Consiglio Nazionale delle Ricerche

NextData

un sistema nazionale per la raccolta, conservazione, accessibilità e diffusione dei dati ambientali e climatici in aree montane e marine

Project of Interest "NextData"

Proposal for a research project

Topic (number and title):
3 - Armonizzazione dei dati relativi alla biodiversità animale e alle reti trofiche in archivi del Progetto NextData

TITLE OF THE PROPOSED PROJECT:
Montane butterflies and mammals as ecosystem indicators of climate change effects: upgrading the NextData bank.

Project duration: 2013-2015
start date (before 31 January 2014):
end date (no later than 30 September 2015):

Scientific coordinator of the proposed project:
Dr Giovanni Amori

CNR Institute coordinating the proposed project:
Institute of Ecosystem Studies (ISE)

Participating units, indicating the scientific responsible for each unit and the motivation for the inclusion in the proposal (in particular, illustrating whether and how the expertise of non-CNR partners is not available at CNR):

Unit 1 (CNR coordinating Institute): Dr Giovanni Amori, CNR ISE
Unit 2: Prof. Valerio Sbordoni, Dept. Biology, Tor Vergata University, Rome
(high level expertise in systematics, evolutionary biology and ecology of butterflies)

1. GENERAL INFORMATION

Abstract of the proposed project (max 1000 characters)
Current global climatic change is undoubtedly causing changes in both density and distribution of biodiversity, so that the sustainability of most ecosystems is going towards a state of crisis. The scientific community has been recognizing and growingly emphasizing this emergency since last decade, particularly for high-mountain ecosystems. The aim of this project is to assemble detailed, spatially and temporally explicit datasets in order to investigate the possible occurrence of shifts in specie ranges, altitudinal distribution and phenology. Understanding and predicting the response of species and ecosystems to global warming are mandatory targets for biodiversity management and conservation policies.

Main goals of the project (max 1000 characters)

This project would likely have a major impact on environmental policies for biodiversity management and conservation, and the mitigation of the climate change impacts. Estimates of the response of mountain ecosystems to climate and environmental variations are difficult; consequently, it is necessary to improve activities devoted to measurement and observation of mountain ecosystems, collecting and organizing as more as possible information on the current and historical distribution of montane species with emphasis on Mediterranean mountains. A particularly significant contribution would derive from the evaluation of the weight of climate change in shaping montane specie ranges, their altitudinal distribution and phenology. In addition, this project would shed light on the ability of the different species to face environmental modifications.

Expected results of the project (max 2000 characters)

Assembling detailed geographical datasets on the occurrence of montane species, will allow:

- to define which species can be considered as strictly montane;
- to provide updated maps of montane species distribution;
- to identify hotspots of montane species richness, montane species endemics and threatened montane species;
- to define the occurrence, the magnitude and the spatial distribution of significant shifts in species optimum elevation and/or of significant phenological shifts in Alps and Apennines;
- to develop spatially explicit species distribution models (SDMs), which are numerical tools that combine observations of species occurrence or abundance with environmental and climatic variables. These models will allow us to evaluate the impact of climate changes on the potential distribution of a set of selected montane species;
- to produce phylogeographic patterns for a set of selected montane species by using molecular markers;
- to test the main macroecological theories related to montane distribution species (e.g. Steven hypothesis, mid-domain effect);
- to develop models to evaluate the impact of climate changes on montane prey-predator systems.

Role of the different units (max 2000 characters)

The working group includes two participating units: one unit will focus its research on mammals, the other one on butterflies and comparative phylogeography. The resulting patterns from research of each unit will be compared.
Detailed description of the roles are reported in the following sections.

2. DETAILED PROJECT DESCRIPTION

State of the art and motivations (max 5000 characters)

As global warming has been modifying biodiversity and its distribution, the response of species and ecosystems to climatic changes is one of the hot topics in Conservation Biology. For this reason, there is growing interest in the development of spatially and temporally explicit datasets and techniques to predict distributions of species and ecosystems, in future climatic scenarios.

Species richness along altitudinal gradient is assumed to increase universally from cool highlands to warm lowlands, mirroring the latitudinal increase of species richness from cool to warm latitude.

Diversity along elevational gradients is a reflection of underlying patterns of primary productivity.

Deforestation is generally most extensive in the lowlands (mainly due to settlements and exploitation of forest resources) and at high altitudes (due to graziing and fire activities), with most forest remaining at mid-altitude.

Climate is very important in determining the distribution ranges and also in producing spatial isolation between populations with consequent speciation processes.

Due to the very recent, quick climatic changes many species are expanding their ranges northward (e.g. migratory species), and species not considered migratory at all are on the move, creeping upslope toward cooler, more hospitable abodes. Animals that can fly are in pretty good shape. Animals that are relatively static have a much more limited ability to move.

So many species have experienced may constrain, in theory, to shift their distribution ranges either north-forward or towards higher altitudes.

Studies understanding patterns and processes associated with species diversity mainly focused on distribution and endemism of montane fauna and on threatened species.

These eventual shifts, or even contractions in the distribution range, can be even accentuated when prey-predator systems are considered. For example, range contraction of potential preys may produce in turn a contraction of the range of even their natural predators, especially when these latter are specialized.

Montane forests have much higher levels of endemism than do lowland forests, even though diversity at a single site is much lower at the montane sites. These pattern is very important for conservation activities.

The impact of climate change on mammal species has been clearly demonstrated considering both the current fauna and fossil records. In particular, it has been clearly

outlined that mammals respond to changes in precipitation regimes, with changes in their ecology and distribution. This is particularly true for montane species which are inherently linked to particular habitat and climate conditions. At the same time montane mammals provide a wealth of ecosystem services, being at the same time predators and consumers, and often building their own niche with physical alterations of their habitats. Moreover, from a conservation point of view, mammals include some of the most widely know flagship species, thus enabling and facilitating more demanding large scale conservation efforts.
No studies up-to-date have explored the impacts of global changes for mountain mammals in Europe. However, a number of international projects and research initiatives have been funded in the framework of the seventh "Framework Programme" of EU. The impact of global changes represents also one of the main research themes in Horizon 2020. In this framework the analyses will be performed collaborating also with the main research labs in the field in EU (e.g. Spatial Ecology Lab, Losanne, CNRS Grenoble).

Butterflies are rigorously dependent upon both biotic and abiotic landscape features even at very tiny scales, since their ecology and evolution have been shaped upon their "coarse-grained" sensitivity to the environmental heterogeneity. Butterflies have short life cycles and thus react quickly to environmental changes. Their limited dispersal ability, larval foodplant specialisation and close-reliance on the weather and climate make many butterfly species sensitive to fine-scale changes. These features make butterflies a valuable indicator of biodiversity and provide an early warning system for biodiversity loss and other kinds of ecosystem changes. As a result, they are now the best-monitored group of insects in the world. In this framework, the taxocenoses of butterflies inhabiting Italian mountain ranges (and specialized montane or alpine species in the Apennines, in particular) represent a remarkably interesting model. In fact, butterflies are ecological specialists and their chrono-geonemic data are abundant and easily available; consequently, they also represent excellent indicators of the responses of the ecosystems to climatic changes.
An innovative task of this project is to assess the effects of climate changes on the vulnerable Mediterranean mountain biota, by using spatially and temporally detailed information about the current and historical distribution of butterfly species (estimated 90.000 - 100.000 records of 265 species).

This project will be strictly related to the activities of the Virtual Lab 'Collections' within the LifeWatch infrastructure (http://www.lifewatch.eu/web/guest/meetings) and to the National Network of Biodiversity (NNB) of the Italian Ministry of the Environment (MATTM, http://www.naturaitalia.it/home_it/biodiversita/conservare-la-biodiversita/nnb.html).

Detailed description of the project, including the work plan, deliverables and milestones (explicitly indicating the activities of the different years) (max 8000 characters)

Our project will take into account mammals and butterfly species as biological models of the effects of climatic change on the ecological communities and habitats. The working group includes two participating units: one unit will focus its research on mammals, the other one on butterflies.

Unit 1 (Giovanni Amori)

The first three months of the first year will be dedicated to build a spatially explicit dataset of the Extent of Occurrence (EOO) of mammalian species across Europe starting from the already published Global Mammal Assessment (IUCN). For a few species, the database will be integrated and corrected with more updated and detailed data sources taken also from museum collections (e.g. British Museum Natural History, London, Natural History Museum, Paris, Zoological Research Museum A. Koenig, Bonn, "La Specola" Museum, Florence). For all species (roughly 272 mammal species) the spatially explicit database on distribution will be integrated with data on species-specific life traits and habitat requirements (referred to land-cover and elevation) based on expert opinion and published literature. In particular mammalogists with expertise on the different *taxa* will be asked for new information on the ecology and distribution of the different species across Europe and for validation of the final database (see for an example of the methods Maiorano et al. 2013, PlosOne doi:10.1371/journal.pone.0074989).The data collection phase will be completed within the first nine months of the project.

The study area includes the entire European subcontinent, from *Macaronesia* (only the islands politically belonging to Spain and Portugal) to the Ural Mountains (west to east) and from Fennoscandia and UK islands to the Mediterranean coast (north to south). Turkey is also included, although geographically part of Asia, to provide a complete picture of the north-eastern Mediterranean coast.

The continent covers at least 11 biogeographical regions and a significant part of three biodiversity hotspots: the entire northern part of the Mediterranean basin, most of the Caucasus and the easternmost part of the Irano-Anatolian region.

The main goals are:

Define and identify montane species among European mammals

Identify hotspots of montane species richness, montane species endemics and montane species threatened

Develop a spatially explicit model to evaluate the impact of climate changes on the potential distribution of a set of selected montane mammal species

Test the main macroecological theories related to montane distribution species (e.g. Steven hypothesis, mid-domain effect)

Develop model to evaluate the impact of climate changes on montane prey-predator systems. For example, range contraction of potential preys may produce in turn a

contraction of the range of even their natural predators, especially when the latter are trophically specialized
Mapping montane biogeographical regions using the species distribution

Unit 2 (Valerio Sbordoni)
We will collect and georeference data on the current and historical distribution of montane butterflies in the Alps and Apennines, using mainly databases (i.e., CKmap5.3.8, GBIF, etc.) and entomological collections (i.e., R. Verity's museum collection at the Florence University, V. Sbordoni's collection (VSRM - http://grbio.org/non-institutional-collection/lepidoptera-collection-valerio-sbordoni), etc.). An additional dataset will be assembled in order to enhance the knowledge on Himalayan butterfly fauna, using both literature data (atlas, field guides and scientific reports) and data from entomological collections (i.e., Sbordoni's personal collection).

These spatially-explicit datasets will be used to develop several activities:
- to define which species can be considered as strictly montane in Alps and Apennines. All the species of the Italian fauna (approximately 265 species) will be analysed using different criteria;
- to provide updated maps of montane species distribution in Alps and Apennines;
- to identify hotspots of montane species richness, montane species endemics and threatened montane species in both the Himalaya and Italian ranges;
- to define the occurrence, the magnitude and the spatial distribution of significant upward shifts in species optimum elevation in Alps and Apennines;
- to define the occurrence, the magnitude and the spatial distribution of significant phenological shifts in Alps and Apennines;
- to develop spatially explicit distribution models to evaluate the impact of climate changes on the potential distribution of a set of selected montane butterflies species;
- to produce phylogeographic patterns for a set of selected mountain species by using molecular markers.

As stated above, both mammals and butterflies represent valuable biological models to study the effects of climate change on montane ecosystems. Results from both research units will be used to investigate common patterns of spatial variation.
Additionally, phylogeographic approach, studying the genetic diversity and allowing to reconstruct the genealogical history and the geographic distribution of genotypes belonging to a particular species, represents an invaluable tool in the study of several key issues of evolution. Comparing phylogeographic patterns of selected montane species will allow to identify possible shared or contrasting evolutionary histories and trajectories. The outcomes of these analyses will provide: (i) detailed inferences about the history of the populations of each investigated species; (ii) comparative evaluation of similarities and differences among species belonging to the same ecosystem (e.g., alpine grasslands).

Deliverables

During the whole project duration, we will produce the following deliverables:
- novel datasets to be added to the NextData databank;
- reports of the research activities;
- conference contribution abstracts;
- scientific publications;
- development of montane species distribution maps;
- development of montane species risk maps;
- assemblage of datasets of current and historical distribution.

Milestones

The activities and the objectives of the project, and their timeline, can be summarized as follows (Figure 1):

A1) Recovering and digitalization of occurrence data from collection and databases. (9 months)

A2) Data analysis activity (montane species definition, production of species distribution maps, analysis of altitudinal and phenological distribution, production of species risk maps, comparison of phylogeographic patterns). (9 months)

A3) Processing activity of the distribution and ecological models for the selected montane species. (6 months)

A4) Compilation of the results (attendance at conferences, report writing, publications). (4 months)

These listed activities will allow us to achieve the following intermediate and final objectives:

O1) To provide a detailed archive of spatiotemporal data on montane species distribution in the study area.

O2) To define montane species and produce range distribution maps.

O3) To investigate altitudinal and phenological temporal variations in several species.

O4) To perform a comparative analysis of phylogeographic patterns in a set of selected montane species.

O5) To obtain distributional models of a set of selected species.

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	2014												2015								
Activity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
A1																					
A2																					
A3																					
A4																					
Objectives									**O1**		**O2**			**O3 O4**				**O5**			

Motivations for the required budget and budget on a unit and year-by-year basis (max 5000 characters)

Unit 1 (Coordinator)
PostDoc fellowship for this project

Unit 2
PostDoc fellowship for this project

	first year	second year
Unit 1 (coordinator)	**40000**	**40000**
Unit 2	**40000**	**40000**

Please attach the curricula and the list of relevant publications of the project coordinator and of the responsibles of each participating unit, and the summary budget table in attachment.

Signatures:

Project coordinator:
Dr Giovanni Amori

Director of the CNR Institute coordinating the proposal:
Dr Piero Guilizzoni

Consiglio Nazionale delle Ricerche
ISTITUTO per lo STUDIO degli ECOSISTEMI
IL DIRETTORE
(Dr. Piero Guilizzoni)