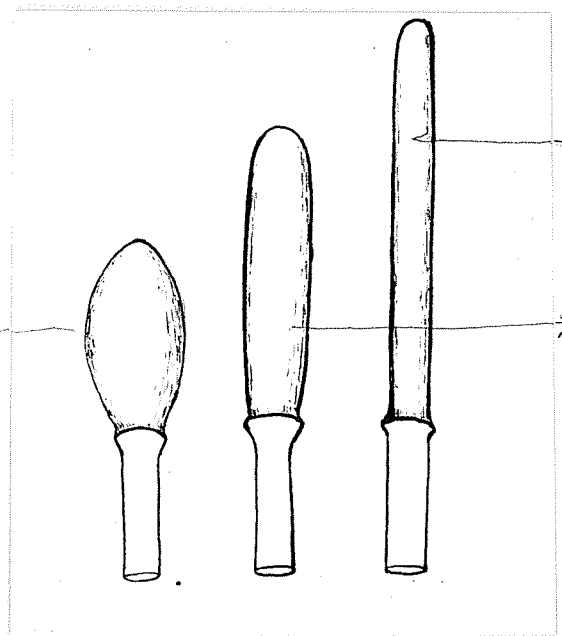


Fig 5 (x2)

ANEMONE CANADENSIS L.

A. Canadensis L, Syst., Ed. 12, iii, App. 231, (1768).

A. Pennsylvanica, L. Mant., ii, 247 (1771).

A. irregularis, Lam. Encyl., i, 167 (1783), fide S.Watson.

A. acónitifolia, Michx., Fl. Bor. Am., i, 320 (1803).

A. dichotoma var. Canadensis, MacMillan, Metasp. Minn, Vol. 237.

A. Laxmanni, Steud, Nom., Ed. 2, 1, 96.

A. dichotoma L, Macoun, Cat. Can. Pl. 1, 12, 1883.

Anemone Canadensis, sometimes called the wood anemone, is a stout plant with a profusion of solitary large white flowers, and is usually found in somewhat shady situations, i.e. in ditches and around the edges of woods. It occurs all over Manitoba, with the exception of the extreme northern part, and blooms continuously from the latter part of May until the end of July. It grows to a height of 18 inches or more, and the flowers are always widely expanded and extend well up above the foliage. The large,coarse,dark-green leaves, and the numerous pure white blossoms render the plant very noticeable, and, in consequence, it is our best known anemone.

This species, like A. patens, has received many different names, but A. Canadensis appears to be the one most generally accepted at the present time. Linnaeus in 1768 called it A. Canadensis, giving Pennsylvania as its place of origin, but when he republished it in the Mantissa three years

later, called it A. Pennsylvanica, habitat Canada, thus inter-changing the locality and the specific name. Linnaeus also listed it as A. dichotoma, which name is the one used in Macoun's "Catalogue of Canadian Plants" (1883) while in Gray's "Synoptical Flora of North America" it is used as a synonym (in part). According to Britton[1], however, A. dichotoma differs from A. Canadensis in two particulars, i.e. the character of the leaf segments, and of the surface of the achenia, which are glabrous in the former species.

DESCRIPTION IN DETAIL.

Roots.

The main root frequently goes straight down into the ground for a distance of 1½ - 2 inches, where it is attached to a long horizontal filiform branching root resembling a rootstock in its habit of growth, but possessing neither nodes nor scale leaves, and being distinctly root-like in structure. (See Fig. 2.). Just below the basal leaves, on the descending portion of this root, and occasionally on the horizontal part, may be seen adventitious buds, from which the flowering stems of the next season develop. The buds just below the ground are the largest, getting successively smaller as their distance from the basal leaves increases, while the ones found on the horizontal roots are very small indeed. (See Fig. 1.)

1. Britton, Am. N.Y. Acad. Sc. VI, 227, (1891).

The root of A. Canadensis was used as a medicine by the Omaha Indians[1], who applied it externally and internally, and also used it as a wash for sores affecting the eyes and other parts.

Stem and Leaves.

The flowering stems number 1 - 3 as a rule, and are surrounded by long petioled basal leaves from 3 - 5 inches in diameter, which are usually five-parted, coarse in texture, and very prominently veined. The divisions are ternately lobed, rhomboid in shape, and crenately toothed towards the apex. The venation is digitately reticulate, the branch veins often running parallel to the midrib for part of their length, giving an effect similar to that obtaining in A. patens. The entire surface of the leaf is covered with short, fine hairs, which are especially numerous on the underside of the lamina, giving to it a silvery appearance. (See Fig. 3)

Each stem bears a sessile 3-parted involucre, variously toothed and divided, from which arises one naked pedicel, followed later by 2 involucellate ones, which in their turn produce one naked and two proliferous pedicels. The plant thus remains in bloom for a long time, and while the first flowers are comparatively low, the last ones usually attain a height of two feet. The secondary involucres are two-leaved and sessile, the divisions three-parted like those of the primary one.

1. Gilmore, Eth. Ann., 33, 82 (1919).

Flowers and their parts.

The flowers are creamy white in colour, and of large size, ranging from 1½ to 2 inches in diameter. The sepals, five in number, are borne on a small convex receptacle and are obovate in shape, blunt at the apex and tapering abruptly to a very narrow base. (See Fig. 4).

The stamens are numerous, bright yellow, and about ½ the length of the sepals above which they are inserted.

The gynaecium is small for the size of the flower, not being nearly so conspicuous as that of A. virginiana, but having long styles. (2/3 the length of the pistils.) The carpels are covered with minute silvery hairs, but have no long woolly ones as in the three preceding species.

Fruit and Seed.

The fruiting head is globose, about 8" in diameter, and containing approximately 40 achenia, which are larger than those of any of the other anemones, dark brown in colour, minutely hairy, and very much flattened. They are fitted in around the receptacle with their short axes horizontal, while the long subulate styles protrude radially, giving to the head a burr-like appearance. (See Fig. 4). There is a wing-like margin (usually 1 mm. in width) surrounding the seed, which is oval in shape, 2 mm. long and a little over a mm. wide. (See Fig. 6). The achenia fall off as soon as they are mature leaving the pedicel topped by the receptacle, which is 2 mm.

high and barely wider than the flower-stalk. The globose head of fruit and the broad-leaved sessile involucre and involucels form the main features to be noted in the identification of this plant after anthesis.

Variations.

In the collection left to the University of Manitoba by the late Canon Burman of St. John's College, are several specimens of double white anemones. (A. Canadensis). (See Fig. 5.). They were collected at Roseisle, near Carman, on the Pembina Hills, and were labelled by Canon Burman as A. dichotoma florepleno, as he followed the nomenclature of Macoun's Catalogue. The writer has heard of these flowers also being found in Somerset, in the same district as the above, but so far has not had the good fortune to find any. Judging by the specimens in the herbarium, and also by descriptions received, this plant is well worth cultivation.

ANEMONE CANADENSIS.

Fig. 1. Root show ing adventitious buds.

Fig. 2. Photomicrographs of hand-cut sections of roots from two different plants of A. canadensis, showing structure.

Fig. 3. Leaf showing general morphology.

Fig. 4. Flower and fruiting head, also involucel.

Fig. 5. Double flower, A. canadensis florepleno.

Fig. 6. Seed of A. canadensis showing winged margin and style.

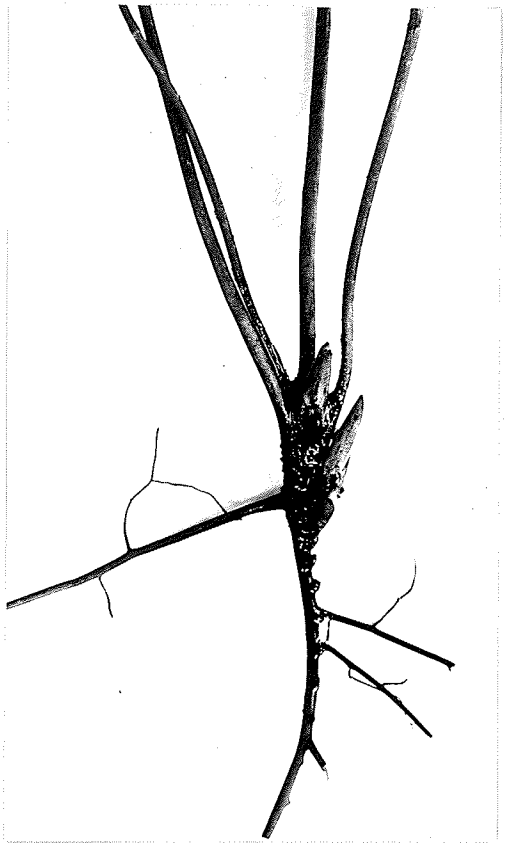
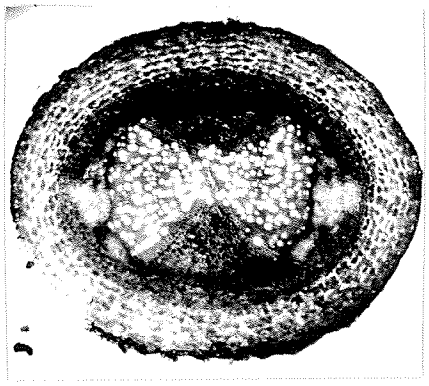


Fig 1



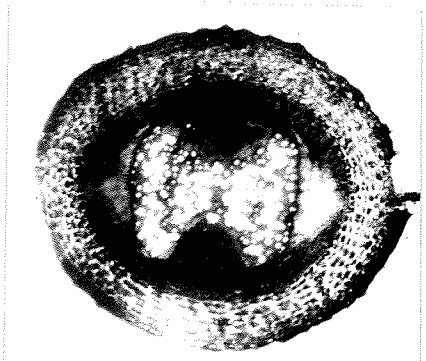


Fig 2. (X 50)

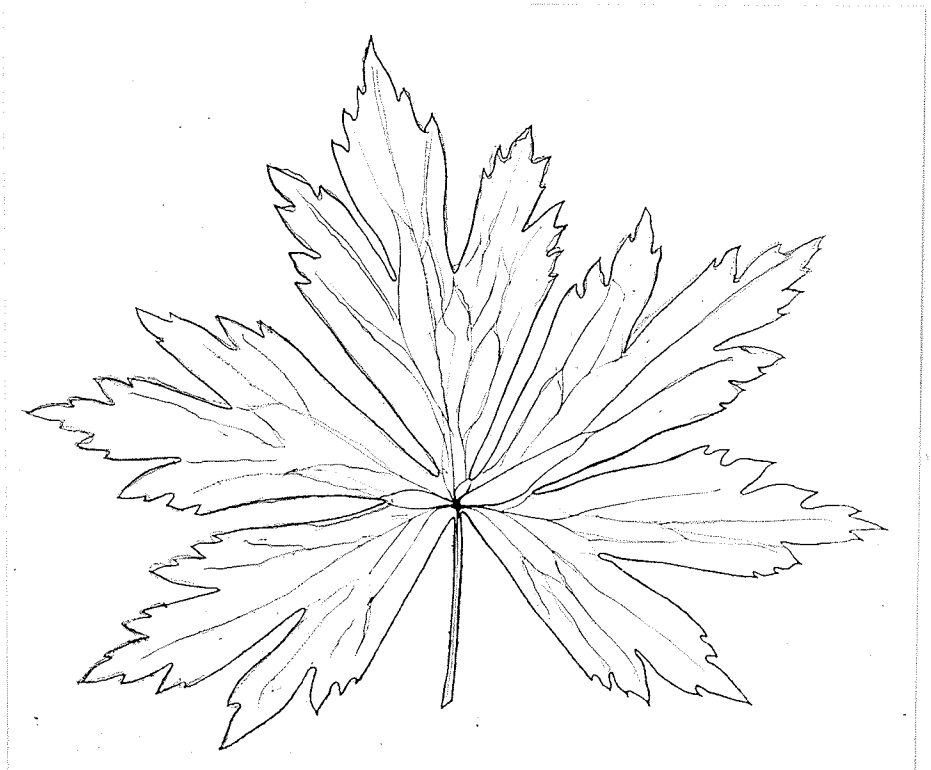


Fig 3 (natural size)

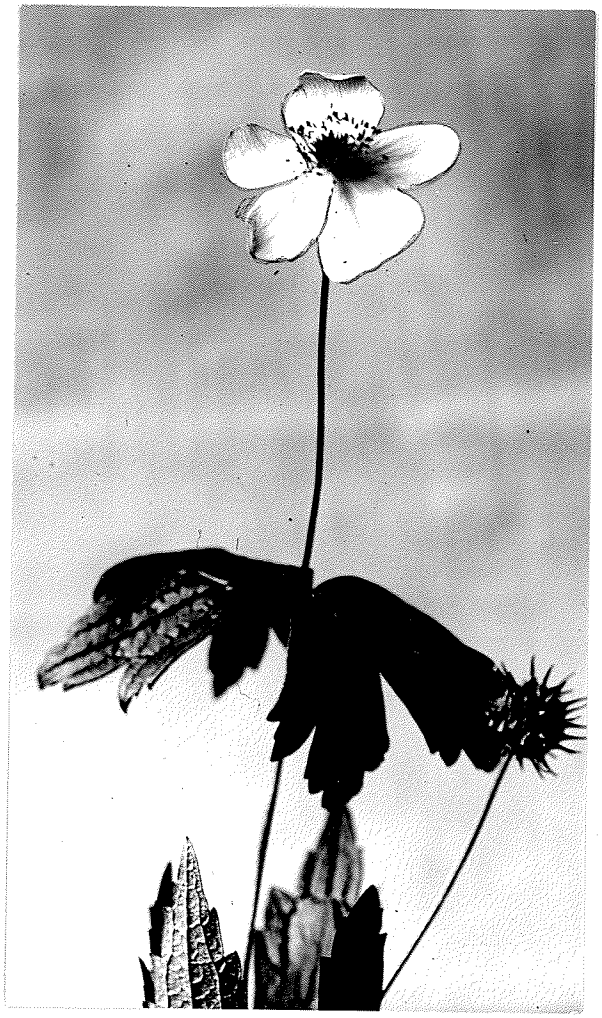


Fig. 4

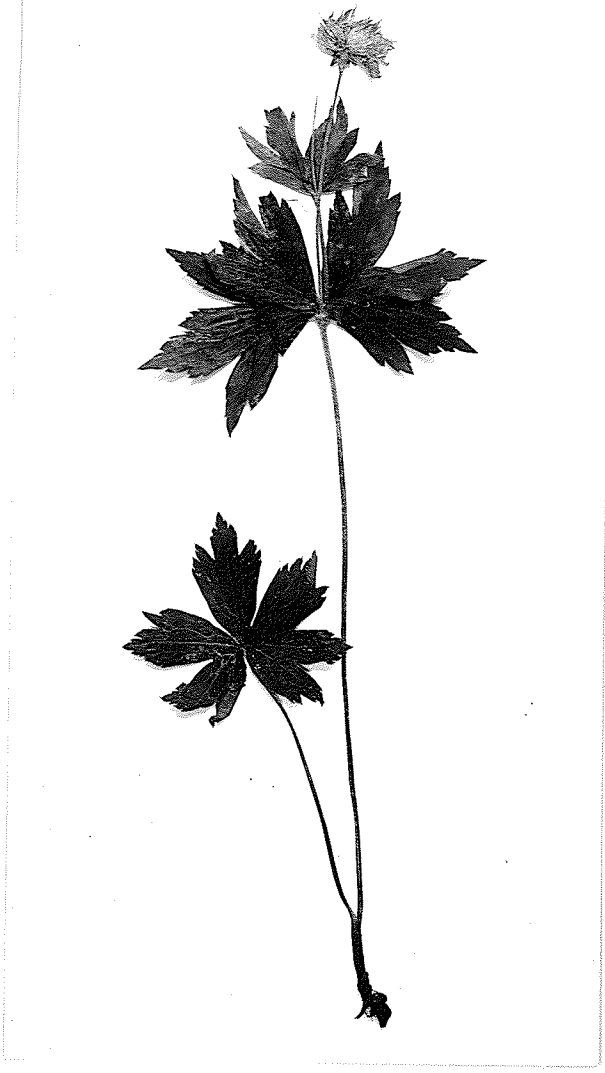


Fig. 5.

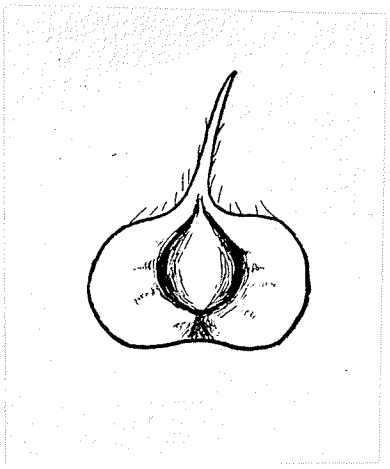


Fig. 6. (× 10)

ANEMONE QUINQUEFOLIA, L.

A. quinquefolia, L. Sp. Pl. 541 (1753).

A. nemorosa, Amer. Authors, not L.

A. pedata, Raf. Med. Rep. (ii) v, 361, (1808).

A. minima, D. C. Syst., i, 206 (1818).

A. nemorosa, var. quinquefolia, A. Gray. Man., Ed. 5, 38, (1867)

A. nemorosa, Macoun, Cat. Can. Plants, i, 12, (1883).

This species has, by some authors[1,2] been confused with A. nemorosa, which is a European species and differs in several particulars from A. quinquefolia, being a stouter plant, with larger flowers, darker leaves, and more divided involucre. Gray, in his sixth edition, describes our Manitoba species as A. nemorosa, but in his seventh edition accepts the name of A. quinquefolia.

A. quinquefolia is a small plant, ranging from 4 - 10 inches in height, and has large, solitary, white flowers, sometimes tinged with pink or purple on the outside. It is found in shady woods in the eastern and central part of the province, blooming in May and June, but is by no means common.

1. Macoun. Cat. Can. Pl. I, 12, (1883).

2. Gray, Man. Ed. IV.

DESCRIPTION IN DETAIL.

Root and Underground Stem.

The flowering stems of Anemone quinquefolia grow singly from the terminal point of a filiform, branching rhizome, brown in colour, which runs horizontally about two inches below the surface of the soil. The internodes are quite short, some of them being only ½ inch in length, and there is a small acute scale-leaf at each node, successive leaves being on opposite sides of the stem. (See Fig. 4.). After the flowering stem is sent up, the end of the rootstock continues to grow in a direction parallel to the surface, the new portion being white and brittle, as also is the older part. In a cross-section treated with phloroglucin, HCl, and Iodine, the structure of the underground stem can easily be determined, and the cause of its brittleness understood. There are three bundles of vascular tissue, near the centre of the rootstock, two of them much larger than the other. There are also isolated lignified fibres scattered throughout the cortex, the ground parenchymatous tissue cells being hexagonal, of varying sizes, and packed with starch grains. There is no apparent differentiation into central cylinder and cortex, as far as the parenchyma is concerned. The epidermis is only one cell in thickness, surrounded by a fairly thin cuticle. (See Fig 2.)

The roots are small, filiform, and adventitious, growing from some of the nodes of the rhizome. (See Fig. 3).

Flowering Stem and Leaves.

The flowering stems are slender, solitary and one-flowered, contrary to the general rule amongst the anemones, but bear the usual three-leaved involucre, from which arises one naked pedicel. (See Fig. 3). The parts of the involucre are leaf-like, and have petioles varying in length from ½ to ⅝ of an inch. Each of these is trifoliate, but different plants vary greatly in the amount of lobing present in the leaflets, some having almost entire margins, while others are so deeply cleft as to appear five-parted. The whole plant, with the exception of the flower, is finely pubescent, the hairs on the peduncle being longer than those on the involucral leaves, which are almost glebrate. The venation is reticulate, but the midrib is not very prominent, and the veining somewhat irregular. (See Fig 5.)

Flower.

The inflorescence is solitary, the flower being bright white, large for the size of the plant, and opening widely in the sunshine, its average diameter being one inch. The oblong ovate sepals are usually five in number, but plants with six are by no means uncommon. They are strongly veined, about ½ inch in length, and attached to the small convex receptacle below the androecium and gynaecium. Flowers are frequently found in clearings or at the edges of woods, having the outside of the sepals tinged with purple or pink. The colouring matter is anthocyanin, which has the power of changing

light into heat, and is found on the underside of the sepals of many periodically opening and closing anemones. The first rays of the rising sun fall upon the cells thus coloured, and are converted into heat.

Androecium and Gynaecium.

The stamens are numerous, pale-yellow, about one-fifth the length of the sepals, and do not differ essentially from those of the other anemones studied.

The gynaecium is similar to that of A. canadensis, but smaller, and containing fewer pistils (4 - 10 as a rule), which are usually 2 mm. long, the stigmatic papillae covering .3 mm. of the style.

Fruit and Seed.

The fruiting head is globose, similar to that of A. canadensis, but on a much smaller scale, as it contains at most only ¼ as many achenes, and they are not so large. (See Fig. 6). The individual achenia are oval, compressed, tipped with short, bent styles and covered with short woolly hairs, thus differing from those of A. canadensis, and fall off very early, remaining green until that time.

Variations.

The principal variations are those in the number and colour of the sepals, and in the character of the margin of the leaflets.

ANEMONE QUINQUEFOLIA.

Fig. 1. Plants of A. quinquefolia showing general morphology.

Fig. 2. Photomicrograph of a hand-cut section of the rhizome showing the internal structure, (vascular bundles, fibres, starch grains, etc.)

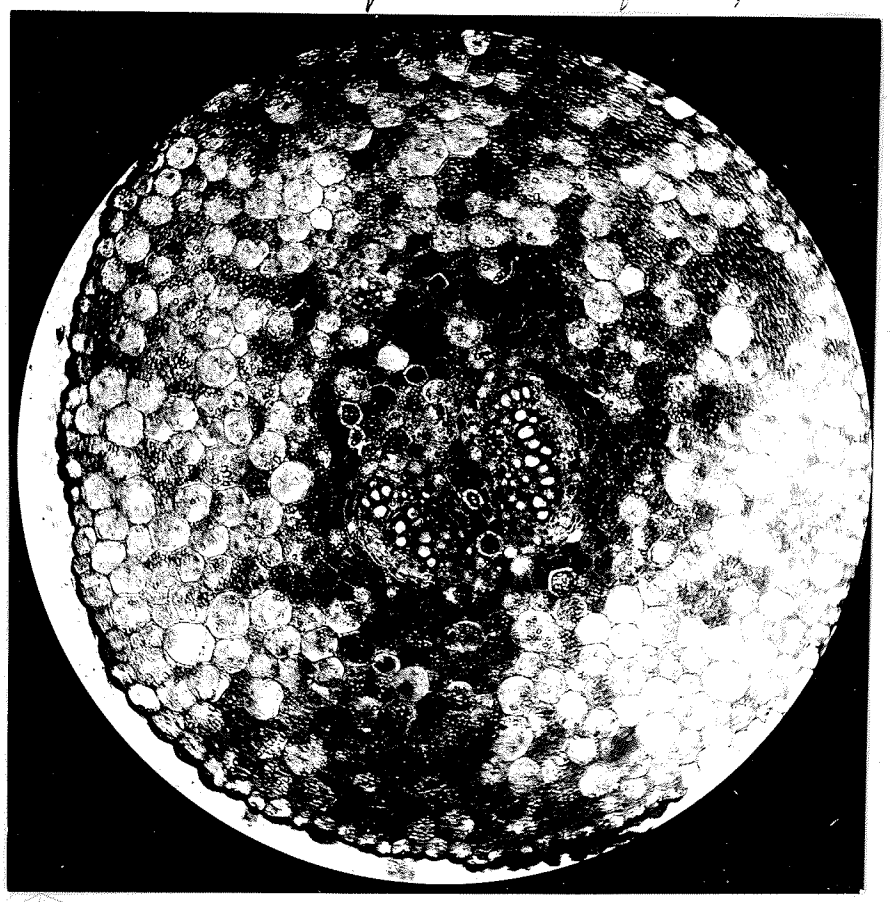
Fig. 3. Plant of A. quinquefolia showing involucre, rhizome, and roots.

Fig. 4. Enlarged drawing of rhizome showing scale leaves, nodes and roots.

Fig. 5. Leaf showing general morphology.

Fig. 6. Fruiting heads of A. canadensis and A. quinquefolia for comparison.

Fig 1. A. grandifolia



X-section of rhizome

Fig 2. (x100)

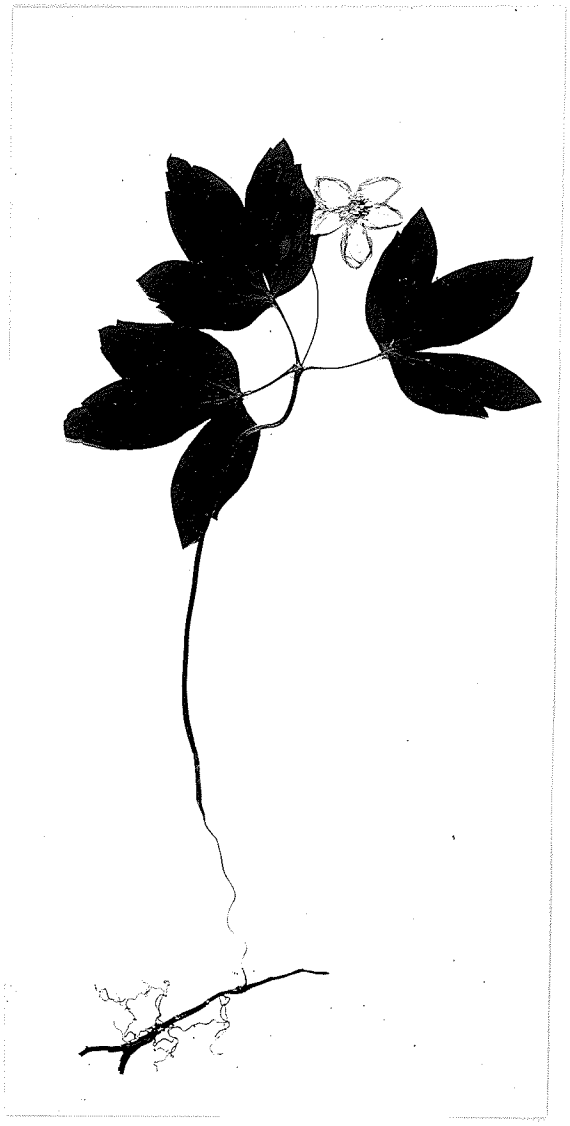


Fig 3. (X 1)

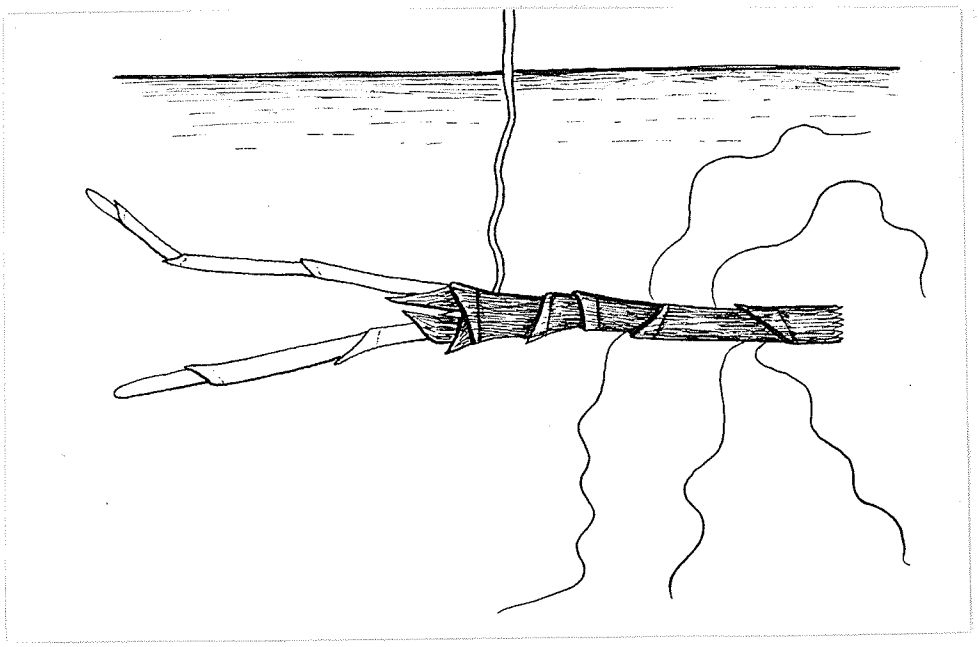


Fig 4. (X 3)

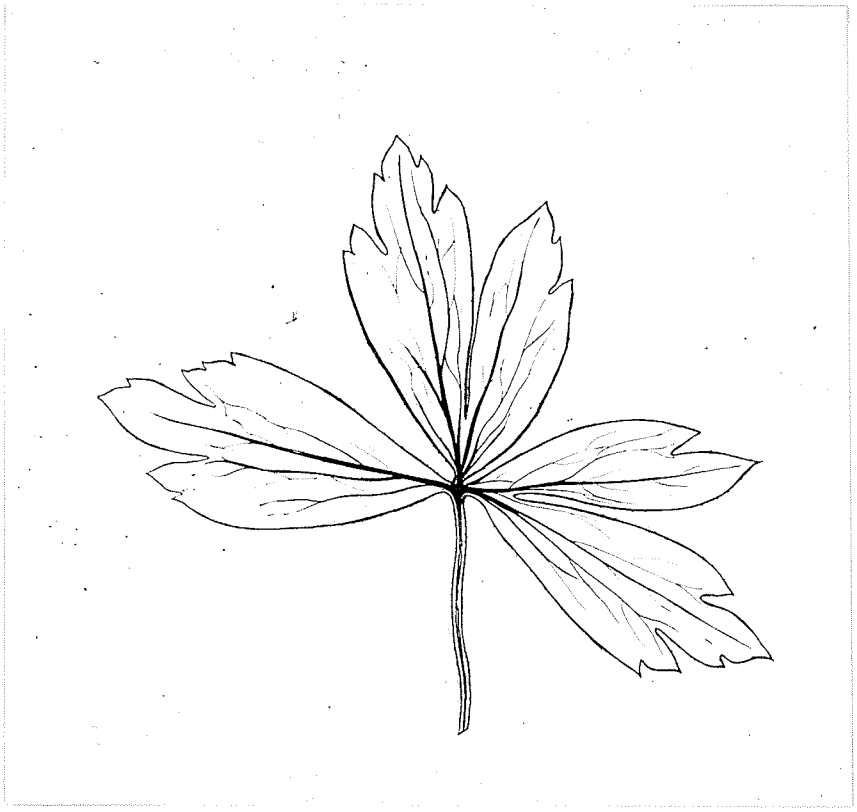


Fig. 5. (x 1/2)

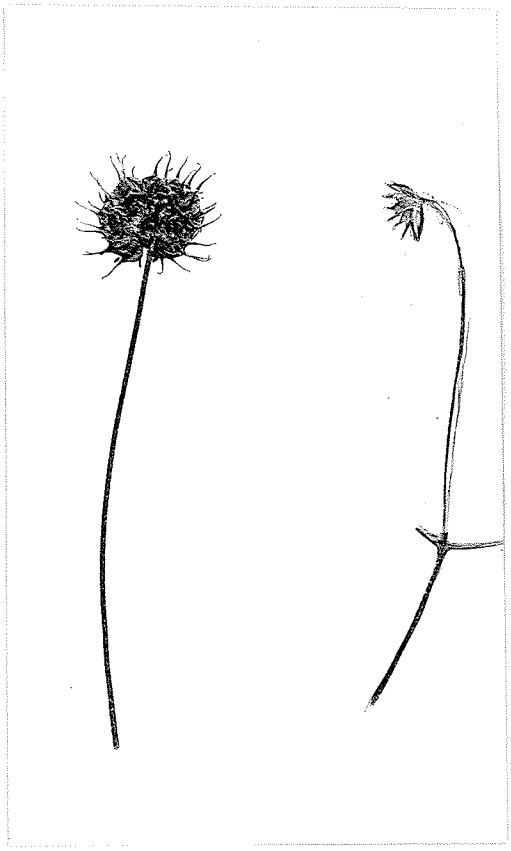


Fig. 6. natural size

SUMMARY.

In concluding this paper it was considered advisable to recapitulate the main features by means of which one can identify the Manitoba anemones in the field. These are as follows:

1. Members of the genus Anemone can be identified by the form of their leaves, the absence of corolla, and the presence of a whorled involucre.

2. A. patens, found on hill or prairie may be recognised by its lilac flower, sessile multifid involucre, its general hairiness, and the long plumose styles of the fruiting head.

3. A. multifida, found on dry hillside or prairie, is medium in height, and may be distinguished from A. cylindrica, which often associates with it, by the shape of the fruiting head, which is globose and woolly, and by the presence of secondary involucres on the lateral pedicels. The flowers are usually red and quite small, and the involucres short-petioled.

4. A. cylindrica grows in a similar environment to A. multifida, but can be distinguished from the latter by its cylindrical woolly fruiting heads, and the absence of secondary involucres.

5. A. virginiana is found in shady situations, and is a taller, greener, less hairy plant than any of the foregoing. The flowers resemble those of A. cylindrica, but the leaf-

segments are broad, the involucres are long-petioled, and there are secondary ones, and the fruiting heads are oval and woolly.

6. A. canadensis grows in damp shady places and is a stout plant with several large white flowers. The leaf segments are broad and prominently veined, the involucres sessile and proliferous, and the fruit orbicular, glabrate, wing-margined and long styled, borne on a globose fruiting head.

7. A. quinquefolia is a small slender plant found in and around woods. It has solitary large white flowers, sometimes tinged with purple, a petiolate 3-leaved trifoliate involucre and a globose fruiting head containing a few oval achenes.

This study was undertaken at the suggestion of Professor A. H. R. Buller, and carried on at the University of Manitoba under the direction of Mr. C. W. Lowe, to whom the grateful thanks of the author are due, as much for his patience and courtesy as for the assistance he has given.