ADVENTIVE WEEDS

WITH PARTICULAR REFERENCE TO THEIR SIGNIFICANCE IN CANADA

by

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M.A., University of Glasgow, 1961

Dip. Ed., University of Glasgow, 1963

AN EXTENDED ESSAY SUBMITTED IN PARTIAL FULFILLMENT

OF THE REQUIREMENTS FOR THE DEGREE

OF

MASTER OF ARTS

in the Department of

Geography

SIMON FRASER UNIVERSITY

November 1973

APPROVAL

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Degree: Master of Arts

Title of Extended Essay: Adventive weeds with particular reference to their significance in Canada

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Abstract

The general ecological characteristics of weeds at the individual and population levels were evaluated and assessed from the available literature. Adventive weed species were found to be difficult to define as a class, but were worth studying for their economic significance. The most adequate definitions of such weeds mention their characteristic aggressiveness and their tendency to occupy disturbed sites. Weeds tend to have inbreeding reproductive systems, but some species form inter-generic crosses, resulting in genetically complex populations.

Adventive weeds were found to be different from non-weeds in a number of respects, being more tolerant of a range of environmental conditions and having more effective long distance dispersal mechanisms. Weeds tend to have general purpose genotypes and plasticity in their phenotypic expression.

Before man's alteration of much of the earth's surface, weeds were probably confined to naturally disturbed sites. Since the development of agriculture, man has created the most important conditions influencing weed reproduction and survival. The use of herbicides is a most important current aspect of man-weed interactions.

The characteristics and distribution patterns of adventive weeds in Canada were analysed from the available government sponsored weed survey reports. The Canadian weed population was found to include a high proportion of species of Eurasian origin. The proportion of perennial species was found to be similar to the proportion of annuals and biennials taken together. There were far fewer annuals than biennials. Many individual weed species had a distribution which covered all of southern Canada. British Columbia, and the southern parts of Ontario, Quebec and the Maritime provinces have a richer weed flora, and a higher proportion of alien species than that found in the rest of Canada. Physical and historical reasons for this distribution are discussed.

Acknowledgements

I would like to take this opportunity to thank the members of my advisory committee in the Geography Department at Simon Fraser University, Prof. M.C. Kellman, Prof. F.F. Cunningham, and Prof. R.B. Sagar. Prof. Kellman in particular has given me academic advice over a long period of time. I would also like to thank Prof. R.C. Brooke of the Biology Department at Simon Fraser University for his meticulous criticism of this essay.

Many thanks are also due to a dear friend, Brother Allan, for some very necessary encouragement, without which this essay could not have been completed.

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Introduction

In this essay the general characteristics of weeds are discussed. Although no one species shows all the potential weedy characteristics which can aid propagation and survival, most share a common group of ecological and reproductive properties which fit them for this role. These are described in some later sections of this essay. There is also some discussion of the evolution of weedy species, and of their interactions with man. Finally, an analysis of the available data on the regional distribution of adventive weeds in Canada is attempted, with emphasis upon richness of flora, weed life spans, and the probable origins of the more important Canadian weed species.

Although the word "weed" is in common use, difficulties in delimiting the class "weed" soon become apparent whenever weeds are to be studied with any precision. Moreover, individual weed species can present a difficult problem for taxonomists, because of extensive inter-specific crossing. Indeed, the whole field of detailed weed biology tended to be neglected until about twenty years ago.

Yet weeds can be a worthwhile topic for a geographical study. They can be of very evident economic significance. In the tropics they are perhaps one of the main causes of field abandonment, and a cause of loss of production, though perhaps at the same time a protection against soil depletion. In Canada, weeds impose a heavy cost in terms of herbicides, and the need to clean grain and other seed carefully.

The study of weeds also leads into prehistory, to the origins of agriculture, and before, in an attempt to trace the origins of weedy species. Both historically and currently weeds are of interest as being involved in man-environment interactions, as man influences the habitats available to weeds, inadvertently helps to disperse them, and sometimes takes deliberate action against them.

Weeds can even colour a whole landscape, varying with the seasons, as have wild oats (Avena fatua) in much of California, or at least be a conspicuous item in fields or along roadsides, as is true of orange hawkweed (Hieracium aurantiacum) in parts of Quebec. In the Lower

Mainland of British Columbia, some adventive weed species which are noticeable along roadsides or on waste ground are Scotch broom (Cytisus scoparius), foxgloves (Digitalis purpurea), and tansy (Tanacetum vulgare).

The main point of agreement in the literature about weeds is that defining the concept is difficult, if not impossible. The problem arises because weeds may be of any species of plant, of any taxonomic affinity, growing where they are not wanted by man. Anderson (1939,p.7) quotes a taxonomist as defining a weed as

> "A species which is very common, very aggressive, very variable and which clutters up herbaria."

Definitions of "weed" are not related to any botanical or taxonomic information, but to human attitudes and perceptions about various plant species, and these attitudes vary both in space and time. Baker (1965b, p,147) suggests,

> "..., a plant is a "weed" if, in any specified geographical area, its populations grow entirely or predominantly in situations markedly disturbed by man, without, of course, being deliberately cultivated plants."

According to Harper (1960a,p.119), weeds are "higher plants which are a nuisance". King (1966,p.1) considers that,

> "..., we may say that weeds comprise the more aggressive, troublesome and undesirable elements of the worlds vegetation."

The word "weed" is applied to a class defined by a number of concepts which overlap, but do not coincide. Weeds are unwanted plants, from an anthropocentric point of view, be they wild mustard in wheat, dandelions in a lawn, or the colourful, but frequently eradicated, weeds of wasteland or roadsides. Current landuse thus is the main criterion against which the desirability of any species is considered. The weeds in any region will include some very common plants, and some which are rare or casual.

The term "weed" need not even be permanently associated with a given species. Decorative or herbal garden plants may escape and come to be regarded as weeds. Neolothic man seems to have eaten seeds of plants now generally regarded as useless. Moreover, Cannabis sativa, which was at one time a useful fibre crop, is now eradicated wherever possible.

Functionally, the largest group of such weed species is composed of plants of disturbed habitats, particularly of sites disturbed by man.

Within this group, Baker (1965b) distinguishes between "agrestals" which enter agricultural land, and "ruderals" which occur in waste places and along roadsides. In this study, it is these "adventive" species which are the main centre of interest. "Adventive" is applied to those species which have the ability to take quick advantage of a new open site, without the intentional aid of man.

Although weed destruction by chemical means is the basis of a major industry, and much has been printed on weed elimination, the literature on basic weed biology and ecology is quite limited. As Harper (1960a) says, most of the detailed studies on weed biology date from after 1945. Snippets of information on weed characteristics may be scattered through the many proceedings of regional weed conferences, but these are difficult of access.

Weed biology is discussed comprehensively by several authors, e.g. King (1966) and Muenscher (1955). A symposium on the biology of weeds took place in 1960 (Harper,1960a), and weeds in Britain are treated in an elementary but informative way by Salisbury (1964). Weed ecology is further analysed in several journal articles, e.g. Bunting (1960), Chancellor (1968), and Lindsay (1953). Aspects of population dynamics are dealt with by Harper (1960b), Sagar (1968), and Thurston (1960).

Taxonomy and weed genetics are covered in the major works of Stebbins (1950&1966) and Baker and Stebbins (1965). Further details on the evolution of weed species are discussed by H.G. Baker (1964) and Pritchard (1960). Mulligan (1957&1959) analyses the pattern of chromosome numbers in Canadian weeds. The history of weeds has been treated by several authors, e.g. Godwin (1960), and Helbaek (1959). Hammerton (1968) discusses the relationship between changes in agricultural methods and in weed populations.

Little experimental research on weed biology exists, but Cumming (1959) compares light sensitivity in four species of *Chenopodium*, especially in relation to their ability to germinate under different conditions. Mann and Barns (1945-1947) experimented with competition between barley and *Holcus lanatus*. Fawcett (1908) investigated seed viability under different conditions. Allelopathy in weeds is discussed by Grummer and Beyer (1960), with particular reference to *Cammelina* spp., while Welbank (1960) worked on possible allelopaths produced by *Agropyron repens*.

Many different classifications of weed species are possible. The value of each depends on the requirements of the study in which it is being used. The potential range, choice of habitat of the species, and the degree to which it is noxious can be influenced especially by its life-form, life span and its place of origin, in which it evolved. These latter two are emphasised in the section on the adventive weeds of Canada.

Life span is closely related to a weedy species survival strategy, and influences attempts to control the weed. Annual weeds especially tend to produce large numbers of seeds, which may remain viable even for many years. Perennial weeds frequently have extremely persistent rhizomatous roots. Even details of the seeding times of individual species can help to determine which weeds may colonize a newly available site, through influencing which seeds will be available at the time the site becomes open (Bard,1952).

Several authors suggest other classifications. Muzik (1970) suggests a division into facultative and obligate weeds. Facultative weeds, such as wild onion, *Allium Vineale*, being found both wild and in association with man; obligate weeds, e.g. *Convolvulus arvensis* and *Lolium temulentum* being found only on sites influenced by man. Another class suggested by Muzik is that of weedy forms of crop plants, such as some of the radish species found in the Prairie Provinces.

Anderson (1939) subdivides weeds into three classes: former cultivated plants; weeds of fields, gardens, pastures or lawns, i.e. agrestals; and ruderals, plants of man-created sites such as barn yards, road ways and dumps. Most authors do mention some information about the type of habitats in which some weed species tend to grow, but this data is not sufficiently rigorously defined, nor sufficiently comprehensive, to be usable as a basis for study.

Genotypic and phenotypic variation in weeds

Weeds present taxonomists with many difficult classificatory problems, partly because of the phenotypic plasticity common in many weedy species, but more importantly because of their often genetically complex ancestry. The ease with which many weeds have migrated has facilitated crossing and back-crossing between related species. Weed species vary widely in form in different habitats and can show great variation in phenotype even within one site. Some weeds are found in many sub-species, often showing ecotypic differences, e.g. dandelion (Taraxacum officinale) and shepherd's purse (Capsella bursa-pastoris), (Salisbury, 1964). Salisbury (1964) says of the ox-eye daisy (Chrysanthemum leucanthemum),

"That there are a number of genetically different races is shown by the fact that some have been bred to larger or smaller numbers of ray florets, others to the degree of indentation of leaf margins."

Chromosome studies may help to clarify these problems. For example, it is now known that fireweed (Epilobium angustifolium) in Europe has 36 chromosomes, while in North America it has 72, which suggests that this at least is not a case of recent colonization from one area to another (Salisbury, 1964).

Distribution maps of weed species may conceal important intra-specific differences, which the maps are not designed to show. A weed species may be aggressive in some parts of its range, and not in others. In spite of the rapid migration commonly shown by weed species, weed ecotypes may differ considerably in their physiological behaviour, and in their competitive abilities under different conditions. Some ecotypes have been brought to light by the use of herbicides. One ecotype of Convolvulus arvensis is much more difficult to control than the others.

According to Salisbury (1964), certain families are especially prolific in providing invaders, e.g. the Cruciferae, the Caryophyllaceae, and the Compositae. To the list Harper (1960a) adds the Gramineae. On the other hand, there is no genus with more than a few weedy species.

As mentioned above, weeds tend to be very complex genetically. In genetic potentials there are often differences between annuals and perennials. Annuals especially tend to have high genetic variability. Many of the weedy perennials are apomicts, reproducing as a true strain. Most wild plants tend to be out breeders, but many weed species are self-fertile inbreeders, (Lawrence, 1968). Self-fertility is a great aid towards migration, since one isolated plant can colonize an area by seed, (Mosquin, 1966). Such a system can be seen as a dead end, since there is no immediately available pool of genetic variability from which further adaptations to the environment can be made. However, in weeds, phenotypic plasticity can replace the capacity to develop closely adapted genotypes, (Baker, 1964). Some annuals combine the advantages of both systems, being facultative inbreeders (Frenkel, 1970). In this case a single plant can colonize an area, and even occasional outbreeding can provide some degree of variability, on which natural selection pressures can operate. Mutations are also always possible.

Hybridization can also be a continuous process of crossing and back-crossing between plant species. This genetic infiltration between genotypes as a result of continued hybridization is termed introgression, and has been studied particularly in some crop plant histories, (Heywood, 1967). Intrageneric crosses are commonly involved in this process, as in the Lactucas and in the Helianthus genus, or in the crossing between Raphanus sativus and Raphanus raphanistrum, (Stebbins, 1950). Intergeneric crosses are also possible, as seems to have occurred between Zea and Tripsacum species, (Baker, 1965a). Heiser (1965) suggests that in North American sunflower weeds, genes acquired from other species may help adaptation to new areas.

Single acts of hybridization may also occur, to form vegetatively reproducing species, as in the cross Oxalis pes-caprae x Oxalis corymbosa, (Baker, 1964). Hybridization can also produce complex seed producing hererozygotes, e.g. the Oenotheras, (Stebbins, 1950). Occasionally, a newly arising species may be noted, e.g. the hexaploid Senecio cambrensis, arisen from a cross between a tetraploid and a diploid, (Warburg, 1960). However, most new hybrid variations tend to be sterile or are less viable than the original species, at least on undisturbed sites, from which they are eliminated by natural selection, (Anderson, 1956). However, the few individuals which survive may be a source of new environmental tolerances in a species.

New weed species can also arise through polyploidy, that is, the doubling of the chromosomes, which may produce more vigorous plants, (Heywood, 1967). According to Haskell, quoted by King (1966) polyploidy was not important for weed spread, at least in Britain. In Canada polyploidy is of equal frequency of occurrence in the natural flora and among weeds (King, 1966), and does not seem to be a significant factor in determining which species will be successful as adventive weeds. Polyploids tend to reproduce through apomixis and so to be a dead end genetically (Salisbury, 1964). The frequency of polyploidy may vary among weeds of different types of habitat. For instance, it is high among weeds of row crops, which are thus fitted for continual disturbance, by being commonly very variable and self compatible (Mulligan, 1965).

For each path of possible further evolution in adventive weed species, the strongest pressures now come from measures taken by man against weeds. In a later section, these and other interactions between man and weeds will be discussed in detail.

Adventive Weed Ecology

All adventive weeds tend to have a number of ecological and reproductive characteristics in common, and to be different in those respects from most non-weed species. Baker (1965) investigated some characteristics of several closely related weed and non-weed species from tropical America. Table I below summarizes some of these important differences, which will be present in each species in a unique pattern.

TABLE I A Comparison between Weed and Non-Weed Characteristics

WEEDS	NON-WEEDS
General purpose genotype	Specialized genotype
Plasticity in phenotype	More uniform phenotype
Wide ecological tolerance	Narrower range of ecological tolerance
Quick initial growth	Slower growth
Light tolerant	Light intolerant
Effective long distance seed dispersal	Mainly shorter distance seed dispersal
Large numbers of seeds	Smaller numbers of seeds

These characteristics tend to fit adventive weeds for the disturbed sites on which they usually occur. Most of these weed species are capable of growing and reproducing in a wide range of climatic and edaphic environments. Baker and Stebbins (1965) suggest that, in contrast to many species composing undisturbed communities, weeds can be regarded as having 'general purpose genotypes'. Such species can show great phenotypic plasticity and an ability to survive under varied conditions. Cumming (1959) finds that there may be direct links between weedy aggressiveness and an absence of sensitivity in germination and photoperiodic responses.

However, although many weed species have wide ecological tolerances, others may have individual needs which result in differences in abundance from area to area. As Muzik (1970) writes,

> "The only characteristic common to all weeds is their excellent adaptation to the disturbed environment in which they are living..."

Nevertheless, whatever degree of difference there is in the climatic and edaphic tolerances of most weedy species within one region, it is usually unimportant in comparison with the advantage taken by all weeds of the reduced competition available on disturbed sites. These sites are similar to early seral stages in vegetation succession on dry or moderately moist sites. The habitat conditions at such sites include high intensities of light, extreme surface temperatures, low humidity in the ground level air, exposure to wind, and low humus and nitrogen levels in the soil.

Adventive weed species can generally exploit most effectively the intensive light characteristic of their habitats. Most species are light tolerant and are able to grow quickly and to develop a large area of leaf. Many weeds have a large cotyledon which aids initial growth. This tends to be rapid once the initial rosette, if any, begins. The individual weed plant quickly establishes control of some area, often by having a rosette of leaves at ground level, and neighbouring plants are likely to lose in the competition for nutrients, moisture and light. Competition is reduced on exposed sites because many species in native floras can not germinate or grow well when exposed to high intensities of light. Some of the environmental conditions on a site may not be optimal for some adventive weed species, for while some species may be obligate heliophytes, others may be only facultative heliophytes, of varying tolerance for high light intensities. However, the reduction in competition from non-weed species seems to be of overwhelming importance for both classes of weed. Competition between weed species will dominate different types of site.

Most adventive weed species quickly develop a rapidly spreading and deeply penetrating root system which can reach any available nutrient or moisture (Muzik, 1970). Generally, more soil nutrients are available during the later stages of a plant succession, but in arable fields, or around farm yards, nitrogen levels tend to be high, and although nutritional tolerances in adventive weeds tend to be wide, most weed species thrive particularly well in these nitrogen rich soils. After fire, the earliest stages of succession may be richer in available nitrates and potassium than subsequent stages from which these have largely been leached or absorbed by the vegetation. Some plants, e.g. Senecio sylvaticus, can take advantage of these temporary soil conditions (West&Chilcote, 1968).

The soil surface at sites occupied by adventive weeds may be loose and unstable, as in a ploughed field or on newly dumped waste material, or hard and compacted, as on the edge of roads or on surfaces exposed to torrential rain, (Buntin, 1960; Frenkel, 1970). Each site type tends to have a characteristic population of weed species. Roadsides vary quite obviously, in micro-climates as well as soil characteristics, and in a regular pattern. Frenkel (1970), in his studies of some Californian roadsides, has distinguished four environmental zones usually found parallel to a road. Each zone tends to have its accompanying group of species, many of them adventive weeds, quite distinct from those of neighbouring zones a few inches or feet away. The most important factors influencing this habitat were road construction materials and methods, drainage, and the degree of treading by vehicles.

Critical temperature and humidity conditions for weed species are often not known. However, although the environmental tolerances of many adventive weeds seem to be wide, most species are abundant in only part of their range, (Lindsay, 1953). Sensitivity to macro-climatic factors in the environment may also be indicated by variations in the numbers of a species in relation to weather cycles (King, 1966). In Saskatchewan, toadflax (Linaria vulgaris) decreases in significance during wet cycles (Coupland et al., 1963).

Many studies of vegetation succession on old field sites or on disturbed pasture land include information on adventive weeds in the early years of the succession and on their decline in subsequent years, (Bard, 1952; Keever, 1950; Shantz and Oosting, 1970). Although so successful on disturbed sites, most adventive weed species are no longer present after the natural vegetation for a site has been allowed to proceed without further disturbance for a few years. Few weeds ever enter into sites which already have a cover of established natural vegetation. Before the occurrence of major human alteration of the land surface adventive species must have been confined to areas of natural disturbance, except for some shrub species and a few other garden escapes .

On recently disturbed sites, considerable competition between weed species usually occurs, in which case the first plants to germinate generally retain their advantage for at least a season (Keever, 1960). Within fields, environmental conditions depend partly on the type of crop present, and each crop tends to have a characteristic group of accompanying weeds, e.g. in wheat, wild oats (Avena fatua), and in barley and oats, wild radished (Raphanus spp.) are common. Even when selective herbicides have been developed, it is often too expensive to eliminate weeds completely, and so an acceptable level of control has to be determined. The outcome of weed-crop competition can depend on the precise variety of crop grown. For instance, barley cultivars vary in their competitive ability (Mann & Barns, 1945&1947).

The widespread presence of populations of weed seeds, of which at least some may be ready to germinate at any time, and the ability of many weed species to grow quickly are both important factors in the competition between adventive species and species from the native flora. Variations in these factors is probably also significant in the competition between weed species at any site. Another competitive mechanism is allelopathy, which has been studied by Klingman (1961), who concentrated on Agropyron repens. Inhibition of other plant species by the products of the decaying roots of this species can be demonstrated in a laboratory setting, but this has been difficult to demonstrate in the field (Welbank, 1960).

Many disturbed sites display considerable environmental heterogeneity, despite a superficial appearance of uniformity. For example, the margins of a field often have an exposure to wind and light which is different from that at the centre, and ridges and furrows offer different micro-sites, which may result in somewhat different species being present on each type of location (Harper, 1960a). Yet, while each site will tend to present different environmental conditions, human influence often has an homogenizing effect in general, as can be noted when an extensive geographical area is studied. At least within regions of temperate climate and western technology, disturbed habitats seem to present sufficiently uniform conditions from one region to another for many weed species to be found across wide areas either in all such places, or in one, such as roadsides, in spite of considerable climatic and edaphic differences.

Reproductive strategies

Weed species tend to have a high reproductive capacity (Salisbury, 1964), far above that usually needed for survival on the current site (Harper, 1960b). Weedy species are able to utilize sporadically available sites through reproductive strategies such as the production of large numbers of seeds, which are often small and easily dispersed, and which may be viable for long periods of time. Plants of many weed species produce seeds continuously as long as growing conditions permit. Many perennial weeds can persist and spread through the growth of rhizomatous roots.

Annual weeds, especially, tend to set many seeds. Muenscher (1955) reports a case of a hedge mustard (Sisymbrium loeselii) with 511,208 seeds, and willow herb (Epilobium angustifolium) commonly has 80,000 seeds per plant (Salisbury, 1964). In addition, many species have a flexible reproductive strategy in regard to seed number, and on poor sites, can set a few seeds quickly on stunted plants. Some annual weeds can complete several generations, with mature seeds, in one year, e.g. Galinsoga spp. (Fog, 1945); Senecio vulgaris and Poa annua (King, 1966) can set seed even during cold weather. Some species can ripen seed even after the plant has been cut (Crafts and Robbins, 1962).

Seed dispersal characteristics are important for adventive weed species, since these depend on being able to reach continually new, scattered, temporarily disturbed sites. As mentioned already, adventive weeds tend to have better long distance dispersal abilities than non-weeds. This can be achieved through small seed size, or through special dispersal mechanisms such as hooks or burs. Adventive weed seeds vary greatly in size, but those which are small tend to be easily dispersed by the wind. A small seed size is in accord with Salisbury's findings on seed size among the species of the British flora, (Salisbury, 1964 p.97). He found that the size of seeds of species growing in shaded habitats tends to be larger than those of species which tend to be found on sites exposed to high intensities of light. Plumose seeds are also wind dispersed, but careful study in the field is needed for appearances can be deceptive. Bakker (1960) finds that most of the seeds of Canada thistle (Cirsium arvense) growing in the polder region in the Netherlands, become detached from the plume before much distance has been covered, and a false impression would be obtained from observation of clouds of thistledown in the air. Some seeds or viable parts of plants may be dispersed by water, by birds or animals, or very frequently, by man. Roads and railways can provide a line of available disturbed sites along which weeds can migrate, and also a rapid means of transport for weed seeds, which adhere to car tires or railway wagons. The considerable dispersal abilities of many weed species was demonstrated by the speed with which adventives moved into newly disturbed sites as European settlers spread across Canada. Many of the seeds produced by weed plants do not reach sites favourable for their growth, but the combination of large seed numbers with good dispersal techniques ensures a high probability that at least some seed from any colony of plants will reach new areas of disturbed soil.

Weed seed germination rates tend to be high (Bunting, 1960) and many species can germinate in most months of the growing season in North America (Chancellor, 1968). The weed species studied by Baker (1965b) appear to have no special requirements for germination. Those seeds which ripened in hot dry conditions germinate most quickly (King, 1966). A spread of germination times gives a higher probability of success for a species on any given site and can make the control of weeds on agricultural sites more difficult. Where large numbers of weed seeds germinate together, they may break through a hard crust on exposed soil more easily. On the other hand, seedlings in such a mass may compete with each other so heavily that each individual survivor is restricted to a small size.

Long viability can enable a weed seed to persist in soil until, perhaps, the site is disturbed, and becomes suitable for weed growth. In tests, some buried seeds of the weed species Rumex crispus, Oenothera biennis and Verbascum blattaria have remained viable for even as long as eighty years (King, 1966). Many areas of natural vegetation cover seem to have a permanent population of buried viable seed, which may include seeds of species not present in the current cover, but which could contribute to the population of adventive weeds if the site were disturbed (Major and Pyott, 1966). Weeds, which seem to have come from residual viable seed, have appeared after land which has been in permanent pasture for fifty years has been ploughed (Thurston, 1960).

Weeds of field crops face strong selection pressures during harvesting and threshing. To survive, such weed species must either mimic a seed crop in some way, or must have already have matured and seeded before being cut at harvest time, or must be able to scatter its seeds while the crop plant is being cut. The weeds which mimic the crop plant must have seeds of similar size and shape as the crop, and must be non-shattering, as are the cultivated crop plants themselves. Mimic weeds, such as Cammelina sativa, the false flax, and Avena fatua, wild oats, have the advantage of being harvested along with the crop. If they are not removed by seed sorting equipment they will be planted the following year in newly ploughed ground, along with a crop to which they are adapted. The non-mimics may seed themselves into a field which may be in grass the following year. The reduction of viable weed seed during pasture years may be one factor which encouraged the practice of crop rotation.

Improvements in threshing and seed sorting techniques have reduced the frequency with which some formerly common weed species such as Agrostemma githago, Centaurea cyanus and Artemisia vulgaris are found (Bunting, 1960; Godwin, 1960). Agrostemma githago was removed from common occurrence particularly easily because the weight of its large seed is quite different from that of the similarly sized seeds of the grain crops among which it grows, and because it has a poor seed viability of only one to two years. Far fewer weeds are planted along with crops when commercially cleaned seed is used than when farmers save their own seed for use, but total weed seed removal is not economical, and so a few weed seeds are still planted along with crops.

Perennial weeds with rhizomatous roots can be particularly difficult to eradicate from agricultural lands, because the roots, which provide food storage, can in many species form the basis for many new plants. Convolvulus arvensis and Cirsium arvense are especially troublesome in this respect. Such weed species can survive repeated disturbance of the site, can spread effectively without even setting seed, and in some cases can even resist the encroachments of the native flora for some time, should the site be left to revert to a continuous ground cover.

The history of adventive weeds

Many of the weeds which grow in temperate parts of the world at the present time can be traced to a regional origin in Eurasia, and to a probable beginning from weed ancestors or proto-weeds on such naturally disturbed sites as river bars, shore lines, screes, landslides, cooled lava flows, or occasional windfall or wild fire sites in forests. Proto-weeds were probably largely restricted to such habitats (Sauer, 1952), which provide open conditions with reduced competition. River and shoreline sites would also provide some opportunities for the natural migration of species. Genetic crossing, important at some stages of evolution, becomes possible if related species are brought close together.

Unusual possibilities for the crossing of species may have occurred during the Pleistocene epoch, when species migrated as climatic conditions changed. In Europe especially, there was a proportionally greater disruption of the vegetation pattern by glaciation, since mountains to the south blocked the retreat of species from the north. At the same time, new species formation would be likely among plant populations isolated for long periods of time by the ice from the main range of the species (Harlan & deWet, 1965). This too may have occurred more frequently in the irregular terrain of western Europe than in the plains of central North America.

The areas of glacial moraine and loess in Europe and North America must have offered the most extensive area of open surface available for adventives before the widespread clearing for agriculture of late Mediaeval times. Fogg (1945, p. 9) suggests that there may have been more available surfaces formed by glacial deposition in Europe than in North America, and considers that this may be part of the explanation for the larger numbers of weeds of European origin. He also considers that the smaller numbers of North American adventive weed species may be related to the fact that native North American species tend to belong to an assemblage of plants belonging to relatively primitive families with less potential for rapid evolution. However, the histories of human occupance of the two areas have also been very different.

The presence of some early weed pollen may indicate proto-weed growth on unforested morainic and outwash deposits during the later stages of the Quaternary glaciation (Godwin, 1960). Godwin (1960) also mentions one of the earliest datings for pollen from weeds such as Artemisia, Rumex and Plantago spp., which he found in Cheshire, England, and dated to 57,000 B.P. He suggests that even during the interglacials in Europe man may have been an agent of seed dispersal. As soon as forests were cleared for agriculture, weed pollen levels increased, as they do in the levels of peat deposits contemporary with Neolithic man in Europe (Godwin, 1960). Adventive weeds are so closely associated with open ground that the presence of pollen from Plantago lanceolata is taken to be a key indicator of de-forestation in

Britain from 3,000 B.C. onwards (Godwin, 1960). This same weed was an early entrant to North America as European settlement spread there (Rousseau, 1966).

From the Neolithic period onwards, there was far more human disturbance of the land surface, especially for agriculture, in Eurasia than in North America. The somewhat arid Middle East, in which precipitation varies seasonally and from year to year, may have offered some opportunities for adventives, especially since the ground cover is often not continuous there. Moreover, the history of agriculture in the Middle East is particularly long. This area seems to be the source of a considerable number of the weeds now found in North America (King, 1966).

For Neolithic man the distinction between weed and crop plants may have been less rigid than it is now. Helbaek (1959) records seeds of Chenopodium album in the stomach of a body found in Danish peat deposits of that period. These seeds were not well ground and may have retained the potential for being eliminated and dispersed in a still viable state. Both oats and rye seem to have arisen as weeds of wheat crops, and wheat itself seems to be descended partly from the weedy grass Aegilops squarrosa (Baker, 1964).

From Neolithic times onwards, the histories of adventive weeds, and of agriculture and settlement have been closely associated. Farm yards, middens and waste heaps are important sites for weeds. Methods of ploughing, planting, seed harvesting, seed selection, and deliberate weed destruction have all affected the weed population, acting on each species in a distinct way. An important part of the modern history of adventive weeds is the increase in effective deliberate action taken against them, which is discussed in detail later.

Agricultural methods have probably always influenced the prevalence of weeds on farm land. The fertilization and drainage techniques which encourage crop plants also encourage weeds. Only in the labour intensive setting of market gardening can some effort be made to fertilize only the strips where the crop grows, or to keep down weeds between rows by the use of a mulch. Modern harvest methods, too, have their distinctive effects on the selection of those weed species which can survive on farm land. Reapers can encourage the development of shorter ecotypes (Hammerton, 1968) and a combine harvester scatters the smaller and lighter seeds (Bunting, 1960).

Other new methods will have some effect too. For example, direct drilling operates against annuals, but favours rhizomatous perennials (Hammerton, 1968).

As well as influencing the sites available for adventive weeds, modern Western man has greatly facilitated the dissemination of weed propagules. After several centuries of increased migration, travel and trade by increasingly rapid means of transport, a high proportion of the weeds in all temperate parts of the world are of European origin. Seventy of the three hundred and two weed species noted by Kashahara (1954) in Japan are also on Muenscher's list of the weed species of North America (Muenscher, 1955). There has also been some migration of North American weeds to Europe, where some Aster and Oenothera species are present in waste sites more conspicuously than they are in their home territory. As is the case with insects outside their home range, weeds can be more of a nuisance abroad, where they are free of their natural predators, and may be able to compete effectively with other adventive plants.

There is a higher degree of weed control now than in former centuries, especially over the control of the purity of imported seeds, but new problems still arise, and the pattern of weed distributions is never likely to become static. For instance, Kochia scoparia has been spreading rapidly in the eastern prairies of Canada in the past few years from decorative plantings of it in gardens (National Research Counceil, 1968). As Pfeiffer (1968) says, there is a need for warnings of increases in populations of weed species. Salisbury (1964) points out that increases in the numbers of a new migrant may be slow up to some critical point. Perhaps a locally successful strain must first be selected out of the population of migrants, before widespread colonization can readily take place.

Not all adventive weeds common in western Europe have migrated successfully to North America. The weed species which have become established have been selected by local conditions from all the potential species represented by transported seeds. Some species appear only as occasional species near a port, and seldom reach a second generation. For example, Papaver roaeas, a common poppy in western Europe, usually sets seeds which are unable to survive winters in Canada (Rousseau, 1966).

Weeds, then, have been largely dependent on man-altered environments throughout most of their history, and have migrated under human influence. Much of weed evolution may have taken place under these conditions, and many weed species are not found outside of man-altered environments, as is true of the crop plants among which some of the weeds grow.

The economic impact of adventive weeds

The impact of any given weed species will depend on where it is growing. The Scotch broom (Cytisus scoparius) which is a useful stabilizer of slopes in Oregon, is a bad range weed in the foothills in Northern California (National Research Council, 1968). Many grasses and clover weeds can be good forage plants in the right setting. Other benefits to man from weedy species can even include their occasional use for human nutrition, though they are seldom of commercial value for this. There is a currently growing interest in such edible wild plants (Hatfield, 1971). In addition, most weed species can add organic matter to soil. Some deep weed roots can help to break through hard pans in soil, and can bring up nutrient minerals from deeper layers, enlarging the feeding zone for crops (Coccanouer, 1950; King 1951). Furthermore, weed species may also be a pool of genetic material for plant breeding.

The losses caused by weeds are especially noticeable in arable farming, where weeds compete with crops for nutrition, especially for nitrogen (Pfeiffer, 1968). Competition for moisture and light are also important. Fungus diseases accentuated by high levels of humidity just above the level of the soil may be aggravated by a dense growth of weeds (King, 1966). Crops vary greatly in their ability to compete with weeds, which tend to germinate first and grow more rapidly. If harvest is delayed by late ripening because of competition from weeds, loss because of bad weather is likely (Muzik, 1970).

Some weeds can harbour insects or crop diseases. For example, Chenopodium album can harbour beet yellows, a virus disease, as can groundsel (Senecio vulgaris) and shepherd's purse (Capsella bursapastoris). Weed crucifers can carry club root disease, as can Holcus lanatus (King, 1966).

Apart from causing losses to crops weeds can be the source of other problems. Many people suffer from hay-fever when weed pollen is in the air, especially in eastern North America, where pollen from several Artemisia species is a common allergen. The health costs from this are difficult to calculate, but are probably considerable. Weeds on waste or among other vegetation on transmission rights-of-way or railway embankments can be a fire hazard if they dry out, as annuals, especially, tend to do in late summer. On roadsides, weeds can dangerously obscure the view for traffic.

The costs of the cleaning and sorting of crop seeds, and the costs of mechanical weeding and of herbicides make up a large part of the costs assignable to adventive weeds in any region. The calculation of the total cash loss caused by weeds is difficult. Klingman (1961) suggests that 33.8% of the total estimated annual loss caused by weeds and other pests in the U.S.A. is assignable to weeds. Furtick (1968) suggests a 40-70% loss of annual output because of weeds in the tropical lowlands of Colombia and a loss of 31% in the highlands there. Ashby and Pfeiffer (1956) estimate that weed removal in temperate parts of the world increases crop yields by an average of 25%, and that in the tropics this increase can even exceed 100%. It is estimated that there has been a gain of at least $2 million per year in the western states from the biological control of Hypericum perforatum (Zwolfer, 1968). The control of wild oats (Avena Hypericum perforatum) in Britain has produced increases in crop yields of up to 19% (Pfeiffer, 1968).

Weed control

Traditional methods of removing weeds by hand pulling, or by hoeing, are labour intensive, and have been replaced in most parts of Europe and North America, first, by mechanical tilling, and now, currently, by the application of herbicides. However, hand weeding and hoeing are sometimes still economic for some market gardening crops, and are still the common methods of control in much of Asia, Africa, and South America. For weed control by tillage, a harrow is taken along between the row crops, but weed plants actually in the crop row can not be removed. Tillage has been used successfully for the control of serious weed infestations. In this situation, an infested field must be left fallow for a year and repeatedly cultivated. Perennial sow thistle (Sonchus arvensis) was largely eradicated in Saskatchewan by this method (Robbins, Crafts & Raynor, 1942). Crop rotations will also reduce the incidence of some weeds.

Regulations on weed control date from the nineteenth century in most countries. Laws have been passed enforcing the destruction of some weeds and also regulating the acceptable level of weed seeds of any species present in commercially produced seed. The move by farmers to the use of commercially cleaned seed instead of seed saved by themselves has greatly helped to reduce the number of weed seeds planted along with crops. Commercial firms can afford the most complex seed sorting equipment, in which seed weight as well as size can be taken into account.

Research, particularly since 1900, has led to a wide range of herbicides of various strengths and degrees of specificity of action. The more important plant killers, such as 2, 4-D developed during the 1940's, tend to be systemic, being absorbed as hormones by some species of plants which are then destroyed by a disrupted metabolism. Crop yields have been greatly increased by the use of these herbicides. However, the widespread use of chemicals for pest control has now aroused some public alarm about possible long term environmental damage, such as that now shown to be caused to many species of wild life by insecticides.

The rates for detoxification by degradation, or for removal by leaching are different for each chemical used as a herbicide. 2,4-D is usually 85% degraded within 13 days (Norris, 1967). Kearney (1970) states that this herbicide may be completely degraded within one month. 2,4,5-T tends to be more stable chemically, and may persist in soil for as long as five months after application at the recommended rates (Kearney, 1970; Fletcher, 1960; Norris, 1967). Picloram may persist for as long as eighteen months, or even longer at high rates or application (Bovey, Dowler, & Merkle, 1969). The rate of breakdown of such herbicides tends to depend on soil moisture content, temperatures, and soil organic content (Audus, 1960).

Herbicides have generally been shown to be harmless to animal life, at normal rates of application (Kearney, 1970); Lawrence, 1967). However, the long term effects of such application, and of the combined effects of several herbicides together is more uncertain. Moreover, herbicides do result in simplified ecosystems, in which a site is occupied by only one crop or by a few herbicide resistant species, a situation which has been shown to be inherently unstable (Egler, 1964). Private householders and gardeners tend to be particularly prone to overusing whatever chemicals they do apply, and perhaps some re-education is possible in householders' concept of what is an acceptable level of weed infestation, and of how to achieve this level.

Even for field crops, herbicides have not totally banished the weed problem, though they have changed its character. Total eradication would be too expensive, and some weeds are too similar to the crops. Grass weeds are now far more troublesome than broad-leaved weeds, because they are more resistent to most herbicides (Godwin, 1960; Pfeiffer, 1968). Perennials with rhizomes, such as convolvulus (Convolvulus arvensis) and Canada thistle (Cirsium arvense), remain difficult to eradicate without totally sterilizing the soil for some time. In general, those weeds resistant to phenoxyacetic compounds have increased; e.g. the grasses and the Equisetaceae, in which the growth processes are little harmed by herbicidal hormones (Hammerton, 1968).

Unless a weed is completely destroyed by an application of a herbicide, there is a danger of the more resistant strains surviving and forming the basis of a herbicide resistant population. Sub-lethal doses may select resistant strains. In Louisiana, plants grown from seeds harvested from survivors of 2,4-D applications were twice as resistant to spraying as those from a population of unsprayed weeds (Pfeiffer, 1968). In sugar cane areas, the composite weed Erechtities hieracifolia has developed strains resistant to 2,4-D (Salisbury, 1964). Some herbicides may even be mutagenic, and may encourage the development of new weed genotypes (Hammerton, 1968). Since for maximum effect, herbicides are usually applied at maximum germination time, another effect may be to select for a spread of germination times (Hammerton, 1968).

As Egler (1958, 1964) points out, much spraying has been done without botanical consultations, and in areas where alternatives were available at equal or lower costs. Attempts at such ecologically sound control programmes must contend with the influence of the large chemical companies, which finance many of the conferences on weed control. These companies can by talking for instance, about "brush control" suggest that bushes are undesirable on any site, and so create a perceived problem where there is none in reality (Egler, 1958).

Railway tracks, roadsides and power-line rights-of-way are frequently sprayed with herbicides. At least for the latter two, alternatives may be available, such as cutting. Piemeisel (1954) suggests a system of "replacement control", under which some undesirable vegetation such as forest trees on power-line rights-of-way may be kept at bay indefinitely by some other vegetation such as a stable cover of low bushes. According to Egler (1964), some open areas in the eastern U.S.A. have been stable for as long as fifty years. Where weeds have invaded grassland because of overgrazing, improved land use methods are needed to take advantage of weed removal, or some other weed species would be likely to invade.

The biological control of weeds is another possibility. It seems to be most effective against perennial weeds which form dense continuous stands, and is less likely to succeed against the many weed species which are annuals, because most insect predators require a fairly stable mass of plants on which to build up their population (De Back, 1964; Huffaker, 1962). In many parts of the world, research institutes are studying possible applications of biological weed control. Care has to be taken lest any introduced insect become a more noxious pest than the weed species they were intended to remove. Insects can greatly reduce the numbers of a weed, but they are unlikely to eradicate it completely, because, eventually, individual plants would be so far apart that some would be missed by insects.

To date, biological control has been little used, but occasionally insect predators have been found which will greatly reduce some weed population. A prime example of this has been the use of the beetle Cactoblastis cactorum against prickly pear (Opuntia spp.) in Australia where this major problem has been greatly reduced. In western North America, the invasion of pastures by St. John's wort (Hypericum perforatum) has been reduced to 1% of its former extent through the introduction of the goatweed beetles Chrysolina gemmellata and C. hyperica (Huffaker, 1962). These beetles do less well in the climate of British Columbia than those of California or Oregon, and the search continues for other insects which might be helpful against this weed in western Canada (Smith, 1956). There have also been some attemps to control toadflax (Linaria vulgaris) in Saskatchewan through the use of several species of beetle (Harris, 1961).

Adventive Weeds in Canada

Alien weeds such as Plantago lanceelata were noticed spreading into Canada in the seventeenth century (Rousseau, 1966). Some details on more recent weed species distributions, such as the spread of toadflax (Linaria vulgaris) in Saskatchewan, are available from botanical and agricultural journals (Coupland, Zilke and Selleck, 1963). In general the amount of information available is disappointingly scanty. The most precise statistical information to date is available from the official Weed Surveys of Canada (Groh, 1944, 1946, and 1947; Groh and Frankton, 1948 and 1949).

In this paper, data from the Weed Surveys were used as a basis for examining the variations in the total number of weed species[1] in different

[1] The species names were in a few cases altered to accord with the Canada Department of Agriculture Publication 1397 (1969).

zones from west to east in Canada. The proportions of species in different life-span categories, and the geographical distribution of life-span types was studied. The source of origin of the Canadian population of weed species was also analysed, along with the distribution in Canada of weeds from different sources. Floras for each region of Canada were also consulted, but the information on plant habitats given is not sufficiently detailed to be of use.

The main disadvantage of the Weed Survey statistics is that they are published by regions delimited by lines of longitude, as shown in Figure 1, which correspond to neither provinces nor geographical regions. Moreover, there is no information from Newfoundland, the Yukon, or the Northwest Territories. It must be emphasized that this study is based on the numbers of species present, with no reference to abundance. Within this population of weed species, the importance of individual species may vary widely, but precise information about these variations is not available.

Floristic Composition

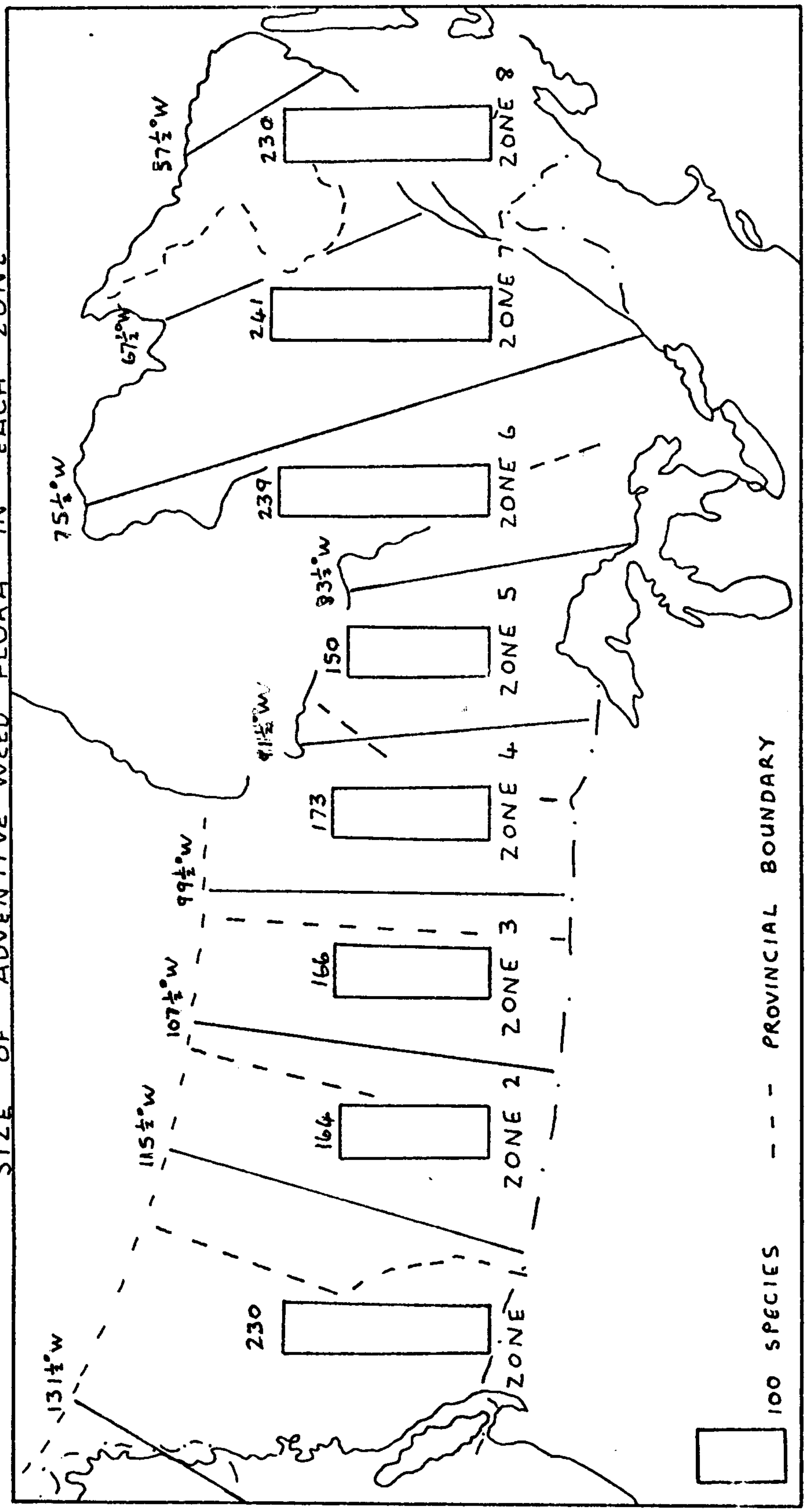
A total of 358 weed species are included in the Seventh Report of the Canadian Weed Survey (Groh and Frankton, 1949) of which 267 species are adventive weeds capable of colonizing disturbed sites. Ninety-one species were excluded as being mainly confined to other types of habitat. The 267 adventive weed species are listed by family in Appendix A. Some families include a particularly large number of the adventive weeds found in Canada, the Composite include 65 species, the Gramineae 33, the Cruciferae 32, the Leguminoisae 13 and the Polygonaceae 13.

The number of weed species in each zone varied from 159 species (Fig. 1) to 239. Variation in the number of weed species present is probably related to both physical environmental factors and to the cultural history of each zone. These regional variations will be discussed in more detail later.

Individual weed species occurred in distributions which occupied almost every possible combination of one or more of the eight regional zones. However, as Mulligan (1965) notes for perennial species, several characteristic distributions are of high frequency. Many species (107), occurred in every zone, e.g. *Ranunculus acris* and *Capsella bursa-pastoris*. Those weeds which are found in every part of southern Canada include a slightly higher proportion of annuals than does the weed population as a whole.

A few species had a distribution limited mainly to British Columbia (zone 1), or to eastern Canada (zones 6-8). For example, *Lolium multiflorum*

FIGURE 1


SIZE OF ADVENTIVE WEED FLORA IN EACH ZONE
131½°W
115½°W
107½°W
99½°W
91½°W
83½°W
75½°W
67½°W
57½°W
230
ZONE 1
164
ZONE 2
166
ZONE 3
173
ZONE 4
150
ZONE 5
239
ZONE 6
241
ZONE 7
230
ZONE 8
100 SPECIES
- - - PROVINCIAL BOUNDARY

is confined to the west, Leontodon autumnalis, Hieracium floribundum, and several other Hieracium species are confined to eastern Canada. Another common pattern is a disjunct distribution in which a species occurs in British Columbia and in one or more zones of eastern Canada. Holcus lanatus, and Agrostis tenuis are examples of such a distribution. Agrostis tenuis is concentrated especially in the Maritimes, to which it was brought by the Highland Scots (Groh, 1943).

Only a few species are confined to the prairie provinces, e.g. Oxybaphus nyctagineus, but most species native to that area have at least spread eastwards, e.g. Amaranthus albus and Artemisia biennis. However, no alien species seems to occur in an exclusively central distribution.

Life Span

The life span types (annual, biennial or perennial) of adventive weed species in Canada are of interest because they are related to reproductive strategies. In particular, perennials with creeping root stocks are among some of the most noxious weeds. Reproductive strategies are thus of importance in planning weed control programmes, and can influence the economic significance of a weed species.

TABLE II Species in each zone by life-span, also expressed as a percentage of the adventive species in each zone

Species numbers underlined

	1	2	3	4	5	6	7	8
Annual N=113 (42.3%)	104 45.2	74 45.1	79 47.6	80 46.2	69 43.4	100 41.8	103 42.7	93 44.3
Biennial N=27 (10.1%)	26 11.3	19 11.6	21 12.6	20 11.6	18 11.3	26 10.9	23 9.5	20 8.7
Perennial N=127 (47.6%)	100 43.5	71 43.3	66 39.8	73 42.2	72 45.3	113 47.3	115 47.8	115 50.0

The total of 267 adventiye weed species is fairly evenly divided between annuals and perennials (Table II). Based on the geographical distribution of species there are higher total numbers and a higher percentage of perennials in the three eastern zones compared to the rest of Canada (Fig. 2). The higher proportion of perennials in eastern Canada may occur partly because many perennials survive best in more humid conditions. Moreover, in eastern Canada there is more long term pasture in which perennial weeds may be relatively undisturbed once established.

TABLE III Life-span by Origin

	N.A.	T.A.	S.A.	N.A. &E.	N.A.& Eu. or O.&As.	E.	Eu.	O.	As.
Annuals N=113	28 / 24.8	3 / 2.7	1 / 0.9	6 / 5.4	3 / 2.7	57 / 50.4	10 / 8.8	2 / 1.8	3 / 2.7
Biennials N=27	8 / 29.6					14 / 51.9	5 / 18.5		
Perennials N=127	33 / 26.0			7 / 5.5	5 / 4.0	62 / 48.8	18 / 14.2		2 / 1.6
Total Species N=267	69 / 25.7	3 / 1.1	1 / 0.4	13 / 4.9	8 / 3.1	113 / 49.7	33 / 12.4	2 / 0.8	5 / 1.9

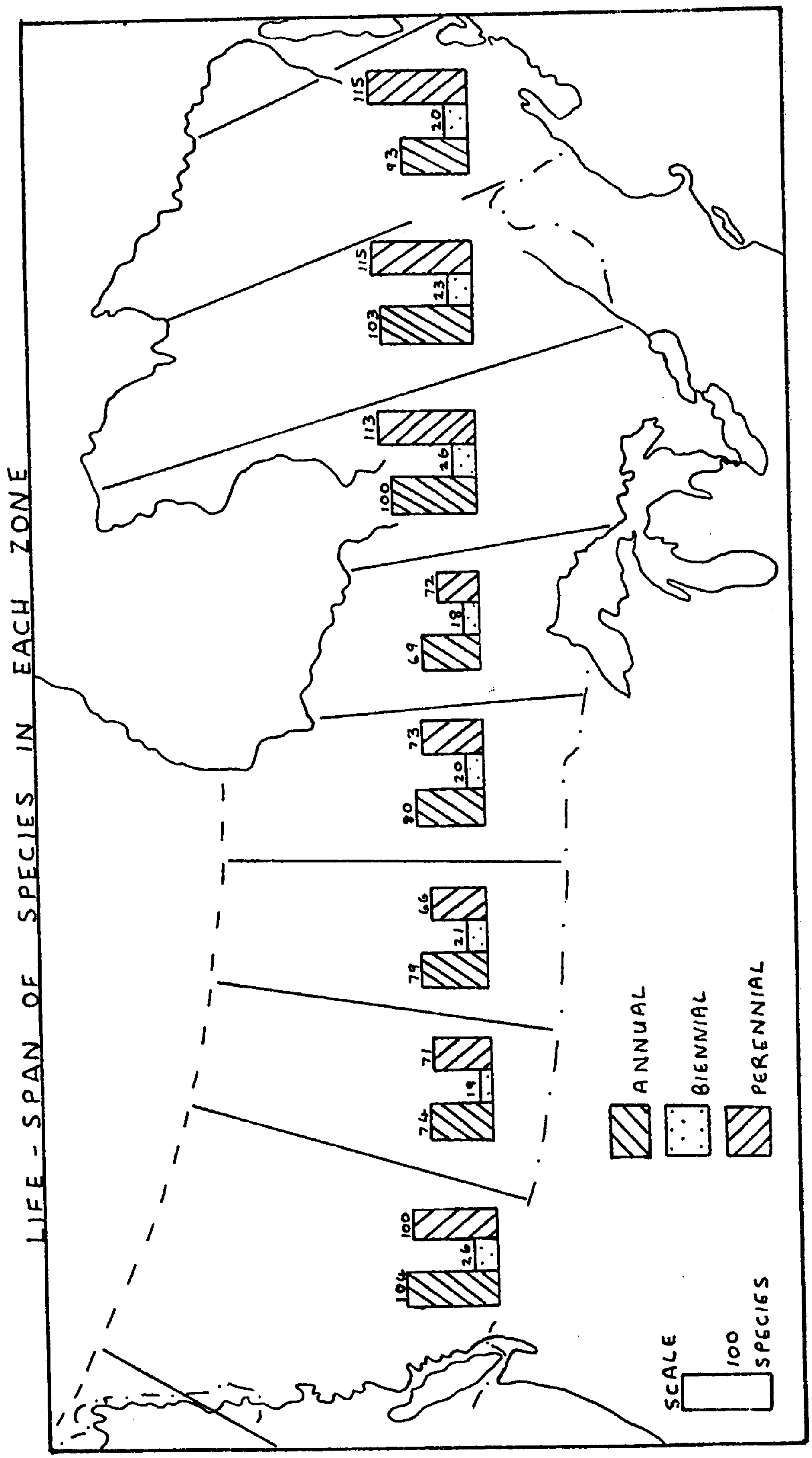
N.A. - North America
T.A. - Tropical America
S.A. - South America
E. - Europe
Eu. - Eurasia
O. - Old World
As. - Asia

There is a remarkable uniformity in the probable world regions of origin of weeds. Biennials are highest, and perennials are lowest in the proportion of species which come from the New World, but these differences are small.

The geographical origin of the adventive weed species which are now present in Canada is of interest because the conditions under which a species evolved will have influenced its environmental requirements. Hence a knowledge of the origins of a species may throw some light on its current distribution and may suggest what the final extent of its range may be, if it is a weed species which is still spreading.

Although the precise origin of most weed species is uncertain, a high proportion of Canadian weed species (66.3%) are definitely alien. Of the alien species, a few come from tropical or South America, and the rest come from the Old World, mainly Europe. However, many European weeds may have

FIGURE 2


LIFE - SPAN OF SPECIES IN EACH ZONE
115
20
93
115
23
103
113
26
100
72
18
69
73
20
80
66
21
79
71
19
74
100
26
104
ANNUAL
BIENNIAL
PERENNIAL
SCALE
100 SPECIES

come originally from the Middle East, perhaps along with crop plants. Only 25% of the adventive species were considered to be of exclusively North American origin, while 8.0% originated in both North America and the Old World (Fig. 3). Some species were probably present on both sides of the Atlantic even before there was large scale human movement across it. When such a species is found as a common weed of disturbed sites in North America, its presence at many sites may be a result of introductions of the species from abroad. Further study may then disclose some chromosomal or ecotypic differences between the individual plants occurring as weeds, and those growing as part of the natural vegetation.

Some of the weeds of North American origin are not native to the whole of their present range. At least 2.7% of the total are native to dry western parts of the continent. These weeds now have a much wider distribution than they seem to have had before European man altered the habitats which they now share with weeds of Eurasian origin. Some of the western species are not found in the Maritime provinces, perhaps because of the humidity of the climate, or perhaps some slower migrating species have not had time to reach there, as they spread along historically recent routeways.

The distribution across Canada of adventive weeds from each source of origin is shown in Table IV. The most conspicuous point in this distribution is that some weed species from any region of origin manage to grow in any section of southern Canada. However, a higher proportion of the undoubtedly alien weed species are found in eastern and western Canada than in the central areas on the prairies or on the Canadian Shield. Possible physical and historical explanations for this distribution of alien weed species are discussed later.

Regional Comparisons

The regional differences which are noted in Table V can be related to regional physical, cultural and historical factors. The higher numbers of species present in both British Columbia and in Ontario, Quebec and the Maritime Provinces seems likely to be partly a result of the higher precipitation in those areas, compared with the Prairie Provinces. Eastern and western Canada also have a more varied range of habitat types than the

FIGURE 3

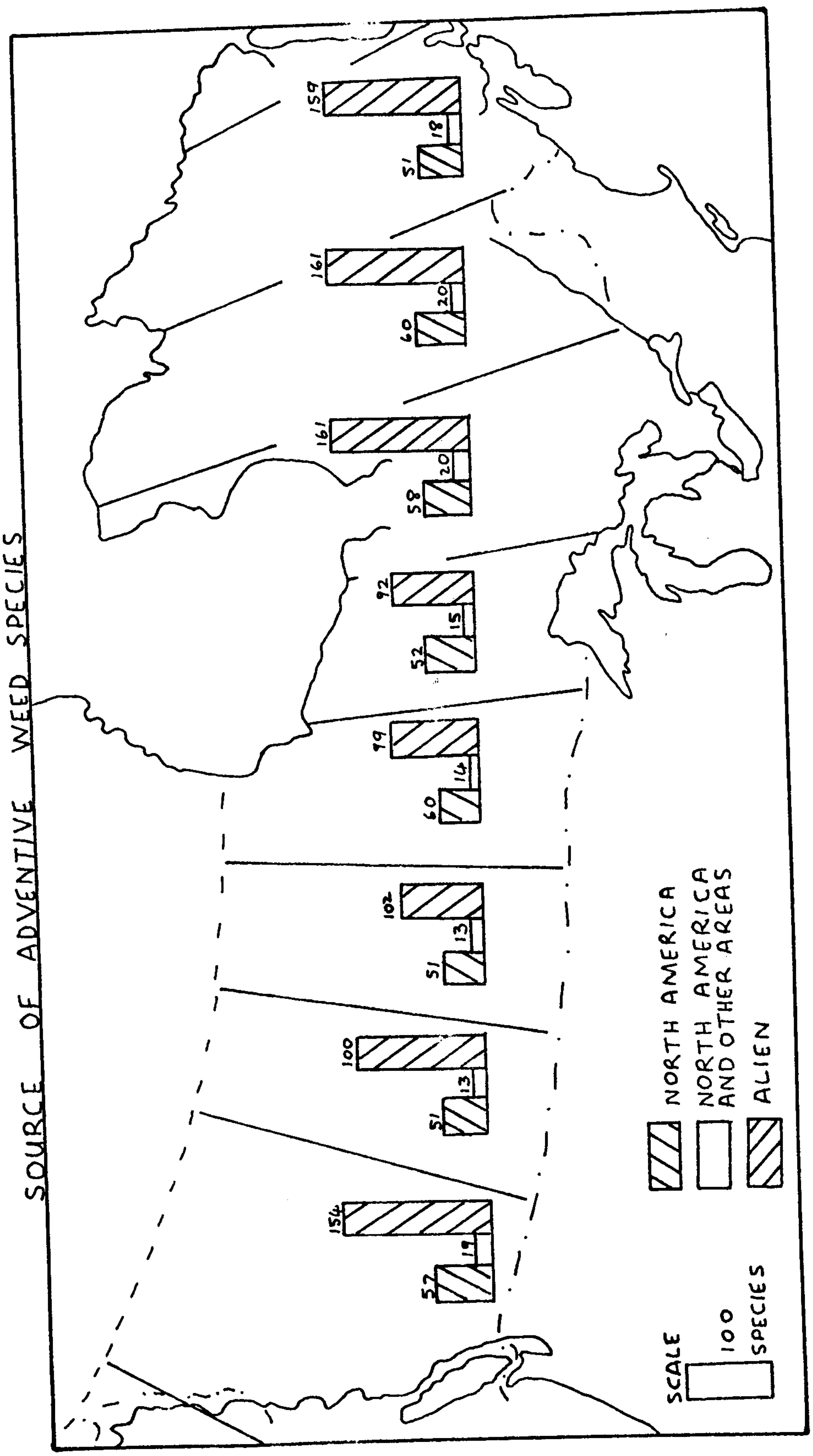

SOURCE OF ADVENTIVE WEED SPECIES
159
18
51
161
20
60
161
20
58
92
15
52
99
14
60
102
13
51
100
13
51
154
19
57
NORTH AMERICA
NORTH AMERICA AND OTHER AREAS
ALIEN
SCALE
100 SPECIES

TABLE IV Species by origin in each zone, with numbers also expressed as a percentage of the total adventive species in each zone

	1	2	3	4	5	6	7	8
North America	57 / 24.8	51 / 31.1	51 / 30.7	60 / 34.7	52 / 32.7	58 / 24.3	60 / 24.9	51 / 22.2
Tropical America	3 / 1.3	1 / 0.6	1 / 0.6	2 / 1.2	1 / 0.6	3 / 1.3	3 / 1.2	3 / 1.3
South America	1 / 0.4	1 / 0.6	1 / 0.6	1 / 0.6	1 / 0.6	1 / 0.4	1 / 0.4	- / 0.4
North America & Europe	12 / 5.2	7 / 4.3	7 / 4.2	7 / 4.0	7 / 4.4	12 / 5.0	13 / 5.4	11 / 4.8
North America & Eurasia	4 / 1.7	4 / 2.4	4 / 2.4	4 / 2.3	5 / 3.1	5 / 2.1	5 / 2.1	5 / 2.2
North America & the Old World	1 / 0.4	1 / 0.6	1 / 0.6	1 / 0.6	1 / 0.6	1 / 0.4	1 / 0.4	1 / 0.4
North America & Asia	2 / 0.9	1 / 0.6	1 / 0.6	2 / 1.2	2 / 1.3	2 / 0.8	1 / 0.4	1 / 0.4
Europe	114 / 49.6	74 / 45.1	74 / 44.6	75 / 43.4	69 / 43.4	119 / 49.8	120 / 49.8	120 / 52.2
Eurasia	30 / 13.0	19 / 11.6	20 / 12.0	16 / 9.2	17 / 10.7	33 / 13.8	32 / 13.3	31 / 13.5
Old World	2 / 0.9	1 / 0.6	1 / 0.6	1 / 0.6	2 / 1.3	2 / 0.8	2 / 0.8	2 / 0.9
Asia	4 / 1.7	4 / 2.4	5 / 3.0	4 / 2.3	2 / 1.3	3 / 1.3	3 / 1.2	3 / 1.3

prairies or the Shield regions, through having more local variations in precipitation, relief and soils. Indeed, those regions which have more weed species also have a richer native flora.

TABLE V Weed Population Characteristics by Region

	WEST (mainly B.C.)	PRAIRIES	CANADIAN SHIELD	EAST (Southern Ont.,Que., & Maritimes)
No. of species	230	164-173	159	230-241
% Annuals	45.2	45.1-45.2	43.3	41.8-44.3
% Biennials	11.3	11.6-12.6	11.3	8.7-10.9
% Perennials	43.5	39.8-43.3	45.3	47.3-50.0
% Aliens	67.0	59.6-61.4	57.6	66.8-69.7

However, since so many of the weed species in eastern and western Canada are aliens, historical human factors may also be important. Eastern Canada, in particular, has been settled much longer than the prairies. In addition, precautions against weed migration were less stringent, or non-existent during the earlier periods of settlement. Both eastern Canada and British Columbia have, at least in some places, a more dense settlement and land use pattern than the prairies, with a greater variety of crops. Around settlement and agricultural land there tend to be a considerable area and variety of the types of sites on which adventive weeds are commonly found. Moreover, ports are most frequently the points of entry for alien weeds, and naturally this affects the weed populations of British Columbia and eastern Canada.

Rousseau (1966) notes how the ox-eye daisy (*Chrysanthemum leucanthemum*) was limited to one side of a lake in Quebec, as long as access across the lake was only by water. However, as soon as a road was built around the lake, the species spread along the road immediately. The colonization of Canada by adventive weeds must have occurred in some such, usually unrecorded way for each species.

Summary

The following summary of some of the major characteristics of the adventive weed population of Canada can be made.

(i) There is a greater richness in the weed floras of British Columbia and of eastern Canada, than in the prairies or on the Canadian Shield.

(ii) There are 107 weed species which occur in every zone, i.e. 40.1% of the total population of adventive weed species.

(iii) The weed species in each area are fairly uniformly divided into annuals (42%) and perennials (47%), with a comparatively smaller number of biennials (10%).

(iv) A high proportion (66.3%) of these weed species are aliens, most commonly of European or Eurasian origin.

(v) The proportion of the weed population which is alien is highest in British Columbia and eastern Canada.

Conclusions

Weeds are a class of plants which are defined in anthropocentric terms, usually with emphasis on the characteristics which make them a nuisance to man. Their ecological strategies and reproductive abilities enable them to occupy disturbed sites quickly and to dominate such sites for at least a year or two. In contrast to non-weeds, they tend to have general purpose genotypes, and to demonstrate great plasticity of phenotype, and a wide range of tolerance for environmental factors.

The history of weed species evolution and migration seems to have been closely tied to human settlement and agricultural patterns, after a possible early beginning in naturally disturbed sites. Weeds now cause a considerable economic loss, especially in tropical areas. Weed control by the use of herbicides has become of major importance and other systems such as biological control may become locally important.

The characteristics of the Canadian adventive weed population are summarized above.

It is difficult to gain any historical perspective on the significance of different weed species and on how patterns of weed distribution may have changed in Canada through time. The pattern of weed species which have failed to migrate or become established in Canada would be of interest. Many European weeds have migrated to Canada, but not by any means all. One case which has been noted already is that of the corn poppy (*Papaver rhoeas*). It would be interesting to know more about current trends in the changing patterns of weed species occurrence in Canada, and about changes in their relative importance in the landscape, but there are only occasional clues in the literature about these topics. Local weed ecological studies are also needed to reach a fuller understanding of the pattern of adventive weeds in the Canadian landscape.

Appendix A.

ADVENTIVE WEED SPECIES IN CANADA

Life-duration: a - annual, b - biennial, p - perenial
Origin: N.A. - North America, T.A. - Tropical America, S.A. - South America, E. - Europe, Eu. - Eurasia, O. - Old World, As. - Asia.
* - present

FAMILY & SPECIES	LIFE DURATION	ORIGIN	PRESENCE IN REGIONAL ZONES 1	2	3	4	5	6	7	8
AIZOACEAE										
Mollugo verticillata L.	a	T.A.	*	-	-	*	-	*	*	*
AMARANTHACEAE										
Amaranthus										
albus L.	a	N.A.(w)	*	*	*	*	*	*	*	*
graecizans L.	a	N.A.(w)	*	*	*	*	*	*	*	-
retroflexus L.	a	T.A.	*	*	*	*	*	*	*	*
APOCYNACEAE										
Apocynum androsaemifolium L.	p	N.A.	*	*	*	*	*	*	*	*
ASCLEPIADACEAE										
Asclepias syriaca L.	p	N.A.	-	-	-	*	-	*	*	*
BORAGINACEAE										
Amsinckia spp.	a	N.A.	*	*	*	-	-	-	-	-
Cynoglossum officinale L.	b	E.	*	-	*	-	-	*	*	*
Echium vulgare L.	b	E.	*	-	-	*	-	*	*	*
Lappula echinata L.	a	E.	*	*	*	*	*	*	*	*
Lithospermum officinale	p	E.	-	-	-	-	-	*	*	*
Lycopsis arvensis L.	a	E.	-	-	-	-	-	*	*	*
Myosotis arvensis L.	b,a	E.	*	-	*	-	-	*	*	*
CAMPANULACEAE										
Campanula rapunculoides L.	p	E.	-	-	-	-	-	*	*	*
Lobelia inflata L.	a	N.A.	*	-	-	-	-	*	*	*
CAPPARIDACEAE										
Cleome serrulata Pursh.	a	N.A.	*	*	*	*	-	-	-	-
CARYOPHYLLACEAE										
Agrostemma githago L.	a.	Eu.	*	-	-	-	-	*	-	*

FAMILY & SPECIES	LIFE DURATION	ORIGIN	PRESENCE IN REGIONAL ZONES 1	2	3	4	5	6	7	8
CARYOPHYLLACEAE cont.										
Arenaria										
serpyllifolia L.	a	Eu.	*	-	-	-	-	*	*	-
Cerastium										
arvense L.	p	E.&N.A.	*	*	*	*	-	*	*	*
vulgatum L.	p	E.	*	*	*	*	*	*	*	*
Lychnis alba Mill.	b,p	E.	*	*	-	-	*	*	*	*
Saponaria										
officnalis L.	p	E.	*	*	-	-	*	*	*	*
vacaria L.	a	E.	*	*	*	*	*	*	*	*
Scleranthus annuus L.	a	E.	*	-	-	-	-	-	*	*
Silene										
antirrhina L.	a	N.A.	*	-	-	*	*	*	*	-
cucubalus Widel	p	Eu.	*	*	*	*	*	*	*	*
noctiflora L.	a	E.	*	*	*	*	*	*	*	*
Spergula arvensis L.	a	E.	*	*	-	-	*	*	*	*
Stellaria										
graminea L.	p	Eu.	*	*	-	-	*	*	*	*
media (L) Vill.	a	E.	*	*	*	*	*	*	*	*
CHENOPODIACEAE										
Artiplex hortensis L.	a	E.	*	*	*	*	-	*	-	-
patula L.	a	N.A.	*	*	*	*	*	*	*	*
Axyris amarantoides L.	a	As.	*	*	*	*	*	*	*	*
Chenopodium										
album L.	a	Eu.	*	*	*	*	*	*	*	*
capitatum (L) Ascher	a	E.&N.A.	*	*	*	*	-	*	*	-
gigantospermum Aellen	a	N.A.	*	*	*	*	*	*	*	*
glaucum L.	a	E.	*	*	*	*	*	*	*	*
Monolepis nuttaliana (R&S) Greene	a	N.A.	*	*	*	*	-	-	*	-
Salsola pestifer A.Nels.	a	Eu.	*	*	*	*	*	*	*	*
COMPOSITAE										
Achillea millefolium L.	p	N.A.	*	*	*	*	*	*	*	*
Ambrosia artemisifolia L.	a	N.A.	*	*	*	*	*	*	*	*
psilostachya T.&G.	p	N.A.	*	*	*	*	*	*	*	*
trifida L.	a	N.A.	*	*	*	*	*	*	*	*
Anaphalis margaritacea (L) B.&H.	p	N.A.	*	-	-	*	*	*	*	*
Anthemis cotula L.	a	E.	*	*	*	*	*	*	*	*
Arctium minus (Hill) Bernh.	b	E.	*	*	*	*	*	*	*	*

FAMILY & SPECIES	LIFE DURATION	ORIGIN	PRESENCE IN REGIONAL ZONES 1	2	3	4	5	6	7	8
EUPHORBIACEAE										
Acalypha rhomboidea Raf.	a	N.A.	-	-	-	-	-	*	*	-
Euphorbia										
cyparissias L.	p	E.	-	-	-	-	-	*	*	*
esula L.	p	E.	*	*	*	*	-	*	*	-
glyptosperma Engelm.	a	N.A.	*	*	*	*	-	-	*	-
helioscopia L.	a	E.	*	-	-	-	-	*	*	*
peplus L.	a	E.	*	-	-	-	-	*	*	*
GRAMINEAE										
Agropyron										
repens (L.) Beauv.	p	Eu.	*	*	*	*	*	*	*	*
smithii Rydb.	p	N.A.(w)	*	*	*	*	*	-	*	-
Agrostis										
alba L.	p	E.	*	*	*	*	*	*	*	*
alba var. palustris	p	E.	*	*	*	*	*	*	*	*
tenuis	p	E.	*	-	-	-	-	-	*	*
Aira caryophyllea	a	E.	*	-	-	-	-	-	-	-
Alopecurus pratensis	p	Eu.	*	*	-	-	-	*	*	*
Anthoxaxum odoratum (L.) Beauv.	p.	Eu.	*	-	-	-	-	*	*	*
Avena fatua L.	a	E.	*	*	*	*	*	*	*	*
Bromus										
inermis Leyss.	p	E.	*	*	*	*	*	*	*	*
secalinus L.	a	E.	*	-	-	-	*	*	*	*
tectorum L.	a	E.	*	*	-	*	-	*	*	*
Cynosurus cristatus	p	E.	*	*	-	-	*	*	*	*
Dactylis glomerata L.	p	Eu.	*	*	-	-	*	*	*	*
Danthonia spicata (L.) Beauv.	p	N.A.	*	*	-	*	*	*	*	*
Digitaria ischaemum	a	Eu.	*	-	-	-	-	*	*	*
Echinoloa crusgalli (L.) Beauv.	a	E.	*	*	*	*	*	*	*	*
Eragrostis spp.	a	N.A.&E.	-	-	-	-	-	-	*	*
Festuca elatior	p	Eu.	*	*	*	*	*	*	*	*
Hierchloe odorata (L). Beauv.	p	N.A.	*	*	*	*	*	*	*	*
Holcus lanatus L.	p	E.	*	-	-	-	-	-	-	*
Hordeum jubatum L.	p	N.A.	*	*	*	*	*	*	*	*
Lolium										
multiflorum Lam.	p	E.	*	-	-	-	-	-	-	-
perenne L.	p	E.	*	-	-	-	-	*	-	*
persicum	a	E.	*	-	*	*	-	-	-	-
Panicum capillare L.	a	N.A.	*	-	*	*	-	*	*	*
Phleum pratense L.	p	Eu.	*	*	*	*	*	*	*	*
Poa										
annua L.	a	E.	*	*	*	*	*	*	*	*

FAMILY & SPECIES	LIFE DURATION	ORIGIN	PRESENCE IN REGIONAL ZONES 1	2	3	4	5	6	7	8
GRAMINEAE cont.										
Poa										
compressa L.	p	E.	*	*	*	*	*	*	*	*
Secale cereale L.	a	Eu.	*	*	*	*	-	*	*	*
Setaria										
glauca (L.) Beauv.	a	E.	*	-	-	*	*	*	*	*
verticillata (L.) Beauv.	a	E.	-	*	*	*	*	*	*	*
viridis (L.) Beauv.	a	E.	*	*	*	*	*	*	*	*
HYPERICACEAE										
Hypericum perforatum L.	p	E.	*	-	-	-	-	*	*	*
JUNCACEAE										
Juncus										
bufonius	p	N.A.,O, &Eu.	*	*	*	*	*	*	*	*
tenuis	p	N.A.	*	-	*	-	*	*	*	*
LABIATAE										
Dracocephalum										
parviflorum Nutt.	a	N.A.	*	*	*	*	*	*	*	*
Glecoma hederacea L.	p	E.	*	*	*	*	*	*	*	*
Galeopsis tetrahit L.	a	E.	*	*	*	*	*	*	*	*
Leonurus cardiaca L.	p	Eu.	-	-	*	-	-	*	*	*
Nepeta cataria L.	p	Eu.	*	-	-	-	-	*	*	*
Prunella vulgaris L.	p	E.	*	*	-	*	*	*	*	*
Stachys palustris L.	p	N.A.&Eu.	*	*	*	*	*	*	*	*
LEGUMINOSAE										
Medicago										
lupulina L.	a	E.	*	*	*	*	*	*	*	*
sativa L.	p	E.	*	*	*	*	*	*	*	*
Melilotus										
alba Desr.	b	E.	*	*	*	*	*	*	*	*
officinalis (L.) Lam.	b	Eu.	*	*	*	*	*	*	*	*
Trifolium										
agrarium L.	a	E.	*	-	-	*	*	*	*	*
dubium Sibth.	a	E.	*	-	-	-	-	-	-	*
hybridum L.	p	E.	*	*	*	*	*	*	*	*
pratense L.	b	Eu.	*	*	*	*	*	*	*	*
procumbens L.	a	E.	*	-	-	-	-	*	*	*
repens L.	a	E.	*	*	*	*	*	*	*	*
Vicia										
angustifolia Reichard	a	O.	*	-	-	-	*	*	*	*
cracca L.	p	N.A.&E.	*	*	*	*	*	*	*	*
tetrasperma (L.) Moench.	a	E.	*	-	-	-	-	*	*	*

FAMILY & SPECIES	LIFE DURATION	ORIGIN	PRESENCE IN REGIONAL ZONES 1	2	3	4	5	6	7	8
COMPOSITAE cont.										
Artemisia										
absinthum L.	p	E.	*	*	*	*	*	*	*	*
biennis Willd.	b,q	N.A.(w)	*	*	*	*	*	*	*	*
frigida Willd.	p	N.A.&As.	*	*	*	*	*	*	-	-
gnaphalodes Nutt.	p	N.A.	*	*	*	*	*	*	*	*
vulgaris L.	p	N.A.&As.	*	-	-	*	*	*	*	*
Bidens spp.	a	N.A.	*	*	*	*	*	*	*	*
Centaurea										
jacea L.	p	E.	*	-	-	-	-	-	*	-
nigra L.	p	E.	*	-	-	-	-	*	*	*
repens L.	p	As.	*	*	*	*	-	*	-	-
Chrysanthemum										
leucanthemum L.	p	E.	*	*	*	*	*	*	*	*
Cichorium intybus L.	p	E.	*	-	*	-	*	*	*	*
Cirsium										
arvense (L) Scop.	p	Eu.	*	*	*	*	*	*	*	*
vulgare (Savi) Tenore	b	Eu.	*	*	*	*	*	*	*	*
Crepis tectorum L.	a	E.	*	*	*	*	*	*	*	*
Erigeron										
annuus (L) Pers.	a	N.A.	-	-	-	-	*	*	*	*
canadensis L.	a	N.A.	*	*	*	*	*	*	*	*
philadelphicus L.	p	N.A.	*	*	*	*	*	*	*	*
ramosus (Walt) B.S.P.	a	N.A.	*	-	-	*	*	*	*	*
Galinsoga ciliata (Raf.) Blake	a	T.A.	*	-	-	-	-	*	*	*
Gnaphalium uliginosum L.	a	N.A.&E.	*	-	-	-	*	*	*	*
Grindelia spp.	b	N.A.	*	*	*	*	*	*	*	-
Helianthus										
annus L.	a	N.A.	*	*	*	*	-	*	*	*
tuberosus	p	N.A.	*	-	-	*	-	*	*	*
Hieracium										
aurantiacum L.	p	E.	*	-	-	-	*	*	*	*
florentinum All.	p	E.	-	-	-	-	-	*	*	*
floribundum Wimm.&Grab.	p	E.	-	-	-	-	-	-	*	*
pilosella L.	p	E.	-	-	-	-	-	*	*	*
pratense Tausch	p	E.	-	-	-	-	-	-	*	*
scabrum Michx.	p	N.A.	-	-	-	*	*	*	*	*
vulgatum Fries	p	E.	-	-	-	-	-	*	*	*
Hypochaeris radicata L.	p	Eu.	*	-	-	-	-	*	*	*
Inula helenium	p	Eu.	-	-	-	-	-	*	*	*
Iva										
axillaris Pursh	p	N.A.(w)	*	*	*	*	-	-	-	-
xanthifolia Nutt.	a	N.A.	*	*	*	*	-	*	*	-
Lactuca										
pulchella (Pursh) D.C.	p	N.A.	*	*	*	*	-	-	*	-
scariola L.	b	E.	*	*	*	*	-	*	*	*

FAMILY & SPECIES	LIFE DURATION	ORIGIN	PRESENCE IN REGIONAL ZONES 1	2	3	4	5	6	7	8
COMPOSITAE cont.										
Leontodon autumnnalis L.	p	E.	-	-	-	-	-	*	*	*
Matricaria										
maritima L.	a	E.	*	*	*	-	*	-	*	*
matricarioides (Less) Porter	a	N.A.(w)	*	*	*	*	*	*	*	*
Rudbeckia hirta L.	b	N.A.	*	*	*	*	*	*	*	*
Senecio										
jacobea L.	p	E.	-	-	-	-	-	*	-	*
viscosus L.	a	E.	*	-	-	-	-	*	*	*
vulgaris L.	a	O.	*	*	*	*	*	*	*	*
Solidago										
canadensis L.	p	N.A.	*	*	*	*	*	*	*	*
graminifolia (L) Salisb.	p	N.A.	-	*	*	*	*	*	*	*
rugosa Mill.	p	N.A.	-	-	-	-	*	*	*	*
Sonchus										
arvensis L.	p	E.	*	*	*	*	*	*	*	*
arvensis L. var. glabrescens Guenth.	p	E.	*	*	*	*	*	*	*	*
asper Hill.	a	E.	*	*	*	*	*	*	*	*
oleraceus L.	a	E.	*	*	*	*	-	*	*	*
Tanacetum vulgare L.	p	E.	*	*	*	*	-	*	*	*
Taraxacum										
officinale Weber	p	Eu.	*	*	*	*	*	*	*	*
erythrospermum Andrz.	p	E.	*	*	*	*	*	*	*	*
Tragopogon										
dubius Scop.	b	Eu.	*	*	*	*	-	*	*	-
porrifolius L.	b	E.	*	-	-	*	-	*	-	-
pratensis L.	b	Eu.	*	*	*	*	*	*	*	*
Tussilago farfara L.	p	E.	-	-	-	-	-	*	*	*
Xanthium spp.	a	N.A.	*	*	*	*	-	*	*	*
CONVOLVULACEAE										
Convolvulus										
arvensis L.	p	E.	*	*	*	*	-	*	*	*
sepium L.	p	N.A.	*	*	*	*	-	*	*	*
Cuscuta campestris Yuncker	a	E.	-	-	-	-	-	*	*	-
CRASSULACEAE										
Sedum telephium	p	Eu.	*	-	-	-	-	*	*	*
CRUCIFERAE										
Alyssum alyssoides	a	E.	*	-	-	-	-	*	*	-
Arabis glabra (L) Bernh.	b	N.A.	*	-	*	*	*	*	*	*
Armoracia rusticana Gaertn.	p	E.	*	*	*	*	*	*	*	*
Barbarea vulgaris R.BR.	p	N.A.&E.	*	-	-	-	-	*	*	*

FAMILY & SPECIES	LIFE DURATION	ORIGIN	PRESENCE IN REGIONAL ZONES 1	2	3	4	5	6	7	8
CRUCIFERAE cont.										
Berteroa incana (I.) D.C.	p	E.	*	*	*	*	-	*	*	*
Brassica										
campestris L.	a	E.	*	*	*	*	*	*	*	*
juncea (L.) Czern.	a	As.	*	*	*	*	*	*	*	*
kaber	a	E.	*	*	*	*	*	*	*	*
Camelina										
dentata Pers.	a	E.	-	-	*	*	-	-	-	-
microcarpa including sativa	a	E.	*	*	*	*	*	*	*	*
Capsella bursa-pastoris (L.) Medic.	a	E.	*	*	*	*	*	*	*	*
Cardaria										
draba (L.) Desv.	p	E.	*	-	*	*	-	-	-	*
chalepensis (L.) Hand.-Maz.	p	E.	*	*	*	*	-	-	-	-
pubescens	p	As.	*	*	*	*	-	-	-	-
Conringia orientalis (L.) Dumort	a	E.	*	*	*	*	*	*	*	*
Descurainia										
pinnata (Walt.) Britt.	b	N.A.(w)	*	*	*	*	*	*	-	-
richardsonii	b	N.A.	*	*	*	*	*	-	-	-
sophia (L.) Webb.	a	E.	*	*	*	*	*	*	*	*
Erucastrum gallicum	a	E.	*	*	*	*	*	*	*	*
Erysimum										
cheiranthoides L.	a	N.A.&E.	*	*	*	*	*	*	*	*
inconspicuum	b	N.A.(w)	*	*	*	*	*	*	-	-
Hesperis matronalis L.	p.	E.	*	*	*	*	-	*	*	*
Lepidium										
campestre (L.) R.Br.	a	E.	*	-	-	-	*	*	*	*
densiflorum Schrad.	a	N.A.	*	*	*	*	*	*	*	*
Neslia paniculata (L.) Desv.	a	E.	*	*	*	*	*	*	*	*
Raphanus raphanistrum L.	a	E.	*	-	-	-	-	*	*	*
Rorippa										
islandica	a	N.A.&Eu.	*	*	*	*	*	*	*	*
sylvestris (L.) Bess.	p	E.	*	-	*	-	-	*	*	*
Sisymbrium										
altissimum	b	E.	*	*	*	*	*	*	*	*
loeselii L.	a	E.	*	*	*	*	*	*	-	-
officinale (L.) Scop.	a	Eu.	*	-	-	-	-	*	*	*
Thlaspi arvense L.	a	E.	*	*	*	*	*	*	*	*
EQUISETACEAE										
Equisetum										
arvense L.	p	N.A.	*	*	*	*	*	*	*	*
prealtum	p	N.A.	*	*	*	*	*	*	*	*

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LILIACEAE										
Asparagus officinalis L.	p	E.	*	*	*	*	-	*	*	*
Convallaria majalis	p	E.	-	-	-	-	-	*	*	*
Hemerocallis fulva	p	Eu.	-	-	-	-	-	*	*	*
LINACEAE										
Linum usitatissimum L.	a	E.	*	*	*	*	*	*	*	*
MALVACEAE										
Malva										
moschata L.	p	E.	*	-	-	-	-	*	*	*
neglecta Wallr.	a	E.	*	*	*	*	-	*	*	*
MORACEAE										
Cannabis sativa L.	a	Eu.	*	-	*	-	-	*	*	*
Humulus americanum	p	N.A.	*	*	*	*	*	*	*	*
NYCTAGINACEAE										
Oxybaphus nyctagineus	p	N.A.	-	-	*	*	*	-	-	-
ONAGRACEAE										
Epilobium										
angustifolium L.	p	N.A.&E.	*	*	*	*	*	*	*	*
glandulosum	p	N.A.	*	*	*	*	*	*	*	*
Oenoethera										
biennis L.	b	N.A.	*	*	*	*	*	*	*	*
perennis L.	p	N.A.	-	-	-	*	*	*	*	*
OXALIDACEAE										
Oxalis europaea Jord.	p	E.	-	-	-	-	*	*	*	*
PAPAVERACEAE										
Chelidonium majus L.	b	E.	-	-	-	-	-	*	*	*
Fumaria officinalis L.	a	E.	*	-	*	*	*	*	*	*
PLANTAGINACEAE										
Plantago										
lanceolata L.	p	E.	*	*	-	-	*	*	*	*
major L.	p	N.A.&E.	*	*	*	*	*	*	*	*
rugelii Dcne.	p	N.A.	-	-	-	-	*	*	*	*
POLEMONIACEAE										
Collomia linearis Nutt.	a	N.A.	*	*	*	*	*	*	*	*
POLYGONACEAE										
Fagopyrum										
esculentum Moench.	a	Eu.	*	-	*	-	-	*	*	*
tataricum (L.) Gaertn.	a	As.	-	-	*	-	-	-	*	*

FAMILY & SPECIES	LIFE DURATION	ORIGIN	PRESENCE IN REGIONAL ZONES 1	2	3	4	5	6	7	8
POLYGONACEAE cont.										
Polygonum										
achoreum Blake	a	N.A.	*	*	*	*	*	*	*	*
aviculare L.	a	N.A.&Eu.	*	*	*	*	*	*	*	*
convolvulus L.	a	E.	*	*	*	*	*	*	*	*
hydropiper L.	a	N.A.&E.	*	-	-	*	*	*	*	*
lapathifolium L.	a	E.	*	*	*	*	*	*	*	*
persicaria L.	a	E.	*	*	*	*	*	*	*	*
Rumex										
acetosella L.	p	Eu.	*	*	*	*	*	*	*	*
crispus L.	p	Eu.	*	*	*	*	*	*	*	*
maritimus (Phil.) Dusen.	a	A.S.	*	*	*	*	*	*	*	-
obtusifolius L.	p	E.	*	-	-	-	*	*	*	*
triangulivalvis	p	N.A.	*	*	*	*	*	*	*	*
POLYPODIACEAE										
Pteridium										
acuilinum var. *latiusculum* (L.) Kuhn	p	N.A.	-	-	-	*	*	*	*	*
var. *pubescens* Underw.	p	N.A.(w)	*	*	-	-	-	-	-	-
PORTULACACEAE										
Portulaca oleracea L.	a	E.	*	*	*	*	*	*	*	*
PRIMULACEAE										
Lysimachia nummularia L.	p	E.	-	-	-	-	-	*	*	*
RANUNCULACEAE										
Acquilegia vulgaris	p	E.	*	-	-	-	-	*	*	*
Ranunculus										
acris L.	p	E.	*	*	*	*	*	*	*	*
repens L.	p	E.	*	-	-	-	-	*	*	*
ROSACEAE										
Agrimonia spp.	p	N.A.	*	*	-	*	*	*	*	*
Potentilla										
argentea L.	p	N.A.&Eu.	-	-	-	-	*	*	*	*
norvegica L.	a	N.A.&Eu.	*	*	*	*	*	*	*	*
recta L.	p	E.	*	-	-	-	*	*	*	*
Galium										
mollugo L.	p	E.	*	-	-	-	-	*	*	*
verum L.	p	E.	*	*	-	*	-	*	*	*

FAMILY & SPECIES	LIFE DURATION	ORIGIN	PRESENCE IN REGIONAL ZONES 1	2	3	4	5	6	7	8
SCROPHULARIACEAE										
Chaenorrhinum minus (L.) Lange	a	E.	*	*	*	*	*	*	*	*
Euphrasia spp.	a	N.A.	-	-	-	-	-	-	*	*
Linaria vulgaris Mill.	p	E.	*	*	*	*	*	*	*	*
Verbascum										
blattaria L.	b	E.	*	-	-	-	-	*	*	-
thapsus L.	b	E.	*	*	-	-	*	*	*	*
Veronica										
officinalis L.	p	N.A.&E.	*	-	-	-	-	*	*	*
peregrina L.	a	N.A.	*	*	*	*	*	*	*	*
serpyllifolia L.	p	N.A.&E.	*	-	-	-	*	*	*	*
SOLANEACEAE										
Solanum										
dulcamara L.	p	E.	*	-	-	-	-	*	*	*
nigrum L.	a	N.A.&E.	*	*	*	-	-	*	*	-
triflorum Nutt.	a	N.A.(w)	*	*	*	*	-	*	-	-
UMBELLIFERAE										
Aegopodium podagraria L.	p	E.	*	-	-	-	-	*	*	*
Carum carvi L.	p	E.	*	*	*	*	*	*	*	*
Daucus carota L.	b	E.	*	-	*	-	-	*	*	*
Pastinaca sativa L.	b	E.	*	*	*	*	*	*	*	*
URTICACEAE										
Urtica										
dioica L.	p	E.	-	-	-	-	-	*	*	*
procera Muhl.	p	N.A.	*	*	*	*	*	*	*	*

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