ISMER/IUEM joint PhD thesis

Fate of seaweed subsides in coastal zones

Summary

Subsidies are matter originating from a donor ecosystem to a recipient one. They play a crucial role in the functioning of communities and the dynamics of food webs (Polis et al. 1997). In temperate to polar coastal zones, brown macroalgae dominated by kelp form highly productive communities (Steneck et al. 2002). These seaweed generate detritus through the progressive erosion of their fronds, their fragmentation and the dislodging of entire thalli (Krumhansl et al. 2012). The organic matter thus produced is exported to adjacent ecosystems, sometimes washing up on beaches to form wracks and strandings. This transfer of seaweed from infralittoral bottoms to nearby rocky coasts is a common phenomenon, but one that is often poorly characterized and estimated.

Yet these freshly detached seaweed represent essential inputs for nearshore food webs, which are often considered to be of low productivity (Quintanilla-Ahumada et al. 2018). The organic matter from wrack algae supports the development of a rich and diverse food web, source of high secondary production (Hyndes et al. 2022). This organic matter can also be buried in coastal sediments, contributing to long-term carbon sequestration (Perkin et al. 2022). However, excessive accumulations can also cause coastal nuisance due to the degradation of organic matter producing methane or hydrogen sulfide (Liu et al. 2019). The aim of this thesis project is to understand the fate of macroalgal subsides in relation to wracks on the coasts of temperate Brittany and boreal Quebec and their role in the productivity of sea-wrack ecosystems by (1) detecting wrack in relation to marine weather events, (2) quantifying the degradation of wrack eaweed and associated carbon fluxes and (3) determining the role of subsides on the food webs of sea-wrack ecosystems.

Issues:

Although the biomass of algal wrack on beaches can reach up to 325 kg m^{-1} of coastline, estimating these wrack is complex due to the wide spatio-temporal variation linked to transport vectors, coastal geomorphology and the characteristics of the source ecosystems from which the macroalgae are removed (Hyndes et al. 2022). These wrack can support different coastal trophic levels, ensuring ocean-continent transfer, but their exact role remains poorly characterized and considered in coastal management and conservation plans. Finally, in some regions, macroalgal wrack have the economic potential for sustainable exploitation. In all cases, appropriate management measures need to be implemented to protect coastal zones.

Objectives:

Obj. 1 : Detect and quantify seaweed wrack in correlation with sea weather conditions

Algal accumulation on beaches depend on many variables, including the intensity of physical forces (currents, waves, ice, tides), the morphology and geology of the coast, and the species present in the donor ecosystems. Ground-truthed images obtained from monitoring cameras (e.g. surf spots, coastal erosion monitoring) will be correlated with meteorological and tidal data available on the coasts of Quebec

and Brittany, in order to assess the meteorological and tidal conditions most conducive to wrack, and the retention time of algae on the shore.

Obj. 2 : Quantify wrack degradation and carbon sequestration using multiple proxi.
The accumulation of seaweed wrack on beaches is of vital importance for nutrient recycling, trophic connectivity and the functioning of coastal ecosystems. These processes depend on macroalgal retention time and decomposition rate. The decomposition/remineralization of wrack and the quality of the organic matter in the sea shore will be measured in degradation experiments at different seasons. Isotopic and lipid markers will be used to monitor algae degradation, while their physiological state and photosynthetic capacity will be monitored using a PAM.

Obj. 3 : Determine the role of subsidies in sea wrack trophic
The transitional ecosystems formed by the sea wrack are home to original communities, including marine organisms (amphipods) and terrestrial organisms (insect larvae and adults), serving as a food source for predators, also marine (fish) and terrestrial (birds). While the importance of the intertidal zone for the associated assemblages is relatively well known for seagrass and salt meadow ecosystems, the trophic role of sea wrack ecosystems remains largely unknown. This third objective will focus on characterizing the structure of the trophic network associated with the wrack, including both resident and transient fauna, using a trophic biomarker approach coupling stable isotopes (δ13C, δ15N) and lipid tracers (fatty acids, sterols, alkanes).

References :

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Ressources and supervision team

PhD supervisor ISMER : Fanny Noisette
PhD supervisor IUEM : Gauthier Schaal

Project partners :

- Reseearch chair in coastal geosciences, Pascal Bernatchez, UQAR
- Arctus, R&D company expert in remote, Rimouski
- Christian Nozais, researcher in trophic ecology, UQAR
- Comité ZIP du Sud de l'estuaire, ONG, Coastal zone management
- Observatoire participatif de la biodiversité des hauts de grèves « Plages vivantes : Laisse de mer" (station de Concarneau)
- Maeva Gonzalvez and Antoine Carlier (Ifremer Brest)

Partnerships already in place in both Quebec and Brittany will enable the candidate to immerse themself in the professional world of seaweed harvesting and coastal environment management and conservation. Means of detecting groundings (e.g. cameras, drones) and equipment for characterizing degradation (e.g. PAM, incubation chambers, LICOR for measuring CO2 emissions) are already available in the supervision teams. LEMAR's isotope and lipid analytical platforms, as well as ISMER's at-sea and experimental resources, will be made available to the candidate to carry out their research project.

Eligibility criteria :

- Hold a master's degree (M.Sc.) in natural sciences, biology, ecology or a related discipline.
- Have an average grade of more than 3.2/4.3, 3.0/4.0 or 11/20 at the graduate level. However, special consideration will be given to candidates with an average slightly below 3.2, but with excellent confidential reports and relevant marine experience.
- Confidential evaluation reports or letters of recommendation must unreservedly establish the candidate's suitability for doctoral studies.
- Very good knowledge of French and sufficient knowledge of English.

We subscribe to an equal opportunity program, and our environment promotes the values of equity, diversity and inclusion, with accommodation measures in place where necessary. We strongly encourage women, people with disabilities, visible and ethnic minorities, Aboriginals and members of the LGBTQ2E+ communities to apply. UQAR recognizes the impact that career interruptions can have on the evaluation of research achievements. If this is the case, the candidate is invited to explain the situation in their application file.

Narrative CVs are accepted in the same way as regular CVs, and should be accompanied by a letter of application describing the candidate's motivations for pursuing research, their suitability for the research subject, and their openness to entering a joint PhD program between Quebec and France.