Ancient rice paddies and reconstructed forests at Nakanishi-Akitsu, Nara Prefecture, Japan,
(Courtesy of Okada Ken'ichi and the Kashihara Archaeological Institute)

農業学の過去、現在、未来
新しい日英共同研究の実現に向けて

Exploring the past, present and future of the science of agriculture: towards new Anglo-Japanese research collaborations

国立科学博物館
National Museum of Nature and Science

2017 年 5 月 30 日
30 May 2017

UEA University of East Anglia
Centre 日本学センター for Japanese Studies
The Great Britain SASAKAWA FOUNDATION グレートブリテン・ササカワ財団
NARA CULTURAL PROPERTIES RESEARCH INSTITUTE
JSPS

Exploring the past, present and future of the science of agriculture: towards new Anglo-Japanese research collaborations

13:00 – 17:00
Tuesday 30 May 2017

National Museum of Nature and Science, Ueno Park, Tokyo

Organised by the Centre for Japanese Studies at the University of East Anglia in conjunction with the Nara National Research Institute for Cultural Properties, supported by the Great Britain Sasakawa Foundation and endorsed by the Japan Society for the Promotion of Science

Programme

13:00: Doors open

13:10: **Welcome and Introduction**
Professor Philip Gilmartin, Executive Dean, Faculty of Science, University of East Anglia

13:20: *Keynote lecture*: **Science in a 'post-truth' world**
Professor David Richardson, Vice-Chancellor and President, University of East Anglia

Part 1: Past agricultural practices and archaeology in Japan

13:45: **Revisiting the 'Agricultural Revolution': archaeology, heritage and farming**
Dr Simon Kaner, Director, Centre for Japanese Studies, University of East Anglia, and Head, Centre for Archaeology and Heritage, Sainsbury Institute for the Study of Japanese Arts and Cultures

14:15: **Recent challenges revealing the diversity of plant use in prehistoric East Asia**
Dr Shinya Shoda, Senior Researcher, Nara National Institute for Cultural Properties

Part 2: Current issues in plant health

14:45: **Harnessing the plant's immune system to improve food security**
Professor Cyril Zipfel, Head, Sainsbury Laboratory, Norwich Research Park

15:15: **Hunting the witch: fighting against *Striga* in a molecular way**
Professor Ken Shirasu, RIKEN Institute, Tokyo

Part 3: Future challenges around water relations

15:45: **Solving the dichotomy of producing enough food while protecting the environment from diffuse pollution**
Professor Kevin Hiscock, School of Environmental Sciences, University of East Anglia

16:15: **Trade-off and synergy of water-energy-food nexus for agriculture**
Professor Makoto Taniguchi, Deputy Director, Research Institute for Humanity and Nature, Kyoto

16:45: Close

Abstracts and speaker biographies

Science in a post-truth world

Professor David Richardson *d.richardson@uea.ac.uk*
Vice-Chancellor and President, University of East Anglia, Norwich

David Richardson is the 9th Vice-Chancellor of the University of East Anglia and took office in 2014, after 23 years at UEA. David was born and brought up near Newcastle-upon-Tyne, was educated at the University of Keele (BSc, Biochemistry) and the University of Birmingham (PhD, 1988) and undertook post-doctoral research at the University of Oxford 1988-91. He joined the University of East Anglia as a lecturer in 1991, became Professor of Bacterial Biochemistry in 2001, Dean of the Faculty of Science and Pro-Vice-Chancellor (Research) before being appointed Deputy Vice-Chancellor in 2012 and Vice-Chancellor in 2014.

David was awarded the Society for General Microbiology Fleming Medal in 1999 and is a recipient of the Royal Society Wolfson Research Merit Award. His research group is active in the area of bacterial bioenergetics, and his work has shed important light on the mechanism of greenhouse gas production by bacteria and the molecular basis and function of bacterial nanowires.
David is active in a range of national and regional higher education bodies. He is also a Non-Executive Director of the Norfolk & Norwich University Hospital (NNUH), Board member of New Anglia Local Enterprise Partnership, Chair of the Norwich Research Partners LLP and is the President of the Royal Norfolk Agricultural Association for the year 2016-17.

Introductory comments on the symposium *The Science of Agriculture: Past, Present and Future*

Professor Philip Gilmartin *p.gilmartin@uea.ac.uk*
Pro-Vice Chancellor, Science and International, University of East Anglia, Norwich

Philip's research is focused on adaptations of flower development that facilitate insect-mediated cross-pollination. Understanding plant reproduction is of significant relevance to agriculture, past, present and future as almost all human food, and that of the terrestrial animals that feed us, is derived from the products of pollination, either directly from seed, grain or fruit, or indirectly from the leaves, roots and stems of the plants arising from seed. Philip's research is supported by the UK Biotechnology and Biological Sciences Research Council and focuses on flower development in *Primula*. *Primula* species produce two floral morphs known as pin and thrum that cannot self-pollinate. Both types of flower have male (anther) and female (stigma) reproductive structures that are located in reciprocal positions in the two forms of flower; this arrangement facilitates the precise transfer of pollen from anther to stigma between the different flowers by insect pollinators. The Gilmartin lab recently completed the genome sequence of the European primrose (*Primula vulgaris*) and identified the cluster of genes that controls development of the two forms of flowers in this

species. A new collaboration with Professor Ryo Ohsawa at Tsukuba University and colleagues at Kyoto and Kobe Universities aims to understand the evolution and function of the genes that control development of the two types of flower in Japanese *Primula* species. Previous research collaborations in Japan include projects on light-regulated gene expression and on flower development with Professor Masaki Furuya (Hitachi Advanced Research Laboratory), studies on the function of Internal Ribosome Entry Sites in plants with Professor Kazuyuki Hiratsuka (Yokohama National University), and work on plant sex chromosome microdissection with Professor Fukumi Sakai (National Institute of Agrobiological Resources). He also previously acted as research advisor at the RIKEN Institute in Wako-Shi.

Revisiting the 'Agricultural Revolution': heritage, farming, and archaeology

Dr Simon Kaner *s.kaner@uea.ac.uk*
Director of the Centre for Japanese Studies, University of East Anglia, Norwich
Head of the Centre for Archaeology and Heritage, Sainsbury Institute for the Study of Japanese Arts and Cultures.

The concept of the 'Neolithic Revolution' was proposed by the great 20th century archaeologist V. Gordon Childe. The defining feature of this 'Revolution' was the advent of farming, as humans moved from procuring their food from what was available in the natural environment, to producing their own food in farms and fields, along the way domesticating a range of animals and cultivating plants. The "Neolithic Revolution' was part of a world view informed by a particular view of history in which humankind passed through a series of stages, a kind of social evolution. Along with the Urban Revolution (which we are arguably also still experiencing, as only in the last few years do more than 50% of humanity live in cities), it represented a threshold in human history of immense impact. The Neolithic and Urban revolutions were among the most significant developments in the Holocene, paving the way for the unprecedented scale of impact humankind now has on the planet, impact that has given rise to the concept of the Anthropocene.

The humans of the Anthropocene have at their disposal potentially the best understanding of how we reached this point. Our self-awareness is supported by an immense body of data upon which we should be able to predict, to an extent, the outcomes of decisions we take today that will influence our future. And yet in many parts of the world, as the bulk of humanity becomes increasingly removed from the process of food production and processing, there is less and less widespread knowledge about and awareness of agriculture: issues which contribute to concerns about the future of food and farming.

This paper is informed by discussions around two collaborative research projects with which I am involved with Japanese colleagues: the 'Small Scale Economies' project that ran at the Research Institute for Humanity and Nature in Kyoto directed by Professor Junko Habu, and of which I was a member, and a conference on the 'Origins of Agriculture' at Ritsumeikan University in 2012.

Through these I will consider how agriculture itself is a critical aspect of human heritage, how archaeology reveals the ways in which we are 'Homo agriculturalist', and why there is a need to protect traditional agricultural landscapes (some now defined by UNESCO as Globally Important Agricultural Heritage Systems). I will close with a consideration of the resilience of agricultural systems when confronted by catastrophic events, drawing on the emerging field of Disaster Archaeology.

Biography
Simon is an archaeologist specialising in the prehistory of Japan and has a PhD from Cambridge University. A Fellow of the Society of Antiquaries of London since 2005, he has taught and published on many aspects of East Asian and European archaeology. He has undertaken archaeological research in Japan, the UK and elsewhere and worked for several years in archaeological heritage management in the UK. His recent publications include *An Illustrated Companion to Japanese Archaeology* (edited, with Werner Steinhaus) (Oxford, Archaeopress, 2016) and he is currently editing the *Oxford Handbook of the Archaeology of Korea and Japan*. Simon is Research Fellow in the Japanese Section, Department of Asia, The British Museum, and Fellow of the McDonald Institute for Archaeological Research at the University of Cambridge. He is Co-Editor of the *Japanese Journal of Archaeology.*

Recent challenges revealing the diversity of plant use in prehistoric East Asia

Dr Shinya Shoda *shinya.shoda@york.ac.uk*
Senior Researcher, Nara National Institute for Cultural Properties
Research Associate, BioArCh, University of York
Academic Associate, Sainsbury Institute for the Study of Japanese Arts and Cultures

This lecture aims to summarize recent achievement of archaeobotanical research in Japan and surrounding area, such as China, Far East Russia and the Korean Peninsula, especially considering the topics related to the studies on prehistoric agriculture including some case studies by the speaker. It has been long time since archaeologists first advocated "Jomon agriculture" in prehistoric Japan as early as in the 19th century based on the study of stone tools. However, still consensus on what actually the "Jomon agriculture" should mean, or, if there would have been any kinds agriculture at all, is still under developing. On the other hand, recent studies using new methodologies such as water flotation sampling, pottery impression replication method, microscopic wood anatomy, pollen and starch grain analysis, use-wear analysis of stone tools, direct AMS dating of plant materials, as well as organic residue analysis of pottery, has started to shed new light on prehistoric cultivation or even food production in Japan and neighbouring areas. In other words, archaeology is increasingly becoming multidisciplinary and the field called archaeological science is getting more and more importance in the study of the human past. Usually, Jomon population is regarded as "hunter-gatherers" but new studies keep providing various evidence for their sophisticated natural resource management other

than sorely hunting and gathering available foods around them. For instance, there are surely some domesticated species in the Jomon period such as lacquer tree and hemp from much earlier than in the continent, as well as potentially domesticated plants such as barnyard millet and chestnuts that show typical enlargement of grain size for domestication syndrome, corresponding to the development of settlements and sedentism. In Japan, food production represented by paddy field rice cropping, which provides staple food for today's Japan and other East Asian countries, had adopted notably later than many other part of the world, followed by immediate adoption and diffusion as total cultural assemblage. This uniqueness is providing good opportunities for Anglo-Japanese collaborative research including some ongoing project by ourselves until today, and from now on. Also we need to extend the research focus onto the Korean Peninsula and beyond, to understand uniqueness of prehistoric plant use in Japan in wider context.

This paper is inspired by and based on my previous Anglo-Japanese collaborative project PONTE: - POttery iNnovation and Transition in East Asia: bridging expertise across continents founded by Marie Curie Fellowship (2014-2016) and a new project EXPRESSO: EXploring PotteRy usE acroSS the JOmon-Yayoi transition, funded by JSPS (2017-2020), which has just started in this April. Taking these examples, the speaker stresses the importance of international and interdisciplinary collaboration not only for better understanding of agriculture in the past, but also for providing historical background to think about agricultural practices today and in the future in global scale.

Biography
Shinya is an archaeologist and is Senior Researcher at the Nara National Research Institute for Cultural Properties. From 2014-16 he was Marie Curie Incoming Fellow in BioArch in the Department of Archaeology at the University of York. He is working on a variety of topics but his main interests include redating the beginning of agriculture and metallurgy in northeast Asia, pottery, metal and lithic technology, and innovations in diet and cooking technology. He completed his Ph.D at Chungnam University in Korea in 2007 after his BA, MA and first stages of Ph.D in the Department of Archaeology at the University of Tokyo. While he is engaged in international collaborative projects that further cultural comparative research on northeast Asia and more recently northwest Europe, he also collaborates with a number of natural scientists to develop archaeological scientific studies on northeast Asia.

Solving the dichotomy of producing enough food while protecting the environment from diffuse pollution
Professor Kevin Hiscock *k.hiscock@uea.ac.uk*
Head, School of Environmental Sciences, University of East Anglia, Norwich

The intensification of land use and climate change seriously threaten the sustainability of global water resources. The widespread use of pesticides and fertilisers in agriculture to control plant growth and improve crop yields has

been instrumental in enhancing global agricultural productivity since the mid-20th century but at significant economic cost associated with removing chemicals from drinking water and environmental damage. Nearly always "prevention is better than cure" in reducing environmental impacts such as eutrophication of freshwaters, and worldwide there has been the adoption of more holistic, integrated approaches to managing land and water resources for economic and societal benefits. In this presentation, research conducted at UEA as part of the nationally-funded Demonstration Test Catchments Programme is shown to support this approach. In the Wensum catchment, an area of intensive arable farming in East Anglia, a range of farming options and cultivation methods have been trialled with the aim of reducing diffuse pollution from agricultural runoff while maintaining a viable farm economy. Techniques have included reduced cultivation techniques, planting of cover crops during the winter fallow period, and the installation of an on-farm biobed and a set of sediment traps. Progress in reducing nitrogen and phosphorus contamination and pesticide runoff has been demonstrated with the installation of advanced high-frequency monitoring of stream water and groundwater quality. Issues of pollution 'swapping' are also apparent as demonstrated by a study of the emissions of the greenhouse gas nitrous oxide associated with nitrate reduction in soil water. Overall the project has been a success in demonstrating that with the right blend of incentivisation and regulation, influencing farmer behaviour can be part of an adaptive management approach to protecting and increasing catchment ecosystem services.

Biography
Kevin Hiscock is Professor and Head of School of Environmental Sciences at the University of East Anglia. Following a first degree in Environmental Sciences at UEA, Kevin joined the School of Earth Sciences at the University of Birmingham as a PhD student and then Research Fellow during which time he studied the hydrochemistry and influence of past climate change on groundwater conditions in the Chalk aquifer of Eastern England. Upon returning to UEA in 1989 as a lecturer, Kevin developed applications in stable isotope chemistry to further understand the hydrogeology of aquifer systems both in the UK and overseas, giving particular emphasis to the fate of nitrate contamination of aquifers. In the last six years, Kevin has been part of a multi-partner project investigating how contamination of surface water and groundwater from agricultural runoff can be mitigated by improved farm management practices.

Trade-off and synergy of water-energy-food nexus for agriculture
Professor Makoto Taniguchi *makoto@chikyu.ac.jp*
Deputy Director, Research Institute for Humanity and Nature, Kyoto, Japan

Water, energy, and food are the most fundamental and essential resources for human being, sustainable society, and global sustainability. Those are complexly and inextricably linked, and there are synergies and tradeoffs among three resources. It becomes more attentions when it comes to Water-Energy-Food Nexus. Lack of the integrated research as a nexus and policy implementation is

the most concerned, in particular for agriculture which is a nexus of food production/transportation/ consumption, water consumption/transportation, and energy consumption/production. Water-energy-food nexus and security in Asia-Pacific region has been analyzed based on the national scale in terms of self-sufficiency and diversity of resources use. The relationship between water-energy-food nexus and urbanization has been also analyzed. The nexus model for integrated policy decision of the nexus has been made, and several scenarios based on national trade policy including food self-sufficiency has been applied to the nexus model in Japan to evaluate how much water, energy, carbon emission will be changed. Case study in Pajaro Valley in California, US, on the nexus of agriculture, shows the two orders difference of economic profit from unit water through each food production. Another case study in Beppu, Oita Prefecture, Japan, on hot spring wasted water after water uses for hot spring power generation showed the impacts on ecosystem and food (fishery) in the rivers, making water-energy-food nexus as food (fishery) in ecosystem. Among the various water-energy-food nexus, different type of nexus exists such as tradeoff, interaction, and synergy, depending on the change in quantity and quality of resources, with difference of environment impacts. Top-down indices (e.g. water/energy footprints) should meet bottom-up local context (value, culture etc.) to make sense and be applicable for sustainability.

Biography
Makoto Taniguchi is Deputy Director-General of Research Institute for Humanity and Nature, President of Japanese Association of Groundwater Hydrology, and Vice President of International Association of Hydrogeologists. He edited the books "*Land and Marine Hydrogeology* (Elsevier)", "*Groundwater and subsurface environment* (Springer)", "*The Dilemma of Boundaries* (Springer), and "*Groundwater as a key for adaptation to the changing climate and society* (Springer)". His recent publications include Taniguchi, M., Masuhara, N., Burnett, K. (2015): Water, energy, and food security in the Asia Pacific region. Journal of Hydrology: Regional Studies. DOI:10.1016/j.ejrh.2015.11.005 and 谷口真人 (2016)大槌発 未来へのグランドデザイン―震災復興と地域の自然・文化」昭和堂、249pp.

Harnessing the plant's immune system to improve food security
Professor Cyril Zipfel *cyril.zipfel@sainsbury-laboratory.ac.uk*
Head of the Sainsbury Laboratory, Norwich Research Park Norwich, NR4 7UH, UK

The ever-growing world population requires a sustained ability to produce food despite a reduction in the overall available arable land. Pests and pathogens impose major crop losses, and as such represent major threats to food security worldwide. Climate change and international trading further increase the spread and emergence of plant diseases caused by these pests and pathogens. Crop diseases are typically controlled through chemical treatments or breeding. Effective fungicides and pesticides are becoming scare due to the evolution of resistance to these chemicals in pathogen/pest populations, and/or their regulatory ban justified by health and

environmental concerns linked to their extensive use in agriculture. Thus, novel methods of plant disease control are required. The field of molecular plant-microbe interactions has made tremendous progress in the past two decades in our understanding of the major concepts and mechanisms underlying the interaction of plants with their biotic environment. This, coupled with novel technologies, which ease the identification and engineering of host components, offer unique opportunities to engineer the plants' own immune system to improve its innate ability to resist pests and pathogens. This approach is part of an integrated scientific programme at The Sainsbury Laboratory, referred to as TSL$^+$, which involves partnerships with industrial partners and non-for-profit foundations. In the medium-to-long term, the TSL$^+$ programme will help delivering durable disease resistance in the field required for the sustainable intensification of agriculture, and thus help achieving food security.

Biography

Cyril's group studies the molecular basis of plant innate immunity. His group aims at deciphering the signaling events linking perception of pathogen-associated molecular patterns (PAMPs) to the establishment of immunity. We use the leucine-rich repeats receptor kinases EFR and FLS2, which perceive bacterial EF-Tu and flagellin, respectively, as model pattern recognition receptors (PRRs). The work of his group also aims at understanding how plant receptor kinases work at the molecular level and how signaling specificity is achieved between different receptor kinase-mediated signaling pathways involved in immunity and growth. It is also exploring how outcomes of our research can be used to engineer sustainable broad-spectrum disease resistance in crops.

Parasitic weeds as clear and present danger for food security

Professor Ken Shirasu *ken.shirasu@riken.jp*
Department of Biological Sciences, Graduate School of Sciences, University of Tokyo

The parasitic plant *Striga*, also known as witchweed, is serious agricultural threats in Africa. *Striga* belongs to the Orobanchaceae family, and the parasitic plants in this family all form a special organ, called haustorium, on their root to connect to host plant roots. Through this connection the parasitic plants obtain water and nutrient from host plants. To understand of the parasitism, we initiated large-scale genome and transcriptome analyses of *S. hermonthica* and its close relative *S. asiatica*. We have also developed a model system to understand the parasitism using the hemiparasite *Phtheirospermum japonicum* a Japanese native Orobanchaceae plant. *P. japonicum* can be easily grown in the lab and is amenable for various genetic analyses, such as crossing, mapping and transformation. The transcriptome analysis has provided a list of genes that are specifically expressed during infection and genes that are horizontal transferred from a host. Our genome and transcriptome data provide important resources

towards complete understanding molecular and evolutional aspects of plant parasitism.

Biography

Ken Shirasu graduated from the Department of Agricultural Chemistry of the University of Tokyo in 1988, and was awarded his PhD in genetics at the University of California, Davis, USA, in 1993. His thesis focused on molecular characterization of virulence factors of the plant pathogen *Agrobacterium*. He continued research as a Salk-Noble postdoctoral fellow at the laboratories of the Salk Institute and the Noble Foundation, USA, where he started to study plant immunity. In 1996, he joined the Sainsbury Laboratory, UK, as a researcher, and in 2000 became a group leader in the laboratory. He then joined RIKEN as a Group Director in 2005, and since 2008 has also held a position of adjunct professor in the Department of Biological Sciences, the University of Tokyo. In 2011 he received a Kihara Memorial Foundation Award for his research on plant immunity.