EUROGARD VII
PARIS

## THEME F:

# EDUCATION

06.

# THEME F

EDUCATION

THEME F

EDUCATION

# COMMENT MOBILISER DES NOUVEAUX PUBLICS AUX CONSERVATOIRE ET JARDINS BOTANIQUES DE NANCY ? DEUX PROJETS ORIGINAUX ET FÉDÉRATEURS

Photo credit : Le mouton géant recouvert de laine au Jardin Botanique de Nancy, ***Katia Astafieff***

**Astafieff Katia**

Conservatoire et jardins botaniques de Nancy, 100 rue du jardin botanique, 54600 Villers-lès-Nancy

katia.astafieff@grand-nancy.org

> Mots-clefs PUBLICS DÉFAVORISÉS NON PUBLIC MÉDIATION CULTURELLE KNITTING GRAFFITI TRICOT URBAIN PROJET TRANSGÉNÉRATIONNEL LIEN SOCIAL DROGUES SANTÉ EXPOSITION CONFÉRENCE ADOLESCENTS

# 06. Résumé

• *Astafieff Katia*

## LES CONSERVATOIRE ET JARDINS BOTANIQUES DE NANCY SONT UN ÉTABLISSEMENT DE CULTURE SCIENTIFIQUE ET TECHNIQUE COGÉRÉ PAR LA COMMUNAUTÉ URBAINE DU GRAND NANCY ET L'UNIVERSITÉ DE LORRAINE.

Avec un parc de 35 hectares, 2500 m² de serres tropicales et un jardin alpin dans les Vosges, ils attirent chaque année un large public venus découvrir quelques-unes des 14 500 espèces en culture. Ils assurent les missions de conservation du patrimoine végétal, de soutien à la recherche scientifique, d'expertise et d'éducation du public à la biodiversité.

Les missions des jardins botaniques évoluent. Centrés sur la conservation des végétaux, ils élargissent aujourd'hui leurs activités pour ancrer leurs projets dans la société, au plus près des problématiques actuelles pouvant toucher les citoyens. Pourtant, tous ne viennent pas forcément dans ces institutions, pour des raisons diverses. Dans une volonté d'élargir leurs publics, les Conservatoire et jardins botaniques de Nancy ont entrepris en 2014 deux projets pour toucher ceux qui fréquentent peu l'établissement : les personnes des quartiers socialement défavorisés (publics empêchés ayant peu d'accès à la culture) et les adolescents.

Les obstacles à la fréquentation des jardins botaniques, comme à celle des musées, sont de natures variées : barrières géographiques, culturelles, sociales, financières, physiques. On pourrait même ajouter parfois la barrière de l'âge. Si les enfants sont nombreux à venir et apprécier les visites au jardin botanique, les adolescents sont souvent peu présents. L'offre éducative proposée aux petits est souvent assez riche dans les institutions de culture scientifique, alors que les plus grands sont parfois laissés de côté. En dehors de la visite parfois obligatoire au collège ou au lycée, ils franchissent plus rarement les portes des institutions culturelles.

De même, les populations de certains quartiers, quelques soient leur âge, sont parfois difficiles à toucher. Même si des efforts tarifaires sont réalisés, la barrière est avant tout culturelle.

Les Conservatoire et jardins botaniques ont donc développé en 2014 deux projets nouveaux pour élargir les publics et faire venir ceux qui ne viennent habituellement pas.

> Mots-clefs PUBLICS DÉFAVORISÉS NON PUBLIC MÉDIATION CULTURELLE KNITTING GRAFFITI TRICOT URBAIN PROJET TRANSGÉNÉRATIONNEL LIEN SOCIAL DROGUES SANTÉ EXPOSITION CONFÉRENCE ADOLESCENTS

# 06. Knitting graffiti

• *Astafieff Katia*

Photo credit : Le mouton géant recouvert de laine au Jardin Botanique de Nancy, ***Katia Astafieff***

## COMMENT FAIRE VENIR LES PERSONNES DE QUARTIERS MOINS FAVORISÉS, POUR QUI LE JARDIN BOTANIQUE EST UNE INSTITUTION CULTURELLE MÉCONNUE, DANS LAQUELLE LES ACTIVITÉS POURSUIVIES, À CARACTÈRE SCIENTIFIQUE, PEUVENT ÊTRE PARFOIS DES FREINS PSYCHOLOGIQUES OU SOCIOLOGIQUES ? EN PROPOSANT DES ACTIONS LUDIQUES ET ORIGINALES.

Le jardin botanique s'est ainsi rapproché de la mission cohésion sociale du Grand Nancy (l'une des tutelles de l'établissement avec l'Université de Lorraine), pour mettre en place un projet autour du tricot urbain, pour réaliser du Knitting graffiti au jardin, une mouvance artistique proche du Street Art. Il s'agit d'habiller de tricot ou de crochet des éléments de l'espace urbain (arbres, bancs, poubelles, statues, etc.), pour réaliser des installations éphémères. L'intérêt est de s'approprier l'espace public et d'investir son environnement de manière décalée et poétique. Les visiteurs portent ainsi un nouveau regard sur leur environnement.

Les CJBN ont donc proposé de réaliser ce type de projet au sein du jardin botanique.

Les habitants de l'agglomération, qu'ils soient des particuliers ou des associations, ont été invité à tricoter des carrés de laine qui ont servi à habiller un mouton géant ainsi que des éléments du jardin botanique (arbres, barrières…). Les réseaux sociaux (Facebook) ont été utilisés pour diffuser un appel à laine et à tricoteurs et l'information a été largement partagée.

L'opération a permis à la fois de mettre en valeur le jardin botanique autrement, en permettant de porter un autre regard sur les collections, de toucher d'autres publics, de développer des partenariats inhabituels et d'impliquer les visiteurs dans un projet différent, transgénérationnel et collaboratif.

### LES OBJECTIFS ET INTÉRÊTS DU PROJET :

- attirer de nouveaux publics (associations de quartiers, classes de jeunes adultes en difficultés, personnes âgées en maison de retraite)
- un projet fédérateur et participatif, à la fois avec le public et les équipes du jardin botanique
- un projet transgénérationnel : retraités et jeunes adultes ont tricoté ensemble
- une démarche amusante et conviviale
- un projet « tendance » (le tricot est redevenu très à la mode !)
- un contexte économique particulier avec la tendance « Do it yourself »
- un faible budget
- de nouveaux partenariats (mission cohésion sociale, Bergère de France)
- une démarche nouvelle au jardin botanique

> Mots-clefs PUBLICS DÉFAVORISÉS NON PUBLIC MÉDIATION CULTURELLE KNITTING GRAFFITI TRICOT URBAIN PROJET TRANSGÉNÉRATIONNEL LIEN SOCIAL DROGUES SANTÉ EXPOSITION CONFÉRENCE ADOLESCENTS

# 06. Knitting graffiti

• *Astafieff Katia*

- une mise en valeur originale des espaces du jardin botanique
- l'occasion également de mettre à l'honneur les moutons du jardin botanique qui entretiennent les espaces herbacés
- un lien avec les Conf'curieuses, cycle de conférences organisées par les CJBN, le Muséum-Aquarium de Nancy et l'Université de Lorraine (thématique 2012 : le mouton). Deux conférences étaient programmées au jardin : sur la gestion des milieux naturels par les herbivores et sur la teinture de la laine.

L'opération a été un succès. L'appel à laine a été bien relayé, notamment par les réseaux sociaux. Le public a été invité à rapporter des restes de pelotes de laine inutilisées à l'accueil du jardin botanique. De même, les visiteurs pouvaient venir récupérer de la laine pour tricoter des petits carrés de laine. Des bénévoles sont venues assembler les morceaux lors de différentes séances pour habiller un mouton géant. Pendant l'été, les visiteurs étaient également invités à venir compléter l'habillage du mouton en ajoutant leur petit carré de laine directement sur la structure.

Le personnel du jardin botanique s'est également fortement impliqué dans le projet (même les jardiniers tricotaient pendant les pauses !). L'installation s'est déroulée dans le parc ; mais des éléments ont également été installés dans les serres tropicales.

## Plantes et drogues

Les adolescents ne constituent souvent pas un public important des jardins botaniques ou des musées. Pour toucher les jeunes et aborder des thématiques transdisciplinaires (botanique et santé), les Conservatoire et jardins botaniques de Nancy ont proposé un projet sur les plantes et les drogues, une problématique forte et d'actualité, en s'inspirant d'ateliers réalisés aux Espaces botaniques de l'Université de Liège.

En effet, les Conservatoire et jardins botaniques de Nancy, lieu de culture scientifique et technique, souhaitent aborder des sujets plus ambitieux, autour de problématiques de société.

Le projet était centré autour de l'exposition « Plantes et drogues », qui s'est déroulée du 26 mai au 31 octobre 2014, contenant une présentation des principales espèces sources de drogues (cocaïer, cannabis, absinthe, plantes à alcool, caféier, etc.), des panneaux d'informations sur la problématique des drogues (définition des drogues, lien entre drogues et médicaments, et, dans les serres tropicales, aspects ethnobotaniques et usages traditionnels des drogues), ainsi que des objets prêtés par la faculté de pharmacie.

Rencontres et conférences ont aussi été réalisées, en développant des partenariats avec la maison des addictions du CHU de Nancy et la police nationale. Evidemment, sur une telle thématique, une large part a été consacrée aux aspects liés à la santé.

Le projet a été l'occasion d'établir des collaborations inhabituelles, avec la police municipale, la maison des addictions du Centre hospitalier ou un ethnologue. C'est surtout la programmation annexe qui a permis de se rapprocher des publics, grâce à des interventions variées : animations avec la police ou cycle de conférences avec des médecins ou scientifiques. Par exemple, étaient au programme :

> Mots-clefs PUBLICS DÉFAVORISÉS NON PUBLIC MÉDIATION CULTURELLE KNITTING GRAFFITI TRICOT URBAIN PROJET TRANSGÉNÉRATIONNEL LIEN SOCIAL DROGUES SANTÉ EXPOSITION CONFÉRENCE ADOLESCENTS

# 06. Plantes et drogues

• *Astafieff Katia*

DANGEROSITÉ DES DROGUES : COMMENT S'Y RETROUVER ?

Par le docteur Laprevote, médecin, spécialiste des addictions, CHU de Nancy.

> LUNDI 26 MAI 2014 À 20H.

AYAHUASCA ET AUTRES PLANTES UTILISÉES PAR LES CHAMANS D'AMAZONIE

Par Sébastien Baud, ethnologue, Université de Strasbourg.

> MARDI 3 JUIN À 18H30.

PLANTES MAGIQUES ET THÉRAPEUTIQUES

Par Jacques Fleurentin, pharmacien et ethnopharmacologue.

> SAMEDI 21 JUIN À 14H30.

REGARD SUR LES DROGUES ET LES ADDICTIONS

Par Laurent Graillot, formateur anti-drogues, Police nationale.

> LES SAMEDIS 14 ET 28 JUIN 2014 À 14H30.

DROGUES ET CERVEAU : CONNAISSANCES ACTUELLES ET NOUVEAUX DÉFIS

Par le docteur Vincent Laprévote.

> MARDI 30 SEPTEMBRE 2014 À 18H30.

DROGUES ET MÉDICAMENTS

Par les Dr Valérie Gibaja et Dr Mickaël Bisch, CHU de Nancy

> MARDI 9 OCTOBRE 2014 À 18H30.

STUPÉFIANT ! DROGUES ET ADDICTIONS

Par Laurent Graillot, formateur anti-drogues, Police nationale.

> JEUDI 23 OCTOBRE À 18H30.

La plupart des conférences se sont déroulées dans l'amphithéâtre du Muséum-Aquarium de Nancy, qui a des capacités d'accueil supérieures à celles du jardin botanique, et ont accueilli un public important (entre 100 et 200 personnes par conférence).

La démarche a permis d'aborder la botanique par une entrée santé, et réciproquement, de parler d'un sujet délicat avec les jeunes par une entrée plantes, inhabituelle pour les médecins et pour la police.

## Conclusion

**Ces deux projets ont donc permis d'attirer des publics inhabituels au jardin botanique - jeunes ou personnes ayant un accès à la culture limité – et ont montré qu'il est à la fois possible d'aborder des thèmes ludiques et créatifs impliquant les visiteurs d'une part, et des problématiques complexes liées à la santé d'autre part.**

> Mots-clefs PUBLICS DÉFAVORISÉS NON PUBLIC MÉDIATION CULTURELLE KNITTING GRAFFITI TRICOT URBAIN PROJET TRANSGÉNÉRATIONNEL LIEN SOCIAL DROGUES SANTÉ EXPOSITION CONFÉRENCE ADOLESCENTS

# 06. Références

• *Astafieff Katia*

**Allard, Michel,** 1993. Les adolescents et les musées. *Revue des sciences de l'éducation,* Volume 19, numéro 4, p. 766-774.

**Darcq, Caroline,** 2013. Les relations adolescents-musées : comparaison France/Etats-Unis, *La lettre de l'OCIM*, n°146. Mars-avril 2013.

**Dodd, Jocelyn & Jones, Ceri,** 2010. *Redefining the role of botanic gardens – towards a new social purpose*. Research Centre for Museums and Galleries (RCMG) School of Museum Studies University of Leicester and Botanic Gardens Conservation International (BGCI). April 2010.

**Jacobi, Daniel & Luckerhoff, Jason,** 2012. *Looking for non-publics.* Presses de l'Université du Québec, collection Culture et publics, 188 pages, D3371.

**Fourès, A., Grisot, D. & Lochot, S. (sous la direction de),** 2011. *Le rôle social du musée – Agir ensemble et créer des solidarités.* OCIM, 196 p.

**Lemerise, Tamara,** 1999. Les adolescents au musée : enfin des chiffres ! *Publics et Musées*, Volume 15, Numéro 1, pp. 9-29.

**Lemerise, Tamara & Lussier-Desrochers, Dany,** 2005. Les adolescents, la science et les musées, *La lettre de l'OCIM*, n°97.

**Martin-Le Mével, Laure,** 2013. *Quand les adolescents vont au musée : Une étude de la médiation au Musée des beaux-arts de Montréal.* Université de Montréal, Département de communication, Faculté des arts et sciences, Mémoire présenté à la Faculté des études supérieures et postdoctorales en vue de l'obtention du grade de Maître ès sciences (M.Sc.) en sciences de la communication, Juin 2013.

**Timbart, Noëlle,** 2005. L'accueil des adolescents dans les institutions muséales scientifiques, *La lettre de l'OCIM*, n°97, janvier-février 2005, pp.24 à 32.

# GENERATIONS LINKED WITH THE GREEN COLLECTIONS IN BOTANIC GARDENS

Photo credit : Fern garden in Hortus botanicus Leiden, ***Hanneke Jelles***

**Keßler Paul J.A., Jelles J.D. & Vandecasteele P.G.M.**

Hortus botanicus Leiden, PO Box 9500, NL-2300 RA, Leiden, The Netherlands

p.j.a.kessler@hortus.leidenuniv.nl

> Keywords FERNS DRAWING GRAPHIC TECHNIQUES AWAKENING INTEREST

# 06. Abstract

• *Keßler Paul J.A.*
• *Jelles J.D.*
• *Vandecasteele P.G.M.*

**'PREHISTORIC PLANTS' WERE IN THE LIMELIGHT IN THE LEIDEN HORTUS IN 2014, TO MARK THE 25TH ANNIVERSARY OF THE NETHERLANDS FERN SOCIETY (*NEDERLANDSE VARENVERENIGING*). IN THIS PROJECT THE EYES OF THE PUBLIC WERE OPENED TO THE BEAUTY OF FERNS USING A COMBINATION OF DRAWING AND GRAPHIC TECHNIQUES, AWAKENING THEIR INTEREST IN THIS GROUP OF PLANTS. THIS COMBINATION OF THE HORTUS COLLECTION WITH USE OF ART AND ARTISTS IS IN KEEPING WITH THE GARDEN'S APPROACH AND IS A USEFUL WAY TO COMBAT 'PLANT BLINDNESS'. IT IS AN ADDED BONUS IF THE INSTRUCTOR IS KNOWLEDGEABLE ABOUT BOTH DRAWING AND PLANTS, SO THAT INFORMATION AND DRAWING INSTRUCTION FORM A NATURAL ENTITY.**

> Keywords FERNS DRAWING GRAPHIC TECHNIQUES AWAKENING INTEREST

# 06. Introduction

• *Keßler Paul J.A.*
• *Jelles J.D.*
• *Vandecasteele P.G.M.*

Photo credit : Fern garden in Hortus botanicus Leiden, *Hanneke Jelles*

**DURING THE CONGRESS PAUL KESSLER REPORTED ON A SUCCESSFUL EXPERIMENT IN THE HORTUS BOTANICUS LEIDEN. IN THIS PROJECT THE EYES OF THE PUBLIC WERE OPENED TO THE BEAUTY OF FERNS USING A COMBINATION OF DRAWING AND GRAPHIC TECHNIQUES, AWAKENING THEIR INTEREST IN THIS GROUP OF PLANTS.**

'Prehistoric plants' were in the limelight in the Leiden Hortus in 2014, to mark the 25th anniversary of the Netherlands Fern Society (*Nederlandse Varenvereniging*). The Hortus used graphic techniques to open the eyes of a broad sector of the public to this group of plants. Groups of participants were asked to make accurate illustrations of fern leaves, under the guidance of artists. The groups were formed of participants from all age groups: people brought along family members or acquaintances from different generations or, if the participant did not know any one, the Hortus found a younger or older participant.

THIS APPROACH HAD A NUMBER OF ADVANTAGES :

- Leiden is a student city. Students in their twenties could bring along their parents or, as was more often the case, their grandparents and do something fun and informative together.
- The mixed age groups created a harmonious atmosphere; they all worked enthusiastically, but also talked quietly and looked at each other's work.
- The participants had no previous knowledge of plants. Before the morning's course they regarded ferns as rather boring green plants. They were allowed to choose 'their' fern from a bucket of assorted ferns – a difficult choice to make because of the great differences between the plants.
- As they were drawing the participants discovered details, and someone explained what they were seeing. Binoculars were available, and the participants studied the ferns through these with great wonder. Some people spontaneously took photos through the binoculars with their mobile phones, so that they could add details to their own drawings
- After they had been drawing for two hours they were given a short tour of the fern garden. Where the average group of visitors chats their way through this, a group of course participants almost had to be dragged away from the fern garden because there was so much to see.

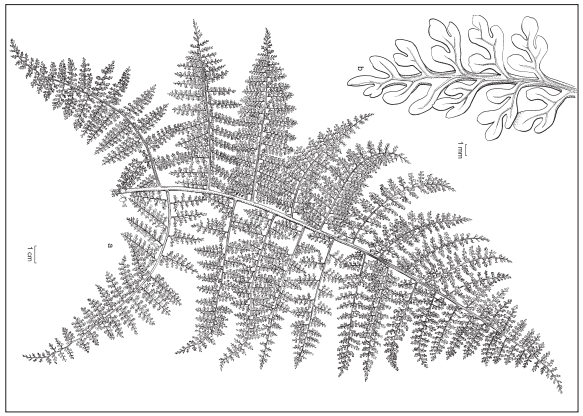
A contribution from the Cultural Participation Fund (*Fonds voor de Cultuurparticipatie*) enabled us to carry out this project, and meant that the Hortus could offer this course to participants for a low price, and direct recruitment towards both older people and students.

> Keywords FERNS DRAWING GRAPHIC TECHNIQUES AWAKENING INTEREST

# 06. Materials & methods

• *Keßler Paul J.A.*
• *Jelles J.D.*
• *Vandecasteele P.G.M.*

Patricia Vandecasteele is Head of Public Affairs at the Hortus botanicus Leiden (for this project involved in fund-raising), Hanneke Jelles is Head of Education (for this project involved in content and implementation). Together with various Leiden artists they assisted Paul Keßler with this project.



**> IMAGE 1**

Ink drawing of a tropical fern, *Monachosorum subdigitatum*; drawing Hanneke Jelles

## Results and discussion

As a result of this successful project the Hortus has started up a new series of workshops; 2/3 of the group are students and 1/3 are other adults. The financial contribution made by the second group means that we have been able to offer the course free to students. These workshops have the same relaxed atmosphere of cooperation between different generations, and combine learning about plants with drawing skills. This series has now been going for more than a year and there is another planned for 2017.

Drawing requires concentration, and gives participants a welcome opportunity to 'go with the flow' in what is for many people a very busy modern world.

Bringing together two or three generations of adults fulfils a need. It is a way of combatting loneliness for the very oldest, and everyone experienced this short time together as highly valuable. There is a good chance that the participants will return to the Hortus.

## Conclusion

**This combination of the Hortus collection with use of art and artists is in keeping with the garden's approach and is a useful way to combat 'plant blindness'.**

**Apart from observation with the naked eye, the participants may have applied ways of observation new to them, with the help of binoculars, a microscope, and by way of detailed photographs. Receiving help with drawing alongside an explanation of what is being drawn is extremely beneficial. It is an added bonus if the instructor is knowledgeable about both drawing and plants, so that information and drawing instruction form a natural entity. Young and old, science and art, united at the Hortus botanicus Leiden.**

> Keywords FERNS DRAWING GRAPHIC TECHNIQUES AWAKENING INTEREST

# 06. References


- *Keßler Paul J.A.*
- *Jelles J.D.*
- *Vandecasteele P.G.M.*

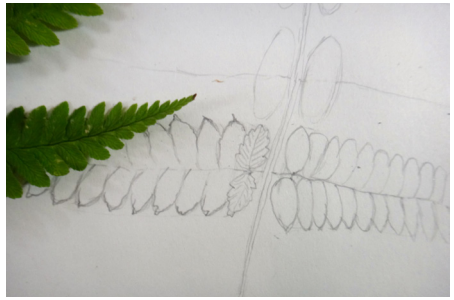
https://artplantaetoday.com/2015/05/08/multigenerational-learning-in-the-botanical-arts/

http://www.botanicalartandartists.com/what-is-botanical-art.html

http://www.esmeewinkel.nl/Publications.html


Students of all generations study and draw fern leafs

Etching techniques are both surprising and exact



Participants discover all kinds of interesting details while drawing fern leafs

People of three generations joined the workshops

Ferns are a good subject to practice observation and drawing

Botanical artist Esmée Winkel teaching during a workshop

Botanical artist Esmée Winkel points out details after the workshop

# A NEW BALANCE BETWEEN PLANT-FOCUS AND PEOPLE-FOCUS IN DUTCH BOTANIC GARDENS

Photo credit : Collaboration, *Wendeline van den Nagel*

**'t Hart Joke[1] & Van Dijk Dick[2]**

[1] NVBT/Planting the future, Plantage Middenlaan 2C, 1018 DD Amsterdam, The Netherlands
Joke@botanischetuinen.nl

[2] Waag Society, Nieuwmarkt 4, 1012 CR Amsterdam, The Netherlands
dick@waag.org

> Keywords COLLABORATION OF ALL DUTCH BOTANIC GARDENS CO-CREATION NEW AUDIENCES FOCUS ON PEOPLE AND PLANTS

# 06. Abstract

• *'t Hart Joke*
• *Van Dijk Dick*

**THIS PAPER INTRODUCES THE PROJECT PLANTING THE FUTURE, INCLUDING RESULTS AND EXPERIENCES GAINED FROM THE COLLABORATION OF 24 DUTCH BOTANIC GARDENS, AND CONCLUDES WITH LEARNING POINTS AND IMPROVEMENTS.**

The 24 botanic gardens are all under the auspices of the NVBT, the Dutch Association of Botanic Gardens. Main focus of the project is on creating new collaborative structures between the gardens and on developing new public programming through co-creation with both existing and potential new visitors based on the knowledge of the plants. The five year project is now half way. As a result of the work so far the gardens have begun to work more closely together, inside and outside the project. Many learning's relate to changing the manner in which the gardens have worked together and the need to be more externally focused whilst at the same time trying to maintain the essence that lies at the heart of being a botanic garden. The NVBT has proclaimed 2017 the year of the Dutch Botanic Garden complete with an extensive presentation aimed at the wider public, and events that will include the launch of a new jointly developed application. Project partners of NVBT are media lab Waag Society and Dutch funding body National Postcode Lottery.

> Keywords COLLABORATION OF ALL DUTCH BOTANIC GARDENS CO-CREATION NEW AUDIENCES FOCUS ON PEOPLE AND PLANTS

# 06. Introduction

• *'t Hart Joke*
• *Van Dijk Dick*

Photo credit : Collaboration, ***Wendeline van den Nagel***

**IN 2013 THE DUTCH ASSOCIATION OF BOTANIC GARDENS (NVBT) STARTED THE PROJECT PLANTING THE FUTURE TO HELP INDIVIDUAL GARDENS INNOVATE BY MOBILIZING THE COLLABORATIVE POTENTIAL.**

The NVBT is an umbrella organization which consists of 24 gardens across the Netherlands. Their mission is to contribute to the conservation of plant biodiversity in the context of a sustainable world. The gardens constitute important Dutch heritage sites, with a living collection. The central concept of the Botanic Garden - stemming from the encyclopaedic tradition of the Renaissance - that all knowledge is collectible, as well as the form of a beautiful and lush garden, often in the inner city, and the collections themselves - both 'natural' and cultured species – are a representation of historic and contemporary society. The gardens are very diverse, some are academic, some are connected to large park areas, some are connected to zoos, etc.

The main reason to start a collaborative project involving all 24 Dutch botanic gardens was the decline of financial support the gardens were receiving from governments and universities. The gardens had little time to think about long term opportunities, they were mostly survival driven. The board of the NVBT decided to make funds available to formulate a combined proposal that would secure the future of all 24 botanic gardens. The proposal was awarded a grant of 2 million euro from the Dutch National Postcode Lottery and started the collaborative Planting the Future project that will run for 5 years.

## Project aims

THE AIMS THAT WERE DEFINED FOR THE PLANTING THE FUTURE PROJECT ARE:

- Initiating dialogue with the public about the importance of plants from a shared and accessible (web based) database.
- Strengthening cooperation between participating gardens
- Rejuvenation of- and widening the target audience

To work from a shared identity, the gardens started with the BGCI definition of a botanic garden, namely 'botanic gardens hold documented collections of living plants for the purposes of scientific research, conservation, public display and education'. It was agreed that not all the NVBT gardens needed to meet all of these four aims, but together the gardens do fulfil the criteria required by this definition. In reality it transpired that most of the botanic

> Keywords COLLABORATION OF ALL DUTCH BOTANIC GARDENS CO-CREATION NEW AUDIENCES FOCUS ON PEOPLE AND PLANTS

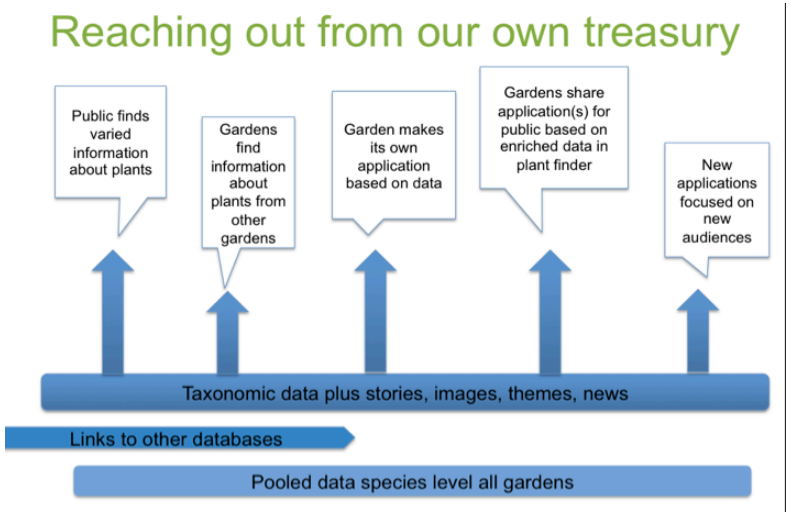
# 06. Project aims

• *'t Hart Joke*
• *Van Dijk Dick*

gardens in the Netherlands are using their plant collections for communication, through public display, and also for educational purposes. The symbol of a flower with four leaves was chosen to illustrate this collaboration (see **Fig. 1**). SPEC (like species!) stands for Scientific research, Public display, Education and Conservation.


**> FIGURE 1**

Symbol of a flower as a representation of the collaboration




**> FIGURE 2**

Facilitating a dialogue with audiences from a shared database

From the outset making the data pertaining to all 24 botanic gardens public was one of the most important aims of the project. New technological infrastructure is currently being designed to enable this information to be accessible by the wider public. The gardens are amalgamating the collection data from each garden to make this wealth of information accessible via the NVBT website. The first pilot of a public application can be viewed at www.botanischetuinen.nl/en/plant-search. See also paper Renske Ek, *What does the public want? Lessons learned from using modern technology in transferring plant knowledge from scientific community to the wider audience.*

## Co-creation labs

At the start of the project, collaboration between the Dutch Botanic Gardens was very limited. Critical to kick start the collaboration was the implementation of the co-creation labs under the leadership of Waag Society. Waag Society is a media lab that uses creative methods that stem from 'design thinking' and centre on 'learning by doing'. These methods focus on the creation of a new type of dialogue between people with different knowledge and backgrounds to get started.

> Keywords COLLABORATION OF ALL DUTCH BOTANIC GARDENS CO-CREATION NEW AUDIENCES FOCUS ON PEOPLE AND PLANTS

# 06. Co-creation labs

• *'t Hart Joke*
• *Van Dijk Dick*

The approach during these labs was not about "coming up with the single right idea" but about generating the broadest range of possibilities, and this proved to be critical. The focus of the three co-creation labs was on:

- Connecting a diverse set of representatives of the 24 very diverse gardens
- Collecting stories
- Connecting with existing and new audiences
- Exploring new technologies

The exploratory co-creative phase finished January 2015. The first two sessions consisted of six days each, and ran over a period of six weeks each. They involved 20 people in each lab from all ranks of the organisations, with alternating involvement of visitors of the gardens. The aim of these sessions was to find new ways to connect the knowledge about plants and biodiversity to the needs of diverse audiences. Participants of the sessions explored which stories from the botanic gardens are important and relevant to the public, identified who their current visitors and new target audiences are, and designed new storytelling methods that can be used to reach these new audiences.

In addition the participants explored which technology might be interesting and which infrastructure (in terms of collaboration and technology, national and international) is future proof. The added value of media/ICT in the context of the gardens is to open up their processes: to linked open data initiatives, opening up their collections to others, but also incorporating crowd sourced materials ('citizen science'); to creative re-use of materials (connecting to Do It Yourself and maker movements); to new locations and channels outside their own physical and geographical location.

> FIGURE 3

Prototyping and testing a route application in the 1st co-creation session

As an example of the method(s) used: the participants prepared for the sessions with a set activities from a 'sensitizing toolkit' that makes them look at their own garden with different eyes: 'where's the hidden treasure in my garden', 'what does my public enjoy least'?, 'what type of behaviour does my audience have'? The first session started with each garden sharing those findings and was followed by an activity in the garden with a set of 'ambiguous prototypes': objects that have no purpose in themselves, but designed to let them imagine what these objects could do in their garden. A free format explorative activity, which gets the participants in a specific mindset and also lets them get to know each other better. Towards the end of the six week activities they designed a number of specific interaction scenarios and prototypes, including a Physical Storytelling tool for grandparents and grandchildren, a Talking Tree and an Urban Gardeners programme, ideas that will be developed further. Among the learnings from the first two labs are:

- Kick starting the dialogue transfers to all topics and domains, education, communication, exhibition design; big spin off in informal connections
- Focus of the gardens is very much on broadcasting and not too much on

> Keywords COLLABORATION OF ALL DUTCH BOTANIC GARDENS CO-CREATION NEW AUDIENCES FOCUS ON PEOPLE AND PLANTS

# 06. Co-creation labs

• *'t Hart Joke*
• *Van Dijk Dick*

listening, bridging the gap to (new) audiences is challenging and terrifying for them

- Varied and lively content is the biggest hurdle to take, yes they do have stories but not verified and not accessible

> FIGURE 4

Prototyping and testing a user application responding to touch

The third lab was aimed at convergence of ideas and was limited to two-days, involving the decision makers of the individual gardens to gain support for the ideas developed. From the 20 proposals that had been developed by the participants, the most viable were developed into scenarios by Waag Society and put forward to an ad hoc decision making body in the third Lab.

> FIGURE 5

Prototyping and testing a user application using augmented reality

## Experiences after two years

1. Sharing of individual knowledge and experience amongst the other botanic gardens has greatly increased the opportunities for each individual garden not only to survive but also to grow. There is now an on-going exchange in exhibits and educational material amongst the gardens. And perhaps more importantly, employees of the gardens regard each other as colleagues who can be called on for advice and who will be there to give advice.

2. Good collaboration requires an understanding of what your colleagues are doing both in your own botanic garden, as well as in each of the other gardens. To give an example: It is possible that within a particular garden the communications officer does not know what the collection manager does, and so the collection manager is not consulted when choices regarding programming are being made. Moreover the collection manager might be purchasing plants that do not conform to the aims outlined in the overall policy for the garden. Using the missions of the co-creation labs, surprising insights into the potential for collaborative and coordinated endeavours has become evident.

3. From the outset informing and involving all employees has increased support for collaboration. For example, the exhibition Protecting Plants, highlighting 240 Red List species in 24 botanic gardens: the exhibition was a success because all the gardens were involved from the outset, and all gardens agreed on the aims. There was a central organisation and the arrangement of the final exhibition is in such a way that leaves room for personal interpretation.

> Keywords COLLABORATION OF ALL DUTCH BOTANIC GARDENS CO-CREATION NEW AUDIENCES FOCUS ON PEOPLE AND PLANTS

# 06. Experiences after two years

• *'t Hart Joke*
• *Van Dijk Dick*

**4.** Communal information about the plants and events held by the NVBT gardens through the website, on facebook and twitter are not only important for the visitors but also for the employees working in the gardens.

**> FIGURE 6**

First shared exhibition on red list species: list means also frame-work in dutch: plants are not only on but also in red list during the exhibition

## Lessons learned

### ANECDOTES BELONGING TO THE PLANTS

If we want to share a large variety of anecdotes about the plants in the gardens with the wider public, it was of great importance that the anecdotes are linked both to the plant concerned and to the taxonomic information held in the collection management system. Again close collaboration between different employees is therefore important. Collection managers oversee taxonomic data, whilst guides recount anecdotes about the plants to the public. Information alignment is therefore of utmost importance.

Up until now the data and the anecdotes in the Dutch Botanic Gardens are not directly linked. Moreover, the anecdotes regarding the plants are not precisely documented. As part of the Planting the Future project, this is now changing: in the plant finder on the NVBT website the anecdotes and taxonomic information have been linked and made available to the general public. However, collecting the anecdotes and checking their reliability proved to be a huge undertaking.

### TARGET-ORIENTATED WORK BEGINS BY KNOWING YOUR AUDIENCE

Bringing botanic garden employees together is a fertile ground for unleashing anecdotes about plants, and these are told effortlessly. But what happens when we suddenly have to recount these anecdotes to members of the local gardening club, or the Christian Women's Association? From working with the co-creation labs it became apparent that the level of experience in doing this within the participating gardens, was very low. Therefore if we want to focus on new target groups, we need to know who they are and where they are interested in. This proved to be an important learning point – regardless of how trivial it initially seemed. Knowing them and asking what they want For example during specific exercises in the co-creation labs series, a number of people were allocated the task of collecting anecdotes about carnivorous plants for the target group grandparents and children, the anecdotes were basically alright but the children understood virtually nothing.

### REACHING NEW TARGET AUDIENCES MEANS BEING VISIBLE TO THE OUTSIDE WORLD

Actively spreading the word about what we do and why we do it, outside the gardens increases interest and attracts new audiences for the plants themselves. It is naïve to think that the visitor's self-motivation alone will be enough to draw him or her into the botanic garden.

> Keywords COLLABORATION OF ALL DUTCH BOTANIC GARDENS CO-CREATION NEW AUDIENCES FOCUS ON PEOPLE AND PLANTS

# 06. Lessons learned

• *'t Hart Joke*
• *Van Dijk Dick*

INTERNAL ORGANISATION OF THE BOTANIC GARDENS

The majority of the botanic gardens in the Netherlands have only a small number of staff who are responsible for a large number of different functions and tasks and they share them with a large number of volunteers. We all know that the botanic garden staff are both highly dedicated and extremely committed. However, the effectiveness of internal collaboration does have room for improvement, especially with regard to the alignment between those employees focused on the plant collections on the one hand and those employees concerned with communication and education on the other. In the botanic gardens the level of internal collaboration between these two groups left much to be desired. Plant-focused and people-focused groups need to work more closely- and become more in tune with one another.

## Discussion

We present 10 key points that can contribute to the increasing success of the botanic gardens. As highlighted earlier, these points need to be regarded in the context of a change in working practices, especially with regard to collaboration, with more focus on the outside world, and not forgetting of course the importance in preserving each garden's own identity.

**1.** Work jointly, in co-creation
**2.** Search for shared identity and create 'ownership' of that identity
**3.** Ensure proper alignment of all the working groups within the organisation
**4.** Involve all employees including volunteers
**5.** Keep training and learning so that they are appropriately equipped for their (potential) new role
**6.** Communicate with the intended audience clearly in mind
**7.** Combine taxonomic data with plant anecdotes that the public find interesting and disseminate the information as pictures and stories
**8.** Be more outward looking, meet your audience
**9.** Be prepared to experiment to find new relevance for society
**10.** Build strong networks - don't try to do everything yourself

## Conclusion

**After a successful start in which the gardens explored new ways of working together, the next year, 2016, is the year of sharing and learning through workshops and lectures, as the process needs to continue to truly transform the organisations. Being both plant-focused and people-focused will make the Dutch botanic gardens more future proof. 2017 is the final year of the project and proclaimed to be the year of the Dutch botanic gardens. Current initiatives need not to end in 2017 but new ways (including funding) need to be explored further now to ensure continuity after 2017.**

> Keywords COLLABORATION OF ALL DUTCH BOTANIC GARDENS CO-CREATION NEW AUDIENCES FOCUS ON PEOPLE AND PLANTS

# 06. References


- *'t Hart Joke*
- *Van Dijk Dick*

www.botanischetuinen.nl

www.waag.org

www.bgci.org

# THE USE OF PHYTOSOCIOLOGY IN THE GARDEN PROJECTS. PRACTICAL APPLICATION UNDER MEDITERRANEAN CONDITIONS

Photo credit : The aspect of the *Olisiponense* Garden in the Jardim Botanico da Ajuda, Lisbon, after three years of plantation

**Salazar Marta L.[1], Oliveira Cristina[1], Soares Ana Luisa[2,4,6], Soares Filipe[5] & Espírito-Santo Dalila[2,3,6]**

[1] ARQOUT, Edifício INOVISA, Instituto Superior de Agronomia (ISA), Tapada da Ajuda, 1349-017 Lisboa, Portugal

[2] Instituto Superior de Agronomia, Universidade de Lisboa (ISA/ULisboa), Tapada da Ajuda, 1349-017 Lisboa, Portugal

[3] Jardim Botânico da Ajuda, ISA, ULisboa, Calçada da Ajuda, 1300-011 Lisboa, Portugal

[4] Centro de Ecologia Aplicada Professor Baeta Neves (CEABN/InBIO), Instituto Superior de Agronomia, Universidade de Lisboa (ISA/ULisboa), Lisboa , Portugal

[5] SIGMETUM, Edifício INOVISA, Instituto Superior de Agronomia, Tapada da Ajuda, 1349-017 Lisboa, Portugal

[6] Linking Landscape, Environment, Agriculture And Food – LEAF

dalilaesanto@isa.ulisboa.pt

> Keywords NATIVE SPECIES NATURAL VEGETATION LANDSCAPE ARCHITECTURE BIODIVERSITY CONSERVATION

# 06. Abstract

• *Salazar Marta L.*
• *Oliveira Cristina*
• *Soares Ana Luisa*
• *Soares Filipe*
• *Espírito-Santo Dalila*

**THE IMPORTANCE OF USING NATIVE SPECIES IN GARDENS AND LANDSCAPE RECOVERY ACTIONS IS A TOPIC THAT HAS BEEN STUDIED FOR ITS NUMEROUS ADVANTAGES, FOR THE ENVIRONMENTAL PERFORMANCE BEST SUITED TO PRESERVE, ENHANCE AND CONSERVE BIODIVERSITY, FOR GREATER ABILITY TO ADAPT TO NATURAL CONDITIONS, AND FOR ITS LOW WATER REQUIREMENTS, FERTILIZATION, AND MAINTENANCE.**

There are generally many accepted reasons, why the use of native plants in gardens privileges the identity of the Green Design and Landscape Unit and is an important contributor to the sustainability of green spaces. However, there are still some obstacles to its practical implementation, including the shortage of available technical information on these native plants characteristics and proper use, their slower growth, the insufficient supply of certified native species in Portugal, but above all the lack of awareness of the difference between the native species and alien and invasive species, at the level of executive positions, technicians, designers and the public in general.

Motivated by the importance of this subject, a research project appeared in 2011, *Phytosociology, Landscape and Sustainable Gardens,* a partnership between Arqout (Landscape Architects) - Sigmetum (native plants nursery) - Instituto Superior de Agronomia/ISA (science), for the survey, characterization, testing, production, and dissemination of indigenous species. This project, financed by the rural development program PRODER (Programa de Desenvolvimento Rural, Portugal), is supported by a strong research component and field work, where the main series of vegetation and characteristic species are identified, as well as their potential for production in nurseries and use in landscape architecture projects and recovery of the landscape. The interpretation of the landscape, based on scientific concepts and procedures in the areas of Botany, Phytosociology and Phytogeography, enables compliance with the principles of sustainability and implements the concept for outdoor spaces.

In parallel with the research work an outreach strategy, with dissemination and promotion of indigenous species is underway. The disclosure is twofold. On the one hand the construction of a site where the scientific content is being processed and interpreted on a native flora (and vegetation)

> Keywords NATIVE SPECIES NATURAL VEGETATION LANDSCAPE ARCHITECTURE BIODIVERSITY CONSERVATION

# 06. Abstract

- ***Salazar Marta L.***
- ***Oliveira Cristina***
- ***Soares Ana Luisa***
- ***Soares Filipe***
- ***Espírito-Santo Dalila***

database as well as its presence in the national market. On the other hand, the highlighting of building garden models, examples of the application of the defined methodology and subsequent increase in use. Two examples are given: an ECOgarden in Ajuda Botanic Garden (Lisbon) and another in a private house at Melides (Alentejo). The aim of Ajuda Botanic Garden was the recovery of the forest zone that always was intended to be composed of native species, in order to be an example of a built garden with native plants, recreating the phytosociological environment of the region. This ECOgarden will allow visitors to see the indigenous flora of the Lisbon region that have a high ornamental value and the consequences of combining this methodology with previously known environmental gains. The Ajuda Botanic Garden gains a new point of interest, which is also important because of its educational panels that were associated with posters identifying the project and species. The aim is to show technical people and the general public that we have native species that have very considerable ornamental value, for any botanical collection that can be easily found in the market. The private house project in Melides is an example of applying the methodology under study to a landscape architecture project in a private garden, where the garden matches the surrounding landscape both in terms of the type of plants and their layout.

> Keywords NATIVE SPECIES NATURAL VEGETATION LANDSCAPE ARCHITECTURE BIODIVERSITY CONSERVATION

# 06. Introduction

• *Salazar Marta L.*
• *Oliveira Cristina*
• *Soares Ana Luisa*
• *Soares Filipe*
• *Espírito-Santo Dalila*

Photo credit : The aspect of the *Olisiponense* Garden in the Jardim Botanico da Ajuda, Lisbon, after three years of plantation

**AT THE PRESENT TIME AS THE CLIMATE IS CHANGING, THE PRESERVATION AND UPGRADING OF THE LANDSCAPE, ALONG WITH THE SCARCITY OF RESOURCES AND THE CURRENT ENVIRONMENTAL INSTABILITY LEAD US TO RETHINK THE WAY WE ACT ON THE LANDSCAPE AT THE VARIOUS LEVELS.**

In this way the new environmental challenges in terms of green spaces are mainly focused on a decline in water consumption, reduced soil erosion and minimum use of exotic species, which often become invasive and harm the landscape balance. We seek to increase the use of native plants as an intrinsic feature of contemporary green space projects by disseminating information and making it available, and through growth in native species production via specialist methods adapted to their use in nature.

Landscape architecture projects should be designed as a living ecosystem, enhancing biodiversity and favoring balanced resource management. Thus, the selection of plant material becomes a determining factor in the creation of a truly sustainable garden, in terms of water management and use of fertilizers, as well as in terms of pest and disease control treatments. The specialist production methods have low production costs, no acclimatization expenses and require less fertilizer and water, which impact on the building of new green spaces, and, above all, their maintenance requires water consumption levels very similar to the natural situation, as close as possible to the average rainfall at each location. It is essential that each project is inspired by the actual location and materials, that plants and typologies be selected to favor local trade and production and at the same time reduce the costs of each project.

The project "*Phytosociology, Landscape and Sustainable Gardens*", financed by PRODER (Programa de Desenvolvimento Rural, Portugal), formed a partnership to study, research, design, produce, deliver and market native species. The parties concerned intend to promote a greater awareness of the importance and benefits of preserving the natural landscape and its biodiversity, which is based on assessment, knowledge and application of indigenous species in Portugal. At the research level a great deal of work has been undertaken in this field, especially as regards botany and phytosociology (reflecting the importance of ISA as a partner and the support of Lusitanian Association of Phytosociology - ALFA). This project was innovative to the extent that it focuses on interpreting the science in terms of landscape architecture, that is to say it promotes and disseminates biodiversity by means of a multidisciplinary understanding of landscape projects that has practical applications.

> Keywords NATIVE SPECIES NATURAL VEGETATION LANDSCAPE ARCHITECTURE BIODIVERSITY CONSERVATION

# 06. Introduction

• *Salazar Marta L.*
• *Oliveira Cristina*
• *Soares Ana Luisa*
• *Soares Filipe*
• *Espírito-Santo Dalila*

By disseminating information and raising awareness among the general public we seek to consolidate the ecological, aesthetical and economic components and above all make the use of native species "fashionable". This type of work makes it possible to design green spaces that are aesthetically appealing yet have a strong social and educational component, since this philosophy is a concept that awakens interest in and curiosity about Portuguese flora, and consequently raises awareness about the importance of the landscape and habitats. The software platform will allow producers to advertise the native species they produce and will bring the sector up-to-date in terms of new technology, acting as a driving force to its commercial presence and to the economic sustainability of this new niche market.

The specific objectives of this operation include: integration and synthesis of a base of knowledge about native species; identification, characterization and recognition of the main series of vegetation; research, demands and behavioral trends of native species; introduction of an increasing variety of indigenous species into the market with the development and implementation of a specialized nursery; definition and dissemination of new methods of intervention in the landscape; development of a platform for awareness, dissemination and promotion of native species in landscaping.

One of the major foreseeable consequence is the strengthening of the national identity by means of native plants. The spirit of each location, the essence of each landscape will be the design guidelines that will impact on tourism, production and society's relationship with the landscape and the environment generally.

Concerns about the environment and the benefits of using native species produced nationally and suited to the particular location will become effective when the general population is properly aware of this reality.

## Methodology

Motivated by the importance of this subject, a research project appeared in 2011, *Phytosociology, Landscape and Sustainable Gardens*, a partnership between Arqout (Landscape Architects) - Sigmetum (native plants nursery) - Instituto Superior de Agronomia (ISA), for the survey, characterization, testing, production, and dissemination of indigenous species. The Project is supported by a strong research component and field work, where the main series of vegetation and characteristic species are identified, as well as their potential for production in nurseries and use in landscape architecture projects and the recovery of the landscape. All the project work, landscape planning and layout, along with the production and respective processes and methods, are based on technical and scientific concepts and procedures that have previously been studied and developed by specialists in the fields of Botany, Geography, Geology and Landscape Architecture.

Thus the project sets out to study and interpret previously developed contents, so as to provide for their practical application and subsequent disclosure, so that the methodology proposed may be used by those working in the fields in question.

In accordance with the concepts put forward by Capelo (2003), vegetation is a fundamental structuring element in landscapes. Not only does it

> Keywords NATIVE SPECIES NATURAL VEGETATION LANDSCAPE ARCHITECTURE BIODIVERSITY CONSERVATION

# 06. Methodology

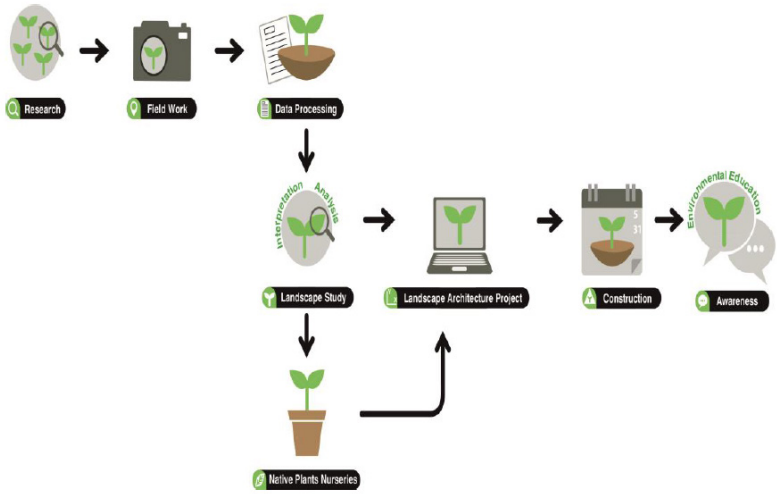
• *Salazar Marta L.*
• *Oliveira Cristina*
• *Soares Ana Luisa*
• *Soares Filipe*
• *Espírito-Santo Dalila*

dominate most land ecosystems through its biomass, it also constitutes the habitat for animal populations and is at the heart of the majority of human productive and cultural activities. It is also the element that best integrates a landscape's biological response to environmental factors (physical, biological and anthropic). In that sense it is also of enormous diagnostic and landscape systemization value.

The new science of landscapes was given the name of *Symphytosociology*. Géhu & Rivas-Martínez (1980) consolidate and promote the use of this term, definitively characterising the sigma associations as the stages of the same ecological succession (vegetation series) subordinated to the same climax and distinguishing the successional stage from the catenal stage (zoning), in the genesis of association complexes in a landscape. They also set up the basis for Integrated Chorology that establishes a territory's hierarchical bio-geographical typology, based on the Landscape Phytosociology units (Costa *et al*., 1998).

The notions of dynamic-catenal phytosociology defined as the basis for Landscape Phytosociology are summarised in an article by Rivas-Martínez in 2005, where he defines the most important units – vegetation series, geoseries, permaseries and geopermaseries. A map of the vegetation series in continental Portugal with a scale of 1:400 000 was presented by Capelo (2007).

In parallel with the research work an outreach strategy, with dissemination and promotion of native species is underway. The disclosure is twofold. On the one hand the construction of a site where the scientific content is being processed and interpreted on a native flora (and vegetation) database, as well as its presence in the national market. On the other hand the challenge of




> FIGURE 1

Scheme for the methodology employed

designing landscape architects' projects with native species in order to be a living ecosystem, enhancing biodiversity and favoring balanced resource management (e.g., ECOgarden in Ajuda Botanical Garden and a private house at Melides).

SO, THE METHODOLOGY ADOPTED WAS AS FOLLOWS (**Fig. 1**):

- To identify and classify the major Portuguese plant series;
- To classify the Portuguese native species, based on knowledge from the fields of Botany;
- Phytosociology and Phytogeography, combined with data acquired from field work;
- To identify sites for collecting seeds and selecting species with the potential to be produced in the nursery and used in Landscape Architecture projects, considering the legislation for species and habitats;
- Experimentation on and production of native species by seminal means;
- To devise new methods of working on landscapes and outdoor spaces;
- To build up a data base containing up-to-date information on native plants and on their availability in the Portuguese market.

> Keywords NATIVE SPECIES NATURAL VEGETATION LANDSCAPE ARCHITECTURE BIODIVERSITY CONSERVATION

# 06. Results

• *Salazar Marta L.*
• *Oliveira Cristina*
• *Soares Ana Luisa*
• *Soares Filipe*
• *Espírito-Santo Dalila*

The current project bases all research and experimentation on thorough field work performed nationally (Costa *et al.*, 1998) that includes plant inventories (**Fig. 2**), landscape interpretation (**Fig. 3**) and the collecting of seeds in relation to landscape architecture and botany, as well as the production of many of these species in nurseries to ensure they are available for projects.

The gardens projected following this methodology were registered by ARQOUT with the name *ECOJardim* (EcoGarden). The project was awarded the ECOFLORA 2012 prize for a winning idea.

| Tour n* | Itinerary | Date | Participants |
|---|---|---|---|
| 1 | APOSTIÇA/MECO/ARRÀBIDA | 9/03/2012 | Sigmetum (Filipe Soares, Joao, Tino), Argout (Mrata Salazar Leite), ISA (Dalila Espirito-Santos) |

| Stage | | Coordinate | Vegetation series | | |
|---|---|---|---|---|---|
| Woodland | Pre-forest | High shrub | Perennial grassland | Low shrub | Annual grassland |
| *Oleo-Quercetum suberis (residual)* | *Junipero navicularae-Quercetum lusitanica* | *Thymo capitellati-Stauracanthetum genistoidis (residual)* | *Euphorbio transtaganae-Celticetum giganteae* | *Erica umbellatae-Ulicetum welwitschiani* | *Corynephoro macrantheri-Arenarietum algarbiensis* |
| *Quercus suber* | *Juniperus navicularis* | *Thymus capitellatus* | *Celtica gigantea (=Stipa gigantea)* | *Ulex australis subsp. welwitschianus* | *Tuberaria guttata* |
| *Phillyrea angistifolia* | *Daphne gnidium* | *Helichrysum italicum subsp. serotinum* | *Asphodelus lusitanicus* | *Erica umbellata* | *Aira caryophyllea* |
| *Phillyrea latifolia* | *Quercus lusitanica* | *Halimium calycinum* | *Brachypodium phoenicoides* | *Calluna vulgaris* | *Iberis contracta subsp. welwitschii* |
| *Asparagus aphyllus* | *Quesrcu coccifera* | | *Agrostis curtisii* | *Lythodora prostrata subsp. lusitanica* | *Anemone palmata* |
| *Asparagus acutifolius* | | | *Carlina corymbosa* | *Lavandula luisieri* | *Scilla monophyllos* |
| | | | *Pimpinela villosa* | *Cistus salviifolius* | *Linaria spartea* |
| | | | *Thapsia dissecta* | *Genista triacanthos* | *Corynephorus macrantherus* |

> FIGURE 2

Example of a field survey form

## Case study

Efforts on building ECOgarden models, and application examples to define methodology were implemented in several gardens. Landscape architects' projects were designed including the principles of sustainability mainly focused on a decline in water consumption, reduced soil erosion and minimum use of exotic species always attending to the aesthetical component.

In this paper we'll present two examples: Ajuda Botanic Garden, with the name of Olisiponensis Garden (**Fig. 4**) and a private garden at Grandola Hills, Melides (**Fig. 7**).

### AJUDA BOTANIC GARDEN

In this Botanic Garden the aim was to recover the forest zone which was always intended to house native species, in order to be a sample of a built garden with native plants, recreating the phytosociological environment of the region (**Fig. 5**).

> Keywords NATIVE SPECIES NATURAL VEGETATION LANDSCAPE ARCHITECTURE BIODIVERSITY CONSERVATION

# 06. Case study

• *Salazar Marta L.*
• *Oliveira Cristina*
• *Soares Ana Luisa*
• *Soares Filipe*
• *Espírito-Santo Dalila*

## Tour sheet

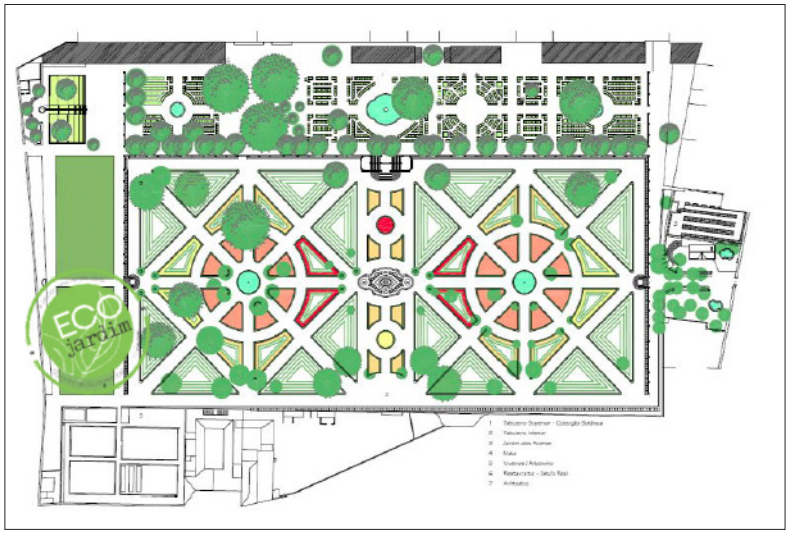
**MELIDES/SERRA DE GRÂNDOLA**

| **arqOUT arquitectura paisagista** | **Sigmetum** | **Instituto Superior de Agronomia** |
|---|---|---|
| *Investigação/Projecto* | *Investigação/Produção* | *Investigação/Consultoria* |
| *Cristina Oliveira, Marta Salazar Leite* | *Filipe Soares, João Paulo Gomes* | *Ana Luísa Soares, Dalila Espírito-Santo* |

| LOCAL | LANDSCAPE | PHYTOSOCIOLOGY |
|---|---|---|
|  | The place is located in Serra de Grândola, predominant formation of shale, exposed to dry weather with little rain in summer and climate sub-humid with low temperatures in winter.<br><br>The diagnosis was confirmed by the landscape phytosociological framework in a 500m radius, which were carried out several inventories and photographic surveys. | *Asparago aphylli-Quercetum suberis* |

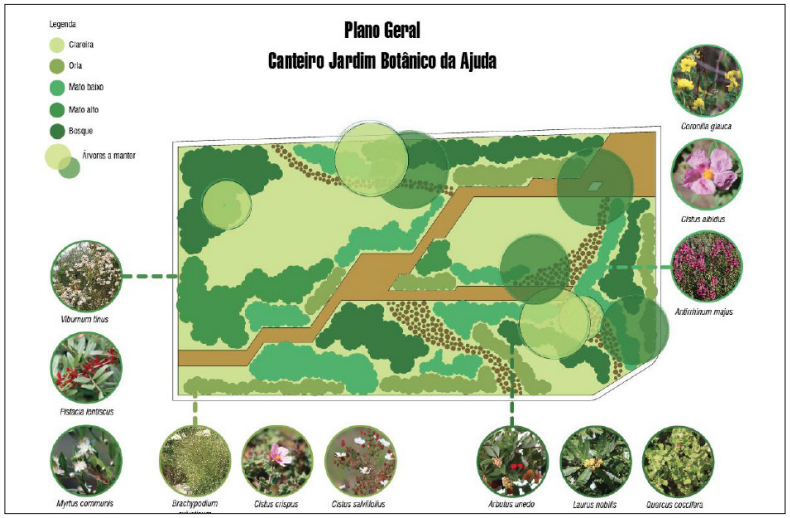
**NATIVE WITH POTENTIAL FOR USE IN GARDEN**

| WOODLAND | HIGH SHRUB | LOW SHRUB | CLEARING/HEDGE |
|---|---|---|---|
| *Arbutus unedo* | *Erica scoparia* | *Asparagus aphyllus* | *Brachypodium phoenicoides* |
| *Crataegus monogyna subsp brevispina* | *Myrtus communis* | *Calluna vulgaris* | *Gladiolus reuteri* |
| *Olea europaea var. sylvestris* | *Phillyrea angustifolia* | *Cistus crispus* | *Origanum vulgare* |
| *Pyrus bourgaeana* | *Pistacia lentiscus* | *Cistus salviifolius* | *Stipa gigantea* |
| *Quercus suber* | *Quercus coccifera* | *Daphne gnidium* | *Thymus capitellatus* |
| | *Rhamnus alaternus* | *Erica australis* | |
| | | *Juniperus navicularis* | |
| | | *Lavandula stoechas subsp. luisieri* | |
| | | *Lonicera etrusca* | |
| | | *Quercus lusitanica* | |
| | | *Rhamnus oleoides* | |
| | | *Rosmarinus officinalis* | |
| | | *Rosa sempervirens* | |



> FIGURE 3

Example of a field landscape interpretation (Tour sheet)




>> FIGURE 4

Localization of *Olisiponensis* Garden (ECOjardim) in Ajuda Botanic Garden

>> FIGURE 5

General Plan of *Olisiponensis* Garden - Ajuda Botanic Garden

> Keywords NATIVE SPECIES NATURAL VEGETATION LANDSCAPE ARCHITECTURE BIODIVERSITY CONSERVATION

# 06. Case study

• Salazar Marta L.
• Oliveira Cristina
• Soares Ana Luisa
• Soares Filipe
• Espírito-Santo Dalila

This ECOgarden will allow visitors to see the indigenous flora of Lisbon region and the combinations of high ornamental value that result of this methodology, associated with environmental gains already known.

A total of 300 plants were planted and the species used are presented in **Table 1** with their survival rate past one year. A mortality rate of 27% was observed in total. Species like *Cistus crispus, C. salviifolius, Coronilla glauca, Lavandula stoechas* subsp. *luisieri* and *Helichrysum stoechas* need sunny places and were planted down old trees where there was too much shadow. Cistus psilosepalus, on the contrary, prefer shadow places, and was planted in a very sunny place. Trees like *Quercus pyrenaica* and Q. *rotundifolia*, so frequent around Lisbon also died, possibly because they need water in the installation phase, and summer was very warm.


> FIGURE 6

Educational panel of *Olisiponensis* Garden

The Ajuda Botanic Garden gains a new point of interest, which is also important because of the educational panels that were associated with posters identifying the project and species (**Fig. 6**). It is intended to show to the technical persons and to the general public that we have native species with very considerable ornamental value, worth for any botanical collection that can be easily found in the market.

| WOODLAND | Survival rate | HIGH SHRUB | Survival rate | LOW SHRUB | Survival rate | CLEARING/HEDGE | Survival rate |
|---|---|---|---|---|---|---|---|
| *Olea europaea* var. *sylvestris* | 100% | *Viburnum tinus* | 100% | *Helichrysum stoechas* | 10% | *Brachypodium phoenicoides* | 10% |
| *Ceratonia siliqua* | 100% | *Phillyrea angustifolia* | 100% | *Cistus albidus* | 100% | *Centranthus ruber* | 100% |
| *Quercus pyrenaica* | 0% | *Phillyrea latifolia* | 100% | *Cistus crispus* | 75% | *Euphorbia characias* | 75% |
| *Arbutus unedo* | 50% | *Pistacia lentiscus* | 100% | *Cistus monspeliensis* | 100% | *Sedum sediforme* | 100% |
| *Quercus rivasmartinezii* | 100% | *Quercus coccifera* | 100% | *Cistus psilosepalus* | 80% | | |
| *Quercus rotundifolia* | 0% | *Rhamnus alaternus* | 90% | *Cistus salviifolius* | 80% | | |
| *Laurus nobilis* | 100% | | | *Coronilla glauca* | 0% | | |
| | | | | *Cytisus scoparius* | 0% | | |
| | | | | *Lavandula stoechas* subsp. *luisieri* | 50% | | |
| | | | | *Rosmarinus officinalis* | 50% | | |

> TABLE 1

Plants used in *Olisiponensis* Garden and survival rate

> Keywords NATIVE SPECIES NATURAL VEGETATION LANDSCAPE ARCHITECTURE BIODIVERSITY CONSERVATION

# 06. Case study

• *Salazar Marta L.*
• *Oliveira Cristina*
• *Soares Ana Luisa*
• *Soares Filipe*
• *Espírito-Santo Dalila*

## PRIVATE GARDEN AT GRANDOLA HILLS (MELIDES)

In the heart of the Grandola Hills, Melides, there is a family house designed by the architect Manuel Aires Mateus for which an ECOgarden was designed that would be a natural space, integrating the house and the pathways, that called for little maintenance and water consumption.

The project (**Fig. 7**) was conceived so as to interact with the local ecosystem and create a welcoming garden where the colours, textures and shapes of the plants would make them part of the surroundings, while encouraging walking and the outdoor life.

The first stages of the project focussed on the analysis and interpretation of the site. The region's main vegetation was classified and the groups of species having the ideal characteristics, resistance and development for this area were identified.

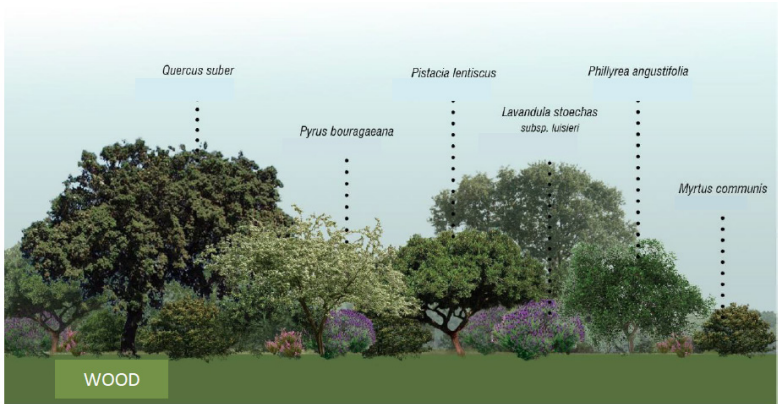
The species used are presented in **Table 2**, tree species like *Quercus suber, Arbutus unedo, Pinus pinea, Olea europaea* var. *sylvestris*, shrubs species like *Rhamnus alaternus, Phillyrea angustifolia, Pistacia lentiscus, Viburnum tinus* and smaller shrubs like *Cistus crispus, Calluna vulgaris, Lavandula pedunculata, Lavandula stoechas* subsp. *luisieri, Myrtus comunis, Daphne gnidium* and other grasses and climbing plants. The criterion for distributing the species was their placement according to exposure to sunlight and aesthetic effects (**Figs. 8** to **10**). As for watering needs during the early installation phase and in the summer, watering was guaranteed.

The garden was built in May 2013. It was inspired on the neighbor Landscape and based on its scientific components and the uses of local materials

> FIGURE 7

Project master plan - ECOgarden in the Melides garden – Grandola Hills, Portugal (ARQOUT)

and the region's native plants (**Figs. 11** to **12**). It is classified as an ECOgarden, a registered trademark created by Arqout in the context of the research project in partnership with ISA and *Sigmetum*, funded by PRODER.



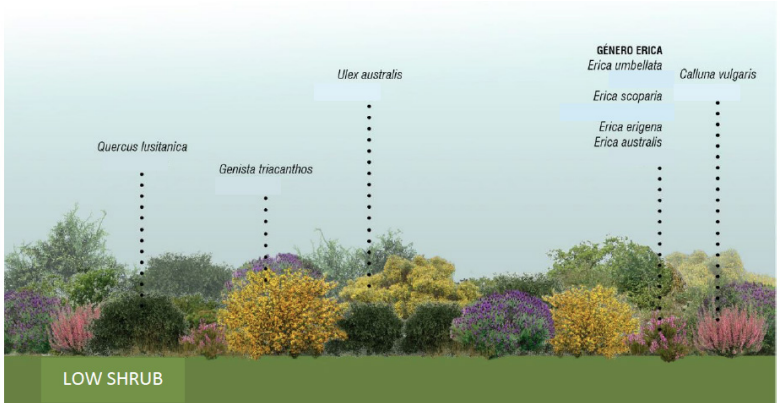

> FIGURE 8

The criterion for distributing the higher ligneous species

> Keywords NATIVE SPECIES NATURAL VEGETATION LANDSCAPE ARCHITECTURE BIODIVERSITY CONSERVATION

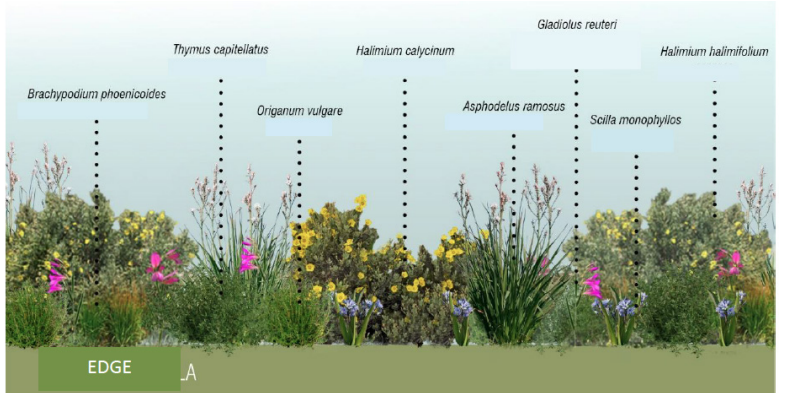
# 06. Case study

• Salazar Marta L.
• Oliveira Cristina
• Soares Ana Luisa
• Soares Filipe
• Espírito-Santo Dalila




> FIGURE 9

The criterion for distributing the lower ligneous species




> FIGURE 10

The criterion for distributing the species (mainly herbs and shrubs)

| TREES | HIGH SHRUBS | LOW SHRUBS | GRASSES | HERBS | GROUND COVER |
|---|---|---|---|---|---|
| Quercus suber | Rhamnus alaternus | Cistus crispus | Brachypodium phoenicoides | Muscari comosum | Lonicera etrusca |
| Arbutus unedo | Phillyrea angustifolia | Cistus monspeliensis | Stipa gigantea | Lithodora prostrata subsp. lusitanica | Rosa sempervirens |
| Pinus pinea | Pistacia lentiscus | Calluna vulgaris | | Anagallis monelli | |
| Olea europaea var. sylvestris | Quercus lusitanica | Lavandula pedunculata | | Linaria amethystea | |
| | Viburnum tinus | Lavandula stoechas subsp. luisieri | | Origanum virens | |
| | Erica arborea | Myrtus communis | | Calamintha baetica | |
| | Ulex welwitschianus | Daphne gnidium | | | |

> TABLE 2

Plants used in Melides garden - Grandola Hills

> Keywords NATIVE SPECIES NATURAL VEGETATION LANDSCAPE ARCHITECTURE BIODIVERSITY CONSERVATION

# 06. Case study

• *Salazar Marta L.*
• *Oliveira Cristina*
• *Soares Ana Luisa*
• *Soares Filipe*
• *Espírito-Santo Dalila*

> FIGURE 11

The garden finished (May 2015)

> FIGURE 12

The garden finished (May 2015)

## Conclusion

In landscape architecture naturalist planting plans should be inspired by the aesthetics of spontaneous plant associations in the landscape. This naturalist vision covers not only planting plans consisting solely of native plants but also those including exotic plants. Piet Oudolf (1944-) is one of the architects who has made the largest contribution to the dissemination of naturalist planting plans through works such as *Planting the Natural Garden* (Oudolf, 2003) and projects such as *High Line Park* in New York.

Thus the selection of plant material becomes a determining factor in the creation of a truly sustainable garden, in terms of water management and the use of fertilisers, as well as in terms of pest and disease control treatments. It is very important that these plants be available through commercial nurseries. The use of phytosociology in the garden projects should also attend the aesthetical principles and the functional role of the green spaces. It is essential that each project is inspired by the actual location and materials, and that plants and typologies be selected to favor local trade and production and at the same time reduce the costs of each project. The make-up of planting plans should take into account and emphasize the project's ecological, aesthetic and functional components.

> Keywords NATIVE SPECIES NATURAL VEGETATION LANDSCAPE ARCHITECTURE BIODIVERSITY CONSERVATION

# 06. Conclusion

• *Salazar Marta L.*
• *Oliveira Cristina*
• *Soares Ana Luisa*
• *Soares Filipe*
• *Espírito-Santo Dalila*

**With the present project we intend to increase the use of native plants as an intrinsic feature of contemporary green space projects by disseminating and making information available, and through the growth of native species production via specialist methods adapted to their use in nature. Reminding that mortality rate in the suited gardens shows us that being a plant of the vegetation series is not everything for the success of a plantation. The ecology of each plant and the respect for its needs in light are decisive for this success. All the plants placed in half shade grew without problems. The software platform will allow producers to advertise the native species they produce and will bring the sector up-to-date in terms of new technology, act as a driving force to its commercial presence and to the economic sustainability of this new market. The two case studies presented in this paper are a practical application under Mediterranean conditions and we intend to apply the methodology developed to other landscape architects' projects.**

## Acknowledgments

The partnership project was funded by PRODER (Programa de Desenvolvimento Rural, Portugal) from December 2011 to March 2015.

## References

**Capelo, J.,** 2003. *Conceitos e métodos da Fitossociologia: Formulação contemporânea e métodos numéricos de análise da vegetação.* Estação Florestal Nacional - Sociedade Portuguesa de Ciencias Florestais. Oeiras.

**Capelo, J.,** 2007. *Nemorum Transtaganae Descriptio. Sintaxonomia numérica das comunidades florestais e pré-florestais do Baixo Alentejo.* Tese de Doutoramento. Instituto Superior de Agronomia. Universidade Técnica de Lisboa. Lisboa.

**Costa, J. C., Aguiar, C., Capelo, J. H., Lousã, M. & Neto, C.,** 1998. Biogeografia de Portugal continental. *Quercetea* 0: 5-56.

**Géhu, J. M. & Rivas-Martínez, S.,** 1980. Notions fondamentales de phytosociologie *in: Syntaxonomie*. J. Cramer. Vaduz.

**Oudolf, P.,** 2003. *Planting the Natural Garden*. Portland: Timber Press.

**Rivas-Martínez, S.,** 2005. Notions on dynamic-catenal phytosociology as a basis of landscape science. *Plant Biosyst*. 139: 135–144.

> Keywords NATIVE SPECIES NATURAL VEGETATION LANDSCAPE ARCHITECTURE BIODIVERSITY CONSERVATION

# 06. Annex

• *Salazar Marta L.*
• *Oliveira Cristina*
• *Soares Ana Luisa*
• *Soares Filipe*
• *Espírito-Santo Dalila*

## TAXA NOMENCLATURE AND USUAL NAMES

### ANACARDIACEAE
*Pistacia lentiscus* L. **(mastic)**

### APIACEAE
*Pimpinella villosa* Schousb.
*Thapsia dissecta* (Boiss.) Arán & Mateo

### ASPARAGACEAE
*Asparagus aphyllus* L. **(wild asparagus)**
*Asparagus acutifolius* L. **(wild asparagus)**
*Muscari comosum* (L.) Mill. (= *Leopoldia comosa* (L.) Parl.) **(tassel hyacinth)**
*Scilla monophyllos* Link

### ASTERACEAE
*Carlina corymbosa* L. **(clustered carline thistle)**
*Helichrysum italicum* (Roth) G.Don subsp. *serotinum* (Boiss.) P.Fourn. **(curry plant)**

### BORAGINACEAE
*Lithodora prostrata* subsp. *lusitanica* (Samp.) Valdés (=*Glandora prostrata* subsp. *lusitanica* (Samp.) D.C.Thomas)

### BRASSICACEAE
*Iberis contracta* Pers. subsp. *welwitschii* (Boiss.) Moreno **(white assemblies)**

### CAPRIFOLIACEAE
*Centranthus ruber* (L.) DC. **(red valerian)**
*Viburnum tinus* L. **(laurustinus)**

### CISTACEAE
*Cistus albidus* L. **(grey-leaved cistus)**
*Cistus crispus* L.
*Cistus monspeliensis* L. **(Montpellier cistus)**
*Cistus psilosepalus* Sweet
*Cistus salviifolius* L. **(sage-leaved rock-rose)**
*Halimium calycinum* (L.) K.Koch
*Tuberaria guttata* (L.) Fourr. **(spotted rock-rose)**

### CRASSULACEAE
*Sedum sediforme* (Jacq.) Pau

### CUPRESSACEAE
*Juniperus navicularis* Gand. **(juniper)**

### ERICACEAE
*Arbutus unedo* L. **(strawberry tree)**
*Calluna vulgaris* (L.) Hull **(common heather)**
*Erica australis* L.
*Erica scoparia* L.
*Erica umbellata* L. **(heather)**

### EUPHORBIACEAE
*Euphorbia characias* L. **(Mediterranean spurge)**

### FAGACEAE
*Quercus coccifera* L. **(kermes oak)**
*Quercus lusitanica* Lam. **(Lusitanian oak)**
*Quercus pyrenaica* Willd. **(Pyrenean oak)**
*Quercus rivasmartinezii* (Capelo & J.C.Costa) Capelo & J.C.Costa **(kermes oak tree)**
*Quercus suber* L. **(cork oak)**

### IRIDACEAE
*Gladyolus reuteri* Boiss. (= *Gladiolus communis* L.)

### LAMIACEAE
*Calamintha baetica* Boiss. & Reut. (=*Clinopodium nepeta* subsp. *glandulosum* (Req.) Govaerts)
*Lavandula pedunculata* (Mill.) Cav. subsp. *pedunculata* **(French lavender)**
*Lavandula stoechas* L. subsp. luisieri **(Rozeira)** *Rozeira*
*Origanum vulgare* L. subsp. virens (Hoffmanns. & Link) Ietsw. **(oregano)**
*Rosmarinus officinalis* L. **(rosemary)**
*Thymus capitellatus* Hoffmanns. & Link **(tyme)**

### LAURACEAE
*Laurus nobilis* L. **(bay laurel)**

### LEGUMINOSAE
*Ceratonia siliqua* L. **(carob tree)**
*Coronilla valentina* L. subsp. *glauca* (L.) Batt.
*Cytisus scoparius* (L.) Link **(common broom)**
*Genista triacanthos* Brot.
*Ulex australis Clemente* subsp. *welwitschianus* (Planch.) Espírito Santo & al. **(gorse)**

### MYRTACEAE
*Myrtus communis* L. **(myrtle)**

### OLEACEAE
*Olea europaea* L. var. *sylvestris* (Mill.) Lehr.
*Phillyrea angustifolia* L. **(false olive)**
*Phillyrea latifolia* L. **(mock privet)**

### PINACEAE
*Pinus pinea* L. **(umbrella pine)**

### PLANTAGINACEAE
*Linaria amethystea* (Vent.) Hoffmanns. & Link
*Linaria spartea* (L.) Willd.

### POACEAE
*Agrostis curtisii* Kerguélen **(bristle bent)**
*Aira caryophyllea* L. **(silver hairgrass)**
*Brachypodium phoenicoides* (L.) Roem. & Schult. **(perennial green grass)**
*Corynephorus macrantherus* Boiss. & Reut.
*Stipa gigantea* Link **(giant feather grass)**

### PRIMULACEAE
*Anagallis monelli* L. **(blue pimpernel)**

### RANUNCULACEAE
*Anemone palmata* L. **(yellow anemone)**

### RHAMNACEAE
*Rhamnus alaternus* L. **(Mediterranean buckthorn)**

### ROSACEAE
*Crataegus monogyna* var. *brevispina* (Kunze) Dippel **(common hawthorn)**
*Pyrus bourgaeana* Decne. **(Iberian pear)**
*Rosa sempervirens* L. **(evergreen rose)**

### THYMELAEACEAE
*Daphne gnidium* L. **(flax-leaved daphne)**

### XANTHORRHOEACEAE
*Asphodelus lusitanicus* Cout

# DARE TO THINK! EDUCATING ABOUT THE NATURE OF SCIENCE IN THE GHENT UNIVERSITY MUSEUM AND BOTANICAL GARDEN

Photo credit : Students re-enact historic experiments of Van Helmont, Priestley and Sachs revealing the central nutrients of plant metabolism. Afterwards, students participate in a discussion about the nature of science, ***Tim Vanhove***

**De Schrijver Jelle[1,2], Dugardin Chantal[1] & Goetghebeur Paul[1]**

[1] Ghent University Museum – Collection botanical garden, K.L. Ledganckstraat 35, 9000 Gent, Belgium

jelle.deschrijver@ugent.be

[2] Odisee University College, Warmoesberg 26, 1000 Brussels, Belgium

> Keywords SCIENCE EDUCATION NATURE OF SCIENCE SCIENCE MUSEUM SCIENTIFIC LITERACY

# 06. Abstract

• *De Schrijver Jelle*
• *Dugardin Chantal*
• *Goetghebeur Paul*

TO INCREASE SCIENTIFIC LITERACY AMONG HIGH SCHOOL STUDENTS AND STIMULATE THEIR CRITICAL REFLECTION ABOUT SCIENCE, EDUCATING ABOUT THE NATURE OF SCIENCE (NOS) IS CONSIDERED CRUCIAL. NOS ENTAILS A FOCUS ON THE CENTRAL EPISTEMOLOGICAL UNDERPINNINGS OF SCIENCE, SUCH AS ITS REALM AND LIMITS, ITS LEVELS OF UNCERTAINTY, ITS BIASES AND THE REASONS FOR ITS RELIABILITY. AS BOTANICAL GARDENS AND SCIENCE MUSEUMS PROVIDE PROOF OF THE SCIENTIFIC PRACTICE AS SUCH, THEY ARE A FERTILE SOIL TO FOSTER UNDERSTANDING OF THE NOS AMONG A WIDE RANGE OF VISITORS AND CONTRIBUTE TO THE SCIENTIFIC LITERACY OF STUDENTS. IN THIS PAPER, WE EXPLORE HOW NOS CAN BE ADDRESSED IN SCIENCE MUSEUMS AND BOTANICAL GARDENS, REPORT ON AN EDUCATION RESEARCH DESIGN-STUDY TACKLING NOS AND DISCUSS THE IMPORTANCE OF TRAINING THE EDUCATIVE PERSONNEL TO OBTAIN A FOCUS ON THE NOS.

> Keywords SCIENCE EDUCATION NATURE OF SCIENCE SCIENCE MUSEUM SCIENTIFIC LITERACY

# 06. Introduction

• *De Schrijver Jelle*
• *Dugardin Chantal*
• *Goetghebeur Paul*

Photo credit : Students re-enact historic experiments of Van Helmont, Priestley and Sachs revealing the central nutrients of plant metabolism. Afterwards, students participate in a discussion about the nature of science.

**PHYLOGENIC CLASSIFICATION IS CONSTANTLY REFINED, THEORIES ABOUT SUBATOMIC PARTICLES ARE DISCUSSED AND CERTAIN PHYSIOLOGICAL PROCESSES REMAIN UNCERTAIN. BUT STILL, MANY PEOPLE AND MOST HIGH SCHOOL STUDENTS CONSIDER THE DOMAIN OF SCIENCE AS A COLLECTION OF UNQUESTIONABLE FACTS.**

Students harbour a range of misconceptions with regard to the scientific process and the role of the scientist. Misconceptions such as “scientific ideas are permanent and unchanging”, or “if scientific ideas are tentative and subject to change, they cannot be trusted”, a “scientist is not creative” (Quigley, Pongsanon & Akerson, 2010).

Some of these misconceptions have probably been acquired in the regular science classes at school where teachers often propagate a purely objectified and disembodied view of science. Indeed, the scientific curriculum in secondary education often only focuses on the scientific content to be acquired by students, such as Newton’s laws or the anatomy of plants. Yet, science education can also play a key role in developing the scientific literacy of citizens. A scientifically literate citizen should be able to participate in or at least take stance in discussions about sensitive scientific issues such as nuclear energy, genetic modification or biodiversity. To become scientifically literate, the phenomenon of science in itself, as a method to obtain reliable knowledge with its own pitfalls and opportunities, should be addressed. This means that students need to understand ‘the nature of science’.

The nature of science (NoS) is concerned with the basic underpinnings of science as a way of knowing and the characteristics of scientific knowledge. It entails several interconnected aspects : **(1)** scientific knowledge is empirically-based implying that it is derived from observations of the natural world. **(2)** There is a distinction between observations and interpretations by inferring on these data. **(3)** Since the practice of science involves human inference, it is a process that relies on the imagination and creativity of the scientist. **(4)** Although scientific knowledge is the product of a process of observation and interpretation, scientific knowledge remains tentative. As scientists continue testing and challenging previous interpretations, answers are only seldom final. After all, science is a human endeavour and the human perspective is fallible. In other words: “The only consistent characteristic of scientific knowledge across the disciplines is that scientific knowledge itself is open to revision in light of new evidence.” (NGSS, 2013).

Thus far, the NoS is not explicitly addressed in Flemish science education, nor does it receive a lot of attention in Flemish science museums or botanical gardens. Many science education experts claim for many years now that

> Keywords SCIENCE EDUCATION NATURE OF SCIENCE SCIENCE MUSEUM SCIENTIFIC LITERACY

# 06. Introduction

• *De Schrijver Jelle*
• *Dugardin Chantal*
• *Goetghebeur Paul*

NoS should be addressed more broadly during science class (Akerson & Donenelly, 2010; Lederman, 2006; Abd-El-Khalick, Bell & Lederman; 1998). All of them underscore the conclusion that the integration of the NoS in the educational curriculum is a most promising endeavour. As botanical gardens and science museums provide proof of the scientific practice as such, they are a fertile soil to foster understanding of the NoS among a wide range of visitors and contribute to the scientific literacy of students. In this paper, we explore how NoS can be addressed in science museums and botanical gardens, report on an education research design-study tackling NoS and discuss the importance of training the educative personnel to obtain a focus on the NoS.

## Materials & methods

In this paper we report on a small educational design research study carried out at the Ghent University Museum and botanical garden aimed at stimulating reflection about science. Educational design research (EDR) provides a methodology to create, evaluate and optimize the educative strategies and material (Plomp & Nieveen, 2007). It entails the study of developing and assessing educational interventions to solve everyday problems encountered by teachers and educators. This kind of research probes for principles to optimize the educational practice and bridge the gap between the educational practice and pedagogical research (Van Braak *et al.*, 2008). EDR is cyclical by nature, implying that it should be envisioned as a spiralling approach where the educative material of the educative intervention is developed, tested, evaluated, improved and then redeveloped, retested, re-evaluated again (Barab & Squire, 2004; Brown, 1992).

In order to tackle the problematic knowledge about the NoS among high school students, a series of workshops is developed at the Ghent University Museum for 12 to 15 year old high school students. 62 students were involved in this study. Interviews with students, teachers and qualitative observation during the educative intervention allows for assessing the learning process of the students. The workshops are developed by the educational staff of the science museum in collaboration with the collections of the botanical garden, the collection of scientific instruments and zoology. The educational personnel provides coaching for the high school students during the workshop.

## Results

### DESIGN PRINCIPLES

In developing the learning material following design principles were kept in mind:

1. As historic scientific cases provide an excellent context to reflect upon the NoS (Höttecke, 2000), it is important to integrate the histories of scientific discoveries in the learning material to be developed. In this regard different historic collections of the university museum can be used to provide the context to elicit understanding of the NoS.
2. As inquiry-based learning is a successful approach to enhance the motivation and commitment of students (Barnett, 2005), the learning material should allow students to discover and experience the scientific content through hands-on activities. This way, "inquiry-based exhibit methods about the processes of science can provide exemplary experiences with

> Keywords SCIENCE EDUCATION NATURE OF SCIENCE SCIENCE MUSEUM SCIENTIFIC LITERACY

# 06. Results

• *De Schrijver Jelle*
• *Dugardin Chantal*
• *Goetghebeur Paul*

inductive learning which can influence school methods." (Dolin *et al.*, 2008).

**3.** As understanding NoS is more than acquiring scientific knowledge, also involving reflection about scientific practice, students should be engaged in a dialogue and thinking activities throughout the learning process (Abd-El-Khalick, Bell & Lederman, 1998). In this regard a philosophical dialogue provides an interesting approach as it aims at eliciting critical reflection (Lafortune *et al.* 2002; Sigurdardottir & Nelson, 1999). This technique entails a conversation of a group of students who are discussing a central question. The coach only facilitates the dialogue by asking for explanations and arguments. The coach takes what is known as the Socratic stance, this means that he or she does not intervene with regard to the content of the discussion, but only stimulates the dialogue (Lipman, 1991; Schjelderup, 2009; Anthone & Mortier, 1997).

LEARNING MATERIAL

The use of three different collections at the Ghent University Museum (a botanical, zoological and scientific historic collection) enables an interdisciplinary approach, allowing students to discover recurring methods of science in distinct domains. The topic of 'energy' is chosen to develop the NoS learning material, as 'energy' plays a key role in the metabolism of plants and animals, but can also be addressed in the domain of physics in the study of historic scientific instruments.

In the botanical garden a workshop addressed the key historic steps in the development of the theory of photosynthesis. Students re-enact historic experiments of Van Helmont, Priestley and Sachs revealing the central nutrients of plant metabolism and the key role of solar energy for the production of organic matter. In the zoological collection, students studied the energy transfer in ecological pyramids by comparing differences in tooth structures between herbivores, carnivores and omnivores. In the collection of historic instruments, we used the experiment of Joule investigating the relation between mechanical energy and warmth as a tool to uncover the conceptual change with regard to warmth and energy.

In the workshops mentioned above, students participated in hands-on scientific experiments. In between and after these activities, students are guided in a discussion about the tentative nature of scientific knowledge, the difference between observation and inference, the creative role of the scientist and the empirical nature of the scientific practice. In a so-called "Salon scientifique", students investigated in a philosophical dialogue questions such as "How does a scientist proceed?", "Is a discovery absolutely true?" or "What makes a good scientist?"

## Discussion

Observation reveals that students are highly motivated when hands-on and minds-on activities are alternated. Citations of students participating in the workshops anecdotally illustrate how understanding of NoS is stimulated. A 14-year-old answered: "*Most ideas change, but some remain the same for a long time. We will never know for sure whether what we know is absolutely correct*". A 13-year-old claimed: "*Last year I thought that a scientist only checks what others discovered. Now I realize that there are many new things to be discovered.*"

> Keywords SCIENCE EDUCATION NATURE OF SCIENCE SCIENCE MUSEUM SCIENTIFIC LITERACY

# 06. Discussion

• *De Schrijver Jelle*
• *Dugardin Chantal*
• *Goetghebeur Paul*

We noted in our study that it was particularly girls who were involved in the discussions. Teachers reported that some of the students who participated in the dialogue at the museum are students that do not participate in science classes at school. It is apparent that the use of the philosophical dialogue stimulates a student population that is not triggered in regular science classes. This corresponds to findings of a study stimulating dialogue and discussion in primary school science demonstrating that this approach elicits interest and motivation in science in a different population (Mant *et al.*, 2007; Hanley *et al.*, 2015). In this case, mainly girls and non-native speakers seem to benefit from this approach.

Observations also show that the coach plays a key role to induce reflection among students in the workshops. Not only does the coach need to find time to question students about NoS, he/she also needs enough time and training to learn the dialogical method. It is especially hard to acquire 'the Socratic stance', which implies the coach questions more than he answers.

As the educational personnel indicated that they were not trained well enough to address the NoS through philosophical dialogue, a training program was set up to overcome this problem. The training program included different sessions focused on science, inquiry-based learning, workshop didactics, dialogical teaching and philosophical dialogue. Key in this approach is the idea that educators in the NoS workshops are to be trained to ask questions rather than answer them.

In future, new cross-disciplinary workshops addressing the nature of science in botanical gardens will be necessary to follow up what was already accomplished.

# Conclusion

**As products of scientific enterprise, botanical gardens are not only pivotal in biodiversity education, they also play a central role with regards to the education about scientific thinking and science. The collaboration with science museums and university museums provides opportunities to discuss and focus on the NoS. What is more: the century old (academic) traditions of enquiry and investigation embodied in the university museum and botanical garden can be disclosed. As the academic heritage provides tactile evidence of this tradition it may allow students to deepen their understanding of the phenomenon of science as such. However, in order to stimulate this understanding, one needs to focus on the thinking processes underlying the development or collection of the objects in university museums and gardens. This shows why the philosophical dialogue is a promising educational instrument to stimulate active discussion and reflection among students. The case study suggests that using the Socratic dialogue to stimulate understanding of the nature of science is most promising. Though further research is necessary, it seems that using this type of dialogue to induce reflection about the nature of science may allow for a happy marriage between the university as a research centre and the university as a locus of scientific heritage. For botanical gardens this implies that these tranquil places can be transformed into spaces filled with the murmur of thought and reflection upon the very fabric of science.**

> Keywords SCIENCE EDUCATION NATURE OF SCIENCE SCIENCE MUSEUM SCIENTIFIC LITERACY

# 06. References

• *De Schrijver Jelle*
• *Dugardin Chantal*
• *Goetghebeur Paul*

**Abd-El-Khalick, F., Bell, R.L. & Lederman, N.G.,** 1998. The nature of science and instructional practice: Making the unnatural natural. In: *Science Education* 82, p. 417–436.

**Akerson, V. L. & Donnelly, L. A.,** 2010. Teaching nature of science to K-2 students: What understandings can they attain? *In: International Journal of Science Education*, 32, p. 97-124.

**Anthone, R. & Mortier, F.,** 1997. *Socrates op de speelplaats. Filosoferen met kinderen in de praktijk.* Leuven: Acco.

**Barab, S. & Squire, K.,** 2004. Design-Based Research: Putting a Stake in the Ground. *In: The Journal of the Learning Sciences.* 13, p. 1-14.

**Barnett, R.,** 2005. *Reshaping the University: New Relationships between Research, Scholarship and Teaching.* McGraw Hill / Open University Press, p.67-78.

**Brown, A. L.,** 1992. Theoretical and methodological challenges in creating complex interventions in classroom settings. *In: The Journal of the Learning Sciences*, 2, p. 141-178.

**Dolin, J., Evans, R. & Quistgaard, N.,** 2008. *Teaching and Learning Scientific Literacy and Citizenship in Partnership with Schools and Science Museums.* www.museoscienza.org

**Hanley, P., Slavin, R. & Elliott, L.,** 2015. *Thinking, Doing, Talking Science.* educationendowmentfoundation.org

**Höttecke, D.,** 2000. How and what can we learn from replicating historical experiments? A case study. *Science & Education*, 9, p. 343-362.

**Lafortune, L., Daniel, M., Mongeau, P. & Pallascio, R.,** 2002. Philosophy for Children Adapted to Mathematics: A Study of its Impact on the Evolution of Affective Factors. *In: Analytic teaching* 23.

**Lederman, N. & Abd-El-Khalick, F.,** 2002. Avoiding De-Natured Science: Activities that Promote Understandings of the Nature of Science. *In: Science & Technology Education Library* 5, p. 83-126.

**Lederman, N.G.,** 2006. Research on Nature of Science: Reflections on the Past, Anticipations of the Future. *In: Asia-Pacific Forum on Science Learning and Teaching* 7, p. 1-8.

**Lederman, N.G. & Zeidler, D.L.,** 1987. Science teachers' conceptions of the nature of science: Do they really influence teacher behaviour? *In: Science Education* 71, p. 721-734.

**Lipman, M.,** 1991. *Thinking in Education.* Cambridge: Cambridge University Press.

**Mant, J., Wilson, H. & Coates, D.,** 2007. 'The Effect of Increasing Conceptual Challenge in Primary Science Lessons on Pupils' Achievement and Engagement'. *In: International Journal of Science Education* 29(14), 5 November, pp. 1707-171

**NGSS Lead States,** 2013. *Next generation science standards: For states, by states.* Washington, DC: National Academies Press.

**Plomp, T. & Nieveen, N.,** 2007. *An introduction to educational design research.* Enschede: Netzodruk.

**Quigley, C., Pongsanon, K. & Akerson, V. L.,** 2010. If we teach them, they can learn: Young students views of nature of science during an informal science education program. *In: Journal of Science Teacher Education.*

**Schjelderup, A.,** 2009. Learning science through philosophical dialogues. *In: Farhang Journal* 22.

**Sigurdardottir, Y. & Nelson, B.,** 1999. *Philosophy for Children on Top of the World.* Akureyri: Univ. Akureyri.

**Van Braak, J., Vanderlinde, R. & Aelterman, A.,** 2008. De wisselwerking tussen onderwijsonderzoek en onderwijspraktijk: de rol van de lerarenopleiding. *In: Tijdschrift voor Lerarenopleiders,* 29, p. 5-12.

# URBAN HOBBY GARDENING AND BOTANIC GARDENS

Photo credit : Urban gardens near University Botanic Gardens Ljubljana (Slovenia), ***Jože Bavcon***

**Blanka Ravnjak & Bavcon Jože**

University Botanic Gardens Ljubljana,
Ižanska cesta 15, 1000 Ljubljana,
Slovenia

blanka.ravnjak@botanicni-vrt.si
joze.bavcon@guest.arnes.si

> Keywords BOTANIC GARDENS URBAN GARDENING SOCIAL ROLE SUSTAINABLE DEVELOPMENT VEGETABLE GARDENING

# 06. Abstract

• *Blanka Ravnjak*
• *Bavcon Jože*

**URBAN AREAS AND CITY POPULATION ARE INCREASING. AT THE SAME TIME THE CONSCIOUSNESS ABOUT THE IMPORTANCE AND QUALITY OF HOME PRODUCED VEGETABLES IS RISING. IN MANY CITIES THERE ARE AREAS, WHERE CITIZENS CAN GROW THEIR OWN VEGETABLES.**

However, due to many generations of urban city-living, the knowledge about gardening, plants and their use, was forgotten by many people. That is why people are eager to receive knowledge and help, to enable them finding a primeval connection with the nature. This is where botanic gardens can play a very important role. Besides the fact, that they are scientific and research institutions and present living plant collections, they also hold a treasury of knowledge about gardening and play a significant social role. At the University Botanic Gardens Ljubljana we attach a particular importance to develop these new botanic gardens roles. In 2013, together with the Municipality of Ljubljana, the National Television of Slovenia (RTV SLO) and Ljubljana citizens, we developed an urban hobby gardening activity. To support this initiative, the Municipality of Ljubljana offered a degraded land, near our botanic garden devoted to the creation of gardens by citizens. The land was divided in several plots that were attributed to several citizens while the staff of our botanical garden helped, during planning and creation phase by giving professional advice and support for physical work. The whole action was well supported by the media. Once a week, professional advices about plants and gardening was given in TV broadcasts, live from the abovementioned gardens. The audience was able to follow at regular intervals the work progress on the gardens, observe the growth of the crops and ask questions. Thus, a once useless, abandoned piece of land was converted into a cultivated land and it also helped connect the botanical garden with citizens through gardening. With the help of the media, the botanic garden's knowledge and good practices were also presented to the broader population. This helped create a small gardening community, which is now actively sharing experiences and good practice as well as contributing to the learning land sustainable management. This project also increased the visibility and recognition of our botanic garden in Slovenia.

> Keywords BOTANIC GARDENS URBAN GARDENING SOCIAL ROLE SUSTAINABLE DEVELOPMENT VEGETABLE GARDENING

# 06. Introduction

• *Blanka Ravnjak*
• *Bavcon Jože*

Photo credit : Urban gardens near University Botanic Gardens Ljubljana (Slovenia), ***Jože Bavcon***

**NOWADAYS, BOTANIC GARDENS HAVE MANY DIFFERENT FUNCTIONS (CHENEY *ET AL.* 2000), IN ADDITION TO THE OLDEST, SCIENTIFIC AND RESEARCH ROLES, THERE IS ALSO THE EQUALLY OLD EDUCATIONAL ROLE (YOUNG 1987, MONEM 2007, OLDFIELD 2010).**

Today, the educational role is ubiquitous. We're not only talking about an educational role in terms of teaching botanical sciences and showcasing plant collections to the experts and general public, but in terms of teaching the public about the usage and cultivation of plants. In large cities, citizens have lost gardening knowledge and know how; therefore, botanical gardens become essential knowledge centres, and provide a connecting link between the experts and the general public. In a botanic garden, knowledge can also be disseminated through lectures, workshops, educational courses, and larger projects. At the Denver Botanic Gardens, gardeners are available every day to give advice to the visitors on gardening issues (http://www.botanicgardens.org). The Brooklyn Botanic Garden organises an 8-week programme (http://www.bbg.org/greenbridge/bug), teaching the participants the basis of urban gardening and planting in urban communal areas. Participants that complete the course are awarded a "Brooklyn Urban Gardener" certificate. With this acquired knowledge, they then volunteer in various planting projects, help in school gardens or in gardening communities. In a poorer district of the city, the Chicago Botanic Garden created a green oasis of urban gardens, where the youth and those with significant barriers to employment are taught gardening and self-sufficient supply of produce http://www.chicagobotanic.org/urbanagriculture. The urban agriculture apprenticeship programme teaches students the theoretical and practical aspects of agriculture and management of agricultural systems. In addition to the listed examples in the United States, many other botanic gardens organise similar programmes, thus transforming parts of the urban environment into green gardens and teaching urban residents about gardening and thus provide self-sufficient supply of produce. Even in the Alhambra complex of palaces and gardens of Granada (Spain), a UNESCO world heritage city, a section of the land was dedicated to vegetable gardens for the citizens of the city.

The Botanic Garden of the University of Ljubljana also organised similar activities in the past. Between 1834 and 1867, as Fleischmann (a gardener and later also a head of the Botanic Garden) was gaining in importance, finally taking over the Garden in 1850, fruit cultivation and gardening were heavily promoted (Praprotnik 1993, 2015). Fleischmann helped farmers throughout Carniola (one of the regions of the former Habsburg Monarchy) with his advice and participated in agricultural fairs (Praprotnik 2015). In his lecture, he

> Keywords BOTANIC GARDENS URBAN GARDENING SOCIAL ROLE SUSTAINABLE DEVELOPMENT VEGETABLE GARDENING

# 06. Introduction

• *Blanka Ravnjak*
• *Bavcon Jože*

wrote, "Many a young lady knows the foreign Camellia, but not the domestic parsley" (Fleischmann 1849, 1850; Praprotnik 1993). After 1850, an entire fruit tree nursery was established, which operated until 1894 (Voss 1884, 1885; Paulin 1912, Bavcon 2010). After 1867, this work was continued, so that the later head of the Garden, Paulin, wrote that the Garden has strayed too far towards fruit and vegetable cultivation, and failed to retain its original purpose (Paulin 1912). Nevertheless, even Paulin, who at the time criticised this direction, cooperated intensively in the management and planning of school gardens (Wraber 2010). In the 1980s, school gardens, even those with useful plants for consumption, were an intensive subject – both in articles and in practice – for Strgar, the head of the Garden at the time (Strgar 1984–1988, 1990). Because of this past history, the transition to today's very popular gardening subjects was anything but difficult for the Botanic Garden of the University of Ljubljana.

Lately, the Botanic Garden of the University of Ljubljana organises various lectures and workshops to try and present the plant world, its biodiversity and usefulness to as many people as possible (Bavcon *et al*. 2004; Bavcon 2010; Bavcon *et al*. 2015). In a time of increasing awareness of the importance of home-grown food, we have further increased our active participation in communication with the amateur gardeners. Despite the fact that Slovenia has a relatively lower proportion of urban population compared to other European countries, the 1960s saw a significant growth of urban population, thereby causing the slow disappearance of gardening knowledge which was no longer passed from one generation to the next. In the past, individuals often asked for advice about gardening in the Botanic Garden. With time, the number of requests increased. So, we decided to develop urban gardens together with urban residents with the support of media. Therefore, in 2013, the Botanic Garden of the University of Ljubljana, the national broadcaster RTV SLO and the City of Ljubljana began the urban gardens project.

## Methods

THE URBAN GARDENS PROJECT WAS IMPLEMENTED IN FIVE PHASES.

In the first phase, we selected the most suitable locations for urban gardens. We selected a location that was close enough to the Botanic Garden and at the same time owned by the City of Ljubljana, since the latter approved unlimited use of this land for gardening. The chosen location is located along a railway line, slightly inclined, and with a southern exposure. The location has been named "Gardens behind the railway line". This land plot has a ruderal and degraded character, and was home to invasive plant species and bushes.
Along with selecting the location, we also selected the candidates – lessees of gardens – with the help of RTV SLO.

In the second phase, during early spring in 2013, we thoroughly cleaned the land plot of all bushes, removed the large stones and the remains of construction material, and ploughed the soil. We then divided the land plot into 6-by-5-metre gardens (30 $m^2$). Such a plot had a size sufficient to provide enough food for a family of four.

In the third phase, we began planting vegetables, and attributed to each garden owner a mentor from the Botanic Garden. All the gardeners selected signed a statement, whereby they agreed to care for the gardens on a regular basis and only use natural materials (wood, hay, homemade compost) in

> Keywords BOTANIC GARDENS URBAN GARDENING SOCIAL ROLE SUSTAINABLE DEVELOPMENT VEGETABLE GARDENING

# 06. Methods

• *Blanka Ravnjak*
• *Bavcon Jože*

their gardens. Following our suggestions, they also agreed to only use natural agents against any potential pests, so the produce grown in the gardens will be truly natural and healthy. Furthermore, we initiated an on-line discussion group for notifications, gardening-related questions, and opinion-sharing. Gardeners were also provided with some saplings cultivated in the Botanic Garden, whereas the purchase of seeds was made possible with the financial support of the broadcaster. In the selection of vegetables, we promoted autochthonous Slovenian species.

The fourth phase was devoted to the development of the area around the gardens (paths, lawn), during which the staff of the Botanic Garden also consulted a landscape architect. A rock garden was created using the dug-up rocks. We also built a composter at the edge of the gardens and the Society Knof (a non-governmental public society) used recycled wooden boxes to build a common area for socialising, decorating it with flowerbeds (for varied flowering plants). Along the edge where the gardens border the railway line, we weaved a wicker fence. Finally, Semenarna Ljubljana (a local seed shop company) donated a water collector.

In the final and fifth phase, we carried out an evaluation of the gardens, of their production and the different gardening practices used. All activities were closely followed by the national broadcaster by means of weekly live shows. This allowed the audience to submit gardening questions to experts

## Results

During the first year of the project, we helped develop four gardens; they were tended by a very diverse group of users: a three-generation family, an old retired couple, a single retired woman, and a younger employed woman. In the following years, they were joined by two young families, two retired couples, and two retired women. Crops grew nicely in the gardens, as the soil was not used intensively before and the gardens exposed in full sun. With intensive care for the garden and the development of the surrounding environment, we successfully exterminated the invasive plants from the area, such as the Canada goldenrod and the giant goldenrod (*Solidago canadensis, Solidago gigantea*). As already mentioned, we tested and presented various gardening practices in the gardens. In one of the gardens, we planted diverse crops in combination with decorative plants and herbs. The combination proved to be effective, as the herbs, such as basil (*Ocimum basilicum*) and summer savory (*Satureja hortensis*) successfully repelled aphids and prevented mould on tomatoes. Decorative flowers, such as marigolds (*Tagetes* sp.), common marigold (*Calendula officinalis*), and monks cress (*Tropaeolum majus*) repelled potatoes underground pests and brassica aphids. We also tested the usage of varied types of mulch. These proved to be effective especially in the dry summer months, as they retained moisture in the soil around the crops. We also built a smaller greenhouse in one of the gardens, where the gardeners successfully grew lettuce and carrots, as well as some vegetable seedlings for the next season. Since the start of the project, decorative plants flourished along the edges of the gardens, additionally attracting pollinators that are important for a good yield. Employees of the Botanic Garden presented the development and growth of the gardens, along with relevant advice, in 70 television live shows, whereas the project was featured in 3 printed publications (Katja 2015; Pirnat 2013; Fišer 2015).

> Keywords BOTANIC GARDENS URBAN GARDENING SOCIAL ROLE SUSTAINABLE DEVELOPMENT VEGETABLE GARDENING

# 06. Discussion

• *Blanka Ravnjak*
• *Bavcon Jože*

Even though Ljubljana, as the capital of Slovenia, is relatively close to the countryside, the proportion of population living in apartments in the city is relatively high. These residents do not own land plots, and therefore do not have the option to grow their own fruit and vegetables. Nowadays, many citizens cultivate vegetables on their balconies and terraces, but even that is most often insufficient, to provide enough food. The City of Ljubljana decided to help out by developing gardening areas, primarily in the vicinity of the larger residential communities. The City of Ljubljana started allocating areas in 1995, and in 2009, after an almost uncontrollable exploitation of space, whereby gardens started tarnishing the image of the city, a more serious development of gardening areas was initiated, with an ordinance on allocation of gardens (ordinances UL RS, št. 28/09). Two sample areas were developed, including a shed and composters for every garden, as well as a common playground. This garden development turned out to be quite costly and the decision was made to postpone the preparation of the areas for the gardens and land allotment in the following years. In 2014 and 2015, the City of Ljubljana passed new ordinances regarding the development and lease of land plots for garden use (ordinance UL RS, št. 8/2014). Any person with a permanent residence in Ljubljana and not in ownership of a land plot suitable to create a garden is entitled to rent a garden. A person renting such a garden pays a rent of 1€/$m^2$ per year. There are some additional operating costs, increasing the cost to about 30€ per year. Since the City of Ljubljana aims for every district community to have an area with gardens and a sample orchard, in 2015, a plan was prepared for the development of 442 gardens, of sizes varying between 25 to 30$m^2$. It was decided that abandoned and undeveloped city areas would thus be transformed into areas for production and self-sufficient supply of food. The goal of the municipal administration is to increase by 10% the number of garden projects that include self-sufficient supply for residents before 2020. The municipal administration also offers expert assistance to owners of already allocated gardens, in the form of lectures and workshops. Interest for self-production of fruit and vegetables is growing every day, as the city residents wish to consume healthy and ecologically produced vegetables with the smallest burden on the environment possible. This conscientiousness is even more present in countries with large urban surfaces, where botanic gardens in particular can instruct the local population – with workshops and various projects – regarding gardening and self-sufficient supply of food (Botanic Gardens Conservations International 2011).

Interest for gardens is quite high in the municipality of Ljubljana, it is therefore not surprising that support by the municipal administration is significant. For this reason, the Municipal Administration Board was happy to adopt the proposal by the Botanic Garden to develop gardens on the abandoned plots. Even more so, as the Botanic Garden helped create a positive story by connecting experts with city residents, and present the knowledge and joint practice to the general Slovenian public with the help of the media. When developing the "Gardens behind the railway line" project, we considered current and traditional practices, as well as the wishes of the individuals. Our garden development and planting programme was in no way fixed; we adapted to our audience, who could submit requests on what they wanted to see or learn in the popular TV live broadcast. By answering questions sent by our audience to the editorial board of the broadcasting company, we constantly followed current gardening subjects. Another positive outcome of the project is that a community also formed among the gardeners – a community of retirees, young families, and other peoples. Before the planting season, they exchanged saplings and seeds, and after the growing sea-

> Keywords BOTANIC GARDENS URBAN GARDENING SOCIAL ROLE SUSTAINABLE DEVELOPMENT VEGETABLE GARDENING

# 06. Discussion

• *Blanka Ravnjak*
• *Bavcon Jože*

son – crops. These crops were truly grown naturally (without pesticides and phytopharmacological agents), and were therefore of high quality. We also taught the gardeners how to eliminate pests from the garden using natural preparations and planting a combination of plants. With the popularisation and supply of domestic species of cultivated plants for the gardeners, we contributed to the preservation of local cultivars. We were able to explain to the gardeners that autochthonous species have the best adaptations for growing in our environment, and will grow more successfully with less care. Other botanic gardens throughout the world are also promoting the autochthonous plant species of their regions. Namely, this increases the genetic diversity of plants and promotes sustainable supply of locally grown cultivated plants characteristic of each individual countries (Taylor & Straley 1988; CBD 2012; Sharrock 2012). There was another positive outcome of the project as the gardeners did not only take care of their own garden, but also cared for the surroundings environment. Occasionally, meetings were organised in the Botanic Garden, where each gardener presented their current gardening difficulties, whereupon the experts attempted to find a solution. An intergenerational community was thus formed, where the experts of the Botanic Garden helped city residents to produce natural food by teaching them sustainable development methods for growing cultivated plants. But gardeners of the "Gardens behind the railway line" were not the only ones with a thirst for gardening knowledge; there were many others, who had sufficient surface to develop a garden next to their house, but lacked the know-how and knowledge. For this reason, the botanic garden organised a gardening course in 2014. It began during spring and lasted until the end of June. Thirty participants attended the course. The participants completed a 20-hours course, where they were primarily taught how to create a vegetable garden and how to grow high-quality vegetables at home. They learned how to suitably prepare the soil, when and how to plant or sow vegetables, what care is needed during the growing season, how to protect plants against pests, and when to harvest the crops. Furthermore, the staff of the botanic garden taught them how to collect the seeds of vegetable plants and how to manage cultivated plants in a sustainable manner. Our experience is not unique, the experts from the Denver Botanic Garden in the United States instructed the local population in a similar way by encouraging them to grow their own plant products and promote a healthy lifestyle (Derewnicka *et al*. 2015). Promotion of health food production was also implemented in the Auckland Botanic Gardens in New Zealand (Benham 2005).

For the city residents that own a garden and have already a basic gardening knowledge, we organised a workshop in the Botanic Garden of the University of Ljubljana, entitled "From seed to seed". During the workshop, we encouraged the participants to create their own seed bank. We taught them how to identify seeds of various plant species and the maturity state. During the practical exercises, we familiarised them with proper collection of seeds and seed cleaning. We also taught them how to properly store the seeds so that they retain their germination ability for as long as possible – as well as stratification procedures. During the workshop we also showed them the seed bank of our botanic garden and explained the importance of seed banks for preserving of biodiversity, as well as promoting sustainable development when considering the preservation of cultivated plants and their wild relatives.

Naturally, new methods and new cultivated plants are constantly arising in gardening, leading even experienced gardeners into uncharted waters. In the Botanic Garden of the University of Ljubljana, we aim at accompanying

> Keywords BOTANIC GARDENS URBAN GARDENING SOCIAL ROLE SUSTAINABLE DEVELOPMENT VEGETABLE GARDENING

# 06. Discussion

• *Blanka Ravnjak*
• *Bavcon Jože*

these trends and help answer current questions. We therefore organise every fortnight the so-called "gardening hours". We organise afternoon short lectures on gardening and answer any potential questions participants may have, thus providing expert assistance.

## Conclusion

Botanic gardens, with their extensive plant collections and know how centres, are important centres for disseminating knowledge on gardening to the general public. With urban expansion and the increase of urban population, the general public has almost lost the knowledge on home-grown food. Today, the demand for healthy food, sustainable development, and reconnection with nature awake in people a genuine interest for gardening and caring for their own gardens. In the way, botanic gardens, through workshops, lectures, or projects – individually or with the assistance of the city authorities – help people grow healthy food, promote autochthonous species and their wild related species, search for new varieties of cultivated plants, and protect nature and biodiversity (Sharrock 2013; Gough & Accordino 2012). In the Botanic Garden of the University of Ljubljana, where we developed urban gardens together with the City of Ljubljana and the Slovenian Radio and Televisions in 2013, we strive to reach the same goals. We taught the owners of these gardens about gardening and provided expert assistance throughout the year. A gardening community developed on these gardens, encouraging members to help each other and exchange crops and seeds. Furthermore, by developing the gardens we gave the area, which used to be degraded and overgrown by invasive species, an added value. And the city got a new managed green area. Considering the success of this project in other parts of the country, other Slovenian cities followed the Ljubljana example and began developing their own urban gardens.

> Keywords BOTANIC GARDENS URBAN GARDENING SOCIAL ROLE SUSTAINABLE DEVELOPMENT VEGETABLE GARDENING

# 06. References

• *Blanka Ravnjak*
• *Bavcon Jože*

**Bavcon, J.,** 2010. *Botanični vrt Univerze v Ljubljani / University Botanic Gardens Ljubljana*, Ljubljana: Kmečki glas, 231 pp.

**Bavcon, J., Marinček, A. & Lesar, H.,** 2004. Lectures and workshops as a source of instruction and education on the world of plants. *Scripta Botanica Belgica*, 29: 25-27.

**Bavcon, J., Marinček, A. & Ravnjak, B.,** 2015. *Kronika / Chronicle In Travniška kadulja* (Salvia pratensis L.) *v Sloveniji/ Meadow Clary* (Salvia pratensis L.) *in Slovenia*, pp. 44-95.

**Benham, S.,** 2005. Botanic Garden promotes healty eating in New Zealand. *Cuttings* 2, 2: 7

**Botanic Garden Conservation International,** 2011. *Growing the Social Role of Botanic Gardens: Partnership in the community – final report*, Richmond, BGCI: 33 pp.

**Cheney, J., Navarrete Navarro, J. & Wyse Jackson, P.,** 2000. Action Plan for Botanic Gardens in the European Union. *Scripta Botanica Belgica* vol 19.: 1-68.

**Convention on Biological Deversity,** 2012. *The Global Strategy for Plant Conservation: 2011-2020*, Richmond, BGCI, 36 pp.

**Derewnicka, L., Vergou, A., Moussouri, T. & Fernandez Rodriguez, A.,** 2015. Case Study: Urban Food Initiatives Denver Botanic Gardens, USA. *In :Caring for your community, A manual for botanic gardens*, London, BGCI: 22 Taylor in Straley.

**Fišer, D.,** 2015. Za progo – *prožni vrt. Prostori sodelovanja*, 2: 23

**Fleischmann, A.,** 1849. Natoroznanstvo je vsakimi človeku silno potrebno. *Novice* 7 (30): 132-133, 31: 137

**Fleischmann, A.,** 1850. Koristnost rastljinoznanstva. *Novice* 8(21): 86-87, 22: 90-91.

**Gough, M. Z. & Accordino J.,** 2012. *The role of Public Gardens in Sustainable Community Development*: 83 pp.

http://www.bbg.org/greenbridge/bug

http://www.botanicgardens.org

http://www.chicagobotanic.org/urbanagriculture

**Katja, C.,** 2015. Vsak je lahko kmetovalec. *Ona Plus* 5, 34: 30-31

**Monem, N. K.,** 2007. *Botanic Gardens a living history*, London: Black dog-publishing.

Odlok o urejanju in oddaji vrtičkov v zakup: Uradni list RS, št. 28/09.

**Oldfield, S.F.,** 2010. *Botanic gardens: modern day arks*. New Holland Publishers UK Ltd.

**Paulin, A.,** 1912. Der k.k. Botanische Garten in Laibach. *Carniola* 3: 75–85. Muzejsko društvo za Kranjsko. Ljubljana.

**Pirnat A.,** 2013. Vrtnarjenje, tu so varčevalni ukrepi. *Biobrazda* 1 (3): 6-10.

**Praprotnik, N.,** 1993. Florist in vrtnar Andrej Fleischmann (1804–1867). *Zbornik za zgodovino naravoslovja in tehnike*. 12: 63–93.

**Praprotnik, N.,** 2015. Andrej Fleischmann (1804-1867) in njegovo botanično delovanje. *Scopolia* No 83/84: 1-414.

Pravilnik o urejanju in oddaji zemljišč Mestne občine Ljubljana za potrebe vrtičkarstva (Uradni list RS, št. 8/2014).

**Sharrock, S.,** 2012. *Global strategy for plant conservation, A guide to the GSPC, All the targets, objectives and facts*, Richmond, BGCI, 36 pp.

**Sharrock, S.,** 2013. Botanic Gardens and food security - the results of BGCI's survey. *BGjournal*, 10, 2: 3-7.

**Strgar, V., Šolski vrt,** *Proteus*, l- 46-50, 1984-1988.

**Strgar, V.,** 1990. Biološko središče v Ljubljani 7, Vrata v svet ali most nazaj domov, *Biološki vestnik*, 38, št. 3, str. 97-102.

**Taylor, I. E. & Startey, G. B.,** 1988. The Botanical Garden – A Tool teach systematycs, physiology and a lot of more. *Association for Biology Laboratory Education* 10, 9: 93-106.

**Voss, W.,** 1884. *Versuch einer Geschichte der Botanik in Krain* (1754–1883). I Hälfe Laibach.

**Voss, W.,** 1885. *Versuch einer Geschichte der Botanik in Krain (1754–1883)*. Zweite Hälfe: 3–7. Laibach.

**Wraber, A.,** 2010., Alfonz Paulin, «Juliana» in Albert Bois de Chesne, *In: 200 let Botaničnega vrta v Ljubljani* (ur. Jože Bavcon), Ljubljana, str. 66-256.

**Young, M.,** 1987. *Guide to the Botanical Gardens of Britain*. Collins., London, 160 pp.

# LET IT GROW: BOTANIC GARDENS, MUSEUMS AND ZOOS CAMPAIGNING FOR BIODIVERSITY ACROSS EUROPE


Photo credit : An exhibition developed by Copenhagen Zoo as part of Let it Grow about what visitors can do to attract biodiversity at home. It includes three experimental patches (grass, weeds and meadow flowers), set aside for local biodiversity. ***Copenhagen Zoo***

**Derewnicka Liliana[1], Attorre Fabio[2], Bonacquisti Sandro[2] & Irwin Zoe[1]**

[1] Botanic Gardens Conservation International, Descanso House, 199 Kew Road, London, TW9 3BW, United Kingdom

liliana.derewnicka@bgci.org
afu212@bangor.ac.uk

[2] Department of Environmental Biology, University of Rome/Orto Botanico di Roma, Piazzale Aldo Moro, 5, 00185, Roma, Italy

fabio.attorre@uniroma1.it
sandro.bonacquisti@uni-roma1.it

> Keywords CITIZEN SCIENCE PUBLIC ENGAGEMENT LOCAL BIODIVERSITY CAMPAIGN COLLABORATION BOTANIC GARDENS ZOOS AQUARIA

# 06. Abstract

• *Derewnicka Liliana*
• *Attorre Fabio*
• *Bonacquisti Sandro*
• *Irwin Zoe*

## HOW CAN WE HARNESS THE POWER OF CITIZEN SCIENCE AND ACTION TO INCREASE AND ENHANCE THE VALUE OF OUR LOCAL SPACES FOR EUROPE'S BIODIVERSITY?

This workshop will be an opportunity to learn about projects focused on local biodiversity running in botanic gardens across Europe, to share your own experiences and to envision how botanic gardens can partner with zoos and museums to maximize their impact for safeguarding the future of European Biodiversity. BGCI will open this session by presenting the *Let it grow* campaign which will run, in collaboration with EAZA and ECSITE, the European Zoo and Museum Networks, between 2016-2017. The campaign will not only aim to raise awareness of biodiversity issues but engage European citizens in practical research and conservation activities in their local environments. This campaign has the potential to reach millions of Europeans who are already engaged with museums, zoos and botanic gardens as well as attracting new audiences. In order to do so, this workshop will brainstorm with delegates, ideas for projects and activities that can be run locally as well as scaled, across many sites and countries. The Botanic Garden of Rome will also present its vision of developing botanic gardens in Europe as citizen science centres. Both of these concepts will act as inspiration for discussing new ideas for projects that botanic gardens can run in collaboration with zoos and museums. Based on recent Eurobarometer surveys, biodiversity is a concept that is hard to communicate and many people are not able to fully understand its meaning. Join us to re-imagine how we could contribute to biodiversity conservation by actively engaging the people of Europe. This paper presents the results of a workshop held as part of the 2015 Eurogard Congress, which was attended by around 15 participants, under the topic of education. Two introductory presentations outlined the "Let it grow campaign" led by BGCI and on the CSMON-Life project led by the Botanic garden of Rome which was followed by group discussions. One of the main outcomes of the workshop was to suggest two areas where collaborative citizen projects could be developed.

> Keywords CITIZEN SCIENCE PUBLIC ENGAGEMENT LOCAL BIODIVERSITY CAMPAIGN COLLABORATION BOTANIC GARDENS ZOOS AQUARIA

# 06. Introduction

• *Derewnicka Liliana*
• *Attorre Fabio*
• *Bonacquisti Sandro*
• *Irwin Zoe*


Photo credit : An exhibition developed by Copenhagen Zoo as part of Let it Grow about what visitors can do to attract biodiversity at home. It includes three experimental patches (grass, weeds and meadow flowers); set aside for local biodiversity. *Copenhagen Zoo*

**WHEN DISCUSSING CONSERVATION, THE TOPIC OF BIODIVERSITY IS MOST LIKELY TO ARISE, HOWEVER THE TERM IS RELATIVELY NEW AND ALTHOUGH SCIENTIFIC UNDERSTANDING ON THE SUBJECT IS BECOMING MORE SUBSTANTIAL, THE GENERAL PUBLIC'S KNOWLEDGE IS STILL LACKING.**

The topic is important as it not only considers species but also necessitates the consideration of the health and function of whole genetic families and ecosystems. Biodiversity is vast and inclusive and, therefore its protection is an essential part of future conservation, which is why it needs to be conveyed to the public effectively to ensure their understanding and support (McKinney, 2002).

From an educational perspective, biodiversity can be a problematic topic. It is difficult to summarise and conceptualise clearly and therefore is difficult to convey to non-specialists (Wals, 2001). When searching for current education resources on biodiversity the results are numerous, with varying definitions of the term. Therefore it is not surprising that the public has only basic knowledge of the topic and little engagement. For biodiversity education to be successful it needs to be clear and relatable. There is also a necessity for active participation as previous citizen science projects have shown, having the public conduct science improves their understanding drastically (Bonney *et al.*, 2009).

The projects presented within this workshop aim to cover both of these factors. The 'Let it Grow campaign' will be based on local biodiversity projects focusing on a few, key identifier species. The Botanic Garden of Rome's CSMON-LIFE project is also localised and seeks to get the public actively engaged in biodiversity conservation. The workshop also provided an arena to discuss the potential for future work on behalf of botanic gardens in this area. Participants discussed the logistics and potential of citizen science as a form of engagement with biodiversity as well as ideas for future citizen science projects. Thereby this paper presents examples of how to make biodiversity education; clear, by targeting specific species; relatable, by focusing on localised issues; and engaging, by allowing the public to be actively involved.

## Why focus on local biodiversity?

Biodiversity, across Europe is under threat. According to the European Environment Agency: "Europe's biodiversity continues to be eroded resulting in

> Keywords CITIZEN SCIENCE PUBLIC ENGAGEMENT LOCAL BIODIVERSITY CAMPAIGN COLLABORATION BOTANIC GARDENS ZOOS AQUARIA

# 06. Why focus on local biodiversity?

• *Derewnicka Liliana*
• *Attorre Fabio*
• *Bonacquisti Sandro*
• *Irwin Zoe*

ecosystem degradation. Recent data showed that 60% of species assessments and 77% of habitat assessments continue to be in unfavorable conservation status." (EEA, 2015, p.1). This is not only problematic for the environment but is having huge impacts on the economy. Rapporteur, Gerben-Jan Gerbrandy, states that: "The services that nature provides us with, like clean water, clean air, fertile soil and food, are not only crucial for the well-being of human kind, they also represent an astronomical economic value. According to economists, each year we lose 3% of GDP due to the loss of biodiversity. That costs the EU €450 billion year after year." (European Commission, 2015). At the same time, there is a general lack of interest and understanding of biodiversity amongst the European public. According to the Flash Eurobarometer on biodiversity, a survey conducted through ad hoc telephone interviews, in 2013, there is definite under appreciation of the term biodiversity. "… slightly less than half of Europeans have heard of the term "**biodiversity**" and know what it means (44%). Three in ten have heard of it but don't know what it means (30%) and slightly more than a quarter have never heard of it (26%)." (European Commission, 2013, p.4).

Yet that does not mean people are not concerned about the concept since, "Nine in ten Europeans believe that the decline of forests, climate change, the endangering and disappearance of animals, the decline of natural habitats and the endangering of some plants are all serious problems." (European Commission, 2013, p.5). Furthermore, there is a discrepancy between those who are concerned and those who actively and knowingly participate in conserving biodiversity. i.e. "Respondents were asked whether they make a personal effort to protect biodiversity. Roughly four in ten respondents (38%) say that they do make such an effort…" (European Commission, 2013, p.79).

Taken all together this indicates that there is need for improvement in both public understanding and action, but that projects which focus on European biodiversity could have great potential. This is supported by a recent summary of progress towards the Aichi Targets. Aichi Target one states that: "by 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably" (CBD, n.d.). The Secretariat of the Convention on Biological Diversity found that although, there is evidence of improvement we are currently not making sufficient progress towards achieving target one.

## The "Let it grow" campaign

The European 'Let it Grow Campaign' seeks to address the deficit in progress on Aichi Target one (Secretariat of the Convention on Biological Diversity, 2014).

'Let it Grow' is a collaborative campaign between Botanical Gardens Conservation International (BCGI), the European Association of Zoos and Aquaria (EAZA) and Ecsite – a European organization representing science centres, museums and institutes. The campaign will be launched in January 2016 and run until December 2017. The aim is to promote public awareness and involvement with local biodiversity. The two year campaign will harness the power of citizen science to increase the value of our local spaces for Europe's biodiversity.

The campaign will exploit varying levels of engagement ranging from awareness raising to active participation in the measurement of biodiversity.

> Keywords CITIZEN SCIENCE PUBLIC ENGAGEMENT LOCAL BIODIVERSITY CAMPAIGN COLLABORATION BOTANIC GARDENS ZOOS AQUARIA

# 06. The "Let it grow" campaign

• *Derewnicka Liliana*
• *Attorre Fabio*
• *Bonacquisti Sandro*
• *Irwin Zoe*

The campaign will also support communities to preserve a portion of their green space for local biodiversity. Flagship species will be used to illustrate the challenges facing our wildlife with explanations on how these challenges have arisen. The partnership began on 11th September last year with the signing of a Memorandum of understanding between EAZA, ECSITE and BGCI. Going forward, these institutions will oversee and disseminate the campaign, share educational resources and recruit and support other partners who will fundraise; design and run activities and citizen science projects focused on local biodiversity in their area and publicize the importance of biodiversity.

Let it Grow is based on EAZA's model of biodiversity campaigns; it produces branding and activities at Zoos in Europe to raise money in order to fund biodiversity conservation projects.

The model has proved successful in European zoos and aquaria. For example, in 10 years, the EAZA biodiversity campaigns have raised over €3.3 million for conservation projects around the world, created new links between EAZA and other conservation organisations, been the catalyst for regulatory change, as well as raising awareness and offering funding to over 100 hundred conservation projects (EAZA Executive Office, 2010).

Specifically, in 2006, they launched their 6th campaign: the EAZA Madagascar Campaign. The aim was to:

- raise awareness of one of the world's most important reservoirs of natural history, using the unique fauna and flora found on Madagascar; promote the idea of biodiversity;
- promote ecotourism to Madagascar;
- raise funds for specific conservation projects;
- highlight ways in which the public can make positive contributions towards conservation through their daily lives;
- raise awareness for Malagasy endemic species amongst EAZA members and thereby influence future collection planning;
- promote the concept of "twinning" between EAZA members and National Parks and protected reserves (EAZA Executive Office, 2010).

Many of the aims of the Madagascar project and the lessons learnt through their other campaigns, are akin to the objectives of 'Let it Grow'. In particular, the ability to raise public awareness and create collaborations and partnerships between institutions within and out with EAZA. However, 'Let it Grow' seeks to take this further. Events and projects associated with the campaign will be run as partnerships between botanic gardens, zoos and science centres. The rationale behind this is that by getting together botanic gardens, museums, science centres and zoos they can maximize their impact through broadening their reach by combining audiences, as well as sharing expertise in different aspects of biodiversity, education and public engagement, in addition to offering a more holistic view of biodiversity by considering animals and plants together. Besides merely raising awareness, this campaign also seeks to be the spark for developing projects which inspire and facilitate participation in conservation on the part of the public through collaboration and citizen science.

The first step in developing the campaign is to *collect resources*, such as lesson plans or field guides, and activities related to local biodiversity that can be adapted and used by institutions across. As part of the campaign preparations, EAZA, Ecsite and BGCI are putting together *working groups* to develop and execute the strategy.

> Keywords CITIZEN SCIENCE PUBLIC ENGAGEMENT LOCAL BIODIVERSITY CAMPAIGN COLLABORATION BOTANIC GARDENS ZOOS AQUARIA

# 06. The “Let it grow” campaign

• *Derewnicka Liliana*
• *Attorre Fabio*
• *Bonacquisti Sandro*
• *Irwin Zoe*

WORKING GROUPS

**Education:** This group will review existing educational resources and adapt them for use across our networks of science centres, botanical gardens, zoos and aquariums.

**Scientific:** This group will advise on the scientific aspects of the campaign, defining what biodiversity means and what a biodiverse environment will look like.

**Communications:** This group will ensure smooth communications with all campaign participants and develop and execute a strategy for external communications to the media.

**Citizen Science:** This group will develop the tools and partnerships needed to allow members of the public to measure biodiversity as accurately as possible.

**Fundraising:** This group will develop a framework for raising funds for worthy local biodiversity causes at our institutions, and how that money will be awarded.

**Assessment group:** This group will design the measurement criteria for the campaign, working out how well we have done in raising awareness of biodiversity and getting people involved in measuring and creating it.

To join a working group e-mail *Liliana.derewnicka@bgci.org*

## Botanic gardens as citizen science centres

To enhance public engagement and encourage participation in conservation, there is need for expertise and shared experience in contemporary techniques, one example is citizen science, which can be defined as the participation of citizens in research activities in several forms, often focused on the collection of field data (Miller-Rushing et al. 2012). There are a number of citizen science projects aiming at preserving biodiversity across Europe and the world which are strictly related to botanic gardens, and zoos. Some examples are:

- The New York Botanical Garden Citizen Science Service has developed several projects involving citizen scientists in collecting data about forest phenology, water quality (by monitoring invertebrates) and observations of birds. The most recent project is “Listening to the trees”, which aims at engaging citizens for monitoring the impact of climate change on natural forests. (NYBG, n.d.).
- The Chicago Botanic Garden has several ongoing citizen science initiatives together with several partner institutions in the US. Two examples are Budburst, in which citizens are asked to observe how plant communities change with seasons (National Ecological Observatory Network, 2015), and project Plant of Concern, aimed at monitoring rare plants (Chicago Botanic Garden, 2015).

In Europe, citizen science has been fostered mostly by Universities and Museums, especially in northern countries. A new project that has the potential to encourage and enhance participation in conservation and thus raise awareness of the importance of local biodiversity is CSMON-LIFE.

> Keywords CITIZEN SCIENCE PUBLIC ENGAGEMENT LOCAL BIODIVERSITY CAMPAIGN COLLABORATION BOTANIC GARDENS ZOOS AQUARIA

# 06. Botanic gardens as citizen science centres

• *Derewnicka Liliana*
• *Attorre Fabio*
• *Bonacquisti Sandro*
• *Irwin Zoe*

## THE CSMON-LIFE PROJECT

The LIFE+ funded, CSMON-LIFE (**Citizen Science Monitoring**), takes place within the Rome area. The project aims to develop simple Apps for smartphones to activate citizen science campaigns, which will be focused on environmental issues, such as:

- Loss of biodiversity because of the presence of alien species
- Effects of climate change
- Conservation of rare species
- Impact of human activities on the environment

During these campaigns citizens monitor targeted animal and plant species, which are indicators of such environmental issues. The data, once validated, will feed the National Biodiversity Network (NNB) portal of the Italian Ministry for the Environment. The project, following other positive experiences from the United States and in other European countries, will also involve several Bio-blitzes in specific survey areas. For example:

- Species campaigns: Lichens and air quality, and Good and Bad Squirrels
- Rare species / climate change
- Alien species monitoring (identified by picture and location, GPS)

## CALL FOR CITIZEN SCIENCE CENTRES AT BOTANIC GARDENS

Botanic gardens are skilled in scientific research and public engagement and therefore have great potential in the area of local biodiversity and citizen science. To encourage support of botanic gardens and similar institutions to carryout work of this nature, effective examples and sharing of best practice is required. Dedicated centres for citizen science, located in botanic gardens, could provide hubs for citizen science to achieve these goals. This would have benefits for both public engagement with local biodiversity, and other environmental topics, as well as for the botanic gardens themselves. Although this would require that botanic gardens adapt to rapidly developing technologies and environmental needs, these centers would: :

- Provide a new function to BGs and increase their visibility.
- Facilitate the spread of knowledge about the CS and related initiatives.
- Increase the capacity of BGs when dealing with biodiversity and environmental issues.
- Support the networking on common methodologies, approaches, exchange of good practices.
- Help BGs with low skills and capacities.

## Discussion points during the workshop

- People need to be rewarded for their contribution to citizen science: Acknowledgement in published paper (name or group name).
- Arguably, in citizen science projects which merely focus on the production of big data, the public are not 'doing science'. There needs to be a real question for it to be science. Not just monitoring for the sake of it. The public must be aware of the intended use for the data. When we consider the idea that citizen science aims to engage people with the scientific process as well as content, collaborative/extreme citizen science is the best way to meet this end as the public are involved from the start. But, there can be different engagement levels in one project, i.e. some groups can be involved in project design and others only in monitoring.

> Keywords CITIZEN SCIENCE PUBLIC ENGAGEMENT LOCAL BIODIVERSITY CAMPAIGN COLLABORATION BOTANIC GARDENS ZOOS AQUARIA

# 06. Discussion points during the workshop

• *Derewnicka Liliana*
• *Attorre Fabio*
• *Bonacquisti Sandro*
• *Irwin Zoe*

- Experienced botanic gardens could be used as professional development hubs for other gardens to visit.
- The design of the project needs to be audience specific.
- Scientific verification tools are required: partner with universities or natural history museums.
- Engaging the public with the concept of biodiversity is not easy. According to the Flash Eurobarometer on biodiversity, conducted in 2013, "Nine in ten Europeans believe that the decline of forests, climate change, the endangering and disappearance of animals, the decline of natural habitats and the endangering of some plants are all serious problems." (European Commission, 2013, p.5) therefore they are generally aware of the issue, yet not actively engaged. Creating links between plants and animals/birds/bees can be an effective engagement method, especially with children. This is also an effective way of illustrating the interdependence of global biodiversity. On the other hand, asking societal questions can make science relevant to people.

## Ideas suggested for collaborative citizen science projects

PROJECT IDEA 1: BIODIVERSITY FOR WELLBEING

**Question:** What affect does biodiversity have on wellbeing?

**Rationale:** Horizon 2020 funding looks for a strong social element. Biodiversity to people's wellbeing highlights the importance of biodiversity and its relevance to human existence. Links to the COHAB initiative that seeks to "address the gap in awareness, policy and action on the links between biodiversity and human health and well-being." (COHAB, n.d.).

**Public involvement:** Monitoring their own wellbeing in various settings.

PROJECT IDEA 2: ORNAMENTAL PLANTS

**Rationale:** There is a lot of public knowledge and interest in this area, but not a lot of scientific research. Using ornamental plants as a hook will lead into questions of native vs non-native plants, hardiness in the face of climate change, monitoring for potential invasiveness and public engagement with the implications of this, etc.

**Public involvement:** Monitoring ornamental plants in public or private gardens.

> Keywords CITIZEN SCIENCE PUBLIC ENGAGEMENT LOCAL BIODIVERSITY CAMPAIGN COLLABORATION BOTANIC GARDENS ZOOS AQUARIA

# 06. References

• *Derewnicka Liliana*
• *Attorre Fabio*
• *Bonacquisti Sandro*
• *Irwin Zoe*

**Bonney, R., Cooper, C.B., Dickinson, J., Kelling, S., Phillipis, T., Rosenberg, K.V. & Shirk, J.,** 2009. Citizen Science: A developing tool for expanding science knowledge and scientific literacy. *Bioscience*, 59, 11, pp. 977-984.

**CBD, n.d.,** *Aichi Biodiversity Targets*, [online] Available at: https://www.cbd.int/sp/targets/ [Accessed 1st September].

**Chicago Botanic Garden,** 2015. *Plants of Concern.* [Online] Available at: http://www.plantsofconcern.org/ [Accssessed: 10th September, 2015].

**COHAB, n.d.** *About COHAB* [Online] Available at: http://www.cohabnet.org/en_about.htm [Accessed 3rd September, 2015].

**EAZA Executive Office,** 2010. *Ten Years of EAZA Conservation Campaigns.*

**European Commission,** 2015. *EU Biodiversity Strategy to 2020 – towards implementation* [Online] Available at: http://ec.europa.eu/environment/nature/biodiversity/comm2006/2020.htm [Accessed 1st September, 2015].

**European Commission,** 2013. *Flash Eurobarometer 379: Attitudes towards biodiversity.*

**European Environment Agency,** 2015. SOER 2015 *European briefings: Biodiversity*. EEA.

**McKinney, M.,** 2000. Urbanization, Biodiversity and Conservation: The impacts of urbanization on native species are poorly studies, but educating a highly urbanized human population about these impacts can greatly improve species conservation in all ecosystems. *Bioscience*, 52, 10, pp. 883-890.

**Miller-Rushing, A., Richard Primack, R. & Bonney, R.,** 2012. The history of public participation in ecological research. *Frontiers in Ecology and the Environment* 10: 285–290. http://dx.doi.org/10.1890/110278.

**National Ecological Observatory Network,** 2015. *Project Budburst* [online] Available at: http://budburst.org/ [Accessed: 10th September].

**NYBG, n.d.** *Citizen Science Programme: Listening to the Trees.* [online] Available at: http://www.nybg.org/sustainability/citizen_science.php [Accessed: 10th September, 2015].

**Secretariat of the Convention on Biological Diversity,** 2014. *Global Biodiversity Outlook* 4. Montréal.

**Wals, A.,** 2001. *Biodiversity as a Bridge Between Nature Conservation Education and EfS.* [Online] Available at: http://www.bgci.org/education/article/0293/ [Accessed: 16th September 2015].

# ENTRÉE DU NUMÉRIQUE DANS LES JARDINS BOTANIQUES DES FACULTÉS DE PHARMACIE : LE PROJET SMARTJARDIN

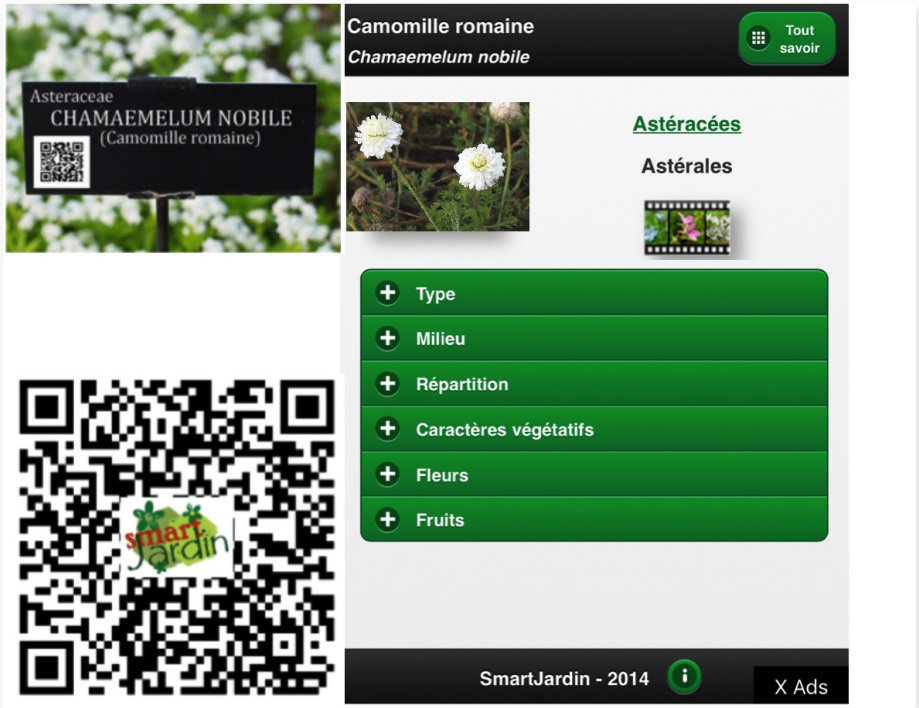



Photo credit : Smartjardin : les éléments majeurs de l'étiquetage connecté, *Frédéric Dupont et Elisabeth Chosson*

**Chosson Elizabeth[1] & Dupont Frédéric[2]**

[1] Université de Rouen, UFR de médecine et de pharmacie 22 bd Gambetta 76183 Rouen Cedex (France)
elizabeth.chosson@univ-rouen.fr

[2] Université de Lille, Faculté des sciences pharmaceutiques et biologiques 3, rue du Pr. Laguesse 59006 Lille Cedex (France)
frederic.dupont@univ-lille2.fr

> Mots-clefs JARDIN BOTANIQUE JARDIN CONNECTÉ QR CODE ÉTIQUETAGE

# 06. Résumé

• *Chosson Elizabeth*
• *Dupont Frédéric*

**SUITE À DEUX APPELS À PROJETS SUCCESSIFS, LE PROJET *SMARTJARDIN* (HTTPS://SMARTJARDIN.UNIV-ROUEN.FR) A VU LE JOUR DANS UNE PREMIÈRE VERSION EN 2012 ET DANS SA VERSION ACTUELLE EN 2014.**

Ce projet s'est construit autour de l'élaboration de 100 fiches numériques illustrées de plantes médicinales ou toxiques par des enseignants-chercheurs en botanique de différentes facultés de pharmacie françaises. Par ailleurs, une application web a été développée pour permettre la consultation des fiches sur des appareils mobiles (smartphones) ; cette application est liée à un espace collaboratif performant, permettant aux auteurs de saisir leurs données (*http://smartjardin.univ-rouen.fr/admin*).

Les fiches signalétiques de chaque plante sont accessibles par le décodage d'un QR Code que les responsables de jardin peuvent directement générer sur la page de présentation du projet et placer sur les étiquettes des plantes. Les fiches sont également valorisées et consultables chez soi sur un ordinateur fixe au travers d'une autre application, jardins botaniques virtuels (*http://jbv.univ-rouen.fr*).

Une troisième version du projet pourrait être multilingue, adaptée à une diffusion et une collaboration au niveau européen.

> Mots-clefs JARDIN BOTANIQUE JARDIN CONNECTÉ QR CODE ÉTIQUETAGE

# 06. Introduction

• *Chosson Elizabeth*
• *Dupont Frédéric*


Photo credit : Smartjardin : les éléments majeurs de l'étiquetage connecté, ***Frédéric Dupont et Elisabeth Chosson***

**C'EST EN JANVIER 2012 QUE LE PROJET *SMARTJARDIN* A ÉTÉ LAURÉAT DE L'APPEL À PROJET ANNUEL DE L'UNIVERSITÉ NUMÉRIQUE DES SCIENCES DE LA SANTÉ ET DU SPORT, (UNF3S, HTTP://WWW.UNF3S.ORG) ET A PU OBTENIR SON PREMIER FINANCEMENT.**

De mars à juin 2012, après une conférence du Dr Jean de Vaugelas, océanographe à l'université de Nice-Sophia Antipolis, pionnier dans l'utilisation des QR-codes et de la réalité augmentée, les auteurs et contributeurs se sont réunis en groupes de travail.

Le groupe «pédagogie» a travaillé sur le choix des plantes et la rédaction des fiches ; le groupe «ingénierie informatique» s'est penché sur la conception de l'application et la mise en forme des bases de données.

De juillet à août 2012 ces mêmes groupes ont assuré des corrections croisées des fiches, la recherche de l'iconographie et la saisie des données dans l'application en pré-production. Ces premiers travaux ont débouché en août 2012 sur l'inauguration du premier *Smartjardin* à l'UFR de pharmacie de Paris Descartes lors des journées scientifiques STOLON (association nationale des enseignants-chercheurs de sciences végétales et fongiques des facultés de pharmacie francophones). Enfin, en octobre 2012, la mise en production de l'application «*Smartjardin*», version 1, a été réalisée.

## L'application Smartjardin, version 1

La première version de *Smartjardin* a été financée par l'UNF3S. Cinq universités partenaires ont travaillé sur le projet : Angers, Lille 2, Paris Descartes, Paris Sud et Rouen. L'application web et la base de données ont mobilisé un ingénieur pédagogique, un développeur et un stagiaire en informatique. La rédaction et l'illustration des fiches ont été réalisées par 6 auteurs des 5 universités suscitées et 2 contributeurs (relecture et iconographie), tous enseignants-chercheurs dans des facultés de pharmacie.

Une page web de présentation du projet a été créée à l'adresse : *http://smartjardin.univ-rouen.fr* (adresse de contact : *smartjardin@univ-rouen.fr*).

50 fiches de plantes médicinales ont été rédigées. Chaque fiche comporte une page d'accueil avec les principaux caractères botaniques de la plante, un lien vers la description de la famille, une rubrique «tout savoir» avec les

> Mots-clefs JARDIN BOTANIQUE JARDIN CONNECTÉ QR CODE ÉTIQUETAGE

# 06. L'application Smartjardin, version 1

• *Chosson Elizabeth*
• *Dupont Frédéric*

confusions, les usages… Des liens dans les textes de cette fiche renvoient vers une image ou vers un carrousel d'images (ex : *http://smartjardin.univ-rouen.fr/fiche.php?id=46*).

Les fiches ont été conçues pour être accessibles sur dispositifs mobiles (smartphone et tablette connectés à l'Internet à travers le Wifi, le 3G ou le 4G) ; l'accès se fait par décodage d'un QR code (*http://qrcode.fr*) directement placé sur l'étiquette de la plante dans les jardins botaniques grâce à l'utilisation d'applications nombreuses et gratuites de décodage (ex : *http://www.beetagg.com/fr/*).

## Evolution de l'application : *Smartjardin* version 2

En janvier 2013 : la seconde version a été de nouveau lauréate de l'appel à projets annuel de l'UNF3S.

De nouveaux partenaires sont venus renforcer le groupe des auteurs : 3 enseignants-chercheurs des Universités de Rennes 1, Lorraine et Bourgogne. 50 nouvelles fiches concernant les plantes toxiques ont été élaborées.

En juin 2013 a eu lieu l'inauguration d'un nouveau Smartjardin en présence des autorités régionales et universitaires : le jardin botanique de la faculté de pharmacie d'Angers dont l'étiquetage présente désormais des QR code intégrés.

Une plateforme collaborative gérée par une équipe d'administrateurs et de gestionnaires : *http://smartjardin.univ-rouen.fr/admin* a été mise en place pour intégrer des contributions soumises à authentification et validation ; de juillet à août 2013, les groupes de travail se sont attelés aux corrections croisées des fiches, à la recherche de l'iconographie et à la saisie des données. Enfin, en septembre 2013, l'application *Smartjardin* V2 a été mise en production. De nouveaux jardins ont mis en place *Smartjardin* en 2014 : le jardin botanique de la faculté de pharmacie de Lille 2 et le Jardin botanique « Dominique Villars » de la faculté de pharmacie de Grenoble.

## Les jardins botaniques virtuels

La base de données de Smartjardin sert également à une nouvelle application : « jardins botaniques virtuels » (*http://jbv.univ-rouen.fr*), qui permet aux étudiants de revoir chez eux sur leur ordinateur de bureau les fiches des plantes vues dans les jardins botaniques. En outre, l'application propose une série de questions de façon ludique par l'intermédiaire de personnages déambulant dans le jardin virtuel, pour en faciliter l'apprentissage.

## Utilisation de *Smartjardin*

Pour les visiteurs des jardins un dispositif mobile connecté 3G, 4G ou WiFi (ce qui facilite le chargement des images) est nécessaire : tablette, téléphone (sous Android ou iPhone). Il faut, en outre, télécharger une application (gratuite) permettant de décoder des QR codes comme Beetag QR Reader, Kairos Flash QR Reader, etc…Au travers de l'objectif du dispositif mobile, le QR code

> Mots-clefs JARDIN BOTANIQUE JARDIN CONNECTÉ QR CODE ÉTIQUETAGE

# 06. Utilisation de Smartjardin

• *Chosson Elizabeth*
• *Dupont Frédéric*

est transformé en adresse Internet, ce qui renvoie automatiquement le visiteur sur le site Internet porteur des informations.

L'utilisation des fiches et des illustrations est gratuite sous licence creative commons CC BY-NC-SA 3.0 FR (Attribution-pas d'utilisation commerciale-partage dans les mêmes conditions 3.0 France, *https://creativecommons.org/licenses/by-nc-sa/3.0/fr/*). La consultation régulière du site permet de connaître les nouvelles fiches disponibles créées par les jardins botaniques souhaitant présenter de nouvelles espèces, avec de nouveaux QR-codes qui peuvent être générés en se rendant à l'adresse *https://smartjardin.univ-rouen.fr/admin/qrcodes/qrcode_index.php*, lien que l'on retrouve sur le site en cliquant sur « Générer d'autres QR codes ».

## Contribution à *Smartjardin*

Chaque jardin ou chaque botaniste peut contribuer à enrichir la banque de données de Smartjardin par la rédaction de nouvelles fiches, le partage d'illustrations ou en suggérant de nouvelles idées.

Les nouvelles idées peuvent être transmises à l'adresse de contact *smartjardin@univ-rouen.fr.* Pour devenir contributeur, il suffit de se rendre à la rubrique « Comment contribuer » du site et de remplir un petit formulaire qui sera soumis aux gestionnaires du site.

## Conclusion

**Ce projet a été le premier du genre en France. En Europe, des projets similaires commencent à se développer dans certaines présentations des jardins botaniques de Kew (Royaume-Uni), Vienne (Autriche), Meise (Belgique). Pour *Smartjardin*, il s'agit désormais d'enrichir la banque de données, d'ajouter de nouvelles fiches, tels des projets actuels de composition de fiches de plantes toxiques d'appartement, rédigées dans le cadre de projets d'unités d'enseignement libres d'étudiants en pharmacie ou de rédaction de fiches de plantes médicinales et toxiques méditerranéennes dans le cadre de thèses de doctorat d'exercice pharmaceutique.**

**Parmi les nouveaux jardins on comptera de 2015 à 2017 le Jardin de la Faculté de pharmacie de Toulouse 3, le Jardin Botanique «Jean-Marie Pelt» de Nancy, le Jardin de l'Arquebuse de Dijon, le Jardin de plantes médicinales du Musée Flaubert et d'histoire de la médecine de Rouen et le Jardin Massart de l'Université Libre de Bruxelles.**

**Une troisième version de *Smartjardin* pourrait devenir multilingue, favorisant ainsi les contributions hors du territoire français.**

> Mots-clefs JARDIN BOTANIQUE JARDIN CONNECTÉ QR CODE ÉTIQUETAGE

# 06. Remerciements

• *Chosson Elizabeth*
• *Dupont Frédéric*

Différents enseignants-chercheurs de faculté de pharmacie doivent être remerciés ici, soit pour leur implication scientifique dans la composition, la rédaction et l'illustration des fiches, au travers de nombreux échanges collaboratifs, soit pour leur aide dans la mise en place matériel de l'étiquetage spécifique dans les jardins botaniques respectifs :

- Université d'Angers : **Anne Landreau** (contributeur), **Olivier Duval** (doyen)
- Université de Bourgogne : **Nathalie Séguy** (auteur)
- Université de Lille 2 : **Luc Dubreuil** (ancien doyen)
- Université de Lorraine : **Marie-Paule Sauder** (auteur), **Francine Paulus** (doyen)
- Université Paris Descartes : **Florence Leclerc** (auteur), **Gwenaël Ruprich-Robert** (auteur), **Annie Brulfert** (contributeur), **Martine Aïache** (ancien doyen)
- Université de Paris-Sud : **Annick Simon** (auteur), **Dominique Porquet** (ancien doyen)
- Université de Rennes1 : **Françoise Le Dévéhat** (auteur).

# THE POTENTIAL OF THE BOTANIC GARDEN FOR INQUIRY-BASED TEACHER EDUCATION

Photo credit : On photo-safari in the botanic garden Bremen, *Doris Elster*

**Elster Doris**

Institute for Science Education,
Department of Biology Education
at the University of Bremen,
Leobenerstraße NW2, 28334
Bremen, Germany

doris.elster@uni-bremen.de

> Keywords SCIENCE EDUCATION GARDEN EDUCATION TEACHER TRAINING BOTANY BIODIVERSITY

# 06. Abstract

• *Elster Doris*

## BASED ON THEORETICAL CONSIDERATIONS ABOUT THE LOW INTEREST OF ADOLESCENT IN BOTANY AND PLANTS A PATHWAY TO OVERCOME THE SO-CALLED PLANT BLINDNESS WITH METHODS OF INQUIRY-BASED SCIENCE EDUCATION (IBSE) IS GIVEN: *THE INQUIRE FOR TEACHER STUDENT PROGRAM* DEVELOPED AT THE UNIVERSITY OF BREMEN.

The program aims in the developing of IBSE activities to promote the awareness and interest in plants using the botanic garden and the green houses as authentic learning environment. The research focuses on the professional growth of the participants and on the demonstration of good practice examples, content and contexts, to raise the awareness of the green biodiversity. In addition, insights of the IBSE activity *Photo-Safari in the Botanic Garden* are given and results about pupils' learning within the program are reported. In the conclusion the potential of the botanic garden as an authentic learning environment for IBSE activities is discussed.

> Keywords SCIENCE EDUCATION GARDEN EDUCATION TEACHER TRAINING BOTANY BIODIVERSITY

# 06. Introduction

• *Elster Doris*

Photo credit : On photo-safari in the botanic garden Bremen, *Doris Elster*

**INTERNATIONAL EDUCATIONAL RESEARCH DEMONSTRATES THAT THE INTEREST IN BOTANY OF ADOLESCENTS IS VERY LOW (SCHREINER & SJÖBERG, 2006; ELSTER, 2007).**

Based on the ROSE survey (The Relevance of Science) Elster (2007) reports an increase of interest if the botanical content is connected with a student relevant context. But which contexts are relevant for the young generation? What are the challenges for biology teacher education to promote the interest in plants and botany? What is the potential of the botanic gardens to promote relevance and interest in botany?

## THE IMPORTANCE OF BOTANIC GARDENS AS AN OUT-OF-SCHOOL LEARNING LOCATIONS

According to Rauer *et al.* (Rauer *et al.*, 2000) '*Botanic gardens are institutions that cultivate a documented living collection of plants to fullfil tasks in the field of scientific research and teaching, of education and the protection of species and nature.*' (Rauer *et al.*, 2000, p.5). In addition, botanic gardens offers visitors the original encounter with plants and any other living being and phenomena. The direct contact with plants allows the visitor the perception of life with all his/her senses (Fischbeck-Eysholdt, 2001).

In the view of the environmental educators, botanic gardens are excellent learning locations for the following thematical domains (Fischbeck-Eysholdt, 2001, p. 37):

- The complex relationship of plants to their environment
- The economic, cultural and aesthetical importance of plants in our life
- The connection between plants and the indigenous population
- The local environment and its global connection
- The global threat of the plant kingdom and the consequences of its destruction

According to Killermann (2005) the importance of the botanic garden is based on the original encounter of the green biodiversity in a multifaceted manner. Learners are allowed to make experiences with plants which are otherwise only possible via media. So they get to know and to value the diversity of plant spieces (Killermann, 2005).

> Keywords SCIENCE EDUCATION GARDEN EDUCATION TEACHER TRAINING BOTANY BIODIVERSITY

# 06. Introduction

• Elster Doris

## PLANT BLINDNESS AS A PROBLEM OF THE HUMAN BRAIN?

According to Wandersee and Schussler (Wandersee & Schussler, 1999) plant blindness is defined as *'the inability to see or notice the plants in one's own environment, leading to the inability to recognize the importance of plants in the biosphere and in human affairs.' Further on, plant blindness also comprises an 'inability to appreciate the aesthetic and unique biological features of plants and the misguided, anthropocentric ranking of plants as inferior to animals, leading to the erroneous conclusion that they are unworthy of human consideration.'* (Wandersee & Schussler, 1999, p. 82).

Most people don't pay attention to the fundamental role of plants and the effect on their life. But what causes plant blindness? Wandersee and Schussler (Wandersee & Schussler, 2001) argued that the primary contributor to plant blindness is the nature of the human visual information-processing system. People don't see all their surroundings by just opening their eyes. Their perception is connected with the knowledge about the object. As soon as people generally know more, for example about animals than about plants, they will pay more attention to the fauna than to the flora. In addition, chromatic homogeneity as well as the fact that plants are not moving at all, it can be seen as one of the parameters for the low interest in plants. The human brain is a detector of differences that needs changes in the patterns of space, time and/or colours. Plants don't show many differences and may therefore easily be overlooked.

## VALORIZATION OF PLANTS – A CHALLENGE

According to Lindemann-Matthies (Lindemann-Matthies, 2009) the conservation of the diversity of plants mainly depends on their valorization and awareness. If nature is considered to be valuable, the readiness to protect endangered species is higher. Based on empirical results, a strong connection between the knowledge about and the valorization of plants can be observed. Therefore, it is an essential task of biology education not only to promote subject knowledge but perception, responsibilty and awareness as well in respect to nature and all living beings too (Weber, 2010).

Beside knowledge-based factors, emotional and experience based factors influence the awareness towards plants (Gebhard, 2013). Nature experiences are closely connected with the valorization towards specific nature experience. If the learners know the plants by name and context in their natural habitat, or have learned in the school about them, they appreciate their beauty and provide a deeper interest of their growing environment (Weber, 2010).

Interest is a decisive factor for the learning process (Krapp, 1998). If a learner is interested, than he or she builds a relationship to the the study object. In turn, this enables development of knowledge and competence in new situations. There are two major points of view from which interest can be approached: interest as a characteristic of a person (personal interest) and interest aroused by specific characteristics of the learning environment (situational interest).

Content and context of a learning object can steer the development of the situational interest or circumstances in which one can find a deepened interest (Krapp, 1998). Based on the ROSE survey (The Relevance of Science) conducted with 8$^{th}$ Graders in Germany and Austria, Elster (Elster, 2007) reports that the following three content items are in respect of relevance among the ten less interesting themes: *Structures and patterns of leaves and flowers; How*

> Keywords SCIENCE EDUCATION GARDEN EDUCATION TEACHER TRAINING BOTANY BIODIVERSITY

# 06. Introduction

• Elster Doris

*plants grow and reproduce; Plants in their environment*. Elster (Elster, 2007) reported an increased interest as soon as the botanical content is connected with a student's relevant context. But what are such contexts? According to Gilbert (Gilbert, 2006) '*A context must provide a coherent structural meaning for something new that is set within an broader perspective.' And further on: 'Students should be able to provide meaning to the learning; they should experience their learning as relevant to some aspects of the lives and be able to construct coherent "mental maps" of the subject.*' (Gilbert, 2006, p. 960).

Based on the ROSE survey (Elster, 2007) such relevant contexts with regard to plants and botany are medicine and health, nutrition, drugs and mysteries, environmental education (ESD) and socio-scientific contexts (STS).

## THE PROGRAM INQUIRE FOR TEACHER STUDENTS

*INQUIRE for Teacher Students* is a program in pre-service biology teacher education at the University of Bremen (Elster, 2013). The program is based on the European project INQUIRE (Inquiry-based teacher training for a sustainable future; INQUIRE Consortium, 2011). Science educators, teacher students and teachers work together in a Community of Practice (Wenger *et al.*, 2002). The goal is to raise the awareness of the plant diversity by developing inquiry-based teacher units in a range of student relevant contexts. The content of these teaching units is about botany, biodiversity loss and climate change, the major global issues of the 21st century. The program is based on a broad understanding of Inquiry Based Science Education (IBSE). We define scientific inquiry is a multifaceted activity that involves making observations; posing questions; examining books and other sources of information to see what is already understood; planning investigations; reviewing what is already known in the framework of experimental evidence; using tools to gather, analyze, and interpret data; proposing answers, explanations and predictions, and to communicate these results (INQUIRE Consortium, 2011). In summary, inquiry based learning is not about to memorize facts – it is about many activities, such as working with living organisms (mainly plants), observing natural phenomena, formulating questions, linking evidence to explanations and finding appropriate solutions to explain observations and to address questions and problems. There may be simple tasks or complex undertakings to be carried out, but they always do lead to learners experience and the excitement of solving a question or a problem of their own, usually in the setting of a team (INQUIRE Consortium 2011; Elster, 2013).

In the program *INQUIRE for Teacher Students* teacher students and teachers organize and built school teams. They exchange learnings about the scientific background of biodiversity loss, climate change and the methods of IBSE in several locations, such as the Botanic Garden, the glass houses and the labs of the Department of Biology Education. They get support of science educators and professional botanists in the development of IBSE activities and of course also in pupil relevant context. All these require an agreement on the working process, shared goals of the participants, as well as a critical rethinking of each personal practice. Next, teacher students and teachers invite all participant school classes to reflect and evaluate the IBSE school projects. Teacher students evaluate the pupils' learned results and their gained increase of knowledge and interest in regard to *green biodiversity and inquiry-based learning*. In addition, the teacher students reflect on their own Professional Development (PD) and Pedagogical Content Knowledge (PCK) according to Park and Oliver (Park & Oliver, 2008). The outcome of the most recent given program results in a further development of the study in IBSE

> Keywords SCIENCE EDUCATION GARDEN EDUCATION TEACHER TRAINING BOTANY BIODIVERSITY

# 06. Introduction

• Elster Doris

Teaching, and twelve teacher students made a MEd thesis on IBSE training programme and pupils'learning.

In this paper, the author reports on teacher students learning in respect to the *INQUIRE for Teacher Student* Program. In addition, the content and methods of nine IBSE teaching units (Master Theses) are proposed and discussed. A special focus could be given by one of these IBSE units, *Photo-Safari in the Botanic Garden*. It shows how effective this learning programme can operate in detail and as useful tool in your Botanic Garden.

## Materials & methods

This study reports the professional growth of teacher students (N=42) and teachers (N=12) within the *INQUIRE for Teacher Students Program*. To gather data we analyzed questionnaires (pre-post) with open-ended questions and the research diaries of the teacher students and teachers according to the paradigm of the Qualitative Content Analysis (Mayring, 1998). In addition, an overview will be given on master theses based on the *INQUIRE for Teacher Students Program*. This paper analyses the content and methods of IBSE activities that were used to promote the awareness of plants (**Table 1**).

As *a best practice example* for learning botany in a student-relevant context, the IBSE teaching unit *Photo-Safari in the Botanic Garden* and its effect on pupils' learning about plants and pupils' connectedness of nature will be given in this paper. The teaching unit *Photo-Safari* was originally developed and conducted in the *INQUIRE for Teacher Student* Course in the summer semester 2013 and later on further developed within a master thesis. The special focus of the evaluation is on the effectiveness of the program regarding the prevention of *plant blindness* described by Wandersee and Schussler (Wandersee & Schussler, 1999). Furthermore, the teaching unit gives insights in the effects on pupils' valorization of plants and their interest in plants in general, as well as their subject knowledge of a neophyte. According to these goals the following main research questions are selected:

**1)** How does the teaching unit *Photo-Safari* influence the awareness of plants and the interest in plants?

**2)** What do participating pupils learn in respect to subject specific content knowledge?

**3)** What are the effects of the *Photo-Safari* on the participant connectedness to nature?

The data of this teaching unit is based on pupils' questionnaires (N=25; 11th Graders) in a pre-post- design and based on interviews with both the participants (five group interviews) and the teaching staff (N=5). The data analysis of the closed items is based on cluster analysis. The open questions and the interviews are analyzed based on the paradigm of the Qualitative Content Analysis (Mayring, 1998).

## Results

### IMPACT OF THE PROGRAM INQUIRE FOR TEACHER STUDENTS

The participating student teachers and teachers reported an increase of subject-specific Content Knowledge (CP) and the Pedagogical Content

> Keywords SCIENCE EDUCATION GARDEN EDUCATION TEACHER TRAINING BOTANY BIODIVERSITY

# 06. Results

• Elster Doris

Knowledge (PCK) in the field of biodiversity and climate change. They gained knowledge about the pupil attitudes, knowledge and interest, and also on knowledge about planning and conducting IBSE activities. Furthermore on knowledge about the curriculum, as well as knowledge about unconventional assessment techniques, like concept cartoons and concept maps.

*'Today we learned a lot about biodiversity. The different plant species and their morphological adaptation to climate factors – that was new for me.'* (diary_teacher student_C1).

Based on the questionnaire survey (pre-test) this paper indicates that the teacher students have only a little prior knowledge about biodiversity. During the course the teacher students gained a more differentiated picture about the dimensions of biodiversity.

*'[…]biodiversity, I knew before that it is about the different plant and animal species, different habitats and genetic diversity, I caught up on the meaning of the word "biodiversity" by reading, but I did not know how to implement this contents into my lessons before.'* (diary_teacher).

The participants reported a constant increase in their level of knowledge about plants species. They gathered detailed information about plants and their survival in the winter, their pollinators, and the diversity of certain plant families, in example *Bromeliaceae*, *Orchidaceae*, and *Ericaceae* (i.e. *Rhododendron*).

An increase of the self-estimation of the teacher students about their own IBSE competences could be noticed at all times. Based on the novice-expert-paradigm (Dreyfus & Dreyfus, 1987), the teacher students moved from mainly "beginners" to "advanced" or "experienced" with regard to their competences in IBSE.

The participants reported an increase in practical knowledge on how to initiate and how to conduct IBSE processes. That led to a readiness to use inquiry-based teaching and learning approaches. The self-estimation of IBSE competences and the willingness to teach in this way arose as well.

The Botanic Garden offered an authentic learning environment to discuss the importance of plants, aspects of endangered biodiversity and the responsibility of human beings for the natural environment.

## An overview of Master theses promoting the awareness of the importance of plants

**Table 1** gives an overview about teaching units (MEd theses) which include IBSE activities. They all use a student-relevant context in the domain of Botany and Biodiversity to raise the awareness of the importance of plants in this respect. It should recognize that the connection of hands-on activities and mind-on activities will be crucial to promote pupils' learning. Socio-scientific contexts (STS) as well as contexts that aim in the Education of Sustainable Development (ESD) trigger also the interest of adolescent learners. Younger children like investigations, learning on stations, and outdoor activities. All programs listed in **Table 1** were evaluated within master theses. They all indicate a positive impact on pupils' awareness of green biodiversity.

> Keywords SCIENCE EDUCATION GARDEN EDUCATION TEACHER TRAINING BOTANY BIODIVERSITY

# 06.

• *Elster Doris*

| Title | Graders | Subject content to promote the awareness of plants | Methods to promote the awareness of plants |
|---|---|---|---|
| Pineapples at all costs? | 8-10 | Rain forests in Costa Rica, diversity of Bromeliaceae and Pineapples industry | Simulation game with IBSE activities; socio-scientific context |
| Foodstuffs and climate change | 7-8 | Plants and their importance for nutrition; foodstuffs and trade | Learning on Stations; inquiry learning; health context |
| A ring-highway for Tenerife? | 8-10 | Nature conservation area at Tenerife and the possible destruction; impact on living beings and danger of erosion | Simulation game according to the syndrome approach; decision making in a socio-scientific context (STS) |
| Renewable resources | 7-8 | Which plant/field crop shall farmer Max plant to act sustainable? | Learning on Stations; inquiry learning; context is Education for Sustainable Development (ESD) |
| Hibernation of plants | 5-6 | Local plants, their stress resistance regarding freezing | Learning on Stations; IBSE activities about plants' mechanism to overwinter |
| Geocaching in the Botanic Garden | 5-6 | Discovering plants in and around the botanic garden; put them in order; invasive species | Outdoor-Activity; scavenger hunt; context is ESD |
| Thorns of roses | 10-12 | International rose farming (Africa) and trade; local and global impact; rose growing | Mystery with integrated IBSE activities; syndrome approach; STS context |
| Expedition to the Mount Kinabalu | 7-8 | Trail through the rain forests of Borneo till the 4000 meter high top; investigation of plants at different stages | Simulation game and inquiry learning; context ESD-adventure |
| Photo-Safari in the Botanic Garden | 8-10 | Classification of local plants and bio-invasive species; specialist - generalist | IBSE activity with focus on self-directed learning and communication; context ESD |

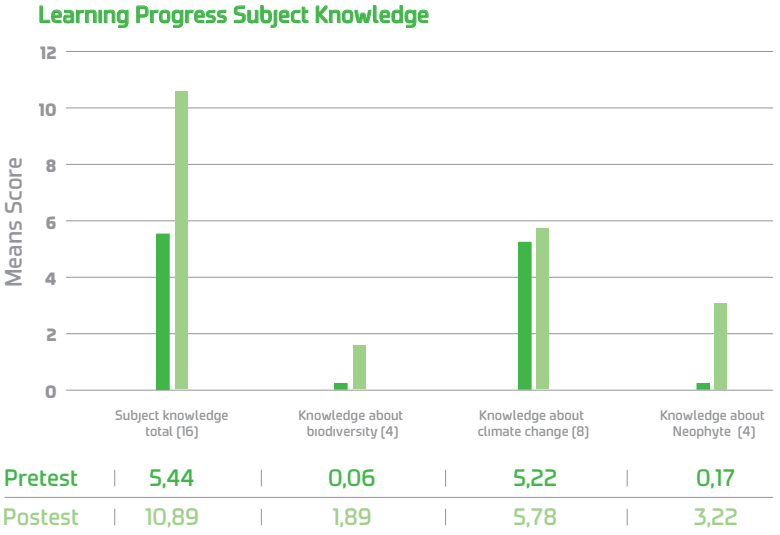
**> TABLE 1.**

List of teaching units (Master Theses) to promote the awareness of plants. All activities are conducted in the botanic garden, the green houses and labs of the University Bremen in the years 2012-2015.

## Learning effectiveness of the IBSE teaching unit Photo-Safari in the Botanic Garden

The findings (**Fig. 1**) demonstrate that the participants could obviously expand their content knowledge regarding plants, their important role in the carbon cycle and the connection to neophytes, biodiversity loss and change in respect to climate change (significant increase). The participants score their subject knowledge developed within the Photo-Safari as important or very important.

Furthermore, the program *Photo-Safari* has a positive impact on the awareness of plants as well as the avoidance of *plant blindness*, as also recorded and in coherence concluded by Wandersee and Schussler in previous studies (Wandersee & Schussler, 1999). **Fig. 2** demonstrates that all factors to prevent *Plant Blindness* could be increased (e.g. Knowledge about Plants, Interest in




**> FIGURE 1.**

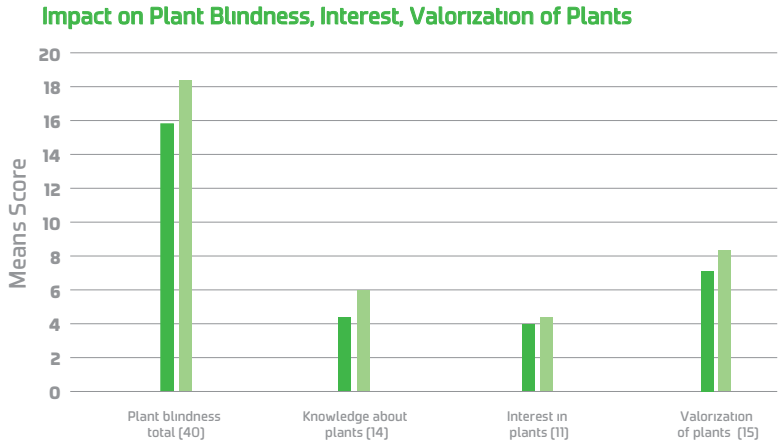
Means of the sum-scores of all participants regarding *Subject Knowledge*. The numbers in brackets are the maximal possible sum-score of the specific domain.

> Keywords SCIENCE EDUCATION GARDEN EDUCATION TEACHER TRAINING BOTANY BIODIVERSITY

# 06. Results

• *Elster Doris*

Plants, and Valorization of Plants). The findings are based on the questionnaire survey and are not statistically seen as significant. But the qualitative findings of the interviews support these positive results. In addition, the teachers agreed in the estimation, that the *Photo-Safari* could be useful as a very effective method to prevent plant blindness (Feldman-Bethe, 2014).




| | Plant blindness total (40) | Knowledge about plants (14) | Interest in plants (11) | Valorization of plants (15) |
|---|---|---|---|---|
| Pretest | 15,78 | 4,56 | 4 | 7,11 |
| Postest | 18,17 | 6 | 4,22 | 8,56 |

**> FIGURE 2.**

Means of the sum-scores of all participants regarding *factors influencing Plant Blindness, Knowledge about Plants, Interest in Plants, and Valorization of Plants*. The numbers in brackets are the maximal possible sum-score of the specific domain.

The participants valued the importance of plants higher after taking part in the Photo-Safari. They argue that they have learned 'important issues'. It was not possible to increase their interest in plants. They only reported a high interest in the activity itself. Finally, the programme has a positive influence regarding their connectedness to nature.

## Discussion & conclusion

The potential of botanic gardens for teacher education lies first of all in the multifaceted authentic learning environment. There are places for subject-content learning suitable for biology teachers and including in addition experiences with all senses. One of the students remarks in an interview: *'Visiting the botanic garden is like coming to an island within the city. It starts with the smell of fresh soil as the floor is not sealed. Watching the nature is like an ever changing adventure. I am fascinated about these changes. It allows me a deep insight in the processes of life.'* (group_interview3_students).

Another student points out *'the botanic garden allows outdoor experiences and helps learning the diversity of species.'* (group_interview2_students). Most of students state that – although the INQUIRE course is at the end of their academic study – they never have visited the Botanic Garden and the glass houses of the University Bremen before. They agree in following statements about the potential of the Botanic Garden:

- The Botanic Garden is an authentic learning environment that promotes fascination for living beings and life processes.
- The Botanic Garden offers possibilities for (guided) subject-content learning and direct observation of the diversity and plants.
- In dependence of age, sex and culture the contexts of interest about dealing with/learning about plants are different.
- Fascination and subject knowledge are essential preconditions to prevent plant blindness and supports awareness of plants and the interest in plants.

> Keywords SCIENCE EDUCATION GARDEN EDUCATION TEACHER TRAINING BOTANY BIODIVERSITY

# 06. Discussion & conclusion



• In addition, inquiry-based learning with hands-on and minds-on experiments supports positive attitudes about the diversity of plants.

To sum up, the integration of visits of the botanic garden in the teacher education program is important. If ongoing teacher value the Botanic Garden as learning environment, and if they recognize the fascination on the multifaceted possibilities, they may as ambassadors promote this fascination on the diversity of plants in the future. This paper show that the readiness to integrate a visit of the Botanic Garden with the given IBSE programme and INQUIRE course of the future school classes will be of great benefit to all other botanic gardens as well and can be seen as a prosperous future educational example.

## Acknowledgements

The author thanks Lars Feldman-Bethe, Yvonne Matzick, Kevin Henning, Sarah Logemann, Magdalena Kurpiela and Julia Seedorf-Bölke, Robert Kinzel, Constantin Abel, Svenja Heinsohn, Deniz Yaman and Nadine Konjevic for their participation in the INQUIRE program.

In addition, the author is very grateful to the reviewers for their thoughtful, detailed and constructive critics of earlier versions of the paper.

> Keywords SCIENCE EDUCATION GARDEN EDUCATION TEACHER TRAINING BOTANY BIODIVERSITY

# 06. References

• Elster Doris

**Dreyfus, H. L., & Dreyfus, S. E.,** 1987. *Künstliche Intelligenz: von den Grenzen der Denkmaschinen und dem Wert der Intuition.* Reinbek: Rowohlt.

**Elster, D.,** 2013. "INQUIRE for Students" - How to promote inquiry based learning? In: PIXEL (Hrsg.) *New Perspectives in Science Education, Conference Proceedings* 2013, March 14th-15th, 2013, Florence, Italy, Liberiauniversitaria, pp. 337-341.

**Elster, D.,** 2007. Contexts of Interest in the View of Students - Initial Results of the German and Austrian ROSE Survey. *Journal of Biological Education*, 42 (1), pp. 1-9.

**Eschenhagen, D.,** 2006. *Fachdidaktik Biologie*. Köln: Aulis.

**Fischbeck-Eysholdt, M.,** 2001. *The Botanic Garden as a Place for Environmental Education - Garden-pedagogical conception under consideration of natural history.* Oldenburg: Universität Oldenburg.

**Gebhard, U.,** 2013. *Kind und Natur - Die Bedeutung der Natur für die psychische Entwicklung.* Wiesbaden: Springer VS Verlag.

**Gilbert, J. K.,** 2006. On the Nature of 'Context' in Chemical Education. *International Journal of Science Education* , 28 (9), pp. 957-976.

**INQUIRE Consortium,** 2011. *INQUIRE Manual for teachers and educators.* Retrieved 10 10, 2015, from http://www.idn.uni-bremen.de/biologiedidaktik/Inquire/InquireHandbuch.pdf

**Killermann, W.,** 2005. *Biologieunterricht heute - eine moderne Fachdidaktik.* Donauwörth: Auer.

**Krapp, A.,** 1998. Psychologische Bedingungen naturwissenschaftlichen Lernens: Untersuchungsansätze und Befunde. In R. Duit, & e. al, *Lernen in den Naturwisenschaften* (pp. 15-20). Kiel: IPN.

**Lindemann-Matthies, P.,** 2009. The influence of plant diversity on people's perception amd aesthetic appreciation of grassland vegetation. *Biological Conservation*, 143, pp. 195-202.

**Mayring, P.,** 1998. *Qualitative Content Analysis: Basics and Techniques.* Weinheim, Basel: Beltz.

**Park, S. & Oliver, J.,** 2008. Reconceptualization of Pedagogical Content Knowledge (PCK): PCK as a Conceptual Tool to Understand Teachers as Professionals. *Research in Science Education*, 38 (3), pp. 262-284.

**Rauer, G., von den Driesch, M., Ibisch, P.L., Lobin, W. & Barthlott, W.,** 2000. *Contribution of the German Botanic Gardens for Conversation of Biodiversity and Genetic Resources - Inventory and Development Concept.* Münster-Hiltrup: Bundesamt für Naturschutz.

**Schreiner, C. & Sjöberg, S.,** 2006. *The Relevance of Science Education. Sowing the Seed of ROSE.* Oslo: Acta Didactica.

**Wandersee, J. H. & Schussler, E. E.,** 1999. Preventing Plant Blindness. *The American Biology Teacher*, 61 (2), pp. 82-86.

**Wandersee, J. & Schussler, E.,** 2001. Retrieved from Plant Science Bulletin: www.botany.org/bsa/psb/2001/psb47-1.pdf

**Weber, A.,** 2010. *Botanik im Kontext unter Berücksichtigung von differenzierten Naturerfahrungen - Naturerfahrungen im Spannungsfeld von Wertschätzungen und Kenntnissen von Pflanzen und Botanikunterricht.* Heidelberg: Pädagogische Hochschule Heidelberg.

**Wenger, E., McDermott, R. & Snyder, W.,** 2002. *Cultivating Communities of Practice.* New York: HBS Press.

# THE BOTANIC GARDEN OF THE UNIVERSITY OF MÁLAGA, A MEETING POINT FOR TEACHING AND AWARENESS

Photo credit : From left to right: Marta Recio (alone ; © ***Elena Bañares***), Antonio J. Jiménez-Lara, Guillermo Thode, Alfredo Asensi, Blanca Díez-Garretas, Elena Bañares, Antonio Heredia, José María Senciales, Manuel Marí-Beffa, José María Nieto-Caldera (© ***unknown visitor***)

**Marí-Beffa Manuel[1], Asensi Alfredo[2], Bañares Elena[2], Díez-Garretas Blanca[2], Heredia Antonio[3], Jiménez-Lara Antonio[1], Murciano Carmen[5], Nieto-Caldera José María[2], Recio Marta[2], Senciales José María[4], Thode Guillermo[1] & Silva-Sánchez Patricia[2]**

# CONTACT DETAILS

[1] Department of Cell Biology, Genetics and Physiology, Faculty of Science, University of Málaga, Campus de Teatinos s/n, 29071 Málaga, Spain
beffa@uma.es

[2] Department of Plant Biology, Faculty of Science, University of Málaga, Campus de Teatinos s/n, 29071-Málaga, Spain
patrisilvasanchez@gmail.com

[3] Department of Molecular Biology and Biochemistry, Faculty of Science, University of Málaga, Campus de Teatinos s/n, 29071 Málaga, Spain

[4] Department of Geography, Faculty of Philosophy and Letters, University of Málaga, Campus de Teatinos s/n, 29071 Málaga, Spain

[5] Colegio Sagrado Corazón, Calle de Liborio García 3, 29005 Málaga, Spain

> Keywords BOTANIC GARDEN AWARENESS COLLABORATIVE TEACHING MULTIDISCIPLINARY RESEARCH WORKGROUP COOPERATIVE LEARNING SECONDARY SCHOOL UNIVERSITY

# 06. Abstract

- *Marí-Beffa Manuel*
- *Asensi Alfredo*
- *Bañares Elena*
- *Díez-Garretas Blanca*
- *Heredia Antonio*
- *Jiménez-Lara Antonio*
- *Murciano Carmen*
- *Nieto-Caldera José Maria*
- *Recio Marta*
- *Senciales José Maria*
- *Thode Guillermo*
- *Silva-Sánchez Patricia*

**SINCE 2007, THE DEPARTMENT OF PLANT BIOLOGY OF THE UNIVERSITY OF MÁLAGA, SPAIN, HAS BEEN DEVELOPING A NUMBER OF TEACHING APPROACHES IN COLLABORATION WITH OTHER UNIVERSITY DEPARTMENTS AND HIGH SCHOOLS OF THE CITY. THESE MULTIDISCIPLINARY ACTIVITIES HAVE BEEN GROUPED IN SEVERAL WORKGROUPS AND ANNUAL DISCUSSION PLATFORMS.**

The workgroups are focused on topics such as histology, genetics, biochemistry, taxonomy, palynology, phenology, biogeography, ecology, ethnobotany, management of botanic gardens, or high school visits.

Amongst many other results, the book entitled “Plants of the Botanic Garden of the University of Malaga (UMA); Gymnosperms” has been edited and educational material for several degrees generated. Students of high schools have been guided during visits to the Botanic Garden and taught plant histology at a workshop in the garden facilities.

> Keywords BOTANIC GARDEN AWARENESS COLLABORATIVE TEACHING MULTIDISCIPLINARY RESEARCH WORKGROUP COOPERATIVE LEARNING SECONDARY SCHOOL UNIVERSITY

# 06. Introduction


- *Marí-Beffa Manuel*
- *Asensi Alfredo*
- *Bañares Elena*
- *Díez-Garretas Blanca*
- *Heredia Antonio*
- *Jiménez-Lara Antonio*
- *Murciano Carmen*
- *Nieto-Caldera José Maria*
- *Recio Marta*
- *Senciales José Maria*
- *Thode Guillermo*
- *Silva-Sánchez Patricia*


Photo credit : From left to right: Marta Recio (alone ; © ***Elena Bañares***), Antonio J. Jiménez-Lara, Guillermo Thode, Alfredo Asensi, Blanca Díez-Garretas, Elena Bañares, Antonio Heredia, José María Senciales, Manuel Marí-Beffa, José María Nieto-Caldera (© ***unknown visitor***)

**IN THIS INNOVATIVE EDUCATIONAL PROJECT, THE ACTIVITY OF SEVERAL PROFESSORS OF THE UNIVERSITIES OF MÁLAGA (UMA, FIGURE 1), MEMBERS OF THE SPANISH NATIONAL RESEARCH COUNCIL (SPANISH: CONSEJO SUPERIOR DE INVESTIGACIONES CIENTÍFICAS, CSIC), TEACHERS OF HIGH SCHOOLS IN MALAGA AND A GROUP OF VOLUNTEER STUDENTS HAVE JOINED THEIR EFFORTS IN A CO-OPERATIVE-EDUCATION ACTIVITY.**

The group, supported by the Málaga University has been accumulating an important data bank of the UMA botanic garden. Educational materials have been generated from the information stored in this bank, that have been used in various degrees offered by UMA and high schools. Teaching in these degrees has been improved and a number of final degree projects, a web site, and a book on the UMA botanic garden have been edited. This experience is similar to teaching experiences in other Spanish cities or cities from other countries.

**> FIGURE 1**

Overview of the Botanic Garden and the Faculty of Sciences of the University of Málaga. Image of the Botanic Garden from the Cactus and Succulent families sector. Observe the hemispheric Umbracle terrace characteristic of this garden

## Teaching context

The project involves different subjects of several degrees of the Málaga University, such as Biology, Geography and Environmental Sciences. Some of these subjects are “Botany”, “Phytogeography and vegetation mapping”, “Evolutionary genetics”, “Developmental Biology”, “Cell Biology and Genetics”, “Cell Biology I”, “Computing for Biologists”, which share a similar plant biology teaching and involve about 700 students.

## Objectives

THE GENERAL OBJECTIVES OF THIS PROJECT ARE:

**a)** Collaborative preparation of slides, posters or histological preparations from the botanic garden plants in UMA,

**b)** Preparation of end-of-degree works by volunteer students,

> Keywords BOTANIC GARDEN AWARENESS COLLABORATIVE TEACHING MULTIDISCIPLINARY RESEARCH WORKGROUP COOPERATIVE LEARNING SECONDARY SCHOOL UNIVERSITY

# 06. Objectives

• Marí-Beffa Manuel
• Asensi Alfredo
• Bañares Elena
• Díez-Garretas Blanca
• Heredia Antonio
• Jiménez-Lara Antonio
• Murciano Carmen
• Nieto-Caldera José Maria
• Recio Marta
• Senciales José Maria
• Thode Guillermo
• Silva-Sánchez Patricia

**c)** Application of educational material to the above-mentioned degrees,
**d)** Promotion of botanic gardens as a teaching tool in University degrees and Masters and in high Schools by the elaboration of a teaching book,
**e)** Development of a co-operative-education activity between teacher-researchers and students.

## Teaching and research methodology

The method adopted by the project comprises a cooperative student-teacher activity which uses teaching material obtained from the Málaga University botanic garden. This teaching material is the result of an eight-year old teaching experience under grants from UMA. The material includes glossaries of garden plants, a book published by SPICUM (Publications Center at the University of Malaga), histological and photographic data from leaves of about 50 plants, and various experiences with students from high schools and UMA. This material has been used in the classroom in order to stimulate the study, visit and preservation of plants in the garden and the entry of students into research groups.

Satisfaction surveys have been conducted to obtain information about the objectives of the experience, this awareness of continuous learning of teachers and interaction between teachers and students. Students have been selected during class to explain this experience to their companions, opening a critical revision. All students have enjoyed this enriching experience. This strategy generates a multidisciplinary workgroup of teachers and students that reinforces learning skills and strengthens the knowledge of previous subjects. Results are stored in a Virtual platform of the Project at a section on formation of teachers: "*Jardín Botánico UMA, fichas bot. e histoteca* (PIE08-071)". Each group is assigned a Scrypt where the method is clearly explained. Each student uploads at a wiki the information and photographs obtained by the group. Debates, commentaries or clarifications are shared at a Forum. The workgroups can be ordered in three main topics: Cell Biology, Biochemistry and Genetics; Phytogeography and Human Geography; and Botanic teaching. While the first two workgroups are focused in both teaching and research, the third is almost exclusively dedicated to botanic teaching.

The teaching and scientific methodologies used are described:

**1)** CELL BIOLOGY, BIOCHEMISTRY AND GENETIC WORKGROUPS

**Leaf histology:** Ethanol fixation, agarose embedding, vibratome sectioning and Picro-fuchsin-Toluidine blue staining method were used for light microscopy histology of leafs. Glutaraldehyde fixation, Critical point drying and Metalizing by Sputtering methods were performed to obtain Scanning Electron Microscopy images (Pathan et al., 2010). Marí-Beffa M. and Jiménez-Lara A.J. are teachers in this workgroup.

**Epicuticular waxes:** Fixation, Critical point drying and Sputtering methods for Scanning Electron Microscopy were performed after Casado and Heredia (2001). Heredia A. is a teacher in this workgroup.

**Genetics:** Amino acidic sequences of proteins from angiosperm species belonging to families present in the botanic garden were compared with an APG classification of the garden species. Proteins were screened from ge-

> Keywords BOTANIC GARDEN AWARENESS COLLABORATIVE TEACHING MULTIDISCIPLINARY RESEARCH WORKGROUP COOPERATIVE LEARNING SECONDARY SCHOOL UNIVERSITY

# 06. Teaching and research methodology

• Marí-Beffa Manuel
• Asensi Alfredo
• Bañares Elena
• Díez-Garretas Blanca
• Heredia Antonio
• Jiménez-Lara Antonio
• Murciano Carmen
• Nieto-Caldera José Maria
• Recio Marta
• Senciales José Maria
• Thode Guillermo
• Silva-Sánchez Patricia

nomic (nuclear, mitochondrial and plastid) sequences (Genbank-PIR-Genomes-Organelle, NCBI; EMBL-Uniprot, EBI, GOLD, Doe Joint Genome Institute). Sequence variation and syntenies were considered using distances, NJ, parsimony, maximum likelihood methods by SeaView v4.25 software (Gouy et al., 2010). Thode G. is a teacher in this workgroup.

### 2) PHYTOGEOGRAPHY AND HUMAN GEOGRAPHY WORKGROUPS

**Phytogeography:** Small team of students were taught appropriate scales, and coordinate reference system (SRC) of each GIS project and reference orthophotograph (year/graphic resolution) and chronograms. Vectorial information layers were elaborated to provide scientific names, biotypes, stem diameters and locations. All groups collaborated at the UNION Geoprocess program fusing their Vectorial layers in each parcel to obtain a final design of the garden with the definition of the pathway network from google map views. Students are from first course of Biology degree with the same competences for plant species identification. Nieto-Caldera J.M. is a teacher in this workgroup.

**Human Geography:** Students from the last course of Geography were assigned several Garden sectors to geolocalize each plant and to provide UTM coordinates to them. Morphological, cartographic, bibliographic and general informative data were also assigned to each plant. Market prices of 50 plant species at garden centers were screened on the internet. Use prices were also estimated to refer added values of products: bonsais, wood, handicraft, cooking use, pharmacy, cosmetics or other uses, price and production by hectare. Local prices are annotated and errors by homonymies are prevented. Senciales J.M. is a teacher in this workgroup.

### 3) BOTANIC TEACHING WORKGROUPS

**Glossary and File cards:** Students from several courses of biology degree elaborated a botanic glossary of the garden using an online platform as a practice of Botany (Recio, 2008). File cards of each species were obtained following a methodology described in Recio et al. (2012). Recio M., Díez-Garretas B. and Asensi A. are teachers in this workgroup. Silva-Sánchez P. is a student in this workgroup.

**Phenology:** Phenology tables were obtained after Orskan (1989). Data from monthly visits to plants, phenophase photographs, and herbarium sheets were organized in an intranet databank. Recio M. is a teacher in this workgroup. Silva-Sánchez P. is a student in this workgroup.

**Visits:** In order to bring science closer to non-university level students, a private (Colegio Sagrado Corazón; CSC) and a public Secondary School (IES Politécnico Jesús Marín; PJM) were invited to bring some students to visit the Botanic Garden. This experience would allow us to check the interest and the "permeability" of these groups to botanical information. Depending on groups and student ages, a variety of teaching materials were produced. Before the beginning of the activity, the students received two brief talks related to the Project and the Botanic Gardens by Dr. Marí-Beffa and Dr. Recio, respectively. Student ages were comprised between 17 to 19 and 13 to 15 years old, for the private and the public secondary school, respectively. For this reason, the activity design was different in both groups. The first group (CSC) were divided into two sub-groups, older students attended a leaf histology workshop and youngest students conducted a visit tour through the garden to describe morphological characters of plants, previously explained

> Keywords BOTANIC GARDEN AWARENESS COLLABORATIVE TEACHING MULTIDISCIPLINARY RESEARCH WORKGROUP COOPERATIVE LEARNING SECONDARY SCHOOL UNIVERSITY

# 06. Teaching and research methodology

• Marí-Beffa Manuel
• Asensi Alfredo
• Bañares Elena
• Díez-Garretas Blanca
• Heredia Antonio
• Jiménez-Lara Antonio
• Murciano Carmen
• Nieto-Caldera José Maria
• Recio Marta
• Senciales José Maria
• Thode Guillermo
• Silva-Sánchez Patricia

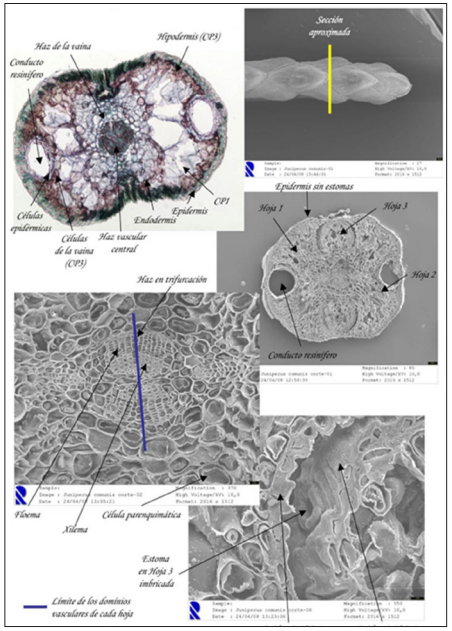
in a brief talk. The PJM students also performed a visit tour through the garden and they were provided with a small handbook with information, illustrations and location of 6 of the most representative specimens of the Botanic Garden. The handbook also contained a plant jigsaw that students had to solve at the end of the visit and some warnings on material recycling and good practice of water supply. Finally, they also red poems related to plants under the Umbracle. Moreover, visiting students took photographs of the garden and answered self-evaluation questionnaires on teachers and themselves. Recio M. and Bañares-España E. are teachers in this workgroup. Silva-Sánchez P. is a student in this workgroup.

## Workgroup results and discussion

### 1. Cell Biology, Biochemistry and Genetic workgroups

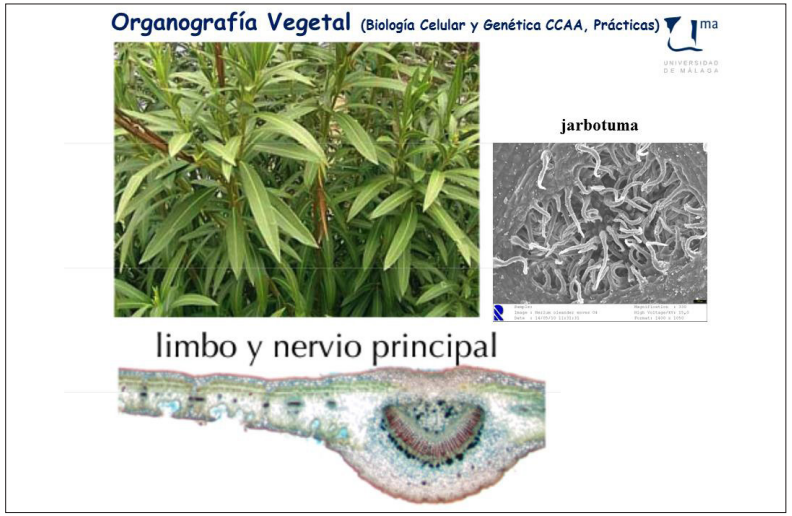
**Leaf histology workgroup:** This group generated histological preparations of leaves to obtain light and electron microscopy images of many species of the UMA Botanic Garden. Nineteen students in this group obtained images from 33 species to generate a histological collection of the botanic garden. Posters (see **Figure 2**) were also obtained from these images.

These results have been presented in several Teaching Congresses: The V Symposium of the Ibero-Macaronesian Association of Botanic Gardens, the Fourth Conference on Educational Innovation and virtual teaching at the University of Málaga, Málaga, Spain and a Congress on Cell Biology Teaching at Lleida, Spain; and several teaching slides of Plant Cell Biology subjects in Cell Biology I course of the Biology degree have incorporated material from this histological collection (see **Figure 3**):




> FIGURE 2

Histological results from *Juniperus phoenicea* L. subsp. *phoenicea* leafs. Poster with an optical image of a stained section and SEM images of leafs and leaf sections showing the main features of the leafs of this species. The figure is part of the book in figure 10




> FIGURE 3

Slide on *Nerium oleander* leaf used in practice of Cell Biology I course. Several images are used in theory and practice of Plan Cell Biology subjects at Cell Biology I course (second course of Biology degree). This slide shows a SEM image of a crypt in the oleander leaf (left) from histology workgroup (A.J. Jiménez-Lara, M. Marí-Beffa, J.M. Fernández-Figares, J. Ruiz-Sánchez)

> Keywords BOTANIC GARDEN AWARENESS COLLABORATIVE TEACHING MULTIDISCIPLINARY RESEARCH WORKGROUP COOPERATIVE LEARNING SECONDARY SCHOOL UNIVERSITY

# 06. Workgroup results and discussion

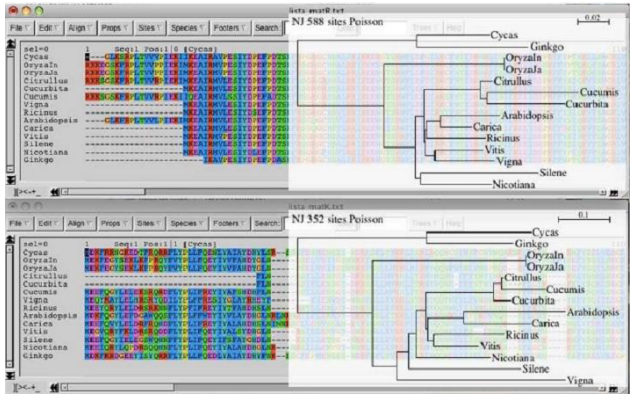

- *Marí-Beffa Manuel*
- *Asensi Alfredo*
- *Bañares Elena*
- *Díez-Garretas Blanca*
- *Heredia Antonio*
- *Jiménez-Lara Antonio*
- *Murciano Carmen*
- *Nieto-Caldera José Maria*
- *Recio Marta*
- *Senciales José Maria*
- *Thode Guillermo*
- *Silva-Sánchez Patricia*


**Epicuticular waxes workgroup:** Three students have studied gymnosperm epicuticular waxes. They used SEM to revise the morphology of epicuticular waxes in leaves from 27 plants (**Figure 4**). According to morphology the molecular content of these waxes can be estimated. This has served as a collaborative teaching-learning experience and a screening for potential model species for chemical and biochemical research of epicuticular waxes.

> FIGURE 4

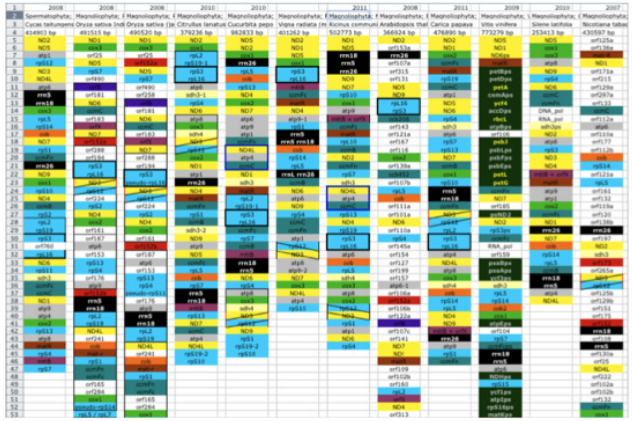
Material, collaborators and results of the epicuticular waxes workgroup. (Left) Scanning Electron Microscopy at the Central Service of Research Support. (Centre) Student of biology degree preparing samples. (Right) SEM image of epicuticular waxes from a leaf sample (A. Heredia)

**Genetics workgroup:** This group has analyzed mitochondrial and nuclear genes phylogenetic trees to assess plant diversity in the botanic garden. Students of evolutionary genetics and G. Thode have studied phylogenetic trees of proteins encoded by nuclear, mitochondrial and chloroplast genomes. Among these genomes, nuclear genes show the highest similarity with APG phylogeny (see matR and matK in **Figure 5**). Some of the characters used in "APG" system may be polyphyletic, such as number of chromosomes (2n), genome size, number of genes, mitochondrial genome size... Comparison of genomes revealed point mutation rates in mitochondria during the last 300 Myriads appropriate for the establishment of a coherent phylogenetic tree (**Figure 5**). Also synteny groups may also be useful for establishing taxonomic hierarchies (**Figure 6**). This data has been used during teaching of Evolutionary genetics (Biology degree) and Bioinformatics (Advanced Biotechnology Master) courses.




> FIGURE 5

Phylogenies of mitochondrial and nuclear proteins from plant families in the Botanic Garden. Sequence alignments and phylogenetic trees of mitochondrial (up) and chloroplast (bottom) proteins (Genetic workgroup, G. Thode)



> FIGURE 6

Mitochondrial genes (boxes) from 12 species of Angiosperms (columns) reveal a certain degree of 'synteny'. Colors must be used to clarify the study. For instance, non-coding rybosomal RNA genes are in black

> Keywords BOTANIC GARDEN AWARENESS COLLABORATIVE TEACHING MULTIDISCIPLINARY RESEARCH WORKGROUP COOPERATIVE LEARNING SECONDARY SCHOOL UNIVERSITY

# 06. Workgroup results and discussion


- *Marí-Beffa Manuel*
- *Asensi Alfredo*
- *Bañares Elena*
- *Díez-Garretas Blanca*
- *Heredia Antonio*
- *Jiménez-Lara Antonio*
- *Murciano Carmen*
- *Nieto-Caldera José Maria*
- *Recio Marta*
- *Senciales José Maria*
- *Thode Guillermo*
- *Silva-Sánchez Patricia*


## 2. PHYTOGEOGRAPHY AND HUMAN GEOGRAPHY WORKGROUPS

**Phytogeography workgroup:** Three students and a teacher have positioned plant species in UMA Botanic Garden (*http://www.jardinbotanico.uma.es/jardin-botanico/index.php*) using the **Geographic Information System** (GIS). During the study, collaborators identified each plant using a GPS. As a result of this collaborative study a map (**Figure 7**) is obtained in which each sector is identified providing information on the plants in it.


> FIGURE 7

Satellite image of the UMA Botanic Garden of the University of Málaga. Sectors are numbered. A list of species names in each sector is provided after this study (A. Asensi and B. Diez-Garretas)

Two other students have compared this information with that provided by other Botanic Garden in Spain and the world writing a Revision on Management and Quality System (62 pages). This text has been given to the University of Málaga for further development of the garden.


> FIGURE 8

Slide elaborated by members of the Human Geography workgroup. Introductory slide of an oral presentation at three congresses on Geography or Botanic Garden Teaching

**Human Geography workgroup:** The analysis of the economic impact of the plants at the botanic garden searched for information in 2015 on the economic value of many plants in it. Three students of geography degree found data from 47 species. These data focused on reference prices and enterprises manufacturing them for different uses. Fluctuating prices depending on fashions (i.e. cosmetics) require continuous updating. An example is:

*Pistacia terebinthus*

- A 10g. envelope of terebinth seeds (terebinto or cornicabra in Spanish) costs 4,4€ (agroterra.com),
- First sap seedlings can be found to cost 0,48€ (turbepal.es), and 20-40 cm plants of 1,98€. A 250 cc. rooted plant costs 3,5€ (ceifraonline.com),
- Turpentine is traditional obtained from terebinth. Turpentine essence Titán (14,42€/l in ebay.es) is offered as a natural terebinthine,
- This is a native plant useful for *Pistacia vera* (Pistachio) grafts (15,01€/Kg. in especiaspedroza.es),
- Cornicabra must not be confused with cornicabra oil, a variety of olive oil.

This data was presented at three different Congresses: The V Symposium of the Ibero-Macaronesian Association of Botanic Gardens, the V Iberian Congress of Teaching Geography and the Fourth Conference on Educational Innovation and virtual teaching at the University of Málaga, Málaga, Spain. A slide from these oral presentations is shown in **Figure 8**.

> Keywords BOTANIC GARDEN AWARENESS COLLABORATIVE TEACHING MULTIDISCIPLINARY RESEARCH WORKGROUP COOPERATIVE LEARNING SECONDARY SCHOOL UNIVERSITY

# 06. Workgroup results and discussion


- *Marí-Beffa Manuel*
- *Asensi Alfredo*
- *Bañares Elena*
- *Díez-Garretas Blanca*
- *Heredia Antonio*
- *Jiménez-Lara Antonio*
- *Murciano Carmen*
- *Nieto-Caldera José Maria*
- *Recio Marta*
- *Senciales José Maria*
- *Thode Guillermo*
- *Silva-Sánchez Patricia*

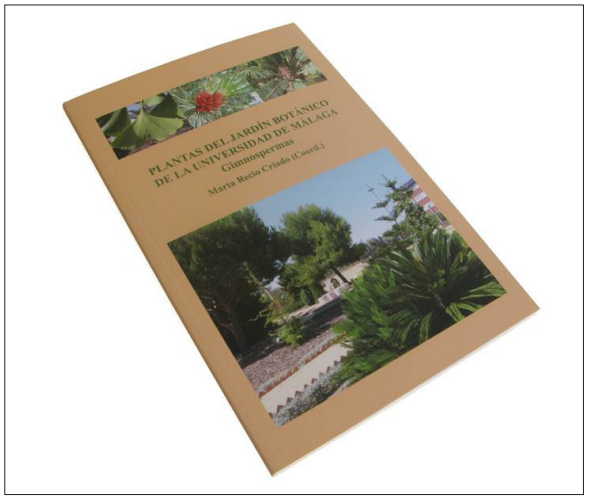

## 3. BOTANIC TEACHING WORKGROUPS

**Phenology, glossary and file cards workgroup:** Eight students and two teachers have been coordinated to study life cycles (**Figure 9**) of UMA botanic garden plants.

> FIGURE 9

Two students of the degree in biology of the phenology workgroup. The collaborators of this workgroup took notes and photographs periodically from plants in the garden (P. Silva-Sanchez)

The results of this group were compiled in species file cards. A total of 50 file cards with taxonomic information, geographical distribution, ecology and uses have been generated. A botany dictionary (185 words and 256 drawings), a photography-phenology database (654 images from 89 species), phenology, life tables (135 species) including gymnosperms (Recio, 2012) and angiosperm trees (Biology degree, 2014-15) to be issued at Acta Botanica Malacitana (2018) have been obtained. The continuous activity of these groups is providing an important database on the plants from the Botanic Garden of UMA (X Symposium of the Ibero-Macaronesian Association of Botanic Gardens, 2009). This effort has ended in the publishing of a teaching book by the Service of Publications and Scientific Exchange of the UMA (Spanish initials SPICUM) (**Figures 10-11**). This book authored by teachers and student volunteers summarize the results obtained by several workgroups to introduce students to the gymnosperm plants of the UMA botanic garden.




> FIGURE 10

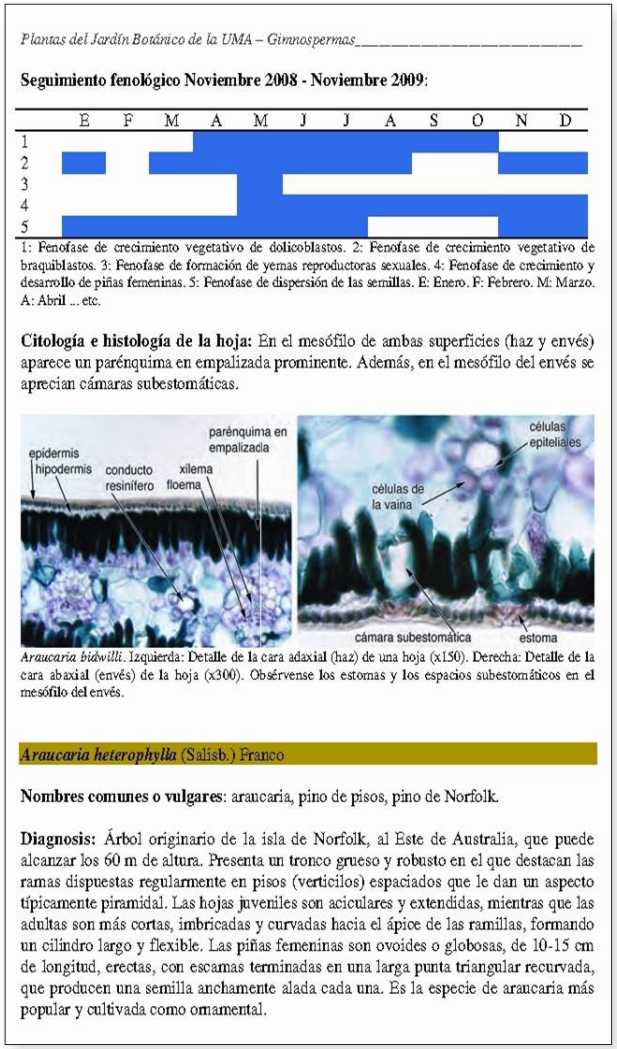
Frontcover of the book "*Plants of the Botanic Garden of the University of Málaga. Gymnosperms*" edited by the SPICUM. This book on gymnosperms was presented in the Book Fair of Malaga in 2012 and it is sold at "Tienda-UMA" shop at the Campus and in bookshops in Málaga

In this book, file cards for each gymnosperm species are provided combining illustrations, phenology information, and histological descriptions. **Figure 11** shows an example of file cards about two *Araucaria* species.

> Keywords BOTANIC GARDEN AWARENESS COLLABORATIVE TEACHING MULTIDISCIPLINARY RESEARCH WORKGROUP COOPERATIVE LEARNING SECONDARY SCHOOL UNIVERSITY

# 06. Workgroup results and discussion


- *Marí-Beffa Manuel*
- *Asensi Alfredo*
- *Bañares Elena*
- *Díez-Garretas Blanca*
- *Heredia Antonio*
- *Jiménez-Lara Antonio*
- *Murciano Carmen*
- *Nieto-Caldera José Maria*
- *Recio Marta*
- *Senciales José Maria*
- *Thode Guillermo*
- *Silva-Sánchez Patricia*

*Plantas del Jardín Botánico de la UMA – Gimnospermas*

**Seguimiento fenológico Noviembre 2008 - Noviembre 2009:**




1: Fenofase de crecimiento vegetativo de dolicoblastos. 2: Fenofase de crecimiento vegetativo de braquiblastos. 3: Fenofase de formación de yemas reproductoras sexuales. 4: Fenofase de crecimiento y desarrollo de piñas femeninas. 5: Fenofase de dispersión de las semillas. E: Enero. F: Febrero. M: Marzo. A: Abril ... etc.

**Citología e histología de la hoja:** En el mesófilo de ambas superficies (haz y envés) aparece un parénquima en empalizada prominente. Además, en el mesófilo del envés se aprecian cámaras subestomáticas.




*Araucaria bidwilli*. Izquierda: Detalle de la cara adaxial (haz) de una hoja (x150). Derecha: Detalle de la cara abaxial (envés) de la hoja (x300). Obsérvense los estomas y los espacios subestomáticos en el mesófilo del envés.

***Araucaria heterophylla*** (Salisb.) Franco

**Nombres comunes o vulgares**: araucaria, pino de pisos, pino de Norfolk.

**Diagnosis:** Árbol originario de la isla de Norfolk, al Este de Australia, que puede alcanzar los 60 m de altura. Presenta un tronco grueso y robusto en el que destacan las ramas dispuestas regularmente en pisos (verticilos) espaciados que le dan un aspecto típicamente piramidal. Las hojas juveniles son aciculares y extendidas, mientras que las adultas son más cortas, imbricadas y curvadas hacia el ápice de las ramillas, formando un cilindro largo y flexible. Las piñas femeninas son ovoides o globosas, de 10-15 cm de longitud, erectas, con escamas terminadas en una larga punta triangular recurvada, que producen una semilla anchamente alada cada una. Es la especie de araucaria más popular y cultivada como ornamental.

**> FIGURE 11**

File cards of *Araucaria bidwilli* (up) and *A. heterophylla* (botton) elaborated by the phenology workgroup. For each studied species, a file card is obtained to show general, phenological, histological, genetic or geographical data. We show a page of the book on gymnosperms (Figure 10) displaying file cards of species from *Araucaria genus*

**Visits workgroup:** After visits, the impact of the experience on students was evaluated by questionnaires. Questionnaires answered by Secondary School students have revealed their positive response to the visiting experience. Among all visitors, 19% considered the experience perfect, and most of them choose cactus and rose plants as their preferable plants. More than 60% understood every explanation and some of them provided interesting suggestions for improving the Botanic Garden. Suggestions were connected with the central pond, the need of a complete labeling of plants, guides and fountains of drinking water. This experience clearly raised awareness to ecological environment to visiting students.

## Conclusions

- A Virtual platform has served to organize a variety of Workgroups for research and teaching of the botanic garden of UMA.
- This is the first step for a profound multidisciplinary knowledge of the UMA botanic garden and useful for its management.
- This teaching-learning experience provides an extensive database on ecological awareness to the Smart-Campus program of UMA (http://www.uma.es/smart-campus).
- Teaching material has been obtained and used in Biology and Environmental Sciences degrees to improve student competences.
- This high quality experience by volunteer students is a first contact with research in our University. Lab and bibliographical skills were developed by volunteers during this project.

> Keywords BOTANIC GARDEN AWARENESS COLLABORATIVE TEACHING MULTIDISCIPLINARY RESEARCH WORKGROUP COOPERATIVE LEARNING SECONDARY SCHOOL UNIVERSITY

# 06. References

- *Marí-Beffa Manuel*
- *Asensi Alfredo*
- *Bañares Elena*
- *Díez-Garretas Blanca*
- *Heredia Antonio*
- *Jiménez-Lara Antonio*
- *Murciano Carmen*
- *Nieto-Caldera José Maria*
- *Recio Marta*
- *Senciales José Maria*
- *Thode Guillermo*
- *Silva-Sánchez Patricia*

**Casado, C.G. & Heredia, A.,** 2001. Ultrastructure of the cuticle during growth of the grape berry *(Vitis vinifera)*. *Physiologia Plantarum* 111, 220-224.

**Chase, M.W. & Reveal, J.L.,** 2009. A phylogenetic classification of the land plants to accompany APG III. *Bot J Linn Soc.* 161, 122-127.

**Gouy, M., Guindon, S. & Gascuel, O.,** 2010. Sea View version 4: multiplatform graphical user interface for sequence alignment and phylogenetic tree building. *Mol. Biol. Evol.* 27(2), 221-224.

**Grant, V.,** 1963. The origin of adaptations. Columbia University Press, New York.

**León, J., Lima, F., Rodrigo, J. & Senciales, J.M.,** 2011. El jardín botánico como recurso didáctico en Geografía. En Delgado, JJ, Lázaro, MªL, Marrón, MªJ. (Eds.): Aportaciones de la Geografía en el aprendizaje a lo largo de la vida. *Actas del V Congreso Ibérico de Didáctica de la Geografía*. Pp. 510-521.

**Orshan, G.,** 1989. *Plant phenological studies in Mediterranean type ecosystems.* Klumer Academic Publishers, Dordrecht.

**Pathan, A.K., Bond, J. & Gaskin, R.E.,** 2010. Sample preparation for SEM of plant surfaces. *Materials Today* 12 (1), 32-43. https://doi.org/10.1016/S1369-7021(10)70143-7

**Recio, M., (Coord.),** 2008. Manual y Guión de Prácticas de Botánica. *Elementos Auxiliares* de clase, 81. Servicio de Publicaciones de la Universidad de Málaga, SPICUM, Málaga

**Recio, M. (Coord.) et al.,** 2012. *Plantas del Jardín Botánico de la Universidad de Málaga. Gimnospermas.* Servicio de Publicaciones de la Universidad de Málaga, Málaga.