Spatial community ecology in highly dynamic landscapes: from island biogeography to metaecosystems.

Project overview 2019

Islands have fascinated ecologists for a long time as they represent natural laboratories to study the interaction between local processes like competition or predation and regional processes, e.g. immigration, dispersal and extinction. 50 years after MacArthur and Wilson published their seminal "Theory of Island Biogeography", DynaCom aims to add a new chapter to our understanding of how biodiversity on islands is assembled and maintained by not only predicting how many species are there, but also which and what they are doing. We will be investigating how biodiversity on islands is created and shaped by geography, colonization and local environmental conditions. We will especially focus on how the characteristics of marine and terrestrial organisms living in an area influence ecosystem processes from local to regional scales.

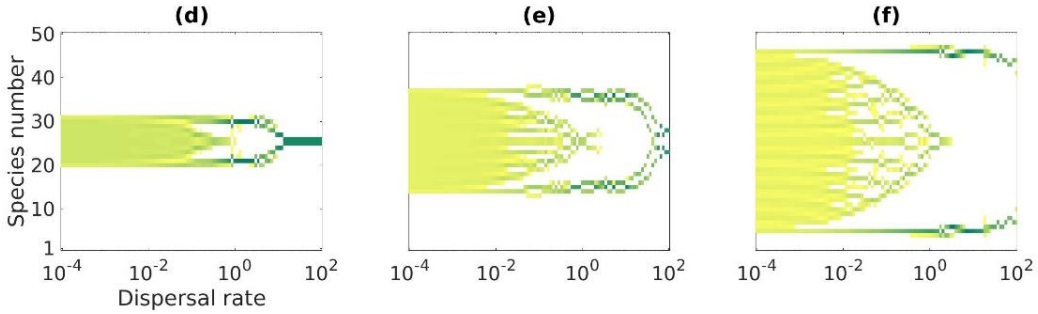
DynaCom is a new project joining outstanding scientists from Universities of Oldenburg, Göttingen, Munich and Münster along with iDiv (Halle-Jena-Leipzig) and the Senckenberg Research Institute. The project is funded by the German Science Foundation (DFG) from January 2019 to December 2021, and has been developed in collaboration with the Wadden Sea National Park of Lower Saxony.

DynaCom researchers during the kick-off meeting at the University of Oldenburg in February 2019.

Walking towards a mudflat on Spiekeroog, the changes in the plants growing along the path are noticeable. Starting from dense tall grasses that are replaced by more species rich salt tolerant species all the way to the border of vegetation and bare mudflats. Prof. Michael Kleyer and Dr. Kertu Lõhmus have been following the development of plant communities on experimental islands and salt marsh plots since 2014. They are now focusing on how the dispersal and competition characteristics of plants explain the typical salt marsh zonation and how these plants will respond to the changing environment.

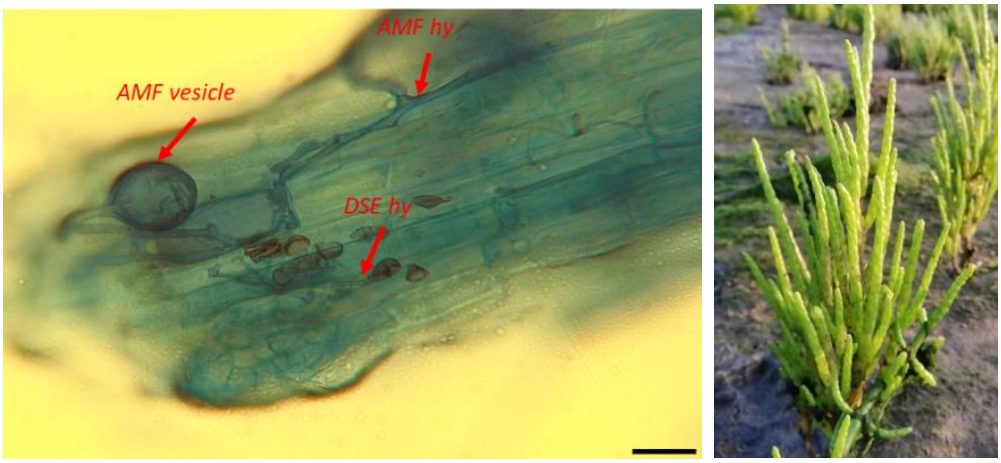
Angelika Hansel and Kertu Lõhmus working on collecting plant traits on Spiekeroog salt marsh. (Photo: Yoav Kedem)

The findings from Spiekeroog salt marshes will be interpreted in close collaboration with Mozzamil Mohammed, a PhD student supervised by Prof. Bernd Blasius and Dr. Alexey Ryavov. They have developed a computer model of a virtual plant community where plants disperse over a simulated landscape. They compete for resources, such as minerals necessary for their growth. Using this model, Mozzamil found that both the dispersal abilities of plants and the distribution of resources in the environment influences biodiversity. Now we have to find out how that relates to our salt marshes on Spiekeroog.



Simulation outcomes assuming three different resource landscapes. From left to right, resources are available in more variable amounts. The wider the colored band, the more species are staying alive at the end of competition. This shows that low dispersal and large spatial variability in the environment allow larger species richness. (Graphic: AG Mathematische Modellierung / UOl)

Salt marsh plants often have fungi in their roots. This interaction is what Danilo Gonçalves is investigating. Focusing on the spatial distribution of the plant fungus interactions in salt marshes, Danilo has collected root samples not only from Spiekeroog, but also at its northern occurrence limit in Norway and southern limit in Spain. Under the supervision of Prof. Dirk Albach, he is looking if different plant species prefer certain fungal partners and if these patterns change through the growing season.

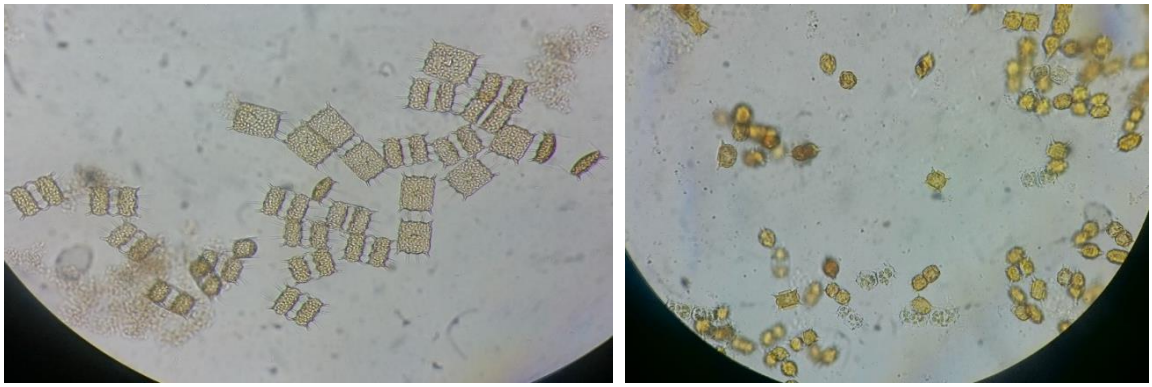


Left - fungi in Festuca rubra root under a microscope. Right - Salicornia is one of the species collected from three different sites including its northern and southern limits. (Photos: AG Biodiversität und Evolution der Pflanzen / UOl)

Maria Rinke and Maria Börger have spent this past year looking into terrestrial consumer communities. Supervised by Prof. Stefan Scheu from University of Göttingen and Prof. Christoph Scherber from University of Münster respectively, they are studying the spatial and temporal distribution patterns of invertebrates in salt marshes of Spiekeroog. Maria Rinke is focusing on soil fauna. Maria Börger adds to our knowledge by looking at the beetles and their diet. Using the experimental islands, they can also determine how well both of those groups are able to disperse to new habitats.

Sampling soil fauna can be challenging. Soil cores taken in the field (left) are brought to lab (middle) where the animals can be extracted and studied (right). (Photos: AG Tierökologie / UGö)

Salt marshes are at the border of land and sea. In addition to plants, benthic algae are important primary producers. Joanne Yong supervised by Dr. Stefanie Moorthi and Prof. Helmut Hillebrand is looking at the spatial algae-resource dynamics. This year they have been focusing on the dynamics in natural systems by collecting algal samples from Spiekeroog, Wangerooge and Norderney. They have found that sediment type and water content often determine the amount of algal biomass in these systems. Next year they will focus on lab experiments to investigate nutrient uptake and growth of benthic microalgae as well as their edibility for predators.



Algae are known to inspire many artists due to their beauty and variety. Here are some examples of benthic algae under microscope. (Photos: AG Planktologie / UOl)

How the aquatic consumers disperse and how the species are distributed along environmental gradients is studied by Jana Dewenter under the supervision of Prof. Ingrid Kröncke, Prof. Peter Schupp and Dr. Sven Rhode. This year, she has been focusing on resource availability in space and time and its effects on the invertebrate fauna in Wadden Sea. Jana has also been studying the abundance of larvae of benthic invertebrates in the water column. Next year she will focus on mesocosm experiments on food preferences, grazing rates and growth rates of benthic invertebrates.

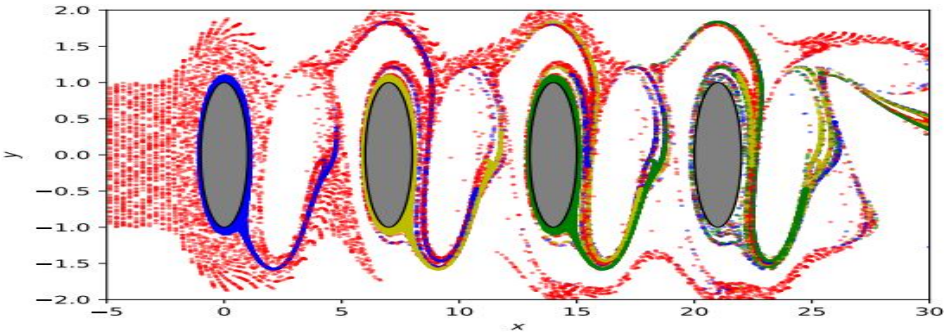
When there is water, there has to be fish. Right? Juan Camilo Cubillos supervised by Prof. Gabriele Gerlach and Prof. Arne Nolte is covering that part of the research in DynaCom. They are focusing on spatiotemporal distribution of sticklebacks and their adaptive traits. Combining field studies and mesocosm experiments, they are studying which genetic variations lead to adaptation to a freshwater or marine environment.

Freshwater (bottom), saltwater (top) and hybrid (middle) ecotypes of sticklebacks. (Photo: A. Nolte)

Environmental conditions at their immediate surrounding affect all organisms. Covering this part of the research, Daniela Meier from the Marine Sensor Systems research group led by Prof. Oliver Zielinski is measuring a large variety of environmental parameters – from air temperature to the speed and direction of currents. Data is already available for anyone in the PANGAEA® database and new data will continuously be added.

In 2020, a field container will be built on Spiekeroog for online access to some of the sensor systems. DynaCom will contribute to the Spiekeroog Coastal Observatory – a planned scientific platform managing research on the island.

Plant seeds dropped into the water at the edge of the salt marsh are carried to new places by water currents. A DynaCom PhD student at the Carl-von-Ossietzky-University Oldenburg, Deoclécio Valente, under the supervision of Prof. Ulrike Feudel, developed a computer model to study this process. The model simulates how small particles are transported by currents around islands. The model is now set up to represent an imaginary landscape, but will later be adapted to the East Frisian Islands and even to global ocean circulation models that represent current movements around the Earth.



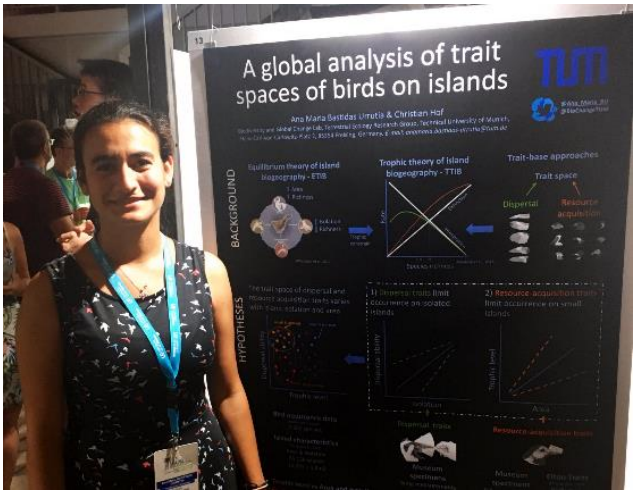
Simulated movement of particles (colored dots) around islands (grey ovals). (Graphic: AG Theoretische Physik / Komplexe Systeme / UOl)

Plant seeds and larvae of many marine animals are carried by the currents, but other creatures travel from place to place by swimming, flying or walking. These active forms of movement are studied by the DynaCom group (Alexander Dyer, Jördis Terlau, Dr. Björn Rall and Prof. Uli Brose) working at iDiv (German Centre of Integrative Biodiversity Research Halle-Jena-Leipzig). They are using miniature radio-trackers to monitor insect movement. First, chips emitting radio signals are attached to an insect's back, like a little backpack. Then it is placed in a landscape with hidden sensors, where it can run freely. Data generated from such experiments can be used to better understand how insects move around to find food or hide from their predators.

Insect with a tag and the setting up of the experimental units. The units mimic a forest environment, where the insects naturally live. (Photos: AG Biodiversitätsökologie / iDiv)

Alexey Dyer is also working on developing a global database on animal dispersal to study how the speed of active dispersal relates to body size and type of movement.

Thalita F. Arruda and Ana Maria B. Urrutia, working at Göttingen University and TUM under Prof. Holger Kreft and Dr. Christian Hof, are collecting data on plants and birds that live on islands. They use data from online databases to assemble lists of species living on each island. Not only that, they are also looking for information about the characteristics of species to be able to link them to island properties. For example, are isolated islands, far away from all continents, populated by birds that have better flight abilities? We don't know yet, but the question is very interesting. At least this is what the organisers of the Island Biology conference (La Reunion) thought, where Ana Maria presented her research ideas on a poster and won a price. Congratulations!



Ana Maria with her award-winning poster at the Island Biology Conference at La Reunion. (Photo: Holger Kreft)

Finally, Dr. Barbara Bauer (iDiv, Leipzig), under the supervision of Prof. Helmut Hillebrand and Prof. Uli Brose is working on simulation models that could integrate information from many of the projects. Such models could ultimately answer questions about why certain types of organisms populate islands.

For more information, check our website uol.de/dynacom

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