

BIOLOGICAL INVASIONS: A BELGIAN PERSPECTIVE

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Introduction

Three years after the SOS invasion milestone, the Science facing Aliens conference is a new opportunity to make the point on the Belgian research dedicated to biological invasions. As a preparatory work to the conference, the Belgian Biodiversity Platform analysed the Belgian research linked to the conference theme.

Methodology

Research projects dealing with biological invasions were surveyed through the BioBel database (Belgian Biodiversity Platform, <http://biobel.biodiversity.be>, accessed April 30, 2009). Projects extracted from the database were sorted in two different categories. The first one includes projects that typically focus on biological invasions and involve at least 1 full time scientist. The second one includes projects that incidentally deal with invasion ecology.

Several attributes were assigned to the projects. This includes starting and ending date of the project, taxonomic affiliation, habitat type, research topic, and funding source. Five main research topics were considered based on the session themes of the last Neobiota conference (Prague, September 2008). These topics are supposed to encompass the full spectrum of research activities linked to biological invasions (see table 1).

For all the analyses presented hereafter, individual projects were weighted based on the number of research teams involved with a least 1 full time scientist. This implies that more importance was given to large networks than to individual PhD theses.

Although we made a great effort to include all invasion-related research projects in BioBel, some may have escaped our attention. The following results will have to be interpreted having this limitation in mind.

Bibliometric analyses were also performed to compare Belgian and international research dedicated to invasion ecology. We used “invasive species” or “biological invasion*” for a search of the Web of Science® (WoS, accessed 29 April 2009), in combination with the keywords corresponding to the 5 main research avenues cited in table 1. This yielded 5220 papers, among which 56 were produced by Belgian authors alone or in collaboration with international authors.

Table 1 – *Invasion ecology research topics and key-words used for bibliometric analyses.*

Research topic	Key-words
1. Invasion and dispersion patterns	Pattern* OR distribution OR dispers* OR range OR pathway OR spread
2. Mechanisms and evolution of invasions	Evolution* OR mechanism* OR process* OR invasiveness OR life-history
3. Impacts of invasions	Impact*
4. Prediction and risk assessment	Predict* OR risk assessment OR impact assessment
5. Management (best practices)	Management OR control

The Belgian research on biological invasions

We identified 56 research projects dedicated to biological invasions being conducted by Belgian scientists from 1990 to 2009. As shown in figure 1, a rising interest in invasion ecology is manifest in the exponential growth of research projects related to invasive species since 1999.

In addition to those projects, 22 more projects involve invasive species in a more incidental way. They are related either to biodiversity monitoring activities or to pest control studies. Such projects will not be considered in further analyses.

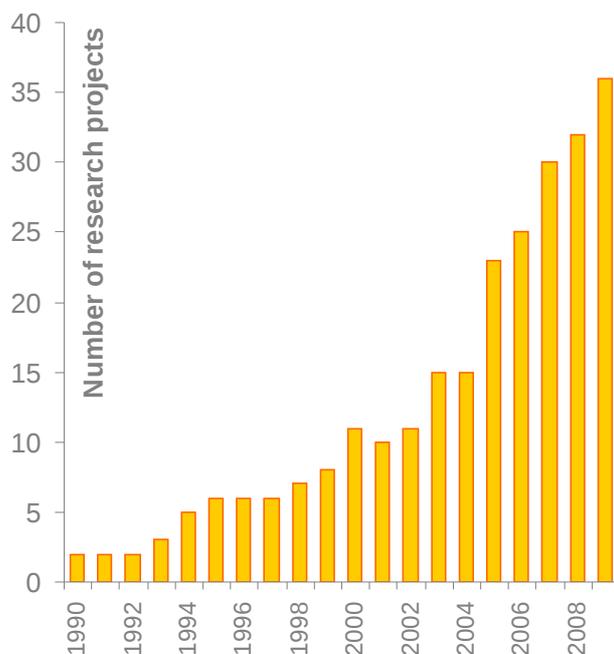


Figure 1 - *Number of Belgian research projects dedicated to biological invasions since 1990.*

A majority of research projects (62 %) focused on invasive plants; vertebrates were considered in 23 % of the projects and invertebrates in only 15 % (see figure 2). There is no project in our BioBel database that deals explicitly with invasive micro-organisms, fungi or algae.

Research dedicated to biological invasions was mainly conducted on terrestrial ecosystems (67 %). Twenty-nine percent of projects targeted freshwater systems whereas only 4 % dealt with marine areas. These proportions are not related to ecosystem invasiveness as many non-native species typically thrive in freshwater and marine environments in Belgium as in other parts of the world.

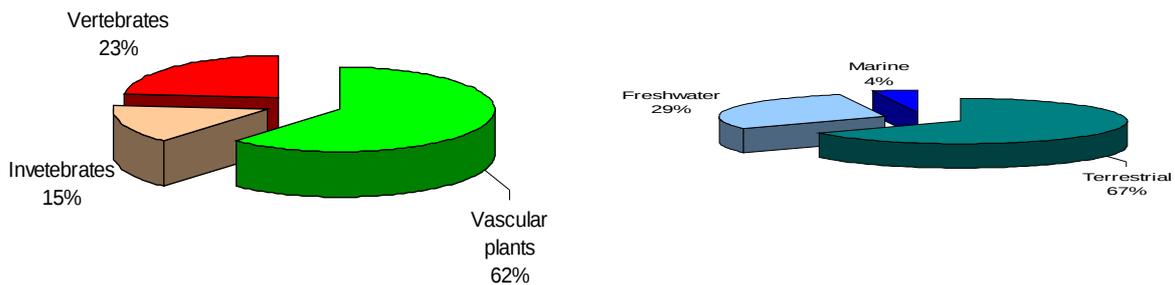


Figure 2 – Share of Belgian research projects dedicated to biological invasions between main taxonomic groups (left) and major ecosystems (right)

Two out of the five main research avenues (invasion patterns and management) are investigated since the early nineties and make the baseline of Belgian invasion ecology research. The three other research topics came progressively on top them. Prediction and risk assessment studies are the most recent and less developed subjects (see figure 3).

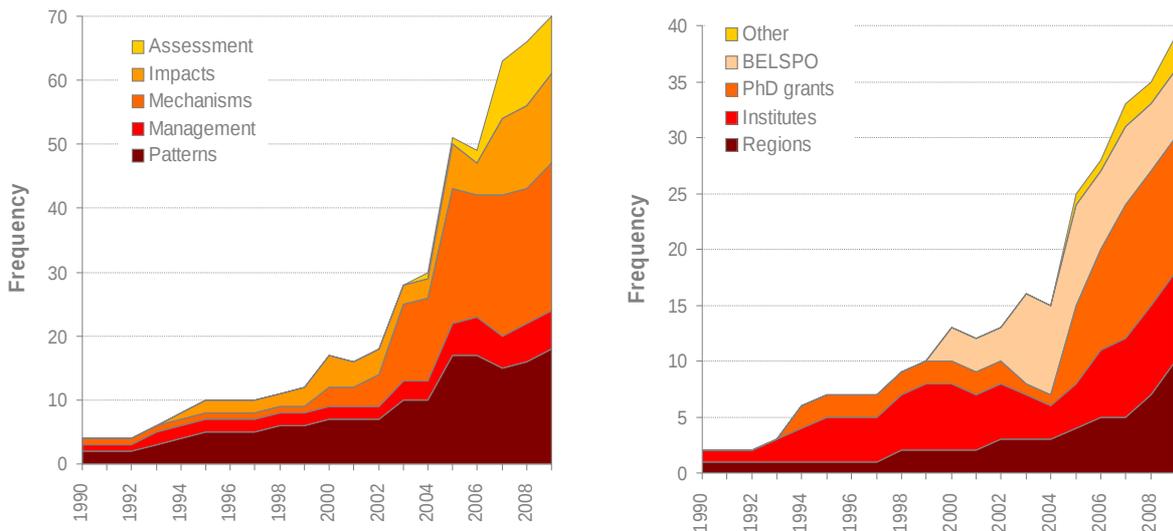


Figure 3 – Evolution of project frequency from 1990 to 2009, shared between research topics (left) and research funding sources (right).

Research funding

Different funding sources supported the Belgian research effort on biological invasions (1990-2009) to the following extent: 25% from BelSPO, 25% from PhD grants, 23% from regional administrations and 18 % from institutes budgets and 9% from various other sources (see figure 3). International funding of the Belgian invasion ecology research during that time was nearly absent.

A core funding was available from regional administrations in charge of environment management and from biological research institutes (e.g. National Botanic Garden of Belgium, Research Institute for Nature and Forests, Royal Belgian Institute for Natural Sciences), allowing the development of long-term monitoring and research programmes. On top of that, more focused initiatives were developed from 1999 onwards based on the work of research teams involved in BelSPO projects and of PhD students. Those studies often focused on invasion mechanisms and impact of biological invasions; they often produced innovative results to be published in international journals (see further). The implementation of the BelSPO “Science for a Sustainable Development” programme which included invasion ecology as a priority topic allowed to significantly increase the research effort from 1999 to 2005 and acted as a strong catalyst for the development of invasion ecology in Belgium.

It has to be noted that Belgian research on biological invasions was limited by the availability of funding sources. During the last decade, several innovative and challenging projects involving a strong partnership between different research teams in Belgium proved abortive due to the lack of funding opportunities.

Belgian vs international research

Fifty years ago, the publication of Charles Elton’s book *The Ecology of invasions by animals and plants* (1958) launched the systematic study of biological invasions. However, biological invasion- related scientific papers only started to be readily produced some 30 years later, mostly as a result of the launch of the SCOPE programme on biological invasions. This programme raised awareness on the importance of the phenomenon at a world-wide scale¹.

Although international publications dealing explicitly with invasion ecology are being produced at an exponential rate since the early nineties, publications by Belgian scientists started to appear with a time lag of approximately 10 years (figure 4A). With a total of 56 international publications, Belgium comes 7th amongst European countries after correcting number of publication by population size (figure 4 B). We expect that this number will continue to rise in the future as a consequence of the increasing number of research projects dedicated to biological invasions in Belgium.

Twenty percent of Belgian papers published in WoS-indexed journals result from BelSPO funded projects. This concerns mainly research teams that are member of the INPLANBEL-PERINBEL-ALIEN IMPACT suite of projects. The following laboratories also contributed significantly to the production of Belgian publications related to invasion ecology: Animal Ecology (UA), Behavioural and Evolutionary

¹ David M. Richardson & Petr Pysek (2008). Fifty years of invasion ecology : the legacy of Charles Elton. *Diversity and Distribution* **14** : 161-168.

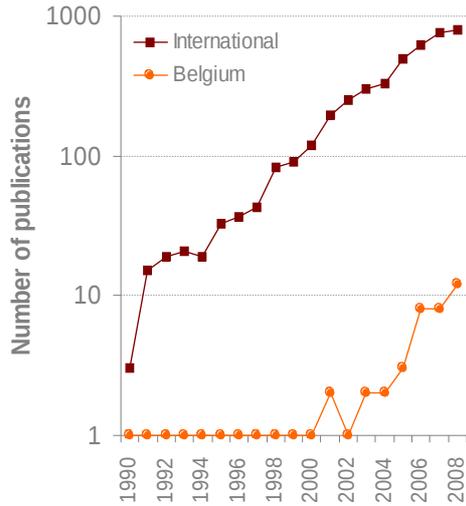


Figure 4A - Growth in the number of publications registered on Web of Science, by Belgian and international scientists.

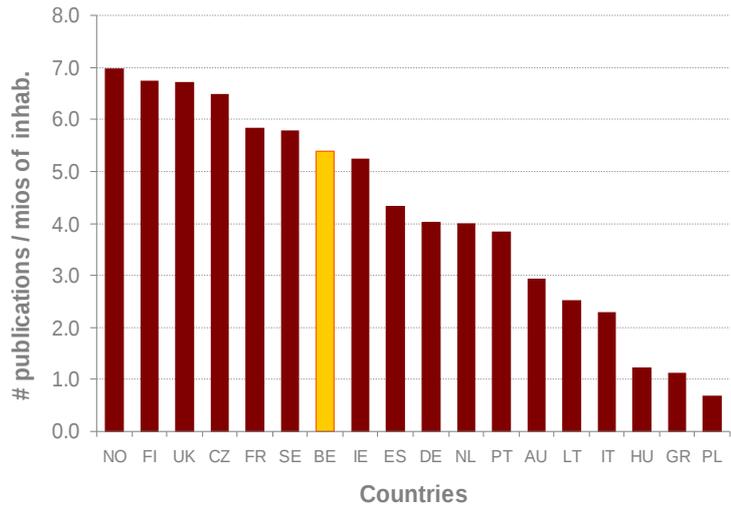


Figure 4B- Number of publications produced since 1990 and registered on Web of Science divided by the number of country inhabitants (in millions).

Ecology (ULB), Biological Control and Spatial Ecology (ULB), Forestry (UGent) and Forest, Nature and Landscape (KUL).

Publications produced by Belgian and international scientists relate to very similar topics. Belgian scientists, however, seem to focus slightly more on mechanisms and evolution of invasions and, relatively less on invasion patterns and management issues (figure 5).

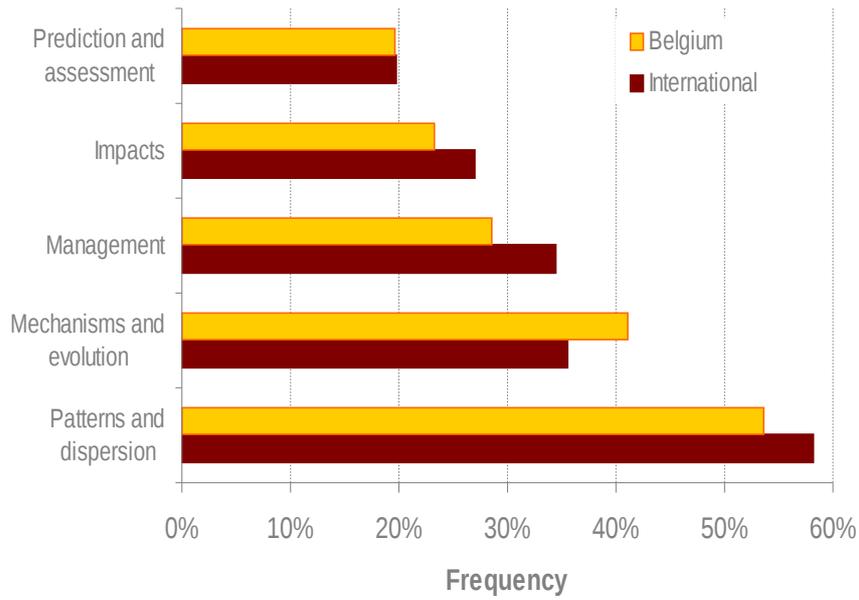


Figure 5 - Frequency of publications related to the 5 main research topics.

On top of international publications, Belgian scientists produce significant amounts of worthwhile “grey” literature,. Notwithstanding the sometimes unjustified poor standing of such publications, they are particularly useful for risk assessment and management purposes. An example is the “Catalogue of the Neophytes in Belgium” (1800-2005)² or the various reports produced by scientists of the Research Institute for Nature and Forest. Most of those publications are referred to in the *Harmonia* information system of the Belgian Forum on Invasive Species and in the data centre of the Flanders Marine Institute.

Integration within international networks

Despite the high level of the scientific research dedicated to invasion ecology in Belgium, only few research teams have been able to take advantage of European funding sources. The only institutions involved in EU RTD projects are VLIZ (MarBEF), INBO (ALTER-Net) and ULB (FORTHREATS). No Belgian partner was involved in the large EU projects that typically focused on biological invasions (ALARM, DAISIE, IMPASSE, etc.). The contribution of Belgian scientists to the European alien species inventory has been provided without any remuneration. This poor integration of Belgian scientists in EU research network is probably due to the publication time lag.

Table 2 – Presentation of the different European RTD projects related to biological invasions and partnership with Belgian research teams.

Program	Acronym	Title of the project	Starting year	Belgian partners
FP5	GIANT ALIEN	Giant Hogweed (<i>Heracleum mantegazzianum</i>) a pernicious invasive weed: Developing a sustainable strategy for alien invasive plant management in Europe	2002	(NBGB)
FP6	ALARM	Assessing LARge-scale environmental Risks with tested Methods	2004	(KUL, UCL)
FP6	MarBEF	Marine Biodiversity and Ecosystem Functioning	2005	VLIZ
FP6	DAISIE	Delivering Alien Invasive Species Inventories for Europe	2005	-
FP6	IMPASSE	Environmental impacts of alien species in aquaculture	2006	-
FP6	REBECA	Registration of Biological Control Agents	2006	-
FP6	ALTER-Net	A Long-Term Biodiversity, Ecosystem and Awareness Research Network	2006	INBO
FP6	FORTHREATS	European Network on emerging diseases and threats through invasive alien species in forest ecosystems	2007	ULB
FP7	PRATIQUE	Enhancements of Pest Risk Analysis Techniques	2008	-

² Filip Verloove (2006). Catalogue of the Neophytes in Belgium (1800-2005). *Scripta Botanica Belgica* **39**, 89 pp.

On the other hand, many Belgian scientists are today involved in EU policy-oriented networks, linked to, amongst others, the Bern Convention, the European Environmental Agency (EEA), the European Food Safety Agency (EFSA), the European Plant Protection Organisation (EPPO) and the European Platform for Biodiversity Research Strategy (EPBRS). The Harmonia information system and the ISEIA assessment protocol elaborated by the Belgian Forum on Invasive Species were welcomed by those initiatives.

Conclusions and perspectives

Today, Belgian research dedicated to biological invasions enters a phase of maturity and is conducted according to high quality standards. Some research topics are well developed by Belgian teams and can be considered as very competitive within the international arena, like studies dedicated to the evolutionary and ecological mechanisms of plant invasions or to those focusing on the spatial dynamics of invasions. Research effort should capitalise on that basis and try to integrate as much as possible within international networks. Scientists should also try to address some gaps and consider invasion issues in less studied ecosystems like freshwater and marine environments.

If we aim at limiting the impact of biological invasions then an important challenge to tackle in the coming year is setting up an early detection and rapid response (EDRR) system in Belgium. This implies developing adequate monitoring activities, correctly identifying new invasive species, performing rapid risk analyses and implementing adequate management responses. Scientific research activities in support of EDRR should be promoted within emergent disciplines like bio-informatics, DNA barcoding and risk analysis. Best practices for the management of invasive species should be also identified.

It is important to document the invasion history of new invasive alien species as much as possible, especially for non-native species that have so far not or hardly been recognised as posing a threat in other countries. We further need to quantify the Impact of such species on biodiversity and ecosystem functioning, using both observational and experimental studies. To be effective, the results of these studies should be dissipated to field managers and experts from Belgian and other countries. We therefore invite scientists involved in research on invasive species to participate to the risk assessment activities co-ordinated by the Belgian Forum on Invasive Species, and to attend meetings organised by EEA, EFSA, EPPO and other international initiatives.

Finally, we advocate that invasion ecologists liaise with colleagues from disciplines to reinforce interdisciplinary and integrative studies. Key areas where improved links with invasion ecology are needed are global change biology, restoration ecology, weed science as well as plant, animal and human health science, as exemplified by BelSPO MODIRISK and EPI-STIS projects.

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