International Conference on Ecological Sciences

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Title of symposium

Tracking Environmental Variability and Global Changes

Main organizer of the symposium

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Session description

Our knowledge of the effects of global changes on biodiversity is growing rapidly, but the research field of global change ecology remains in its infancy (Bellard et al. 2012). Accurate assessments of the sensitivity and vulnerability of the organisms must be achieved in order to further '*forecast species trajectories with some credibility*' (Bellard et al. 2012). Until now, several studies mainly focused on single or dual drivers to infer the effects of global changes on biodiversity. However, these investigations comport several caveats, as (i) they do not capture the complexity of the environmental conditions, (ii) downscaling of the large-scale changes at the organisms level is irrelevant, as considerable variability can occur among localities, eliciting different ecological and physiological responses and (iii) distribution of a species over environmental gradients often involves local adaptation, thus significantly increasing the set of responses (reaction norms) of a given species. It is crucial to better consider the incredible environmental complexity, in order to offset the above-mentioned major locks currently hampering thorough predictions of the multifactorial effects of environments on organisms. Of course, it can be hard to accurately reproduce environmental conditions under controlled conditions, and such experiments are time-consuming and data-intensive collections. Meanwhile, it is possible to skirt this lock by grouping environmental variables that provoke similar ecological and physiological responses in organisms (Helmuth et al. 2010) and by taking into account their interaction types (Piggot et al. 2015). Moreover, invasive species are underestimated models to address the effects of global changes on organisms' physiology and resilience capabilities, even though some species experience on-time changes of abiotic variables during the invasion process. All these results can be further used for refining the parameters of predictive models, guiding and alerting scientists for the designing of their future researches, and

communicate to politicians and general public with reliable predictions of the effects of global changes on biodiversity, nourishing COP - CMP discussions.

Speakers

Talk 1. THOMAS Chris, Department of Biology, University of York, Wentworth Way, York YO10 5DD, UK

"Changing biological assemblages of the Anthropocene"

All ecological and evolutionary processes are dynamic: the birth, death and movement of individuals, the changing distributions of species and composition of biological assemblages in space and time, through to evolutionary adaptation and diversification. These dynamic events have always generated a kaleidoscope of biological diversity across our planet, particularly during periods when the physical environment was changing. Then humans evolved, natural event for sure, but one with surprising consequences. The resultant changes to the world's vegetation, the distributions of species, the atmosphere, and the climate could not have been imagined. In this talk, I will discuss how two processes are generating changing biological assemblages, climate change and biological invasions. Whilst both are clearly negative in some situations (e.g. local endemics threatened by climate change, isolated island endemics unable to survive in the presence of continental-origin species), the perhaps surprising result is regional diversity is increasing in many parts of the world. Human-altered ecosystems contain different sets of species, but not always fewer. Even more surprising, new hybrid and other species are coming into existence because humans. This Anthropocene realisation – that humans are generators as well as destroyers of diversity – requires a reappraisal of the relationship between humans and nature. Humans are part of nature and it is as legitimate for us to facilitate novel biological diversity as it is for us to try to save the old.

Talk 2. HOLMSTRUP Martin, Department of Bioscience, Soil fauna ecology and ecotoxicology, Aahrus University, Vejlsøvej 25, 8600 Silkeborg Denmark

"Interactions between effects of adverse climatic conditions and environmental chemicals"

The potential impacts of interactions between multiple climatic and anthropogenic stress factors have received little attention in the past, but this topic has now become an (re-)emerging research area because we are facing rapid climatic changes in the near future. Predicted climate changes are likely to encompass more frequent extreme weather events and thus create a higher frequency of stressful situations for organisms in the environment. This is important for risk assessment of chemicals since organisms under the influence of one type of stressor likely become more vulnerable to additional stressors. However, such effects are generally not quantified in risk assessment procedures, or in research forming the basis of risk assessments.

In ecotoxicological effect studies test organisms are in most cases exposed to chemicals under optimal environmental conditions despite the fact that organisms in their natural settings rarely experience optimal conditions. On the contrary, during most of their lifetime

they must cope with sub-optimal conditions and occasionally with severe environmental stress. Interactions between the effects of a natural stressor and a toxicant can sometimes result in greater effects than expected from either of the stress types alone. Although there are experimental methods available to deal with such interactions and quantify them at the level of the individual or population, it is complicated to extrapolate results of laboratory experiments to the level of communities or ecosystems.

In my talk I will discuss some possible ways to circumvent these complications for example by combining species sensitivity distributions obtained from broad ecophysiological and ecotoxicological studies. The examples will elucidate methodological considerations associated with this problem and also dive into physiological mechanisms underlying synergistic interactions between effects of climatic and chemical stressors. These examples use soil invertebrates as model organisms but the conclusions may well be generally applicable to other organisms.

Talk 3. PENUELAS Josep, CSIC, Global Ecology Unit CREAF-CSIC-UAB, Bellaterra (Catalonia) E-08193, Spain; CREAF, Cerdanyola del Vallès (Catalonia) E-08193, Spain

"Physical, chemical and biological laws driving life responses to environmental global changes"

Life on Earth is the result of a continuous accumulation of information by combination and innovation using endo- (inside the organism) and exosomatic (outside the organism) energy. Sustenance occurs through cycles of life and death. We will define five life laws for these vital processes. In this talk we will focus especially on matter. Every living creature on Earth is made of atoms of the various bio-elements that are harnessed in the construction of molecules, and tissues. Each species is expected to have different requirements for each bio-element. We therefore propose that a "biogeochemical niche" can be associated with the classical ecological niche of each species. We will show that a biogeochemical niche is characterized by a particular elementome defined as the content of all (or at least most) bio-elements. The differences in elementome among species are a function of taxonomy (phylogenetic distance), homeostasis with a continuum between high homeostasis/low plasticity and low homeostasis/high plasticity and sympatry (the bioelemental compositions should differ more among coexisting than among non-coexisting species to avoid competitive pressure). We will consider these physical, chemical and biological laws of life to better understand and characterize the biological responses to current global environmental changes generated by human activities. This will lead us to conclude that current anthropic carbon dioxide and nitrogen fertilization effects on ecosystem carbon sequestration may slow down in the future because emerging nutrient constraints, high temperatures and droughts are leading to negative impacts on carbon sinks. We suggest that, together, these two phenomena might drive a shift from a period dominated by the positive effects of fertilization to a period characterized by the saturation of the positive effects of fertilization on carbon sinks and the rise of impacts of climate change. We will thereafter consider the

pressure that these impacts of climate change are likely to pose on terrestrial ecosystems as shown by diverse experimental and observational field evidences including rapid genetic, epigenetic, metabolic, morphological, physiological, growth, reproduction, and mortality changes. Some species are more vulnerable to these changes than others, which alters their competitive ability and thereby changes microbial, plant and animal community composition. These impacts strongly affect structure and functioning of ecosystems and therefore rapidly alter ecosystem services. Learning from the way nature deals with the accumulation of information, the limits of size and the rates at which life can acquire and expend energy and resources for maintenance, growth and competition will help us to model and manage our environmental future and sustainability.

Talk 4. CONVEY Peter, British Antartic Survey (BAS), High Cross Madingley Road Cambridge CB30ET, United Kingdom

Most ice-free habitats on land in Antarctica and the sub-Antarctic are. Antarctic terrestrial ecosystems are extremely isolated, in effect often islands surrounded by hostile ice and ocean, and have developed unique and striking features. True terrestrial vertebrates are generally absent, except for a small number of native birds on some sub-Antarctic islands, meaning that most foodwebs consist only of invertebrates. Ecosystem structure is generally simplified. Decomposition processes are slow, while few true native herbivores or predators are present, and the predators in particular have very limited impact on their prey species. Over the last two centuries human activities have led to the accidental introduction and establishment on land of many non-indigenous species of vertebrate, invertebrate and plant, particularly to the ecosystems of the sub-Antarctic islands, but also increasingly to the Antarctic Peninsula and Scotia Arc archipelagoes. These introductions have encompassed a range of trophic functions, some of which are poorly or not represented in indigenous ecosystems, in some cases leading to drastic alterations in ecosystem structure and function. Although the number of introductions currently known in parts of the Antarctic Peninsula is small, the sub-Antarctic provides a direct warning of the likely trajectories of these and any future establishment events. This presentation will consider the impacts of non-indigenous biota in Antarctic ecosystems to date, and their implications in a future where these ecosystems are also faced by some of the most rapid rates of environmental change on the planet. It will also identify urgent challenges faced by the authorities responsible for conservation and governance in the sub-Antarctic and Antarctic regions, if the Antarctic is to remain the only continent globally that is largely unaffected by biological invasions.