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Evolutionary Genomics at the Human–Environment Interface in Africa

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Meeting Report of the Society for Molecular Biology and Evolution (SMBE) Regional Meeting in Zomba, Malawi, September 18–21, 2019.

Abstract

We report on the first meeting of SMBE in Africa. SMBE Malawi was initiated to bring together African and international researchers who use genetics or genomics to study natural systems impacted by human activities. The goals of this conference were 1) to reach a world-class standard of science with a large number of contributions from Africa, 2) to initiate exchange between African and international researchers, and 3) to identify challenges and opportunities for evolutionary genomics research in Africa. As reported, we think that we have achieved these goals and make suggestions on the way forward for African evolutionary genomics research.

Key words: meeting report, evolutionary genomics, SMBE regional meeting, Africa, human impact, challenges.

Introduction

Most natural systems are impacted by human activities such as resource extraction, habitat perturbation, or the introduction of alien species. Although human impact poses a serious threat to many of these systems, it can also generate testable hypotheses about the processes of molecular evolution. The SMBE Regional Meeting Malawi was initiated to bring together African and international researchers that use genetics or genomics (in the broadest sense) to study natural systems impacted by human activities, with a specific focus on African systems. Although there is excellent science being carried out within Africa, many African countries are identified as lagging

in research and development (R&D). Indeed, a recent report by the World Bank ([The World Bank and Elsevier 2014](#)) suggests that Africa accounts for <1% of the world's research output, despite being home to 16% of the global population. Furthermore, African researchers are underrepresented in first and last authorship positions in papers published from research done in Africa ([Mbaye et al. 2019](#)). Such a disjunct leaves gaps in knowledge and problem-solving capacity that could help support solutions for the largest challenges facing African biodiversity and human populations. Therefore, besides organizing a world-class scientific conference with a large number of African contributions, a major goal of the SMBE Malawi meeting was to discuss and propose solutions

for these challenges through intensive exchange between African and international researchers.

The First African SMBE Meeting

Africa, as the cradle of humankind and home to one of the largest arrays of natural diversity, is a hotspot for evolution. As such, it was fitting that the first regional meeting of the SMBE in Africa was held in beautiful Malawi at the heart of the continent. To many biologists, Malawi is known for the explosive radiation and unique evolutionary adaptations of cichlid fishes in Lake Malawi (The coastline of Lake Malawi is shared between Malawi, Tanzania, and Mozambique. In the latter two countries, the lake is known as Lake Nyasa and Lago Niassa, respectively.), but also beyond that it is home to an incredible fauna and flora and wonderful people. The SMBE meeting was held at Chancellor College, in the southern town of Zomba, over which towers the impressive Zomba plateau.

The meeting attracted a host of regional and international speakers, with 74 participants from 13 countries (see [fig. 1](#) for meeting impressions and graphical talk abstracts), the majority coming from sub-Saharan Africa. Ten travel grants were awarded on a competitive basis from funding provided by SMBE to help early career and African researchers participate in the meeting. Many of the meeting attendees were faculty and students from the host country, Malawi, but other African countries such as Zimbabwe, Zambia, South Africa, and Kenya were also well represented. In general, contributions came from diverse research backgrounds that broadly study the evolution of natural systems, as well as how anthropogenic pressures leave signatures on the evolutionary trajectories of species and ecosystems. There was a strong focus not only on understanding the process of evolution in general but also on how this can be applied to both nature conservation and resource management in Africa and beyond. The three main themes of the meeting were genetics/genomics of 1) health and disease, 2) breeding and agriculture, and 3) natural diversity/conservation/environment. Sessions included, for example, genomic effects of hybridization between native and alien species, pathogen control in humans and crops, and the impact of human-induced selection on genomes (be it directly through hunting or fishing, or indirectly through environmental perturbation). Furthermore, population genomic techniques to infer human-induced population changes and the use of (meta-) genomics to monitor ecosystems were also included.

Twenty-eight presentations were given over the 5 days, with a good balance between African and international researchers (see [supplementary table S1, Supplementary Material](#) online, for the meeting program and <https://smbe-malawi.org/talk-illustrations-by-alex-cagan/> for graphical abstracts of all presentations). Eight keynote lectures were presented by Cyprian Katongo (University of Zambia, Zambia), Peter Visscher (University of Queensland, Australia), Benjamin Kumwenda (University of Malawi, Malawi), Anne Charmantier (University of Montpellier, France), Sophie von der Heyden (University of Stellenbosch, South Africa), Naomi Wray (University of Queensland,

Australia), Richard Durbin (University of Cambridge, United Kingdom), and Alex Cagan (Wellcome Sanger Institute, United Kingdom). The topics covered by the speakers were very broad, encompassing somatic mutations in African mammals, drug-resistant nontyphoidal *Salmonella* infections, hybridization between invasive and native *Tilapia* species, genomics to study human disease and detect evidence of natural selection and adaptation, as well as how genomics can support the management and conservation of African biodiversity.

Importantly, the conference objectives included a strong focus on capacity building, teaching, and learning through a series of background presentations, as well as lectures given by some of the keynote speakers aimed at postgraduate students. In turn, the students introduced their projects and research interests and lively “match-making” discussions connecting students to speakers emerged (see also graphical abstract in [fig. 1h](#)). One of the main highlights of the meeting was its success in providing numerous opportunities for exchange between students and regional and international faculty, both at the conference and during some memorable hikes on the Zomba plateau and snorkeling in Lake Malawi.

Barriers and Opportunities for Genomic Research in Africa

The last day moved away from presentations and saw animated discussions around the priorities and challenges for genomic research in Africa. This teamed up students, faculty, and invited speakers into working groups to identify challenges for doing this type of research, but also to put forward solutions that would benefit the development of genomic research on the continent, including how to build human and infrastructure capacity ([Box 1](#)). All groups identified the main barriers to research focused on genomics and bioinformatics as a lack of technological and funding infrastructure, but importantly also a disconnect of African researchers, particularly from least developed countries, from other scientists in genomic research globally, including between African scientists. However, many solutions also exist to address these issues, such as a more concerted effort for targeted training of bioinformaticians and omics researchers in Africa, including free access to online material from international conferences and workshops for African researchers. Furthermore, we suggest implementing networking platforms for African researchers, and establishing excellence centers in Africa, which provide continent-wide access to sequencing and bioinformatics infrastructure ([box 1](#)).

Setting a Challenge to Hold More Africa-Focused Genomic Meetings

This conference was the first of its kind in Malawi and provided unique opportunities for all participants. It was a high-profile event for the University of Malawi attracting national TV and press coverage. The meeting generated a highly stimulating environment for everyone who participated, with a high quality of talks that generated progressive discussion



Fig. 1. Impressions from the SMBE Malawi regional meeting. (a) Some of the attendees on the first day of the meeting. (b) A key note presentation in Great Hall, Chancellor College. (c) Rest at a creek during a hike at Zomba plateau by the SMBE Malawi participants. (d) Some participants waving at the top of Zomba plateau. (e–h) Examples of graphical abstracts captured by A.C. A full list of sketches can be found at: <https://smbe-malawi.org/talk-illustrations-by-alex-cagan/> (last accessed May 08, 2020; after February 2021, accessible at: <http://smbemalawi.wordpress.com/talk-illustrations-by-alex-cagan/>).

Box 1. Enabling Genetics and Genomics Research in Africa

The SMBE Malawi conference in Zomba in September 2019 included a discussion session where groups of students and researchers from Africa and abroad addressed the challenges faced by African researchers and students when ambitioning to develop genetics and genomics projects. Participants also discussed potential solutions that we share below. Many of these issues were also recently tackled by the Human Hereditary and Health in Africa (H3Africa) initiative (see [Adebamowo et al. 2018](#)).

The most salient challenges faced by genomic research in Africa include:

Lack of adequate “capacity building and training,” for example, in areas such as population genetics and evolutionary genomics.

Inadequate “hands-on experience in experimental genetics and genomics.” Most of the aspiring researchers receive theoretical training, with very limited access to laboratory work.

Insufficient “connection among researchers” involved in genetics and genomics research in Africa. This issue is further complicated by the absence of knowledge/information sharing platforms.

Inadequate “partnership between researchers in Africa and other global scientists” involved in genetics and genomics research.

Low “computing capacity.” In most African countries, there is an absence of high-capacity computers necessary for handling high-throughput genomics data and performing bioinformatics.

Insufficient “funding.” Several of the issues raised above (e.g., the lack of experimental research and low computing capacity) result from costs that cannot be covered by local grants.

Although many of these issues involve funding and policy changes that are beyond the scope of individual research centers or universities, we suggest the following accessible paths toward resolving some of the limitations mentioned.

A large effort should be invested into training bioinformaticians in Africa, as well as enhancing theoretical knowledge in evolutionary quantitative genomics/genetics, population and conservation genomics, phylogenomics, GWAS, or meta-genomics. This can be done through additional courses or summer schools, but also via online training workshops or massive open online courses. Many international conferences now allow live streaming of most talks; this possibility should be advertised across Africa and tutors should encourage their students to “attend” conferences online. Conferences should be urged to remove online access fees for researchers in Africa.

There is an urgent need to set up networking platforms that can link researchers involved in genetics and genomics work. We dared dream about an “African Genetics Society” that would organize biennial meetings, regular workshops, and local summer schools.

Emplacing high-speed internet connectivity and high-capacity computers for students and researchers. It was suggested that such servers could conveniently be installed in a “Centre of Excellence” with free access to anyone with a University connection. Note that such servers could be installed anywhere in the globe provided they are accessible to African researchers and students.

among participants. Importantly, the meeting’s welcoming atmosphere fostered extensive interaction among speakers, local faculty, and students, leading to many new collaborations. As most conference participants were students from Malawi and other sub-Saharan countries, it provided invaluable access to ideas and researchers from elsewhere. To this end, keynote speakers delivered, in addition to their research talks, broad introductory lectures on the state of the field, and also made available lecture materials and papers to benefit teaching and learning. Through a collaborative process, conference participants also identified key challenges in, and opportunities for broadening access to genomic research in Africa ([box 1](#)). In summary, we think that this event was a great success. There was enthusiastic feedback from young African researchers asking for the opportunity to organize similar events in other African countries in the future and we hope that SMBE and other academic societies will continue to support African research in Molecular Biology and Evolution and that this event will be followed by many others,

ideally combined with hands-on genomics workshops and further opportunities for capacity building.

Supplementary Material

[Supplementary data](#) are available at *Molecular Biology and Evolution* online.

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