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roots

Botanic Gardens Conservation International Education Review

October 2008

From there to eternity?
The lessons of Darwin's legacy

Darwin the botanist

Teaching children to ask big questions

The great plant hunt

Evolution holds the key

BGCI

Plants for the Planet

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Taking a leaf out of Darwin's book

Editorial - English

When, in November 1859, Charles Darwin published *On The Origin of Species*, he triggered an intellectual and conceptual earthquake of such magnitude that its aftershocks remain with us a century and a half later. No single document in history, it could be argued, has so profoundly affected humankind's understanding of the living world. Darwin's theory of natural selection challenged all received opinion about life on earth and, in an era of intellectual, political and scientific ferment that gave rise to the modern age, was perhaps the most revolutionary idea of all.

In its essence Darwin's theory encapsulates the struggle for existence: healthier or better-adapted organisms tend to outlive or out-compete weaker organisms, allowing favourable traits to be passed on in successive generations.

With 2009 marking the 200th anniversary of Darwin's birth and 150th anniversary of the publication of *On the Origin of Species*, this issue of *Roots* calls on botanic gardens to celebrate the legacy and thinking of this extraordinary man. As Professor David Kohn, Senior Research Fellow of the Charles Darwin Trust, explains in his keynote article, Darwin spent the last 30 years of his life working mainly on plants and he argues that Darwin was, above all, a botanist. Professor Kohn wrote an essay for the catalogue of an exhibition entitled *Darwin's Garden: An Evolutionary Adventure*, presented earlier this year at The New York Botanical Garden. Elsewhere in this

Editorial - Français

Lorsque, en novembre 1859, Charles Darwin publia *L'origine des espèces*, il provoqua un bouleversement intellectuel et conceptuel d'une telle envergure que ses répercussions nous préoccupent encore aujourd'hui, un siècle et demi plus tard. On peut même affirmer qu'aucun autre document n'a aussi profondément influencé la compréhension humaine du monde vivant. La théorie de la sélection naturelle de Darwin a défié toutes les opinions reçues au sujet de la vie sur terre et, à une époque de bouillonnement intellectuel, politique et scientifique qui nous conduisit aux temps modernes, était peut-être l'idée la plus révolutionnaire de toutes.

La théorie de Darwin résume au fond la lutte pour l'existence: les organismes plus sains ou les mieux adaptés ont tendance à vivre plus longtemps ou dépasser les organismes plus faibles, permettant ainsi aux caractéristiques favorables d'être transmises aux générations suivantes.

L'année 2009 marquant le 200ème anniversaire de la naissance de Darwin et le 150ème anniversaire de la publication de *L'origine des espèces*, ce volume de *Roots* invite les jardins botaniques à célébrer l'héritage et la pensée de cet homme extraordinaire. Comme nous l'explique le Professeur David Kohn, chargé de recherches du Charles Darwin Trust, dans son article d'introduction, Darwin passa les 30 dernières années de sa vie à travailler principalement sur les plantes et il affirme que Darwin était avant tout un botaniste. Professeur Kohn a écrit un

Editorial - Español

Cuando Charles Darwin publicó en Noviembre de 1859 *On The Origin of Species*, ocasionó un seísmo intelectual y conceptual de tal magnitud, que sus réplicas permanecen hasta hoy, siglo y medio después. No hay otro texto en la historia, se podría argumentar, que haya afectado tan profundamente la comprensión del mundo de los seres vivos. La teoría de la selección natural de Darwin desafió todas las opiniones recibidas acerca de la vida, en una época de ebullición intelectual, política y científica que dio paso a la edad moderna, quizás la más revolucionaria de todas las ideas.

En su esencia la teoría de Darwin contiene la lucha por la vida: los organismos más sanos y mejor adaptados sobreviven y compiten con los débiles, posibilitando la transmisión de esos caracteres a las generaciones siguientes.

Con motivo del bicentenario del nacimiento de Darwin y el 150 aniversario de la publicación del *Origen de las especies*, en 2009, este número de *Roots* solicita a los jardines botánicos que celebren el legado y el pensamiento de este extraordinario hombre. Tal y como el Professor David Kohn, Miembro Investigador Senior del Charles Darwin Trust, explica en el artículo principal, Darwin dedicó sus últimos 30 años de trabajo a las plantas, y argumenta que era, por encima de todo, botánico. El Professor Kohn escribió el ensayo para el catálogo de la exposición titulada *Darwin's Garden: An Evolutionary*

issue of *Roots*, George Shakespear, Director of Science Public Relations at the garden, describes the interpretation and educational programming for this exhibition.

Throughout his life Darwin meticulously observed, recorded and pondered the similarities, differences and distribution between species. He also had the intellectual courage to ask big questions to which there were no clear or easy answers. Encouraging children and adults to emulate Darwin's approach is seen by several of our authors as key to encouraging critical thinking. Through her work with the Charles Darwin Trust, Dr Sue Johnson encourages children to find their own answers to self-generated questions. She has developed Darwin Inspired Learning resources that draw attention to plants associated with Darwin, ranging from foxgloves and cabbages to tropical orchids. Professor Angela McFarlane shares with us the outline of a project in gestation at Royal Botanic Gardens, Kew. In April 2009, a treasure chest full of resources will be sent from the gardens to 22,000 UK primary schools, giving children an opportunity to become plant hunters and discover plants in the wild - much as Darwin did some 180 years ago.

Darwin visited Australia on *HMS Beagle* and his association with that country, as well as his bicentenary, is regarded by The Botanic Gardens Trust in Sydney as a cause for celebration. The Trust is collaborating with botanic gardens and cultural institutions across Australia to plan a year-long programme of events. Janelle Hatherly and Sophie Daniel outline these events and believe that Darwin's legacy will inspire a passion and appreciation for nature in budding naturalists and the next generation of scientists.

The evolution of plants is highlighted in many botanic gardens around the world, enabling people to take a 'walk back in time'. In his later years Darwin carried out extensive work on adaptive strategies of plant movements and Mara Sugni from Bergamo Botanic Garden, Italy describes an exhibition which used lower plants such as algae through to higher plants like trees to highlight the importance of tropisms to plant evolution. At Marnay-sur-Seine

essai pour le catalogue d'une exposition intitulée *Darwin's Garden: An Evolutionary Adventure* (Le jardin de Darwin: une aventure évolutionnaire), présentée cette année au jardin botanique de New York. Plus loin dans cette édition de *Roots*, George Shakespear, directeur des relations publiques de la science de ce jardin nous décrit l'interprétation et les programmes éducatifs mis en place pour cette exposition.

Tout au long de sa vie, Darwin a minutieusement observé, enregistré et analysé les similitudes, les différences et leur répartition entre les espèces. Il a eu aussi le courage intellectuel de poser de grandes questions auxquelles il n'y avait pas de réponses claires ou faciles. Plusieurs de nos auteurs considèrent que le fait d'encourager enfants et adultes à suivre l'approche de Darwin est la clé pour inciter à une réflexion critique. Par son travail avec le Charles Darwin Trust, Dr. Sue Johnson invite les enfants à trouver leurs propres réponses à des questions qu'ils se posent eux-mêmes. Elle a développé des supports éducatifs inspirés par Darwin, qui appellent l'attention sur les plantes associées à celui-ci, depuis les digitales et les choux jusqu'aux orchidées tropicales. Professeur Angela McFarlane nous fait part des grandes lignes d'un projet en cours d'élaboration aux jardins botaniques royaux de Kew. En avril 2009, un coffre aux trésors rempli de supports éducatifs sera envoyé aux 22.000 écoles primaires du Royaume-Uni, permettant aux enfants de devenir des chasseurs de plantes et de découvrir des plantes dans la nature – tout comme Darwin l'a fait quelque 180 ans auparavant.

Darwin a visité l'Australie à bord du *HMS Beagle* et son lien avec ce pays, de même que son bicentenaire, sont autant de motifs de célébration pour le Botanic Gardens Trust à Sydney. Le Trust collabore avec des jardins botaniques et des institutions culturelles à travers l'Australie pour organiser un programme de manifestations tout au long de l'année. Janelle Hatherly et Sophie Daniel en donnent un aperçu et sont convaincues que l'héritage de Darwin inspirera une passion et une appréciation de la nature chez les naturalistes en herbe et la prochaine génération de scientifiques.

Adventure, que se presentó este año en el New York Botanical Garden. En otro lugar de este número de *Roots*, George Shakespear, Director de Relaciones de ciencia para con el público de este jardín, describe la interpretación y programación educativa de esta exposición.

A lo largo de su vida Darwin observó, anotó y sopesó meticulosamente la similitudes, las diferencias y la distribución de las especies. Tuvo el coraje intelectual de plantear grandes preguntas para las que no había respuesta clara o fácil. Animar a niños y adultos para que emulen el enfoque de Darwin es considerado por varios de nuestros autores como clave para estimular el pensamiento crítico. La Dra Sue Johnson, por medio de su trabajo con el Charles Darwin Trust, alienta que los niños encuentren su propias respuestas a cuestiones que ellos mismos suscitan. Ella ha desarrollado los recursos didácticos 'Aprendizaje Inspirado en Darwin' que dirige su atención a plantas asociadas con él, abarcando desde las digitales o dedaleras y repollos hasta las orquídeas tropicales. La Profesora Angela McFarlane comparte con nosotros el diseño del proyecto en gestación en el Royal Botanic Gardens de Kew: En abril 2009 un baúl del tesoro lleno de recursos será remitido a las más de 22.000 escuelas de primaria del Reino Unido, dando a la infancia la oportunidad de convertirse en cazadores de plantas y descubrir las plantas silvestres, tal y como Darwin lo hizo hace 180 años.

Darwin visitó Australia a bordo del *HMS Beagle*, y su relación con ese país, así como su bicentenario, es causa de celebración para el Botanic Gardens Trust de Sydney. El Trust colabora con los jardines botánicos y las instituciones culturales a lo largo y ancho de Australia en un plan de eventos para todo el año. Janelle Hatherly y Sophie Daniel perfilan los acontecimientos y aseguran que el legado de Darwin inspirará pasión y alta estima por la naturaleza en los naturalistas promesa y la próxima generación de científicos.

La evolución de las plantas destaca en mucho jardines botánicos de todo el mundo, lo que permite a los visitantes

Botanic Garden, Darwin's evolutionary tree was used as the inspiration for the design of the garden. Opened to the public in 1999, the garden takes visitors along the evolution road, from plants emerging in their simplest forms and evolving over time to flowering plants.

On the eve of these two key Darwin anniversaries, what lessons may we draw from his life and work? Darwin was a genius who, as one commentator writes*, had "arguably the most powerful idea ever" so it may be over-ambitious, to say the least, to attempt to emulate him directly! But among Darwin's most determined supporters was the pioneering biologist and educator, Thomas Henry Huxley and here we may find inspiration. Nicknamed 'Darwin's Bulldog', Huxley's courageous defence of the theory of natural selection has become a byword for determined and principled advocacy of scientific enquiry. In our own time, surely, it is not the origin but the survival of species that is in question. Global climate change is altering the biological landscape in this century just as radically as Darwin revolutionised biological thought in his. Botanic gardens should be in the vanguard of humankind's response to this challenge and, just as Darwin's Bulldog, we educators have our own part to play.

* Richard Dawkins (Guardian, February 8th 2008). Richard Dawkins FRS is the Charles Simonyi Professor of the Public Understanding of Science at the University Oxford, UK.

L'évolution des plantes est un thème phare dans de nombreux jardins botaniques de par le monde, permettant au public de faire un 'voyage dans le passé'. Au cours de ses dernières années, Darwin a beaucoup travaillé sur le sujet des stratégies d'adaptation des mouvements des plantes et Mara Sugni du jardin botanique de Bergamo en Italie décrit une exposition dans laquelle les plantes inférieures, tout comme les plantes supérieures, ont servi à mettre en évidence l'importance des tropismes pour l'évolution des végétaux. Au jardin botanique de Marnay-sur-Seine, l'arbre phylogénétique de Darwin a inspiré la conception des lieux. Ouvert au public il y a neuf ans seulement, en 1999, le jardin emmène ses visiteurs sur la route de l'évolution, depuis l'apparition des plantes sous leur forme la plus simple en suivant l'évolution au cours du temps jusqu'aux plantes à fleurs.

A la veille de ces deux importantes dates anniversaires, quelles leçons pouvons-nous tirer de la vie et de l'œuvre de Darwin ? Il était un génie qui, comme le dit un commentateur*, a eu « indiscutablement l'idée la plus puissante de tous les temps » : aussi est-il sans doute pour le moins ambitieux de vouloir l'imiter directement! Cependant l'un de ses plus fervents partisans était le biologiste et éducateur d'avant-garde Thomas Henri Huxley, chez qui nous pouvons trouver une inspiration. Surnommé le « bulldog de Darwin », sa défense courageuse de la théorie de la sélection naturelle est devenue le symbole d'un soutien déterminé et rigoureux de l'enquête scientifique. Certes, de nos temps, ce n'est pas l'origine, mais la survie des espèces qui est en question. Le siècle en cours est marqué par des changements climatiques planétaires qui sont en passe de modifier le paysage biologique tout aussi radicalement que Darwin a révolutionné la pensée biologique à son époque. Les jardins botaniques devraient être à l'avant-garde de la riposte de l'humanité à ce défi et, tout comme le bulldog de Darwin, nous les éducateurs avons notre propre rôle à jouer.

** Richard Dawkins (Guardian, 8 février 2008). Richard Dawkins FRS est le Charles Simonyi Professor of the Public Understanding of Science à l'Université d'Oxford, Royaume-Uni.*

hacer un 'paseo por el pasado".
En sus últimos años Darwin trabajó muy intesamente en las estrategias adaptativas de los movimientos de las plantas, y Mara Sugni del Jardín Botánico de Bergamo, Italia, describe una exposición que utiliza desde algas hasta plantas superiores y árboles, subrayando la importancia de los tropismos en su evolución. En el Jardín Botánico de Marnay-sur-Seine, Francia, el árbol evolutivo de Darwin fue usado como inspiración para el diseño del mismo. Abierto hace nueve años solamente, en 1999, el jardín conduce a los visitantes por el camino de la evolución desde las formas más sencillas hasta las plantas con flor.

En vísperas de estos dos aniversarios de Darwin tan importantes, ¿qué lecciones podemos extraer de su vida y obra? Darwin fue un genio que, como escribe un comentarista*, tuvo "la idea más poderosa de todos los tiempos" por lo que podría ser demasiado ambicioso, al menos, ¡intentar igualarle! Pero entre los más decididos partidarios se encontraba el pionero biólogo y educador Thomas Henry Huxley, en el que podemos encontrar inspiración. Apodado el 'Bulldog de Darwin', la defensa valiente que Huxley hizo de la teoría de la selección natural se ha convertido en símbolo de la defensa firme y honesta de la búsqueda de la verdad científica. En nuestro tiempo, no es el origen, sino la supervivencia de las especies la que está en discusión. En esta centuria, el cambio climático global altera el paisaje biológico tan radicalmente como Darwin revolucionó el pensamiento biológico en el suyo. Los jardines botánicos deben estar en la vanguardia de la respuesta de la humanidad a semejante reto y, como el 'Bulldog de Darwin', nosotros como educadores tenemos que jugar nuestro papel.

** Richard Dawkins (Guardian, Febrero 8/2008). Richard Dawkins FRS es el Charles Simonyi Professor de la cátedra de Comprensión pública de la Ciencia en la Universidad de Oxford, Reino Unido.*

Darwin le botaniste

Darwin el botánico

David Kohn

Darwin
the botanist

Summary In his theory of evolution, Charles Darwin proposed that living beings were "all netted together" through a common ancestry. Yet one branch of the tree of life, the plant kingdom, was Darwin's most enduring focus.
He was a major field collector, a consummate and sustained observer of plant life, a rigorous botanical experimentalist, and the high theorist of plant evolution.

Botany played a pivotal part in each phase of Darwin's life. As an undergraduate, he collected specimens for his botany professor's herbarium while on a geological expedition in Wales. Voyaging for five years aboard the HMS Beagle, he collected plants along with fossil bones and bird skins. Preparing to write On the Origin of Species, botany became critical to the growth of his evolutionary theory. Ultimately, he turned his home and the surrounding countryside into a botanical field station.

Darwin's six botanical books would recast large areas of plant science. His studies on the fertilisation of orchids, on insectivorous plants, and on the climbing and other plant movements were each a beautifully articulate example of how evolution could solve the traditional mysteries of natural history. Through his work, Darwin laid foundations for modern botany that remain firm to this day.

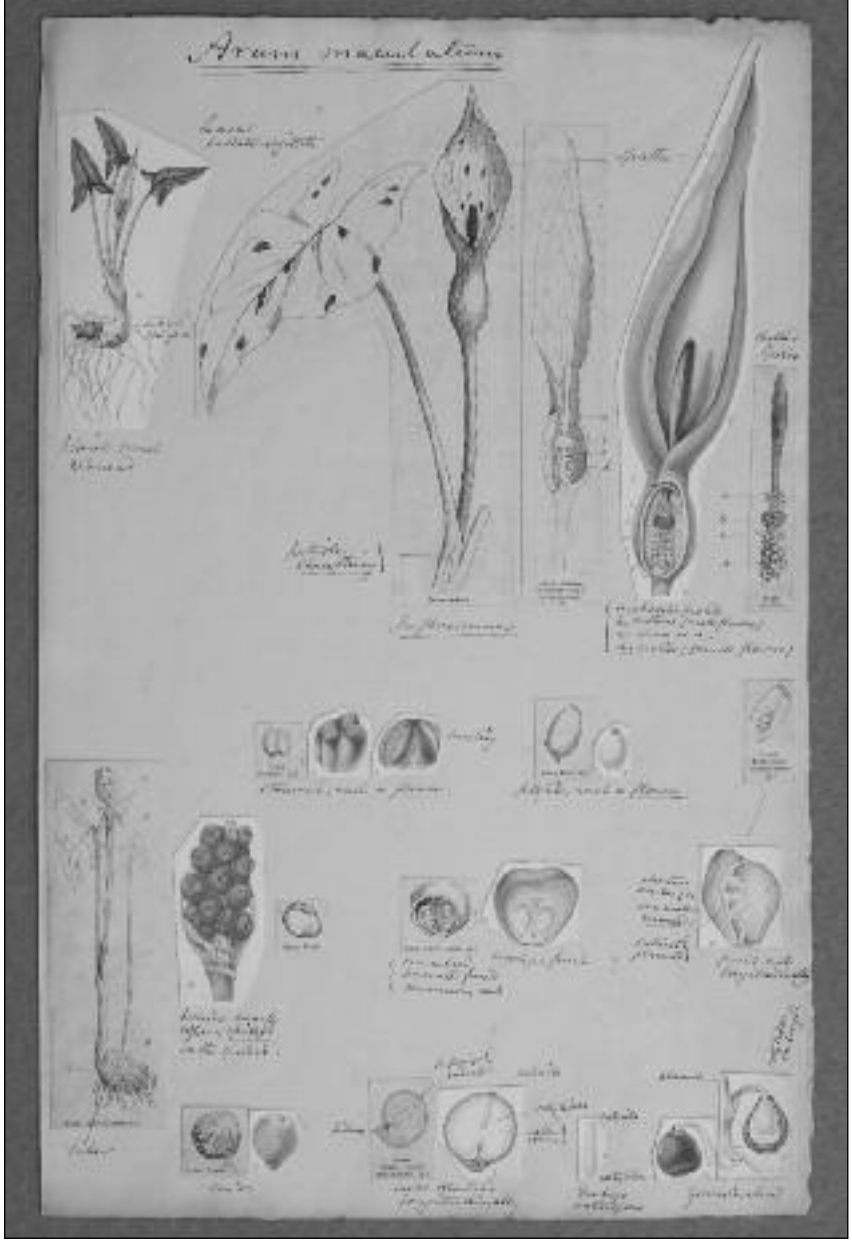
Left: *Matthiola sinuata* collected by Charles Darwin in 1831 for Prof. J.S. Henslow's Herbarium. Earliest known Darwin specimen in a working natural history collection (Cambridge University Herbarium)

Darwin's botanical formation

Darwin was heir to a rich botanical tradition, one that often resonated in the specific botanical topics and viewpoints he was to adopt. His grandfather Erasmus Darwin, for example, was an evolutionist and spread the Linnaean doctrine that plants, just like animals, have sexes. Darwin's first botanical exposure was in his father's ample garden at The Mount in Shrewsbury where young Charles played among apple trees bred by Thomas Andrew Knight, President of the Royal Horticultural Society. However, the foundations of Darwin's formal education in botany were laid at Cambridge by his dynamic professor John Stevens Henslow (1796-1861) who later opened the way for Darwin to participate in the *Beagle's* scientific cruise around the world.

The *Beagle* voyage

The *Beagle* expedition concentrated on certain regions of South America: coastal Brazil, Patagonia, Tierra del Fuego, the Andean coast as far north as Lima and the oceanic Galápagos archipelago.



Right: Henslow's Arum 'cut & paste' teaching sheet, c. 1837 (Cambridge University Herbarium)

Plants came before birds in the birth of Darwinian evolution. Darwin did not become an evolutionist on the Galápagos, but the basis for a profound shift in his understanding of species was established there – and it began with plants. When the Beagle arrived in the Galápagos in September 1835, Darwin immediately observed that the flora appeared unique. Therupon, he collected "all the plants in flower". This we know from a pocket field notebook that Darwin kept when he was in the archipelago. Darwin's Galápagos plant specimens, numbering well over 200, constitute the single most influential natural history collection of live organisms in the entire history of science. Indeed, Darwin's plants represent the foundational collection for the entire Galápagos flora. Settled back in London in 1837, he sketched his first evolutionary tree and began firmly applying the idea of descent with modification to all of natural history.

In 1856, Darwin put ink to blue foolscap and began to steadily write. His seminal book, *On the Origin of Species*, was finally published in November 1859.

Preserving priority

Once the *Origin* was published, botany became the central focus of Darwin's research for the remaining years of his life. This botanical work was highly original, not only because of the quality of his observations, but because it was the first attempt to apply the principles of evolution to plants.

Darwin's crucial contribution to botany was his understanding of and ability to demonstrate that the flower is a product of evolution. By the 18th century, botanists were convinced that flowering plants have both male and female parts, and assumed that most plants self fertilise or inbreed. This erroneous and deeply ingrained view of the flower continued until Darwin began publishing on the biological meaning of flowers in the 1860s. The prevalence of cross-pollination was Darwin's single most important botanical truth.

Indeed Darwin realised there was a problem with plant sex immediately after discovering natural selection in 1838. If flowers perpetually self fertilised then both natural selection and evolution would be invalid, because natural selection requires hereditary variation. If there is no variation, there is simply nothing to select. Evolution stops. If flowers self fertilised for generation after generation, they would become unvarying clones. Furthermore, without variation, where did the thousands of known plant species come from? Evolution would not explain the diverse families of flowering plant genera and species. The world's flowers were just too big a part of nature for Darwin to forfeit them to the creationist position that species are immutable.

In the case of flowers, he undertook decades of field and garden observations and breeding experiments, all focused on testing and supporting one powerful hypothesis: that of natural selection. Through his painstaking studies, such as the *Primula* example below, Darwin discovered that flowering plants have evolved elaborate structures, strategies, and relations with animals and reasoned that it was all to avoid the apparent necessity of perpetual inbreeding. Thus the Darwinian meaning of flowers became a pillar of botany and botany became one of the strongest fields supporting evolution.

Love, primula style

Spring 1860 was the first flowering season following *Origin's* publication. Darwin, bursting with experimental energy, made several crucial botanical discoveries. In May, he observed two different kinds of flowers among common primulas. The style, or shaft of the female part, is either tall, protruding like a pin, or it is short. Darwin's children gathered armloads of flowers for their father, who noticed something: the two kinds of flower occur in a 50:50 ratio. To explain these

two morphs, Darwin would follow the scientific method, but after his very own personal style. At first, the 50:50 ratio reminded him of a normal male-female sex ratio. So he believed the two kinds of flowers were evolving into separate sexes. That is, he thought he had witnessed one step in the evolution of separate male and female flowers. The tall-style flowers must be evolving into pure females, he surmised. Conversely, their short stamens must be losing potency. To test this he crossed the two forms. But to his surprise, the 'males' produced abundant seeds. So the experimental method forced him to abandon his first hypothesis. As Darwin once observed, his first explanations of things frequently proved wrong. The originality and breakthrough would come with thinking up the next explanation.

He now realised that the maximum fertility occurs when pollen moves from one form to the other. It was always the self fertilised flowers that had reduced fertility. Thus the two forms, each of which is both male and female, are favoured to maintain a stable population. Darwin had in fact discovered a breeding strategy that gave a clear advantage to cross-pollination and thus provided experimental support for his long-held interpretation of the meaning of flowers. To think of flowers in terms of plant breeding strategies, now that is evolutionary botany. And Darwin's primulas have been a prime example of this new way of thinking ever since.

Plant sensitivity: green adaptations

Plants don't have feet and they also don't have brains. But as far as Darwin was concerned, some plants as good as have eyes, and they do have behaviour, often expressed in the extraordinary ways these beings can move despite being rooted in the soil. Darwin's passion for working out the botanical adaptations that allow plants to stay in sensitive touch with their environment occupied him for years in physiological experiments that prefigure the biochemical and cellular studies of the early 20th century on enzymatic catalysis and plant hormones. Thus these green adaptations in leaves and stems not only paralleled Darwin's flowers, they added a new level of sophistication to the botanical bulwarks Darwin had built to support evolution and adaptation by natural selection. For example, insectivorous plants that trap and digest insects with specialised leaves fascinated Darwin. So did vines that climb up and over other plants. He saw plants as sensitive creatures whose growing tips or leaves or seedlings can track the movement of the sun. Indeed, he showed they could respond to the least beam of incident light, the pull of gravity, and the slight touch of a browsing animal.

Much of this work Darwin performed in a string of hothouses that gradually sprang up along the kitchen garden wall beginning in the late 1850s. Eventually, there were five houses heated by a boiler and offering a fair range of conditions for the array of plants that Darwin, assisted in his last years by his son Francis, wished to study.

Time-lapse time machine

Darwin was also keenly aware of the cell theory, and by the end of his life in April 1882 was venturing quite earnestly with Francis into what we now call biochemistry and cell biology. Darwin believed there must be cellular processes underlying, for example, a sundew's ability to trap insects. He used a James Smith achromatic compound microscope to visually capture what went on at the cellular level when the tentacles of a *Drosera rotundiflora* curl over a fly that has landed on one of its leaves. In his field of vision he focused on a single cell from the tentacle of a sundew that had earlier been 'fed'. Over a period of an hour he drew the same cell seven times as he observed progressive changes in what he considered to be the cell's protoplasm. He called the process *aggregation*. He also observed that as a tentacle relaxes, the aggregation disappears. Darwin compared this reversible process, which he thought required a ferment (soon afterwards called an enzyme), "with a reflex action in the nervous system of an animal".

What he actually saw, by modern lights, has not been established and is controversial to this day. Today, mechanisms for communication between plant cells are at the forefront of research. But the point is just how far Darwin pushed his *Drosera* studies towards experimental biology while pursuing his evolutionary physiological botany.

Power of movement: are plants alive?

Darwin wrote six botanical books, over 75 articles, and well-articulated and rigorously executed studies. He titled his last plant book *The power of movement in plants* (1880). Fascination with the ways that plants move entered the early botanical literature in conjunction with a difficult question: Are plants alive? Although they don't have evident nervous systems, they can respond to irritation in some cases. This was taken as a sign of life. At the bottom is the even more difficult question, 'What is life?' For Darwin, the traditional 'What is life?' question was transformed into an effort to demonstrate the unity of all life and hence, by implication, the common descent of all branches of the evolutionary tree. This is the unspoken thesis of *Power of Movement*. Darwin was once again universalising. By showing that plants have a power of movement and given that mobility and the capacity for movement are animal-like characteristics, he is supporting the unity of common descent, which in turn is an underlying assumption or implication (depending on how the argument is phrased) of evolution.

Darwin and the foundation of evolutionary botany

As we have seen, Darwin not only contributed to botany, he actually changed the discipline by his very contributions. Since all of his botanical researches were conducted as applications of the theory of evolution, replete with well-worked examples

Left: The Sandwalk, Darwin's, thinking path, at Down House where he lived from 1842-1882 (David Kohn)

Right: *Scalesia pedunctulata*, 'daisy tree', A distinctive Galápagos endemic collected by Darwin in 1835 (David Kohn)

often treated as evidence for natural selection, he was using botany to defend his theory. But simultaneously he was also providing botanists with a model for how to think about their own observations in evolutionary terms. Those who followed Darwin's botanical writings would have seen that their discipline, and indeed the plant kingdom, was full of examples of evolution. It was not left for late-19th-century botanists, as it largely was for zoologists, to apply the concepts in the *Origin* on their own. Darwin directly led the way for his botanical followers. Thus he was the first openly practicing evolutionary botanist in the midst of a community that included some botanists who were - and some who weren't - swayed by evolution. Darwin was so invested in his plant research that he himself built the bridge directly from the *Origin* to fundamental problems in botanical science. Thus did Darwin assist at the birth of evolutionary botany.

This dual role as both founder of evolution by natural selection and exponent of how the theory could be applied in botany is quite remarkable. Later generations of Darwinian botanists would complete the transformation of botany into evolutionary science. But Darwin went a long way in providing a model for that transformation.

Résumé

Dans sa théorie de l'évolution, Charles Darwin avançait que les êtres vivants étaient « tous reliés les uns aux autres » à travers un ancêtre commun. Toutefois Darwin porta une attention des plus vives à l'une des branches de l'arbre de la vie, le règne végétal, source intarissable de sa joie. Il étudia les plantes avec cohérence et profondeur au cours d'une longue carrière scientifique. Il s'agissait d'un grand homme de terrain, d'un observateur accompli et soutenu du monde végétal, d'un expérimentateur botanique rigoureux, et de l'éminent théoricien de l'évolution végétale.

La botanique a joué un rôle crucial à chaque étape de la vie de Darwin. En tant qu'étudiant, il collecta des spécimens pour l'herbier de son professeur de botanique lors d'une sortie géologique au pays de Galles. En voyage à bord du HMS Beagle durant cinq ans, il rassembla des plantes, ainsi que des os fossilisés et des dépouilles d'oiseaux. Dans sa préparation à la rédaction de *L'origine des espèces*, la botanique prit une place essentielle dans le développement de sa théorie de l'évolution. Il finit par transformer son domicile et les paysages environnants en une station botanique et se complut fortement dans son jardin expérimental. Les six volumes botaniques de Darwin allaient reprendre la phytologie en de nombreux points, à présent uniquement abordables à la lumière de l'évolution. Ses études sur la fertilisation des orchidées, sur les plantes insectivores et sur les plantes grimpantes ainsi que d'autres actions de végétaux ont toutes fourni des exemples très clairs et précis sur la manière dont l'évolution est en mesure de résoudre les traditionnels mystères de l'histoire naturelle. Par son travail, Darwin a posé les fondations de la botanique moderne, encore solides à ce jour.

Resumen

En su teoría de la evolución, Charles Darwin planteó que todos los seres vivos "estaban relacionados" ya que provenían de un ancestro común. De hecho, la rama del árbol de la vida que más llamó la atención de Darwin, fue la del reino vegetal, siendo éste una continua fuente de asombro. Estudió las plantas con gran consistencia y profundidad en el transcurso de una larga carrera científica. Fue un gran colector, un paciente y concienzudo observador del mundo vegetal, un riguroso botánico experimental y el mejor teórico de la evolución de las plantas.

La botánica jugó un papel central en cada una de las fases de la vida de Darwin. Como estudiante, colectaba plantas para el herbario de su profesor de botánica mientras desarrollaba actividades de geología en Gales. En su travesía de cinco años a bordo del Beagle, colectó tanto plantas como huesos fósiles y pieles de aves. Preparándose para escribir *El origen de las especies*, la botánica fue un elemento crítico para el desarrollo de su teoría de la evolución. Se sabe que convirtió su casa y los terrenos aledaños en una estación botánica la que con un enorme gusto fue su jardín experimental. Los seis libros de botánica escritos por Darwin abarcan diversas áreas de la biología vegetal hoy en día solo entendibles bajo la luz de la evolución. Sus estudios en la fertilización de orquídeas, plantas insectívoras, trepadoras y otros movimientos de las plantas, constituyen un ejemplo bellamente articulado de cómo la evolución solucionó algunos de los misterios dentro de la historia natural. A través de su trabajo, Darwin sentó los fundamentos de la botánica moderna, los cuales a la fecha son vigentes.

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Apprendre aux enfants à aborder de **grandes questions**

Enseñando a los niños a enfrentar **grandes preguntas**

Sue Johnson

Teaching children to tackle **big questions**

Summary The garden at Down House, Charles Darwin's home for 40 years, provided him with experimental sites. Now managed by English Heritage, the garden contains many vegetable and fruit varieties that Darwin would have known. Growing similar plants in botanic gardens puts a new perspective on plant science for school groups and the potential for Darwin inspired learning. Many gooseberry, raspberry, cabbage, pea, bean and potato varieties grow in the kitchen garden. An orchard of newly planted old varieties of apple, plum and pear grow in a wild flower meadow. The herb garden attracts pollinators, particularly honey and bumble bees. Worms still move soil on Darwin's modest estate, probably at the annual rate he calculated, about "83.7 pounds per square yard".

Some of Darwin's experiments can be replicated (e.g. the weed plot experiment illustrates how weeds out compete seedlings), to encourage children to observe, identify, and think laterally and, like Darwin, record every detail in a notebook.

Whether in England or on the Beagle voyage, Darwin's passion for orchids provided fascinating insights into the interdependence of plant and pollinator. The huge range of plants grown in botanic gardens around the world prompt questions about diversity - most of which Darwin answered in his seminal publication *The Origin of Species*.

Introduction

2009 marks the bicentenary of Darwin's birth and 150 years since the publication of *On the Origin of Species*. This is a year full of opportunities for botanic gardens. The Charles Darwin Trust (CDT) has already developed Darwin Inspired Learning resources for schools and professional development programmes for teachers.

Darwin Inspired Learning draws attention to plants associated with Darwin, ranging from foxgloves and cabbages to tropical orchids. Educational visits during 2009 may be used to emphasise Darwin's ways of working and establish some of his experiments to develop children's thinking, debating and reasoning skills. Simple experiments that underpin Darwin's theories can be illustrated both in botanic gardens and at school.

Thinking about key questions

Darwin asked key questions about the distribution and diversity of life on earth based on close observation during the *Beagle* voyage and in the countryside of Kent. His observations led him to think about plant and animal adaptation and survival. Close observations led to thoughtful questioning and two or three times each day Darwin walked along the Sandwalk (Bromley Borough Council, 2006), his thinking path, pacing along as he thought deeply about his observations and reflecting on conflicting evidence. Botanic gardens could provide thinking paths for children on routes away from the general bustle of visitors. To encourage them to think more deeply, they should be asked big questions: why are there so many different plants? How did so many plants come about? Have plants always looked like those we see today?

Left: Using digital notebooks to record images, discussions and sounds, children are encouraged to work like scientists (Charles Darwin Trust by kind permission of English Heritage)

Collaboration

Motivated to solve plant related problems, Darwin wrote meticulously and at length about his experiments,

Above: Children walking along the Sandwalk, Darwin's thinking path (Charles Darwin Trust by kind permission of English Heritage)

his methods, his observation and the inferences he drew. Then he asked for corroboration from others or for data disclosing anomalous evidence from their experiments. He wrote and received hundreds of letters in protracted correspondence ranging across many subjects, including measurement of worm casts and orchid taxonomy, in different parts of the world.

Educators understand the benefits of group work and drawing out knowledge that comes from children's different experiences. Dividing a plant investigation between groups and ensuring time for a sufficiently long plenary to present findings follows Darwin's scientific practice and makes plants a focus for vocabulary and scientific language development.

Right: The wormstone was invented by Darwin and his son Francis to measure the rise and fall of the soil level. Using the wormstone, Darwin was able to calculate the total amount of soil moved by earthworms in a year (Charles Darwin Trust by kind permission of English Heritage)

Providing children with a means of recording their findings will be important. For each of his research topics, Darwin wrote in a different notebook. He did not fill in worksheets or rely on his memory of field work to write up his findings later. To work like scientists, children need access to notebooks or their contemporary equivalent - digital cameras, hand held computers, MP3 players to record discussions and sounds, digital video to capture plant-insect interdependence and data loggers to record environmental conditions. Most of these functions can be made available on a single device which saves data to a website ready for use in school.

Growing experiments

While Darwin's garden enabled self sufficiency for a household of about 20 people, it was also his laboratory. His ideas about natural selection began with the artificial selection he saw at horticultural shows. Botanic gardens might emphasise his findings by growing 'wild' and known varieties of the crops he grew in his kitchen garden. A keen gooseberry breeder, Darwin cultivated fifty-four varieties, studied reports of gooseberry exhibits and visited county shows. He noted that, in as little as 25 years, champion gooseberries went from the size of a marble to "6½ inches in circumference". Darwin also grew many varieties of cabbage and bean which provided him with a source of inspiration for reasoning and theorising:

"See how different the leaves of the cabbage are, and how extremely alike the flowers; … how much the fruit of the different kinds of gooseberries differ in size, colour, shape, and hairiness, and yet the flowers present very slight differences.….as a general rule, I cannot doubt that the continued selection of slight variations, either in the leaves, the flowers, or the fruit, will produce races differing from each other chiefly in these characters." (Darwin, 1859 Chapter 1)

Growing fruits and vegetables in botanic gardens or school grounds would allow children to see what Darwin saw with his magnifying glass, because Darwin noticed what previous scientists had overlooked. Closer observation revealed variations in the size, colour or hairiness of the corolla or calyx.

Time

Darwin explored the effects of time. For example, experiments to determine the depth to which earthworms buried chalk and ash took more than 20 years. Children can gain some notion of time passing and the effect on plants if one of Darwin's shorter, but nonetheless compelling experiments, is replicated.

At Down House, Darwin chose a piece of ground "three feet long and two wide". He dug and cleared it to prevent choking of new seedlings by other plants. For this weed plot experiment he marked all the seedlings "of our native weeds as they came up, and out of the 357 no less than 295 were destroyed, chiefly by slugs and insects." (Darwin, 1859). A simple experiment, such as this, encourages children to work systematically, observe closely, identify plants and think laterally. From just five minutes data collection daily they too can theorise about natural selection through predation and Darwin's notion that: *"the real importance of a large number of eggs or seeds is to make up for much destruction at some period in life; and this period in the great majority of cases is an early one."* (Darwin quoted in Glick & Kohn p167).

Each year a new weed plot could be started and the old plot, if left untouched, can show the process of succession and how plant composition in the plot changes over time. For educational progression and to generate questions, the plot could be mowed or grazed and changes in plant diversity and form observed.

The local environment

The landscape and natural environment was Darwin's laboratory but botanic gardens can still encourage children to make close observations over the year to understand their local environs. Every year of observation adds to a long term study of local plants and ecosystems. Such strategies and conservation activities were encouraged by the European Union funded PlaSciGardens project (2007) when resources were developed to help children understand the importance of local conservation (www.plantscafe.net).

Darwin was fascinated by the structure of orchids and delighted in the study of co-evolution of pollinators. He involved

his own children in watching bees and, to fully understand the pollination process, Darwin covered various plants to exclude pollinators. He compared the minimal number of seeds from covered plants with the copious seed produced by those left uncovered. Attracting bees to a public or school garden confronts Health & Safety concerns but educational experiences are a priority when children have to understand human dependence on pollinating insects for food production. Weighing yields of covered and uncovered plants shows children human reliance on insect pollinators.

Inspired learning

Work at CDT has supported children in finding their own answers to self-generated questions by observing closely the local environment and plants in particular. They have time to think and big questions to consider. If you implement some of these suggestions your way of teaching may alter. The way children react in a botanic garden is likely to change if you abandon worksheets and trust children to record the information that they think is important to the big questions they pose for themselves. You will have to be prepared for children to think the unthinkable and surprise you – just as Darwin shook the world when he put forward his ground breaking theories.

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Résumé

Le jardin de Down House, demeure de Charles Darwin pendant 40 ans, a mis divers sites expérimentaux à sa disposition. À présent entretenu par English Heritage, le jardin rassemble de nombreuses variétés de légumes et de fruits que Darwin aurait connues. La culture de ce type de plantes dans les jardins botaniques apporte une nouvelle dimension à la phytologie pour les groupes scolaires, ainsi que des possibilités d'apprentissage inspiré de Darwin. De nombreuses variétés de groseilles, de framboises, de choux, de pois, de haricots et de pommes de terre poussent dans le jardin potager. Un verger d'anciennes variétés de pommes, de prunes et de poires récemment plantées partage une prairie de fleurs sauvages. Le jardin d'herbes aromatiques attire les pollinisateurs, notamment les abeilles et les bourdons. Les vers remuent toujours la terre de la modeste propriété de Darwin, vraisemblablement à la vitesse annuelle qu'il avait calculée, soit environ « 83,70 livres au yard carré ».

Certaines expériences de Darwin sont reproductibles (par exemple l'expérience du carré de mauvaises herbes démontre comment celles-ci gagnent sur les jeunes plants), afin d'encourager les enfants à observer, identifier, réfléchir en formulant des comparaisons et, comme Darwin, enregistrer chaque détail dans un carnet.

En Angleterre tout comme lors du voyage sur le *Beagle*, la passion des orchidées de Darwin a été source de données fascinantes sur l'interdépendance entre plantes et pollinisateurs. L'immense variété de plantes cultivées dans les jardins botaniques à travers le monde soulève des questions liées à la diversité, auxquelles Darwin a répondu en grande partie dans sa publication-phare « *L'origine des espèces* ».

Resumen

El jardín en Down House, hogar de Charles Darwin durante 40 años, le brindó sitios experimentales. Actualmente manejado por el Patrimonio Británico, el jardín contiene muchas variedades de frutas y vegetales que Darwin conoció. El cultivo de plantas similares en los jardines botánicos presenta una nueva perspectiva de la biología vegetal para los grupos escolares, particularmente el potencial de inspirar el aprendizaje a través de la vida y obra de Darwin. Muchas variedades de frambuesas, zarzamoras, coles, chícharos, frijoles y papas crecen en su jardín. En un prado hay una huerta recién plantada con antiguas variedades de manzana, ciruela y pera creciendo junto con la flora silvestre. El jardín de plantas aromáticas atrae a los polinizadores, especialmente a las abejas y abejorros. Las lombrices presentes aún mueven el suelo de la propiedad de Darwin, probablemente a la velocidad que él calculó de "83.7 libras por yarda cuadrada".

Algunos de los experimentos de Darwin pueden reproducirse (por ejemplo, en la parcela de malezas puede mostrarse como compiten éstas con las plántulas), para motivar a los niños a observar, identificar, y pensar abiertamente, y al igual que Darwin, anotar cada detalle en su libreta. Ya sea en Inglaterra o a bordo del Beagle, la pasión de Darwin por las orquídeas le permitió fascinantes introspecciones sobre la interdependencia de la planta y el polinizador. La enorme variedad de plantas que crecen en los jardines botánicos del mundo, incitan a cuestionarnos sobre la diversidad; muchos de estos cuestionamientos tienen respuestas en la obra magna de Darwin "El origen de las especies".

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Below: One of the experimental plots at Down House (Charles Darwin Trust by kind permission of English Heritage)

La grande **chasse aux plantes**

La gran **búsqueda de plantas**

Angela McFarlane

The great plant hunt

Summary The Royal Botanic Gardens, Kew has a long and successful history of working with schools at our gardens in South West London and Wakehurst Place in Sussex. Just under 100,000 children enjoyed organised visits in 2007 and 2008. But to celebrate Darwin200 (a national programme to celebrate the impact that Darwin's ideas had on evolution), and our 250th anniversary in 2009 we are embarking on The Great Plant Hunt. This exciting and challenging project will take plant science and conservation into every primary school in the UK. Funded by The Wellcome Trust we will be sending a treasure chest of resources to 22,000 maintained primary schools in March ready for them to start studying the native spring flowering species that grow around them, whether in the local park, beauty spot or cracks in the playground. A website, produced in partnership with The Guardian (newspaper and website), will connect schools to share their findings, uniting British children in the largest ever project to collect and bank the seeds of one species. By engaging children in real science will help them to appreciate not only the great contribution Darwin made to science but how real life plant hunters still play a vital role in understanding and saving our plant heritage, and realise that they too can make a contribution.

Right: Materials developed for the Great Plant Hunt are available on the website (Royal Botanic Gardens, Kew)

Below: The Great Plant Hunt aims to get children out and about and excited by nature (Royal Botanic Gardens, Kew)

It is usual for botanic gardens to have a clear mission to inspire and educate our visitors, in particular the young. Through its two properties at Wakehurst Place and in Kew, the Royal Botanic Gardens, Kew has nearly 100,000 school visitors a year with over 250,000 children visiting with their families. We are delighted to enjoy the company of so many young people, but there is a limit to the number we can reach directly. And yet the messages we have to offer young people about the importance of plants in their lives, and the need to better understand and protect plant life are equally important to all.

In 2007 RBG, Kew engaged a consultant to review the learning activities across Kew, and recommend how we could make our offer more attractive to more people and increase the impact of our messages.
The result was Kew's Learning Agenda, with its four key messages:

- Plants and plant diversity are vital for life.
- Kew maintains diverse and beautiful gardens where threatened plants are cared for.
- Kew leads science-based plant and fungal conservation worldwide.

- And you can take action too.

We were also set the ambitious challenge of reaching out to every child in the UK. So in addition to our onsite schools and families operation, we were looking for a way to engage with an outreach programme that could take our work and the work of botanic gardens to every child. The result is our most exciting schools' project so far.

To coincide with the 200th anniversary of Charles Darwin's birth, Kew has teamed up with the Wellcome Trust to create The Great Plant Hunt. This innovative project aims to get primary school children out and about and excited by nature. The Great Plant Hunt will offer children aged 5-11 hands-on experience of what it's like to be a plant hunter, working with Kew's Millennium Seed Bank scientists who play a vital role in saving our natural world heritage.

In March 2009, Kew will be sending the UK's 22,000 primary schools a Treasure Chest full of free resources to be used in the classroom, online and in the great outdoors. The activities are clearly mapped to the primary science curriculum and include fun activities for Years 1-6. With exciting missions to discover plants in the wild (from the school playing fields to weeds growing in the cracks in the pavement!), the Great Plant Hunt also gives children the chance to be part of the UK's biggest ever school science project. Year 5 children will be invited to take part in a unique experiment to help

Left:
A young girl experiencing what it's like to be a plant hunter (Royal Botanic Gardens, Kew)

Kew's Millennium Seed Bank build the world's largest, and most genetically diverse, collection of seeds from a single species. The heart of The Great Plant Hunt is children doing real science in a fun and accessible way. Dr Steven Sinkins, Wellcome Trust Senior Research Fellow at Oxford University, observed that Charles Darwin, perhaps the most influential scientist of all time, made meticulous observations of nature and maintained an open mind in interpreting what he found. His methods were low-tech, but his science has revolutionised our understanding of the world and of our place in it. Children in schools across the country can readily follow his inspiring example.

People often forget how young Charles Darwin was when he set out for foreign shores on the Beagle. We all know him as a bearded old man but in actual fact he was a mere stripling of 22 when he started his travels overseas. On his return, still not 30, he was a national celebrity.

The project is already causing some excitement. On 1st July, the anniversary of the first reading of Darwin and Wallace's papers at the Linnaen Society in London, we launched the project website where teachers can find the information they need to plan the project into next year's lessons. Teachers are invited to register their interest in the project by visiting www.kew.org/great-plant-hunt. In the first week over 1100 schools had registered.

Left:
By engaging children in real science they will appreciate how plant hunters play a vital role in saving our plant heritage (Royal Botanic Gardens, Kew)

Right: Over 250,000 children and their families visit Kew each year and learn about the wonderful world of plants (Royal Botanic Gardens, Kew)

Mick Waters, Director of Curriculum at the Qualifications and Curriculum Authority, is looking forward to the project: “Children are fascinated by plants. Darwin challenged the thinking of his time. He asked key scientific questions. Teachers have to sow the seeds of learning...we’re trying to grow scientists! This project will help.”

All the materials developed for the project will be made available through the web under a creative commons licence. This means that anyone who wants to can take the material and reproduce or amend it for their use so long as they acknowledge the source and do not sell the materials. We are also making the materials in such a way that they can easily be localised for use outside the UK. We have had interest from as far away as Brazil, the US and Australia. We plan to develop some of the materials for use within the gardens at Kew and Wakehurst Place and hope these will be of use to other gardens wishing to mark Darwin200.

Through The Great Plant Hunt we hope to introduce the nation’s children to a lifetime of caring for the natural world. Who knows, we may find the next Darwin!

Below: The Great Plant Hunt will give children a chance to be part of the UK’s biggest ever school science project (Royal Botanic Gardens, Kew)

Résumé

Une longue histoire de partenariats scolaires florissants est associée aux Jardins botaniques royaux de Kew, dans nos jardins du sud-ouest de Londres et de Wakehurst Place dans le Sussex. Presque 100 000 enfants ont participé à des visites guidées en 07/08. Et pour célébrer le bicentenaire de Darwin, et notre 250ème anniversaire en 2009, nous nous lançons dans « La grande chasse aux plantes ». À travers ce projet passionnant et ambitieux, des notions de botanique et de conservation seront diffusées dans toutes les écoles primaires du Royaume-Uni. Avec le soutien du Wellcome Trust, nous enverrons en mars une malle aux trésors de ressources à 21 000 écoles primaires financées par l’Etat. Elles permettront l’étude d’espèces indigènes à fleurs printanières qui poussent dans leurs environs, dans les parcs alentour, les lieux pittoresques ou les fissures de la cour de récréation. Un site internet, réalisé en collaboration avec The Guardian, mettra les écoles en réseau pour partager leurs résultats, rassemblant ainsi les enfants du Royaume-Uni dans le plus important des projets de collectage et de mise en banque de semences d’une même espèce. L’introduction des sciences pures aux enfants leur permettra d’apprécier la remarquable contribution de Darwin à la science, de même que le rôle crucial encore joué par les chasseurs de plantes actuels quant à la compréhension et la conservation de notre patrimoine végétal. Ils verront qu’eux aussi peuvent apporter leur contribution.

Resumen

Los Reales Jardines Botánicos de Kew, cuentan ya con una larga y exitosa trayectoria trabajando con escuelas en nuestros jardines en el Sur Oeste de Londres y en Wakehurst Place en Sussex. Poco menos de 100 000 niños y niñas disfrutaron visitas organizadas en 2007 y 2008. Pero para celebrar el bicentenario de Darwin y los 250 años en 2009 de los Jardines Reales de Kew, estamos emprendiendo “La gran búsqueda de plantas”. Este emocionante y retador proyecto llevará la ciencia de las plantas y la conservación a todas las escuelas primarias del Reino Unido. Financiado por el Fideicomiso Wellcome, en el mes de marzo enviaremos un cofre de tesoros para 21000 escuelas primarias con los recursos necesarios para que estudien y las especies nativas que florecen en esa época, ya sea en el parque cercano, en las jardineras o entre las grietas del patio escolar. Un sitio web, producido en colaboración con el periódico The Guardian, conectará a las escuelas para compartir sus descubrimientos, uniendo así a los niños y niñas británicos en un proyecto sin precedentes para colectar y almacenar las semillas en un gran banco de semillas de estas especies. Involucrar a las niñas y niños en un proyecto científico real les permite apreciar no solo la importante contribución de Darwin a la ciencia, sino también como los buscadores de plantas en la actualidad aún juegan un papel vital para el conocimiento y protección de nuestro patrimonio vegetal, y que ellos también pueden contribuir a protegerlo.

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Le Jardin de Darwin : **une aventure évolutionniste**

El Jardín de Darwin: **una aventura evolutiva**

George Shakespear

Darwin's garden: an evolutionary adventure

Summary The untold story of Charles Darwin's lifelong fascination and work with plants was presented in an exhibition entitled *Darwin's Garden: An Evolutionary Adventure* at The New York Botanical Garden, April 25–June 15, 2008. Rich in interpretation and educational programming, Darwin's Garden included displays of living plants and historical documents in three venues plus an 'evolutionary tour' of living plants in the Tree of Life. It showed how Darwin's botanical experiments and discoveries helped shape his contributions to the understanding of life in general. A symposium with leading scientists, extensive hands-on programmes for children, and lectures for adults were among the highlights in the educational programming. *Darwin's Garden* was the latest in the botanical garden's ongoing flower shows and exhibitions combining horticulture, botanical science, and education, the three pillars of its institutional mission as an advocate for the plant kingdom. Major sponsors included the National Endowment for the Humanities and Mr. and Mrs. Marvin H. Davidson.

Few people know that Darwin was an avid gardener and that many of his scientific discoveries were inspired by more than 40 years of research and experimentation with plants and flowers. Darwin historian and *Darwin's Garden* curator David Kohn, Ph.D., explains the significance of the exhibition: "Only in his work as a botanist can we truly see all the dimensions of Darwin as a scientist—that is as a successful collector, as a powerful theorist, as an insightful observer, and as a rigorous and almost prophetic experimenter."

Darwin's own garden re-created

Darwin's Garden was a garden-wide exhibition, with components in multiple venues. In the botanical garden's Enid A. Haupt Conservatory, a stunning flower show re-created Darwin's own garden in Kent, England, filled with colourful delphiniums, foxgloves, and other typical English cottage garden flowers that Darwin and his wife, Emma, grew, as well as a 'kitchen garden' and orchard. The exhibition also featured Darwin's work with living plants and botanical research.

Interactive displays of plants explained some of Darwin's often simple yet ingenious experimental studies, such as his investigations into pollination and co-evolution of plants and their pollinators, and his many explorations into the power of movement in plants, from insectivorous plants that dynamically trap their prey to the many different climbing mechanisms of vines and other climbing plants. On June 16, 2008, *The New York Times* observed,

Left: A re-creation of Charles Darwin's garden and study at his home in Kent, England, was a centerpiece of the exhibition *Darwin's Garden: An Evolutionary Adventure* (Mick Hales)

Right; Sixty-two rare books and objects were displayed in the LuEsther T. Mertz Library's gallery at The New York Botanical Garden (Talisman Brolin/Talisman PHOTO)

Above: Visitors were invited to sit at Darwin's desk, to observe the garden. A notebook further encouraged people to comment on or to sketch what they saw (Talisman Brolin/Talisman PHOTO)

"…the garden can make us feel like Darwin, looking through his window on the variety and density of life, seeking fundamental principles. And out of the careful observation of differentiation and interaction, out of the pleasures taken in park and forest, the garden works that timeless ancient magic: we begin to see things whole."

Darwin's botany in his own words

The exhibition in the LuEsther T. Mertz Library's Rondina and LoFaro Gallery included original historical documents exploring Darwin's deep personal relationship with plants, beginning in childhood. It combined information about Darwin as a person with the story of his rich botanical ideas, featuring Darwin's own writings and collections. Illustrated books, manuscripts, and other historical documents offered insight into his thinking and demonstrated the importance of botany throughout his life. A handsome exhibition catalogue accompanied the exhibition, featuring a scholarly essay by Dr. Kohn on the essential role of plants in Darwin's life and science. On May 29, 2008, *The Christian Science Monitor* (an international daily paper published by The First Church of Christ, Scientist) commented,

"the documents and artifacts at the botanical garden's Mertz Library… chronicle Darwin's 'journey of the mind.' The library exhibit illuminates Darwin's long love affair with plants, not only as experimental subjects and objects of enthralling beauty, but as examples of nature's greater process."

Children's aventures with Darwin

In the Everett Children's Adventure Garden, an interactive exhibition including plants important to the development of the concept of evolution invited children to explore and learn through hands-on activities. A centerpiece of the display was a replica of the ship, HMS *Beagle*, which took Darwin on a five-year voyage to South America and around the world. Children's activities included potting up a vegetable plant, creating a herbarium specimen, and investigating various bogs. At an interactive Tree of Life, focused on the oak family, children were invited to create their own evolutionary tree to show simple relationships between different species of oak trees.

Darwin's living legacy

As part of *Darwin's Garden*, visitors were also brought up-to-date on current evolutionary plant science. The concept of evolution is the foundation of all plant science today at institutions such as the New York Botanical Garden. To educate visitors on the latest thinking, the exhibition also included an Evolutionary Tour and a scientific symposium.

The Evolutionary Tour consisted of a 40-minute scavenger hunt in the Enid A. Haupt Conservatory and surrounding outdoor plantings. Representative plants in the evolutionary Tree of Life were highlighted at stops along the way, using signage and commentary by the exhibition curator and garden scientists and visitors were also able to access this information using their mobile phones. In the Conservatory, visitors saw living representatives of some of the earliest forms of plant life such as algae, mosses, ferns, and cycads, while in the surrounding outdoor plantings, the Evolutionary Tour featured some of the great diversity of flowering plants that have evolved on Earth in the past 140 million years. In 1859, Darwin's theory of natural selection as the engine of evolution shattered basic assumptions about science and the world. The impact of the thinking that he launched is no less significant today. A symposium on two evenings in May featured presentations by scientists, historians, philosophers, and environmentalists. Hosted by The New York Botanical Garden in collaboration with the American Museum of Natural History, the symposium, entitled *Darwin: 21st-Century Perspectives*, offered an opportunity to hear top class scholars and commentators discuss how his thinking continues to influence science and society today. Edward O. Wilson, Ph.D., two-time Pulitzer Prize winner,

entomologist, and biologist known for his pioneering work on evolution and sociobiology, introduced both sessions and served as moderator.

Many other educational tools and programmes were employed to tell the historical story of Charles Darwin's work with plants, to explain the cultural and historical context of his work, and to relate it to today's scientific challenges. A special website (www.nybg.org/darwin) was created for the exhibition, including an interactive diagram of the Evolutionary Tour, information on the other various elements of the show, and background material on the life of Charles Darwin. Weekend programmes featured drop-in lectures, workshops, and guided tours. Performances featured music and poetry from Darwin's era, much of it heavily influenced by nature. An audio tour – separate from the Evolutionary Tour – was available to guide visitors through *Darwin's Garden* in the Haupt Conservatory and Mertz Library.

Results and travelling exhibition

Both the exhibition and the symposium received extensive press coverage and were very well attended, with more than 200,000 visitors to the Botanical Garden during the run of the exhibition. In a popular feature of the exhibition in the Haupt Conservatory, visitors were invited to sit at Darwin's desk and to jot down their observations as they looked out the window at the re-

Left: A visitor observes insectivorous plants up close (Talisman Brolin/Talisman PHOTO)

creation of his own garden. It allowed visitors to literally put themselves in his home and surroundings, to take on Darwin's worldview. Feedback included sketches of the flowers in the garden as well as commentary, which ranged from the personal to the philosophical. Many visitors commented on the sheer beauty of the flowers and others on Darwin's penetrating insights or the exhibition's celebration of the diversity of life.

After closing in New York, parts of the *Darwin's Garden* exhibition are travelling to The Huntington Library, Art Collections, and Botanical Gardens in San Marino, California and will be on display from October 4, 2008 – January 5, 2009.

Résumé

L'histoire non relatée de la fascination et du travail incessant de Charles Darwin sur les plantes a été présenté dans une exposition intitulée « *Le jardin de Darwin : Une aventure évolutionniste* » au Jardin botanique de New York du 25 avril au 15 juin 2008. Exposition riche en interprétations et en programmations pédagogiques, « *Le jardin de Darwin* » était composé de galeries de plantes vivantes et de documents historiques disposés dans trois salles, plus une « visite évolutionniste » de plantes vivantes sur l'Arbre de l'évolution. Cette exposition témoigne de la façon dont les expériences et découvertes botaniques de Darwin lui ont permis de formuler ses contributions à la compréhension de la vie en général. Un symposium rassemblant des personnalités scientifiques, de vastes programmes pratiques pour les enfants, et des cours pour adultes ont constitué les points forts de la programmation pédagogique.

Above: 'Vegetable Voyaging', one of several interactive activities at the Children's Adventure Garden (Talisman Brolin/Talisman PHOTO)

Right: An Evolutionary Tour with 30 stops allowed visitors to walk through the Tree of Life, viewing living plants in Enid A. Haupt Conservatory and across the garden grounds (Talisman Brolin/Talisman PHOTO)

Resumen

La historia desconocida del largo y fascinante trabajo de Charles Darwin con las plantas, se presentó en una exhibición titulada "El Jardín de Darwin: una aventura evolutiva" en el Jardín Botánico de Nueva York del 25 de abril al 15 de junio de 2008. Una exhibición de gran riqueza interpretativa y con programas educativos, *El Jardín de Darwin* incluyó la exposición de plantas vivas y documentos históricos en tres sitios del jardín botánico, así como el "recorrido evolutivo" en la colección viva de El Árbol de la Vida. El recorrido mostraba cómo los experimentos botánicos de Darwin y sus descubrimientos le ayudaron a moldear sus contribuciones al entendimiento de la vida en general. Un simposio con investigadores, actividades prácticas, programas para niños y pláticas para adultos fueron las acciones más sobresalientes del programa educativo.

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Darwin 'down under'

Summary Charles Darwin's observations of Australian flora and fauna during his visit in 1836 formed a key part in the development of his theory of evolution through natural selection and his subsequent publishing of *Origin of Species*.

2009 is the bicentenary of Charles Darwin's birth and his work will be the focus of celebrations throughout the year in Australia's scientific and cultural sectors. Botanic gardens, with their scientific integrity and rich diversity of living plants and animals, are ideal places to introduce people to the man, his achievements and his legacy through interpretive programmes focusing on Darwin's fascination with life, his keen eye for detail and his theory of evolution. Linked to national herbaria and horticultural research centres, botanic gardens encourage an exploration into modern methods of studying the origin of life and all its forms.

Botanic gardens across Australia are exchanging ideas and discussing potential partnerships for a year-long programme of community events. Hopefully our collective legacy will be to inspire a passion and appreciation for nature that fosters budding naturalists and the next generation of scientists.

In 1836 Charles Darwin disembarked from HMS *Beagle* in Sydney Town, Australia. The arid landscape he observed was a stark contrast to the lush tropical forests of South America from where the *Beagle* had recently sailed, and equally removed from the misty green pastures and cultivated gardens of Darwin's homeland, England. Between January and March of 1836, Darwin visited New South Wales, Tasmania and finally King George's Sound in Western Australia. His impressions of the landscape were sometimes less than flattering and on leaving Australia, his parting words were:

'…you are too great and ambitious for affection, yet not great enough for respect. I leave your shores without sorrow or regret.' (Charles Darwin, *The Voyage of the Beagle*, Modern Library, New York 2001 p 403).

Right: Big Answers to Big Questions is a programme that provides opportunities for people to exchange ideas and express their opinions about issues, such as Natural versus Unnatural Selection (Botanic Gardens Trust)

While visiting Sydney Town, he strolled through the Royal Botanic Gardens and Domain and looked favourably on our fledgling gardens, stating:

'…there are no fine trees, but the walks wind about the Shrubberies & are to me infinitely more pleasing than the formal Alamedes of S. America' (A.J Marshall, *Darwin and Huxley in Australia,* Hodder and Stroughton, Sydney 1970 pp 89-90)

On his arrival in Hobart, Tasmania, Darwin commented:

'… The town stands at the base of Mount Wellington, a mountain 3100 ft, but of no picturesque beauty: from this it receives a good supply of water, a thing which is much wanted in Sydney.' (F.W and J.M Nicholas, *Charles Darwin in Australia*, Cambridge University Press, 1989 p 84).

Darwin describes at length his attempts to climb Mount Wellington on the two days before his 27th birthday. Although a botanic garden was established in Hobart in 1818, we have not found direct reference to it in any accounts of

Darwin's visit. Darwin's detailed observations about Australian flora and fauna documented in diaries, letters and books were part of the development of his theory of evolution through natural selection. As such, his work will be the focus of celebratory events throughout 2009 in Australia's scientific and cultural sectors. Major exhibitions and scientific conferences on evolution and Darwin's voyages are being held around the country and botanic gardens are already forging potential partnerships to showcase the contribution of plants to Darwin's life-work.

Botanic garden educators across Australia are a particularly collaborative group and are sharing information and exchanging ideas for a year filled with Darwin-themed public programmes. Botanic gardens linked to herbaria and historic libraries will make historical material accessible to the public and interpret the challenges society faced in the light of Darwin's theory of natural selection. Highlights of contemporary scientific research related to Darwin's work will also be interpreted.

Partnerships already budding between cultural institutions and botanic gardens in major cities include the Australian National Botanic Gardens in Canberra supplying plant material to the National Museum of Australia to complement its travelling 'Darwin' exhibition from New York's American Museum of Natural History. Further south in Hobart, staff at the Royal Tasmanian Botanic Gardens are exploring links to two planned exhibitions at the Tasmanian Museum and Art Gallery and a series of eight 'Walks with Charles Darwin' run by Tasmanian Adult Education.

Royal Botanic Gardens Melbourne and Royal Botanic Gardens Cranbourne are participating in an Evolution Conference opening in Melbourne in February 2009. The conference embodies the concept of 'Melbourne as a thinking city' and will bring intellectuals and specialists to the city while encouraging a social and public programme to run alongside the specialist conference. A highlight of the conference will be the public Grand Evolutionary Dinner. Diners will be encouraged to 'Eat your way up the tree of life, starting with primeval soup and finishing with a devastating meteorite impact surprise!'

In Sydney, the Botanic Gardens Trust (the Trust) is developing a year-long public programme at the Royal Botanic Gardens to celebrate Darwin's ongoing legacy. Launched around Darwin's 200th birthday on 12 February, the programme will involve the Australian Museum and other neighbouring cultural and scientific organisations. The Trust will also take part in events staged at other institutions, such as the two-day Darwin symposium to be held at the Australian National Maritime Museum in conjunction with its major exhibition 'Charles Darwin – Voyages and Ideas that Shake the World'.
A major exhibition in our Red Box Gallery will be launched during the National Science Week festival in August and this will remain open to the public until November, in recognition of the month of the 150th anniversary of the publication of *On the Origin of Species*. Highlights of this exhibition will be the display of rare specimens from the Trust's Library: a first edition print inscribed copy of *On the Origin of Species*, correspondence between Darwin and the Garden's Director at the time, Charles Moore, and a Linnaean Society Journal containing the joint papers of Darwin and Wallace outlining their theory of natural selection.

Visitors to the botanic gardens will investigate plant breeding and propagation through a self-guided trail 'Mutants, Clones and Crossbreeds' or discover extreme plant adaptations on a themed guided walk with our volunteer guides. Holiday programmes for families will encourage the exploration of ideas such as cooperation between plants and insects and feature displays and plant sales will be held in partnership with local plant societies. In addition, the NSW school curriculum lends itself well to incorporating a Darwin focus into our Australian Biota lessons, currently run in partnership with Taronga Zoo and the Australian Museum.

Above: Miguel Garcia, Botanic Gardens Trust Librarian holding 1st edition of Darwin's *On The Origin of Species* (Botanic Gardens Trust)

Following in the footsteps of the Trust's 'Big Answers to Big Questions' (BABQ) programme in 2005, there will also be many opportunities for the public to gather information, exchange ideas and express their opinions freely at evening lectures, public seminars and a special 'Darwin's Birthday' dinner debate. These BABQ events will engage people in discussion of contemporary issues such as Evolution vs Intelligent Design, Natural vs Unnatural Selection, and Taxonomy: is it as dead as the dodo?

There is much being planned to celebrate Darwin's bicentenary 'Down Under' and Australian botanic gardens are key players. Our contribution will ensure that the important role plants played in Darwin's life and work will be appropriately acknowledged and that botanic gardens will continue to be recognised as places of inspiration and education.

Résumé

Les observations de Charles Darwin sur la flore et la faune d'Australie lors de sa visite en 1836 constituent un élément clé dans le développement de sa théorie de l'évolution par la sélection naturelle et la publication de « l'Origine des espèces » qui s'ensuivit.

2009 est le bicentenaire de la naissance de Charles Darwin, et son travail sera au cœur des célébrations tout au long de l'année dans le secteur scientifique et culturel en Australie. Les jardins botaniques, en raison de leur intégrité scientifique et la riche diversité de plantes et d'animaux vivants qu'ils possèdent, sont l'endroit idéal pour présenter au public l'homme de science, ses travaux et son héritage au travers de programmes d'interprétation ciblés sur la fascination qu'avait Darwin pour le monde vivant, son oeil assidu pour les détails et sa théorie de l'évolution. En collaboration avec les herbiers et les centres de recherches horticole nationaux, les jardins botaniques invitent à explorer les méthodes modernes d'étude des origines de la vie et de toutes les formes vivantes.

A travers toute l'Australie, les jardins botaniques échangent des idées et discutent de partenariats potentiels concernant un programme annuel d'évènements publics. Nous avons bon espoir que notre patrimoine commun inspirera une passion et une appréciation de la nature qui favorisera l'émergence de naturalistes en herbe et de la prochaine génération de scientifiques.

Right: Botanic gardens across Australia are planning a year filled with Darwin-themed programmes. Here the public are listening to a debate that took place at the Royal Botanic Gardens in Sydney (Botanic Gardens Trust)

Resumen

Las observaciones de Charles Darwin de la flora y fauna Australiana durante su visita en 1836 fueron una parte clave en el desarrollo de su teoría de la evolución a través de la seleccion natural y su publicación subsecuente del *Origin of Species*.

2009 es el bicentenario del nacimiento de Charles Darwin y su trabajo será el foco de la celebraciones a través del año en los sectores científicos y culturales en Australia. Los Jardines botánicos con su integridad cientifica y rica diversidad de plantas y animales vivientes, son lugares ideales para introducir al público los logros del hombre, sus alcances y su legado a través de programas interpretativos enfocando sobre la fascinación de Darwin con su vida, su ojo apto para el detalle y su teoría de evolución ligado a los herbarios nacionales y sus centros de investigación hortícola, jardines botánicos que animan a explorar entre los métodos modernos de estudio del origen de la vida y todas sus formas.

Los jardines botánicos a traves de Australia estan intercambiando ideas y discutiendo socios potenciales para un largo año de eventos de la comunidad. Para nosotros nuestro legado colectivo sera inspirar pasión y apreciación por la naturaleza que adopta naturalistas budding y la próxima generación de científicos.

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Professional development course for botanic gardens educators

With so much happening at Sydney's botanic gardens during the Darwin celebrations, the Trust is taking this opportunity to run a professional development course for botanic garden educators around September 2009.

Participants will take part in our school, community and outreach programmes and acquire hands-on experience in design, development and delivery of educational material. They can also visit other botanic gardens.

This course will be similar to BGCI/Kew's International Diploma in Botanic Gardens Education in format, cost and duration. It is being developed collaboratively with BGCI/Kew and Australia's botanic garden network: Botanic Gardens of Australia and New Zealand (BGANZ).

It will complement a similar initiative (a Diploma in Asia Pacific Botanic Gardens Management) being developed within the Asia-Pacific region.

Anyone interested in taking part in this course can find out more by emailing the authors on janelle.hatherly@rbgsyd.nsw.gov.au or sophie.daniel@rbgsyd.nsw.gov.au

Mara Sugni

A walk through time

Summary Visitors in Italy have been invited to take a walk back in time through the evolution of plants at Bergamo Botanic Garden. As part of their celebrations of Darwin's 199th birthday, the gardens have created an exhibition focussed on the adaptive strategies of plant movements. Strategies such as tropisms to light or touch have been extremely important in the evolutionary development of plants and Darwin in his latter years did extensive work on both. This work was revolutionary for botany as well as helping to solidify his evolutionary theory. The exhibition has used lower plants such as algae through to higher plants such as trees to highlight the importance of tropisms to plant evolution. Practical activities are offered and there is an opportunity for visitors to interact with botanists and take a refreshing drink in the garden's ancient Sala Viscontea laboratory rooms.

A special birthday party was held this year on 12 February at Bergamo Botanic Garden, Italy, to celebrate Charles Darwin's 199th birthday. In a crowded medieval laboratory room (Sala Viscontea), where educational activities usually take place, visitors were offered a unique presentation about Darwin's work concerning plant sensitivity and movement.

The evening party began with Darwin's words spoken by an actor, located in a scene resembling Darwin's studio. The actor read some extracts from the texts *The Power of Movement in Plants* and *The Movements and Habits of Climbing Plants* which perfectly described the enthusiasm, curiosity and accurate observations of the man who, two centuries earlier, laid the foundations of our modern vision of evolution. Following the readings, the voice of a 'modern' botanist expounding Darwin's words took visitors by the hand for a trip back in time, during which time they were invited to look at the most important steps in plants evolution.

In order to help people visualise these steps, a spiral-shaped path was designed on the laboratory room floor by means of a long tissue cloth. Along the path a few potted specimens were placed to illustrate the plant features of sensitivity and movement which mark the most important groups, including

Left: One of the visitors to the exhibition using a magnifying lense to closely observe a living plant specimen (Bergamo Botanic Garden)

Mimosa pudica and *Dionea muscipula*: both have leaves that demonstrate rapid plant movement (*nyctinastic* movement) and are representative of the angiosperm group.

On a table a petri-dish was prepared with wild oats seeds (*Avena sativa*) to illustrate their twisting movement due to the variation in atmospheric humidity and garden cress seed (*Lepidium sativum*) was grown in glass tubes with agar jelly to illustrate phototropism (growth and response to a light stimuli) and geotropism (turning or growth movement in response to gravity). During the week prior to the 'party', one of the glass tubes had been turned upside down once a day so that the stem and radicle clearly showed rotations.

During the evening, a selection of short movie clips were shown from the celebrated TV series *The Private Life of Plants* by David Attenborough, to illustrate some of the most surprising examples of plant reactions: dispersal, *nyctinastic* movements, climbing, pollination, etc. The metaphorical step back in time also encouraged visitors to look at the group of gymnosperms and progymnosperms, with their cones perfectly adapted to wind-mediated pollen transport. Graphs were used to illustrate how the perfect geometry of female cones enhances the probability of pollen entrapment and seed dispersal while dormant Gingko seeds were on display to highlight motile gamete fertilisation - a type of fertilisation only occuring in gingkos, cycads, ferns, mosses and algae.

Left: Garden cress seed (*Lepidium sativum*) was grown in a glass tube with agar jelly to illustrate phototropism (Bergamo Botanic Garden)

Far right: The exhibition displayed herbarium specimens and artefacts to illustrate the evolution of plants (Bergamo Botanic Garden)

Right: Petri dishes prepared with wild oat seeds (Avena sativa) to illustrate twisting movements (Bergamo Botanic Garden)

With the help of stereomicroscopes (a microscope used to analyze specimens side-by-side) and magnifying lenses, visitors were able to closely observe a sample of specimens. For example, fern sporangia with spores that can survive for extended periods of time in unfavorable conditions and mosses with their small moving leaves which orient themselves in order to convey and accumulate water drops (their gametes need water, as they move by means of flagella!). Mosses also move to release their spores: they open their spore case lid and enlarge their peristomal teeth to let the spores out.

The final stage of this virtual journey looked at the most primitive members of the plant family, algae. In particular, the focus was on cyanobacteria (also known as blue-green algae or Cyanophyta), which were probably among the first photosynthetic organisms on earth. Scientists suggest that they have a key-role to play in oxygen enrichment of our atmosphere, allowing the ozone layer to form and protecting us from excessive solar radiation. Cyanobacteria also represent the base level of the planet's trophic pyramid and in the Precambrian era were the primary producers. A digital microscope camera with an image projector allowed people to see examples of the first ever plant movements, those of *Oscillatoria* ssp.

A beautiful citation from Charles Darwin's Beagle Diary helped us to feel the emotions he probably perceived when, on the 18th April 1832 he was walking through a forest in Socêgo, Rio de Janeiro:

"If the eye was turned from the world of foliage above, to the ground beneath, it was attracted by the extreme elegance of the leaves of the ferns and mimosæ. The latter, in some parts, covered the surface with a brushwood only a few inches high. In walking across these thick beds, a broad track was marked by the change of shade, produced by the drooping of their sensitive petioles. It is easy to specify the individual objects of admiration in these grand scenes; but it is not possible to give an adequate idea of the higher feelings of wonder, astonishment, and devotion, which fill and elevate the mind".

Darwin's 199th birthday celebration ended with a cocktail accompanied by a special time-traveller dish, Vanilla Pudding which contains vanilla from an orchid (*Vanilla planifolia*) at the height of evolution and Agar Agar from a seaweed (*Gelidium amansii*) a jelly thickener from the most ancient plant form, algae!

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Résumé

En Italie, les visiteurs sont invités à remonter dans le temps à travers l'évolution des plantes au Jardin botanique de Bergame. Dans le cadre des célébrations du 150ème anniversaire de la naissance de Darwin, le jardin a réalisé une exposition ciblée sur les stratégies adaptatives liées aux mouvements des plantes. Ces stratégies, comme le tropisme vers la lumière ou le toucher, ont été extrêmement importantes dans le développement et dans l'évolution des plantes, et Darwin, à la fin de sa vie, fit une étude très vaste sur ces deux sujets. Ce travail a été révolutionnaire pour la botanique ainsi que pour la consolidation de sa théorie de l'évolution. Cette exposition utilise des plantes inférieures, telles que les algues, jusqu'aux plantes supérieures, comme les arbres, pour souligner l'importance du tropisme dans l'évolution des plantes. Des activités pratiques sont proposées et sont une occasion pour les visiteurs d'échanger avec les botanistes et de prendre un rafraîchissement dans la salle de l'ancien laboratoire Sala Viscontea du jardin.

Resumen

Visitantes en el Jardín botánico en Bergamo Italia, han sido invitados a realizar un paseo desde el pasado a traves de la evolución de plantas. Como partea del 150º aniversario de Darwin, los jardines han creado una exhibición enfocada en las estrategias adaptivas del movimiento de las plantas. Estrategias tales como los tropismos a la luz o al tacto han sido extremedamente importantes en el desarrollo evolutivo de plantas y Darwin en sus años posteriores hizo trabajo extensivo sobre ambas. Este trabajo fue revolucionario en la botánica como tambien ayudo a solidificar su teoria de la evolución. La exhibición ha usado desde plantas inferiores como algas hasta plantas superiors como los árboles para resaltar la importancia de tropismos para la evolución de las plantas. Actividades prácticas son ofrecidas y hay una oportunidad para los visitantes de interactuar con botánicos y tomar una bebida refrescante en el jardin de los cuartos de laboratoriao de la Sala Viscontea.

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Didier Rousseau-Navarre

Le Design comme outil pédagogique

Résumé L'arbre de l'évolution de Darwin a inspiré l'aménagement du Jardin Botanique de Marnay-sur-Seine, qui a ouvert au public en 1999. Les visiteurs peuvent suivre le chemin de l'évolution des plantes en commençant par les formes les plus simples puis, en progressant dans le temps, vers les plantes à fleurs. La volonté d'aménager le jardin de cette façon s'inspire du philosophe Gaston Bachelard et de son idée d'une relation intelligente entre l'homme et les plantes. Les modèles de classification de ce dernier ainsi que l'arbre de l'évolution de Darwin et ses idées d'évolution continuelle ont fourni l'ossature conceptuelle pour aménager le jardin suivant un thème progressif. Partant du principe de n'utiliser que des plantes vivantes, il a fallu trouver des plantes pour évoquer les espèces éteintes ou pour représenter certains maillons du développement évolutionniste. Celles-ci ont été sélectionnées sur la base de critères communs, telles les cyanobactéries et leur capacité à réaliser la photosynthèse. Le début de la vie dans l'eau évolue jusqu'aux algues. Puis le terrain s'assèche et les sélaginelles et les fougères représentent les premières plantes terrestres. On avance pour arriver ensuite à la partie du jardin consacrée aux plantes pollinisées par le vent et les fleurs, qui dominent le monde actuel.

Left: Panneau d'interprétation expliquant le plan du jardin systématique (Jardin Botanique Marnay-sur-Seine)

Le Jardin Botanique de Marnay-sur-Seine, ouvert au public, est sans doute le plus jeune des jardins botaniques de France. Créé en 1998, la première partie, d'une surface de 5 000 m^2, a été inaugurée en 1999. Il est en cours d'aménagement et son étendue actuelle atteint 2ha. La motivation qui m'a conduit à sa création était et reste l'envie de restaurer et de refonder un rapport intelligent entre l'Homme et la Nature.

Le philosophe Gaston Bachelard m'a inspiré, puis m'a convaincu lorsque dans son ouvrage *La terre et les rêveries du repos* il cite le poète Lucien Becker qui a écrit : « Personne ne sait si son corps est une plante que la terre a faite pour donner un nom au désir ».

Comment ne pas se sentir alors soi-même comme faisant partie du règne du vivant au même titre que les plantes?

C'est dans cet esprit que j'ai abordé cette réflexion pour aménager la « partie systématique » du jardin. Ma préoccupation immédiate était et reste la suivante:

- « Donner à voir certes mais donner à comprendre pour mieux voir. »
- Quoi de mieux qu'une école et s'agissant des plantes, quoi de mieux qu'une école de botanique ?

Une école doit permettre de former des spécialistes et d'informer des non-initiés aux arcanes de la science botanique, en divulguant les connaissances actuelles. Au regard des différents modèles de schémas classiques, créés par des systématiciens comme Dahlgren, Cronquist, qui sont autant de propositions conceptuelles brillantes mais caduques, nous avons choisi une modeste mais pertinente solution.

C'est pourquoi notre jardin systématique a été pensé, voulu et réalisé sous l'appellation de « Chemin de l'Évolution » en suivant le modèle de K. Kubitski le plus proche de l'Angiosperm Phylogeny Group 2 ème édition (APG2).

« Chemin de l'évolution » pour parler de la systématique, nous voici bien dans l'idée de phylogénie, et la phylogénie, à l'instar de C. Darwin, est fondée sur la non fixité des espèces. Ce modèle nous invite à revisiter le monde du vivant dans le cours de l'histoire et à comprendre la vie selon une définition du hasard comme étant : « la rencontre de plusieurs déterminismes à un moment déterminé ».

Exprimer la systématique sous la forme d'un cheminement

C'est associer le monde vivant à un monde en mouvement qu'on accompagne physiquement. L'image la plus appropriée pour évoquer la phylogénie, comme la généalogie, c'est l'arbre. C'est une image fractale : on peut considérer que la phylogénie du règne végétal est à l'image de la perception qu'on a des individus qui la composent.

Après avoir défini la forme et le cadre, il restait à définir le contenu. Évidemment, on ne saurait être exhaustif dans une telle démarche qu'en incluant les éléments fossiles de l'histoire des plantes, mais le parti pris de n'utiliser que des végétaux vivants a permis d'éviter la connotation muséale, (passéiste), une étiquette qui colle encore aux botanistes. C'est pourquoi le choix des Eucaryotes chlorophylliens encore vivants s'est imposé. Il nous a semblé, par ailleurs, important de représenter quelques Champignons et Lichens de manière à être plus explicite sur leur appartenance à des Règnes différents en ayant recours à une forme signalétique différente.

Montrer des végétaux vivants

Montrer des végétaux vivants comme témoins des âges les plus reculés est frappant pour exprimer la réalité.
Il restait à faire les recherches pour identifier et se procurer des végétaux rustiques sous notre climat océanique à nuances continentales concernant toutes les Classes, Sous-classes, Ordres, Familles et Genres à représenter. Ces grandes divisions du règne végétal sont présentées dans ce « chemin de l'évolution ».

Un détail important qui caractérise notre systématique : la surface attribuée à la culture des plantes correspond à un ratio établi en fonction du nombre de genres et d'espèces selon l'estimation de D.J.Mabberley. Cette particularité permet d'un seul regard de se faire une idée de l'importance de la diversité des espèces représentant les différentes divisions du règne végétal. Nous avons fait le choix de montrer peu d'espèces d'algues, d'hépatiques et de mousses, difficiles à gérer en culture et exigeant des aménagements particuliers, mais leur présence est suffisamment explicite. Les végétaux ont été disposés selon un cheminement pédagogique montrant les étapes de l'évolution. L'aménagement a été réalisé avec des matériaux naturels et courants pour créer une ambiance simple et conviviale.

Évoquer l'évolution en suivant le « Chemin de l'évolution »

Dans un bassin circulaire enchâssé dans la pouzzolane des cyanobactéries évoquent les débuts de la vie et des algues vertes figurent, dans l'eau, les débuts de la vie végétale différenciée (premiers Eucaryotes chlorophylliens).

Eucaryotes chlorophylliens terrestres

Sur le bord du bassin, des hépatiques et des mousses colonisent les terres et roches émergées…on avance.

Cryptogames vasculaires

Toujours inféodées à la présence de l'eau, les sélaginelles, prêles et fougères représentent les premiers végétaux dotés de tissus vasculaires permettant la circulation de la sève depuis les racines jusqu'aux organes chlorophylliens. À la faveur des ombrages créés par les plus grands représentants de ces groupes, la diversité s'accroît. Le Carbonifère est évoqué par la présence des fougères arborescentes. L'évolution engendre aussi la différenciation des organes reproducteurs et photosynthétiques ; l'osmonde royale (*Osmunda regalis* L.), installée à l'extrémité de ce massif en témoigne.

Gymnospermes

Les Cycadacées : La charnière entre les Cryptogames et les Gymnospermes est évoquée par la présence du Cycas du Japon (*Cycas revoluta* Thunb.). Les premières plantes à fleurs et à graines apparaissent. Nous voulons montrer par là que les Gymnospermes se sont émancipées du point de vue sexuel, par rapport à la présence de l'eau et que, les premiers, ils ont pratiqué l'anémogamie, les plus avancés d'entre eux pratiquant même l'entomogamie.

Ephédracées

La charnière entre Gymnospermes et Angiospermes est mise en évidence par *Ephedra equisetina* Bunge. Le genre *Ephedra*, apparu pendant la période entre le Jurassique qui s'achève par la dernière grande extinction (190/135 millions d'années) et le Crétacé (65 millions d'années).

Angiospermes

Les plantes à fleurs modernes figurent le dernier modèle de sexualité apparu et ne manquent pas d'imagination. Ce sont les végétaux dominants depuis 65 millions d'années. On y reconnaît deux grandes Classes distinctes : les Dicotylédones et les Monocotylédones.

Signalétique

Afin de rendre plus accessible l'approche de la classification et de l'évolution lors du cheminement sur le terrain, les Classes sont signalées par un panneau rouge sur l'axe principal ; les allées secondaires signalées en bleu marquent l'entrée dans les Sous-classes ; les panneaux verts signalent l'entrée dans les Ordres ; les cartels blancs déclinent les différents taxons de rangs inférieurs et indiquent l'entrée dans les Familles, Genres et Espèces.

L'avenir de ce jardin systématique

C'est un espace modulable. Il est aisé d'en modifier les tracés et les surfaces afin de faire évoluer le jardin en fonction des connaissances. Ainsi, cette représentation de la systématique au Jardin Botanique de Marnay-sur-Seine restera d'actualité.

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Summary

Darwin's evolutionary tree was the inspiration for the design of Marnay-sur-Seine Botanic Garden, which opened to the public in 1999. Visitors can follow the road of evolution, from plants emerging in their simplest forms and evolving over time to flowering plants. The motivation to design the garden in this way came from the philosopher Gaston Bachelard and his ideas of an intelligent relationship between humans and plants. His classification models as well as Darwin's evolutionary tree and continual evolution ideas provided the conceptual framework for the garden's design along a progressive theme. With the desire to use only living flora, plants had to be sourced to either stand in for extinct plants or represent plants in a certain part of the evolutionary progress. These were selected on shared characteristics such as cyanobacteria and their ability to perform oxygenic photosynthesis. From this initial water based start there is a progression to algae. From there the garden moves onto dry land with selaginella and ferns representing the first land-based plants. This progresses until the garden reaches the wind and flower pollinating plants that dominate the world today.

Resumen

El árbol evolutivo de Darwin fue la inspiración para el diseño del Jardin Botánico de Marnay-sur-Seine, el cual abrió al publico en 1999. Los visitantes pueden seguir el camino de la evolución, desde plantas que emergen en las formas mas simples y evolucionan con el tiempo hasta las plantas con flor. La motivación para el diseño en esta forma viene del filosofo Gaston Bachelard y sus ideas de una relación inteligente entre humanos y plantas. Su modelo de clasificación asi también como el árbol de la evolución de Darwin y las ideas sobre la continua evolución proporcionaron la estructura conceptual para el diseño del jardín a lo largo de un tema progresivo. Con el deseo de usar únicamente las plantas vivientes, las plantas tenian que haber sido encontradas para representar plantas que estan extintas o que representan una cierta parte del progreso evolutivo. Estos fueron seleccionados sobre caracteristicas compartidas tales como cianobacterias y su habilidad para realizar fotosíntesis oxigénica.

De este inicio basado en agua hay un avance a las algas. De ahi el jardin se mueve a tierra seca con selaginellas y helechos representando las primeras plantas terrestres. Esto progresa hasta que el jardin alcanza el viento y las flores polinizando plantas que dominan el mundo hoy.

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Far right: Vue aérienne du Jardin Botanique de Marnay-sur-Seine qui a ouvert au pubic en 1999 (Jardin Botanique Marnay-sur-Seine)

L'évolution détient la clé

La evolución tiene la clave

Tracy Greenfield

Evolution holds the key

Summary Thousands of schools around the world are gripped by Rockford's Rock Opera, a unique story with an important environmental message. This is an engaging, original view of the current tragedy of mass species extinction. Though the use of music, a narrated story and animated videos, Rockford's Rock Opera highlights the crucial discoveries and inventions made possible as a result of the study of plants and animals, evolved to meet their own challenges of existence. It demonstrates how the secrets locked up in at-risk species could hold the solutions to the world's future needs.

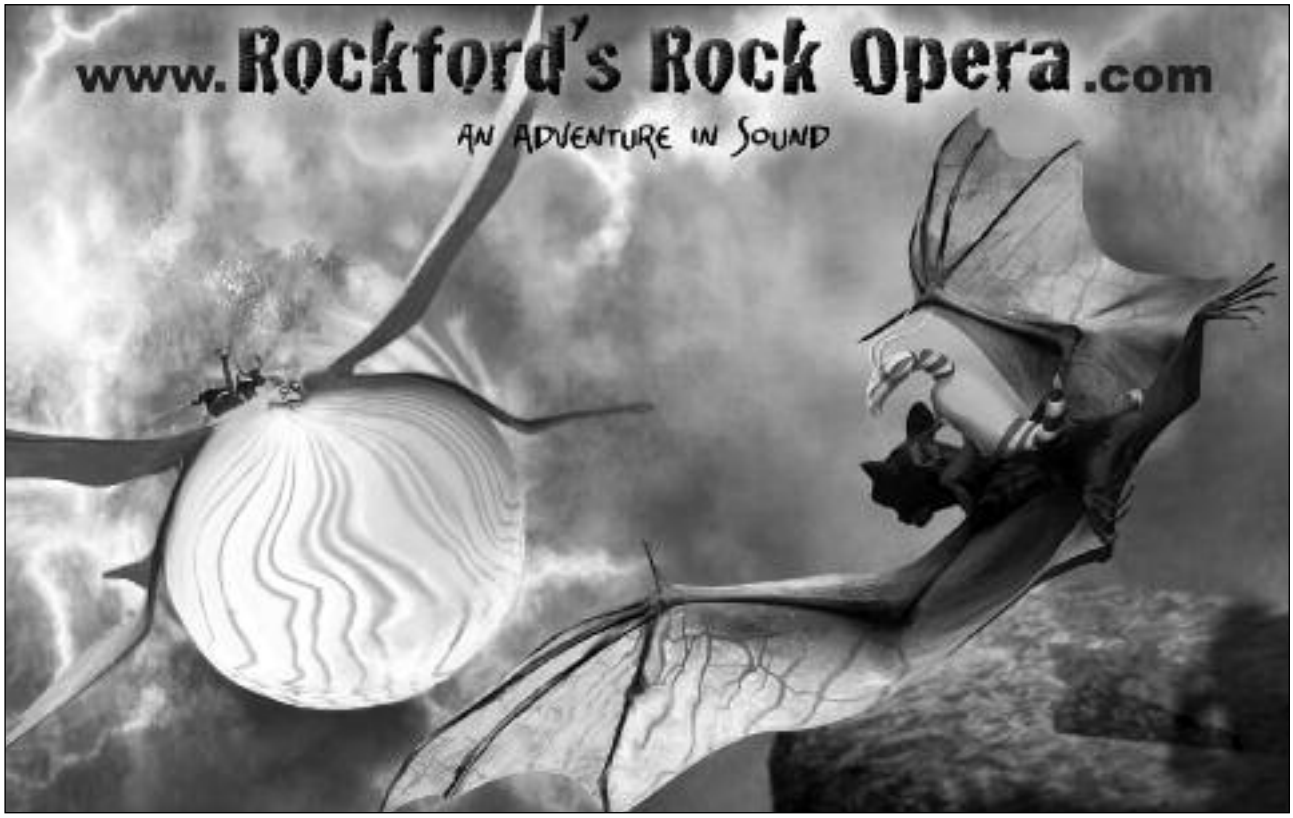
Evolution and the secrets of life

No one knows how many plant species we have on our planet, but they are the ultimate source of medicines for 75% of the world's population. A quarter of all modern drugs – including Aspirin, morphine, antibiotics, antiseptics and anesthetics – are either derived from or based on plant compounds. And the influence of plants goes further than their study in medicine. For example, the Cocklebur seed (*Xanthium strumarium* L.) was the inspiration for the creation of Velcro fastenings and many tropical plants are now showing scientists how to create self-cleaning paints and surfaces, reducing our need for harmful soaps and detergents.

In solving the challenges of existence, evolution has led plants (and animals) to create innovative design solutions – the true 'secrets of life' that now provide the bedrock of human scientific 'discovery'. Losing plants and animals to the current crisis of mass extinction is a tragedy and without doubt we are throwing away important answers – naturally evolved solutions that could hold the key to the earth's future challenges. By saving species, we could actually be saving ourselves. To those of us who understand the crucial role of the natural world this may seem utterly obvious, but to the wider population, it's an original message that we are using to engage minds across the world.

An ecological multi-media musical story

Rockford's Rock Opera is a unique ecological musical story with this important environmental message at its heart. Think of a cross between 'Hitchhiker's Guide to the Galaxy' and Jeff Wayne's 'War of the Worlds', or perhaps, 'Jurassic Park' crossed with 'The Jungle Book' and a bit of 'The Butterfly Ball'! Rockford's Rock Opera deals with extinction, evolution, the secrets of life and the importance of eco-systems. It engages minds, asks questions and addresses the wonder of life in an entirely original way.
This multi-media story (a great deal of which is free to stream or download from the web) is for all ages with a free audio book, characters, songs, sound effects, animated videos and more.
The site also includes an extensive selection of ecological lesson plans and teaching resources that can be downloaded free to use in the classroom. The Rockford's Rock Opera



website also contains a fascinating 'Secrets of Life' directory, listing just some of the amazing breakthroughs that have happened as a result of the study of plants and animals.

Reaching the World

Although individual stories of extinction are very sad, Rockford's Rock Opera is a positive story of wonder, hope and of belief that we can learn from the mistakes of our past and make things better. This is the message that's now spreading across the world, from the Rockford's Rock Opera website and in live performances, education materials and lots more. We hope it will inspire all people to view life, in all its evolved forms, not just as a work of 'nature', but also as a gift for us to treasure, to protect and to learn from.

Take a look at our video, 'Distant Generation':http://www.rockfordsrock opera.com/video/distant-generation.asp Or discover the whole story at: www.rockfordsrockopera.com

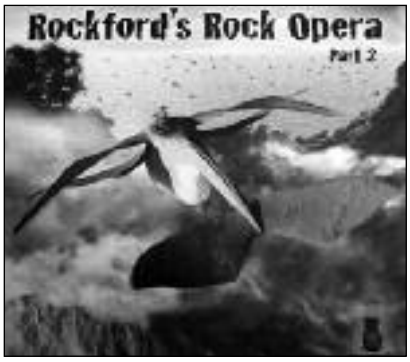
Rockford's Rock Opera was created by award winning creative team, Sweetapple (www.sweetapple.co.uk), and features well-known BBC writer, Steve Punt. It is an entirely self-funded, self-produced project created to make a positive impact.

Résumé

Des milliers d'écoliers à travers le monde se sont passionnés pour l'Opéra rock de Rockford, une histoire sans égal transmettant un important message pour l'environnement. Il s'agit d'une représentation intéressante et originale de la tragédie actuelle de l'extinction massive des espèces. Par le biais de la musique, d'une histoire retracée, de vidéos et de musique d'animation, l'Opéra rock de Rockford met en lumière les découvertes cruciales et les inventions réalisées grâce à l'étude des plantes et des animaux, qui ont évolué en relevant leurs propres défis de l'existence. Il démontre comment les secrets que recèlent les espèces menacées pourraient être sources de solutions aux futurs besoins planétaires.

Resumen

Miles de escuelas alrededor del mundo estan emocionado por la Rockford's Rock Opera, una historia única con un mensaje importante. Esta es una historia unica con un mensaje ambiental importante. Esta es una forma atractiva y original de la tragedia actual de la extinction massiva de especies.



El uso de la música bien pensado, una historia narrada, videos animados y musica,

Rockford's Rock Opera resalta los descubrimientos cruciales e invenciones que hicieron possible como un resultado del estudio de plantas y animales, evolucionó para alcanzar sus cambios propios retos de existencia. Ella demuestra como los secretos tan bien guardados en especies al riesgo de la extinctión, podrian contener las soluciones de las necesidades futuras del mundo

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Resources

Resources

Books and Education Curriculum

The Kiwi's Egg: Charles Darwin and Natural Selection

If you have ever wondered who Darwin was and what he said, then this book is an excellent read. Evolution, during the early nineteenth century, was an idea in the air. Other thinkers had suggested it, but no one had proposed a convincing explanation for how evolution occurs. In September 1838, Charles Darwin hit upon the idea that 'natural selection' among competing individuals would lead to adaptations and species diversity. However, it took another 21 years until The Origin of Species was published. Drawing from Darwin's secret 'transmutation' notebooks and his personal letters, David Quammen has sketched a colourful life portrait of the man whose work continues to be controversial.

David Quammen, 2008, 304pp, paperback, Orion Publishing Group, ISBN 9780753823507. www.orionbooks.co.uk.

Forensic Botany Investigations (FBI)

This new curriculum unit on economic botany introduces sixth through eight graders to the vital roles plants play in culture, commerce and our daily lives. Students are presented with fun and challenging scenarios and

Disponible

Livres et programmes scolaires

L'œuf du kiwi : Charles Darwin et la sélection naturelle

Si vous vous êtes déjà demandé qui était Darwin et ce qu'il a dit, ce livre est pour vous. Au début du XIXème siècle, l'évolution était une idée dont on parlait déjà. D'autres penseurs en avaient fait état, mais personne n'avait encore proposé d'explication valable de la façon dont fonctionne l'évolution. En septembre 1838, Charles Darwin découvrit que la sélection naturelle entre des individus qui se font concurrence mène à l'adaptation et à la diversité des espèces. Cependant, il fallut encore 21 ans pour que paraisse « L'origine des espèces ». En s'appuyant sur les carnets secrets de Darwin sur la « transmutation des espèces» et ses lettres personnelles, David Quammen dresse le portrait imagé d'un homme dont le travail reste, aujourd'hui encore, controversé.

David Quammen, 2008, 304pp, livre de poche, Orion Publishing Group, ISBN 9780753823507. www.orionbooks.co.uk.

Enquête scientifique en botanique

Ce nouvel élément du programme relatif aux aspects économiques de la botanique présente aux jeunes de 10 à 13 ans le rôle essentiel que jouent les plantes dans la culture, le commerce et

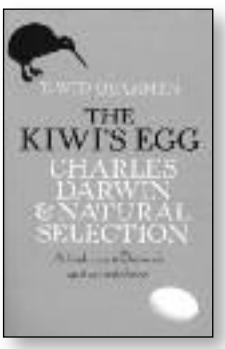
Recursos

Libros y programas escolares

Carlos Darwin y la Selección Natural El huevo de Kiwi: Charles Darwin y la selección natural

Te has preguntado quien fue Darwin y que dijo que lo ha hecho famoso, si no lo sabes, entonces este libro es el adecuado para informarte. Durante el siglo XIX Evolución era solo una palabra en el 'aire'. Ya algunos estudiosos habían notado que la evolución existía pero ninguno de ellos había dado una explicación convincente de como ocurría. A pesar de que en septiembre de 1838, la idea de la 'selección natural' fue propuesta por Darwin como la competencia que a los que los organismos se veían presionados a responder al medio ambiente con adaptaciones que reflejan la su diversidad, fue sino hasta 21 años después que el 'Origen de las especies' fuese publicado. En este libro David Quammen saca a la luz de los cuadernos de 'notas de transmutación' y cartas personales de Darwin, un extraordinario relato de quien fue este gran y controversial personaje.

David Quammen, 2008, 304pp, edition rustic a, Orion Publishing Group, ISBN 9780753823507. www.orionbooks.co.uk.



investigations, and work in teams to solve plant based mysteries while learning about plant science, ecology and conservation. The lessons are accompanied by a documentary style DVD, which features New York Botanical Garden scientists and their long term research projects.

The curriculum includes classroom lessons, a teacher's guide and handouts, a 24 minute documentary style DVD and materials for hands-on activities and investigations. Lessons found in the curriculum include understanding different plant parts and their functions; the important role that bees play in maintaining balance with forest ecosystems; analysing ecological and botanical data; and learning the important variables for growing rice.

Funded through a generous grant from Bristol-Myers Squibb, the curriculum was developed in collaboration with Education Development Center (EDC), a leading science curriculum development firm.

Forensic Botany Investigations, 2008, Glencoe, the science education division of McGraw-Hill, ISBN 0078804477. www.glencoe.com. Available only in the USA.

The Tree of Knowledge

The construction of knowledge and development of a creative, critical human being, with responsibility for the planet is like the growth of a tree. This is the thinking behind a new education

la vie quotidienne. Des scénarios et enquêtes amusantes et stimulantes sont proposées aux élèves qui travaillent en équipe pour résoudre des mystères liés aux plantes tout en se familiarisant avec la botanique, l'écologie et la conservation. Les leçons sont accompagnées d'un DVD documentaire présentant les scientifiques du jardin botanique de New-York et leurs projets de recherche à long terme.

Le programme comprend des leçons, un guide pour les enseignants et des fiches à distribuer, le DVD et du matériel pour les enquêtes et activités pratiques. Les leçons portent, entre autres, sur les différentes parties d'une plante et leurs fonctions, le rôle essentiel des abeilles dans l'équilibre des écosystèmes forestiers, l'analyse de données écologiques et botaniques, et les facteurs déterminant la croissance du riz.

Financé par un don de Bristol-Myers Squibb, le programme a été élaboré en collaboration avec une entreprise spécialisée dans la conception de programmes scientifiques.

Forensic Botany Investigations, 2008, Glencoe, the science education division of McGraw-Hill, ISBN 0078804477. www.glencoe.com

L'arbre de connaissance

La construction des savoirs et le développement d'êtres humains créatifs et dotés d'un esprit critique, assumant leurs responsabilités à l'égard de la planète, ressemble à la croissance d'un arbre. Telle est l'idée qui sous-tend le nouveau dossier pédagogique produit par le jardin botanique de Xiitbal neek à Mexico. Le dossier (en espagnol) contient 3 livrets, l'image d'un arbre de la connaissance (qui explique le cadre conceptuel du projet) et une affiche en couleurs pour

Investigación de medicina forense botánica (FBI)

Es una nueva materia en el plan de estudios del sexto al octavo grado botánica económica. Resaltando que las plantas son un aspecto importante en la cultura, comercio y eventos cotidianos de nuestra vida. La medicina forense se presenta a los estudiantes por medio de escenarios interesantes con retos e investigaciones detectivescas; el trabajo se efectúa en equipos que tratan de resolver los misterios de las plantas, en los que al mismo tiempo, el alumno aprende ciencia, ecología y conservación de las mismas. En un DVD se ilustran algunos ejemplos de proyectos científicos que se desarrollan en el Jardín Botánico de Nueva York.

Se incluyen actividades para el salón de clases, guía practica para los profesores, cuadernos de trabajo, un documental de 24 minutos en DVD y materiales para actividades de investigación practica. En las lecciones se tratan las diferentes partes de las plantas y sus funciones; asimismo temas como: la importancia que juegan las abejas en mantener el balance del ecosistema del bosque; como analizar datos ecológicos y botánicos; aprender las variables importantes para crecer arroz, entre muchos mas.

Esta iniciativa fue lograda gracias al apoyo económico de Bristol-Myers Squibb, en colaboración con el plan de estudios de el Centro de Desarrollo Educativo - Education Development Center, (EDC).

Forensic Botany Investigations, 2008, Glencoe, the science education division of McGraw-Hill, ISBN 0078804477. www.glencoe.com

El árbol del conocimiento

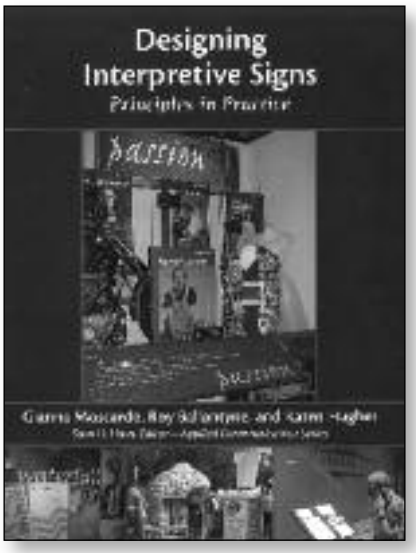
El jardín botánico Xiitbal neek (México) pensando en el reto educativo y con un paso creativo al futuro, ha producido el paquete 'El árbol del conocimiento', cuya responsabilidad es como crecer un árbol para el

pack produced by the Xiitbal neek Botanic Garden in Mexico. The pack (in Spanish) contains three booklets, a pictorial representation of a 'tree of knowledge' (which explains the conceptual framework of the project) and a colourful poster aimed at preschool, primary and secondary school teachers. The booklets offer a wide range of activities that are linked to the Mexican National Curriculum and centred within the Education for Sustainable Foundations. Focusing on environmental themes, the activities can be carried out in any botanic garden, green space and school garden as well as a classroom.

Jardín Botánico Regional Xíitbal neek', Mexico, 2008, Available for the cost of postage and packing. Contact Verónica Franco- vefranco@cicy.mx

Designing Interpretive Signs: Principles in Practice

This excellent comprehensive guide is intended for students, researchers and educators working in the field of interpretation. It provides a series of principles for effective sign design, with instruction based on research, the latest in educational and psychological theory and practical guidelines. Full colour illustrations are used throughout the guide to reinforce the principles and provide real world examples. Valuable information is included about choosing sign locations, attracting and keeping visitors' attention, organising information so that visitors find it easy to follow and designing signs for a



les enseignants de maternelle, du primaire et du secondaire. Les livrets proposent diverses activités liées au programme national mexicain et entrant dans le cadre d'une éducation au développement durable. Centré sur des thèmes environnementaux, les activités peuvent être menées dans n'importe quel jardin botanique, espace vert, jardin d'école ou même en classe. *Jardín Botánico Regional Xíitbal neek', Mexico, 2008, Disponible en échange du coût de l'emaballage et de l'envoi . Contact: Verónica Franco- vefranco@cicy.mx*

Concevoir des panneaux d'interprétation: des principes mis en pratique

Ce très bon guide a été écrit à l'intention des étudiants, chercheurs et éducateurs qui travaillent dans le domaine de l'interprétation. Il expose une série de principes pour concevoir efficacement des panneaux, avec des instructions basées sur la recherche et les plus récentes théories en pédagogie et psychologie, ainsi que des indications pratiques. Tout au long du guide, des images en couleur illustrent ces principes et donnent des exemples concrets de réalisations. Il contient d'utiles renseignements sur la façon de choisir un emplacement, d'attirer et de soutenir l'attention des visiteurs, de disposer les informations de telle sorte que les visiteurs s'y retrouvent facilement et de concevoir des panneaux pour des sites très divers. Une liste récapitulative est proposée comme aide mémoire. Ce guide est un outil précieux dans tout département pédagogique d'un jardin botanique.

Gianna Moscardo, Roy Ballantyne, and Karen Hughes, 2007, Fulcrum Publishing, USA, 140pp, ISBN-13: 978-1-55591-550-6. www.fulcrumbooks.com

Sites

www.seedsavers.net/publications/
De la graine à la graine: des potagers dans les écoles

Le réseau des Seed Savers (« Sauveurs de semences ») a produit un nouveau livre qui encourage le

planeta. El material es en español y consiste en 3 pequeños libros en los que se ilustran y explican el concepto del proyecto, además de un colorido cartel. El diseño esta orientado para profesores de educación pre escolar, primaria y secundaria. Los libros contienen actividades que se conectan al plan de estudio nacional mexicano en el tema de educación para la sustentabilidad. Enfocados a los temas del medio ambiente, se proyectan actividades para llevar a cabo en el salón de clases así como las áreas verdes de las escuelas o de un jardín botánico.

Jardín Botánico Regional *Xíitbal neek', México, 2008, Disponible al costo del porte del correo, por medio de Verónica Franco- vefranco@cicy.mx*

Diseñando señales interpretativas: principios y practicas

Guía excelente para estudiantes, investigadores, educadores y profesores que trabajan en el campo de la interpretación. Aquí se proporciona una serie de principios para un diseño efectivo, con instrucciones que se basan en investigaciones, con pautas o directrices practicas de lo ultimo en educación y teoría de la psicología. Con numerosas ilustraciones se refuerzan los principios y se proporcionan ejemplos del mundo real. Se incluye información de como seleccionar un gran rango de sitios adecuados que atraigan y mantengan la atención del publico; asimismo de la organización de la secuencia de la información para el fácil entendimiento y comprensión de los visitantes. También se incluye un listado de temas a manera de ayuda memoria. Esta guía es una adición muy valiosa para los jardines botánicos como parte de la biblioteca educativa.

Gianna Moscardo, Roy Ballantyne, and Karen Hughes, 2007, Fulcrum Publishing, USA, 140pp, ISBN-13: 978-1-55591-550-6. www.fulcrumbooks.com

wide range of sites. As an aide memoir a check list is also provided. This guide is a valuable addition to a botanic garden education library.

Gianna Moscardo, Roy Ballantyne, and Karen Hughes, 2007, Fulcrum Publishing, USA, 140pp, ISBN-13: 978-1-55591-550-6. www.fulcrumbooks.com

Websites

www.seedsavers.net/publications/
Seed to Seed: Food Gardens in Schools

The Seed Savers' Network has produced a new book encouraging gardening and growing food in schools. The book seeks to address the problem of children's deteriorating eating habits as well as their lack of gardening skills. It argues that with shrinking backyards and increasingly busy lives, domestic food gardens have become a thing of the past and that the opportunity to pass on important gardening skills from generation to generation is being lost. Consequently schools, with their more readily available space, are ideal locations for children to see and be a part of food production. The book covers everything school teachers and children might need to know from planning a garden to planting, maintaining, harvesting and saving seeds. Seed to Seed: Food Gardens in Schools is free to download as a pdf on the website.

http://evolution.berkeley.edu/evolibrary/home.php
Understanding Evolution

This website is written for a general audience and offers an excellent introduction to evolution. A wide range of content is available including a section entitled 'Evolution 101' which provides simple explanations about the patterns and mechanisms of evolution. Also included on the site are more detailed, but still understandable, courses on the more advanced ideas on evolution. There is a regularly updated news section as well as a teachers' section with teaching frameworks and ideas for lessons and activities.

jardinage et la création de potagers à l'école. Ce livre cherche à remédier au problème de la dégradation des habitudes alimentaires des enfants, ainsi qu'à leur méconnaissance du jardinage. Les auteurs font valoir que, vu la diminution de la taille des jardins et des cours et le caractère de plus en plus trépidant de la vie moderne, les potagers sont devenus une chose du passé, d'où une disparition de la transmission des connaissances de jardinage de génération en génération. C'est pourquoi les écoles, qui disposent plus facilement d'espace libre, sont l'endroit idéal pour que les enfants se rendent compte de ce qu'est la culture maraîchère, et y participent. Le livre couvre tout ce que les enseignants et enfants doivent savoir, de la conception d'un jardin à la plantation, l'entretien, la récolte et la conservation des graines. De la graine à la graine : des potagers dans les écoles est téléchargeable gratuitement en pdf sur le site Internet.

http://evolution.berkeley.edu/evolibrary/home.php
Comprendre l'évolution

Ce site s'adresse à tout public et offre une excellent introduction à la théorie de l'évolution. Divers sujets y sont traités, y compris une partie intitulée « Evolution 101 » qui fournit des explications simples sur les mécanismes de l'évolution. Sur le site, on trouve également des cours plus détaillés mais toujours compréhensibles sur des aspects plus avancés de la théorie de l'évolution. Le site comprend une page consacrée à l'actualité qui est régulièrement mise à jour, ainsi qu'une partie destinée aux enseignants contenant des indications pédagogiques et des idées de leçons et d'activités.

www.nhm.ac.uk/index.html
Le muséum d'histoire naturelle

Le muséum d'histoire naturelle de Londres abrite le centre Darwin, ainsi qu'un centre Darwin 2 qui ouvrira l'an prochain. Ce nouveau bâtiment recevra la collection de 28 millions d'insectes et 6 millions de plantes du musée. La partie évolution du site contient des nouvelles, des informations sur la théorie de l'évolution, et même des jeux qui aident à comprendre les

Sitios Web

www.seedsavers.net/publications/
Semilla a Semilla: Jardines de comida en escuelas

La red 'Salvadores de las Semillas' ha lanzado al publico un nuevo libro que motiva la jardinería y el crecimiento de comida en las escuelas. En el se tratan aspectos del deterioro alimenticio infantil y la carencia de habilidad para la jardinería. Se discute la reducción de los espacios de cultivo y el incremento de la vida agitada de nuestros días; consecuentemente como los jardines domésticos se han perdido en el pasado y con ellos la oportunidad de transmitir nuestros conocimientos o habilidades de jardinería. Las escuelas con su rápida disposición a ayudar pueden proporcionar espacios adecuados para que los niños vean, aprendan y crezcan vegetales que forman en parte de la comida. El libro es una fuente muy completa para maestros y alumnos que requieren de conocimiento, planeamiento y mantenimiento de cosechar y salvar semillas. El libro 'Semilla a semilla: Jardines de comida en escuelas' es gratis y se puede descargar en archivo pdf por medio del sitio Web.

http://evolution.berkeley.edu/evolibrary/home.php
Entendiendo la Evolución

Este sitio web es dirigido de manera general al publico y es una magnifica introducción al tema evolución. Los contenidos son muy amplios; en una sección titulada 'Evolución 101' se explican de manera accesible los mecanismos y patrones evolutivos. También se incluye de manera mas detallada, pero fácil de entender, ideas mas avanzadas en el tema. El sitio es actualizado por medio de una sección de noticias, asimismo como otra dedicada a los maestros o profesores proporcionándoles esquemas de trabajo y actividades para impartir sus clases.

www.nhm.ac.uk/index.html
El Museo de Historia Natural en Londres

En el se alberga el Centro de Darwin y el Centro de Darwin 2; que entrara en acción el año próximo. Este edificio

www.nhm.ac.uk/index.html
The Natural History Museum

The Natural History Museum in London is home to the Darwin Centre and the Darwin Centre 2 which will open next year. This new building will host the museum's collection of 28 million insects and six million plants. The evolution section of the website has news, information on evolutionary theory and even games to help explain how evolution works. The video archive has excellent videos on all kinds of subjects including Darwin.

http://fruitipedia.com/
Fruitipedia: Encyclopedia of Edible Fruits of the World

As the title states this recently launched website aims to be an encyclopedia of all fruits of the world. Produced by Dr. Chiranjit Parmar, a fruit expert from India, the site is quickly gathering a large and diverse record of fruit. He would like to encourage readers to send in articles on fruit from their part of the world. A look through the database of fruit makes you quickly realise the small number of fruit we actually eat and the interesting things that we could be eating. The website is easily translated into a number of different languages.

www.indicator.org.uk
in'di-ka'ter

Indicator is an initiative of the Education for Sustainability (EfS) programme run at London South Bank University, UK. The EfS programme has over 12 years experience in debating and delivering EfS across the global regions. This website provides a forum for programme students, alumni and others to publish material that does not fit within the usual formal, 'stuffy' criteria that academic publications generally require. It is freely accessible and downloadable content will be archived to build a valuable resource over time.

mécanismes de l'évolution. Les archives vidéo contiennent d'excellentes vidéos sur toutes sortes de sujet, y compris sur Darwin.

http://fruitipedia.com/
Fruitipedia : encyclopédie des fruits comestibles du monde

Comme l'indique son nom, ce site Internet récemment créé a pour ambition de constituer une encyclopédie de tous les fruits du monde. Réalisé par Dr. Chiranjit Parmar, un spécialiste indien des fruits, le site accumule rapidement toutes sortes de données sur les fruits. L'objectif est d'encourager les internautes à envoyer des articles sur les fruits de leur région. Un coup d'œil à la base de données permet rapidement de constater que nous en consommons en fait très peu et que nous pourrions en goûter de très intéressants. Le site Internet est facile à traduire dans différentes langues.

www.indicator.org.uk
in'di-ka'ter

Indicator est une réalisation du programme Education pour le durable mené par l'université londonienne South Banks en Grande-Bretagne. Ce programme organise depuis plus de douze ans des débats et des cours sur ce sujet de par le monde. Le site comprend un forum permettant aux élèves, aux anciens élèves et à toute autre personne de publier des informations qui ne répondent pas aux critères traditionnels des publications universitaires. Il est libre d'accès et tous les documents téléchargeables seront archivés pour construire un outil très utile pour l'avenir.

nuevo mostrara colecciones de 28 millones de insectos y 6 millones de plantas. En el sitio Web del Museo, en la sección de evolución se puede encontrar la información sobre la Teoría de la Evolución que incluye juegos para explicar los posibles mecanismos de la evolución. En un video disponible se encuentran muestras excelentes de todo tipo, incluyendo aquellos que han hecho famoso a Darwin.

http://fruitipedia.com/
Frutipedía: Enciclopedia de los frutos comestibles en el mundo

Como el titulo lo dice se trata de una enciclopedia para todos los frutos existentes alrededor del mundo. Esta fue elaborada por el Dr. Chiranjit Parmar, experto en frutos de la India. El sitio esta rápidamente compilando numerosos y diversos frutos; el Dr. Parmar le gustaría motivar a los usuarios para que envíen sus artículos de frutos de cualquier parte del mundo. Dando una mirada a la base disponible al momento, nos damos cuenta que pequeño es el numero de frutos comemos, asimismo todos los interesantes otros que podríamos estar disfrutando. El sitio web puede consultarse por medio de diferentes idiomas ya que una de las opciones nos lo permite.

www.indicator.org.uk
in'di-ka'ter

Indicator es una iniciativa en un programa de Educación para la Sustentabilidad (EfS) de la universidad de South Bank de Londres, Reino Unido. Este programa EfS tiene a la actualidad mas de 12 años de experiencia en debates y expresiones orales en todas regiones. El sitio Web provee un foro para estudiantes, alumnos, y otros profesionales permitiéndoles publicar en línea electrónica materiales que no encajan totalmente de una manera formal a los criterios o requisitos generales académicos. El sitio es de libre acceso y los contenidos son descargables para poder ser usados en forma de archivos los que eventualmente con el tiempo constituyan un recurso muy valioso.

How to join Botanic Gardens Conservation International

The mission of BGCI is to mobilise botanic gardens and engage partners in securing plant diversity for the well-being of people and the planet. It was founded in 1987 and now includes over 525 member institutions in 115 countries.

Institutions can join BGCI for the following benefits:

- Membership of the worldwide plant conservation network
- Botanic Garden Management Resource Pack (upon joining)*
- Regular publications:
  - the regular newsletter, *Cuttings*
  - *BGjournal* – an international journal for botanic gardens (2 per year)
  - *Roots* - environmental education review (2 per year)
  - A wide range of new publications
- Invitations to BGCI congresses and discounts on registration fees
- BGCI technical support and advisory services

	Institution Membership	£ Stlg	US $	€ Euros
A	BGCI Patron Institution	5000	8000	7500
B	Institution member (budget more than US$2,250,000)	750	1500	1000
C	Institution member (budget US$ 1,500,000 - 2,250,000)	500	1000	720
D	Institution member (budget US$ 750,000 - 1,500,000)	350	700	500
E	Institution member (budget US$ 100,000 - 750,000)	185	370	265
F	Institution member (budget below US$100,000)*	85	170	125
	**Generally applies to institutions in less developed countries*			

Other Membership Categories:

Membership benefits depend on category - see below. These can include:

- Regular publications:
  - the regular newsletter, *Cuttings*
  - *BGjournal* - an international journal for botanic gardens (2 per year)
  - *Roots* - Environmental Education Review (2 per year)
- Invitations to BGCI congress and discounts on registration fees

	Individual Membership	£ Stlg	US $	€ Euros
J	Conservation donor (*BGjournal*, *Roots* and *Cuttings* plus more)	250	500	350
K	Associate member (*Cuttings* and *BGjournal*)	40	80	60
L	Associate member (*Cuttings* and *Roots*)	40	80	60
M	Friend (*Cuttings*) available through online subscription only (www.bgci.org)	10	20	15

*Contents of the Botanic Garden Management Resource Pack: *The Darwin Technical Manual for Botanic Gardens, A CITES Manual for Botanic Gardens, A Handbook for Botanic Gardens on the Reintroduction of Plants to the Wild, BGjournal - an international journal for botanic gardens (2 past issues), Roots - environmental education review (2 past issues), The International Agenda for Botanic Gardens in Conservation, Global Strategy for Plant Conservation, Environmental Education in Botanic Gardens, BG-Recorder (a computer software package for plant records).*

Payment may be made by cheque payable to Botanic Gardens Conservation International, or online at www.bgci.org or by VISA/Mastercard sent to BGCI, Descanso House, 199 Kew Road, Richmond, Surrey, TW9 3BW, U.K or Fax: +44 (0) 20 8332 5956.

❑ I wish to apply for membership of Botanic Gardens Conservation International.

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❑ I would like to make a donation to BGCI. Amount . . . . . .

Please clearly state your name (or the name of your institution) on all documentation. Please contact info@bgci.org for further information.

BGCI
Plants for the Planet

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