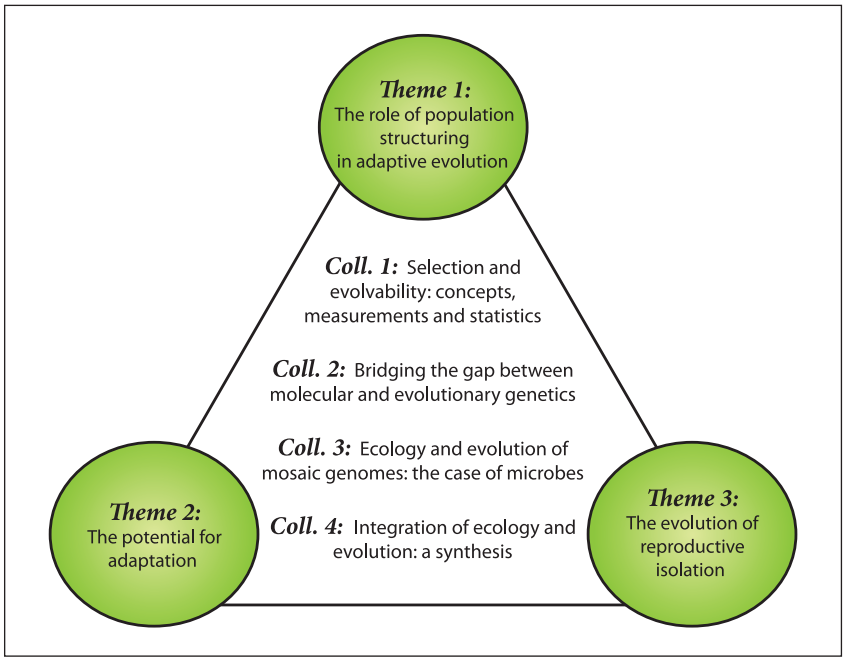
Combining ecology and evolution

Training a new generation of scientists…

Ecological and evolutionary processes are inescapably intertwined. Environmental changes affect the ecology of species, causing novel selection pressures to which the species respond evolutionarily. Ever since the industrial revolution, the influence of human activity on Earth has accelerated, and today anthropogenic impacts on the biota are of great concern to politicians, academics and laypeople. In order to comprehend how such distortion of the environment may affect tomorrow's nature, we need more and better knowledge of how ecology determines the course of evolution, which again determines future ecological dynamics. Understanding how living organisms respond and adapt to environmental changes remains a major and most urgent scientific challenge.

Individual organisms constantly face challenges to which they respond through behavioural mechanisms, physiological plasticity and habitat selection. Populations may contract or expand their geographic ranges, change their densities, divide or merge with other populations, or adapt evolutionarily to new conditions. To achieve a better understanding of these subjects, some major biological questions have to be answered: How do ecological structures and processes, as well as intrinsic processes, act as drivers of, or constraints on, evolution? What determines the potential for adaptation to environmental change? Who will survive, who will become extinct, and who will adjust to new circumstances?

Answering these questions demands combined efforts. Research departments that include both ecologists and evolutionary biologists are found all over the world. Nevertheless, ecological processes are typically studied under the assumption of homogenous populations, whereas evolutionary processes are studied under the assumption of ecological stability. However, with the remarkable developments in molecular biology and computer science, huge amounts of data can now be obtained, analysed, and most importantly, synthesised to answer imperative questions at the interface between ecology and evolutionary biology.



To meet these challenges, we have gathered scientists of various backgrounds, such as theoretical and experimental biologists, as well as statisticians interested in biology. Together we will target numerous obstacles for an ecological and evolutionary synthesis using old and new data from the field and the lab.

The Centre for Ecological and Evolutionary Synthesis (CEES) is a national centre of excellence with core funding from the Research Council of Norway and the University of Oslo. The CEES is chaired by Professor Nils Chr. Stenseth (see picture). As of 31st December 2008, CEES consists of 148 members, including students, researchers, technical and administrative personnel. The centre has a core group of 18 employees, of which 11 are full-time, one is a part-time employee of the Department of Biology, two are employed by the Department of Mathematics, one by the Department of Economy, one by the Institute of Marine Research, and one being a visiting scientist at the University of Alberta in Edmonton. The CEES staff represents 20 nationalities.

The research within the CEES is structured into three interlinked themes: the role of population structuring in adaptive evolution; the potential for adaptation; and the evolution of reproductive isolation. Faculty members, researchers, post-docs and graduate students participate in one or more of these themes. In addition, four more

focused projects, Colloquia, will be held over the course of the next 10 years (each lasting three years). The first, 'Selection and evolvability: concepts, measurements and statistics', started in the summer of 2008. The other three Colloquia – 'Bridging the gap between molecular and evolutionary genetics', 'Ecology and evolution of mosaic genomes: the case of microbes' and 'Integration of ecology and evolution: a synthesis' – will run subsequently (see diagram). For more and detailed information about our research focus, we refer to our webpage and the CEES Annual Report: www.cees.uio.no/about/annual-reports/2008.pdf.

The CEES comprises a broad spectrum of expertise in ecology, evolutionary biology, molecular biology, bioinformatics, methodological and computational statistics. We work on a wide range of well established biological research systems, covering the terrestrial, limnic and marine world. By joining forces within this centre of excellence, the participants mutually benefit by sharing knowledge and tools across scientific boundaries. Moreover, the centre facilitates collaboration with internationally prominent scientists. The activities of the centre of excellence allow us to offer a multi-disciplinary training programme for MSc, PhD, and post-docs, and thus attract a diverse group of students from biology, as well as from statistics and mathematics. The centre of excellence is an open, inclusive and integrative international centre, a platform from which we aim to better understand the evolutionary play in the ever changing ecological theatre.

We work on a broad spectrum of systems (freshwater and marine fishes, small and large mammals, microbial systems, including the plague system, passerine birds, arctic plants and crustaceans), and adopt a wide range of approaches (experimental field studies, statistical time series modelling, mathematical modelling and genetic laboratory work). We are a well equipped centre with highly modern facilities, including a 454 DNA sequencing machine. The CEES represents a truly interdisciplinary scientific environment co-ordinating several international networks and training programmes, and with English as the daily working language.

Among our prioritised research areas are: genetic and phenotypic variation in passerine birds across Europe; genotypic and phenotypic variation in stickleback fish; evolutionary responses to anthropogenic changes (including harvest induced selection) in a broad spectrum of terrestrial, freshwater and marine species; polyploidy evolution; and evolution under the influence of biotic and abiotic variation across timescales.

> 'How do ecological structures and processes act as drivers of, or constraints on, evolution? What determines the potential for adaptation to environmental change.'

CEES hosts a single site Marie Curie Early Stage Research Training Programme: 'Ecological and Evolutionary Response to Climatic Variation' (CEES-MCO), a European mobility programme for 11 PhD students in evolution, ecology and bio-economy focusing on the following scientific challenges: How does climatic change affect the structure and dynamics of ecosystems? How does climatic change affect the rates of speciation and extinction? How does climate affect the link between short-term ecological and long-term evolutionary processes? How does climatic change interact with anthropogenically caused habitat destruction or exploitation in determining ecological and evolutionary

Nils Chr. Stenseth, Professor and Chair of CEES

processes? How will sustainable resource management (bio-economical management) be affected by climate change? The current CEES-MCO is in its final stage, but will be continued, conditional upon future funding.

Our research training is organised as a research school with journal clubs, annual research conferences, and frequent seminars given by internationally recognised speakers. The CEES provide a good social environment for young researchers. We pay attention to their needs (socially, as well as academically), not least since they will be the future generation of scientists in the field. Students (Master students, as well as PhDs), post-docs and senior scientists are welcome to join us.

CEES
Centre for Ecological and Evolutionary Synthesis

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