Research and Innovation for biodiversity: What role for gene drive research?

29 October 2020, 15:00 - 17:00 CET

Online event

Hosted by MEP Maria da Graça Carvalho

Speakers:

- **MEP Maria da Graça Carvalho**
- **Dr. Austin Burt**, Professor of Evolutionary Genetics at Imperial College London and principal investigator of the Target Malaria consortium
- **Dr. Luke Alphey,** Professor in the emerging field of genetic pest management at The Pirbright Institute
- **Camilla Beech**, Regulatory expert specializing in novel biotechnology products, Cambea Consulting Ltd
- **Prof. Claudia Emerson**, Founding Director, Institute on Ethics & Policy for Innovation at McMaster University, and Associate Professor of Philosophy
- **Dr. Patrick Rüdelsheim,** Partner and General Manager, PERSEUS
- **Dr. Kent Redford**, Chair of IUCN Task Force on Synthetic Biology
- **Dr. John Reeder**, Director, Special Programme for Research and Training in Tropical Diseases (TDR) & Director, Department of Research for Health, World Health Organization

Welcome Remarks

MEP Maria da Graça Carvalho

"Gene drive, using a variety of genetic engineering tools, holds great potential in the field of infectious diseases, vector and pest control, poverty-related diseases and outbreak preparedness."

MEP Ms. Carvalho started her intervention by highlighting **the need to raise awareness on the issue of gene drive,** which is rather new and sometimes not well understood by different stakeholders. Afterwards, Ms. Carvalho disclosed her personal professional pathway related to gene drive issue. Ms. Carvalho continued her presentation by stating that the **EU legal framework on Genetically Modified Organisms (GMOs) is an example to the rest of world**. Even if there are still several uncertainties regarding this genetic engineering technology, Ms. Carvalho displayed the **potential benefits that gene drive could secure, for instance in the field of infectious diseases or poverty-related diseases.** Moreover, Ms. Carvalho explained that **Europe is an expert in the field of gene drive research** and has developed international partnerships notably under the framework of the European & Developing Countries Clinical Trials Partnership (EDCTP). Ms. Carvalho also underlined the **importance to align policies on the "highest ethical principles"**, and, nevertheless, stressed the need for the EU to be flexible on its legislations when evidence is backed by scientific research. Finally, Ms. Carvalho stated that well-prepared and well-informed debate at the legislative level can result in a productive and content-focus outcome.

Introduction to Gene Drive

Dr. Austin Burt, Professor of Evolutionary Genetics at Imperial College London and principal investigator of the Target Malaria consortium

"Gene drive is also a bit of a 'buzzword' for the moment, with no precise widely accepted definition (…) which is indicative of being a young and active field of research."

First of all, Dr. Burt described **gene drive as a natural phenomenon of biased inheritance that has evolved many times in different species**. According to Dr. Burt, it has more recently **turned into a process that scientists are trying to exploit in order to develop tools to address long-standing challenges in the control of disease vector or invasive species.** Moreover, Dr. Burt also explained that gene drive can be considered as a **"buzzword"** since there is no widely accepted definition yet. Nevertheless, engineered gene drives have two main features in common. First, **they are LMOs** (Living Modified Organisms), which make them fall under current case-by-case assessment regulations. Secondly, **the transmission of genes from one generation to the next is non-Mendelian**. Accordingly, Dr. Burt presented 4 different approaches of those non-Mendelian transmission (the Cytoplasmic incompatibility approach, the MEDEA approach, the Y

chromosome approach and the Homing approach). Then, Dr. Burt displayed the **diversity of gene drive under development** (e.g.: diversity of molecular mechanisms, diversity of intended effects …), which in fact **fits the variety of challenges that this technology aims to answer.** To conclude, Dr. Burt argued that the diversity of scenarios that gene drive provides, notably in term of combination, must lead to case-by-case assessment of risks and benefits, and to narrowly focused guidelines on the nearest-term possibilities.

Dr. Luke Alphey, Professor in the emerging field of genetic pest management at The Pirbright Institute

> ***"One of the key elements is that gene drive aims to introduce new heritable traits into target population."***

Dr. Alphey started his intervention by explaining that **gene drive allows to introduce new heritable trait into targeted population, with the idea to address specific species.** Then, Dr. Alphey explained that those traits can be used, firstly, to **aim for population suppression** (reduce number of population) **and, secondly, for population modification** (reduce harm cause by population). Accordingly, Dr. Alphey illustrated this point by presenting a list of potential targeted species such as rodents (mice, rats) or mosquitoes, especially due to their role in the spread of disease. The example of malaria in sub-Saharan Africa was then underlined by Dr. Alphey, claiming that gene-drive could represent a potentially promising complementary method to fight against this widespread disease. A second example presented by Dr. Alphey is the issue of rodents on island which has often led to endemic species extinction. In this case, gene drive could represent a potential solution, spreading reduced-fertility or se-ratio (male bias) gene through target population in order to eliminate those invasive species from the island.

Research oversight and guidance

Camilla Beech, Regulatory expert specializing in novel biotechnology products, Cambea Consulting Ltd

> ***"The regulatory approach for gene drives can build on existing regulatory frameworks for Genetically Modified Organisms (GMOs) and biocontrol solutions."***

First of all, Ms. Beech explained that gene drive is still at a very early evaluation stage, but that **many national and international organizations have already published guidance for risk assessment and policy-building on this issue.** Then, Ms. Beech presented the conclusion of the Convention on Biological Diversity by the "Ad hoc Technical Expert Group (AHTEG) on Risk Assessment". The latter notably recognized that **risk should be balanced with benefit in decision-making, that gene drives are LMOs which therefore fall within the scope of the Cartagena Protocol on Biosafety, or that analysis should be "case by case",** with thorough risk assessment prior to release. Moreover, Ms. Beech also displayed the risk assessment work

being done by the EFSA (European Food Safety Authority) on gene drive activities, which already published a draft opinion in April 2020 including several proposals. The final opinion from the EFSA is expected to be published in December 2020. Finally, Ms. Beech also revealed that, **beyond biosafety risk assessments, several countries and institutions were also planning and conducting environmental impact assessments on this issue**.

Prof. Claudia Emerson, founding Director, Institute on Ethics & Policy for Innovation at McMaster University, and Associate Professor of Philosophy

"The technology is new; the ethics issues are not."

During her speech, Dr. Emerson **highlighted three main points that are ethically significant for policymakers when they consider the role of gene-drive technology** in addressing potential challenges that we are facing in public health, in biology conservation or in agriculture. Firstly, Dr. Emerson explained **that technology such as gene drive is new but that ethics issues have been discussed since a long time.** Therefore, Dr. Emerson claimed that there are standards and norms at an international level to govern such issues, notably regarding genetically modified organisms. Moreover, those norms or regulatory frameworks can be adapted, following a case by case approach, to match with new issues at stake. The second point underlined by Dr. Emerson is that **the risk/benefit evaluations need to be comprehensive, fair and mindful, notably related to the SDGs** linked to poverty reduction, health and wellbeing, education, inequality reduction or gender inequality. For her last point, Dr. Emerson argued that **the justification for research in technologies such as gene drive is its scientific and social value at a global level**. Indeed, Dr. Emerson highlighted the ethical need to address public health issues, and therefore related research, from a universal perspective.

Dr. Patrick Rüdelsheim, Partner and General Manager, PERSEUS

"Despite the limited experience, we have not seen any indication so far of negative impacts of gene drive on human health and the environment.''

The presentation of Dr. Rüdelsheim focused on the outcome of a research project produced on genetic modification (based on gene drive) for a Dutch scientific advisory body. **The main findings showed that**, **until now, natural and synthetic gene drive have been explored**, **and that research is almost exclusively focusing on mosquitos**. The report also suggests that case-by-case risk assessments remain important. Moreover, Dr. Rüdelsheim also revealed that **no harmful effects to human health or to the environment have been observed so far.** Several key points were then put forward by Dr. Rüdelsheim; to begin with, Dr. Rüdelsheim underlined that the **diversity of gene drive must be considered in a broader picture** (including for instance the type of application, the alternatives, etc.). Secondly, Dr. Rüdelsheim argued that **regulatory settings**, based on a precautionary approach which requires risk assessment, **have to be prepared ahead of**

new systems introductions. Thirdly, Dr. Rüdelsheim explained that one key element is that **research gaps, questions and uncertainties must be taken into account within the precautionary approach**. Finally, Dr. Rüdelsheim pointed out that there is an unequalled effort from all stakeholders to identify and reduce risk accompanying scientific development.

International activities around gene drive

Dr. Kent Redford, Chair of IUCN Task Force on Synthetic Biology

"The use of synthetic biology applications in the development of a coronavirus vaccine may influence public opinion on synthetic biology technologies."

During his intervention, Dr. Redford presented the IUCN assessment entitled ***"Genetic frontiers for conservation: An assessment of synthetic biology and biodiversity conservation"***. Dr. Redford started his intervention by mentioning that **synthetic biology is a further development of modern biotechnology** accelerating the understanding, design and re-design of genetic materials. However, it was noted that **synthetic biology** - while advanced in the fields of agriculture and human medicine - **is still at early stages of application as far as biodiversity conservation is concerned**. Among the **key messages** of the IUCN assessment, Dr. Redford highlighted the existence of important conservation implications and the need to address them; the potential of engineered gene drive to be a transformative tool for conservation applications; and the possibility of synthetic biology and engineered gene drive to have both beneficial and detrimental conservation impacts. Moreover, Dr. Redford mentioned that the **IUCN assessment led to a draft set of principles on the intersection of biodiversity conservation and synthetic biology**, which will be voted as a motion at the upcoming IUCN World Conservation Congress. Indicative examples of those principles include the importance of biodiversity conservation, intergenerational equity, evidence-based decision making, dialogue between conservationists and synthetic biologists and ethics. Furthermore, Dr. Redford stressed the importance of case-by-case decision making, evaluation of existing alternatives, filling the knowledge gaps and facilitating transnational knowledge transfer. Dr. Redford concluded his intervention by underlining that **the use of synthetic biology applications in the development of a coronavirus vaccine may influence public opinion on synthetic biology technologies**.

Dr. John Reeder, Director, Special Programme for Research and Training in Tropical Diseases (TDR) & Director, Department of Research for Health, World Health Organization

"Among the key messages of WHO's recent position statement on genetically modified mosquitoes, is the encouragement of innovation and the evaluation of its potential to contribute to reducing the global burden of vector-borne diseases."

As far as WHO's approach to gene drive and genetically modified mosquitoes are concerned, Dr. Reeder highlighted that the ***"Guidance Framework for testing of genetically modified mosquitoes"*** published in 2014 is currently being **updated to include gene drive**. Moreover, **in October 2020 a new position statement on genetically modified mosquitoes was launched**, the **key messages** of which are the need to tackle vector-borne diseases; the encouragement of innovation and the evaluation of its potential to contribute to reducing the global burden of vector-borne diseases; and the need of a step-wise approach to the evaluation process. Furthermore, Dr. Reeder stressed that **public opinion and ethics influence the success of new technologies** and in that line the new ***"Guidance on ethics and vector-borne diseases"*** was also **launched in October 2020**. Last but not least, Dr. Reeder underlined that as far as regulation is concerned, the **WHO Vector Control Advisory Group** was established in 2012, in order to address various vector-control-related issues, including gene drive. Looking into the future, **the WHO Regulation and Prequalification Department is also working on how to successfully monitor gene drive vector control products** in terms of regulatory approval, quality, safety and performance.

Q&As session

During the discussion with the audience Dr. Burt highlighted the **difference between gene editing and gene drive**. More specifically, in terms of application **gene editing** is used to change properties of organisms under human control (e.g. crops and livestock), while **gene drive** is used to manage organisms not under human control (e.g. pest populations) and has the added property of intergenerational gene transmission. Dr. Alphey further mentioned the following risks related to gene drive applications; investing research funds in solutions that prove to be inefficient; achieving the desired outcome (e.g. suppressing a population or eradicating a gene) and realizing that at the same time previously unknown benefits are lost; and transferring genes to species others than the target species. However, Dr. Alphey stressed that the gene transfer risk is highly unlikely due to the species specificity of gene drive applications. In addition, Dr. Burt commented on the **risk of unintentional gene spread to non-target species** and mentioned the two main ways of such spread; **hybridization** and **horizontal gene transfer** from one organism to another without mating, the latter being extremely rare and happening on an evolutionary timescale of millions of years. Dr. Burt also highlighted the **risk of unintentional spread to different populations**. In that line, Dr. Burt underlined the importance of restricting intervention to specific regions and mentioned that there are tools to achieve that. Moreover, both Dr. Burt and Dr. Alphey highlighted the **benefits of gene drive applications in EU**, by mentioning their **potential for addressing vector borne diseases and invasive alien species**.

Dr. Rüdelsheim also gave his insight into **how Member States could support responsible gene drive research both in EU and in developing partners**. Firstly, EU's policy priorities regarding synthetic biology should be made clear especially towards developing partners, that have very different priorities. Secondly, the role of the precautionary principle, which is not to halt research, but to promote responsible research

should be highlighted. Thirdly, the EU should share its knowledge in terms of relevant legislation and risk assessments' utilization with its non-EU partners. Furthermore, Dr. Rüdelsheim commented on the **risk assessment guidelines**, noting that there is no major failure in the current procedures, but depending on the application **there are some gaps regarding specific technologies or species** and more information is needed for the risk assessment in those cases.

Also during the Q&A session, Ms. Beech commented on the balance of risk and benefits within the existing regulatory framework and highlighted that while **according to EU legislation the evaluation focuses only on risks**, there are other regions like Africa, where the legislation enables the consideration of both.

Responding to a question from the audience, Dr. Emerson gave her insight into the **risk of privatization of gene drive technology**, by mentioning that **currently such risk is not significant**, since no profit-making motives are involved in the gene drive research. However, Dr. Emerson underlined that any privatization attempts would deprive equitable access and advancement of the full benefits of such technologies, should be appropriately addressed.

While according to the IUCN's technical assessment, new conservation tools are needed, Dr. Redford clarified, that such **new tools are meant not to replace, but to complement the existing tools** and provided the following concrete examples of new tools: **environmental DNA**, which is effective for detection and monitoring of - particularly rare - species; **audio monitoring**, i.e. using advanced artificial intelligence for very long acoustical recordings in forest areas, in order to determine changes in community structure; and the **use of drones**, which revolutionized sampling.

Last but not least, Dr. Reeder took the floor commenting on the **interplay between WHO guidelines and the Convention on Biological Diversity** (CBD), by specifically highlighting that **WHO tries to adjust its guidelines to the existing policy framework**. Dr. Reeder also added that if a country needed support for the use of a gene drive tool for public health reasons, WHO would provide assistance either in terms of capacity or guidance framework evaluation, as is the case with any other health issue.

Closing remarks

MEP Maria da Graça Carvalho

"Today's discussion has shown the potential benefits that gene drive research could have. It is therefore important to support information sharing about this research."

Within her concluding remarks Ms. Carvalho underlined that the webinar showcased the potential benefits of gene drive research and stressed the importance of knowledge dissemination, so that policy-makers can make informed decisions. Moreover, Ms. Carvalho mentioned that gene drive is still at an early stage and any release of gene drive organisms for research purposes seems to remain several years away. Last but not least, Ms. Carvalho highlighted the importance of this topic, as EU is a global leader on biodiversity and public health policy, but also with reference to EU partners around the world.