

The blue revolution

The Earth's oceans and seas continue to provide some of the most extraordinary scientific discoveries of our age. **Professor Bernard Kloareg**, a marine biologist at the Station Biologique de Roscoff in France, explains why the future of marine science lies with genomics



How would you sum up the term 'marine genomics' and more specifically the Marine Genomics for Users (MG4U) project?

Cutting-edge genomic approaches are now completely mature for the study of marine organisms and ecosystems. Referred to as marine genomics, such approaches carry enormous potential to provide the basis of numerous applications in sectors including fisheries, aquaculture and biotechnologies. Through development of these applications, marine genomics can improve our lifestyle and prosperity, assisting with governance and sustainable management of the marine environment.

However, one of the main challenges affecting marine genomics is a lack of awareness of the many advantages and benefits of incorporating it into current practices. Valuable knowledge must be made accessible and transferred in a user-friendly format. In this context, MG4U aims to facilitate targeted knowledge transfer between marine genomic researchers and stakeholders including governance, industry and wider society.

Can you give an example illustrating the benefits of using a marine genomic approach?

In response to the increasing impact of human activities upon our planet, better and more cost-efficient methods for environmental monitoring and assessment need to be

developed. Novel sequencing technology has become routine methodology in most biological disciplines but environmental monitoring still relies on traditional methods (eg. taxonomists typically manually identify species in samples). Genomic methods have the potential to provide high quality, standardised and extensive observations of the marine ecosystem covering all biodiversity (ie. microorganisms) and all life stages (including larval stages). These methods can also provide novel data such as gut content analyses for trophic web analyses or a species' genetic diversity at the population level.

The project encourages scientists, government officials and representatives from SMEs to participate in diverse transfer activities. How has this been implemented?

From the beginning of the project, interacting and developing relationships with the various stakeholders considered relevant to the transfer of knowledge from marine genomic research was paramount. These included industry, policy, education and the scientific community itself, both as knowledge bearers and receivers. Using key conferences and events, the MG4U team was able to broaden the scope of stakeholders with whom to interact and as such could develop an in-depth understanding of the varied interests in marine genomics and its methods.

During several industry conventions (such as Biomarine Business Conventions, Biotechnica, Achema, etc.), we have facilitated meetings between researchers and industry potentially interested in innovation opportunities. During these events, MG4U was involved in sessions dedicated to promoting the potential of marine genomics and for some of them, the project was not only involved in the session but also in its organisation. Training sessions were also organised, mostly dedicated to young researchers to improve their skills in genomics, but also to highlight how to identify the huge potential of their research for other users. MG4U also organised a highly successful workshop between marine

genomic scientists and marine policy makers to discuss the potential of genomics technology for marine monitoring.

What have been the successes of the project so far?

The MG4U consortium succeeded in developing an efficient methodology to collect and collate relevant knowledge outputs from marine genomic research. In turn we have carried out an analysis of the potential applications of the research which enabled the identification of potential end-users. All the knowledge collected will be placed in an open access online portal, the 'Marine Knowledge Gate'. Complex concepts have been translated to make them understandable for targeted user groups and this has been used as a basis to develop advanced knowledge transfer methodologies.

As mentioned, this transfer has been achieved through training courses, conferences and technical workshops, where MG4U brought together researchers, industrial representatives and policy makers to promote and explore the potential of marine genomics. Furthermore, some of the MG4U partners have developed a white paper on the marine genomics methods which could be used for environmental monitoring.

MG4U ends in June 2013. What are the next steps in order to reach the goals of the project?

Training sessions and workshops have been organised over the next few months as part of the MG4U knowledge transfer strategy. We will be working on promoting the MG4U knowledge transfer methodology in the field of marine genomics and marine biology in general, but also in other sectors, as we believe that it could be used by other initiatives that aim to promote knowledge arising from scientific research.



Unlocking the potential of **marine genomics**

Marine genomics has made great strides in recent years and is spearheading a 'blue' revolution in the marine sciences. **MG4U** is a collaborative project intent on spreading the message of the potential for marine genomics to deliver significant societal benefit

GENOMIC APPROACHES IN biological science enhance our knowledge of organisms by analysing their genetic make-up. By employing cutting-edge technologies, scientists are able to define the differences within and among species. Such techniques have wide-ranging applications in biotechnology, most significantly in food industries, agriculture and medicine. For land-based organisms, this is a relatively well understood and established field, but the vast potential of marine genomics is only just being fully realised by researchers. Indeed, only 1 per cent of all biotechnology enterprises are tapping into the vast marine ecosystem knowledge globally.

Marine genomics can help provide knowledge of how marine ecosystems function and evolve, and could be the key to realising the impact of climate change on the marine environment. At a time when these ecosystems are intensively exploited for their natural resources, the field of marine genomics offers a groundbreaking approach to secure the sustainable management of marine resources in a changing landscape. Industries such as fisheries, aquaculture, biomedicine and food processing (where biotechnologies are used for production of vitamins, antioxidants, and essential oils) are set to benefit from the increasing application of marine genomics.

Against such a context, it may be unsurprising that marine genomics is considered a driving force in delivering innovative methods which have the capacity to improve the sustainable management and preservation of the marine environment whilst greatly benefiting policy makers, industries and

society as a whole. Unfortunately, the sheer volume of knowledge produced by the rapid advances in marine genomic research means many potential beneficiaries remain unaware of the commercial advantages which are now attainable. In response, a collaborative project titled Marine Genomics for Users (MG4U) has been set up to facilitate the dissemination of marine genomics to potential end-users, such as policy makers, industrial representatives and marine biologists. By making this wealth of information and technology accessible and user-friendly, the project hopes to fully unlock the potential of marine genomics and ensure a sustainable marine environment for the future.

FOREFRONT OF MARINE GOVERNANCE

Funded by the EU's Seventh Framework Programme (FP7), the MG4U project is a consortium of seven partners led by France's Centre National de la Recherche Scientifique (CNRS). Scientists at the Station Biologique de Roscoff, part of CNRS, are collaborating with teams from Ireland, Germany, Spain, Portugal and Sweden to enhance marine genomic research capacity in Europe and bring its valuable applications to the forefront of marine governance and industry.

Scientists, government officials and representatives from relevant businesses are participating in diverse activities which promote the existence of ongoing and completed research projects and encourage dialogue amongst end-users. This knowledge transfer process does not only involve reviewing and promoting what has already been done; rather, MG4U is actively identifying potential applications and stakeholders once

INTELLIGENCE

MG4U

MARINE GENOMICS FOR USERS

OBJECTIVES

To facilitate knowledge transfer, technology transfer and technology translation between high-throughput marine genomics, industry and society.

PARTNERS

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University College Cork, Ireland

AquaTT, Ireland

Sven Lovén Center, Göteborgs Universitet, Sweden

Institut De Recerca I Tecnologia Agroalimentaries, Catalonia, Spain

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PROFESSOR BERNARD KLOAREG is the coordinator of MG4U, and trained in agronomy, biochemistry and genetics. He is Professor at Université Pierre et Marie Curie. Having worked as a researcher at the CNRS since 1978, he is now leading the Station Biologique de Roscoff (CNRS/UPMC institute). Kloareg is also scientific co-coordinator of ASSEMBLE (I3, FP7), coordinator for France of ppEMBRC (Infrasstructures, FP7) and coordinator of EMBRC-France (Investissement d'Avenir project).

the research results have been reviewed and analysed. In doing so, the project is generating tangible ideas fit for commercial application. Professor Bernard Kloareg, a marine biologist at CNRS and the project's scientific coordinator, elaborates: "Effective knowledge transfer requires a proactive approach to clearly identify the knowledge applications for different users. The better we understand the end-users, the better we are able to develop a tailor-made transfer strategy to ensure that our transfer activities are successful and result in uptake and application".

RESEARCH AND APPLICATION

This strategic research approach and end-user focus underpins MG4U's approach to knowledge transfer. The methodology employed by MG4U consists of three stages: to collect and understand; to analyse and consult; and to transfer and connect. The transfer activities are not designed until the needs and motivations of all potential end-users have been considered and thoroughly understood. It is very much an all-inclusive approach: "From the beginning of the project, interacting and developing relationships with the various stakeholders considered relevant to the transfer of knowledge from marine genomic research was paramount," Kloareg emphasises.

At the project's inception in January 2011, the contributors highlighted five key objectives to achieve by the time MG4U comes to an end in June 2013. Following the collection and collation of marine genomic research across Europe, a single entry point to marine genomics knowledge was created in the form of an online database with efficient and user-friendly functions. Secondly, innovative knowledge transfer methodologies were customised to different users and explained concisely for use in diverse commercial applications. These commercial applications are to be featured on an 'occupational map' of the marine genomics field, which will chart the state of the industry whilst defining and identifying essential job roles.

The final two outcomes focus on transferring the knowledge and connecting with stakeholders. Training courses and technical workshops designed and run by MG4U have been central

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to the knowledge transfer strategy and involve all stakeholders considered relevant. Ultimately, the MG4U project aims to broker relationships between all biotech sectors and marine genomics experts. By initiating contact between the different groups, it is hoped that the potential offered by marine genomics can continue to be realised beyond MG4U.

SECURING THE FUTURE

With most of MG4U's work nearing completion, the focus of the final stages of the project is on delivering training sessions and workshops so that the knowledge transfer initiated by the project can be continued in future. As increasing numbers of research studies in marine genomics are carried out, the task of up-to-date knowledge transfer is huge – a point recognised by Kloareg: "As knowledge transfer in marine genomics is likely to be a never-ending process, I hope that MG4U's activities can be continued on a pan-European scale".

Kloareg and his partners in MG4U have worked tirelessly to set the ball rolling in bringing marine genomics to a wider community. Societal needs will be severely tested in the coming decades as global warming adversely affects marine ecosystems. With its skilled scientific base and strong ties between experts and industrial partners, marine genomics looks set to play a crucial role in the future of sustainable management of a marine environment so vital to society.

