

The Biology of Canadian Weeds. Revised Instructions and Format, Updated Lists of Accounts Published and In Preparation

P. B. Cavers¹, S. I. Warwick², and D. R. Clements³

¹Department of Biology, University of Western Ontario, London, Ontario, Canada N6A 5B7; ²Eastern Cereal and Oilseed Research Centre, Agriculture and Agri-Food Canada, Neatby Building, Central Experimental Farm, Ottawa, Ontario, Canada K1A 0C6; and ³Department of Biology, Trinity Western University, 7600 Glover Rd., Langley, British Columbia, Canada V2Y 1Y1.

Three years ago, we published a revised format for the series on the Biology of Canadian Weeds, as well as instructions for the preparation of Updates of Previous Accounts (Cavers and Warwick 2000). This led to renewed interest in the series with 15 new accounts and two updates being published from April 2000 to October 2003. In addition, four new accounts and two updates have been accepted for publication, pending revision. There have also been many changes in the list of manuscripts in preparation. Since there are also a number of changes that need to be made in the Format and the Instructions to Authors, we are reprinting all of this information here.

The term “weed”, as used in this series, refers to any vascular plant that perpetuates itself in habitats where it is not wanted. Individual contributions should contain accounts of a single weed species or a group of related species.

Prospective authors should note that a new series, the Biology of Invasive Alien Plants in Canada, is being launched in this journal issue (Warwick et al. 2003). Before submitting an offer of contribution, authors should consider carefully the status and history of their species in Canada and then select the appropriate series. The Biology of Canadian Weeds series addresses undeniable problematic weeds in Canada, whereas the new series is designed to cover aliens in Canada that have demonstratable potential risk. In cases where the assignment to a particular series is not clear, the editors of both series may be called upon to make a judgment call. Please consult the new series (Warwick et al. 2003) for further information.

If you wish to write an account on a weed species, you must first check to ensure that the species has not been assigned to someone else. This involves sending an “offer of contribution” to Dr P. Cavers. After approval of your offer, you may proceed with writing the paper. The completed paper is to be submitted directly to the Canadian Journal of Plant Science (see below).

Offers of contributions by individuals or groups should be made to Dr. Paul B. Cavers, Department of Biology, University of Western Ontario, London, Ontario, N6A 5B7, e-mail pcavers@uwo.ca. These offers of contributions will be subject to approval by a committee of the

Canadian Weed Science Society (CWSS). Approved offers will be subject to re-approval after three years if the article has not been completed during that period. Any inquiries about the format to be used or advice on preliminary drafts should be directed to Dr. Cavers. He can also supply blank maps of Canada and will suggest specialists or institutions that will provide various types of services for authors. The Canadian Weed Science Society has a web site [<http://cwss-scm.ca/>] with on-line references to common English and French names, links to provincial and federal legislation and current lists of species published and in preparation for this series.

The finished manuscript should be submitted to: Canadian Journal of Plant Science; Mr. T. Fenton, Head, Journals Section, Agricultural Institute of Canada, 141 Laurier Ave. W., Suite 1112, Ottawa, Ontario, Canada K1P 5J3. All contributions must comply with the format of this journal. Accounts on a single species, including all maps, drawings, diagrams and photographs, should not exceed 50 pages [12 point font, double-spaced with numbered lines]. Of course, accounts on more than one species can be longer. The authors should also provide the names and addresses [including phone numbers and e-mails if available] of three potential referees.

REVISED FORMAT

TITLE: Each account will be given a number when it is accepted for publication. The number will be part of the title and precede the species name, e.g., The Biology of Canadian Weeds. 118. *Artemisia vulgaris* L.

1. Name

Give the scientific name (genus, species, and nomenclatural authority) currently accepted by plant taxonomists and the recommended English and French vernacular names of the weed that are given in *Common and botanical names of weeds in Canada* (Darbyshire et al. 2000). Also, list synonyms that are used in the weed literature with a source citation for each name. Provide the Bayer code for the species [see web site <http://cipm.ncsu.edu/names/index.cfm>]. Include the Latin, English and French names of the family to which the weed belongs.

2. Description and Account of Variation

(a) *Species Description*—Present a short description of the weed, similar to that given in *Weeds of Canada* (Frankton and Mulligan 1987). Use the metric system for measurements. Where possible, use simple descriptive terms rather than more technical taxonomic terms in describing features (or if no simple term exists explain the taxonomic term in brackets). Include the chromosome number(s), with provincial location of any Canadian material counted, and give the chromosome number range for the species as a whole.

(b) *Distinguishing Features*—Describe morphological characters that distinguish the weed from all other Canadian plants with which it may be confused and consider including a diagnostic key.

(c) *Intraspecific Variation*—Describe any recognizable intraspecific variation in Canadian populations and populations elsewhere [taxonomic, cytological, ecological, genetic (allozyme, molecular data), chemical, etc.].

(d) *Illustrations*—Include a photograph or drawing, or both, of a mature plant, a seedling at approximately the two-leaf stage, and any other stage that persists for some time (for example, the rosette of a biennial). Each of these illustrations should portray clearly any diagnostic characters that would be useful for identification in the field. Important alterations in the appearance of any stage in the life history that results from grazing, mowing, herbicide applications, parasites, diseases, etc., would be useful. List any published illustrations or Internet sites with illustrations, such as the web site of the Weed Science Society of America [<http://www.wssa.net/>].

3. Economic Importance

(a) *Detrimental*—Specify the nature of economic loss resulting from the growth of this species (e.g., competes with crop or pasture species, is toxic or irritant to farm animals or humans, chemically inhibits crop species, makes harvesting difficult, destroys appearance of lawns or gardens, etc.). Is the weed a close relative of crop species grown in Canada or elsewhere, with which it is capable of hybridization (See Section 9)? Does it have herbicide-resistant biotypes (See Section 11)? Does the weed harbour insects or disease organisms that attack other plant species (See Section 13)? Give financial estimates of losses wherever possible.

(b) *Beneficial*—Does the species have an important role as a part of various food chains? Does it bind together soils that are laid bare by fire, construction, farming, etc.? Is it an important genetic resource? Is it a source of honey? Does it have aesthetic value? Is the plant used as a crop or ornamental in Canada or elsewhere?

(b) *Legislation*—Is the species listed in any Canadian Federal or Provincial Weed or Seeds Acts (see web site of the Canadian Weed Science Society: <http://cwss-scm.ca/>)?

4. Geographical Distribution

Give the distribution and abundance in Canada (blank maps for plotting the Canadian distribution can be provided) and also the extra-Canadian distribution. Computer-based maps of acceptable standard can be used. Smaller scale maps may be used for weed species with a narrower distribution. Supplementary maps may be necessary if there are different biotypes. Note that Nunavut has been created from the eastern portion of the former Northwest Territories. See Holmgren et al. (1990) for herbarium abbreviations; on-line version available at <http://www.nybg.org/bsci/ih/ih.html>.

5. Habitat

(a) *Climatic requirements*—Include the climatic (including microclimatic) limitations and preferences with regard to temperature, rainfall, atmospheric humidity, exposure to wind, etc. Where relevant, give the light intensity and its seasonal variation in relation to the life history and distribution of the species (where measurements are given, the methods used should be mentioned). Any restriction or expansion of distribution caused by low temperatures, flooding, drought or other extremes in climate should be considered.

(b) *Substratum*—Give the characteristics of the soils in various habitats and different parts of the range of the species. If the species occurs in specific habitats or is geographically distributed in a way that suggests specific substrate requirements, identify the soil properties affecting this distribution (textural class, drainage class, soil reaction or profile types). Terminology should conform to that specified in *The Canadian System of Soil Classification* (3rd edition), NRC Research Press (Anonymous 1998).

(b) *Communities in which the species occurs*—Briefly describe the community (e.g., spring wheat fields, corn fields, lawns, waste places, etc.) and give the abundance and frequency of your species in each community. For each community where the species is an important component, list in tabular form the associated plant species and give a history of the habitat (e.g., pasture for 50 years). State whether the weed grows in the open or if it normally grows in the shade of other plants.

6. History

For introductions, give evidence and dates for the first introduction of this species into North America and Canada. Also, give available information on time and rate of spread. Give any information on how the plant was originally introduced (e.g., as an impurity in crop seed, as a cultivated plant, or in ballast). For native species, give a brief account of the history of the species as a natural part of the native flora with notes on the changes in the distribution and abundance of the plant since the time of first European settlement.

7. Growth and Development

(a) *Morphology*—List any morphological characteristics that are of special importance in the colonization and sur-

vival of the weed (e.g., underground stems, spines, unpalatable hairs, and hooked seeds) and discuss why these characteristics are of survival value.

(b) *Perennation*—Include the mode of perennation and give a general description of winter conditions.

(c) *Physiological data*—Include transpiration rates, osmotic values, etc., when relevant. Information on a broad range of physiological topics, including mineral nutrition, can also be placed here.

(d) *Phenology*—Give the times of maximal growth of roots and other underground organs; of appearance and growth of leafy shoots (especially for woody species); of flowering; of maturation and shedding of seeds; of germination of seeds or appearance (emergence) of seedlings.

(d) *Mycorrhiza*—State presence or absence of mycorrhiza and, if present, describe.

8. Reproduction

(a) *Floral biology*—Describe the mode of pollination of flowers. List the insect visitors to flowers and describe their behaviour. Are the flowers self-compatible? Are seeds usually produced by autogamy, allogamy, or agamospermy? Is there any evidence of outcrossing in species that can produce seeds autogamously? Does vivipary occur?

(b) *Seed production and dispersal*—What are the average numbers of seeds per fruit, per inflorescence, and per plant? What is the average weight per seed and/or per propagule? Give mode of seed dispersal and special features, if any (e.g., seeds attaching themselves to clothing and fur of animals).

(c) *Seed banks, seed viability and germination*—What is the longevity of seeds in the seed bank? Does the species have a persistent seed bank or only a transient one, and does this differ across the range of the species? Include information on the viability of seeds under different conditions (state how determined). Give geographical location for germination under natural conditions or seed source if under controlled conditions. List any special conditions affecting germination, e.g., sensitivity to light, necessity for preliminary freezing, etc., and conditions for successful establishment of seedlings.

(d) *Vegetative reproduction*—Describe the mode and rate of vegetative reproduction and spread. Describe any vegetatively produced propagules. Give the age of the plant when vegetative reproduction first occurs. State the relative importance of various means of reproduction. Is the reproductive strategy different in different habitats (for example, more seeds in one habitat but more bulbils in a second habitat)?

9. Hybrids

Describe the existence and frequency of natural hybridization with other plants. Is there any evidence of interspecific hybridization between the species and cultivated plants? How can these hybrids be recognized? To what extent do

the hybrids show a diminished fertility or increased vigour as compared with the parents? Are the hybrids of any biological or economic significance?

10. Population Dynamics

Give the rate of increase and decline of populations in various habitats (numbers of individual stalks should be given if possible). Include the mean length of life of individuals in various habitats. Do more plants appear or die in certain months or seasons or after certain changes in the habitat (e.g., drought, flooding) or manipulation (e.g., after clipping)? Describe the plant's competitive ability (intraspecific and interspecific) and its method of competing with other plants. Does the species usually occur as solitary plants, large patches, small patches, etc.? Give the number of generations per year, per decade, or perhaps per century. Describe processes of decay and decomposition involving this species, including the names of the organisms involved. Note: seed population dynamics should be discussed in Section 8(c).

11. Response to Herbicides and Other Chemicals

Give the susceptibility of this species to the most widely used herbicides and herbicide combinations at various stages in its life history. Are there any herbicide-resistant biotypes of the weed in Canada and/or elsewhere? Has the composition of the associated flora changed in response to the repeated application of herbicides?

12. Response to Other Human Manipulations

Describe any response by the weed due to mowing, fertilizing chemicals and manure, ploughing, trampling, fallowing, crop rotation, harvesting, integrated pest management, etc.

13. Response to Herbivory, Disease and Higher Plant Parasites

Includes biological control and controlled grazing programs.

(a) *Herbivory*

- (i) Mammals, including both domestic and wild animals
- (ii) Birds and/or other vertebrates
- (iii) Insects
- (iv) Nematodes and/or other non-vertebrates

(b) *Diseases*

- (i) Fungi (e.g., Farr et al. 2002)
- (ii) Bacteria
- (iii) Viruses (e.g., Brunt et al. 1996)

(c) *Higher Plant Parasites*

In each instance, for all subsections listed above, name the organism attacking the weed (provide the Latin name and nomenclatural authority), indicate its host specificity, abundance and distribution. Describe the stage of the plant attacked, type of damage inflicted, response of the plant population, and value of the attacking species for control of the weed.

Note: In each section, place the Canadian (and/or North American) information first. Where possible in each section,

indicate whether the study was done in the field or in a greenhouse/growth chamber). For field studies, provide the geographic location where the work was done (province/state, country) or the source of the wild population studied. For any plant species, provide the Latin name and nomenclatural authority when first mentioned in the text. In general, authors should cite printed materials and limit reference to illustrations/information from internet sites to those sites maintained by a major society or organization.

PUBLICATIONS TO DATE

Up to October 2003, 127 papers had been published, many of them dealing with two or more species. There have also been two updated accounts, on *Sinapis arvensis* and *Thlaspi arvense*. Interest in the complete series has resulted in the re-publication of individual contributions 1–32, 33–61, 62–83 and 84–102 in four separate compilations edited by G. A. Mulligan (1979, 1984) and P. B. Cavers (1995, 2000).

Accounts have been published on:

Abutilon theophrasti, *Achillea millefolium*, *Acroptilon (Centaurea) repens*, *Agropyron (Elytrigia) repens*, *Alliaria petiolata*, *Amaranthus albus*, *Amaranthus blitoides*, *Amaranthus blitum*, *Amaranthus hybridus*, *Amaranthus powellii*, *Amaranthus retroflexus*, *Ambrosia artemisiifolia*, *Ambrosia psilostachya*, *Ambrosia trifida*, *Anthriscus sylvestris*, *Apera spica-venti*, *Arctium lappa*, *Arctium minus*, *Artemisia absinthium*, *Artemisia vulgaris*, *Asclepias syriaca*, *Atriplex patula*, *Atriplex prostrata*, *Atriplex rosea*, *Avena fatua*, *Barbarea vulgaris*, *Bromus tectorum*, *Cannabis sativa*, *Cardaria chalapensis*, *Cardaria draba*, *Cardaria pubescens*, *Carduus acanthoides*, *Carduus nutans*, *Centaurea diffusa*, *Centaurea maculosa*, *Chenopodium album*, *Cicuta douglasii*, *Cicuta maculata*, *Cicuta virosa*, *Cirsium arvense*, *Comptonia peregrina*, *Convolvulus arvensis*, *Conyza (Erigeron) canadensis*, *Cornus canadensis*, *Crataegus crus-galli*, *Crepis tectorum*, *Cynoglossum officinale*, *Cyperus esculentus*, *Cytisus scoparius*, *Danthonia spicata*, *Datura stramonium*, *Daucus carota*, *Dennstaedtia punctilobula*, *Descurainia sophia*, *Dipsacus sylvestris (fullonum)*, *Echinochloa crus-galli*, *Echium vulgare*, *Elodea canadensis*, *Epilobium angustifolium*, *Equisetum arvense*, *Erucastrum gallicum*, *Euphorbia cyparissias*, *Euphorbia esula*, *Fagopyrum tataricum*, *Galeopsis tetrahit*, *Galinsoga parviflora*, *Galinsoga quadriradiata*, *Galium aparine*, *Galium mollugo*, *Galium spurium*, *Gaultheria shallon*, *Gypsophila paniculata*, *Helianthus tuberosus*, *Holcus lanatus*, *Hordeum jubatum*, *Hydrocharis morsus-ranae*, *Hypericum perforatum*, *Hypochoeris radicata*, *Iva axillaris*, *Kalmia angustifolia*, *Lactuca serriola*, *Lappula squarrosa*, *Linaria dalmatia*, *Linaria vulgaris*, *Lotus corniculatus*, *Lythrum salicaria*, *Malva pusilla*, *Matricaria perforata*, *Medicago lupulina*, *Melilotus alba (albus)*, *Melilotus officinalis*, *Myrica pensylvanica*, *Myriophyllum spicatum*, *Neslia paniculata*, *Oenothera biennis*, *Oxalis corniculata*, *Oxalis dillenii* ssp. *filipes*, *Oxalis stricta*, *Plantago lanceolata*, *Plantago major*, *Plantago rugelii*, *Poa annua*, *Polygonum convolvulus*, *Portulaca oleracea*, *Potamogeton crispus*, *Potentilla anserina*, *Potentilla argentea*,

Potentilla norvegica, *Potentilla recta*, *Prunus serotina*, *Prunus virginiana*, *Pteridium aquilinum*, *Pyrus melanocarpa*, *Rhus (Toxicodendron) radicans*, *Rubus hispidus*, *Rubus parviflorus*, *Rubus spectabilis*, *Rubus strigosus (idaeus)*, *Salsola pestifer*, *Senecio jacobaea*, *Senecio vulgaris*, *Setaria glauca (pumila)*, *Setaria verticillata*, *Setaria viridis*, *Silene alba (pratensis)*, *Silene noctiflora*, *Sinapis arvensis* [+update], *Solanum carolinense*, *Solanum nigrum*, *Solanum ptychanthum*, *Solanum rostratum*, *Solanum sarrachoides*, *Solidago canadensis*, *Sonchus arvensis*, *Sonchus asper*, *Sonchus oleracea (oleraceus)*, *Sorghum halepense*, *Spiraea latifolia (alba)*, *Stellaria media*, *Symphyotrichum (Aster) ericoides*, *Symphyotrichum (Aster) lanceolatum*, *Symphyotrichum (Aster) lateriflorum*, *Symphyotrichum (Aster) novae-angliae*, *Symphyotrichum (Aster) pilosum*, *Taraxacum officinale*, *Thlaspi arvense* [+update], *Tragopogon dubius*, *Tragopogon porrifolius*, *Tragopogon pratensis*, *Trifolium repens*, *Typha angustifolia*, *Typha latifolia*, *Typha xglauca*, *Ulex europeus*, *Urtica dioica*, *Vallisneria americana*, *Veratrum viride*, *Verbascum blattaria*, *Verbascum thapsus*, *Vicia angustifolia*, *Vicia cracca*, *Vicia sativa*, *Vicia tetrasperma*, *Vicia villosa*, *Viola arvensis*, *Xanthium strumarium*.

MANUSCRIPTS IN PREPARATION

(Includes several submissions under review)

Acer negundo, *Agrostis scabra (A. hiemalis)*, *Alliaria petiolata* [update], *Amaranthus hybridus* [update], *Amaranthus powellii* [update], *Amaranthus retroflexus* [update], *Apera interrupta*, *Apocynum cannabinum*, *Artemisia biennis*, *Astragalus miser*, *Bidens cernus*, *Bidens frondosus*, *Bidens tripartitus*, *Bidens vulgatus*, *Bromus inermis*, *Bromus japonicus*, *Butomus umbellatus*, *Calamagrostis canadensis*, *Capsella bursa-pastoris*, *Cerastium arvense*, *Cerastium vulgatum*, *Chenopodium album* [update], *Cirsium vulgare*, *Cornus canadensis* [update], *Coronopus didymus*, *Cynanchum (Vincetoxicum) louiseae*, *Cynanchum (Vincetoxicum) rossicum*, *Daphne laureola*, *Digitaria ischaemum*, *Digitaria sanguinalis*, *Erysimum cheiranthoides*, *Galinsoga parviflora* [update], *Galinsoga quadriradiata* [update], *Glechoma hederacea*, *Glyceria maxima*, *Hedera helix*, *Hieracium aurantiacum*, *Hieracium pilosella*, *Hieracium pratense*, *Hordeum vulgare*, *Kochia scoparia*, *Lepidium spp.*, *Leucanthemum (Chrysanthemum) vulgare*, *Lonicera spp.*, *Mentha arvensis*, *Mollugo verticillata*, *Muhlenbergia frondosa*, *Onopordum acanthium*, *Panicum capillare*, *Panicum miliaceum*, *Pastinaca sativa*, *Phalaris arundinacea*, *Phragmites australis*, *Polygonum aviculare*, *Polygonum coccineum*, *Polygonum lapathifolium*, *Polygonum pensylvanicum*, *Polygonum perfoliatum*, *Polygonum persicaria*, *Polygonum scabrum*, *Raphanus raphanistrum*, *Ranunculus acris*, *Rhamnus catharticus*, *Rhamnus frangula*, *Rhus glabra*, *Rhus typhina*, *Robinia pseudoacacia*, *Rosa multiflora*, *Rumex crispus*, *Rumex obtusifolius*, *Saponaria officinalis*, *Setaria faberi*, *Silene vulgaris*, *Solanum triflorum*, *Spergula arvensis*, *Stachys palustris*, *Tanacetum vulgare*, *Tussilago farfara*, *Veronica spp.*

UPDATED ACCOUNTS

Where there has been a substantial amount of new information published on a weed species after the publication of its

initial treatment in the biology of Canadian weeds series, then an updated account on that species is warranted. There must have been a minimum of 20 years since the publication of the original account before the update can be published. The aim of such accounts should be to augment the original publication, rather than to produce an entirely new manuscript. Please consult with the CWSS committee (Dr. Cavers) if you wish to prepare an updated account.

FORMAT FOR UPDATED ACCOUNTS

The number of the account will be the same as the original (e.g., The biology of Canadian weeds. 8. *Sinapis arvensis* L. (updated). At the beginning of each updated account (before Section 1) the following sentence should appear:

“This account is an update of the original paper by [name(s)] (date) published in the Canadian Journal of Plant Science (Volume) (page numbers).”

Section 1 Name, Section 2 (a)–(d) inclusive and part of Section 4 (Map of Canadian distribution), should be repeated in full in the revised account.

The remaining sections (3 to 13 inclusive) should only include information that was not included in the original account. However, minimal repetition may be needed to provide a contextual framework for new data.

ACKNOWLEDGEMENTS

The authors wish to thank Stephen Darbyshire, Agriculture and Agri-Food Canada, Ottawa for comments on the manuscript.

Anonymous. 1998. The Canadian System of Soil Classification. 3rd ed. NRC Research Press, Ottawa, ON. 188 pp. [Online] Available: http://sis.agr.gc.ca/cansis/references/1998sc_a.html. [24 July 2003].

Brunt, A. A., Crabtree, K., Dallwitz, M. J., Gibbs, A. J., Watson, L. and Zurcher, E. J. (eds.) 1996 onwards. Plant viruses online: Descriptions and Lists from the VIDE Database. Version: 20th August 1996. [Online] Available: <http://image.fs.uidaho.edu/viderefs.htm>. [24 July 2003]

Cavers, P. B. (Ed.) 1995. The biology of Canadian weeds. Contributions 62–83. Agricultural Institute of Canada, Ottawa, ON. 338 pp.

Cavers, P. B. (Ed.) 2000. The biology of Canadian weeds. Contributions 84–102. Agricultural Institute of Canada, Ottawa, ON. 338 pp.

Cavers, P. B. and Warwick, S. 2000. The biology of Canadian weeds. Revised format and instructions for preparation of updated accounts. Can. J. Plant Sci. **80**: 237–240.

Darbyshire, S., Favreau, M. and Murray, M. 2000. Common and scientific names of weeds in Canada. Publ. 1397/B. Agriculture and Agri-Food Canada, Ottawa, ON. 132 pp.

Farr, D. F., Rossman, A. Y., Palm, M. E. and McCray, E. B. 2002 onwards. Fungal Databases, Systematic Botany & Mycology Laboratory, ARS, USDA. [Online] Available: <http://NT.ars-grin.gov/fungaldatabases> [24 July 2003].

Frankton, C. and Mulligan, G. A. 1987. Weeds of Canada (revised). Publ. 948. Ministry of Supply and Services Canada. NC Press Ltd., Toronto, ON. 217 pp.

Giins, J. H. 1986. Compendium of plant disease and decay fungi in Canada 1960–1980. Agriculture Canada, Publ. 1813. Canadian Government Publishing Centre, Ottawa, ON. 416 pp.

Holmgren, P. K., Holmgren, N. H. and Barnett, L. C. (Eds.). 1990. Index Herbariorum, Part I: The Herbaria of the World, 8th ed. New York Botanical Garden, Bronx, NY. 693 pp.

Mulligan, G. A. (Ed.) 1979. The biology of Canadian weeds. Contributions 1–32. Agriculture Canada, Publication 1693, Agriculture Canada, Ottawa, ON. 380 pp.

Mulligan, G. A. (Ed.) 1984. The biology of Canadian weeds. Contributions 33–61. Agriculture Canada, Ottawa, ON. 415 pp.

Warwick, S. L., Cavers, P. B. and Darbyshire, S. 2003. A New Series—The Biology of Invasive Alien Plants in Canada. Instructions for Preparation of Accounts. Can. J. Plant Sci. **83**: 655–659