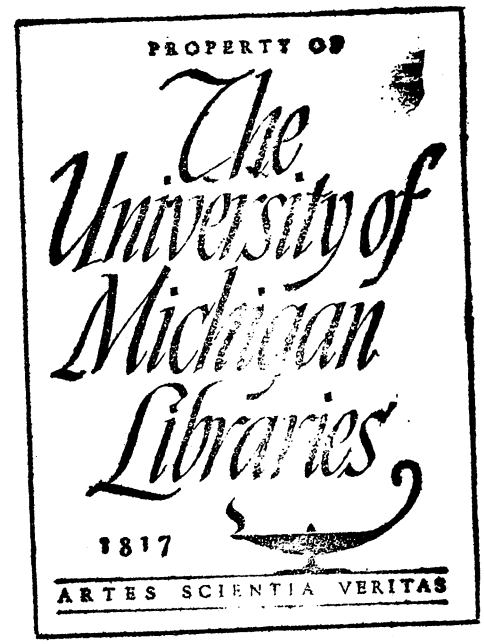
THE POISONOUS PLANTS OF MICHIGAN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THE POISONOUS PLANTS OF MICHIGAN

by

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Submitted in partial fulfillment
of the requirements for the degree
of Master of Forestry at the
University of Michigan.

Ann Arbor, Michigan May 31,1938

ACKNOWLEDGEMENTS

Grateful acknowledgement is made to Dr. E. C. O'Roke, under whose direction this work was done, and to C. L. Lundell for helpful co-operation at the University of Michigan Herbarium. Many others have given valuable assistance concerning the distribution of the poisonous plants of Michigan. These cooperators will be cited throughout this paper.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF MAPS

INTRODUCTION

The study of the poisonous plants of the East presents somewhat of a different problem than it does in the West where cattle and sheep-raising is the principal use of the land. However, we have an abundance of these plants in Michigan and it is highly probable that certain of them may be more important to the farmer than is generally conceded.

Michigan, especially the upper peninsula and the northern counties of the lower peninsula, was originally a heavily forested state but due to the practices of the timbermen this condition no longer exists. Much of this denuded land is unfit for agriculture but it may be used as a pasture range for sheep and cattle. This relatively new use of land in Michigan has turned our interests toward the poisonous plants. There is a likelihood that some species may become important where sheep and cattle are grazed.

Just what toll poisonous plants take each year in Michigan from the farmer is difficult to determine. An occasional loss here and there may go unnoticed, but these losses, however, if investigated may show that certain plants do cause serious damage to the farmer.

The dividing line between plants which are actually poisonous and those which are only suspected is rather hazy. In most cases the toxicity of a species has been determined through injections of the toxic extract and not from

observations made from natural poisoning following ingestion of the plants. Experimental feeding of plants has been attempted in most cases with western species. This gives a better indication of the toxicity of the plant but does not indicate the likelihood of poisoning under natural conditions where other forage is present. Also, there may be doubt as to the identification of the plant suspected of poisoning. In some cases the identification rests on the veterinary or the stockman assuming a certain plant is the cause. In view of these facts it is probable that many of the species discussed in the following pages may never cause poisoning to animals. However, plants known to contain toxic substances should be looked upon with suspicion.

All descriptions of the plants discussed in this paper were taken from Gray's Manual. Nomenclature in most instances was checked from this same authority, although, in some cases, Schaffner's Flora of Ohio was used.

DEFINITION OF A POISONOUS PLANT

Several definitions of poisonous plants have been set forth by various authors. Poisonous plants differ widely in their toxicity; some of those suspected of poisoning are actually quite harmless and others unsuspected may prove in the future to be very toxic. In some cases it is impossible to come to any conclusion as to the degree of toxicity of a plant owing to the lack of definite information. Many plants such as Lolium temulentum are quite harmless except when affected by fungi.

For our purpose we will define a poisonous plant as one when eaten in a small quantity induces some form of indisposition with narcotic, irritant, or nervous symptoms, with serious or fatal consequences. These symptoms may be produced immediately or by cumulative action of the toxic property.

GENERAL DISCUSSION

Although many plants will be discussed in this paper very few of them are of importance in the poisoning of livestock. Many species are to a considerable extent protected from animals by the fact that they have an unpleasant odor, are acrid or bitter to the taste, or produce spines. In nature, animals seem to avoid such plants as are toxic, and

to be less readily poisoned than are domesticated animals living under artificial conditions. However, it would not be logical to assume that wild animals never eat poisonous plants. Dixon (1928), while working on food habits of deer in the Yosemite Valley, found that larkspur, azalea, and cow parsnip were never touched, while other poisonous plants such as green manzanita (Arctostaphylos patula), and California laurel (Rhododendron californicum) were grazed upon freely. He refuses to state that deer never eat a certain species. (does not)

It has been observed that livestock reared in a locality where poisonous plants abound are much less likely to be poisoned than imported stock. It would appear that animals learn to avoid certain species through past experiences.

The individuality of stock is also a factor which may be responsible for poisoning, some animals having a depraved appetite for unwholesome food plants. It would appear that animals are often tempted to eat dark-green plants of luxuriant growth which are soft and succulent. Especially is this true with sheep, which usually avoid tall old rank-growing and coarse vegetation unless absolutely pressed by hunger. Cattle, however, are not so particular and will commonly eat large coarse-growing plants.

Sheep have been observed to be particularly variable in their choice of food plants, not only individually in the flock, but from day to day. Chesnut and Wilcox (1901)

say that "there seems to be no way of accounting for the appetite or taste of stock. This statement is especially true of sheep. We have often observed sheep eating greedily on one day plants which they could scarcely be persuaded to eat on the following day on the same range. In the case of one flock of sheep on a foothill range at an altitude of 4,600 feet a few of the sheep were observed eating large quantities of wild sunflower (Balsamorhiza sagittaria); a few ate freely of false lupine (Thermopsis rhombifolia), some confined their attention largely to the wild geranium, while others ate false esparcet (Astragalus bisulcatus) almost exclusively. Two sheep were seen eating leaves of lupine, and about fifty ate a greater or less quantity of Zygadenus venenosus while the majority of the sheep in the band fed exclusively upon the native grasses of the range."

The different classes of livestock are often very differently affected by poisonous plants, some being highly susceptible to a given plant while others may be little or not at all. Pigs can often vomit the poison of a plant while horses are not able to do so and hence be the more seriously injured. Sheep are said to be practically immune to larkspur while cattle are highly susceptible to it. Poisonous effects may also vary with the age of the animal -- young horses are much more likely to be poisoned by horsetail than are older animals. (Gates 1930).

At certain periods of the year such as early spring and dry summers, poisoning may be much more prevalent.

This is due to the fact that there is a deficiency of green vegetation at these seasons and consequently stock are forced to eat whatever is available which may often be a poisonous species.

Animals may be poisoned by certain toxic seeds; corn cockle (Agrostemma Githago) is a good example. Poisoning usually occurs through feeding wheat and other small grains such as screenings which often contain large amounts of cockle, and many animals are poisoned through this source. In Europe, where grains are utilized much closer than in this country, people have been poisoned through eating bread made from low grade flour which usually contains a high percentage of cockle.

Many garden flowers and shrubs contain poisonous principles and when clippings from gardens are thrown where they may be fed upon by livestock, poisoning often occurs. Milch cows that are accustomed to being fed in barnyards seem to eat this material that has been cut which they would not touch on the range. Plants such as daphne, privet, rhododendron, azalea and nightshades often cause poisoning in this manner.

Effect of Soil, Climate, and Cultivation on the Toxic Properties of Plants. In general, wild poisonous plants are richer in their alkaloids and glucosides than the same species when cultivated, although in some cases exceptions to this rule occur. In many cases plants vary widely in toxicity according to soil, light, and moisture. Plants

of the Solanaceae family are the best examples of this. Solanum nigrum varys so widely that it is considered poisonous in one country and quite harmless in another.

Experiments conducted at the Arlington Experimental Farm, Virginia, showed that in 24 first-year plants of Atropa Belladonna grown in 1910 the alkaloidal content of the leaves varied from .334 to .700 per cent, and averaged .547 percent. In 1911 the alkaloidal content (usually the average of five pickings) of the leaves of 59 plants varied from .306 to .766 percent, and averaged .532 percent. In 1912 the alkaloidal content of the leaves of 57 plants varied from .352 to .768 percent, and the average was .545 percent. In individual plants at a single picking the highest alkaloidal content in 1911 was .925 and the lowest .200, and in 1912 the highest was .882 and the lowest .292. (Sievers 1913).

The variation in the percentage of poisonous substances is shown in several papers read at the International Congress of Applied Chemistry held at Washington and New York in 1912. F. H. Carr stated that at the Wellcome Materia Medica Farm in England, the effect of manuring on medicinal plants has been tested for some years and the effect of the more common fertilizers on Atropa Belladonna was shown by the following table.

Percentage of Alkaloid in Dry Stem and Leaf

Fertilizer	Time of Application	Amount per Acre	1906 3rd. Years Plants	1907 4th. Years Plants	1910 1st. Years Plants	1911 2nd. Years Plants	1912 3rd. Years Plants
Main crop			0.54	0.34	0.61	0.59	0.68
Farm Manure	March	50 loads	0.54	0.34	0.61	0.53	0.71
Nitrate	Mar.& April	2 cwt.	0.52	0.23	0.54	0.46	0.64
Calcium cyanamide	March & April	1 cwt.			0.69	0.49	0.75
Basic Slag	Mar.& April	2 cwt.	0.61		0.65	0.56	0.84
Superphosophate	Mar.& April	5 cwt.	0.46		0.81	0.49	0.76
Potash	Mar.& April	5 cwt.	0.61	0.40	0.75	0.53	0.69

It has been shown that the Belladonna root sold commercially varies widely in the alkaloidal composition. In a number of analyses made of commercial roots, variations from 0.27 to 0.69 percent have occurred. The average of twenty-one analyses of German and Austrian commercial roots was 0.40 per cent. Other observers have recorded similar results. Chevalier gives the following figures for Continental roots: French, 0.300 to 0.450 per cent; Austrian, 0.257 to 0.372 per cent; Italian, 0.107 to 0.187 per cent. Henderson has shown the average of thirty samples of foreign roots to be 0.3 per cent. It is interesting to observe that the average of nine samples of root grown at Darneth, England was 0.54 per cent. In order to determine whether this varia-

tion was due to collecting at different times of the year, roots from the same plot derived from second year's plants which were sown at the same time were dug up at intervals and dried. The following is a record of the analysis of these samples:

March, 1911	0.56	percent
May, 1911	0.59	" "
June, 1911	0.53	" "
August, 1911	0.50	" "
December, 1911	0.59	" "

The amount of variation throughout the year is thus seen to be very small. (Long 1923 after Henderson and Chevalier).

In connection with experiments conducted with Hyoscyamus muticus grown in India and Egypt, a variation of C.6 per cent was found between plants grown in these two countries. (Dunstan 1905).

Esser states that no coniine is found in Conium maculatum growing in the far north. He also says that the root of Hyoscyamus niger is free from the toxic principle in winter. (Long, 1923 after Esser)

In view of these records it would be fair enough to suppose that a plant may be poisonous in one locality and not in another. Past experiences have shown that certain localities are "poison areas" and great losses occur in these places. These areas are no doubt due to differences in soil fertility and climatic factors. The statement that plants in one locality are poisonous while plants from another are not, should not be taken to mean that some plants of the same

species do not contain the toxic principle, rather it would indicate that those plants contain a smaller per cent of the toxic principle and therefore animals are less likely to receive a lethal dose.

Another interesting effect of soil on plants is shown by that produced by selenium-bearing soils. It has been found that plants growing on these soils take up the selenium and are thus poisonous to man and animals. This subject will be dealt with later on in this paper.

Poisonous Principles Contained in Plants The poisonous substances in plants may be classed either (a) accordto their physiological effects on certain organs or (b) in accordance with their chemical relationships.

With regard to (a) the poisons may act upon the brain (narcotics, deleriants, inebriants), the spinal cord (convulsives), or the heart (asthenics, depressants).

Narcotics are substances which act on the brain and produce symptoms such as giddiness, contracted pupils, dimness of sight, headache, noises in the ears, wild and confused ideas, and drowsiness, passing into deep sleep.

Species of poppy (Papaver) produce poisons such as opium and herion which act on the brain as narcotics.

Deleriants are substances which act on the brain and produce spectral illusions, delirium, thirst and dryness of the mouth, dilated pupils, and lack of coordination.

Species producing poisons that act as deleriants are: black nightshade (Solanum nigrum), hemp(Cannabis sativa), jimson weed (Datura stramonium), and darnel (Lolium temulentum).

Inebriants or intoxicants are substances that act on the brain and produce symptoms such as loss of power of co-ordination and muscular movements, excitement of cerebral functions and of circulation, double vision, followed by deep sleep.

Wormwood (Artemisia absinthium) produces poisons in the seeds which act as inebriants.

Convulsives are poisons acting on the spinal cord, producing symptoms such as intermittant convulsions extending from above downwards; swallowing is spasmodic and the body may be drawn backwards. Death usually occurs in less than three hours or the patient recovers rapidly.

Strychnine is a good example of this class of poison.

Depressants are poisons acting on the heart, producing dizziness, vomiting, confused vision, abdominal pain, convulsions, paralysis, occasional delirium, loss of consciousness, and sometimes asphyxia.

Plants producing poisons that act on the heart as depressants are: Indian tobacco, (Lobelia inflata), tobacco (Nicotiana tabacum), and poison hemlock (Conium maculatum).

Asthenics are poisons acting on the heart, producing symptoms of numbness, tingling of the mouth, abdominal pain, dizziness, vomiting, purging, paralysis, and occasional delirium, ending in loss of consciousness.

Plants acting as asthenics are: Green hellebore (Veratrum viride), white hellebore (Veratrum alba), foxglove Digitalis purpurea), monkshood (Aconitum noveboracense), and lima bean (Phaseolus lunatus).

With regard to (b) -- Chemical classification of poisons -- the toxic principles of many plants are not yet well understood, either as to chemical composition or symptoms produced. Most of the toxic principles of our native poisonous plants are either alkaloids or glucosides. Other poisonous principles produced in plants are tannins, organic acids, resinoids, and phytotoxins.

The alkaloids all contain nitrogen, differ widely in molecular construction, and are usually combined with organic acids. In the pure state they are colorless and usually stable, crystalline, or amorphous solids, or volatile liquids; they usually have a burning taste. These strong vegetable bases have very striking physiological effects upon animals and are frequently used as narcotics, stimulants, and for various other medicinal purposes. These are:

conine	reduces temperature
nicotine	reduces temperature
atropine	reduces temperature and dries secretions
hyoscyamine	Local anaesthetic
cocaine	Local anaesthetic
quinine	used for malaria
strychnine	stimulant
brucine	Deaden pain
curarine	Deaden pain
morphine	Deaden pain
codeine	Local anaesthetic
solanine	Local anaesthetic

In general the same base is confined to species of the same order; solanin is confined to the Solanaceae etc. The alkaloids include the most powerful poisons to be found in plants.

The glucosides embrace a group of substances which by the action of an acid on an enzyme are split up into sugars and other substances (alcohol, aldehydes, acids).

Glucosides have a bitter taste and are generally readily soluble in water.

There are many groups of glucosides; the following table briefly outlines these.

CLASSIFICATION OF GLUCOSIDES
(revised after Gates)

Group	Glucoside	Plants	Action
Phenol	iridin, baptisin	Iris	cathartic diuretic purgative
Alcohol	Salicin Coniferin populin	Salix Conifers Populus	Astringents
Acid	gaultherin Japalin convolvulin	Gaultheria Exogonia Convolvulaceae	Cathartic purgative
Cyanogenetic	amygdalin dhurrin vicianin phaseolunatin lotusin	Rosaceae Sorghums Vetches Lima bean Leguminosae	Produce Hydro cyanic acid
Mustard group	Sinalbin Sinigrin	White Mustard Black Mustard	Emetic
Digitalis group	digitoxin digitalin cymarin	Digitalis Digitalis Apocynum	Heart stimulants
Saponin	saponins	Many groups	dissolves hemoglobin from red blood corpuscles

Phytotoxins are poisonous proteins which usually cause purging and extreme irritation of the intestinal tract. There are three of these substances which cause poisoning

to livestock and people; these are ricin, robin, and croton and are known as toxalbumins. Ricin is found in the castor oil plant (Ricinus communis), robin is found in the black locust (Robinia pseudacacia), and croton is found in the seeds of Croton tiglinum.

Tannins are generally glucosides but have different characteristics than those mentioned before. The characteristics are:

1. They are non-crystalline in nature.
2. They are acid in reaction.
3. They form colloidal solutions in water.
4. They have a sharp astringent taste.
5. They unite with gelatin-containing tissue to form insoluble compounds.
6. They form soluble bluish or greenish black compounds with ferric salts.
7. They are precipitated from solutions by many metallic salts.
8. They precipitate out of solutions albumins, alkaloids and basic organic coloring matters.
9. Most tannins, when in alkaline solutions, absorb oxygen from the air and become black in color.

Some of these characteristics are used to an advantage by certain industries. Leather is made when tannins combine with the gelatinous material in skins, and inks are made by combination with ferric salts.

Because of their precipitating action on alkaloids they are used as antidotes for alkaloidal poisoning. (Gates 1930)

Tannins are of wide occurrence in plants and in some they occur in large quantities. The oaks, chestnut, and hemlock contain large quantities and are of commercial importance in the leather tanning industry. The species

growing in warm climates contain higher precentages of tannin than those species growing in cooler regions. This explains why poisoning from oak leaves is of more importance in the southern states.

Organic acids are of relatively little importance in the poisoning of stock. These substances occur either as free acids or partly neutralized as salts of calcium, potassium, and sodium. They also occur in combination with certain alcohols as esters; these are of frequent occurrence in the fleshy tissues of plants but large amounts must be consumed before any ill effects occur.

The resinoids are a very important class of poisons. These substances, implied by the name, are resinous in character. These are complex substances and few of them have been purified; their chemical relationships are still uncertain. Some plants of the Ericaceae family contain a resinoid, andromedotoxin (C_{19} H_{30} O_6). Couch (1937) says that this substance is contained in the flowers of the heath plants and consequently the honey is very poisonous. The toxic principles of water hemlock and whorled milkweeds are attributed to resinoids.

This chemical classification of poisons was taken from the chemistry of stock poisoning plants (Couch 1937), Thatcher's Chemistry of plant life (1921), and the principal Poisonous plants of Kansas (Gates 1930). Classification as to physiological effect was taken from Pammel's Manual of poisonous plants (1911).

THE POISONOUS PLANTS OF MICHIGAN
(Those marked with asterisk*
will be discussed in detail later)

POLYPODIACEAE

1. Adiantum pedatum L. Maidenhair Fern

   Found over entire state in rich moist woodlands. Said to contain hydrocyanic acid.

2. Dryopteris Spp. Shield Ferns

   Rare. Used in early days for tape-worm. Contains filmarone (C_{47} H_{54} O_{16}). (Trease)

3. *Pteridium aquilinum L. Bracken Fern

   Found over entire state in woods, thickets, and pastures. Hydrocyanic acid and large quantities of silica present. Pteritannic acid present. (Trease)

EQUISETACEAE

4. *Equisetum arvense L. Field Horsetail

   Common in damp sandy ground throughout the state. Large amounts of silica present. Toxic properties probably due to alkaloid Equisetine. (Lohmann)

5. *Equisetum hymeale L. Scouring Rush

   Grows locally throughout state. Very large amounts of silica present. Toxic principle probably same as E. arvense.

PINACEAE

6. Juniperus communis L. Juniper

   Grows over most of the state on dry hillsides, pastures, and oak-hickory woodlands. Oil from fruit poisonous to people. Leaves poisonous to goats. (Woodcock)

7. Juniperus virginiana L. Eastern Red Cedar

Over entire state in dry open places. Oil from berries produce abortion in animals. (Woodcock)

TAXACEAE

8. Taxus canadensis Marsh. Ground Hemlock

Occasional in woods over entire state. Fruit reported poisonous to people. (Woodcock)

TYPHACEAE

9. Typha latifolia L. Cat-tail

Common in swamps and marshes over the state. The stem and rhizomes are used for food and have been known to poison people.

SCHEUCHZERIACEAE

10.*Triglochin maritima L. Arrow-grass

Grows along sandy shores of Great Lakes and in damp sandy ground in the interior. Contains hydrocyanic acid. (Marsh)

GRAMINEAE

11.*Holcus halepensis L. Johnson Grass

Cultivated for hay. Produces hydrocyanic acid. (Couch)

12.*Holcus sorghum Var. sudanensis Piper. Sudan Grass

Cultivated for hay. Produces hydrocyanic acid.

13.*Stipa robusta Scribn. Sleepy Grass

Occasional in lower peninsula. Produces narcotic effect on horses. (Marsh)

14. *Lolium temulentum L. Poison Darnel

Occasional in abandoned lands and cultivated grounds. Poisonous properties due to fungus harbored in seed. This is in some dispute. (Long). Contains the narcotic acid temuline.

ARACEAE

15. Arisaema triphyllum(L.) Torr. Jack-in-the-pulpit

Grows over entire state in rich moist woods. Corm exceedingly irritating and poisonous when ingested. Contains sharp crystals of silica.

16. Symplocarpus foetidus (L.) Nutt. Skunk Cabbage

Grows over entire state in bogs and wet places. Toxic as Arisaema triphyllum.

LILIACEAE

17. *Zygadenus elegans Gray. Death Camas

Occasional on sandy grounds. One of the most poisonous plants of the west. Contains a poisonous alkaloid. (Marsh & Clawson) Couch

18. *Zygadenus chloranthus Richards. Death Camas

More common than the above form. Contains the same toxic substances as Z. elegans.

19. Colchium autumnale L. Meadow Saffron

Grown in gardens. Causes many losses to livestock in England. Contains colchicine ($C_{22}H_{25}N_{06}$). (Hertel)

20. Convallaria majalis L. Lily-of-the-valley

Cultivated in gardens over the entire state. Contains convallamarin, Pardin, and convallarin. (Chesnut.) Cornevin

21. Allium canadense L. Meadow Garlic

Common in moist meadows and thickets. Poisonous to cattle because of the irritating effect of the oil of the plant. (Woodcock)

22. Trillium erectum L. Ill-scented Wake Robin or Trillium

Occasional in moist woods. Roots have a violent emetic action. (Lindley) Woodcock

23. Trillium Grandiflorum (Michx.) Salisb. Trillium

Common in moist woods over entire state. Poisonous same as T. erectum. (Pammel)

24. Smilax herbacea L. Carrion Flower

Common over entire state. Flowers said to be poisonous. (Woodcock)

IRIDACEAE

25. Iris versicolor L. Large Blue Flag

Cultivated in flower gardens. Escaped and is now found growing in low damp lands. Some species contain the glucoside irigenin (C_{18} H_{16} O_8). (Pammel)

URTICACEAE

26. Humulus Lupulus L. Common Hop

Frequent along banks of northern streams. Produces inflammation.

27. *Cannabis sativa L. Hemp (Marijuana)

Found in waste places over the entire state. Cultivated in vacant lots in cities. Used in cigarettes for its narcotic effect. Acts as a deleriant. (Beath)

28. Laportea canadensis L. Wood Nettle

Common in moist rich woods in central and southern Michigan. Toxic principle is formic acid, causing intense itching. Death caused to stock from starvation after injury to mouth and stomach. (Beath)

29. Urtica dioica L. Great Nettle

Occasional in waste places. Poisons same as preceding.

30. Urtica gracilis Ait. Slender Nettle

Common in dry soil over the entire state. Poisonous properties same as above.

ARISTOLOCHIACEAE

31. Asarum canadense L. Wild Ginger

Common in woods over the entire state. Reported to be poisonous. (Woodcock)

32. Aristolochia macrophylla Lam. Dutchman's Pipe

Cultivated over entire state. Contains the poisonous principle aristolochin ($C_{32}H_{22}N_2O_{13}$), and the alkaloid aristolochinin. Used as an antidote for snake bite. (Pammel)

POLYGONACEAE

33. Rumex acetosella L. Sheep Sorrel

Common on dry hills and fields. Said to cause poisoning to sheep and horses. Docks contain the substance rumicin ($C_{14}H_{10}O_4$) used for destroying parisites on the skin. Also contains chrysophanic acid (Sollmann). Also contain oxalic acid. (Couch)

34. Rumex crispus L. Narrow Dock

Common over entire state; used as an astringent. (Pammel). Toxic same as above.

35. Fagopyrum esculentum Karst. Buckwheat

Produces dermatitis in people and hogs. Seems to act like St. John's Wort, producing dermatitis when exposed to light. May be serious in sheep. (Long)

36. Polygonium hydropiper L. Smartweed.

Common in moist ground over the entire state. Said to be troublesome to sheep. (Pammel) Produces gastroenteritis.

CHENOPODIACEAE

37. Chenopodium ambrosoides L. Mexican Tea

Grows occasionally in waste places. Seeds contain volatile oils and chenopodin ($C_6 H_{13} NO_2$) which is a narcotic, acrid poison. Oil of chenopodium is used as a treatment for amoebic dysentery. (Trease)

PHYTOLACCACEAE

38. Phytolacca americana L. Poke-berry

Frequent in central and southern Michigan. Roots and seeds act as a violent emetic. Also effect nerve and muscle cells. (Beath)

CARYOPHYLLACEAE

39. Stellaria media (L.) Cyrill. Common Chickweed

Common all over the state. Seeds produce digestive disorders in lambs. (Pammel after Carruthers)

40. *Agrostemma Githago L. Corn Cockle

Common over entire state in grain fields. Contains narcotic substance githagin. (Couch)

41. *Saponaria officinalis L. Bouncing Bet

Common in grain fields. Seeds contain same narcotic principle as Agrostemma.

42. *Saponaria Vaccaria L. Cow Cockle

Found in grain fields. Toxic as the above two. (Cornevin)

RANUNCULACEAE

43. *Delphinium Spp. Larkspurs

These plants are grown in flower gardens and have escaped in some places. This is one of the most troublesome plants of the western stock ranges.

44. Actaea Alba (L.) Mill. White Baneberry

Common in moist woods over the state. Berries are poisonous, acting as an abortive. (Beath)

45. Actaea rubra (Ait.) Willd. Red Baneberry

Common in moist woods over state. Poisonous berries act same as A. Alba.

46. Anemone quinquefolia L. Wind Flower

Common in moist woods over the entire state, Contains a very poisonous substance anemonin (C_{10} H_8 O_4), Acts as a narcotic.

47. *Caltha palustris L. Marsh Marigold

Common in bogs and swamps. Contains helleborine (C_{36} H_{42} O_6), a glucoside. Produces diarrhoea and reduction in flow of milk. (Long)

48. *Ranunculus Spp. Crowfoot or Buttercup

Many species present over the state. Contain the poisonous alkaloids aconitine and delphinine. (Pott)

49. Clematis virginiana L. Virgin's Bower

Common in moist woodlands and along streams. Juice causes blisters and ulcers. (White)

50. Thalictrum dioicum L. Early Meadow Rue

Common in woods all over the state. Poisonous to stock. (Woodcock)

51. *Aconitum noveboracense Gray. Monkshood

Grown sometimes in gardens. Rarely found growing wild. Very poisonous. (Blyth)

BERBERIDACEAE

52. Berberis vulgaris L. Common Barberry

Common over entire state. Berries when used for jelly may cause poisoning. (Woodcock)

53. Caulophyllum thalictroides (L.) Michx. Blue Cohosh

Common all over the state. May be poisonous. (Pammel)

54. Podyphyllum peltatum L. May Apple

Common in rich woods in southern part of the state. Causes purging in animals. Cows produce bad milk after eating leaves. Roots are irritating.

MENISPERMACEAE

55. Menispermum canadense L. Canada Moonseed

Grows in woods and along streams. Berries poisonous. Contains several toxic substances and the alkaloid menispermin (C_{38} H_{24} NO_4). Has caused death when mistaken for wild grapes.

PAPAVERACEAE

56. Papaver somniferum L. Garden Poppy

This plant has been grown extensively in flower gardens and has escaped in places. Opium is obtained from the unripe capsule.

57. Sanguinaria canadensis L. Bloodroot

Common in moist rich woods over the entire state. Contains sanguinarin (C_{20} H_{15} NO_4). Not likely to cause poisoning because of its exceedingly acrid taste.

58. Chelidonium majus L. Celandine

Occurs rarely. Produces conjestion of lungs and liver. (Pammel)

FUMARIACEAE

59. Dicentra canadensis Goldie. Squirrel Corn

Frequent in lower peninsula. All parts of the plant contain the alkaloid cucullarin which is poisonous to cattle.

60. Dicentra cucullaria (L.) Bernth. Dutchman's Breeches

Sometimes grown in gardens. Found growing wild in the lower peninsula. Contains cucullarin.

CRUCIFERAE

61. Brassica Alba L. White mustard

Occasional over the entire state. Seeds act as a powerful stimulant. Contains the glucoside sinalbin.

62. Radicula Armoracia (L.) Robinson. Horse Radish

Occasional in moist ground over the lower peninsula. Contains the glucosides sinigrin and myrosin. Powerful irritant of the urinary organs. (Rusby)

63. Capsella Bursa-pastoris (L.) Medic. Shepherd's Purse

Very common in fields and waste places over entire state. Produces the same symptoms as other members of the family only less severe.

ROSACEAE

64. Malus Spp. Apple

All species of apple contain the glucoside amygdalin which forms hydrocyanic acid under certain conditions.

65. Prunus serotina Ehr. Wild Black Cherry

Frequent in the lower peninsula. Cattle are often killed from eating the leaves which contain hydrocyanic acid when frosted, wilted or crushed. The cherries contain amygdalin, a glucoside which hydrolizes under the influence of enzymes to benzaldehyde, glucose, and hydrocyanic acid. (Couch)

66. Prunus pennsylvanica L. Fire Cherry

Common all over the state. Comes in thickly following fires. Poisonous character same as above species.

67. Prunus virginiana L. Choke Cherry

Common in entire state. Poisonous character same as above.

LEGUMINOSAE

68. Gymnocladus dioica (L.) Koch. Kentucky Coffee Tree

Occasional in rich woods in southern countries. Fruit poisonous to people. Contains the alkaloid cystisin (C_{11} H_{14} N_2 O). (Chesnut)

69. Baptisia leucantha T. & G. White Wild Indigo

Occurs occasionally in rich soil in southern Michigan. Acts as a violent emetic and cathartic. (Hyams). Contains the alkaloid baptisin (C_{26} H_{32} O_{14}). (Couch)

70. Baptisia tinctoria (L.) R. Br. Wild Indigo

Occasional on dry soil in southern part of state. Has same action as B. Leucantha. Contains the alkaloid Cytisine (C_{11} H_{14} N_2 O). (Couch)

71. *Crotalaria sagittalis L. Rattle Box

Occasional on dry open places. Poisonous to horses, causing what is known as the "Missouri Bottom" disease. (Stalker). Contains a poisonous alkaloid. (Couch)

72. *Lupinus perennis L. Wild Lupine

Central and southern part of state in dry sandy soil. Poisons sheep and horses. Contains lupinin, lupinidum and arginin. (Chesnut)

73. Trifolium hybridum L. Alsike Clover

Occasionally produces bloat. Moses and Harcourt at the Tennessee Agricultural Experiment Station (1905) report poisoning to horses and mules that may be due to some toxic substance. Mold has been suggested as causing the trouble. Possibly the plant undergoes some chemical change in the digestive tract, producing a poison.

74. Trifolium pratense L. Red Clover

Occasionally produces bloat.

75. Trifolium repens L. White Clover

Produces bloat in cattle and slobbering in horses.

76. Melilotus alba Desr. White Sweet Clover

One of our most common weeds of roads and pastures. Makes good hay if cut while young. The sweet clover contains cumarin ($C_9 H_6 O_2$), which is found in Tonka bean and vanilla grass. This substance is a constituent of vanilla.

77. Medicago sativa L. Alfalfa

When fed green in large quantities to cattle it may produce bloat.

78. Robinia pseudoacacia L. Black Locust

Leaves and bark contain robin an aromatic phytotoxin. Poisoning has occurred to horses and cattle from eating the leaves. (Couch)

79. *Vicia sativa L. Common Vetch

Occasional in fields and waste places. Vicin ($C_8 H_{15} N_3 O_6$) has been found in the seeds. Plant has been known to poison pigs. (Schaffner)

80. *Astragalus mollissimus Torr. Wooly loco

Occasional in southern Michigan. One of the most troublesome weeds of the west. Poisonous to horses and cattle. (Marsh and Clawson)

81. *Lathyrus maritimus (L.) Bigel. Everlasting Pea

Occasional over the state along with other species of Lathyrus. Poisonous to horses and pigs, causing debility in the rear parts.

82. Phaseolus miltiflorus Willd. Scarlet Runner Bean

Cultivated as an ornamental vine. Seeds said to be poisonous.

83. Phaseolus lunatus L. Lima Bean

Cultivated. Wilted leaves contain hydrocyanic acid. (Pammel). The acid is produced from linamarin ($C_{10} H_7 NO_3$) found also in flax. (Couch)

OXALIDACEAE

84. Oxalis stricta L. Yellow Wood Sorrel

Common throughout the state in woods and fields. Causes convulsions. (Schaffner)

LINACEAE

85. Linum usitatissimum L. Common Flax

Cultivated and escaped. Seeds sometimes cause poisoning because of hydrocyanic acid present. Acid is generated from linamarin. (Couch)

EUPHORBIACEAE

86. *Euphorbia Spp. Spurge

Several species in the state. Contains a powerful irritant. The acrid blistering poison causes "slobbering" in horses. (Gates)

87. Ricinus communis L. Castor Oil Plant

Cultivated as an ornamental plant. Seeds produce castor oil which is used as a purgative. The seeds contain a phytotoxin ricin. Ricin when injected into the blood stream is more poisonous than strychnin, hydrocyanic acid, or arsenic. (Woodcock)

88. Acalypha virginiana L. Three-seeded Mercury

Occasional in southern counties. Reported to be poisonous. Cattle refuse to eat the plant.

89. Celastrus scandens L. Climbing Bitter Sweet

Common in rich soil throughout the state. Leaves said to be poisonous to horses.

90. Euonymus atropurpurens Jaeq. Wahoo

Occasional in southern and central part of state. Fruit contains euonymin, a powerful heart poison.

RHAMNACEAE

91. Rhamnus alnifolia L'Her. Buckthorn

Common in swamps all over the state. Berries contain the glucoside rhamnetin (C_{16} H_{12} O_7). Sap has strong purgative properties.

HYPERICACEAE

92. *Hypericum Spp. St-John's Wort

Several species are common over the state. Poisonous to sheep, cattle, and horses. Contains hypericin which acts as sensitizing agent in the unpigmented skin. Sunlight causes intense itching in unpigmented skin containing the substance. (Marsh & Clawson)

VIOLACEAE

93. Viola tricolor L. Pansy

Cultivated; contains an acid emetic. Causes stinging, burning, and itching of the skin followed by eruptions.

THYMELACEAE

94. Dirca palustris L. Leather-wood

Frequent in wet woods over entire state. Bark causes intense irritation to the skin, causing sores that are difficult to heal. The fruit is also poisonous.

UMBELLIFERAE

95. *Conium maculatum L. Poison Hemlock

Occasional in waste places in central and southern Michigan. Contains a very poisonous principle known as coniine ($C_8 H_{17} N$). Other poisonous alkaloids are found. (Trease)

96. *Cicuta maculata L. Water Hemlock

General in swamps and low grounds over entire state. Very poisonous. Contains the resinoid substance cicutoxin. (Sollman and Couch)

97. Pastinaca Sativa L. Wild Parsnip

Occasional in waste places. Produces a severe dermatitis in people. Commonly confused with poison hemlock.

98. Daucus carota L. Wild Carrot

Common in many parts of the state. Leaves when wet with dew cause vesication.

99. Heracleum lanatum Michx. Cow Parsnip

Common in moist ground throughout state. Leaves produce irritation and blisters. Contains heraclin (C_{32} H_{29} O_{10}).

ERICACEAE

100. *Kalmia angustifolia L. Sheep Laurel

Occasional on moist soil over the state. Contains several glucosides and is very poisonous to sheep. (Clawson). Contains a resinoid andromedatoxin (C_{19} H_{30} O_6). (Couch)

101. *Kalmia polifolia Wang. Swamp Laurel

Common in bogs over the entire state. Poisonous properties same as K. angustifolia.

OLEACEAE

102. Ligustrum vulgare L. Privet

Used commonly for hedges. Contains syringin and a glucoside syringopicrin (C_{26} H_{24} O_{17}). Leaves and fruit poisonous. (Chesnut)

APOCYNACEAE

103. *Apocynum Spp. Dogbane

Three species growing over the state. Plants contain a milky latex like the milkweeds. Contains the glucoside cymarin, having the same effect as digitalin. Also contains the glucoside apocynein. (Trease and Pammel)

ASCLEPIADACEAE

104. Asclepias[1] syriaca L. Common Milkweed

Common in fields and waste places throughout the state. Contains asclepion. Said to be poisonous to stock, causing paralysis and spasms, followed by respiratory paralysis. (Beath)

105. *Asclepias verticillata L. Whorled Milkweed

Occasional in barren regions in the southern counties. Contains asclepidin and is poisonous to horses, cattle, and sheep. (Gates)

106. *Cynachum nigrum (L.) Pers. Black Swallow Wort

Occasional in Lower Peninsula. Probably causes trouble in the same manner as Asclepias.

CONVOLVULACEAE

107. Convolvulus Spp. Bindweed

Several species common in the state. Roots poisonous to hogs. Contains several glucosides. (Schaffner)

108. Ipomoea purpurea (L.) Lamm. Morning Glory

Cultivated and escaped in places. Contains the glucoside ipomoein that acts as a purgative.

LABIATAE

109. Glecoma hederacea L. Ground Ivy

Cultivated in flower gardens and escaped. Contains volatile oil and a bitter principle. Said to be poisonous to horses. (Schaffner)

SOLANACEAE

110. Solanum dulcamara L. Bittersweet

Common in thickets in central and southern Michigan. Fruit poisonous. Contains solanin (C_{28} H_{48} NO_{11}). (Chesnut)

111. Solanum tuberosum L. Irish Potato

Cultivated extensively. Wilted leaves and stems poisonous. Sunburned tubers are green in color and contains the alkaloid solanine.

112. *Solanum nigrum L. Black Nightshade

Common in central and southern Michigan. All parts of the plant contain alkaloids that are poisonous to animals. Plants growing in shade are said to be harmless. (Gates)

113. *Hyoscyamus niger L. Black Henbane

Rare in waste places. Contains hyoscyamin which is used for medicinal purposes. (Trease)

114. *Datura stramonium L. Jimson Weed

Introduced from Europe and planted in flower gardens. Escaped in southern and central Michigan. Seeds may cause temporary insanity and death. Contains alkaloids atropin and hyoscyamin. (Chesnut)

SCROPHULARIACEAE

115. Linaria linaria (L.) Karst. Butter and Eggs

Common in fields and waste places. Contains linarium (C_{64} H_{56} O_{40}), a poisonous glucoside. Probably poisonous.

116. Digitalis purpurea L. Purple Foxglove

Cultivated in flower gardens. Contains digitalin used in treating heart cases. Poisonous to animals. (Winslow)

RUBIACEAE

117. Cephalanthus occidentalis L. Button-bush

Common in swamps of lower peninsula. Leaves contain the bitter glucoside cephalanthin (C_{22} H_{34} O_6).

CAPRIFOLIACEAE

118. Sambucus canadensis L. Common Elder

Common in moist soil throughout the state. Leaves and bark contains hydrocyanic acid.

119. Sambucus racemosa L. Red berried Elder

Common in upper and southern half of lower peninsula. Poisonous as S. canadensis.

LOBELIACEAE

120. Lobelia inflata L. Indian Tobacco

Occasional in fields and thickets. Contains a narcotic poison. Contains lobelian, a poisonous alkaloid. (Lloyd) Millspaugh (Sollmann)

COMPOSITAE

121. *Xanthium commune Britton. Cocklebur

Common in moist grounds all over the state. Young shoots poisonous to hogs due to the glucoside xanthostrumarin.

122. Solidago Spp. Goldenrod

Many species over the state. Reported to have caused a disease of horses in Wisconsin. May be a poisonous substance or a fungus growing on the plant. (Scott) Sollmann

123. *Erigeron Spp. Fleabane

Many species growing in the state. E. canadensis contains a terpine ($C_{10}H_{10}$) and is reported to be poisonous.

124. *Helenium tenuifolium Nutt. Sneezeweed

Occasional throughout state. Contains a narcotic poison. (Chesnut). Poisonous to horses and sheep. H.Hoopesii Gray. Causes some trouble in the west.

125. Achillea millefolium L. Yarrow

Common over entire state. Contains the alkaloid achillein (C_{30} H_{38} N_2 O_{15}). Has a toxic action upon blood vessels, especially in the pelvis. Causes hemorrhages. (Millspaugh) Sollmann

126. Chrysanthemum leucanthemum L. Ox-eye Daisy

Common in pastures and meadows. Contains chrysanthemin, an alkaloid.

127. *Tanacetum vulgare L. Common Tansy

Cultivated in gardens. Escaped and is common along roadsides. Contains a narcotic irritant poison in the oil. Very poisonous, causing a condition similar to rabies. (Millspaugh) Sollmann

128. *Artemisia absinthium L. Common Wormwood

Occasional in waste places. Contains a volatile oil that resembles that obtained from tansy in action. Contains absinthin (C_{15} H_{20} O_4). (Rusby) Pammel

129. *Eupatorium urticaefolium Reichard. White Snake-root

Not very common in Michigan. Few localities in rich woods. Produces "trembles" in cattle, horses, and sheep. Produces "milk sickness"in people. Pammel reports loss of 5,000 cattle in a small area in Northern Ohio. Contains tremetol (C_{16} H_{22} O_3). (Couch)

Fig. 1.
Pteridium aquilinum
Bracken Fern

POLYPODIACEAE

Pteridium aquilinum Bracken Fern

Bracken Fern (Pteridium aquilinum) has long been recognized as a poisonous plant of some importance. Chesnut and Wilcox (1901) reported cases of poisoning in the United States and England. It has been a matter of much controversy as to the nature of injury to stock from the eating of bracken. As far back as 1893 it was thought by some writers that any disorders due to this plant was not a toxic effect but a digestive trouble. However, a number of authorities have determined that bracken is definitely of a poisonous nature. In Oregon (Oregon Agr. Exp't. Sta. - 1901) "staggers" due to Pteridium aquilinum was reported as "confined almost entirely to horses, although there are occasional reports that cattle have been poisoned by the fern." They found that the trouble was caused chiefly by feeding hay that contained this weed and is dangerous any time of the year. Fyles (1920), in quoting experiments by Hadwen in British Columbia, says that the ingestion of dried bracken caused "staggers" in horses, and that in the hard winter of 1915-16 the mortality among horses was great. He cites one instance in which, out of twenty-four horses owned by eleven farmers, sixteen died of bracken poisoning. Two horses were reported to have died from eating the green plant in a pasture where other vegetation was scarce.

The most recent and probably the best work on poisoning by ferns has been done by Hagan and Zeissig (1927). Their work was carried on at Cornell University and feeding experiments were conducted on cattle. Although in some cases their experiments were negative, they produced poisoning in several instances. This work proves that cattle may, under certain circumstances, suffer from a fatal disease associated with the eating of bracken. Many angles of this disease have yet to be investigated; it has been found that soy bean meal if extracted with trichlorethylene is toxic to cattle. This disease closely resembles that attributed to bracken and in some cases may be the cause of disturbances.

It is true that in the field only a few animals from a herd are affected. Also, the failure of Hagan and Zeissig to produce fatal results in some of their feeding experiments remains to be explained.

In certain years it has been found that very few cases of bracken poisoning occur. Hagan points out that there are several possible explanations for this. Animals will not ordinarily eat the plant but in dry years it is almost the sole green vegetation available. Since bracken is a very pernaceous weed, it recovers quicker from drought than do other plants. Naturally, in certain critical periods stock must eat bracken or go without green feed. It has been pointed out that young cattle seem to be more susceptible than older animals. This may be due to the fact that younger animals are given no supplementary

feeding as are milch cows. This supplementary feeding seems to partly appease the appetites of the cows and therefore they are less likely to be tempted to eat unwholesome food. The body no doubt eliminates the toxic principle at the same time it is being ingested. Naturally, if the concentration of the toxic principle is to be raised it must be ingested faster than it is being eliminated. In the case of adults larger quantities can be eliminated than in younger animals which may explain why young animals seem to be more susceptible.

The operation of the toxic principle remains yet to be explained. In Hagan's and Zeissig's experiments one animal died sixty-five days after the first feeding of bracken and fourteen days after the last feeding. This might indicate that the disease requires an incubation period and, since animals are not likely to eat large quantities ~~XXXX~~ in the field, a small amount, if given at definite periods,may cause poisoning.

The summary of this experimental bracken feeding included the following topics:

1. An undiagnosed disease of cattle in New York has been reproduced in all its essential features by feeding Pteridium aquilinum, and is probably caused by that plant.

2. The fact that other plants causing similar diseases, must be kept in mind.

3. In view of the fact that the disease is due, usually, to shortage of other plants in a pasture, the incidence of the disease may be reduced by supplemental feeding in the stable.

Description of Plant

Bracken is a large coarse fern, having a black, woody rootstock. The plant above ground appears as one large greatly-divided frond with a central stalk and may rise from one to four feet, with a maximum width of three feet. The spores are borne on the under side of the leaf along the margin. (Fig. 1.)

Range

This plant is common over the entire state of Michigan. It grows on dry hillside pastures and in woods and thickets.

Toxic Principle

The toxic principle in bracken has been a matter of some dispute. The plant contains the poisonous Pteritannic acid, which is identical with Filicic acid used for the expulsion of tape worms. The scouring action of silica present in the plant has been suggested as the toxic principle. The experiments of Hagan and Zeissig seem to disprove this theory.

Animals Affected

Poisoning has been reported from horses and all classes of cattle. Young animals are more affected than are older individuals. Sheep are also susceptible.

Nature of Injury

High temperature, salivation, nasal bleeding, and necrotic areas on the liver are common symptoms in field cases. Sampson and Malmsten (1935), in quoting a letter from Dr. A. B. Clawson, state that "the effect of the fern on cattle in the west has been wrongly diagnosed as hemorrhagic septicemia." This same authority states that the first symptoms observed in horses is uncertain gait; the head is usually carried low and the animal often batters objects with the head. Contrary to cattle, horses retain a normal temperature until death.

The poison is cumulative in action and drying of plants does not cause them to lose their toxicity.

Preventive Measures

In view of findings by Hagan and Zeissig, the supplemental feeding of cattle in the barn should reduce losses in most cases. However, young cattle and those other than milch cows are seldom given supplementary feed as a general rule. In some cases it may be advisable to eradicate bracken from the pasture rather than to depend upon this practice. Methods advised by Cox (1936) for eradication of ferns are as follows:

1. Cutting or mowing during June and August.
2. Cutting supplemented by burning.
3. Place stock salt in fern patches.
4. Spray with iron sulphate, arsenite of soda, or sodium chlorate.
5. Cultivation.

In treating animals that have been poisoned Sampson and Malmsten (1935) quote Drs. B. T. Simms and Jay recommend-

ing immediate removal to a shady place. It is indicated that direct exposure to sunlight following poisoning usually results in death. Raw linseed oil is recommended as a purgative to be given when first symptoms are observed.

Fig. 2.
Equisetum arvense
Field Horsetail

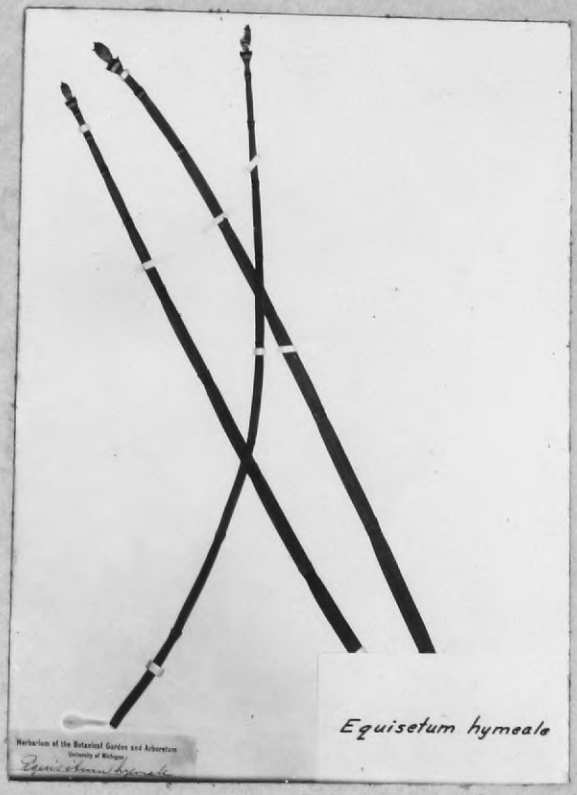


Fig. 3.
Equisetum hymeale
Scouring Rush

EQUISETACEAE

Equisetum arvense Field Horsetail

Equisetosis or horsetail poisoning has been a subject much discussed with widely varying opinions among various authors. Much work has been done by the way of experimental feeding, the greater part of which has been done in Europe by various German and French investigators.

The results of these investigations have been far from convincing as to the species causing poisoning and the classes of livestock commonly affected. The results of two German investigators Weber and Lohmann, reported by Long (1924), indicate that Equisetum palustre contains a specific poison for cattle but horses and pigs suffer very little. Lohmann conducted feeding experiments with guinea pigs using E. palustre, E. pratense, E. sylvaticum, E. maximum, and E. heleocharis. The results of these experiments showed that of the above named species only E. palustre and E. sylvaticum were poisonous. Experiments with horses, cattle, sheep, and pigs showed that E. palustre was toxic but E. arvense was not. These results do not bear out the findings of investigators in the United States and Canada. Chesnut and Wilcox (1901) state that E. arvense is poisonous both to horses and sheep. Smiley (1922) says that the toxic principle seems to be specific for horses, sheep seems to be very little affected, and cattle are immune. In the Canadian Agricultural Farms reports for 1910 and 1912 it is said that horses suffer most from E. arvense and when eaten in hay it is toxic to horses

and particularly to young animals. The plant is said to be harmless when eaten green. They state that sheep are also affected.

These differences of opinion by seemingly competent investigators seem to indicate that the climate or soil may have some effect on the production of the toxic principle. The fact that E. arvense is considered toxic in the United States and Canada while it is considered harmless in Europe, bears out our earlier statement that the production of poisons in plants is greatly affected by soil and climatic differences.

The scouring rush (E. hymeale) has been reported causing poisoning in several instances. Gates (1930) lists the scouring rush (E. praealtum) as one of the principal poisonous plants of Kansas.

Description of the Plant

Horsetail is a plant having perennial, jointed, creeping, and black rootstocks; these may be either felted or naked and often bear tubers. The stems are erect and branched in the case of E. arvense (Fig. 2), and in the case of E. hymeale (Fig. 3) the stems are simple and not branched.

Both the scouring rush and the horsetail are dioecious. The fruiting body of E. arvense is borne on a separately unbranched, leafless, straw-colored stem.

Range

This plant is common all over the state in damp pastures

and hay fields. It usually prefers sandy soil but has been reported on other types.

Toxic Principle

There has been much discussion as to the Toxic principle as well as the animals affected by it. For some years it has been commonly believed that the toxicity of this plant was due to either the scouring action of silica or to aconitic acid. Long (1922) quotes Lohmann finding an alkaloidal nerve poison to which the name Equisetine was given.

In view of the fact the younger plants which contain in general little silica are more poisonous than older plants that contain large amounts, it would seem improbable that silica is the toxic principle. The fact that large amounts of horsetail are hard to digest should not be lost sight of. The scouring action of large amounts of silica may also cause minor digestive disorders.

Animals Affected

There seems to be some difference in opinion as to the animals affected but the plant has been known to poison both horses and cattle. Sheep seem to be less susceptible because their slim muzzles are more adapted to sorting the plants from hay. Young horses are more susceptible than are older individuals. (Gates 1930)

Nature of Injury

Symptoms usually appear two or three weeks after feeding, depending on the age of animals and the dosage.

Animals are weak and unthrifty in appearance and lose flesh rapidly. As the disease progresses, control of muscles is lost; pulse and temperature are low and mucous membranes lose their color. Convulsions with higher temperature appear toward the last and death ensues from exhaustion. The appetite usually remains hearty and horsetail seems to be preferred rather than other food. (Gates 1930)

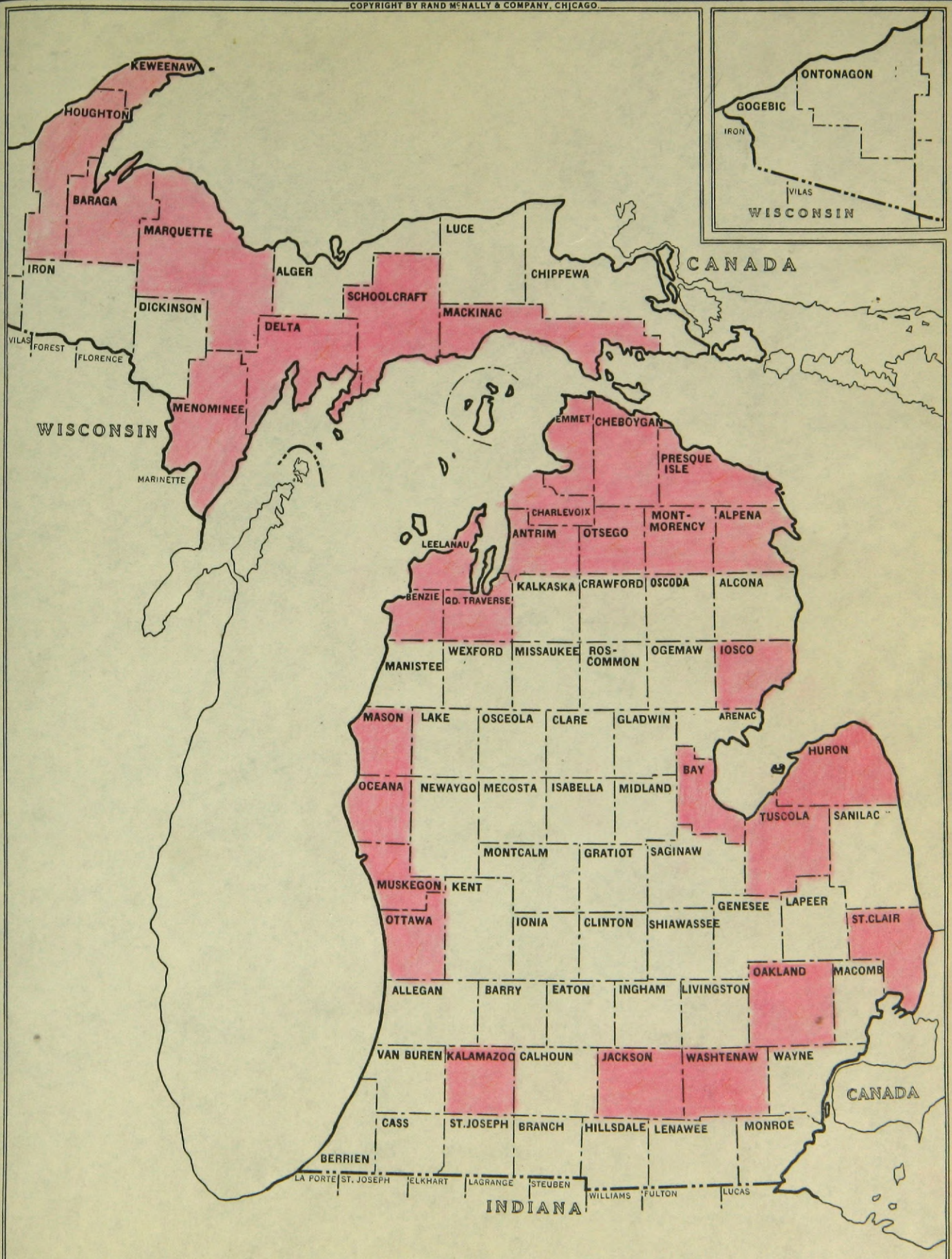
Preventive Measures

As in the most cases of poisonous plants, prevention rather than medical methods should be used for control. At the first signs of poisoning, the hay should be investigated and feeding discontinued if the plant is found to be present.

Although poisoning from the green plant seems to be uncommon, cases have been reported. Cattle and horses should be removed to clean pastures at the first signs of poisoning.

Fig. 4.
Triglochin maritima
Arrow Grass

Fig. 5.
Holcus halepensis
Johnson Grass



Arrow Grass (Triglochin maritima)

0 5 10 20 30 40 50 60 MILES

11N36

SCHEUCHZERIACEAE

Triglochin maritima L. Arrow grass

Arrow grass (Triglochin maritima) has caused some trouble as a poisonous plant. Marsh (1929) mentions that Greshoff lists this plant as being poisonous and found that it contained from 0.02 to 0.06 per cent of hydrocyanic acid. Beath (1920) showed that extracts from the plant were very toxic when injected into the blood stream of rabbits. He observed that there were no symptoms produced when the plant was fed in a green condition to cattle. Marsh later showed that poisoning is produced by the green plant and that upon drying for different lengths of time the dosage required varied directly with the length of drying. This work also seems to disprove the statement by Fleming (1920) that the dried plant was much more toxic than the green plant. This point is still in some dispute but the fact that hydrocyanic acid is volatilized upon drying would indicate that Marsh is more likely to have been correct in his findings.

Arrow grass produces quick, succulent, second growth following mowing, recovering more quickly than other plants and it is in this state that livestock are most likely to consume large quantities and become fatally poisoned.

Description of Plant

Arrow grass is an erect perennial grass-like herb, ranging from six inches to over two feet in height. It

grows in large patches or small clumps. The leaves are fleshy, bright green, and shorter than the flowering stalks. The flowering racemes are ten to fifteen inches long, bearing greenish flowers. (Fig. 4). Unlike the grasses, the leaves of this plant are thick and spongy. They can be distinguished from sedges by the fact that the leaves are not triangular in cross section.

Range

Arrow grass grows along the sandy shores of Lake Michigan and Erie and in wet sandy places throughout the state. Woodcock (1925) reports it as growing around deer licks in the interior.

Toxic Principle

This weed is one of the cyanogenetic plants. These are plants that produce hydrocyanic acid when their glucosides and enzymes are mixed.

In general, young plants contain more of the potential acid than do the older individuals. Plants grown on poor soil contain less than those grown on fertile soil and, in general, plants grown in southern states have caused less poisoning than those grown in the north. This suggests that the reason for the difference may be climatic. (Couch 1932)

Animals Affected

The highly toxic nature of hydrocyanic acid makes it a virulent poison for all classes of livestock that feed upon cyanogenetic plants. More losses have been reported in horses and cattle than others.

Nature of Injury

Symptoms of hydrocyanic poisoning given by Couch (1937) are as follows:

> "A brief period of stimulation followed by depression and paralysis often with symptoms of colic. Stupor, difficult breathing, and frequent convulsions result from the action of the poison on the nerve centers that control respiration."

Since death is caused by respiratory paralysis, the heart continues to beat for some time after breathing has stopped.

Hydrocyanic acid works very rapidly, frequently killing within a few minutes.

Control

The first line of attack is prevention of animals from eating cyanogenetic plants. Feeding of certain feeds such as alfalfa hay and linseed cake retard the production of hydrocyanic acid in the stomach. (Couch 1937)

GRAMINEAE

Holcus halepensis L. Johnson grass

Holcus sorghum var. sudanensis Piper. Sudan grass

Johnson grass (Holcus halepensis) Fig. 5, along with sudan grass (Holcus sorghum var. sudanensis) are plants producing injury from hydrocyanic acid. These plants are not ordinarily toxic and are planted extensively by many farmers for use as hay and cover crops. The seeds of these grasses make excellent food for game birds and have been planted extensively for that purpose. However, under certain conditions they may contain large quantities of hydrocyanic acid and as a result cause serious stock losses. A knowledge of the conditions under which poisoning occurs should be understood if these plants are to be used. As in arrow grass (Triglochin maritima) the young plants contain less of the toxic principle than do older plants; the young leaves are more toxic than young stems. The percentage of hydrocyanic acid steadily decreases as the plants develop and at the time the seeds are ripe the percentage is so small that stock are not affected.

Climate has a definite action on the production of hydrocyanic acid in plants. In localities when early and late frosts are experienced, cyanogenetic species are more likely to produce poisoning. Interruption of growth by drought is another common cause of large quantities of hydrocyanic acid being formed. (Sampson and Malmsten 1935)

Sorghum, if well cured, may be safely used as hay since the toxic principle volatilizes upon drying. (Vinall 1921). However, in some instances poisoning has occurred from eating the dried plant. This is true of plants bearing immature seeds which retain much of their hydrocyanic acid even upon drying. (Couch 1937)

Description of Plants

The sorghums are annual or perennial grasses with solid stems, long, broad, flat, leaves and large terminal panicles. Johnson grass has stems that are usually not over 1/4 inch thick and the panicle at the end is not compact. The stems of sudan grass are usually 1/2 to 1 1/2 inches in diameter and the panicle is large and compact.

Range

As stated before, these plants have been used for hay, cover crops, and game food patches. They are grown all over the state and in some places have escaped from cultivation and may be found growing wild.

Toxic Principle

Hydrocyanic acid as in arrow grass is the toxic principle. James F. Couch, Chemist, Pathological Division, Bureau of Animal Industry, makes the following observations on the toxicity of hydrocyanic acid: "Six grains (0.4 gram) is considered a fatal dose for the average horse. A 1,000

pound cow would be made sick by 6 grains (0.882 milligram per kilogram), a 100 pound sheep would be made sick by 0.69 grain (0.992 milligram per kilogram) and killed by 1.61 grains (2.315 milligrams per kilogram). A 20 pound dog would die if given 0.03 to 0.04 gram."

Couch comments further to say that five pounds of a plant containing as little as 0.02 per cent potential hydrocyanic acid would be fatal to a horse or cow and 1.25 pounds would kill a sheep.

Animals Affected

Sheep, cattle, and horses have been reported to be poisoned by these two plants.

Control

Aside from preventive measures Couch prescribes the following remedies: Injection of methylene blue, sodium nitrate, or sodium thiosulphate intravenously. A combination of sodium nitrate and sodium thiosulphate have been very successful.

GRASSY PLANTS OF MINOR IMPORTANCE

Stipa robusta Scribn. Sleepy grass

This is a grass that is more common in California and other western states, but is has been reported in some of the counties of the lower peninsula.

This grass is supposed to contain a narcotic principle which causes drowsiness and sleepiness in horses and sheep and is said to affect horses particularly (Sampson and Malmsten 1935). No cases of fatal poisoning have been recorded. Horses go to sleep and may remain so for a day or more. Marsh (1929) remarks that this plant is particularly troublesome to parties traveling by pack trains. Sometimes when their horses are affected parties are obliged to wait in camp until their horses awaken.

Toxic Principle

The toxic principle is not known.

Lolium temulentum L. Poison darnel

This plant is sometimes called "cheat" by farmers. It grows all over the state occasionally in waste places and cultivated grounds (Woodcock 1925). Whether the toxic principle is contained in the grain or in a fungus associated with it has not been determined.

Darnel poisoning induces giddiness, drowsiness, uncertain gait, and stupefaction. Long (1924) quotes the following symptoms from Pott: Vomiting, convulsions, loss of sensation and death. (These apply to older animals).

Long quotes Cornevin, indicating that the amounts of darnel necessary to kill certain animals would be as follows:

Horse	0.7	lb.	per 100 lb. live weight
Ruminant	1.5 to 1.81	lb.	per 100 lb. live weight
Poultry	1.5 to 1.81	lb.	per 100 lb. live weight
Dog	1.8	lb.	per 100 lb. live weight

Toxic Principle

There seems to be some difference of opinion concerning the production of the toxic principle. Fyles (1920) states that poisoning is caused by a fungus (Endoconidium temulentum). Long (1924) says that the grains contain a narcotic alkaloid temuline ($C_7 H_{12} N_2O$) which occurs to the extent of .06 per cent in the seeds.

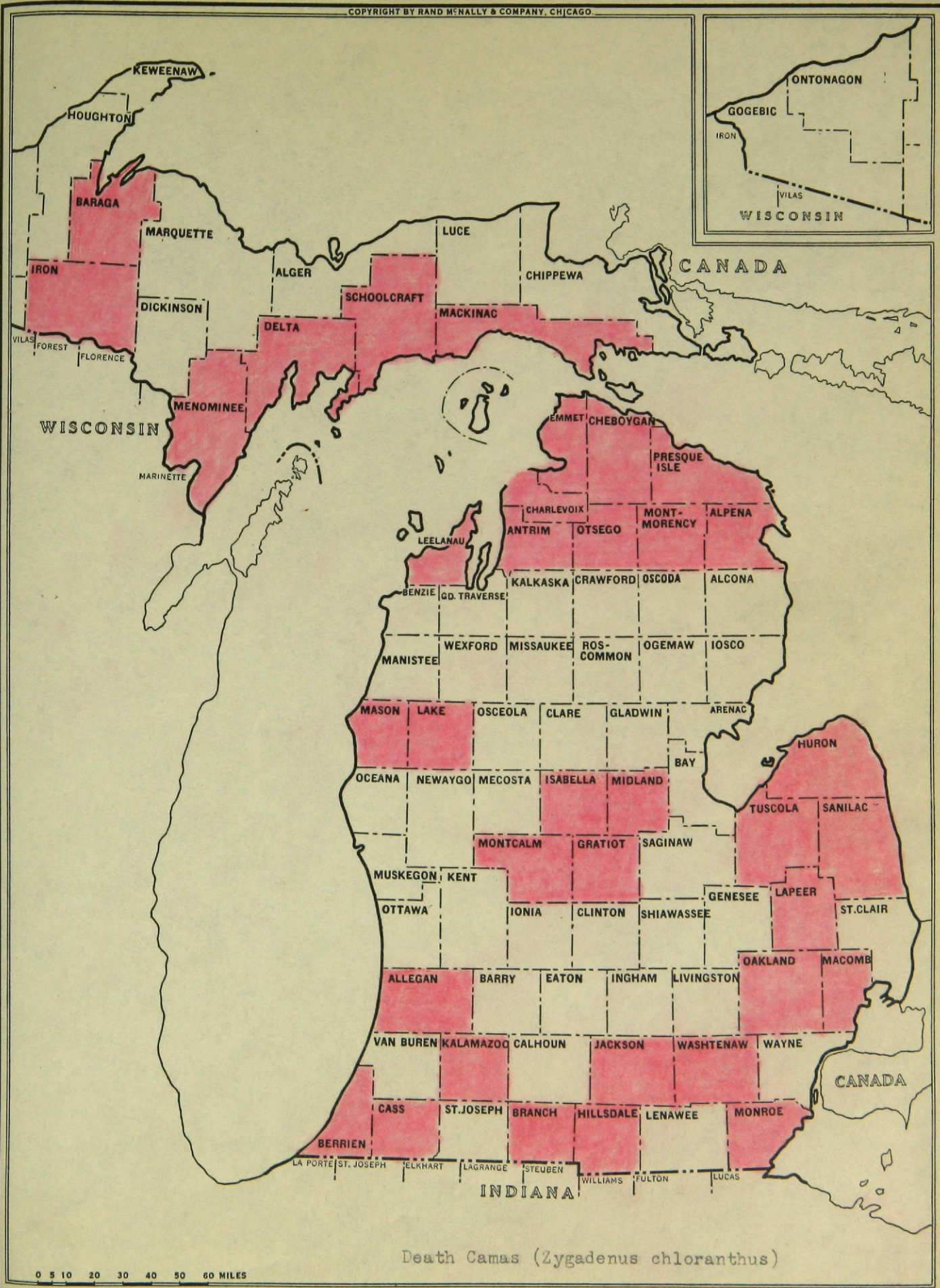
The toxic principle seems to be more pronounced in wet seasons than in dry, indicating that the fungus produces the toxic principle.

Fig. 6.
Zygadenus chloranthus
Death Camas

Fig. 7.
Zygadenus elegans
Death Camas

Fig. 8.
Ornithogalum umbellatum
Star of Bethlehem

Fig. 9.
Trillium grandiflorum
Wake-Robin



Death Camas (Zygadenus chloranthus)

LILIACEAE

Zygadenus chloranthus Richards. death camas

Much work has been done in the western states concerning the poisoning of stock by death camas. Marsh and coworkers (1929) say that of all the plants which cause losses to sheepmen, death camas is the most troublesome.

This weed has been recognized from early times as a poisonous plant. Early settlers experienced losses to horses and cattle,and many persons have been poisoned from eating the plant in mistake for other food plants. Many species of the genus Zygadenus are found in the west. Zygadenus elegans, a well known western form, has been reported growing in Michigan. The range of this plant is very local, however. Zygadenus chloranthus is of wider range in Michigan and is the only one likely to be important.

There have been no reports of poisoning in Michigan so this discussion will be based upon what is known of the western forms. It has been stated by Marsh (1929) that species differ widely in poisonous properties and it may be possible that our form (Z. chloranthus) is less poisonous than the western species.

Description of Plant

The death camas is a slender grass-like plant with smooth, and mostly basal leaves 1/6 inch wide, and from

6 to 20 inches long. Stems are from 4 inches to 3 feet tall, arising from dark, onionlike bulbs with paper-like covering. The flowers are greenish or yellowish-white and are born on racemes 3 to 10 inches long. (Fig. 6)

Z. elegans resembles this plant somewhat but is a slightly smaller form. (Fig. 7)

Range

Z. chloranthus occurs occasionally in moist soils along the shores of Lakes Michigan and Erie and in scattered places in the interior.

Toxic Principle

The poisonous substance is generally considered to be an alkaloid of one form or another (Marsh & Clawson 1924). The seeds are very poisonous and the bulbs next in order. Poisoning rarely comes from eating the bulbs; the fruiting parts and the leaves usually cause the trouble. The amount of poison varies with the habitat as well as with the species. (Marsh 1929)

The minimum lethal dose of meadow death camas (Z. venenosus) has been given by Sampson and Malmsten (1935) to be two pounds of the green plant per 100 pounds of animal weight.

Animals Affected

In general the greatest loss comes to sheep but horses and cattle are affected. It is said that poisoning seldom

occurs to cattle (Marsh & Clawson 1929). Sampson and Malmsten report that goats and hogs are affected. Hogs however, are seldon poisoned fatally because they are able to vomit the poisonous substance.

Nature of Injury

Death camas is most dangerous early in the spring, especially where grazing is heavy. Zygadenus produces a vigorous growth before grasses and forage plants appear, hence this is often the only food available. It is at this time of year that the ground is soft and animals are likely to pull up the bulbs and eat them and since the bulbs contain a high percentage of the toxic principle animals are often poisoned by a very few plants.

Symptoms of poisoning given by Gates (1930) are: "frothing at the mouth, followed by nausea, and frequently accompanied by vomiting. In milder cases the animals are depressed and stagger, particularly in the hind legs. In some cases coma may continue for several days before recovery or death ensues. The temperature of the affected animal is usually depressed." Marsh states that difficult breathing is also a symptom.

Control

No effective remedy has been found for Zygadenus poisoning. Since these plants ordinarily grow in large patches, they may be either fenced or eradicated.

Death camas retain much of their poison when dried in hay and care should be taken that large patches are not cut and included with hay.

PLANTS OF MINOR IMPORTANCE IN THE LILY FAMILY

Convallaria majalis L. Lily-of-the-valley

This plant is grown extensively in gardens for ornamental purposes and may be found growing wild in some places. No cases of poisoning have been recorded in this country. Long reports that it injures animals in some instances and indicates that sheep and goats seem to be immune from the toxic principle. This authority quoting experiments by Cornevin, states that 4 drops of the plant extract injected into the blood stream of a dog produced death in ten minutes.

The plant has an acrid bitter taste and all parts are poisonous, especially the flowers.

The plant contains three toxic principles, all of which are glucosides. These are:

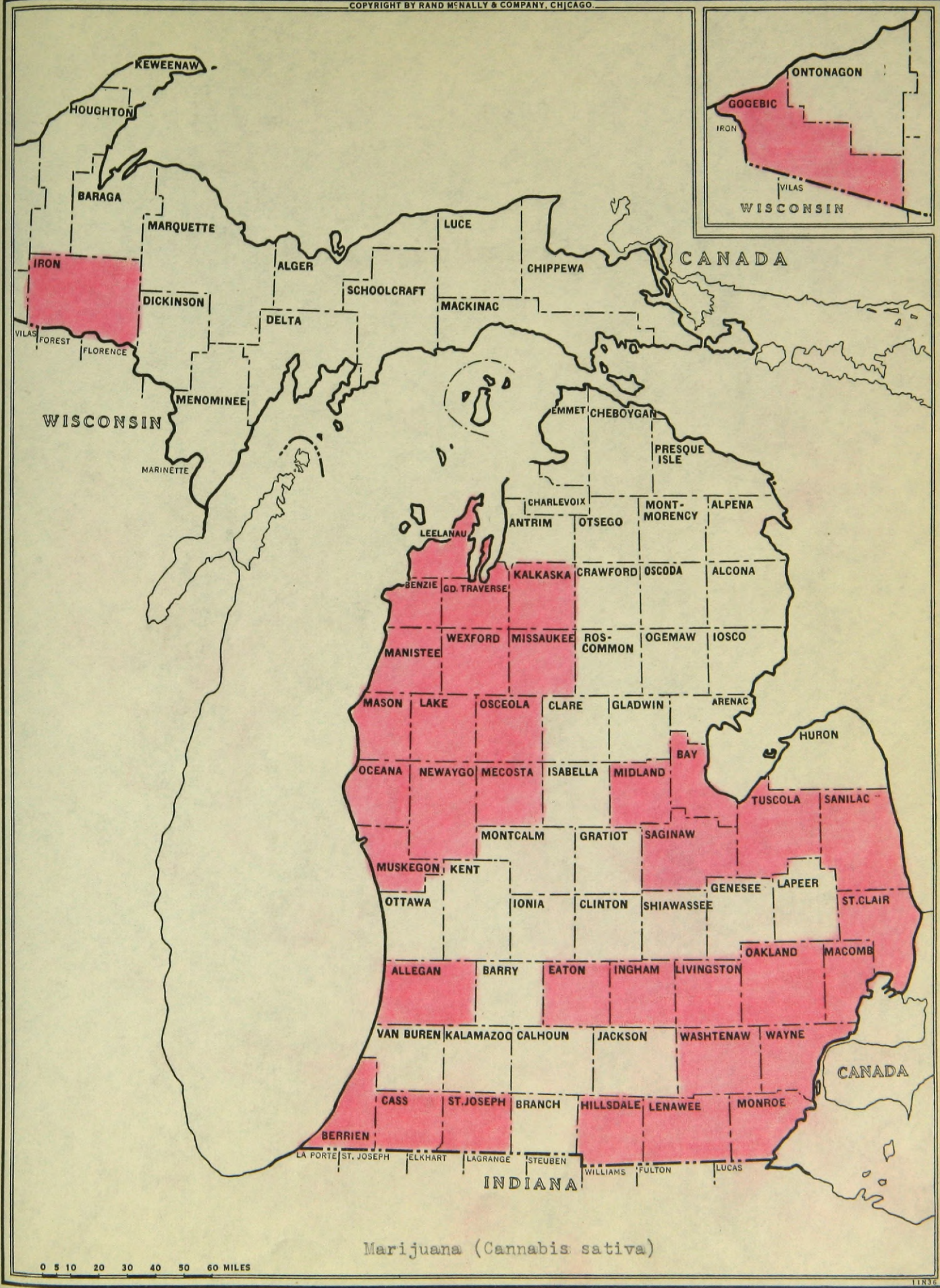
1. Convallamarin ($C_{23} H_{44} O_{12}$)
2. Pardin ($C_{16} H_{28} O_7$)
3. Convallarin ($C_{34} H_{62} O_{11}$)

The first is a strong prugative and the last is a cardiac poison resembling Digitalis. Convallarin is crystalline in nature.

Long cites Cornevin, giving the following symptoms: "Taken in moderate quantities a period of retardation of heart and lung action is followed by a period in which the heart action is intermittant; vomiting follows. When taken in larger quantities death is caused from heart failure."

Ornithogalum umbellatum L. Star of Bethlehem (Fig. 8) and Trillium grandiflorum L. Wake-robin (Fig. 9) are said to be poisonous.

Fig. 10.
Cannabis sativa
Hemp or Marijuana



Marijuana (Cannabis sativa)

URTICACEAE

Cannabis sativa L. Hemp or marijuana

The common hemp or marijuana is a drug, the use of which in this country during the past few years has spread rapidly. According to figures of the Federal Narcotic Bureau, a third of the estimated 100,000 marijuana addicts in the United States are children in their teens. Consequently, the innocent looking "reefer" can now be ranked high up among the menaces to the youth of America.

Marijuana peddlers apparently practice their trade in much same manner as do other dope peddlers. Operating to a large extent in the neighborhoods of high schools and even elementary schools, they work themselves into the confidence of the pupils. To the older ones they give first a few cigarettes trusting that these will create a craving. Pupils too young to smoke do not escape the marijuana peddlers. Harmless looking pink candy flavored with pineapple, strawberry, and other fruits, is used to tempt the younger children. Mixed with sugar and flavoring is enough marijuana to create a craving for the drug and make the child an addict.

An older and more sinister name for marijuana is hashish. It is an herb that will grow in most parts of the world and as it needs little or no cultivation it is easy to grow quantities of it without detection. Great fields of cultivated hashish were discovered recently by the Federal Narcotics Bureau in various parts of the country, indicating to what extent the habit has developed.

The name hashish is indicative that the addict will often kill. The name comes from the Hashan tribe of Persia, who, before going into battle, would brew a drug that they knew would give them superhuman power and make them killers. They drank this tea and went out and killed. The drug became identified with this tribe and was called hashish. One who used the drug was known as a hashshashin, from which we get the English word "assassin." (Trease 1935)

This drug has come into wide use among swing bands recently. The terrific strain as well as the exciting nature of the work, the long hours of rehearsal and work have created a physical condition that makes some sort of stimulus necessary. Probably the greatest reason for its use among swing bands comes from the fact that while under the influence time seems interminable; seconds seem like minutes, minutes like hours and so on. Therefore it is very easy to play difficult numbers where rapid motions are necessary. Many orchestra members say that they can easily play numbers that they could never hope to accomplish without the aid of this drug.

Description of Plant

This plant is very characteristic in form and would never be mistaken once it has been properly identified. It is a tall annual, with digitate leaves of 5-7 linear-lanceolate coarsely toothed leaflets. The upper leaflets are alternate. Flowers are green in color. The inner bark contains very tough fibers which are used when the plant is

cultivated for commercial fibre. (Fig. 10)

Range

Marijuana was introduced from Asia but is widely distributed in the United States today. It is probably found in every county in Michigan on waste and cultivated ground. Many vacant lots in cities are full of these plants that have been planted by dope peddlers.

Toxic Principle

The toxic principle is a brown, resinous, amorphous, semi-solid. It is often called "cannabinone." A composition known as cannabinol has been isolated. This has very strong narcotic properties.

This drug cannot be stored and the toxic principle is said to be completely dispelled in two years. "Reefer" smokers report that cigarettes made from fresh plants are much more potent than those made from plants that have been stored.

Animals Affected

Although this plant affects animals other than humans, it has never been reported as causing disturbances through ingestion. Indeed, it is considered one of the best of foods for game birds and has been widely planted as such in the past. Federal regulations now prohibit its cultivation.

Nature of Injury

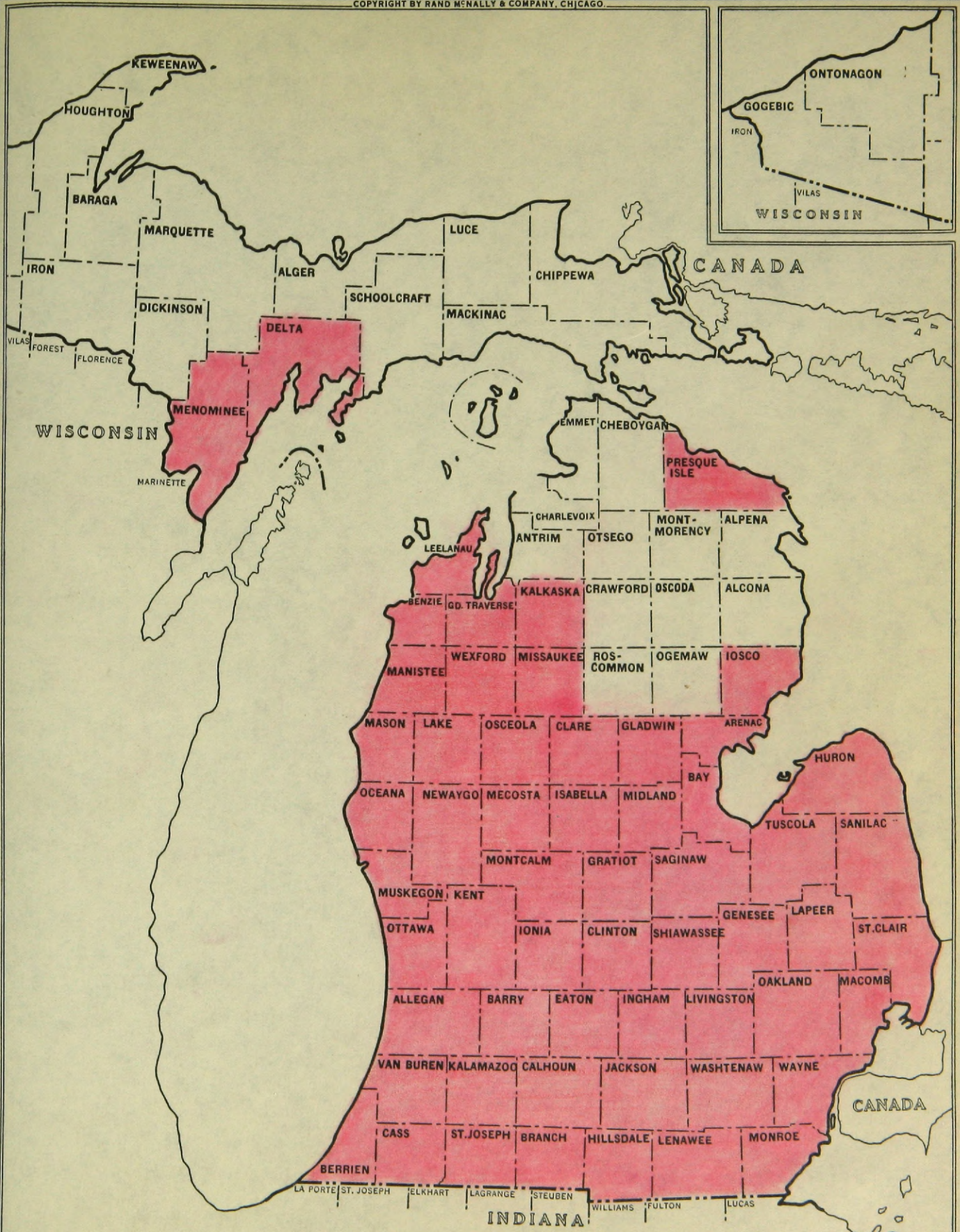
While the effects of marijuana are variable with different individuals, it usually produces first an exhaltation with a feeling of well-being, a happy jovial mood, and a greatly exaggerated feeling of physical strength. There is also a stimulation of the imagination followed by a delirious state characterized by vivid visions, sometimes pleasing, but occasionally of a gruesome nature. Accompanying this delirious state is a remarkable loss in space and time relations;persons and things in the environment look small and time seems interminable, which accounts for the effect upon those who play musical instruments. Persons driving automobiles while in this state may be going at a terrific rate yet have the sensation that they are scarcely moving.

The principal effect of the drug is upon the mind which seems to lose the power of directing and controlling thought. Ideas flow freely but are replaced by others so quickly that they are seldom carried out. The continued use of this drug produces pronounced mental deterioration in many cases. Its more immediate effects are apparently to remove the normal inhibitions of the individual and release any antisocial tendencies which may be present. Those who indulge in its habitual use eventually develop a delirious rage, during which time they are irresponsible and prone to commit violent crimes.

It is said that the use of this drug with alcohol magnifies its effects many times.

Fig. 11.
Agrostemma Githago
Corn Cockle

Fig. 12.
Ranunculus abortivus
Crowfoot



Corn Cockle (Agrostemma Githago)

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CARYOPHYLLACEAE

Agrostemma Githago L. Corn Cockle

Corn cockle (Agrostemma Githago) is a well-known plant found in wheat fields throughout Michigan. Hardly a grain field is free from this poisonous weed.

Poisoning occurs when wheat or other small grain screenings are fed to stock. Long gives accounts of many cases of poisoning of both humans and livestock in England. Cornevin's experiments in feeding calves and pigs indicated that the amounts of cockle flour necessary to poison and cause death are as follows:

Calf	0.25 lb. per 100 lb. live weight
Pig	0.10 lb. per 100 lb. live weight
Dog	0.90 lb. per 100 lb. live weight
Fowl	0.25 lb. per 100 lb. live weight

Description of Plant

Corn cockle is an annual or biennial plant, wooly or pubescent; leaves are opposite, sessile, linear-lanceolate, acute or acuminate; flowers are reddish or purple with five petals which are shorter than the sepals. (Fig. 11)

Range

The range of this plant covers the entire state where wheat or other small grains are grown. The round black seeds are difficult to screen from grain and as a result most seed wheat contains them.

Toxic Principle

The toxic principle which occurs chiefly in the round black seeds is githagin (C_{17} H_{26} $O_{10})_2$. It occurs in varying percentages up to 6.56 per cent, appearing when seeds begin to mature. This glucoside is freely soluble in water and froths much like soap when shaken. It has a sharp taste and little or no odor.

Animals Affected

When ground up in flour these seeds are poisonous to people. Cattle, pigs, horses, dogs, and poultry are susceptible.

Nature of Injury

Githagin acts as a strong nerve poison and usually produces dysentery. Chesnut (1898) gives the following symptoms: "Intense irritation of the digestive tract, vomiting, headache, nausea, vertigo, diarrhoea, hot skin, sharp pains in the spine, difficult locomotion, and depressed breathing."

There are two forms of the disease, chronic and acute. Chronic cases are usually found in humans while the acute form is found mostly in animals (Long 1924). The symptoms given by Cornevin, Pott, and Degen and cited by Long are much the same as given by Chesnut.

Control

Poisoning usually occurs from feeding wheat screenings to cattle and chickens. Inspection will show if screenings contain the seeds since they are easily detected by their black color.

CARYOPHYLLACEAE PLANTS OF MINOR IMPORTANCE

Saponaria Vaccaria L. Cow Cockle

This plant closely resembles corn cockle (Agrostemma Githago). Although not as common as corn cockle it has been reported to be very poisonous. It contains the same toxic principle, Githagin. The poisonous substance produces a burning sensation in the digestive tract. (Cary and others 1924)

Saponaria officinalis L. Bouncing Bet

Saponaria officinalis is a plant that closely resembles cow cockle (Saponaria Vaccaria). It contains the same toxic principle as corn and cow cockle.

Injury from this plant is much the same as the above two mentioned.

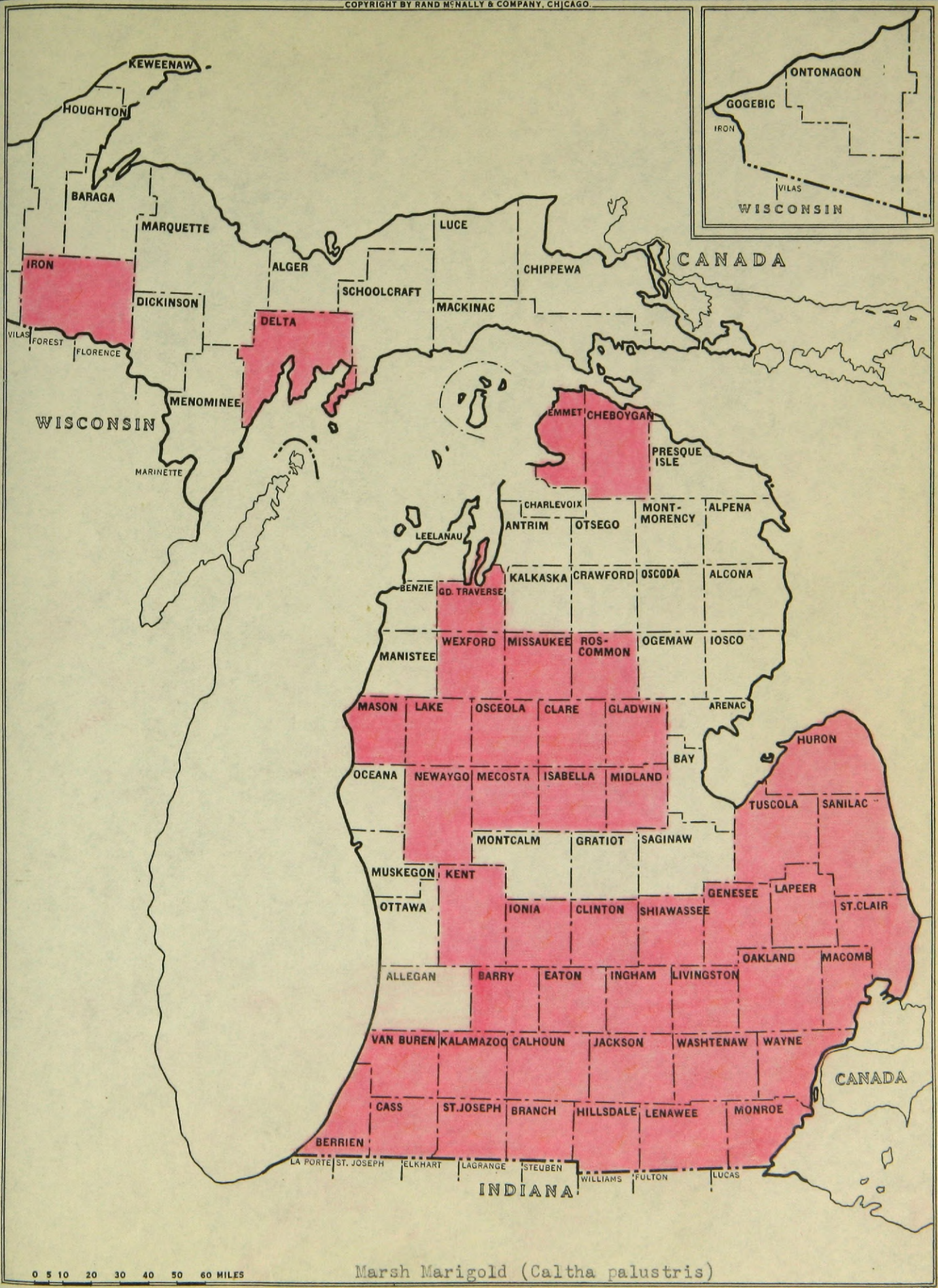
Pammel says that the mucilaginous juice forms a lather with water and is valuable for removing grease spots from woolen cloth.

Fig. 13.
Delphinium Nelsonii
Low Larkspur

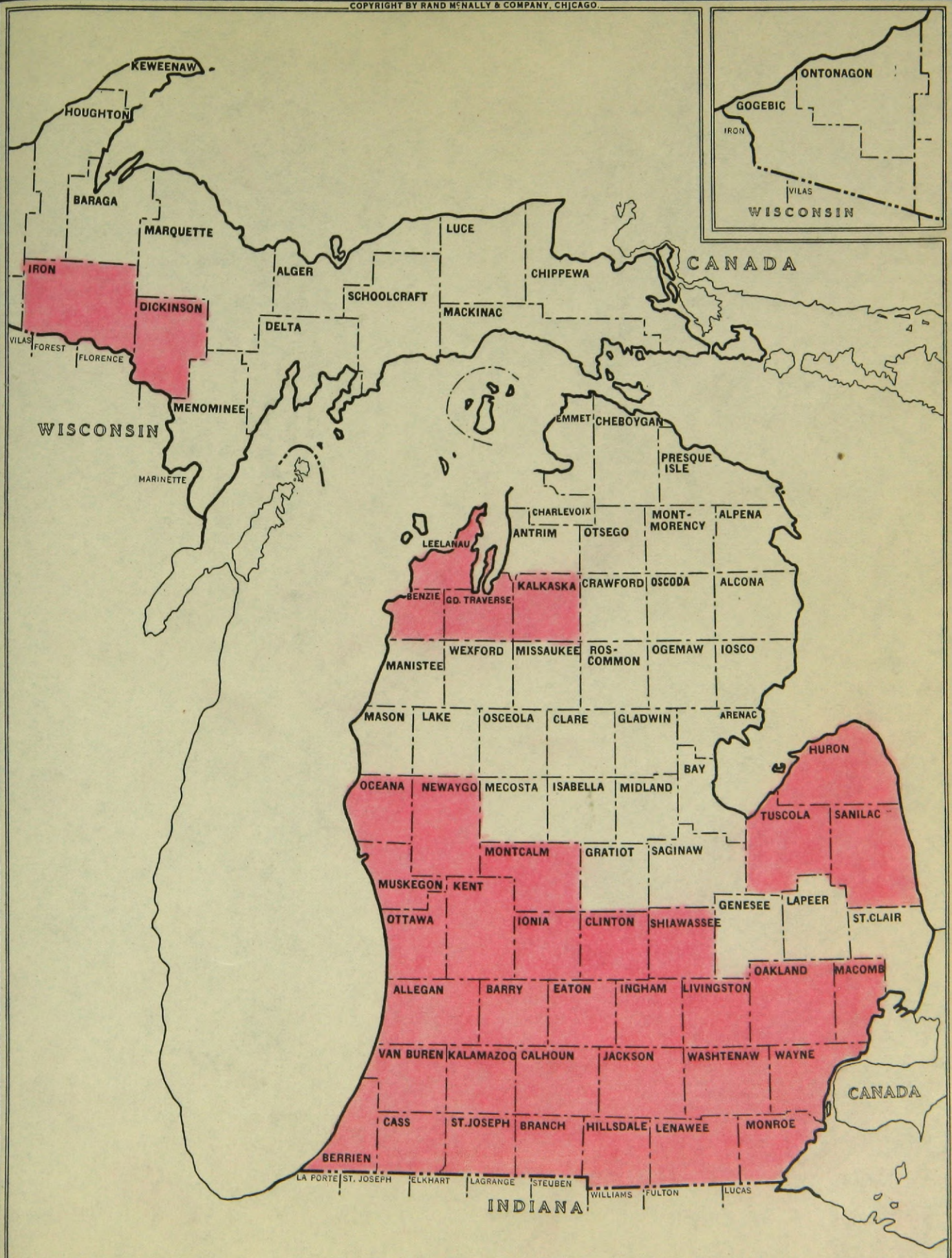
Fig. 14.
Delphinium Barbeyi
Tall Larkspur

Fig. 15.
Caltha palustris
Marsh Marigold

Fig. 16.
Clematis virginiana
Virgin's Bower



Marsh Marigold (Caltha palustris)



Virgin's Bower (Clematis virginiana)

RANUNCULACEAE

Delphinium spp. Larkspur

The larkspurs are well-known plants to most of us because they are to be found in many flower gardens. In some cases they may escape from cultivation and cause some trouble to farmers, but in general they may be said to be of very little importance in Michigan. They are included in this paper because they have caused such extensive losses to cattle in the west. Marsh (1934) says that "in the cattle ranges of the West probably no other group of closely related plants, with the exception of the loco weeds, has caused such heavy losses to the stockmen." Marsh further states that a conservative estimate indicates that three to five per cent of the cattle grazing on the western ranges are fatally poisoned by these plants yearly. Most of the reported losses by the dwarf larkspur of the East have occurred during the months of March, April, and May. (Marsh 1934)

Description of Plants

Larkspur may be classified roughly into two general forms, tall and low. The tall larkspurs are perennials three to seven feet high with coarse erect stems arising from bunched woody roots. Leaves are broad, alternate, and divided into three to seven lobes. The flowers may be almost any shade of blue, white, or red. They have a distinct

spine, which is longer than the petals. Larkspurs may be distinguished from Monkshood (Aconitum) by this spur. This form is represented by Delphinium barbeyi (Fig. 14), a western species.

The low larkspurs differ from the tall in that they are seldom more than three feet high and usually average around one and one-half to two feet. They have a solitary or, at most a few stems. The leaves are smaller, much thicker, and are more finely dissected. The flowers are generally of the same range in color as the tall and the rootstocks are similar. Some forms, however, have fleshy tuberous roots. The low form is illustrated by Delphinium Nelsonii, another western species. (Fig. 13)

The low forms are usually found growing on the plains at low altitudes while the tall forms are confined to mountainous regions. (Sampson and Malmsten 1935)

Range

The range of the larkspurs cover the entire state of Michigan. Since they are widely grown in flower gardens they are found in practically every county although they are seldom found growing wild.

Toxic Principle

Four alkaloids have been found in large amounts in these plants. Marsh (1918) indicates that the most important is the alkaloid delphinin which acts upon the spinal cord. The

amounts of larkspur required to poison fatally vary considerably with the climate, time of year, etc. Fleming and Schapelle (1918) say that an eight hundred pound cow must consume twenty-five pounds to cause death. Clawson has produced poisoning with 0.5 per cent of the animals weight, and death with 0.7 per cent. Sampson and Malmsten say that on a dry weight basis, the leaves from plants in flower are about one-half as poisonous as leaves from young plants.

Animals Affected

Cattle are very highly susceptible (Marsh 1929), horses only slightly, and sheep seem to graze upon the plant with little ill effects. However, Sampson and Malmsten say that Dr. Clawson succeeded in poisoning a sheep fatally with the leaves of Delphinium barbeyi, but the dosage was several times the amount required for cattle.

Nature of Injury

Marsh gives the following symptoms for larkspur poisoning: "As animals are noticed on the range the first symptom commonly observed is the sudden falling of the animal accompanied by violent struggles. The animal is unable to rise, but after a few moments may get upon its feet and walk away, and show no further symptoms. In more acute cases the first fall will be followed by a second, and that possibly by a succession of falls, which in severe cases are followed by complete prostration, vomiting, and death." Death occurs

from respiratory paralysis. The poisoning is acute and the toxic alkaloids appear to be rapidly eliminated through the kidneys. Chronic cases have not been observed. (Couch 1937)

Control

Cattle should not be allowed to graze on an infested area until after the plants are in flower. However, in Michigan this plant is seldom found in large enough patches to cause any serious losses.

In cases of severe poisoning Marsh prescribes the following remedy:

Physostigmine	1 grain
Philocarpine hydrochloride	2 grains
Strychnine sulphate	1/2 grain

These three compounds, when mixed together are known as physostigmine and should be injected into the animal hypodermically.

Aconitum noveboracense Gray. Monkshood

This plant closely resembles the tall larkspur but is said to rarely, if ever, cause fatal poisoning in livestock (Marsh 1929). It is, however, a strong dangerously poisonous plant and should be avoided.

Aconite owes its activities to a rather unstable alkaloid known as aconitine. This acts as a peripheral stimulant and depressant, producing local tingling and numbness of sensory nerves. Small doses are used in medicine to slow the heart. Large doses kill almost instantly from stoppage

of the heart. In severe cases of poisoning the symptoms in man, as given by Sollmann (1932), are pulse slow and feeble, later becoming very rapid, uneven respiration, incoordination of muscles, weakness, and unconsciousness. The skin is cold and the pupils are first constricted then dilated. Convulsions are common and the speech may be impaired.

The range of this plant in Michigan is very local in the lower peninsula.

Caltha palustris L. Marsh marigold (Fig. 15)

This weed is common all over the state in wet soils and swamps and bogs. When growing in dense patches the yellow flowers make a very striking appearance. Marsh marigold is sometimes called cowslip. The leaves are heart or kidney shaped and flowers may be yellow, white or pink. (Ours are always yellow.)

The poisonous properties have not been definitely proven and in some cases this plant is used for food, the flowers and buds being sometimes pickled. Coville says that it is considered superior to any other plant used in this way, indicating that boiling dispels the poisonous principle. Chesnut, in reporting poisoning by Veratrum californicum, says these plants were eaten in mistake for marsh marigold, indicating that Caltha palustris is commonly used for food.

Sollmann (1932) states that Caltha palustris contains anemonin, an active irritant that exists in plants of the crowfoot family. He further says that it is dispelled by

steam which accounts for the fact that it may be cooked and eaten without injury.

Clematis virginiana L. Virgin's Bower

This plant is a perennial, climbing herb with broadly ovate leaflets. Flowers are dioecious and white in color. (Fig. 16)

The toxic principle has not been definitely determined. Long reports that Grishof found a saponin in the leaves of Clematis Vitalba and further states that the strong irritant, anemonal has been found.

The young shoots are said to produce purging, dysentery, and in some cases death. Pammel (1910) says that the European Clematis recta causes blisters and ulcers upon the skin which are difficult to heal.

Ranunculus Spp. Buttercups

A number of buttercups are poisonous and some of them are dangerously so. The poisonous character varies according to the season and stage of growth. Young shoots are said to contain very little, poison, the toxic quality appearing about the time of flowering. Flowers, leaves, and stem vary in toxicity in the order named. Henslow (1901) says that the flowers and fruits of some species are intensely toxic.

Some species of Ranunculus are especially harmful. These are Ranunculus bulbosa, Ranunculus sceleratus, and Ranunculus abortivus. (Fig. 12). Mulvey records the death of three

heifers in England from eating Ranunculus acris. (Long)

The toxic principle is an acrid burning narcotic. Most species contain the two alkaloids aconitine and delphinine. These substances cause irritation of the mucous membrane and inflammation of the digestive tract. Ranunculus sceleratus "induces gastro-enteritus, colic, diarrhoea with black ill-smelling feces, vomiting, lowering in milk yield, nervous symptoms, depression in pulse, dilatation of the pupils, enfeebled condition, difficult mastication, spasmodic movements of the ears, lips, etc., followed in serious cases by convulsions, sinking of the eye in its socket, and death in six to twelve hours following the first appearance of convulsions." (Cornevin cited by Long)

Lander (1922) states that sheep have been poisoned fatally by Ranunculus repens. Symptoms given are sudden falling, rolling of eyes, and signs of dizziness. Death follows with the head thrown over the left flank. Cows, when poisoned by species of Ranunculus, produce a reddish milk.

Few cases of poisoning have been recorded in the United States. These plants are considered to be very toxic in Europe and England and many cases of poisoning have been attributed to them. Possibly they are harmless in this country due to climatic differences, although Pammel (1910) lists them as poisonous.

The poisonous principle is driven off through cooking and drying and many people use the buttercups for food.

PAPAVERACEAE

Chelidonium majus L. Celandine

This plant has been found to be poisonous but has never been reported as a stock-poisoning plant. Livestock of all classes seem to avoid it, possible because it has a very disagreeable taste. When crushed between the fingers it emits a very characteristic and offensive odor.

Celandine is a biennial herb with brittle branches; alternate, deeply pinnatified leaves, with yellow sap; and yellow flowers. (Fig. 17)

The toxic principle contained in this plant is chelidonine, an alkaloid closely related to opium and morphine. (Trease 1935). Large doses act upon the muscles, depress the reflexes, produce paralysis, slow and dilate the heart, followed by coma. (Sollmann 1932)

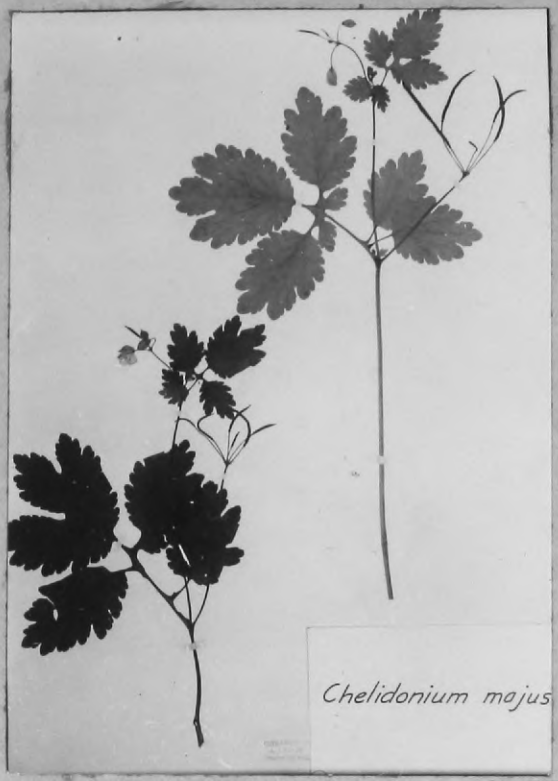


Fig. 17.
Chelidonium majus
Celandine

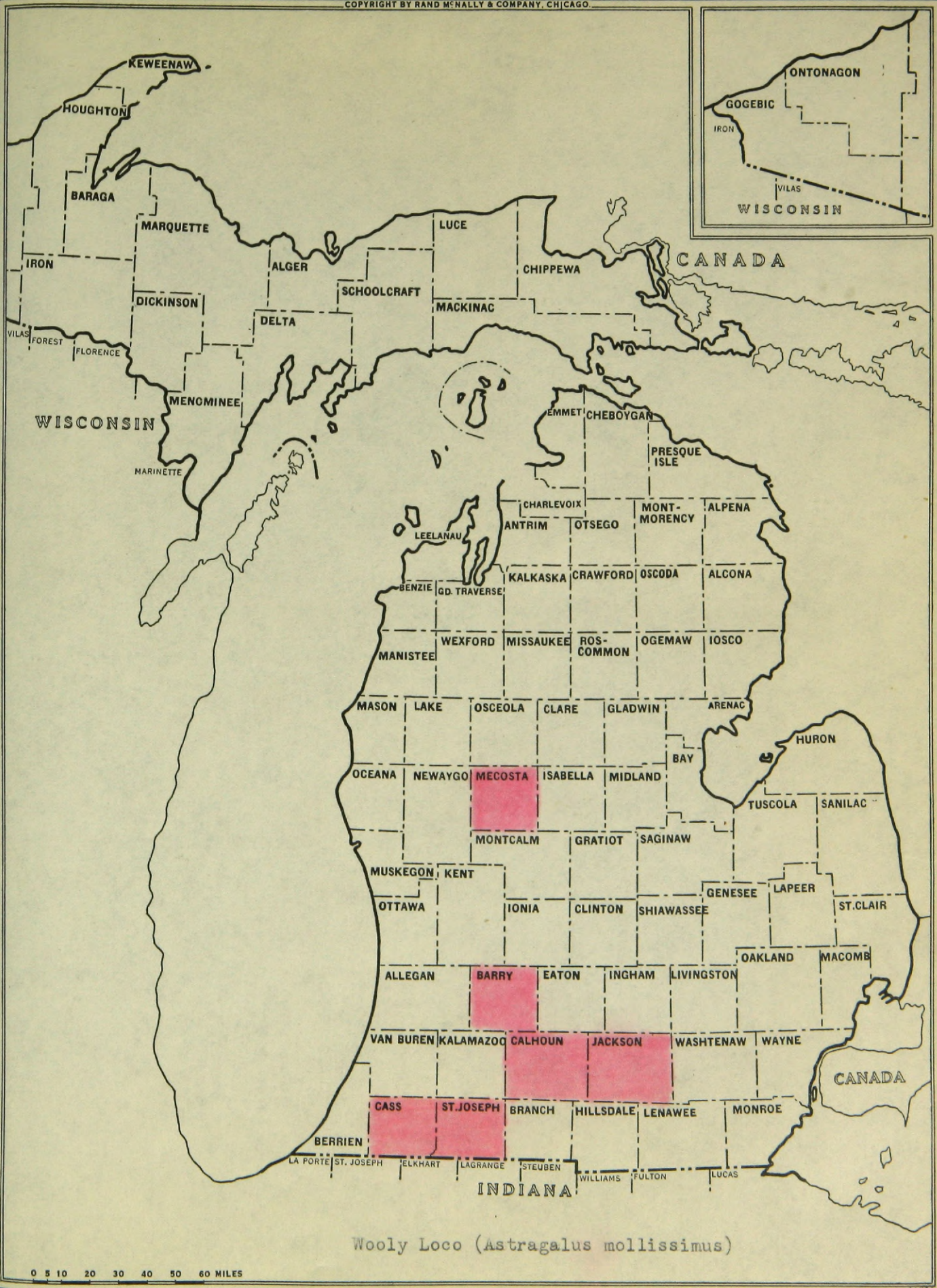
Fig. 18.
Astragalus mollissimus
Wooly Loco

Fig. 19.
Vicia sativa
Common Vetch

Fig. 20.
Crotalaria sagittalis
Rattle Box

Fig. 21.
Lathyrus maritimus
Everlasting Pea

Fig. 22.
Lupinus perennis
Wild Lupine



Wooly Loco (Astragalus mollissimus)

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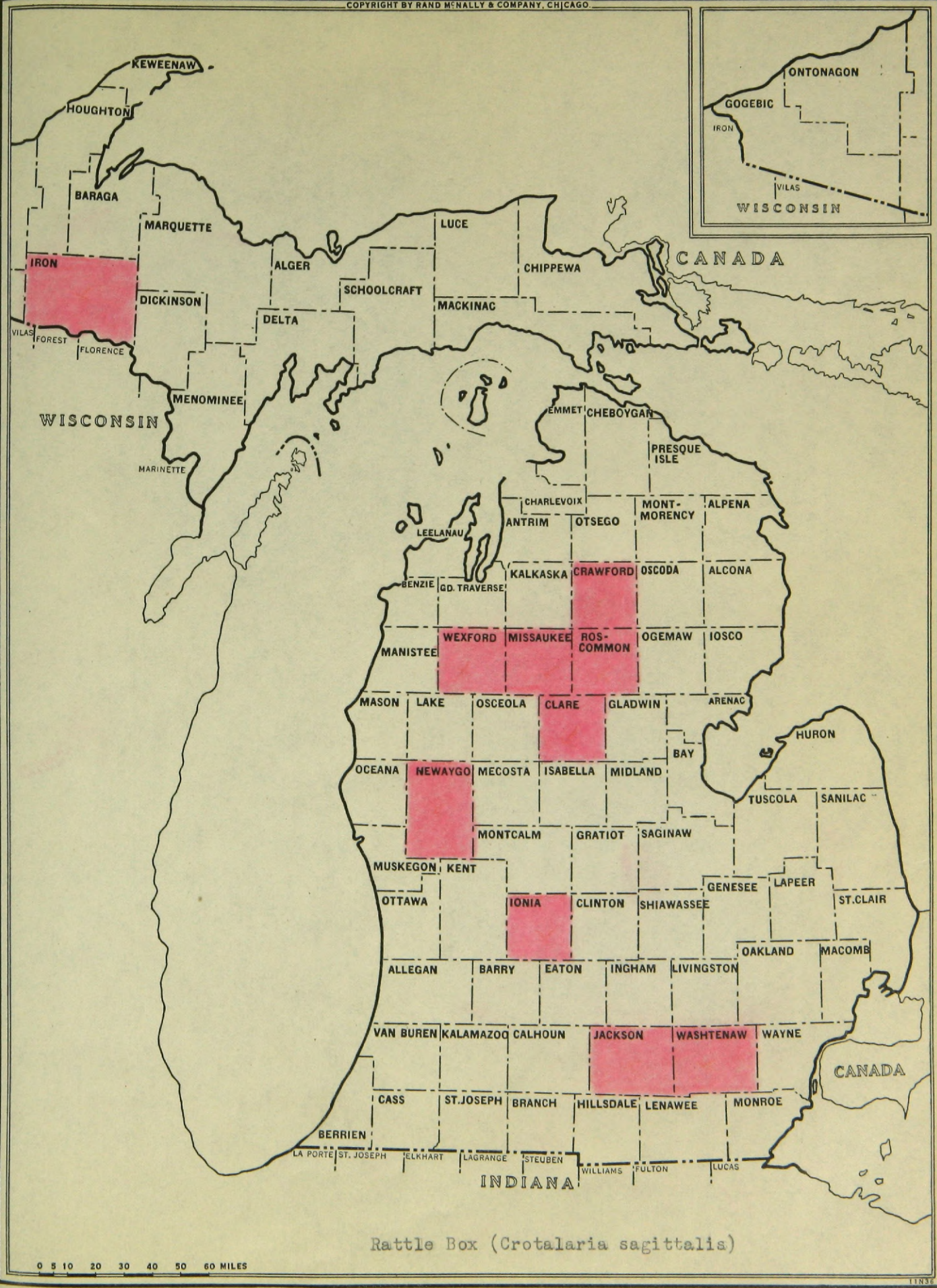


Rattle Box (Crotalaria sagittalis)

LEGUMINOSAE

Astragalus mollissimus Torr. Wooly Loco

Without a doubt the most troublesome plants of the western ranges are the loco weeds. These plants come under the two genera, Oxytropis and Astragalus.

The word "loco" is of Spanish origin and has been used in connection with a disease of the western states for many years. Kellogg (1875) reported that thousands of horses and cattle were poisoned in California by the gray loco (Astragalus menziesii).

Astragalus mollissimus is the only true loco found in Michigan, although other species of Astragalus are present. This plant is known as the wooly loco or purple loco. Other species of Astragalus, commonly known as poisonvetch, have caused considerable damage in the west. Many species of poisonvetch are present in this state but their status as stock-poisoning plants has not been determined. All of these plants, however, should be looked upon with suspicion.

Description of Plant

This plant rarely grows to a height of more than twelve inches. The flowers are small, with deep purple corollas; the fruit pods are hairless, short, thick, two-celled, and dark brown when mature; the leaflets are ovate or elliptical and very densely covered with hairs, from which the plant

gets its name. The branches of the plant usually lie close to the ground making the plant have a diameter about twice its height. (Fig. 18)

Range

This species is rare in Michigan, occurring occasionally in old dry fields throughout the lower peninsula.

Toxic Principle

The toxic principle has baffled investigators for many years. The toxic substance was formerly thought to be barium but this later has been disproven (Marsh, Clawson and Eggleston 1919 Rev. 1936). These investigators showed through feeding experiments with extracts of loco, that the extract did not contain either barium or selenium. These extracts, however, did produce locoism in amimals. Marsh, on the other hand, points out certain cases where Astragalus flavus has caused poisoning due entirely to the selenium present in the plant. A short discussion at the end of this paper will bring out other interesting facts on selenium poisoning of stock.

Couch has succeeded in isolating a compound thought to contain the toxic principle. It is a highly hygroscopic powder soluble in water. It does not fall in any of the well known poison groups. C H N and O are present in approximate proportion of 19, 35, 2 and 12.

Animals Affected

Field work carried on over several years has showed that the wooly loco is rarely injurious to cattle. The losses have been almost entirely confined to horses, although other species have caused much trouble to sheep and cattle (Marsh, Clawson and Eggleston 1919 Rev. 1936). It appears that cattle will not eat the plant readily and experiments show that they will often starve rather than feed upon it. Horses do not normally eat this plant unless forced to do so through shortage of food although, once started they seem to prefer it to wholesome food. Sheep are also said to find the loco weeds distasteful. (Gates 1930)

Nature of Injury

As pointed out by Marsh (1929) the losses from loco weed have been enormous. This weed alone has caused many ranches to go into bankruptcy because in many cases it is impossible to run horses on the ranges.

Marsh, Clawson, and Eggleston give the following symptoms: Horses: The first symptom in horses is usually a change in the general condition of the animal. High spirited animals usually become dull; next' irregularity in gait appear which may be caused by general weakness. The horse drags its feet, particularly noticeable in the hind legs. Normal muscular control is usually lacking. Normal motions are exaggerated in passing over small obstructions, which makes locoed horses difficult and often dangerous to ride. In the later stages of the disease the animal loses much

flesh, the coat becomes rough, and eventually death comes from starvation.

Cattle: The symptoms in cattle are similar to those in horses. The head of a badly locoed steer shakes violently, particularly following heating. Animals are usually dull but may occasionally become excited and run wildly into obstructions. Mathews (1932) found that by feeding Astragalus earli experimentally, abortion was produced in cattle. This has been observed in many instances and many losses of this kind have occurred.

Sheep: Lack of muscular control is not so noticeable in sheep as in horses and symptoms in general are not so marked. Weakness is shown more clearly; animals stumble and fall, rising again with great difficulty.

Control

Since the loco weed is very rare in Michigan it would rarely, if ever, require controlling. Where plants are found they should be grubbed as a precautionary measure to prevent possible loss. Marsh indicates that grubbing is a good control measure.

OTHER LEGUMES LIKELY TO CAUSE POISONING

Vicia sativa L. Common Vetch

This is a smooth or slightly pubescent annual ranging from one to two and one-half feet high with simple stem and five to seven pairs of leaflets. The leaflets are obovate-oblong or linear and notched at the tip. The flowers are

borne in the axils of the leaves. Flowers are purple or bluish. The compound leaf ends with two or three tendrils; the pod is flat and two valved. (Fig. 19)

Pammel lists this plant as being poisonous in Europe and says that it is the cause of tympanites. Dr. Schaffner of the Ohio State University says that this plant is poisonous to hogs but may be fed to cows without harm.

The toxic principle is vicin ($C_8 H_{15} N_3 O_6$). The plant also contains convencin ($C_{10} H_{15} N_3 O_8 H_{20}$). Citric acid is also present.

This species ranges over the entire state and should be suspected of being toxic at least to pigs.

Crotalaria sagittalis L. Rattle box

This plant is an annual ranging from three inches to a foot in height; stem branched and wing margined; leaves oval or lanceolate, about one-half inch wide, entire, having united stipules. Flowers are yellow and the seed pods are inflated having much the same appearance as the garden pea. (Fig. 20)

Injurious alkaloids are present in various parts of the plant, but particularly in the seeds. Poisoning has been most serious along the sandy river beds of the Missouri river. It has been reported to be most serious in horses but also occurs in cattle. The trouble is often called the "Missouri bottom" disease. (Gates 1930)

Dr. Stalker (1884) while investigating this disease in

Iowa collected some of these plants and attempted to feed them to a horse. The horse refused to eat the plant so was fed about ten pounds through a stomach pump. The symptoms observed by him are as follows: "In twenty minutes stupor began to ensue, the eyes were closed, the head was rested against the sides of the box, the breathing became hard, and all the symptoms developed that were to be seen in patients observed in the field. At the end of six hours the stupor began to disappear, the eye began to regain its brightness and in another hour the horse began to eat." The horse apparently recovered from this dose and the next day was given half the dosage as on the previous day. In this instance the symptoms were developed much more rapidly, the animal became unconscious in a short time and died in an hour and a half.

Post mortem examination showed the following lesions: Liver and spleen abnormally dense, walls of intestine destitute of blood, and stomach distended with undigested food.

The range of the plant is probably over most of the state. However, it does not occur in abundance being only occasional on dry, open places. (Woodcock 1925)

Lathyrus maritimus (L.) Bigel. Everlasting pea

The everlasting peas are represented by several species in the state, Lathyrus maritimus being most common. These plants resemble the genus Crotalaria somewhat, having winged stems ending in a simple or branched tendril, two to six leaflets, and purple flowers. (Fig. 21)

Some species such as Lathyrus ornatus, L. polymorphus, and L. palustris are considered valuable forage plants.

A form of intoxication, known as latherism, is said to be caused by some species of Lathyrus.

Woodcock (1935) says that there are several species in the state and they are all toxic to horses and pigs, causing debility in the rear parts and paralysis of the larynx.

The seed contains an alkaloid that is dispelled through long-continued heating at high temperature. (Pammel after Astier)

Lupinus perennis L. Wild lupine

Several lupines occur over the state of Michigan. Lupinus perennis is probably the most common and is reported by Woodcock to be poisonous when mature to horses and sheep. The most noticeable symptoms are great frenzy and death accompanied by marked convulsions.

The alkaloids present in lupines act upon the central nervous system causing depression of the motor functions. Couch (1937) says that there are differences in the symptoms shown by animals poisoned by different species. He states that sheep on some lupines exhibit a train of symptoms indicative of nervous stimulation; on others they show symptoms of depression.

Poisoning in this country is generally acute, no chronic cases having been observed. However, in Germany a chronic disease known as lupinosis has been very prevalent. This has been attributed to eating mouldy lupine hay in which there develops a protein-like toxin, ictrogen, that is not

present in the fresh or properly cured plant. (Couch)

Lupinus perennis is a perennial, somewhat hairy; erect stems, one to two feet high; leaves compound, having seven to eleven oblanceolate leaflets; flowers showy, purplish-blue, in long racemes; pods broad, very hairy, five to six seeded. (Fig. 22)

Chesnut and Wilcox (1901) make some very interesting statements concerning the poisoning of sheep from lupines in Montana. They say that lupines are particularly harmful to sheep when they are rapidly trailed through strange country or when they have just been unloaded from cars. Under these conditions animals are likely to be very hungry and may consume large quantities in a short time. One case cited was an instance where sheep were being rapidly moved from one range to another. When the band was allowed to rest a great amount of lupine was consumed in a short time and within two hours after beginning to eat the lupine a number of sheep manifested symptoms of poisoning and a few died within one hour after the first symptoms were noticed. Out of two hundred sheep in the band one hundred had died before the following morning. Another instance was cited where one hundred and fifty bucks were fed hay containing lupine. Ninety out of the bunch died after one feeding and several others were poisoned but recovered. Following the removal of the hay, no more trouble was experienced. The plant that caused the trouble was evidently Lupinus holsericeus, a western species.

The toxic principles listed by Pammel to occur generally in lupines are lupinin, lupinidum, and arginin. These are all powerful alkaloidal substances. Couch (1936) found monolupine (C_{16} H_{22} ON_2) in Lupinus caudatus.

In view of the above cases reported by Chesnut and others the lupines may cause poisoning under certain conditions. The species found in Michigan may or may not produce poisoning as indicated by Chesnut but should be looked upon with suspicion until more information is obtained.

Fig. 23.
Euphorbia maculata
Spotted Spurge

Fig. 24.
Hypericum perforatum
St. John's Wort

EUPHORBIACEAE

Euphorbia maculata L. (Spotted spurge)

Many species of spurge are acrid, purgative, and toxic. Stock, however, are not likely to feed heavily upon these plants because of the acrid effect of the milky juice upon the mouth. Chesnut says that cattle are resistant to its influence but sometimes they may eat it and suffer poisoning. In England Long reports that the fruits are sometimes used as pickles and poisoning sometimes occurs. Pratt records a case where five women ate the pickled fruits, suffering severe poisoning of an irritant nature.

Description of Plant

Euphorbia maculata is a prostrate, spreading, hairy annual; leaves oblong-linear, pubescent or smooth with small brown spots and opposite; seeds are sharply four angled. The plant contains a milky sap. (Fig. 23)

Range

The spotted spurge ranges over the entire state in dry habitats. It is common along roads.

Toxic Principle

The juice of all species is said to contain the alkaloid euphorbon ($C_{29}H_{44}O_7$). This compound acts as an irritant

to the mucous membrane throughout the alimentary tract in much the same way as croton oil.

Animals Affected

The fresh juice is exceedingly acrid and the fruit highly poisonous to all stock (Sampson and Malmsten 1935). Chesnut (1898) says that goats will eat the plant excessively and their milk, as a result, contains the toxic properties of the plant. It is further reported that people have been poisoned from using the milk of goats that have fed upon spurges. This particularly true of Euphorbia lathyrus.

Symptoms given by Dr. Millspaugh and quoted by Pammel are: "Brilliant, staring, wide-open eyes, dilated pupils; pallor of the countenance; retching and vomiting; violent purging, stools frequent, and in some cases bloody; irregular pulse; body cold and rigid, followed by heat and perspiration."

The species Euphorbia Preslii causes "slobbers" in horses.

Control

Control of these species would be next to impossible due to their wide distribution and their aggressive habits of growth. Every farmer should recognize this plant and its potential possibilities as a stock-poisoning plant. Careful handling of stock should prevent any serious cases of poisoning. It is important that pastures should not be grazed so closely that stock will be forced to use the plant for food.

HYPERICACEAE

Hypericum perforatum L. St. John's wort

This is the only member of the St. John's-wort family occurring in Michigan that is definitely known to be poisonous. Sollmann (1932) says that Ray in 1914 reported that cattle feeding upon Hypericum crispum developed dermatitis in the non-pigmented portions of the skin and inflammation of the mucous membranes exposed to light. Rogers, as early as 1914 claims the same effects were produced by Hypericum perforatum. Pammel in 1910 also reported this plant as being poisonous, causing eruptions on cow's udders and on the feet of white haired animals.

Description of Plant

St. John's wort is an erect, freely branching perennial, one to three feet high. The leaves are sessile, oblong or linear with conspicuous dark glands or ducts on their margins. The main stem, which arises from a woody base, bears many leafy shoots and ends in a thick cymose cluster of yellow flowers. The flowers are about one inch in diameter. The petals of the flowers have conspicuous black glandular dots near the margin. The fruit is a three-parted capsule. (Fig. 24)

Range

Many species of St. John's wort are common over the entire state. Hypericum perforatum is one of the most common weeds to be found in old pastures and abandoned fields.

Toxic Principle

The toxic principle named by Sollmann is a non-volatile organic irritant, acting upon the unpigmented skin due to a fluorescent substance. The viscid oily substance found in the black spots on the leaves and flowers contains the toxic substance (Marsh and Clawson 1930). This compound is known as hypericin.

Animals Affected

Marsh and co-workers say that cattle and sheep are affected. Chesnut has record of two horses being poisoned fatally. Sampson and Malmsten record the poisoning of goats only mildly.

Nature of Injury

It was observed by Chesnut as early as 1898 that animals suffered severe dermatitis in unpigmented areas around the udder, nose, and eyes. It is interesting to note that this blistering does not occur unless the animal is exposed to sunlight. Animals, if confined to shade, may eat these plants with no apparent ill effects whatsoever.

Symptoms given by Sampson are dilation of the pupils and increased heart action, indicating that the toxic sub-

stance works on other organs as well as the skin. Marsh and Clawson (1930) give the following symptoms: "High temperature, rapid pulse, diarrhoea, abnormal respiration, and sometimes salivation." These same authorities say that cattle are poisoned by consuming one per cent of their weight of the green plant while five per cent may kill them. Sheep have shown symptoms from eating four per cent of their weight in one day. The severe dermatitis around the eyes and head may cause the animal to become blind and as a result of sores about the mouth and nose, animals find it difficult to find forage and are usually in poor condition (Sampson and Parker (1930).

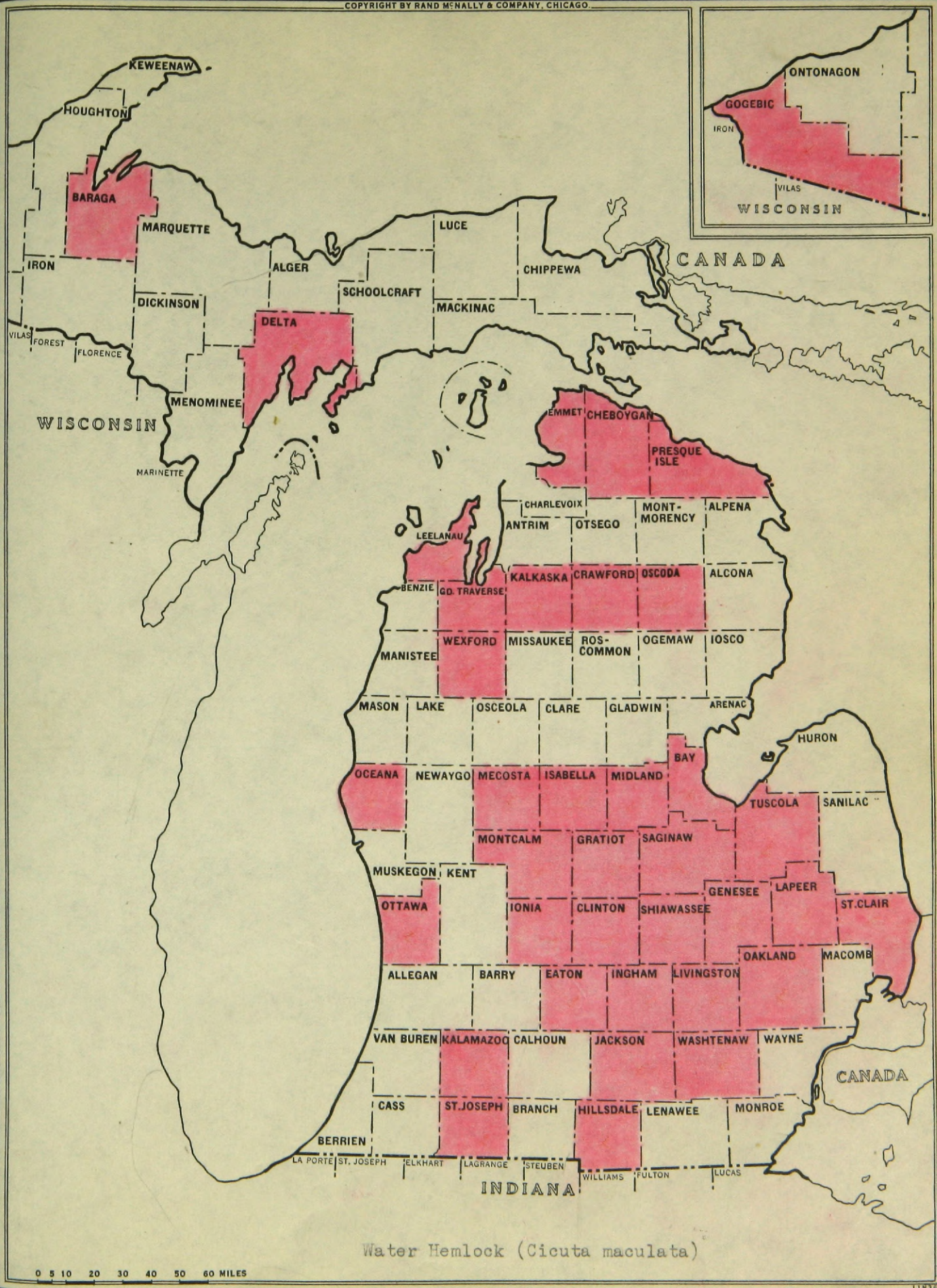
Since the black animals from a herd are never affected, special breeds of black sheep have been developed for certain areas. This is true of southern Australia. (Sampson and Malmsten 1935)

Control

This is one of the few weeds that have been considered to be controlled by insects. Insects have been introduced from Europe into Australia for this purpose and entomologists in this country are considering the possibility of such measures although they are in general reluctant to introduce any new insects that may later become pests on other species of plants.

Fig. 25.
Cicuta maculata
Water Hemlock

Fig. 26.
Conium maculatum
Poison Hemlock



Water Hemlock (Cicuta maculata)

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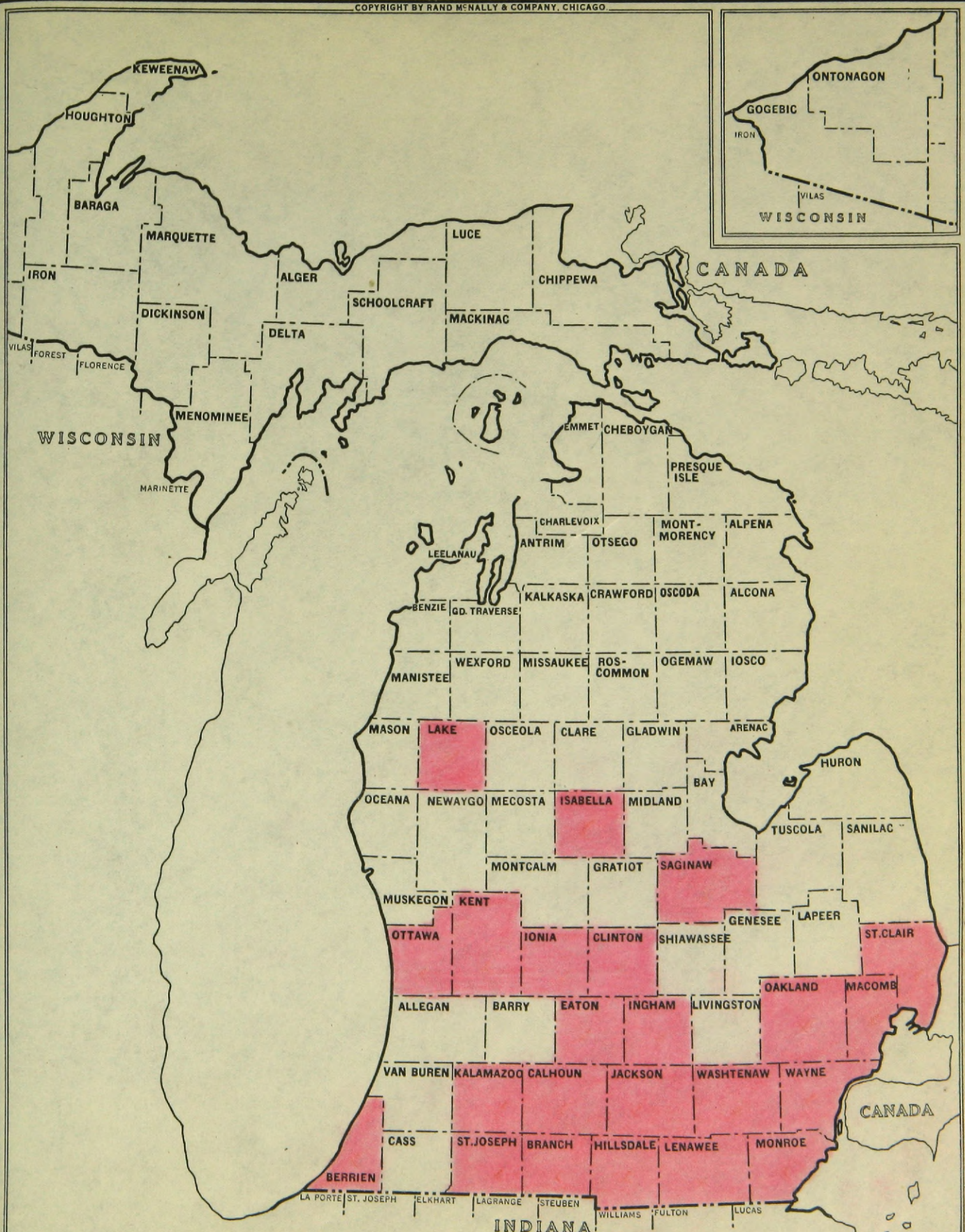

Poison Hemlock (Conium maculatum)

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UMBELLIFERAE

Cicuta maculata L. Water Hemlock

The genus Cicuta or water hemlocks are undoubtedly the most poisonous plants growing in the United States. These plants along with the poison hemlock (Conium) have some historical significance. In the days of Caesar, prisoners were put to death by a poison said to have been concocted either from poison or water hemlock.

Water hemlock, sometimes called cowbane, wild parsnip, poison parsnip, snakeroot, beaver poison, and many other local terms, has often been mistaken for parsely, celery, or parsnip, with many fatal results. Children are especially attracted to the rootstock because of its sweetish taste.

There are many cases of poisoning reported in Wisconsin, Iowa and Minnesota (Pammel 1910). On April 10 of this year a case of poisoning from Cicuta was reported in Detroit. An eight year old boy died after eating a very small quantity of the root.

Description of Plant

Cicuta maculata is a smooth marsh perennial ranging from two to five feet in height, with fasicled fusiform roots; leaves pinnately compound (two or three times pinnate), long petioled; the coarsely serrate leaflets lanceolate; flowers white; fruit oval, parsley-like (Fig. 25). The rootstocks are particularly characterized by central

hollow spaces divided by cross partition forming chambers. This characteristic separates the genus of Cicuta from genera of the Umbelliferae.

Range

This plant is general in swamps and low grounds and particularly abundant in Saginaw County. (Woodcock 1925)

Toxic Principle

There is some confusion about the poison contained in this plant. Sollmann gives the toxic principle as cicutoxin a member of the picrotoxin group. This substance is much like picrotoxin, a substance from which knock-out drops are obtained. These drops are used by certain unscrupulous individuals for adulterating beer, and are known by those who use them as "Micky Finns."

Long says that the alkaloid cicutine and oil of cicuta are present. Cicutoxine occurs in dried roots to the extent of 3.5 per cent. The toxicity is said to vary with the season and climate, the rootstock being most poisonous in the spring. It is also at this time of the year that the roots are most likely to be exposed.

According to Chesnut, the fatal dose of cicutoxine is fifty milligrams for each kilogram of body weight when administered through the mouth and seven milligrams when injected into the blood stream.

Animals Affected

Animals of all kinds are said to be affected by Cicuta. Woodcock says that serious losses have occurred in Saginaw County to cattle. Pammel cites several interesting cases of poisoning both to livestock and people. He relates of the poisoning of four cows from eating roots that had been harrowed up in preparing ground for planting. Another case was cited where a man in Iowa lost several horses; and cows were caused to abort from eating hay containing Cicuta.

Dr. E. F. Smith (Bot. Gazette Vol. 13) reports of two boys eating the root and one, eight years of age, dying within one hour after ingestion.

Chesnut (1900) says that Dr. Wilcox observed 105 cases of water hemlock poisoning among sheep, fifty of which were fatal, and thirty-six among cattle of which thirty were fatal.

Scores of other reports have shown that this plant is to be feared as a violent poison to all classes of livestock.

Nature of Injury

Old rootstocks are said to be the most toxic parts of the plant, although all parts contain large amounts of the poison. In many cases where livestock trample the roots, enough of the poison is liberated and dissolved in the water around water holes to cause fatal poisoning.

Hall and Yates (1915) give the following symptoms: "Nausea, involuntary muscular movements, quivering of the

lips, excessive salivation, and frothing at the mouth." Fleming and other co-workers (1920) add other symptoms such as: violent convulsions, groaning, clamping of the jaws and grating of the teeth, dilated pupils, backward bending of the head, and rapid kicking, or rigid extension of the legs. Sampson and Malmsten (1935) say that the pulse is weak and rapid, with labored, irregular respiration. Generally there is diarrhoea and bloating occurs in some cases in cattle and sheep. Death may come in a very short time if the dose is sufficient.

Fleming and others (1920) determined that it required much more of the new tubers to cause death than old ones. They found that as little as one-half ounce of dried tubers killed ewes quickly. They also found that cows fed one-half pound of dried tubers died in three to four hours.

Reports from Pammel seem to conflict with statements made by Sampson and Malmsten that hay containing Cicuta is not dangerous.

Control

Water hemlock is not apt to cause poisoning under normal conditions. In some cases it has been known to poison water holes when the roots are crushed by stock. Swamps containing poison hemlock should be fenced. Marsh and Clawson (1914) recommended the injection of morphine to control the convulsions.

Conium maculatum L. Poison Hemlock

This plant is also famous from ancient times. It was

used by the Greeks to inflict the death penalty upon criminals and philosophers (Gates 1930). It is said that Socrates was poisoned by it.

Animals rarely appear to eat this plant, probably because of its foetid mousy odor. However, some cases have been reported of its poisoning both livestock and humans.

Description of Plant

This a biennial plant, three to six feet high, with spotted branched stems, and large decompound leaves with lanceolate pinnatififid leaflets (Fig. 26). The flowers are in umbels and are white. The fruit is somewhat flattened on the sides with prominent wavy ribs. There are no oil tubes present and the roots are not hollow as in species of Cicuta.

Range

The distribution of this species is not as wide as that of Cicuta maculata, being only occasional in the lower peninsula. (Woodcock 1925)

Toxic Principle

Trease indicates that the toxic principle is coniine ($C_8 H_{17} N$), an alkaloid that produces the mousy odor observed when the plant is crushed. It also contains disomin found in Capsella bursa-pastoris. Pammel lists two other alkaloids that occur: conicein ($C_8 H_{15} N$), said to be eighteen times more poisonous than coniin, and conydrin ($C_8 H_{17} NO$).

Other alkaloids occur in small amounts. The per cent of coniin in new leaves is said to be 0.095 per cent; the ripe seeds contain around 0.7 per cent.

Animals Affected

While all parts of the plant are toxic, the seeds are said to be especially injurious which accounts for many cases of poisoning occurring to chickens.

All higher animals may be affected if the plant is eaten in sufficient amounts.

Nature of Injury

This is a dangerous narcotic plant, even the smallest quantities may cause inflammation of the digestive tract, paralysis, and death.

General symptoms are salivation, bloating, dilation of the pupils, rolling of the eyes, laboured respiration, slow breathing, irregular heart action, loss of sensation, convulsions, staggering gait, falling, and paralysis. The poison acts upon the motor nerve endings.

Long gives the following symptoms for horses and cattle: Horse: "Nausea, unsuccessful attempts to vomit, gritting of teeth, accelerated respiration, muscular tremors, difficult locomotion, sweating (intermittent), falling, paralysis, loss of feeling, lowering of temperature, rapid pulse and difficult respiration followed by death from stoppage of respiration."

Cattle: "Stoppage of digestion, bloating, constipation, weakness and stupor. Pregnant cows are often caused to abort." Chesnut gives additional symptoms of loss of appetite,

salivation, bodily pain, weakness, and rapid feeble pulse. Poisoning differs from that of Cicuta maculata in that convulsions are absent. (Pammel)

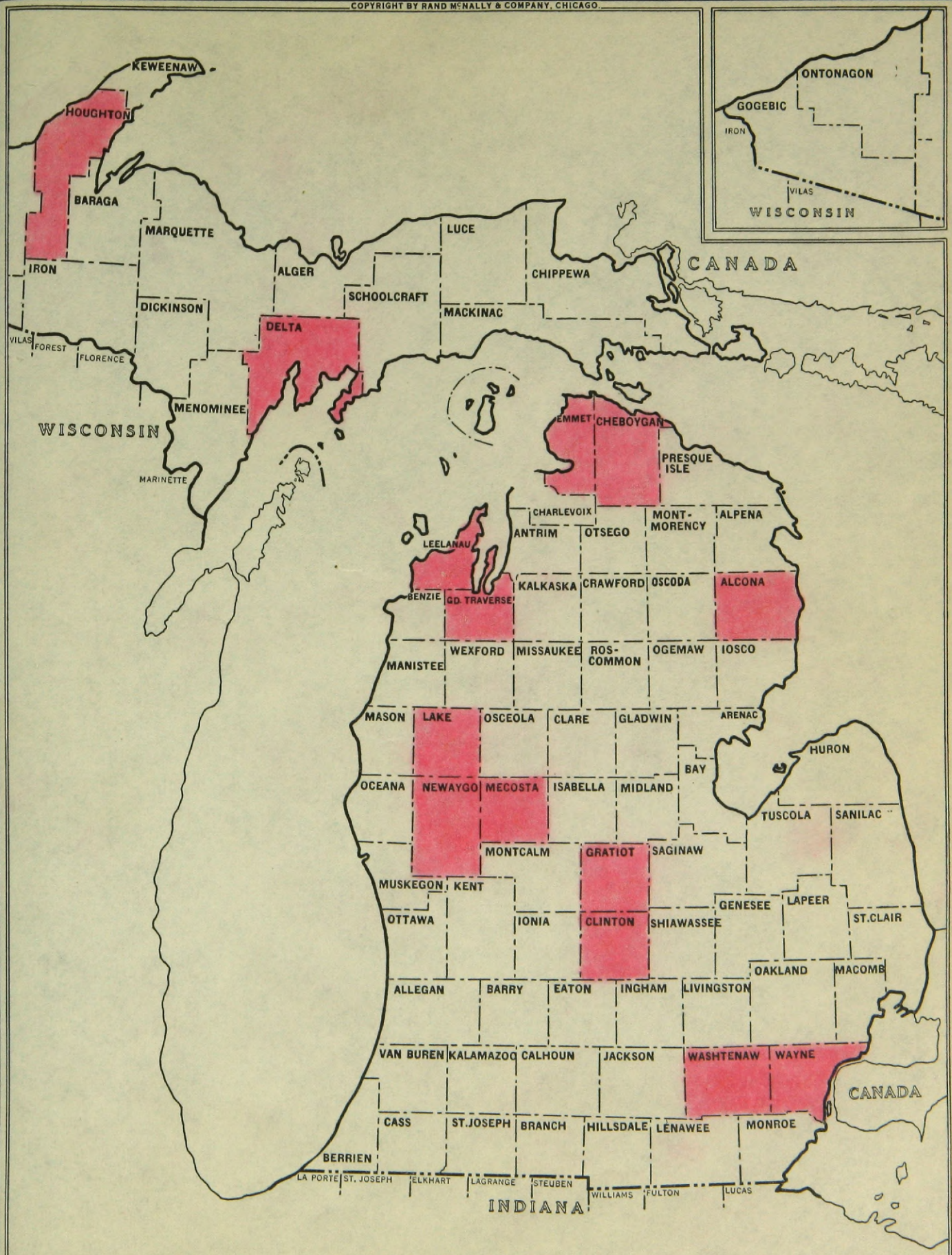
Blyth gives the fatal dose in man to be 2.3 grains of the plant extract.

Control

Control measures in Michigan would seldom be necessary. Fencing of dense patches is advised as in Cicuta maculata.

Fig. 27.
Kalmia angustifolia
Sheep Laurel

Fig. 28.
Kalmia polifolia
Swamp Laurel



Sheep Laurel (Kalmia angustifolia)

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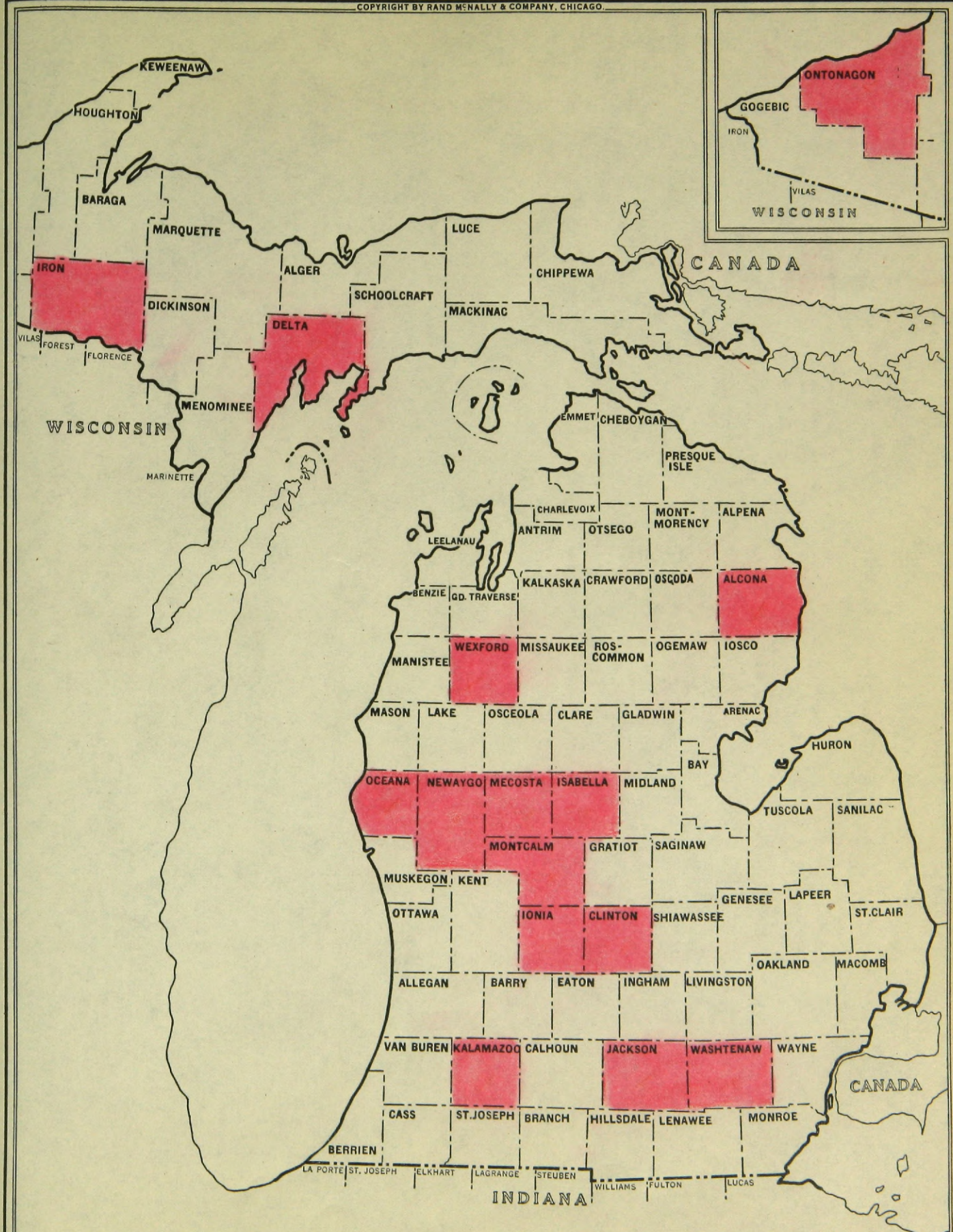


Swamp Laurel (Kalmia polifolia)

ERICACEAE

Kalmia angustifolia L. Sheep laurel

A number of the heaths or laurels are definitely known to be poisonous. Clawson (1933) indicates that Kalmia angustifolia is much more toxic than some of the others.

A review of the literature cited by Clawson will indicate that these plants are of wide importance and much experimental work has been done concerning them. The following work was cited by Dr. Clawson:

Davey (1902) "suspected that Kalmia polifolia may possibly prove poisonous to sheep as some of the eastern species of the genus are considered among the most dangerous of cattle poisons."

Hall and Yates (1915) "referred to Kalmia polifolia in California and stated it is one of our most poisonous plants, but fortunately grows in districts where there is but little stock raising."

Glover and Robbins (1915) "include Kalmia polifolia among the poisonous plants of California."

Fleming (1920) "fed Kalmia microphylla to twenty-six sheep and ten calves and poisoned both classes of animals. From his experimental work he concluded: From this it would seem that the plant varies in toxicity in different environments, and that there is considerable seasonal change in the poison present."

Fyles (1920) "concludes that because Kalmia latifolia and Kalmia angustifolia are poisonous, no doubt other species of Kalmia including Kalmia polifolia are equally poisonous."

Sifton (1922) "also writing of Canadian plants, lists Kalmia polifolia as a poisonous plant, saying it grows across the continent except on the prairies. It is found on mountains and on cold bogs."

Dayton (1931) "says of Kalmia microphilla: Generally, livestock do not touch the species but instances are reported of sickness or even loss, especially among lambs admitted to high range too early in the spring."

Description of Plant

Kalmia angustifolia is a shrub from one to three feet high; leaves usually opposite or in threes, pale or whitish beneath, light green above; acute or narrowly oblong, petioled; flowers in simple or compound corymbs, purple or crimson. The pedicels are filiform and recurved in fruit (Fig. 27). Kalmia polifolia (Fig. 28) differs from Kalmia angustifolia in that the branchlets are two edged and the leaves are barely sessile.

Range

Kalmia angustifolia grows over the entire state of Michigan on moist soils. It, however, is rather scarce. Kalmia polifolia is confined to bogs over the entire state.

Toxic Principle

Couch (1937) states that all parts of the plants contain andromedatoxin ($C_{19}H_{31}O_6$), a resinoid substance. Long names the glucosides ericolin, arbutin and rhododendron to be present in the Rhododendrons. These may also be present in Kalmia.

Animals Affected

Cattle do not normally eat these plants. Clawson conducted feeding experiments on sheep, cattle, and goats. He fed a 765 pound steer about 2.3 pounds of green laurel but produced no ill effects. It has been found, however, that cattle may be poisoned. Fleming (1920) conducted feeding experiments and succeeded in poisoning calves with nine ounces of Kalmia microphilla, sheep with one ounce, killing them with eight ounces. Sheep seem to be more highly susceptible.

Nature of Injury

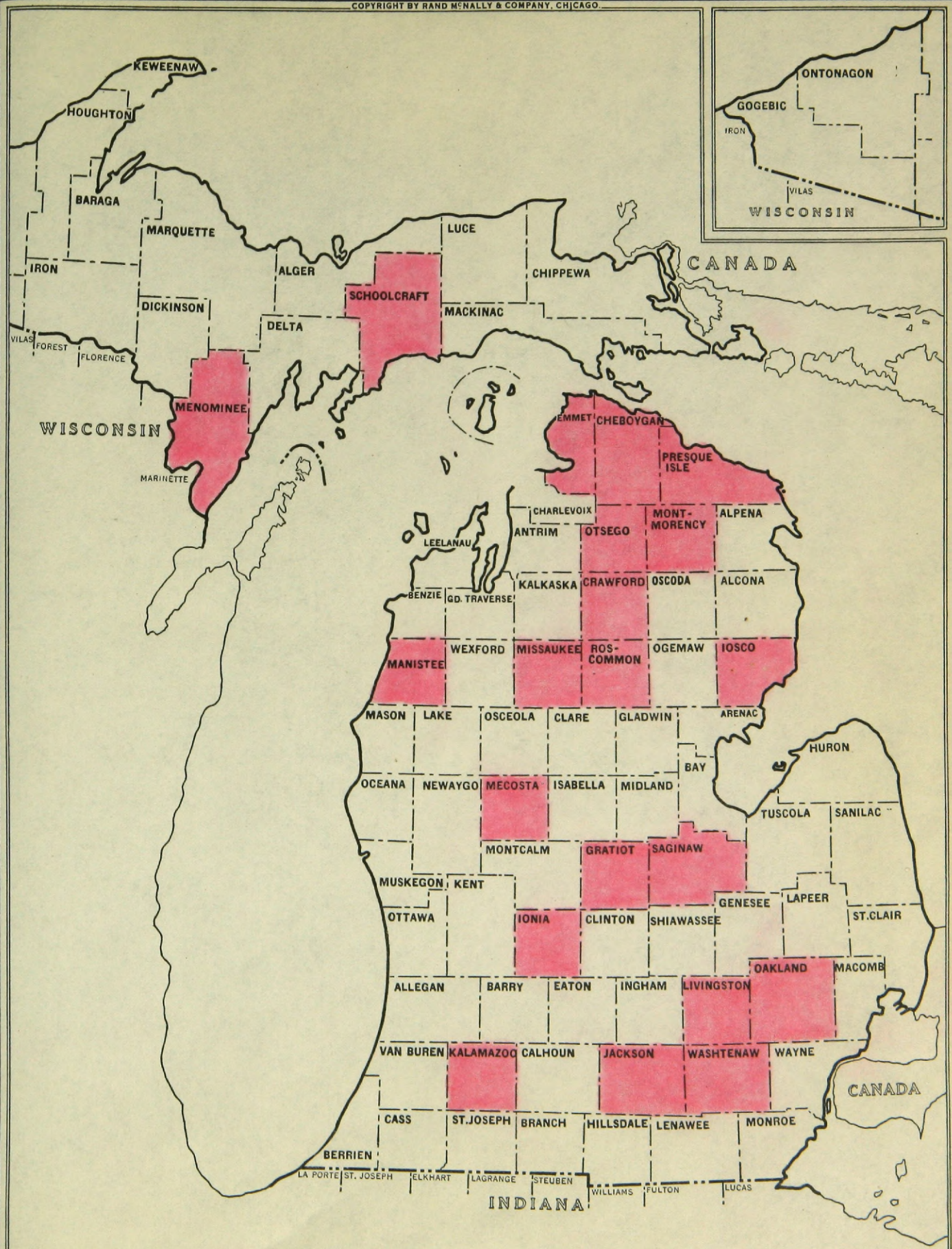
Both Kalmia angustifolia and Kalmia polifolia produce severe illness and death in animals. The symptoms of poisoning given by Clawson are: "Weakness and nausea, accompanied by salivation and vomiting. These may develop within less than three hours after a toxic dose has been eaten, poisoned animals may remain sick for more than two days and still recover."

Control

Kalmia polifolia may be controlled by fencing bogs. Sheep should not be allowed to run where either of these plants are common. Eradication of Kalmia angustifolia may be feasible in some cases.

Fig. 29.
Apocynum cannabinum
Indian Hemp

Fig. 30.
Apocynum androsaemifolium
Dogbane



Dogbane (Apocynum androsaemifolium)

APOCYNACEAE

Apocynum Spp. Dogbane

There are three species of Apocynum growing in Michigan these are Apocynum androsaemifolium (Fig. 30), Apocynum cannabinum (Fig. 29), and Apocynum sibericum. A. cannabinum is known as Indian hemp and is used for medicinal purposes as is Apocynum androsaemifolium.

These plants are close relatives of the milkweed family and contain a white latex much like the species of Asclepias. According to Trease they contain a glucoside known as cymarin. Couch reports three other toxins present. These are: a glucoside, apocynein; a resin, apocynin; and cynotoxin ($C_{20}\ H_{38}\ O_6$).

Cymarin is used in medicine, having about the same effects as digitalin. Pammel says that all these species contain the glucoside apocynein which is used as an emetic, cathartic, and diuretic. Gates (1930) lists Apocynum cannabinum among the poisonous plants of Kansas and says that it may cause disastrous results if eaten in sufficient quantities.

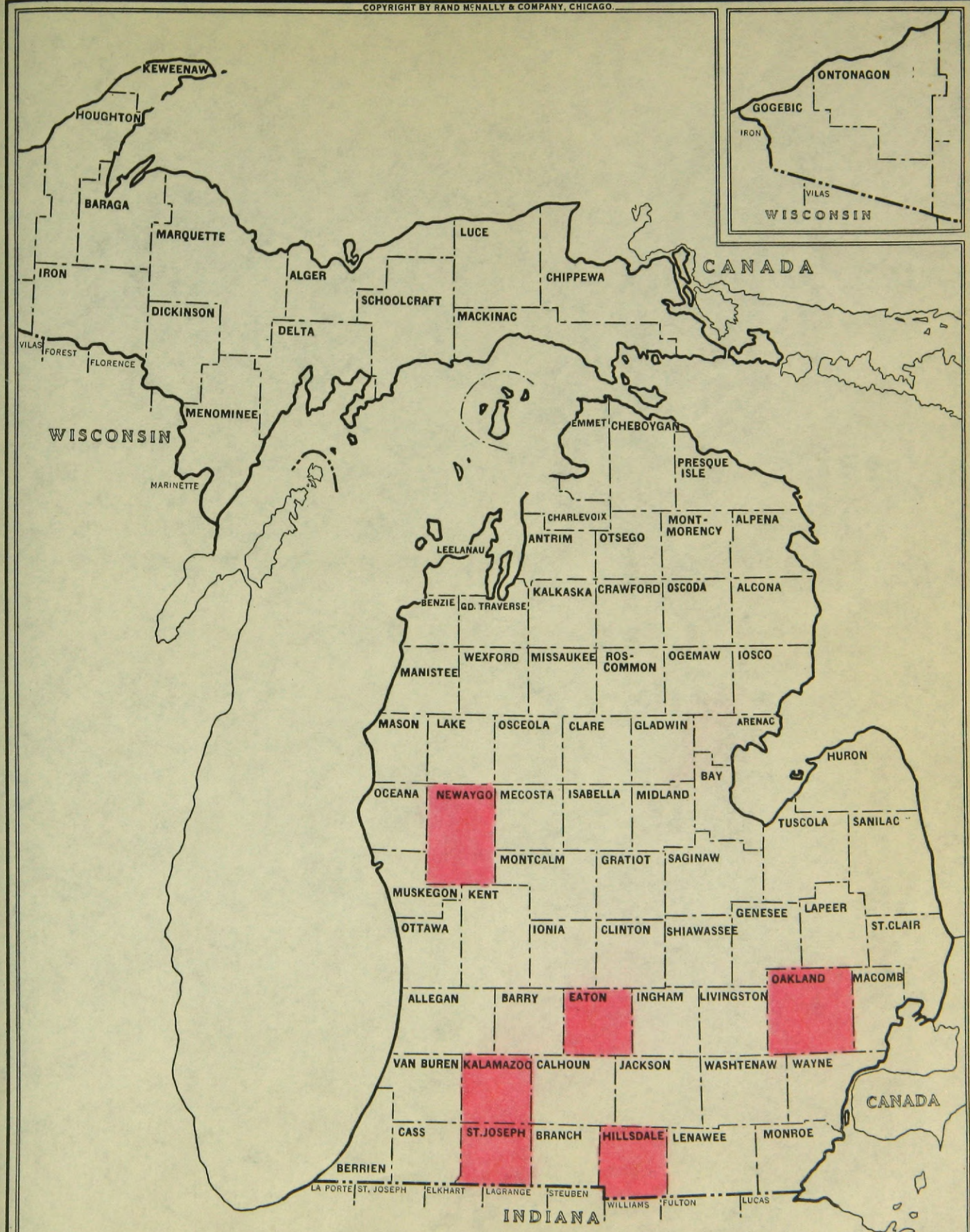
All three species listed above occur rather commonly throughout Michigan, being common in thickets, pastures, and abandoned farmland. These species have a very aggressive habit of growth, sprouting from the long white roots and in many places they form very large patches which

should be considered dangerous to stock if other forage is not present.

The bitter taste imparted to the plant by the milky sap makes it distasteful to stock and is not likely to be eaten if any other suitable plants are present.

Fig. 31.
Asclepias verticillata
Whorled Milkweed

Fig. 32.
Cynachum nigrum
Black Swallow Wort



Whorled milkweed (Asclepias verticillata)

0 5 10 20 30 40 50 60 MILES

11N36

ASCLEPIADACEAE

Asclepias verticillata Whorled milkweed

A number of the milkweeds are said to be poisonous but Asclepias verticillata is the only one growing in Michigan known to be definitely so. Asclepias galioides has caused many losses in the west. This is one of the very narrow leaved species which are said to be much more poisonous than the broad leaved species (Gates 1930). Of the broad leaved species we have Asclepias syriaca L. which should be considered with suspicion until more information has been gathered concerning it.

Description of Plant

Ascelepias verticillata is a perennial herb with slender stems arising from a fibrous root, very leafy to the top; leaves linear, three to six in a whorl; umbels small, lateral, and terminal; flower greenish white. (Fig. 31)

Range

This plant occurs occasionally in the lower counties of the lower peninsula on barren lands and abandoned fields.

Toxic Principle

Little is known about the true nature of the toxic substance which is contained in the milky latex and is probably

a glucoside. Pammel says that Asclepias tuberosa contains a bitter glucoside asclepidin. This is a bitter yellow emetic substance. Couch lists Asclepias galioides next to Cicuta vagrans in toxicity. He says that the toxic principle is a resinoid (C_{17} H_{24} O_4).

Animals Affected

Very little mention is made of Asclepias verticillata in the literature although Gates mentions it as being poisonous. More work has been done on other species of the narrow leaved milkweeds and these will be used in drawing conclusions.

Gates says that Asclepias galioides is toxic to horses, cattle, and sheep. He gives the lethal doses for cattle to be around 0.5 pound for every 100 pounds of animal, sheep between 0.138 and 0.22 pounds, and horses about 0.2 pounds. This would indicate that this plant is more toxic to sheep and horses than to cattle.

There is evidence that the poison of the narrow-leaved species is found largely in the leaves. The pods rank next in toxicity. (Fleming and co-workers 1920 and Marsh and Clawson 1921)

Marsh and Clawson say that a broad-leaved species(Asclepias eriocarpa) is four times as toxic as Mexican whorled milkweed. Fleming found that mature sheep are poisoned from eating one-half to one and one-half pounds of Mexican whorled milkweed (Asclepias mexicana) in the green state. Fleming

also found that from five to sixteen ounces of the dried plant would cause sickness and death in mature sheep. Marsh and Clawson give 0.353 pound per hundredweight of sheep and cattle as a minimum toxic dose and 0.882 pound as the minimum lethal dose.

In view of these above works it is safe to state that Asclepias verticillata is toxic to cattle and sheep and probably to horses.

Nature of Injury

Symptoms given by Sampson and Malmsten (1935) are as follows: "The symptoms caused by the narrow-leaved milkweeds appear about fourteen hours after eating the plants. The animals become weak, wobble and stagger about. The pulse is high and rather weak. In mild cases of poisoning these may be the only symptoms." In more severe cases these investigators give the following symptoms: "loss of control over leg muscles, spasms at short intervals, legs stiff, grating of teeth, and champing of the jaws. Attacks may last for twenty-four hours during which time the temperature rises, having been known to reach a maximum of 106.4 degrees F." Marsh and Clawson noticed salivation and bloating in some cases.

Control

The milkweeds retain the toxic principle upon drying and as a result are very dangerous to feed in hay. This seems to be the most likely channel through which poisoning might occur. So care should be taken when these plants may be pre-

sent in hay fields. The broad leaved species are very common and may occur in great patches. These patches should never be cut and included in hay.

PLANTS OF MINOR IMPORTANCE IN THE MILKWEED FAMILY

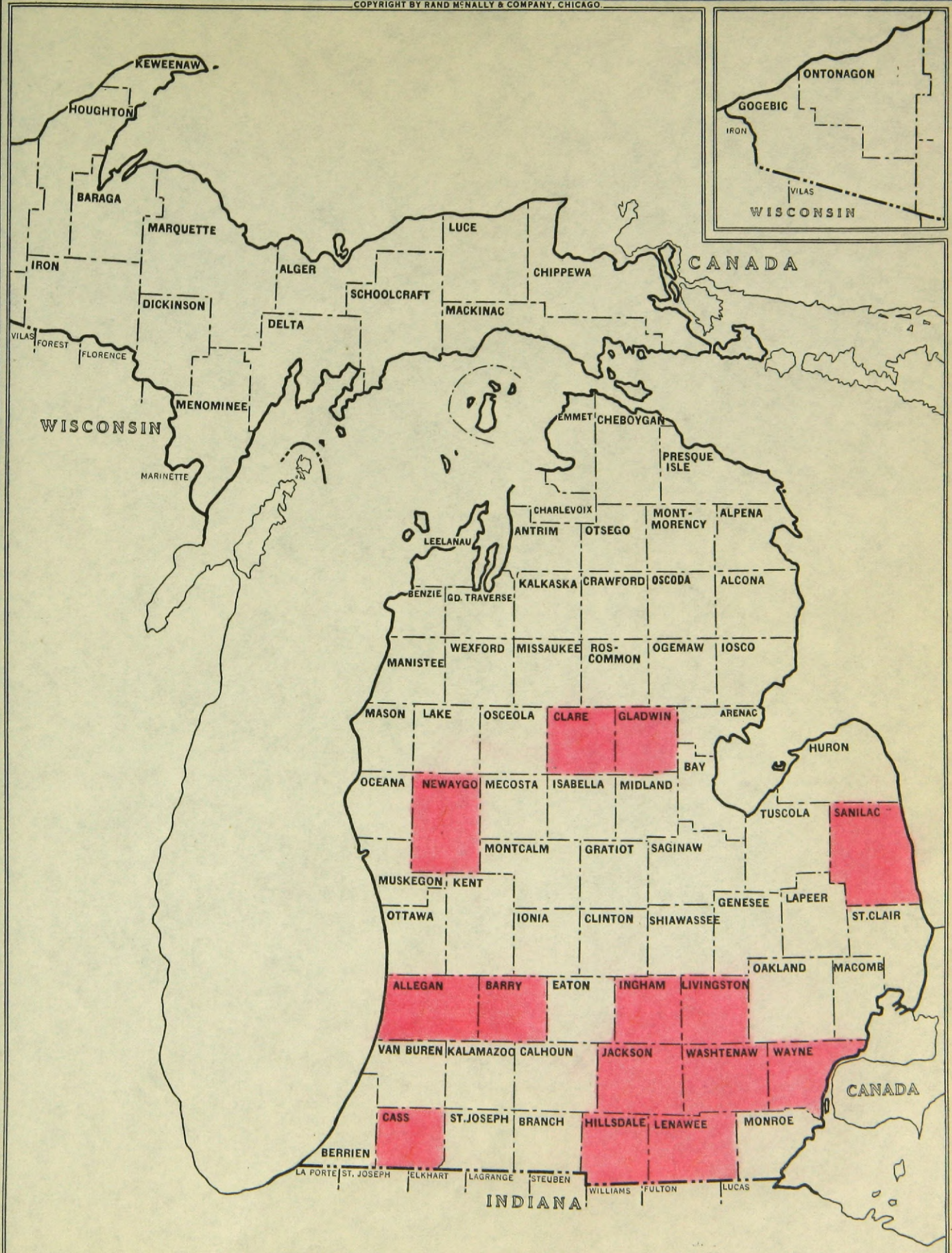
Cynachum nigrum (L.) Pers. Black Swallow-wort

This plant probably contains the same toxic principle as the other milkweeds. It resembles the dogbanes (species of *Apocynum*) more than the true milkweeds (Fig. 32). No definite cases of poisoning have been recorded but the plant should be suspected.

Fig. 33.
Solanum nigrum
Black Nightshade

Fig. 34.
Datura stramonium
Jimson Weed

Fig. 35.
Hyoscyamus niger
Black Henbane



Black Nightshade (Solanum nigrum)

SOLANACEAE

Datura stramonium L. Jimson weed (Fig. 34)

Solanum nigrum L. Black nightshade (Fig. 33)

Hyoscyamus niger L. Black henbane(Fig. 35)

The jimson weed is a well known plant of the lower peninsula. It contains the alkaloids atropin, hyoscyamin, and hyoscine. Daturin, the compound most commonly mentioned in literature, is a mixture of hyoscyamin and atropin, The leaves of this plant are used in the treatment of asthma and atropin is used to relieve pain and for the dilation of the eyes. (Trease 1935)

Chesnut (1898) says "the poisonous alkaloids, atropin and hyoscyamin, the active constituents of belladonna, are found also in the jimson weeds. Hyoscyamin is the poison of the henbane and is identical in its physiological action with atropin ----- The alkaloids exist in all parts of the plants. The seeds are especially dangerous." Chesnut reports several cases of children being poisoned by eating the seeds. He reports that five children were poisoned at Alpena, Michigan in 1897. Children have been poisoned by playing with the flower and sucking it in the mouth. Chesnut also reports cases of cattle being poisoned by eating leaves of the young plants. These animals usually avoid the plant, however,

Gates (1930) indicates that jimson weed is poisonous to all classes of stock and should never be included in hay as the toxic principle is not dispelled on drying.

Marsh (1929) mentions Datura stramonium as a poisonous plant but states that it is not of importance under range conditions. Gates says that the disagreeable taste is not present in the dried plant and cows are more often poisoned than other classes of stock.

Chesnut gives the following symptoms of poisoning: Vertigo, headache, nausea, extreme thirst, dry skin and nervous confusion with dilated pupils, loss of sight and of voluntary motion, and sometimes mania, convulsions and death.

This plant was introduced from Europe and was formerly cultivated in gardens under the name of night flowering cactus. It has escaped from cultivation and is now found in most counties of the lower peninsula.

Black nightshade (Solanum nigrum) grows in waste places over most of the state. These plants are sometimes called stubble berry and are cultivated occasionally for the fruit. Pammel says that the fruit should be used with care unless ripe. Chesnut says the poison is present in all parts of the plant and varies with the condition of growth. He further states that the more musky-odored plants are more poisonous, and that poisoning has occurred in calves, sheep, goats, and swine.

The toxic principle given by Long is solanine which is readily converted into a poisonous substance called solanidine. This is the same substance that is found in the green

parts of the potato tuber after it has been sunburned and it is said that sunburned potatoes are much more toxic than the berries of Solanum nigrum.

Solanum nigrum is much more toxic in some countries than others, the toxicity varying considerably with the soil, climate, and general condition of growth. This explains why the fruits may be used in some localities without apparent ill effects. It may be possible that the toxic substance is driven off by heat.

Symptoms of poisoning are stupefaction, staggering, loss of speech, feeling, and consciousness, dilation of the eyes, and sometimes cramps and convulsions.

Although this plant does not always cause poisoning, it should be considered as a poisonous plant and avoided. Gates (1930) says "sufficient amounts to poison are most likely to be in the plant when growing in the sun without sufficient moisture. Consequently it is usually safe to ignore the plant if growing in the shade or if no cases of poisoning have developed. Because of the fact that it may contain so little poisonous material, the plant is one that should be known for what it can do under proper circumstances."

Black henbane (Hyoscyamus niger) is not a common plant in Michigan. At most it occurs only occasionally in waste places. It is a well known plant from which the alkaloid hyoscyamin is obtained for medicinal purposes. Trease claims that henbane seeds contain about 0.06 to 0.10 per cent of alkaloids (hyoscyamine with a little hyoscine and atropine). Henbane resembles belladonna and stramonium in

action but is somewhat weaker. It is often used with purgatives to prevent griping. Couch (1937) indicates that atropine it also present.

Not many cases of livestock poisoning have been reported. Long reports cases of poisoning of cows and chickens but says that birds eat the seeds with no ill effects. He says that sometimes small quantities of the seeds are mixed with the food of fattening stock. Fattening is promoted through inducement of quiet and repose caused by the narcotic properties of the toxic substance.

Symptoms of poisoning are depression of the heart, dilation of the pupils, loss of muscular power, slowing and failure of respiration, stupor, and asphyxia. Death usually comes from respiratory paralysis.

This plant is very rarely eaten by stock because of its unpleasant taste.

Fig. 36.
Xanthium commune
Cocklebur

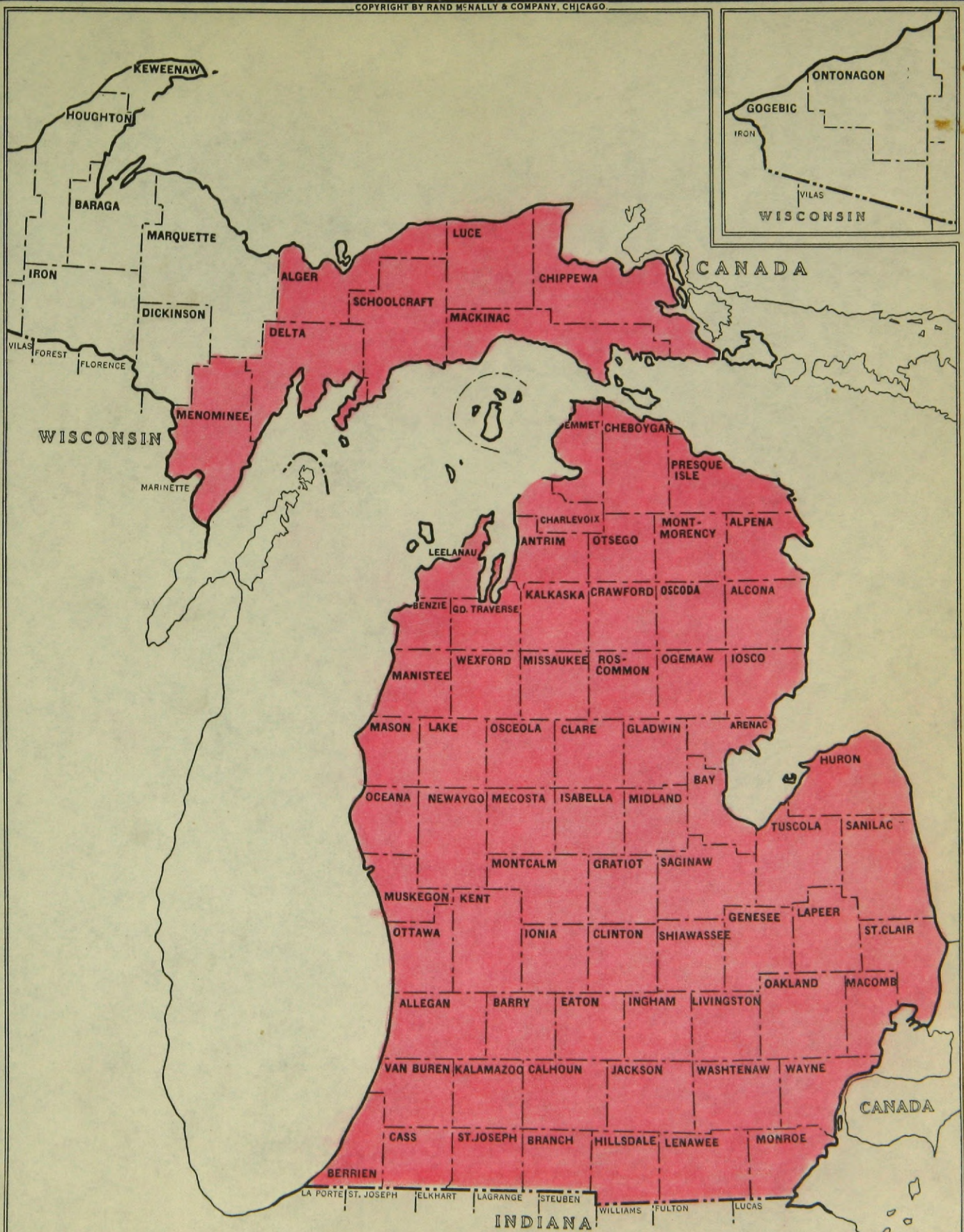
Fig. 37.
Eupatorium urticaefolium
White Snakeroot

Fig. 38.
Tanacetum vulgare
Common Tansy

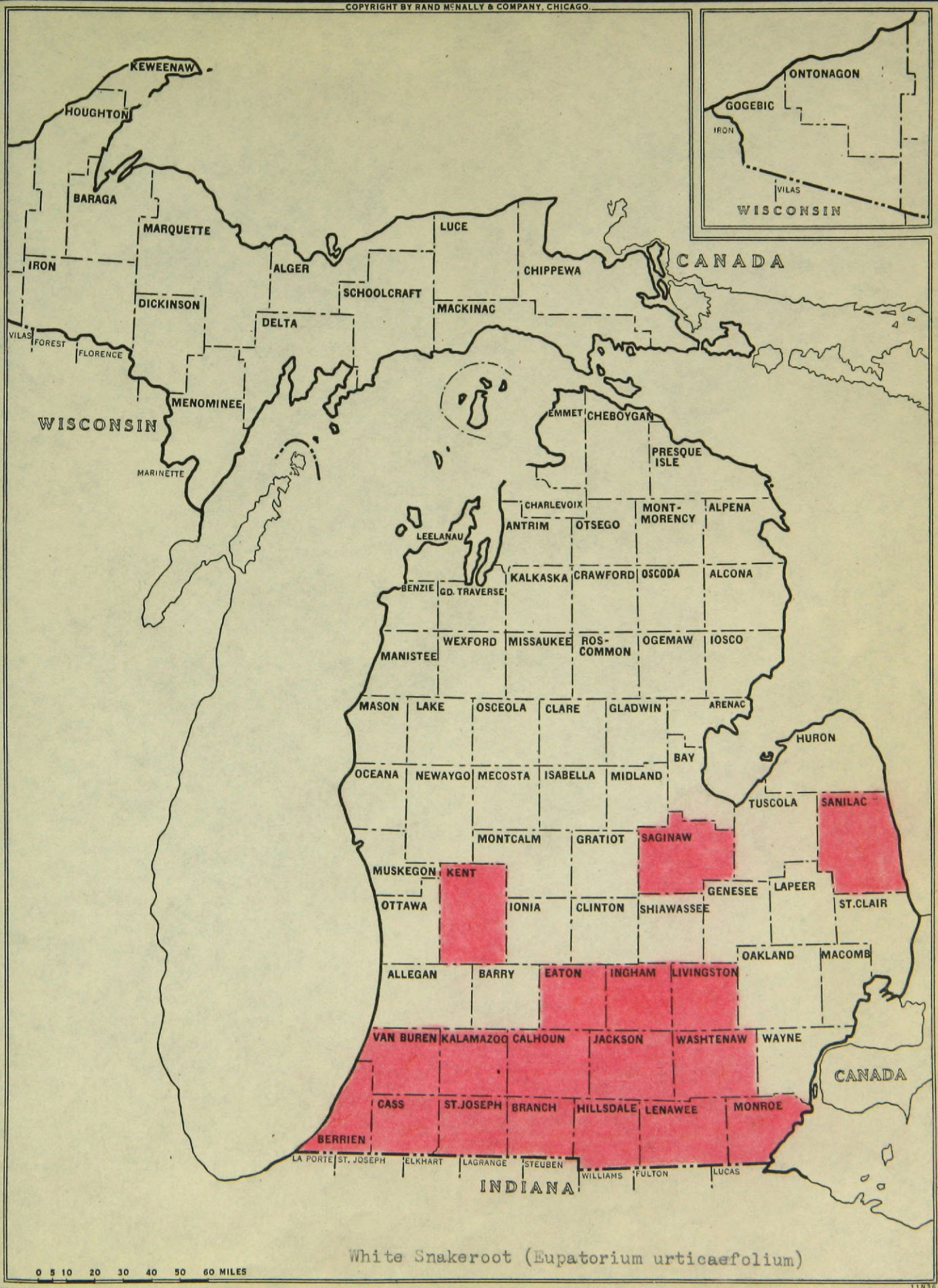
Fig. 39.
Helenium tenuifolium
Sneezeweed

Fig. 40.
Artemisia absinthium
Wormwood

Fig. 41.
Erigeron canadensis
Fleabane



Cocklebur (Xanthium commune)



White Snakeroot (Eupatorium urticaefolium)

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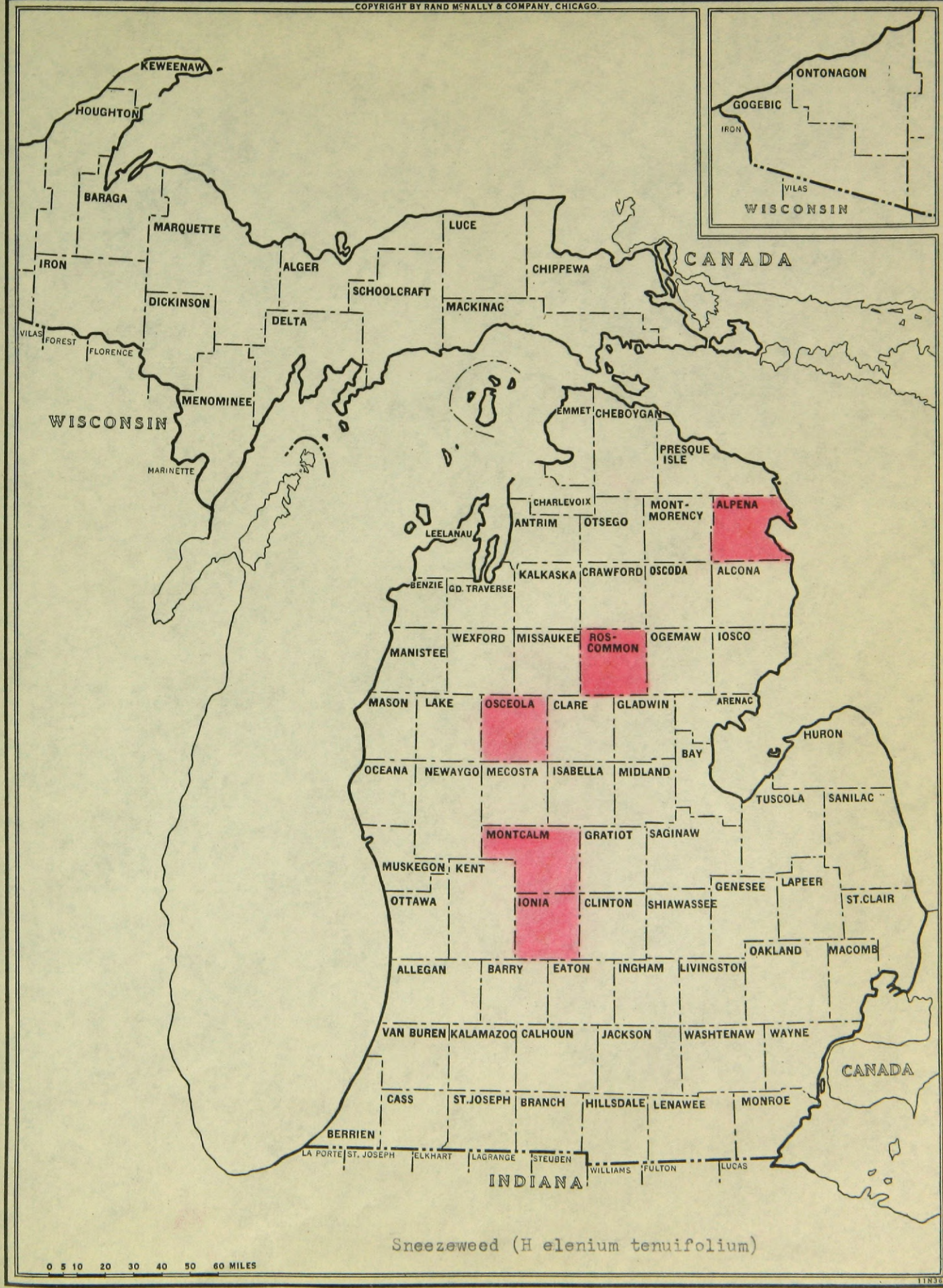

Sneezeweed (H elenium tenuifolium)

COMPOSITAE

Xanthium commune Britton. Cocklebur

The toxicity of the cockleburs has been a matter of some dispute. While this plant has been known for causing mechanical injuries to animals, many cases have been reported where poisoning in hogs has been attributed to it. In a conversation with Dr. Sailor of Groveport, Ohio, cases were brought out where hogs were poisoned and cocklebur was suggested as the cause. One case was reported where ten pigs weighing around fifty pounds were made ill and six of them died. The pigs were in good health the preceding evening when they were fed. The following morning about ten o'clock symptoms were noticed; the animals were vomiting and slobbering from the mouth. Three had died before noon and two more died before six o'clock that night. When the dead pigs were opened their stomachs were found to contain young sprouts of Xanthium. A survey of the premises showed that the plants were growing in abundance where the pigs were running. The remaining pigs were removed immediately from the pasture and no further trouble was had.

In another instance three pigs weighing around one hundred pounds each were poisoned, two of them fatally. Vomiting was noticed and upon examination, the material vomited was found to be young shoots of cocklebur. A survey of the pasture showed that these plants were growing in abundance.

This was the first case of poisoning on this farm, although hogs had been run in this pasture year after year. It is not quite clear why poisoning had not occurred before since the plant was abundant and had been eaten by the animals in the past without any ill effects. Possibly the toxic principle is not normally present under ordinary conditions of growth. Possibly some deficiency in the diet of hogs cause them to seek and eat this plant in greater quantities on some occasions than others.

Chesnut says that cockleburs are poisonous to hogs, stating that it is the young shoots that are especially toxic.

In view of the evidence we must consider the cocklebur as a poisonous plant that can produce death quickly when eaten in sufficient amounts.

Description of Plant

Cocklebur is a rough, coarse annual from one to three feet high; stem marked with brown punctate spots; leaves alternate, cordate or ovate, long petioled; flowers monoecious, staminate and pistillate flowers on different heads. The fruit is a densely prickled bur. (Fig. 36)

Range

Common on moist rich soils over the entire state.

Toxic Principle

All species of Xanthium contain the poisonous glucoside

xanthostrumarin which closely resembles datiscin. This substance is stored in the seed and is imparted to the Cotyledon upon sprouting. (Couch)

Animals Affected

All cases reported have been in young hogs. The plant has a disagreeable taste which accounts for it not being eaten readily by stock. Just why hogs eat large quantities of it at times remains to be explained.

Nature of Injury

In the cases reported, vomiting was always one of the first symptoms; spasms and paralysis usually follow.

Control

The bur contains two seeds, one sprouting the first season and the other sprouting the following season. In wet years both may sprout at once, suggesting that such a time is particularly favorable for eradicating the plant. Since this plant is an annual, it may be controlled through the prevention of seed production. Cutting with a hoe or plowing under before seeding has been suggested as a control measure. Clover is particularly useful as a shade crop for subduing cocklebur. Close grazing by sheep has been suggested as a good control practice.

Hansen (1920) says "if the farm is equipped with spraying machinery it is practicable to eradicate cockleburs

entirely by spraying early in the spring with a solution of iron sulphate used at the rate of two pounds to a gallon of water."

Eupatorium urticaefolium Reichard. White Snakeroot

This plant has long been considered as poisonous in Ohio. It is reported to cause trembles in cows and milk-sickness in people using the milk from cows feeding upon it. There has been some doubt as to whether or not white snake-root is the cause of this disease but the fact still remains that it does contain some toxic substance. Dr. Crawford, Chemist, of the Bureau of Plant Industry, has said that there is no conclusive evidence that this plant can be associated with the disease known as milk-sickness. This work, however, has been replaced by later and more conclusive studies.

The fact that white snakeroot does contain a toxic substance may be demonstrated by the following experiment performed by the author in 1937.

> One plant of Eupatorium urticaefolium was simmered slowly in one pint of milk for about twenty minutes. This brew was allowed to cool and placed before a half-grown female cat. At first the cat refused to take the milk but later took about one-quarter of it. In about twenty minutes the dose seemed to take effect, the cat was taken by convulsive vomiting attempts. However, none of the milk came up. Following this came a period of drowsiness intermittent with spells of violent trembling, growing more frequent as the symptoms progressed. During this time slobbers ran from the mouth freely. After about an hour the trembling spells became more frequent and the cat seemed to lose consciousness which lasted

about one hour. Upon awakening she walked a short distance and lay down and went to sleep, breathing easily. She died without moving from the spot in about a half hour. Death came very easily, no struggle accompanying.

Description of Plant

Erect perennial herb with opposite, cordate, coarsely and sharply toothed leaves; heads in loose corymbose clusters; flowers white. The plant ranges from two to three feet high and all parts are smooth. (Fig. 37)

Range

Reported in a few locations in rich woods in the southern part of the lower peninsula.

Toxic Principle

The toxic substance tremetol ($C_{16} H_{22} O_3$) found also in rayless goldenrod Bigelowia nudata has been described by Couch (1929). This is described as an oily straw yellow substance slightly soluble in water. The glucoside euparin ($C_{12} H_{11} O_3$) has been found in Eupatorium perfoliatum. This substance has been used in medicine as an emetic.

Animals Affected

Past records show this plant especially harmful to cattle. The plant is extremely distasteful and is not relished by animals. Cows, however, eat the plant during the summer when resting in the shady woods. The above experi-

ment would indicate that it is very toxic to other animals.

Control

Inasmuch as this plant grows in shady woods, control may be exercised by preventing grazing in woodlands. Since it has been shown that farmwoods grazing is bad forestry practice, it should pay to fence all woods against livestock. Where a section of woods is retained as shade for cows, the plant may be eradicated by continued mowing with a scythe.

COMPOSITE PLANTS OF MINOR IMPORTANCE

Tanacetum vulgare L. Common Tansy

A bitter acrid strong scented simple or branched perennial herb from two to four feet high; leaves pinnately divided into linear pinnatifid divisions, lobes serrate; heads corymbose, many flowered; flowers yellow. (Fig. 38)

This plant is a native of Europe and has escaped from gardens. It is frequent along roadsides.

Oil of Tansy is obtained from this plant. The bulk of the oil consists of tanaceton or thujon ($C_{10} H_{15} OH$). The oil has been used in medicine as an anthelmintic against Ascarids when used as an enema. Half an ounce of this oil has produced death in two or three hours with symptoms as in rabies and is said also to cause abortion.

Symptoms in animals given by Millspaugh are: salivation, vomiting, dilation of pupils, muscular twitchings, followed by colonic spasms, followed by convulsions and death.

Poisoning has occurred in women from using tansy tea at the menstrual period for difficult menstruation.

Helenium tenuifolium Nutt. Sneezeweed

A perennial, erect branching herb from one to three feet high; leaves alternate decurrent on the stem, linear filiform; flowers borne on corymbed clusters; heads many flowered; flowers yellow. (Fig. 39)

The poisonous nature of this plant is not fully understood. The western sneezeweed Helenium hoopseii has been reported to be very toxic to sheep in the west. The pollen from these plants cause violent sneezing. Pammel says that it is often the cause of bitter milk in the south. Chesnut says: "Helenium tenuifolium is a weed of the Gulf States, fatal to horses and mules. It contains a narcotic poison." Couch (1937) indicates that some phenolic compound is probably the toxic principle although this is not definitely proven. The phenol compounds are also found in poison ivy, poison sumac, rhubarb and other plants of the Polygoniaceae family. The same authority says that western sneezeweed Helenium hoopseii contains a glucoside which causes a chronic spewing disease in sheep and cattle.

Artemisia absinthium L. Common Wormwood

A shrubby hairy plant from two to three feet high; leaves two to three pinnately parted, the lobes lanceolate, obtuse; flowers yellow. (Fig. 40)

This weed is found occasionally on waste land in Michigan.

According to Pammel this plant contains the principle absinthin (C_{15} H_{20} O_4), the action of which is similar to that of tansy. The western sagebrush, a species of Artemisia, is said to be "suspected as poisonous to stock." (Chesnut and Wilcox)

The well known absinthe is made from this plant and is used in alcoholic drinks. It is sometimes added to beer to make it more exhilerating.

Erigeron canadensis L. Horseweed. Fleabane

A bristly herb, stem hairy, one to six feet high, simple or branched; leaves usually pubescent, the lower spatulate, the upper linear; heads numerous with inconspicuous white flowers. (Fig. 41)

This plant is common in waste places throughout the state.

The poisonous substance, said to be a terpine (C_{10} H_{10}), causes smarting of the eyes, soreness of the throat, aching of the extremities, and colic. Since this plant is a common constituent of hay, it has caused poisoning in some cases.

PLANTS CAUSING SELENIUM POISONING

No discussion of poisonous plants would be complete without some mention of selenium poisoning. It appears that some plants, not otherwise toxic, may become so when grown on seleniferous soils. Other plants like the woody aster (Aster parryi) may have their toxic properties increased.

Selenium poisoning or the "alkali disease," as it has been erroneously termed, is a disease causing great losses in the Great Plains and Rocky Mountain regions. The first written report of this disease was by an army surgeon at Fort Randall, Nebraska in 1856. The symptoms he gave closely conform to those recognized today although at this time the cause of the disease was not known. However, it was suspected that toxic plants were the cause.

The early settlers termed the malady "alkali disease" because of the occurrence of alkali waters in the regions affected. Ergot was suspected at one time but following investigations started by the U. S. D. A. in 1929, this was disproven. In 1931, H. G. Knight, Chief of the Bureau of Chemistry and Soils, suggested that selenium could possibly be the cause of the disease, and this statement was later proven to be true. Since that time, investigations by Drs. Frank, Rice, Piemesil, Smith, Beath, and Moxon have contributed to the general knowledge on this subject. The latest work (Moxon 1937) has reviewed the past work and the following material has been taken from this bulletin.

It has been found that different kinds of plants show wide differences in their abilities to draw selenium from the soil. Some plants have the power to draw large quantities of the poisonous element while others only take up minute quantities. These plants that take up selenium and listed by Beath (1937) are the following:

1. Astragalus bisulcatus
2. Astragalus pictinatus
3. Astragalus racemosus
4. Aster communatus
5. Stanleza bipinnati
6. Onopsis condensata
7. Atriplex Nuttallii
8. Atriplex canecens
9. Mentzelia decapatela
10. Xylorhiza Parryi

The amount of selenium taken up by plants depends upon several factors such as:

1. The total amount of selenium in soil.
2. The distribution in soil horizons.
3. The chemical form of the selenium in the soil.
4. The chemical composition of the soil aside from selenium.
5. The kind of plants.
6. The plant population (other kinds of plants present).
7. Stage of growth of plants when examined.
8. The part of the plant analyzed (seeds, leaves, roots, stems, etc.).

The chemical form of the selenium present in the soil is probably the most important factor of the above mentioned. Moxon states that "at the present time there are indications that selenium exists in the soil in two general types of compounds, organic and inorganic. The organic form includes most of the selenium which is readily available to crop plants. The inorganic group includes iron selenide, basic ferric selenite and elemental selenium as relatively insoluble forms and calcium selenate as a more soluble form.

Selenium in an organic form or as calcium selenate is more readily available to plants because of the greater solubility than selenium in the elemental form or in the form of one of the iron compounds. Iron selenide and basic selenite are both practically insoluble in neutral or alkaline solutions such as would be present in the soils of the Great Plains area and the selenium of these compounds is practically non-available to most crop plants of importance but it apparently is available in these forms to certain "converter" plants which contaminate the soil around them with selenium in an organic form readily available to crop plants. These "indicator" or "convertor" plants have been listed above.

Moxon says that there are two forms of the disease, acute and chronic. The acute type is known as "blind staggers" and is caused by those plants containing high percentages of selenium or "indicators." This form of the disease is prevalent throughout Wyoming. The chronic type predominates in South Dakota and is known as the "alkali disease." This form is caused from eating grains, forage, and hay that have taken up selenium in small quantities after it has been deposited in the organic form by "indicators."

General Symptoms of the Disease:

Horses, cattle, pigs, poultry and humans are affected by selenium. The general symptoms of the chronic form are:

1. Dullness and lack of vitality.
2. Emaciation and rough coat.
3. Atrophy of the heart (dish-rag heart).

4. Atrophy and cirrhosis of the liver.
5. Anemia.
6. Erosion of the long bones, especially the joints, which cause stiffness.
7. Loss of the long hair from the mane and tail of horses and from the switch of cattle. Loss of hair from the body of hogs.
8. Soreness and sloughing of the hoofs.

In poultry the disease shows up in chicks hatched from eggs laid from selenized hens. "Many of the eggs fail to hatch because of the high incidence of monstrosities. The most common deformities are: missing or short upper beaks, missing eyes, edema of the head and neck, and wiry down. The chicks which do hatch are usually weak and have a wiry down."

It has been demonstrated that these deformities can be produced by feeding inorganic selenium or toxic grains as well as injecting small amounts of selenium salts into the air cell of the egg.

The toxicity of many different grains has been determined by feeding experiments with albino rats. The symptoms in rats are atrophy and cirrhosis of the liver, hemorrhages in the mucosa of the stomach and small intestines, brashness of the leg bones and intra-muscular hemorrhages around the joints of the leg bones, edema, ascitic fluid in the abdominal cavity, anemia, roughness of the coat, and a general loss of vitality.

Control Measures:

At the present there is no approved method of treatment

for selenium poisoning other than moving diseased animals from affected areas and feeding them on selenium free grains. Grazing animals should have as much free range as possible so they can avoid toxic areas.

Experiments have been conducted with sulphur to prevent the absorption of selenium by plants. Some success has been had in laboratory experiments but these conditions have not been applicable to toxic areas.

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