Royal Horticultural Society

Sharing the best in Gardening

RHS Science Strategy Update 2017

The RHS Vision

To enrich everyone's life through plants, and make the UK a greener and more beautiful place.

Our four key themes

1. A global knowledge bank for gardening and garden plants

2. Plant health in gardens

3. Gardening in a changing world

4. Plant science for all: people, plants, planet

Welcome

2017 has been a year to remember in RHS Science & Collections, and I'm delighted to bring you this update full of exciting developments. The team has delivered against so many of our key objectives that it would be impossible to present everything that has been done, so please enjoy these highlights and keep an eye on rhs.org.uk for more science news and information.

We need to raise £13m from donors and RHS members to help build the new Centre for Horticultural Science and Learning and refurbish the historic Laboratory building at RHS Garden Wisley. We have received initial support from the Heritage Lottery Fund (HLF), with the award of a first-round pass for a grant of £4.8m, and are extremely grateful for the many further generous donations and pledges. However, we still need help to reach our target in order to inspire future generations of horticultural scientists and gardeners. If you would like to offer support, please see rhs.org.uk/donate.

The plants we choose to grow in our gardens can have a positive impact on our health and environment, from providing food for pollinators to helping us manage stress. Making smart choices about what and how we plant has been a hot topic for RHS Science and the wider scientific world this year. In particular, our work on climate change has demonstrated the importance of understanding the role that plants, gardens and gardening play, and how aesthetic appeal and functional needs can be balanced to ensure the UK remains a green and beautiful place.

Professor Alistair Griffiths
RHS Director of Science & Collections

"In particular, our work on climate change has demonstrated the importance of understanding the role that plants, gardens and gardening play."

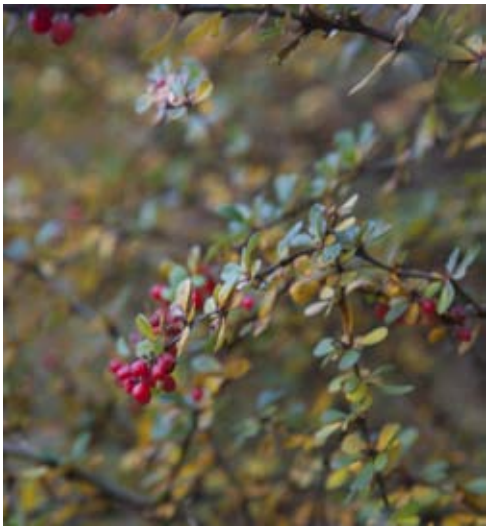
Right. **Artist's impression of the new Centre for Horticultural Science & Learning at RHS Garden Wisley.**

1 A global knowledge bank for gardening and garden plants

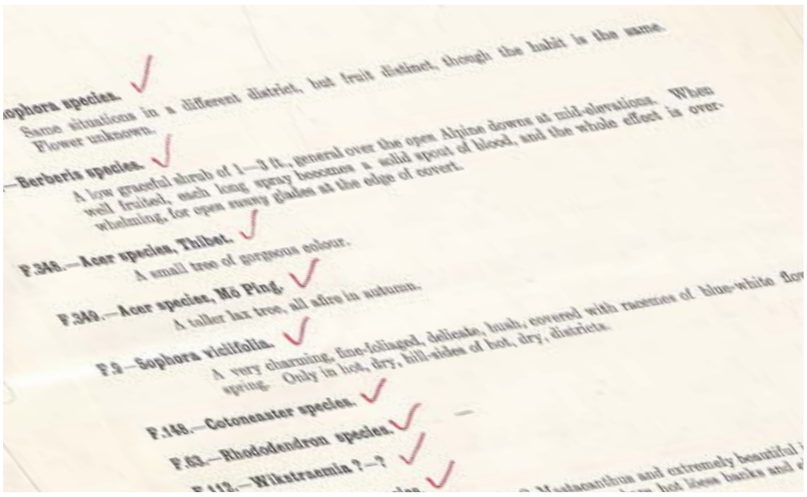
Gathering and sharing information

The RHS Herbarium

As part of our commitment to both preserve and make available the RHS Herbarium's collections, we have now digitised our intriguing collections of notes from plant-collecting expeditions dating back to the early 1900s. The expedition notes provide fascinating insights into the history of British plant-collecting. The collection will go on to form part of an exhibition at the Lindley Library and with more funding these rare documents can be made available online and used to develop educational resources and interpretation in both science and social history, helping to bring our heritage alive.



Left. ***Berberis arido-calida*** **(barberry), from a plant at Wisley collected by Reginald Farrer on his 1919–1920 expedition to Kansu. His collection notes** (below, under "Berberis species") **describe sprays of berries like "a solid spout of blood". Now digitised with more than 10,000 pages of similar notes from other well-known plant collectors, these records provide an important research link between herbarium specimens from collecting expeditions and the plants now growing in UK gardens.**



Identifying and understanding plants in our gardens

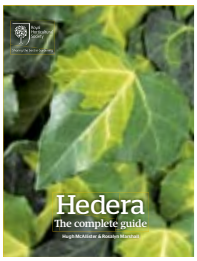
Analysing *Daphne* DNA

Funding from the International Dendrology Society, the Stanley Smith Horticultural Trust and the Alpine Garden Society is enabling RHS scientist Kálmán Könyves to use molecular techniques to better understand the taxonomy and uses of this popular garden plant. Initial results show that the current classification of *Daphne* species does not reflect evolutionary relationships and will need to be revised. Critically, a firm genetic understanding of this genus will enable us to provide better advice on how to grow and use this ever-popular garden plant.

Left. **RHS Scientist Dr Kálmán Könyves was supported as a PhD student by the RHS.**

New resources for gardeners

Continuing our drive to publish inspirational and relevant books for gardeners and the wider horticultural industry, this year we have launched:



♦ ***Hedera: The Complete Guide***. The second in our series of horticultural monographs includes work from Rosalyn Marshall (RHS Monographer – Intern), Dr Tijana Blanuša (RHS Principal Horticultural Scientist) and Dr Brent Elliott (RHS Historian). Bringing together knowledge from a wide range of sources about this useful and diverse plant group, this book shares the benefits for people and the environment of growing ivies and includes some wonderful supporting images from the RHS's heritage collections.

♦ ***The International Dianthus Register and Checklist.*** Bringing together 44,000 names, this is the first comprehensive guide to *Dianthus* (pinks and carnations) names since 1984. With descriptions as well as breeder information on this popular garden plant, the publication lists cultivar names from the late 17th century onwards, and represents a key milestone in the RHS's role as International Cultivar Registration Authority for the genus.

♦ ***Sander's List of Orchid Hybrids* – 3-year supplement, 2014–2016.** Orchids represent a large proportion of new plant registrations through the RHS each year, and this latest edition adds over 9,000 new grexes to the 168,000 already registered. Another example of our work as an International Cultivar Registration Authority, this publication is a vital resource for orchid enthusiasts, collectors and the orchid industry, as well as a fascinating insight into this vibrant plant group.

Above right. **New orchid hybrids at an RHS show. *Sander's List* helps bring stability to plant names in the fast-moving world of orchid hybridisation.**

> "Our work will make a difference by improving plant identification, informing effective management of invasive plants, safeguarding our important collections, and making them more accessible as a learning resource."
> RHS Science Strategy 2015–2019

2 Plant health in gardens

> "Our work will make a difference by improving plant health in gardens, enabling better detection, identification and control of plant pests and diseases, and safeguarding biodiversity through improved stewardship of nature."
> RHS Science Strategy 2015–2019

Encouraging good garden stewardship

The Plants for Bugs project

Gardens are a major habitat for wildlife, and the recently published second paper from the RHS Plants for Bugs experiment suggests that planting more plants, and particularly native plants, does lead to a greater abundance of invertebrates. Native plants supported marginally more invertebrates than plants from other regions; however, the density of the planting was key to invertebrate abundance, regardless of plant origin. Practical advice for gardeners based on this research is now available online at rhs.org.uk.

Advancing control and management strategies

Honey fungus

RHS Gardening Advice receives more questions from UK gardeners about honey fungus (*Armillaria* spp.) than any other plant disease, and has done for many years. Usually attacking long-lived, woody and often high-value plants, the disease is a real worry for gardeners. Innovative management and control strategies are a priority for RHS research, which has begun in earnest this year. New projects include investigations into rapid diagnosis methods using quantitative molecular analysis, as well as examining whether *Trichoderma* (a non-pathogenic soil-dwelling fungus) or less virulent species of *Armillaria* can provide plants with protection against the more serious *Armillaria mellea*.

Honey fungus (left) **accounted for over 19% of the disease enquiries received by the RHS in 2016.**

Controlling slugs and snails

Almost every gardener in the UK will have trouble with the damage caused by slugs and snails at some point. Having completed the first year of our two-year investigation into the effectiveness of available slug control methods, we now understand that organic ferric phosphate slug pellets can perform almost as well as metaldehyde pellets. We have also seen interesting results suggesting that the use of mulch may lead to an increase in slug damage – something that we have been investigating further in year two of this BASF-supported project. Nematode treatments combined with mulch were shown to be effective for daffodils and lettuces, but were less so on beans and hostas.

A better understanding of what control methods work against slug and snail damage will be a big step forward in our drive to ensure UK gardeners have the best possible information on which to base decisions about how to manage the problem.

"In the second year of the study we will try to answer some of the questions generated by the results from the first year. We will look at the treatments with and without mulch, so we can better understand how the mulch interacts with the pesticides and nematodes."

RHS Entomologist Dr Hayley Jones

3 Gardening in a changing world

"Garden hedges, particularly those in front gardens, can offer their owners many benefits, such as protection from noise, roadside pollution and localised flooding. In our research we are trying to establish which plant characteristics best provide these benefits. Once we understand that, we can offer advice on choosing the best combination of plants for a particular balance of needs."
RHS Principal Horticultural Scientist Dr Tijana Blanuša

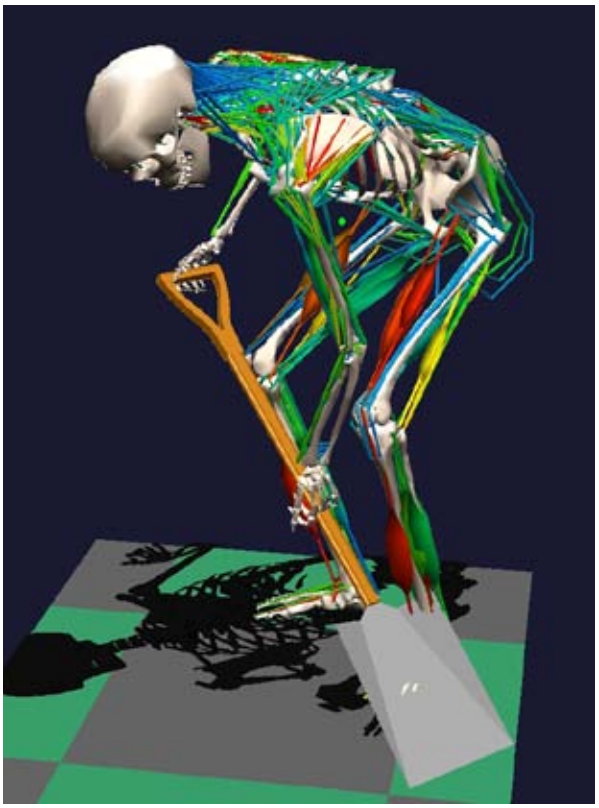
Understanding the vital role of plants

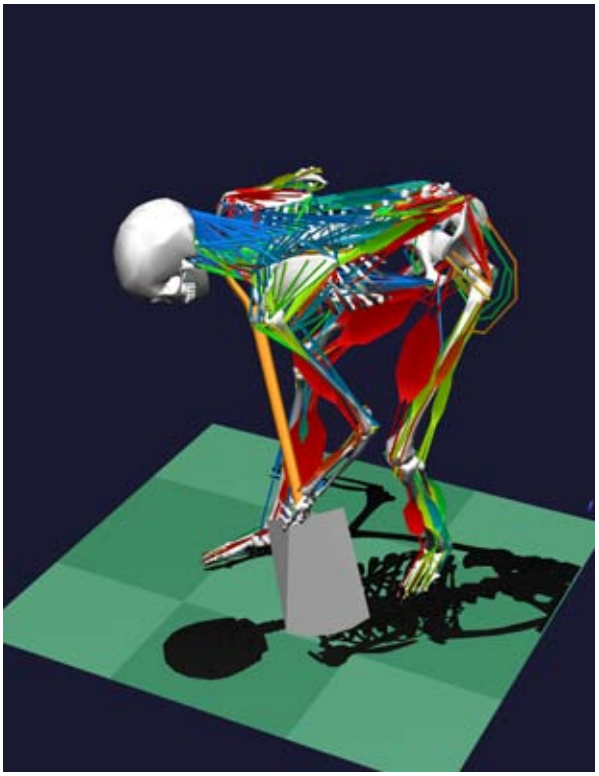
Plants and survivability in urban environments

As both our climate and our ways of living change, challenges to our physical, mental and social health, economic productivity, sustainability and safety arise. As part of the RHS Greening Grey Britain campaign, RHS Science is investigating how plants can help us meet these challenges. Our research will help planners, developers and individuals create a more healthy, sustainable urban environment by selecting and using the right plants for the right job.

RHS Principal Horticultural Scientist Dr Tijana Blanuša is currently researching how different hedging plants can capture particulate air pollution, making our air safer to breathe, and also help manage rainwater run-off and mitigate flooding. Two years into this work, it is becoming clear that there are significant differences between plants in terms of how they interact with rainwater and pollutants, demonstrating both that the right plant can make a difference, and that more research is needed to properly understand the potential of plants in our towns and cities.

Right. **Urban hedges can capture particulate air pollution and mitigate localised flooding.**





Maximising the health benefits of gardening

How do you dig?

The benefits of gardening for your physical health, including calorie burning and mobility, are now well known and widely publicised. In order to help people make the most of these benefits, RHS Head of Horticultural & Environmental Science Dr Paul Alexander is collaborating with scientists and physiotherapists at Coventry University to understand the biomechanics of digging and how you can dig effectively while protecting your body from unnecessary strains. In a forthcoming paper in *HortTechnology* (see p.16) the team have shown that motion capture technology can be used to better understand how we dig and that good technique can be identified to provide gardeners with guidance that will allow them to garden safely for longer.

Left. **Computer analysis of how hard muscles work during digging – the redder the muscle, the harder it is working.**

"Our work will make a difference by improving understanding of the health benefits of plants and gardening, promoting the use of plants for their ecosystem services, reducing resource use and equipping gardeners to meet the challenges of climate change."
RHS Science Strategy 2015–2019

Right. **By the year 2100, tender fruit trees will be able to grow outside in our gardens. Though they prefer dry conditions, alliums will tolerate periodic wetting during extreme rainfall events.**

Left. **Water captured during extreme weather is stored in tanks and transported in rills to ponds or rain gardens. Plants such as *Primula vialii*, Vial's primrose** (top left), **thrive in wet conditions, while permeable broken brickwork allows water to reach the ground below without run-off.**

Promoting environmentally responsible gardening

Gardening in a changing climate – report and events

In April 2017 we launched the Gardening in a Changing Climate report, authored by RHS Climate Scientist Dr Eleanor Webster in conjunction with Dr Ross Cameron (University of Sheffield) and Dr Alastair Culham (University of Reading). With 50% of the UK population identifying themselves as gardeners and a sense that gardeners want to understand the implications of climate change, this report has the potential to motivate and empower gardeners to take action in their own spaces to manage the impact of the changing climate and mitigate future climate change challenges.

The launch event was attended by more than 60 horticultural practitioners, policy-makers and scientists, and generated over 300 news pieces around what gardeners can do at home. A guide for gardeners produced from the findings of the report has been widely shared in print and online, and demonstrates our commitment to providing practical advice from our research.

The first-ever RHS Chatsworth Flower Show provided us with an opportunity to showcase the garden adaptations suggested in the report as a response to changing climate in the north of England. Designed by Dr Ross Cameron and Andy Clayden, the Garden for a Changing Climate (left) proved hugely popular. Volunteer students from the University of Sheffield and RHS staff engaged with over 6,500 visitors during the show, reaching a huge television and online audience through coverage on *BBC Gardeners' World*, *The One Show*, RHS podcasts and the RHS YouTube channel.

4 Plant science for all: people, plants, planet

Involving people of all ages

The buzz around bees

The Heritage Lottery-funded Blooms for Bees project led by the Centre for Agroecology, Water and Resilience at Coventry University, with partners Bumblebee Conservation Trust, Garden Organic, Hozelock and the RHS, has seen the installation of hanging baskets on the RHS Wisley Trials Field that enable visitors to monitor the visiting bees and contribute their observations to the project. A first for Wisley, the project uses a smartphone app to help users photograph, identify and log the bumblebees they see on the baskets, and is a great way of encouraging families and enthusiasts alike to get involved in scientific research into bumblebee foraging. Beyond Wisley, the project engages gardeners (including a large number of RHS members) in observing bees at home, and also raises awareness through its social media and website about bees and their role in the ecosystem.

Since 2010 BeeWatch has been run by the University of Aberdeen and the Bumblebee Conservation Trust. Through the project the British public has had more than 13,000 bee photos identified by experts and the community, helping us to learn more about the spread of the UK's 25 species of bumblebee. This year, the RHS has worked with BeeWatch to create a planting guide which draws on their data about which plants bees are more frequently seen to visit, and helps gardeners by showing season by season which plants will provide the best floral rewards for different bumblebees.

"To be able to provide gardeners with valuable information about the steps they can take to support bumblebees is a great achievement, and one that all the partners should be proud of."

Senior Horticultural Advisor Helen Bostock

Top right. ***Chaenostoma* Abunda Colossal Blue ('Balabolue'), one of the four plants in the RHS / Bloom for Bees Hanging Basket Trial.** Middle, left to right. **Three of the UK's 25 species of bumblebee: red-tailed bumblebee (*Bombus lapidarius*), early bumblebee (*B. pratorum*), and common carder bee (*B. pascuorum*).**

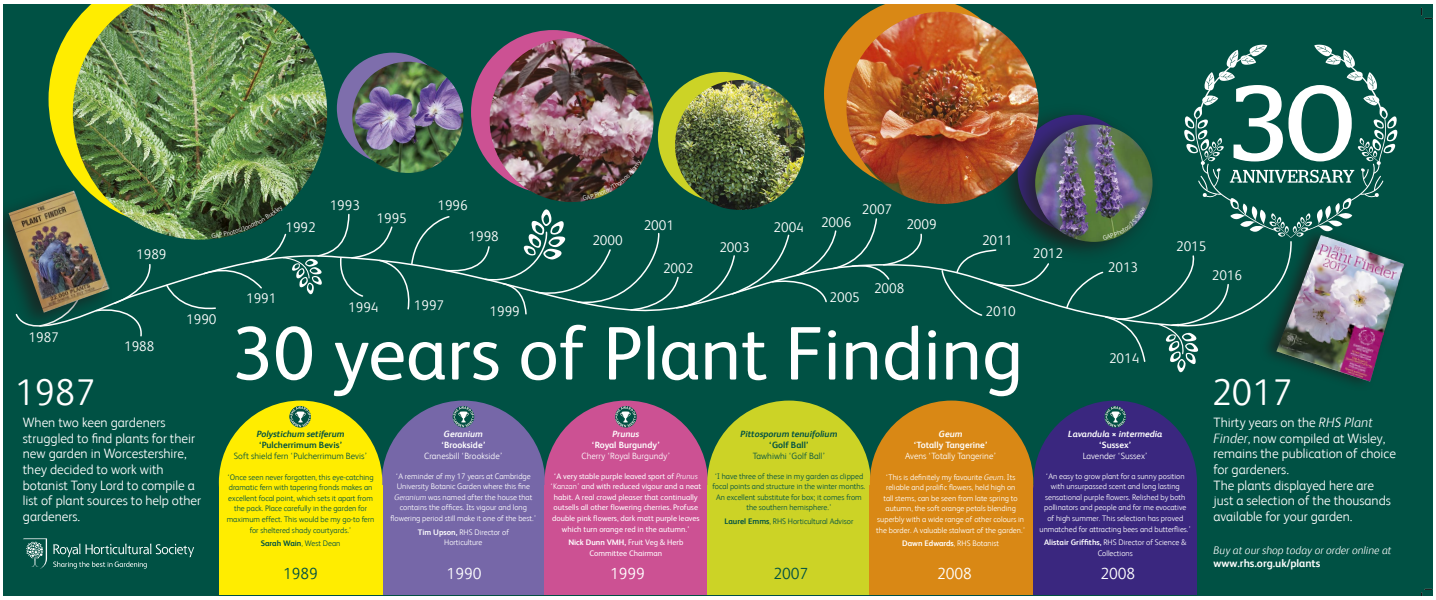
> "Our work will make a difference by fostering greater understanding of plants and gardens, training the next generation of horticultural scientists, enabling more people to benefit themselves and their communities through gardening, inspiring young people to garden, and providing evidence for effective policy-making."
> RHS Science Strategy 2015–2019

Inspiring and informing

RHS Plant Finder celebrates its 30th anniversary edition

Over three decades, first in book form and now also online, *RHS Plant Finder* has provided a snapshot of British garden plants and has been instrumental in connecting gardeners with nurseries and plant breeders. As well as providing an important resource for home and professional gardeners alike, it promotes stability in plant names, and is a major support for the UK nursery trade. This year saw the publication of a special 30th anniversary edition of the book, which included a new colour section with a history of *Plant Finder*, contributions from plantspeople, nursery owners and notable horticulturists, and an explanation of the book's importance for gardeners and the UK horticultural trade.

Right. **Celebrations of *Plant Finder*'s contribution to gardening included a special garden and display** (below) **at RHS Garden Wisley, featuring notable plants from the last 30 years.**



The RHS supported 10 PhD students during 2017, working on the following:

- Removing the barriers to retrofitting of "green walls" in an urban domestic setting (University of Reading)
- Garden plants within a changing landscape (University of Sheffield)
- Understanding the fate of soil carbon addition from sustainable sources to horticultural systems (University of Reading)
- Can we use soil microbes to help produce novel, sustainable growing media? (Royal Holloway College)
- Gardening tools for an ageing population (University of Coventry)
- Towards a monograph of *Narcissus*: problems and challenges in section *Pseudonarcissus* (University of Reading)
- The accumulation of regional diversity in the Anthropocene: insects on plants (University of York)
- Pathogen-induced changes in plant–insect interactions in the genus *Solanum* (University of Cambridge)
- Do front garden landscapes influence wellbeing? (University of Sheffield)
- Investigating the impact of plants on indoor air quality: a multi-scale cross-disciplinary approach (University of Reading)

Training the next generation of horticultural scientists

RHS and University of Reading PhD student Sarah Duddigan has now submitted her thesis on how gardeners can manage their soils to balance a fantastic garden with contributing to mitigating climate change, and has accepted a post-doctoral position at the University of Reading. Sarah's research involved extensive use of citizen science methods, with gardeners all over the UK burying tea bags in their gardens for three months and then sending them back to her for analysis in order to better understand decomposition rates following additions of organic matter. Sarah has been incredibly active in keeping her citizen scientists updated and engaged through her blog, social media and website and has travelled across the country engaging with gardeners, scientists and students about her work using the Tea Bag Index approach, which she pioneered in the UK.

We are delighted to announce that Dr Gracie Barrett completed her fellowship at the RHS and has gone on to a brand new role as Technical Manager – Trials and Lab at Walberton and Binsted Nurseries LLP. Gracie has taken the skills learnt in her time at the RHS into the horticultural industry – exactly what the fellowship was designed to do.

Top left. **PhD student Sarah Duddigan in Oxford, during a science outreach event where female scientists took to their soapboxes in 13 cities across England, Scotland and Wales.** Middle. **Using a "pooter" to extract invertebrates from soil.** Left. **Dr Gracie Barrett's research into different growing media blends and how they retain and release nutrients will be particularly useful for growing media manufacturers and nurseries.**

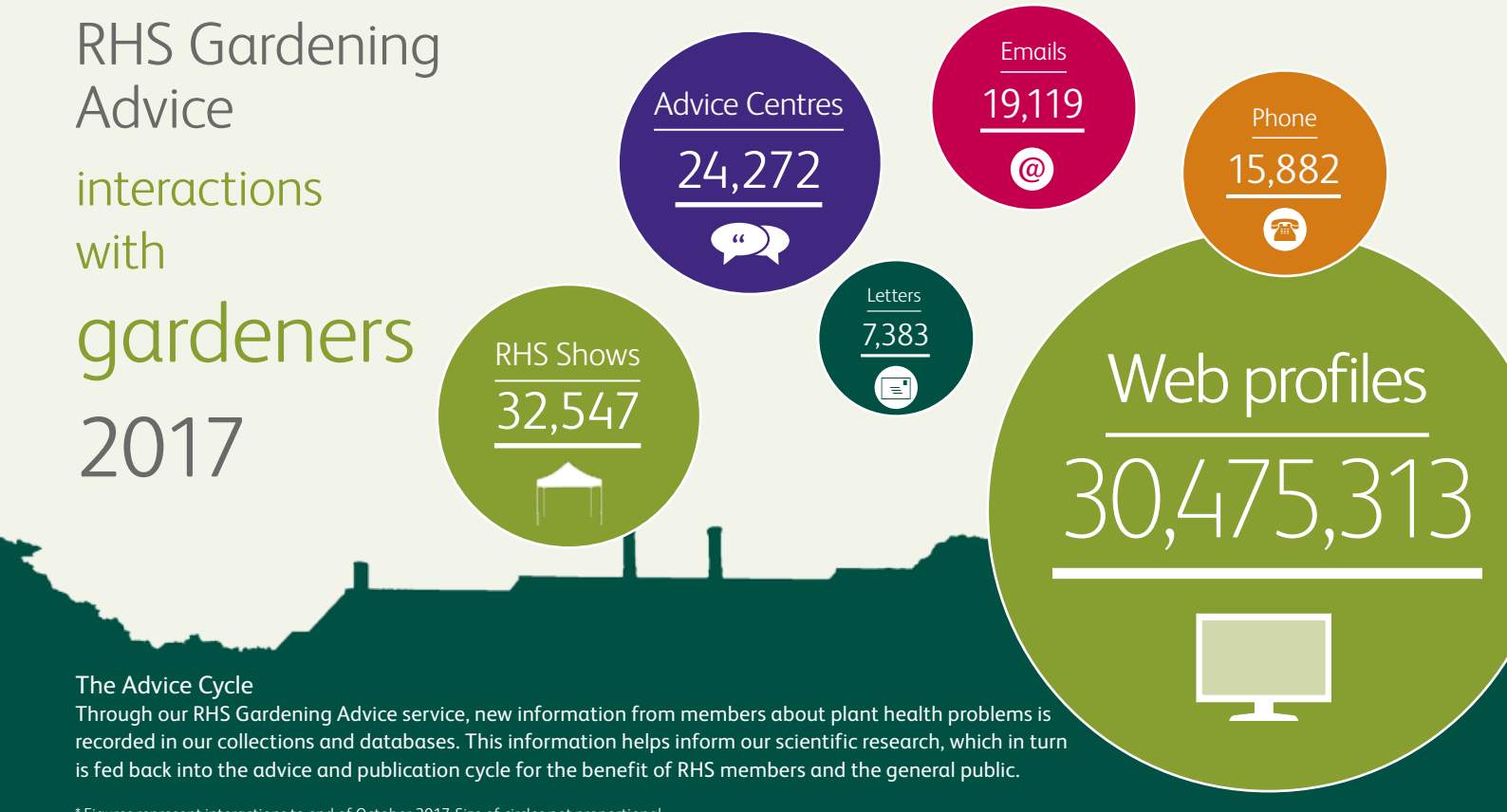
Providing excellent advice

RHS Gardening Advice has now launched its first-ever regular face-to-face Gardening Advice service (left) at RHS Garden Harlow Carr. The service is a joint venture between RHS Science and Harlow Carr's Curatorial team, and has been growing steadily as local members become more aware of it.

"The combination of a growing membership, excellent gardening weather, more advisors available at RHS Flower Shows and the raising of our profile has made for a challenging but satisfying year."

Principal Horticultural Advisor Leigh Hunt

RHS Gardening Advice interactions with gardeners 2017



The Advice Cycle

Through our RHS Gardening Advice service, new information from members about plant health problems is recorded in our collections and databases. This information helps inform our scientific research, which in turn is fed back into the advice and publication cycle for the benefit of RHS members and the general public.

* Figures represent interactions to end of October 2017. Size of circles not proportional.

Selected recent RHS Science publications

Plant Health

♦ **Drakulic, J., Gorton, C., Pérez-Sierra, A.M., Clover, G.R.G. & Beal, L.** (2017). Associations between *Armillaria* species and host plants in UK gardens. *Plant Disease* **101**: 1903–1909.

♦ **McLaughlin, M.S., Lockhart, B., Jordan, R.L., Denton, G. & Mollov, D.S.** (2017). Complete nucleotide sequence of *Clematis chlorotic mottle virus*, a new member of the family *Tombusviridae*. *Archives of Virology* **162**: 1373–1379.

♦ **Robinson, R.J., Könyves, K. & Scrace, J.** (2017). First record of the fungus *Blumeriella kerriae* in the UK. *New Disease Reports* **35**: 34.

♦ **Salisbury, A., Al-Beidh, S., Armitage, J., Bird, S., Bostock, H., Platoni, A., Tatchell, M., Thompson, K. & Perry, J.** (2017a). Enhancing gardens as habitats for plant-associated invertebrates: should we plant native or exotic species? *Biodiversity and Conservation* **26**: 2657–2673.

♦ **Salisbury, A. & Malumphy, C.** (2017b). Changes in status and distribution of hydrangea scale, *Pulvinaria hydrangeae* (*Hemiptera*: *Coccidae*) in Britain. *British Journal of Entomology and Natural History* **30**: 145–153.

Rosalyn Marshall joined the RHS in 2015 as an intern to learn the processes and skills associated with writing and publishing plant monographs. She co-authored *Hedera: the complete guide* in 2017, and is now working on *Wisteria*, the next monograph in the series.

The second Plants for Bugs project paper (Salisbury *et al.*, 2017a) dealt with plant-associated invertebrates in gardens, such as the springtail (*Dicyrtomina* sp.) above.

♦ **Wibowo, A., Siddharthan, A., Anderson, H., Robinson, A., Sharma, N., Bostock, H., Salisbury, A., Comont, R. and Wal., R.** (2017) Bumblebee-friendly planting recommendations with citizen science data. Workshop on Recommender Systems for Citizens at ACM RecSys. Como: Italy.

Horticultural Information & Advice

♦ **Armitage, J., Cubey, J., Edwards, D., Könyves, K., Lancaster, N., Marshall, R.** (2017). *RHS Plant Finder 2017.* 31st edn. London: RHS.

♦ Gardening in a Changing Climate – a guide for gardeners. London: RHS.

♦ Plants for Bugs Bulletin 2: gardens as habitats for plant-dwelling invertebrates – a guide for gardeners. London: RHS.

Horticultural Taxonomy

♦ **David, J.C.** (2017). Evolution of the species of *Narcissus*: a review. *The Daffodil Journal* **53**(3): 4–25.

♦ **Harvey, Y. & David, J.C.** (2017). Revisiting the UK's 'Wilson 50' Kurume azaleas. *Rhododendrons, Camellias & Magnolias* **68**: 126–139.

♦ **Leslie, A.C.** (2017). *International Dianthus Register and Checklist 2016*. London: RHS.

♦ **Marshall, R. & Armitage, J.D.** (2017). A summary of hybrids detected in the genus *Hedera* L. with the provision of three new names. *New Journal of Botany* **7**(1): 2–8.

♦ **McAllister, H. & Marshall, R.** (2017). *Hedera: the complete guide*. London: RHS.

♦ **Shaw, J.M.H.** (2017). *Sander's List of Orchid Hybrids*: 3-year addendum, 2014–2016. London: RHS.

Horticultural & Environmental Science

♦ **Alexander, P.** (2016). Managing soils using organic matter. *The Organic Grower* **37**: 16–18.

♦ **Alexander, P., Stuart, J.H.C. & Bragg, N.C.** (2017). Informed decision making: a tool to aid the decision making process of sourcing responsible growing media throughout the UK supply chain. *Acta Horticulturae* **1168**: 93–100.

♦ **Blanuša, T., Hadley, J., Hunt, L., Alexander, P. & Hobbs, K.** (in press). Provision of ecosystem services by urban hedges: focus on rainfall mitigation. *Acta Hort*.

♦ **Shippen, J., Alexander, P. & May, B.** (in press). A novel biomechanical analysis of horticultural digging. *HortTechnology*.

♦ **Vaz Monteiro, M., Blanuša, T., Verhoef, A., Richardson, M., Hadley, P. & Cameron, R.W.F.** (2017). Functional green roofs: importance of plant choice in maximising summertime cooling and substrate insulation potential. *Energy and Buildings* **141**: 56–68.

♦ **Webster, E., Cameron, R.W.F. & Culham, A.** (2017). Gardening in a Changing Climate. London: RHS.

RHS Principal Horticultural Scientist Dr Tijana Blanuša has co-authored papers on green roofs and ecosystem services this year.

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Royal Horticultural Society, RHS Garden Wisley, Woking, Surrey GU23 6QB
Email: science@rhs.org.uk Registered charity no. 222879 / SC038262