

BIOLOGICAL CONTROL OF WEEDS
A WORLD CATALOGUE OF AGENTS AND
THEIR TARGET WEEDS

FIFTH EDITION

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Introduction

Biological Control - A World Catalogue of Target Weeds and Their Agents has proven to be one of the most important publications in the field of biological control. This database represents an electronic version of the Fifth Edition of the catalogue. It includes all releases catalogued in the previous four editions, along with updated information and updated references where applicable. It also includes information on releases made since the fourth edition was collated, that is, releases made after 1996 until the end of 2014. Releases overlooked in previous editions which occurred prior to 1996 have also been added.

In this Database:

List 1

List 1 contains entries for **exotic organisms** that have been **intentionally introduced** and released for the biological control of their target weeds. The numerous organisms that have been studied, and in many cases introduced into quarantine facilities in exotic countries, but were not released, are not included in this catalogue. Organisms that were introduced accidentally or illegally into a country prior to their official approval and subsequent redistribution are not listed in this section but are included in List 3.

List 2

List 2 contains entries for **native organisms** utilized within their native ranges to control weeds. Only those organisms that have been **intentionally redistributed** are included in this database.

List 3

Far too many exotic organisms have been found adventively attacking weeds within the introduced range for all to be listed in this catalogue. List 3, therefore, includes only those exotic organisms that are currently utilized and/or are of particular interest to weed biological control practitioners. This list typically includes **exotic organisms** which have been released as biological control agents and **now occur in countries other than those into which they were released**. In other words, they were accidentally or illegally moved, or they spread naturally to another country. This list also includes organisms which are found in exotic ranges where they were not deliberately released but have since been intentionally redistributed or are of interest to researchers or practitioners to potentially be approved for future use. It should be noted that even when an organism on this list has been intentionally redistributed, this redistribution could have been done illegally, and further inquiry should be made before extending the practice.

List 4

List 4 deals solely in **bioherbicides**. The term “bioherbicide” is applied to various types of biologically based herbicides. In this database, bioherbicide refers to a pathogen that is utilized in a manner akin to a chemical herbicide application—namely in a deliberate, prescriptive, intensively managed, and relatively large-scale application where the pathogen of interest is the active ingredient of a standardized product. Bioherbicide research is an active field that has tested an extensive number of pathogens and formulations. Included in this database are only those that have been or currently are formally registered, as well as those that are approved for public use without registration. When utilizing bioherbicides for weed control, it is important to always follow the label or official guidelines for properly applying the organism and to only use the product in the manner for which it was designed.

Structure of Release Pages

An explanation of the sections and headings displayed on individual release pages are given below. There are differences in the structure and information included in each list; consequently, explanations are provided individually for each list. Weed and agent taxonomy, limiting factors, other attack, research organizations, and the use of references are similar for all lists.

Lists 1-4

Agent Taxonomy

Every effort was made to utilize the most updated and accurate taxonomy for each species. This was accomplished with help from numerous taxonomists, references, and taxonomic databases. Many agents have been previously associated with several different names. In this database, we include only those past names that appear in the literature cited for this database. Past names known to have been misidentifications or misspellings are included under the heading "Incorrect Past Name/Synonyms". All past names are included in the agent search table, with appropriate referencing to the currently accepted name used in the lists. Additional notes are given on occasion to further explain or elucidate the taxonomic status of each species. References are provided for all current and past names listed in this database.

Weed Taxonomy

Every effort was made to utilize the most updated and accurate taxonomy for each weed species. This was accomplished with help from numerous taxonomists as well as worldwide and regional Floras. Many weeds have been previously associated with several different names. In this database, we include only those past names that appear in the literature cited for this database. Past names known to have been misidentifications or misspellings are included under the heading "Incorrect Past Name/Synonyms". All past names are included in the weed search table, with appropriate referencing to the currently accepted name used in the lists. Additional notes are given on occasion to further explain or elucidate the taxonomic status of each species. References are provided for all current and past names listed in this database. For each weed, common names listed in the literature cited in this database are included. Common names often vary between countries. Finally, the country or region of origin of the weed is also included.

Limiting Factors

Factors known to limit the efficacy of any particular release are listed separately, along with supporting references.

Other Attack

If additional attack has been documented on plant species other than those targeted for control, this information is given, along with supporting references.

Research Organizations

The research entities involved with releases are given when known.

References

The reference list is not exhaustive for the biological control of a particular weed species. It is limited to only those references that provided the information included in the database. Where published references were not available for information cited, the name of the expert who provided the information via a personal communication is included, along with their current address. Some information stated in previous editions of this catalogue was gleaned from very old personal communications. All attempts were made during this revision to use new and/or published references to update this information. Where this was not possible, personal communications from previous editions of the catalogue are retained and cited, using the old dates and contact information provided at the time.

List 1 (Exotic Organisms Intentionally Introduced)

Release Information

Some species have been released in the same country multiple times. When subsequent releases originated from different sources, were separated by five years or more, or were successfully established following the failure of the original release(s), then these subsequent releases are given their own entries. The original source of release material is preceded by "Ex." When the release material was not obtained directly from its native range, the countries or regions from where it was obtained are given, preceded by "via". For example: AUSTRALIA Ex. Argentina via USA via India - means that the species that was released in Australia originated in Argentina (probably its native range) from where it was sent to the USA. Thereafter a colony was sent to India, and Australia obtained material from India.

Current Status

The establishment status of each species is given when known. The current abundance and impact of established agents are then stated using key choices pre-determined for the ease of quick data summary. Agent abundance is represented by seven categories: *Rare*, *Limited*, *Moderate*, *High*, *Variable*, *Too early post release*, and *Unknown*. Agent impact is represented by eight categories: *None*, *Slight*, *Medium*, *Heavy*, *Variable*, *Too early post release*, *Unknown* and *Compromised* (the latter for sites destroyed post release). In order to place the agent impact into a geographical context, the scale of impact is also provided. The four categories for scale of impact include: *Localized*, *Regional*, *Widespread* throughout range, and *Unknown*. Because the choices selected for abundance, impact, and scale of impact are subjective estimates by the editors, an additional notes section is provided which includes a brief summary of the status for each release system.

List 2 (Native Organisms Intentionally Redistributed)

Release Information

Releases in this table are typically redistributions because the agents in question already occur naturally within the country of discussion and are simply redistributed to select locations within the country. Some species have been redistributed in the same country multiple times. When subsequent releases were separated by five years or more, or were successfully established following the failure of the original release(s), then these subsequent releases are given their own entries and are listed numerically by the release year.

Current Status

Please note that all information included in this section pertains only to the intentionally introduced populations, and not to naturally occurring populations established elsewhere within the country. The establishment status of each intentional release is given when known. The impact of established agents is then stated using eight categories pre-determined for the ease of quick data summary, including: *None*, *Slight*, *Medium*, *Heavy*, *Variable*, *Too early post release*, *Unknown* and *Compromised* (the latter for sites destroyed post release). Because the choices selected for impact are subjective estimates by the editors, an additional notes section is provided which includes a brief summary of the status for each release system. All impact is assumed to occur only on a localized scale following the release, unless stated otherwise in the notes.

List 3 (Previously Used or Potential Agents Found in Exotic Ranges where their Deliberate Release is not Recorded)

Release Information

Entries are listed according to the country where the agent was recorded as established, accompanied by the year the agent was first recorded, when known. In some instances, organisms initially introduced accidentally or illegally into a country were subsequently approved for redistribution within that country by the appropriate authorities. In these instances, the first year of intentional redistribution is also given. The original source of each species is typically not known and is listed as such. However, in some cases, the pathway of accidental introduction is known for certain. For these cases, the source of the accidental/adventive population is given, preceded by "Ex." When the population did not originate directly from the agent's native range, the countries or regions from where it originated are given, preceded by "via". For example, a species that originated in Argentina and was intentionally introduced into India prior to the agent naturally crossing the border from India into NEPAL would be stated as: NEPAL Ex. Argentina via India.

Current Status

Establishment of each species is given when known, but is typically "Yes" for all entries on this list. The current abundance and impact of established agents are then stated using key choices pre-determined for the ease of quick data summary. Agent abundance is represented by seven categories: *Rare*, *Limited*, *Moderate*, *High*, *Variable*, *Too early post release*, and *Unknown*. Agent impact is represented by eight categories: *None*, *Slight*, *Medium*, *Heavy*, *Variable*, *Too early post release*, and *Unknown*. In order to place the agent impact into a geographical context, the scale of impact is also provided. The four categories for scale of impact include: *Localized*, *Regional*, *Widespread throughout range*, and *Unknown*. Because the choices selected for abundance, impact, and scale of impact are subjective estimates by the editors, an additional notes section is provided which includes a brief summary of the status for each release system.

List 4 (Bioherbicides)

* Please note that although some references indicate *Mycoleptodiscus terrestris* (Gerd.) Ostaz. was registered as Aqua Fyte for the control of *Myriophyllum spicatum* L. in the USA, official registration has not occurred. Consequently this pathogen/weed system has been intentionally removed from this table.

Source

The host source and location of isolation are given.

Registration

Entries are separated according to the country in which a bioherbicide has been registered and are accompanied by the first year of registration with the appropriate authority. Also included are the name of the registered product(s), the research organization involved, and registration notes, where applicable.

Impact

Bioherbicide impact is represented by six categories: *None*, *Slight*, *Medium*, *Heavy*, *Variable*, and *Unknown*. All impact is assumed to occur only on a localized scale following the application. Because the choices selected for impact are subjective estimates by the editors, an additional notes section is provided which includes a brief summary of each bioherbicide system.

Commercialization

The commercial status of the organism is given, along with the name of the commercialized product, the company or institution responsible and notes, if applicable.

Acknowledgments

All four previous editions of this catalogue were collated and edited by **Mic H. Julien** (CSIRO retired), with support from other key individuals. Those earlier editions were compiled at a time when references were more difficult to obtain and contacts were more challenging and time-intensive to establish worldwide. This Fifth Edition would not have been possible were it not for Mic's willingness to share his painstakingly collected data, references, and contacts. Despite retiring *prior* to the onset of this major effort, Mic played a crucial role in the revision. He always made himself available for guiding us through all questions and issues we encountered. He also personally handled the collation and updating of numerous weed systems spanning multiple countries. Mic's dedication to this project through all five editions helps explain why many in our discipline continue to affectionately refer to this and previous versions simply as "Julien's Catalogue". We are very grateful to have been able to join him in this effort.

Michelle Lewis (Private Contractor, Rigby ID, USA) was key to the revision process. Michelle designed the original electronic database, migrated existing information to the new format, completed the entire first draft of the update and expansion, and maintained the integrity of the database during subsequent editing phases. Long after her involvement with the effort was to have ended, she continued to volunteer her time and skills to ensure this project was completed and with the highest quality possible.

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