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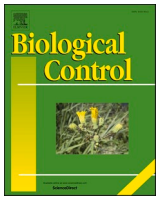

PROSPECTS FOR THE BIOLOGICAL CONTROL OF WEEDS IN ARGENTINA

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HIGHLIGHTS

- Classical weed biological control is hardly practiced in Argentina today.
- There is a small community of local experts that work mostly for overseas projects.
- The National Strategy on Invasive Alien Species promotes biocontrol initiatives.
- A prioritization process is developed to select the best target(s) for biocontrol.
- Public awareness and outreach activities could help gain biocontrol public support.

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ABSTRACT

Argentina hosted pioneering classical weed biological control projects that were carried out by state institutions between the 1970s and 1990s, at a time when the practice was almost unheard of in Latin America. Despite the early development of these initiatives, the discipline did not prosper and all projects were discontinued. Notwithstanding, Argentina continued to provide biological control agents for the control of weeds in many other parts of the world, ensuring the expertise persisted. Although public concern about invasive plants and chemical-dependent agricultural practices has increased over time, it did not lead to a greater acceptance of classical biological control of weeds, which is still regarded with mistrust or ignored in many public and academic circles alike. Furthermore, there are no systems in place to reach a consensus on declaring weeds as targets for biological control in Argentina. In this paper we discuss different ways in which the community of researchers working in the field in Argentina can help relaunch the biological control of weeds, including the preparation of a prioritized list of target species. A list of this kind would not only reduce costs, but also help in developing trust in the discipline of biological control informing regulators and decision makers in this regard. Prospects are brighter today than a few years ago, but considerable communication and educational work on the benefits of this practice is still required to gain more support before it can effectively be re-implemented.

1. Background

The history of classical weed biological control (CWBC) in Argentina is not well documented. The first initiatives in this discipline began when a USDA-ARS laboratory was established in 1962 at the Plant Pathology Institute of the National Institute of Agricultural Technology (INTA), in Castelar, Buenos Aires Province, to search for natural enemies of alligator weed (*Alternanthera philoxeroides* (Mart.) Griseb.), and water hyacinth (*Pontederia crassipes* Mart.), two of the most serious weeds of waterways in southeastern U.S. at the time. The success of these research projects lead to the establishment of the South American Biological Control Laboratory (USDA-ARS-SABCL, now Fundación para el Estudio de Especies Invasivas, FuEDEI) as an autonomous facility located in Hurlingham. The SABCL took on the first case of local application of CWBC in 1974, when the weevil *Neochetina bruchi* (Warner) was used to control *P. crassipes* in the Los Sauces reservoir, in the province of La Rioja

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(DeLoach and Cordo, 1983). In the 1980s and 1990s, the country hosted more CWBC projects, at a time when the practice was young in South America (Cabrera Walsh et al., 2014). The targeted plants were *Carduus* spp., against which the weevils *Rhinocyllus conicus* Froelich and *Trichosirocalus horridus* (Panzer) (Coleoptera: Curculionidae) were released in the early 1980 s; and skeleton weed (*Chondrilla juncea* L.), against which *Cystiphora schmidti* Rubsaamen (Diptera: Cecidomyiidae), *Bradyrrhoa gilveolella* Treitschke (Lepidoptera: Pyralidae), *Aceria chondrillae* Canestrini (Acariformes: Eriophyidae), and the rust fungus *Puccinia chondrillina* Bubák & Syd. were released during the 1980s and 1990s. Of these, only *R. conicus* on *Carduus* spp., and *A. chondrillae* and *P. chondrillinaa* on skeleton weed became established, with mixed results in the control of the population densities of their target weeds. Other invasive plants, both exotic and native, were targeted for biocontrol, but no agents were released for them (Erb, 1984, Deloach et al., 1989). Up until the late 1990s, the targets were chosen through the personal initiative of researchers from state institutions and did not necessarily respond to national policies. In addition, post-release studies were for the most part lacking due to the limited support these projects received (Enrique de Briano et al., 2013). Meagre financial support and a prevailing tendency towards the use of synthetic herbicides as the main tool in weed control, soon ended the initial interest in these more environmentally friendly enterprises, and all local CWBC programs were discontinued. Notwithstanding, Argentina continued to work on several CWBC projects providing biological control agents for the control of weeds in many parts of the world (Greco et al., 2020). This activity is carried out mostly through the FuEDEI, as a result of which, a total of 48 weed BCA from Argentina have established around the world (Winston et al., 2023). The FuEDEI has thus greatly contributed to the building of expertise in the field of CWBC in Argentina, supported by its collaboration with the international biological control community. In the last 20 years, a few other research groups started working on weed biological control, so that at present there is a small community of researchers working in the field. However, the discipline is still regarded with mistrust in certain circles (Cabrera Walsh et al., 2023a). Although public concern about invasive plant species and chemical-dependent agricultural practices has increased, it did not lead to a greater acceptance of CWBC. There appears to be a general bias against the potential of this practice amongst policy makers, academics, and the public in general, whose perception is more oriented towards its potential risks than to the benefits derived from it (Mc Kay et al., 2021, Cabrera Walsh et al., 2023a). It is surprising that this scenario prevails despite intense research regarding the ecology and impacts of invasive exotic plants on the natural environments of practically all of the country's biomes (Brancatelli et al., 2022, Cipriotti et al., 2010, Marbán and Zalba, 2019, Montti et al., 2017, Natale et al., 2012, Speziale and Ezcurra, 2011, among many others). Moreover, many of the cases in which the advance of invasive plants on wild environments have been recorded, involve national parks and other protected areas (Barros and Pickering, 2014, Brancatelli et al., 2020, Francisconi, 2019, Gervazoni et al., 2020, Sanguinetti et al., 2014). The extent of the areas covered by invasive species, and the difficulties in accessing these areas for the application of mechanical or chemical control techniques would appear to make them, a priori, particularly appropriate targets for the implementation of CWBC. This is the case, for example, of Spanish and French brooms (*Spartium junceum* L. and *Genista monospessulana* (L.) L.A.S. Johonson) in many areas of Argentina (Sanhueza and Zalba, 2014, Puntieri and Chiapella, 2019), of broad-leaf privet (*Ligustrum lucidum* W.T. Aiton) in riparian forests of the Río de la Plata (Franco et al., 2018) and the subtropical Yungas forest (Zamora Nasca et al., 2014), and, tamarisk (*Tamarix* spp.) in arid and semi-arid regions of the country (Natale et al., 2008). In recent years, some promising steps have been taken towards the adoption of CWBC for the management of some particularly aggressive invasive plants. For example, a control project against invasive *Tamarix* spp. (Tamaricaceae) was quite recently funded by the Argentine ministry of science, technology and productive innovation (FONCyT-PICT, 2017), and another one against *Iris pseudacorus* L. (Iridaceae) is currently underway (Mc Kay et al., 2017, Gervazoni et al., 2023).

2. Winds of change

There have been two recent milestones which open up new prospects for CBCW in Argentina. The development of the National Strategy on Invasive Alien Species (ENEEI), and its formal approval by the National Ministry of the Environment and Sustainable Development in May 2022, and the hosting of the XVI International Symposium on Biological Control of Weeds in Argentina (ISBCW), in May 2023.

The national strategy was built over ten years of extensive work involving hundreds of experts and other stakeholders from public and private institutions around the country, and provided, among other key components for public policies in this matter, the first official list of invasive species in Argentina (MAyDS, 2021). The list includes 728 species that have been detected in natural or semi-natural environments in the country or that, while still limited to cultivation or breeding, have become invasive in other parts of the world. More than half of these species (412) are plants, with a predominance of members of the families Asteraceae, Poaceae and Rosaceae. Two hundred and thirty-one of these plants are classified as "*restricted species*", that is, species that are not subject to any type of exploitation, or that, should they be used, represent a threat that in the opinion of the enforcement authority exceeds the benefits associated with their exploitation. A further 174 plant species are considered "*controlled use species*", and are those that are being exploited in some way and because of the importance of such activities, these should be maintained but ensuring the necessary conditions to minimize the risks of escape and establishment; the remaining seven species are pending classification (MAyDS, 2021). This list is a work in progress that is shortly bound to be modified greatly, but it will be the basis for the prioritization, once is agreed on. According to the national database on invasive alien species (INBIAR-UNS, 2023), 369 of all the invasive and potentially invasive plants listed in the national list have been already detected in national parks and other protected areas. It should be noted that the ENEEI specifically mentions the need to promote the use of biological control as a tool to confront the challenge of invasive alien species (IAS). Furthermore, objective 5 of the strategy highlights the need for innovative proposals aimed at developing, testing and adjusting management tools, including biological control. In turn. strategic axis 2 specifically proposes "*promoting initiatives for the use of biological control, especially in cases of widely distributed IAS, though previously evaluating any associated impacts*" (MAyDS, 2022). Both the official identification of the IAS as responsible for impacts on biodiversity in the country, and the recognition of biological control as a promising tool to face the problem, generate a qualitative change in the scenario of environmental weed management in Argentina.

Shortly after the approval of the ENEEI, Argentina hosted the XVI ISCBW, the first to be held in Latin America. The organizers of the event managed to overcome the constraints imposed by the Covid pandemic, and gathered 164 participants from 64 institutions from 19 countries (Cabrera Walsh et al., 2023b). It was auspicious that the organizing committee was awarded a grant from the Ministry of Science (Ministerio de Ciencia, Tecnología e Innovación, MinCyT) that allowed the attendance of local scientists who had the chance to meet specialists from other countries and lay the foundations for future collaborations (MinCyT, 2022). The state of the art in Argentina was discussed in the session on Prospects for weed biological control in South America (Cabrera Walsh et al., 2023b). Many foreign researchers from countries with a long tradition in CWBC offered their support to help in the development of future projects in Argentina, including representatives of CSIRO and USDA's Agricultural Research Service (ARS) proposing support for the development of biological control initiatives in general and for the control of *Tamarix* in particular.

3. A communication challenge

Despite the above, the implementation of CWBC in Argentina, and Latin America in general, still needs to gain the support of the general public, policy makers and academics alike (Cabrera Walsh et al., 2023a). A recent survey was conducted among decision-makers of the public administration in the fields of natural resources and conservation, technical advisors in those institutions, NGOs, academics, park rangers, and education and communication professionals across the country, It showed that, despite a majoritarian recognition of the importance of biological control for the management of environmental weeds, 20 % of the respondents said that they would recommend, authorize or enforce BC of IAS in natural areas only "as a last option", and 8 % would not do so at all, with a slightly higher rejection from the academic sector compared to those working in the public administration (Zalba, 2023). Forty-two percent of respondents overestimated the number of IAS originally introduced in Argentina for BC, however when asked about specific cases, only five species (less than 0,7% of the national list of IAS) were mentioned. In fact, only two of the latter, the harlequin ladybird (*Harmonia axyridis* (Pallas)), and the grass carp (*Ctenopharyngodon idella* (Valenciennes)) were actually introduced into the country in association with pest or weed control projects (Zalba, 2023). Another survey on CWBC was carried out at a workshop during the VII National Biodiversity Conservation Congress held in April 2023 in Puerto Iguazú, Misiones, Argentina. The survey was answered by 45 people including mostly undergraduate and graduate students, researchers, teachers and technical staff from 14 of the 24 jurisdictions of Argentina. Among the survey respondents, 60 % were not familiar with the discipline of CWBC and did not know about any examples of its implementation in the world, or in Argentina. When asked what aspect of the CWBC they considered worrisome, direct impacts on non-target species and indirect impacts on native biodiversity were the two most chosen aspects. In addition, 93 % of the respondents said they were not aware of the risk assessment studies that are nowadays common practice before approval for the use of any particular classical weed biocontrol agent is granted. However, at the end of the survey, 70 % of the respondents said they were in favor of considering CWBC as a management tool in state environmental management policies in Argentina (unpublished).

The results of both surveys highlight the need to promote research/management projects aimed at the control of IAS in natural areas, disseminate the potential and advantages of CWBC for the management of IAS, and publicize the procedures and safety of modern CWBC.

4. The way forward

There are several protocols in place for the selection and ranking of potential biocontrol targets in different parts of the world (Paterson et al., 2021, Paynter et al., 2009; Raghu and Morin, 2017). Existing protocols can be applied in Argentina, however, given the shortage of economic resources, the protocol to be adopted should include attributes that allow decisions to be made with the available information and that do not require additional studies (Downey et al., 2021). In this context, weeds targeted by biocontrol programs elsewhere that have resulted in successful control should receive higher weighting than novel targets, leading to time and resources savings. In Argentina, Cordo (2004) proposed a prioritization protocol based on six criteria: 1. Choose weeds that have been successfully controlled abroad; 2. Choose weeds that are not related to beneficial plants; 3. Focus only on exotic plants; 4. Target weeds that grow in comparatively stable environments; 5. Avoid grasses as targets; and 6. Avoid annuals. Following these, he proceeded to make lists of suitable candidates for classical biocontrol in protected areas in the province of Buenos Aires. This protocol took into consideration several concepts already accepted in CWBC, and could be considered a valuable precedent, with the exception of avoiding grasses as targets, a concept that has since been revised (Sutton et al., 2019). However, current protocols are much more systematic and comprehensive. The development of an updated protocol to help in the prioritization and selection of targets would allow for an informed choice of projects with the best chances of success, in the shortest possible time. The list of invasive alien species (MAyDS, 2021) provides an official data base from which to select the most suitable targets. As mentioned before, the list includes 412 alien plants spontaneously growing in natural and semi-natural environments in the country, as well as others that although still remain contained, have a history of invasion in other regions of the world. These species, plus other alien plants affecting productive environments, could be the basis for such an analysis (Fig. 1).

Most of the existing published protocols are based on ranking traits of the weed and available agents. Important information in choosing valid CWBC targets includes impact in economic and/or environmental terms, wide distribution, potential for conflict of interest (i.e., plants with no or negligible use are preferred), background research available, and the existence of successful and safe agents in place somewhere else. Such a systematic process is yet to be applied in Argentina, but in the meantime baseline information is being gathered for three invasive plants: *Tamarix* spp. (mostly *T. ramossisima,* but there are three other species, and probably hybrids (Natale et al., 2008)), *Hedychium coronarium* Koenig, and *I. pseudacorus.* The choice of these three candidates did not follow any specific protocol, but as it may take years to agree and apply one, these three species were proposed in order to advance the discipline while interest was high. *Tamarix* spp. were chosen because they were at the top of the priority list produced by the Ministry of Environment. *H. coronarium* and *I. pseudachorus,* on the other hand, were top of the concern lists for the Northeastern National Parks section and the Province of Buenos Aires environment agency, respectively. They are also severe invasives in many other countries where they are currently targeted for biocontrol, and subjects of intense research.Given these circumstances, the researchers involved assumed they would be the targets least prone to find resistance, and with higher chances of receiving research funds. Such predictions proved to be correct, and the projects currently have full support, and have produced fruitful base studies. These studies include taxonomy, current and potential distribution, conflicts of interest, impact, available control methods, checklists of natural enemies, all of which are being analyzed to evaluate the appropriateness of these invasive weeds as targets for biological control programs in Argentina (Mc Kay et al., 2017, Mc Kay et al., 2021, Gervazoni et al., 2023). The contributions by Mc Kay et al. were meant not only to provide the ecological framework needed for evaluating the implementation of a CWBC program against species like *Tamarix* spp. and *H. coronarium*, but also as a source of thorough information for an open discussion between researchers and policy and decision makers, to achieve the necessary consensus for the implementation of CWBC programs.

In a second attempt to prioritize targets for weed biological control in Argentina, Ansaldi (2019) applied the framework developed by Paynter et al. (2009). This framework is a quantitative system that consists of a series of 15 questions grouped into three modules. *Module 1*: refers to weed importance and desirability of biocontrol; *Module 2*: to the effort required to obtain biocontrol agents and for host range testing, while *Module 3* : refers to the prediction of the potential impact of biocontrol. The absence of a ranking of importance of weeds in Argentina, necessary to apply the first module of the framework developed by Paynter et al. (2009), forced the implementation of an adaptation developed by Maczey et al. (2012) to prioritize targets for weed biological control in the UK Overseas Territories in the South Atlantic. The adaptation consists of 12 questions to determine whether a species is widespread, intractable, and important enough to justify investment in biocontrol. The framework was applied to a list of 95 exotic invasive plant species that was elaborated before the publication of the official national list and based on the wide distribution of these plants in natural areas of Argentina, as well as their environmental/economic impact. As a result of this study, the four most highly ranked targets were: *Tamarix ramosissima* Ledeb., *Carduus nutans* L., *Chondrilla juncea* L. and *Echium*

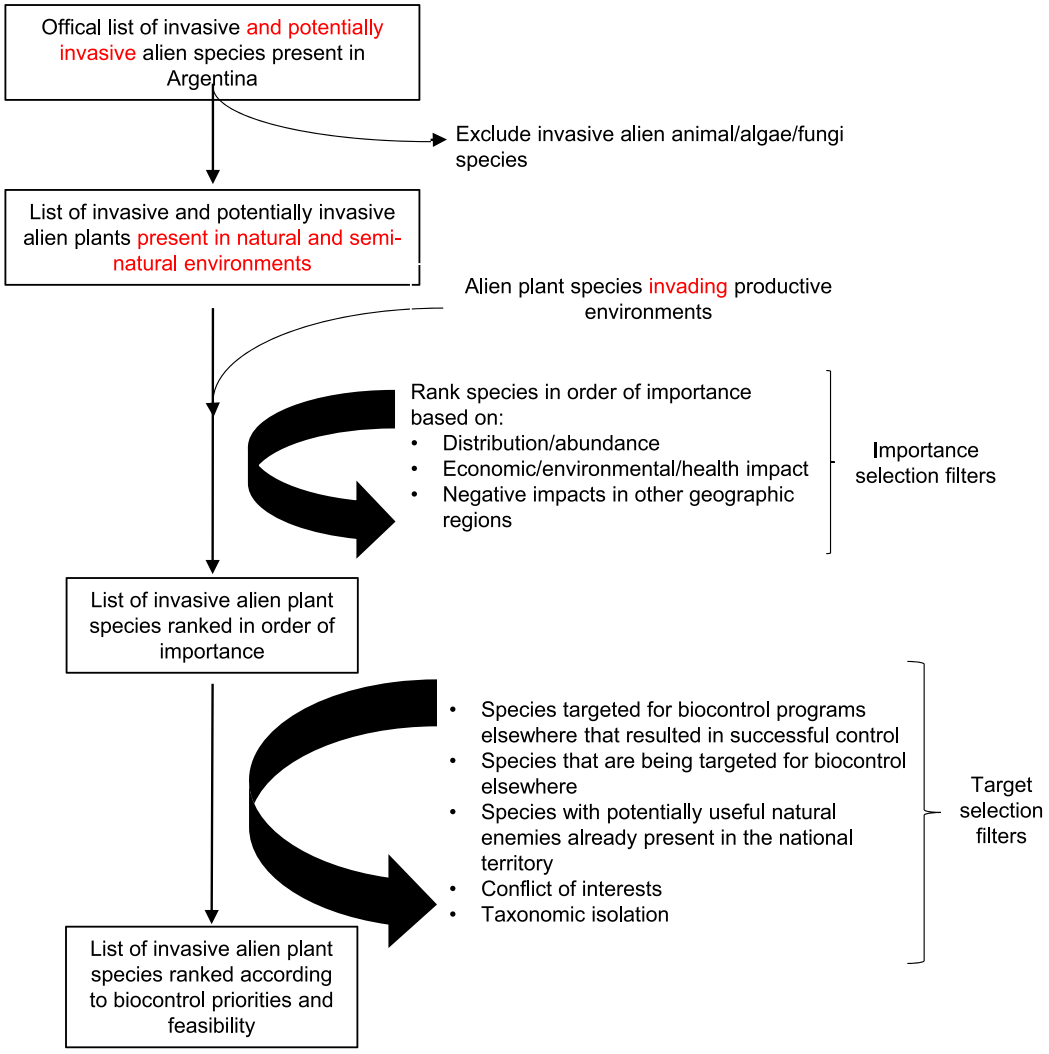

Fig. 1. Proposed schema for selecting andprioritizing invasive alien plants as targets for biocontrol programs in Argentina.

plantagineum L., all of which have been subject to biological control in other countries (Winston et al., 2023). Coincidentally, these species have been classified as species of *mandatory control* and *restricted* or *of controlled use* in the list of invasive alien species (MAyDS, 2021). This study showed that it is possible to adapt existing prioritization protocols to local situations. Notwithstanding, a comprehensive discussion about which would be the best system/protocol to apply in Argentina is still pending.

4.1. Engage neighboring countries in regional programs

In September 2023 the session "Invasive plants: impact and natural based management in Latin America", took place at the Science Summit at the 78 United Nation General Assembly (SSUNGA 78, 2023). In this session, it was suggested that it would be very helpful to select CWBC targets that are important at a regional level, rather than for single countries, so that efforts from neighboring countries can be combined against common problematic invasive plant species (SSUNGA 78, 2023).

Another conclusion from the same session was that the International Organization for Biological Control (IOBC), through its Neotropical Regional Section, could be the liaison between invasive plant researchers and biological control practitioners in Latin America through the constitution of work/study groups, and the one to act as a facilitator organizing regional meetings. One such group already exists, the Classical Weed Biological Control Workgroup (https://www.iobc-global.org/global_sg_Classical_Weed_BC.html), and a great deal could be achieved if interested Latin American parties were willing to participate. The Third International Congress on Biological Control (ICBC3) in Costa Rica in June 2024, organized by IOBC and CABI, would constitute an ideal venue at which to address these issues.

In a paper published in 2013, Fonseca and collaborators addressed common challenges for the management of invasive exotic plants in Pampean grasslands shared by Argentina, Brazil and Uruguay. Of a total of 356 IAS listed for the entire biome, 50 are present and problematic in the three countries. It is expected that similar results will be obtained when comparing other transnational biomes, highlighting the opportunity to develop cooperative management efforts. In the same spirit, and with financing from the Biobridge program of the Convention on Biological Diversity, recent initiatives have been developed to promote the exchange of information between countries in Latin America and the Caribbean, as a basis for joint work against the challenge of transnational threats by IAS (CBD-Biobridge, 2021; 2022). Finally, in December 2023, the Food and Agriculture Organization of the United Nations (FAO) launched a regional network on forest health and invasive species that will include political and technical representatives from Latin American countries and the Caribbean, that will contribute to regional coordination of efforts, including the promotion of CWBC.

4.2. Public awareness and outreach

Actions are being taken by the small community of researchers working on the subject to publicize the theory behind the practice, the successes that have been achieved in other parts of the world, the reliability of risk analysis studies for decision making, and, to explain the consequences of not controlling invasive plant species. These activities include graduate and postgraduate courses, seminars, conferences at public and administration levels, brochures and online material, and participation in advisory boards at the municipal, provincial and national government levels (Fernández Souto et al., 2023, Jiménez et al., 2023, Sosa et al., 2021, Varone et al., 2022).

At the SSUNGA78 referred to earlier, it was concluded that we, as biocontrol scientists and practitioners, need to become better in communicating our work. It was suggested that one way could be to engage a global public relations company to do the publicizing for us. This approach is most likely not feasible for low income countries like Argentina, but the country would certainly benefit from this action being eventually carried forward by more developed countries.

4.3. Regulatory framework

The entry into Argentina of any biological agent intended for the control of agricultural pests is subject to prior authorization from the National Agri-Food Health and Quality Service (SENASA). Between 1996 and 2019 more than 20 biological control agents and beneficial organisms have been evaluated (SENASA 2024). All import requests need to be evaluated and the introduction of biological control agents agreed upon by the neighboring countries that are members of the Southern Cone Committee (COSAVE).

The COSAVE is a regional plant protection organization covering Argentina, Bolivia, Brazil, Chile, Paraguay, Peru and Uruguay. It was created in 1989 within the framework of the International Plant Protection Convention (IPPC) to solve phytosanitary problems of common interest among member countries (COSAVE, 2023). At present COSAVE coordinates regional pest containment plans such as the control of the boll weevil (*Anthonomus grandis* Boheman), a surveillance and biological control plan for the eucalyptus bug (*Thaumastocoris peregrinus* Carpintero & Dellapé) and a containment plan for the citrus greening disease or huanglongbing – HLB (COSAVE, 2023). In addition, the COSAVE participates in the Inter-American Coordinating Group in Plant Protection (GICSV), a collaborative agreement among the regional plant protection organizations of the Americas and the Caribbean. The GICSV has working groups on HLB, fruit flies and the tomato leaf miner (*Tuta absoluta* Meyrick) (GICSV, 2023). COSAVE and the GICSV could be the appropriate organizations to promote communication between working groups in the member countries, dealing with invasive plants of regional importance. The building of consensus among participating parties on regulations regarding the access, collection, movement, liberation, and monitoring of weed biological control agents is of paramount importance for the adoption of CWBC in this part of the world.

4.4. Incorporation of biological control and stakeholder involvement in integrated management programs

The feasibility of using native natural enemies in integrated weed management programs should be pursued as a way of habituating stakeholders to CWBC, as this approach is generally perceived as less risky than importing exotic ones (Cabrera Walsh et al., 2017). One such example, the introduction of the weevil *N. bruchi* to control *P. crassips* in the Los Sauces Reservoir, originated from the personal motivation of one researcher approximately 50 years ago (DeLoach and Cordo, 1983). However, recent years have seen the active involvement of provincial and local universities in system monitoring (Faltlhauser et al., 2023). This particular case serves as a model of successful control, with current efforts primarily dedicated to reservoir monitoring to detect any resurgence of the plant from seedlings. In this regard, the effective management of aquatic weeds, incorporating biological control measures, stands out as a prime illustration of the Multiple Stakeholder Approach: i.e. with the involvement of policy makers, scientists, teachers, students, non-formal educators, and the general public (Hemmati, 2012, Sosa et al., 2021), featuring noteworthy examples. These monitoring activities are conducted collaboratively by scientists from the FuEDEI, the University of La Rioja, and residents. A second one stems from grassroots initiatives, where local communities engage with scientists to address aquatic weed management in both urban and *peri*-urban ecosystems such as the control of water lettuce, *Pistia stratiotes*, in the provinces of Buenos Aires and Chaco (Cabrera Walsh and Maestro, 2015, Franceschini et al., 2023). In both scenarios, the introduction of two native natural enemies, the weevil *Neohydronomus afinis* Hustache and the planthopper *Lepidelphax pistiae* Remes Lenicov, has proven effective. Another example pertains to water hyacinth management, in lake El Ojo, in Buenos Aires Province, employing the weevil *N. bruchi* and the planthopper *Megamelus scutellaris* Berg. In this case, it is noteworthy to emphasize the involvement of the local community. Students from a nearby school constructed a small facility for rearing insects, ensuring an ample supply of weevils and planthoppers for release into the local lake to manage water hyacinth. The financial backing for these facilities was provided by provincial authorities from the provincial Education Department (Sosa et al., 2018).

Another initiative that is underway is the investigation into the use of the fungal pathogen *Cercospora elongata* Peck in combination with sublethal doses of herbicides for the control of common teasel (*Dipsacus fullonum* L.). This important weed is especially abundant in the province of Buenos Aires, where it invades natural areas, pastures, and road sides. The bioecology of the plant under local conditions, together with the feasibility of applying traditional control methods was investigated (Daddario et al., 2021; 2022a). In addition, surveys were conducted in search for fungal pathogens affecting the populations located within the province of Buenos Aires. Of these, the causal agent of a common leaf spot, *C. elongata*, was selected for further studies. From the literature, the fungus is presumed to be restricted to *Dipsacus* spp. A protocol has been developed for the production of inoculum in the laboratory (Daddario et al., 2022b). Studies on the optimal environmental conditions needed for infection and disease development to take place are underway. From preliminary observations both in the laboratory and the field, it is presumed the disease alone would not be enough to achieve the required level of control, even if inoculum load would be increased in the field. This is why the combined use of the fungus and herbicides is suggested.

The success of initiatives like the above could help in increasing awareness of the potential of biological control and gain support from relevant stakeholders for CWBC.

5. Closing remarks

CWBC is a discipline with a remarkable safety record that is, nevertheless, in constant evolution. The evidence for this is readily available and easy to acquire. In addition, several countries with advanced scientific systems and hard environmental policies have been applying this discipline for decades with great success, both because of its effectivity and its comparatively low investment and high returns. Ironically, countries that are prone to ignore or express contempt for the discipline, notably in Latin America, would be in the best position to benefit from CWBC, with low investment and high probabilities of success, precisely by taking advantage of the experience of the developed countries that use it regularly (Cabrera Walsh et al., 2023a). Our recent experience indicates that the tide may be turning, but this will still require a lot of public relations work, and intense collaboration with experts from abroad.

From the scientists' perspective, we need to develop and promote a few success stories that will "warm up" administrators and policy maker to the discipline of CWBC. This process is in the making with several of

the projects mentioned throughout this work. The discipline must also be promoted in academia in order to stimulate students and young scientists to pursue careers in weed biocontrol, another aspect everyone involved has pursued through conferences, postgraduate courses, and classes. Finally, we need to get involved in the habitats where policy is made, such as local and national environment and sanitary offices, and aspect which is also advancing with our participation in regulation and Nagoya Protocol meetings all over the country.

According to the scenario described in this work, it seems safe to state that CWBC is being given a second chance in Argentina. As opposed to the individual initiatives observed in the past, this time the projects are being approached in a more organic and unified manner, in which every interest group is involved in the evaluation and research process.

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CRediT authorship contribution statement

F.E. Anderson: Writing – review & editing, Writing – original draft, Supervision, Project administration, Conceptualization. **S.M. Zalba:** Conceptualization, Writing – review & editing, Writing – original draft. **J. Ansaldi:** Writing – review & editing, Writing – original draft. **A Sosa:** Writing – review & editing, Writing – original draft, Funding acquisition, Conceptualization. **F. Mc Kay:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – review & editing, Writing – original draft. **G.J. Cabrera Walsh:** Writing – review & editing, Writing – original draft, Project administration, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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