

HOW POLLINATION ECOLOGY RESEARCH CAN HELP ANSWER IMPORTANT QUESTIONS

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Abstract—Pollination Ecology is a dynamic field of scientific research constantly adopting novel methods and making progress in understanding the interactions between plants and their pollinators. A recent paper listed the main scientific questions in this field focussing on the ecological and biological system itself. Here, we follow up on that paper and present some ideas on how to broaden our perspective and explore the role that pollination research can play in answering both ecological and societal questions relevant to a range of different stakeholders. We hope this paper may be useful to researchers aiming at improving both the scientific and societal impact of their research.

Keywords: Conservation, ecosystem services, society, research impact, stakeholder involvement

INTRODUCTION

A recent paper by Carolin Mayer and co-authors (Mayer et al. 2011) presents a list of 86 questions that were generated by researchers in the broad field of pollination ecology and aim to inspire new ideas in research in that field. This impressive effort, to which many leaders in the field of research contributed, will surely form the basis for future research. It introduces many important topics and reads like a crash course in pollination research and as such could also be the first port of call for any novice in the field.

In addition, the authors state that they hope the paper will contribute to raising awareness of pollination-related topics including those of interest to policy-makers, funding agencies and the wider public. The potential impact of the paper in that respect is, however, not so clear, because the questions have all been generated and organized by pollination ecology academics. They, undoubtedly, have an excellent overview of the major gaps in scientific knowledge and the technological challenges and opportunities of research, but they might have a limited view of the needs of and challenges in society at large. The priority of core research areas identified by the natural science research community is not necessary equivalent to the priorities that would be identified by other relevant partners reflecting different group of stakeholders that may have interest in pollination topics. This does not mean that the priorities of natural science researchers are not important, but it cannot stand alone for strategic decision making of future research activities. A question can be important for natural science to serve several objectives: (1) as scientifically interesting question to fill up critical

knowledge gaps before more complete understanding is achieved.; (2) for the society (delivery of different ecosystem services). Obviously, it is not possible to claim one objective as more valid than others as it will depend on the context. But it is important to be aware of the specific objectives that are in play before the “importance” of a question is considered.

In this contribution, we will present a simple framework integrating ecological, societal and socio-ecological issues relevant to pollinators and pollination and outline a pathway to come to a ‘whole-society’ list of key questions for future research in the field of pollination ecology. The former allows us to identify the main society stakeholders that might use our scientific outputs, the latter allows the stakeholders, other than scientific researchers, to be involved in the process and identify their major issues. Both aspects are important, in addition to the researchers’ perspective presented by Mayer et al. (2011), to provide research on pollinators and pollination with the broad scientific and societal audience and impact it deserves.

THE DIFFERENT TYPES OF QUESTIONS

Of the 86 questions in the Mayer et al. (2011) paper, some address the intricate mechanisms and evolutionary processes of pollination, such as “What is the lifespan of pollen grains” or “Why does floral deception evolve?”. Other questions, however, address largely societal issues such as “How can we better employ plants and their pollinators as educational tools for public awareness?” or “How can we ensure adequate prioritization, sufficient action and implementation [of conservation]?”. Whereas natural scientists are trained to tackle the first set of questions, expertise in policy, education, social sciences and law, among other disciplines, is needed to deal with the latter set of questions.

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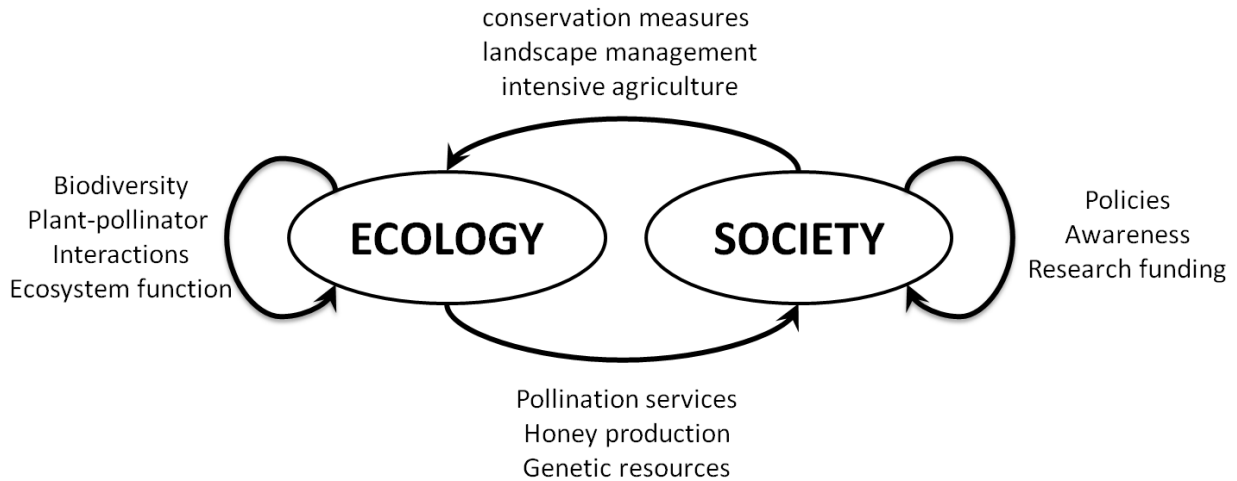


FIGURE 1. Schematic representation of the pollinator-relevant issues in natural systems (ECOLOGY) in society and linking both.

If we take a little step back we can see that there are in fact four major fields that these questions can address (Fig. 1; note that some questions might address more than one field at the same time), namely:

(1) Questions dealing with the workings of nature, including ecology, evolution and behaviour; in Fig. 1 referred to as “ECOLOGY”.

(2) Questions on how ecosystems and biodiversity provide human society with goods and services, including crop pollination, honey production and genetic resources of managed pollinators. (ECOLOGY → SOCIETY)

(3) Questions dealing with societal issues in which pollinators and pollination play a role, including policies such as the convention of biological diversity, Natura 2000, habitat directive, but also funding for research, knowledge transfer and raising awareness of the general public. (SOCIETY)

(4) Questions on how societal actions affect pollinators and pollination. These include questions related with impact of land management and intensification of agriculture (e.g. pesticide & nutrient use; habitat fragmentation), but also the impact of conservation measures. (SOCIETY → ECOLOGY)

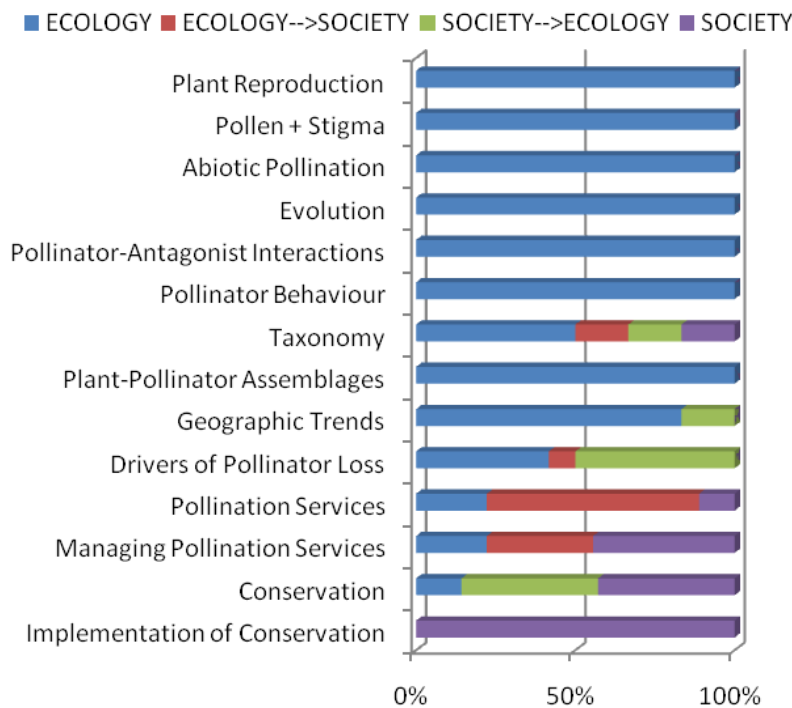


FIGURE 2. Mapping of the 86 questions and research areas from Mayer et al. (2011) onto the four topic categories identified in Fig. 1. Questions may address more than 1 topic. The number of questions per research area is given in brackets.

Natural Scientists are best placed to address the ECOLOGY questions, but might also be more inclined to ask such questions. Indeed, 77% (66 of 86) of the questions reported by Mayer et al. 2011 are ECOLOGY questions and 58 of these questions only address the ECOLOGY area and do not have any direct link to SOCIETY. The questions posed by natural scientists addressing exclusively one of the other realms (SOCIETY: 9 questions, SOCIETY → ECOLOGY: 4, ECOLOGY → SOCIETY: 4), had to do with knowledge transfer and implementation of findings and policies and were, therefore derived from issues directly related to their research.

GENERALITY VERSUS SPECIFICITY OF QUESTIONS

Any question tends to be addressed at a specific level of aggregation (specificity). The level addressed by the Mayer et al. (2011) questions is highly variable, with some addressing broad global issues, whereas others concern a very specific relationship or phenomenon. In addition, some broad questions might need answers to many more detailed questions before we can address it (Fig. 3). Some of these more detailed questions might be in the list, but others are probably not. For example, the answer to question 80 (“What essential modifications in land use management and practices are needed to halt

and reverse plant and pollinator declines?”) requires answers to several other questions, including Q59: “Which pollinator taxa and functional groups are in decline?” and Q62: “What is the relative importance of the various drivers of pollinator decline?”), but also to questions that were not identified by the Mayer team (Figure 3). Any question can be subdivided into a set of more detailed ones. However, if not all detailed questions are asked and the ones that are identified are themselves heterogeneous in their specificity then the whole set of questions is potentially biased and incomplete. If we aim at generating a complete set of balanced questions to guide research activities (which is not equivalent to the aim of Mayer et al. 2011) then understanding the relationships between the questions is very important and might help to identify gaps (“recognized ignorance”; Walker et al. 2003). A quick scan of the Mayer et al (2011) questions suggests that the ecology questions address global issues, but overall overpopulate the more detailed level. This is a natural consequence of the fact that it is natural scientists that have been asked to deliver the questions. They can be more specific in their own scientific field of competence (ecology), but are restricted to more broad levels in areas of less competence including social sciences. If the same exercise was performed including the social science community then more detailed society related questions would have been considered.

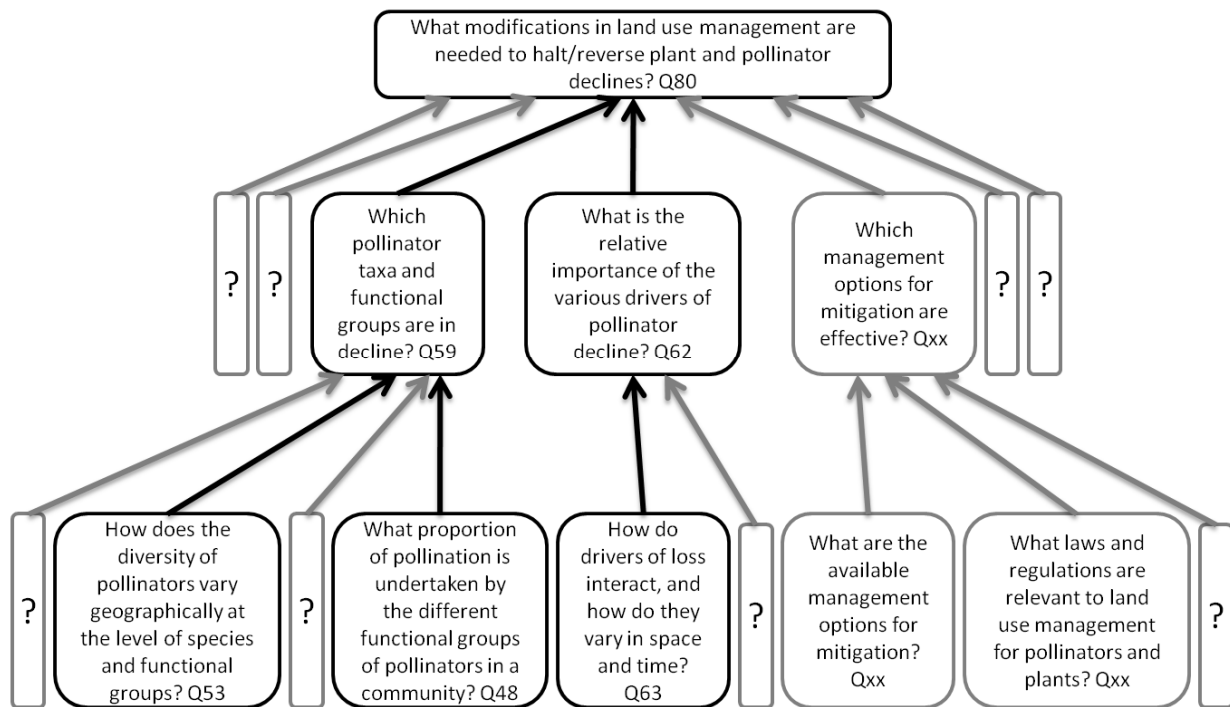


FIGURE 3. Illustration of the possible relationships and hierarchy of some of the questions presented in Mayer et al 2011 (highlighted in black) and others identified by us (in grey). The broad question (Q 80 at the top) needs input from many different areas some already listed by Mayer et al. 2011 (Q48, Q53, Q59, Q62, Q63), some identified by us (Qxx), some not yet identified (boxes with question marks).

QUESTIONS FROM OTHER STAKEHOLDERS: WHY ARE THEY IMPORTANT?

Policy makers, Conservation managers, Farmers, School teachers and Research funders, some of the other main stakeholders in the SOCIETY compartment, might ask very different questions with relevance to the ecology of pollinators and pollination. Policy makers might raise issues related to the need, for example, of good indicators of environmental change (presence of butterflies, other pollinators or level of seed set in focal plants might serve this purpose in some cases). School teachers might use pollination as an entry-point for raising awareness of broad ecological and environmental issues. Conservation managers might need answers about the biology of some focal species in need of protection (nesting or food plant requirements of declining species of bees, pollination requirements of rare plants).

Similarly, farmers might need answers to questions such as “how can I integrate pollinator management into current management?”, “what is the best way to enhance pollinator populations in my crop?”, “is there any spill-over (pollinators, pests, natural enemies) from natural habitats to my crop?” or “what is the cost-benefit analysis of different pollinator management measures?”. Beekeepers might need to know “how do habitat management regimes affect honey production and honeybee health?”, “do wild pollinators transmit disease to honeybees?” or “are honeybees important for pollination of wild plants?”. All these questions address aspects of pollination ecology and require scientific research to improve our understanding and underpin policy and management decisions. Yet few of these and similar questions have come up in the questions generated by the pollination ecologists (Mayer et al. 2011).

Societal stakeholders can consider a question as “important” if it either (1) is addressing a problem that is considered as directly important by SOCIETY (or at least for one stakeholder group); (2) provides an answer to a question that is considered indirectly important as input to a broader question important to SOCIETY. E.g. the question (A) “What is the crop yield benefit of insect pollination” can be considered as important by SOCIETY because it is addressing food production and the economical benefit of agriculture. However, another question (B) “What is the degree of wind pollination compared to insect pollination” is not necessary considered important by the SOCIETY but based on scientific considerations could be indirectly important as part of the answer to question (A). Again, understanding the relationships between questions can reveal the relevance of detailed questions to the broader ones across stakeholder interest areas.

Integrated multi-stakeholder assessment could potentially also identify important issues that are likely to become important scientific challenges in the future. Sutherland et al. (2010) have used horizon scanning techniques to identify gaps of knowledge for global

conservation issues. This approach may prepare researchers for the future need of scientific evidence in emerging areas of general concern. It could improve the immediate relevance of science, because solutions and scientific evidence can be provided at the right time when policy decisions have to be made. With respect to pollinators and pollination one such area of future concern could be the spatial shift in cropping areas resulting from climate change and the corresponding need for wild and managed crop pollinators in places where they might not be available now. Several other areas could be identified and again academics are not necessarily capable of recognizing them all.

HOW CAN WE INVOLVE OTHER STAKEHOLDERS?

If we agree that polling the opinion of other stakeholders would be useful to improve the relevance and impact of our science, we need to consider how different stakeholders can use pollination ecology research? The topics identified in Fig. 1 all relate to one or more stakeholder group. A first attempt to map stakeholder interests onto the main topics, open for improvements, is given in Tab. 1. Clearly, interests of different stakeholders do not align and each research topic has a unique stakeholder community as potential users and beneficiaries.

Next, we need to decide how to involve the other groups. Do we invite them to generate questions; do we invite them to select the most important questions from a compiled list or both? Also do we invite all members of a stakeholder group to contribute (e.g. through an internet or email poll) or just representatives (e.g. in a small meeting)? Bill Sutherland and his team have used different approaches to come up with the top 100 important questions in policy relevant UK ecology (Sutherland et al. 2008), global biological diversity (Sutherland et al. 2009) and global agriculture (Pretty et al. 2010). First (in Sutherland et al. 2008), similarly to Mayer et al. 2011, they asked academics to generate questions (in consult with their research groups) and after that the importance of the questions was determined through voting by representatives of multiple stakeholders (academics could express their preference, but did not vote). In the later exercises representatives of many stakeholder groups were asked to generate questions and representatives of the same groups were then selected to vote for the most important questions either in a workshop (Sutherland et al 2010) or through electronic voting (Pretty et al. 2010).

RELEVANCE, IMPACT AND DISSEMINATION OF POLLINATION ECOLOGY RESEARCH

Clearly, it is important and worthwhile to understand the relevance of the research activity both in terms of advancing our ecological knowledge and with respect to the supporting activities of other parties of society. Improved understanding of the relevance will facilitate dissemination toward the main stakeholders and interested parties and thereby improve the impact outside the scientific community.

	STAKEHOLDERS										
	Researchers	Conservation managers	Farmers	Horticulture	Beekeepers	Policy: national	Policy: international	NGOs	Education	General public	Planners
ECOLOGY											
Biodiversity	X	X				X	X	X	X	X	X
Plant-pollinator interactions	X		X	X	X						
Ecosystem function	X					X	X	X			X
ECOLOGY-> SOCIETY											
Pollination services	X		X	X	X	X					X
Honey production					X	X					
Genetic resources	X	X	X	X	X	X		X			X
SOCIETY											
Policies	X		X			X	X	X		X	X
Research capacity	X					X	X		X		
Awareness		X						X	X	X	
Research funding	X					X	X		X		
SOCIETY->ECOLOGY											
Conservation measures	X	X				X	X	X			X
Agricultural management	X	X				X		X			X
Land management	X	X				X		X			X

TABLE I. Putative relationships between the different topics (from Fig. 1) relevant to pollinators and pollination and the stakeholder groups that have the strongest affinity with these topics.

The main route to impact used by most of us is that of publishing papers and giving talks at scientific meetings. This is the best way to achieve researcher-to-researcher dissemination. However, as the topics we study are relevant to others we need to use additional methods for spreading the news. Here again, the questions generated by 'the others' are essential because they give us an insight into the most important questions and issues they raise and therefore provide an entry point for the dissemination of our results.

To increase the impact of pollination research on society, it is essential to consider alternative means for science communication and to make the link between researchers and stake-holders. It would be good here to mention the activities of the Xerces Society, a non-governmental organization for invertebrate conservation, and the FAO [the United Nations Food and Agricultural Organization], through their pollinator information management system. Both are developing into important partners of the pollinator research community. They do not only produce beautifully illustrated, very informative and practical instruction books, fact sheets and reports, they are also actively involved in education and outreach, advocacy and policy as well as in applied research. Many of the leading pollinator and pollination ecologists have liaised with the Xerces Society or the FAO for dissemination activities and to improve the impact of their scientific research. In this way both have become

natural partners linking research to societal stakeholders in the USA. Nationally or regionally, we often seem to lack a partner of similar status and power, although in some countries entomological societies or pollinator recording societies cover some of the same ground at a smaller scale. It might be worthwhile to explore who could take up an intermediary role like the Xerces Society, in other regions of the world, for example in Europe. It might even be the Xerces Society or the FAO, because both have a global remit (even though most activities of the Xerces Society have been USA-centred).

CONCLUDING REMARKS

The paper by Carolin Mayer and colleagues (2011) has provided an excellent first set of questions that point to major challenges for pollinators and pollination research. In this contribution, we have explored how we might go beyond the academic perspective and move towards the second goal of their paper: raising awareness of pollination-related topics including those of interest to policy-makers, funding agencies and the wider public.

We are experiencing golden times for research opportunities and media-attention is high for pollinators and pollination, and pollinators are under pressure from multiple drivers (Potts et al. 2010). Large national projects have started, e.g. the Insect Pollinator Initiative in the UK, The Canadian Pollinator Initiative CANPOLIN, North American Pollinator Protection

Campaign NAPPCC in the USA, and international research projects (International Pollinator Initiative coordinated by FAO) addressing honeybee declines (COLOSS), honeybee health and management (BeeDoc) and the patterns, drivers and impacts of change in pollinators and pollination (STEP). Together they use millions of Euros and Dollars of public funds to come up with solutions to important problems and make scientific progress in many fields. Undoubtedly, each of these projects has ideas, pathways and budgets to disseminate results and link to stakeholders. Therefore, this is an excellent chance for all of us to make an impact in science, in policy, in conservation and in raising awareness and education. With a concerted effort the impact of our research will be highest and we hope that the ideas presented in this paper can be used as part of that process.

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