Among the cues that animals use to communicate, olfactory signals or pheromones are especially interesting because they escape the human eye and may seem to be secondary to other forms of communication. However, although vertebrate pheromones have been somewhat neglected, behavioral studies have shown that they are essential for reproduction, finding food and even for staying alive in many animals.
Pheromones are composed of several lipid and/or protein components and are usually different even between closely related species. Despite the importance of pheromones in animal communication, we lack an understanding of the mechanisms maintaining their extraordinary diversity, as well as an evolutionary perspective of the role of environmental conditions in shaping their composition. In principle, the chemical composition of a pheromone should be narrowly correlated to the environment that a species inhabits because this maximizes the efficiency of signal transmission to the intended receivers. Indeed, climatic parameters such as temperature and humidity affect the rate of evaporation of chemical signals, and should shape the evolution of the pheromones towards efficiency in their environments. Still more marked are the differences between aquatic and terrestrial habitats, as they strongly differ in terms of physical and chemical qualities, factors that would promote the evolution of divergent pheromones between aquatic and terrestrial animals.

Our main goal is to use turtles – an ancient group of vertebrates – to study the effect of environmental factors on pheromone composition under a phylogenetic framework, i.e. incorporating the evolutionary history of the group. A phylogenetic perspective is important because closely related species tend to be more similar looking, and thus they may also have more similar pheromones simply because of their closer relationships. The suitability of turtles to test hypotheses on how pheromones evolved in different habitats is supported by their excellent olfactory abilities that allow them to detect chemical cues in the environment, as well as by the fact that they inhabit a wide range of environmental conditions, including terrestrial and/or aquatic habitats. One of the main tissues that produce pheromones in turtles are mental glands - paired structures on the skin of the throat. It has been shown that the secretions (composed of lipids and proteins) produced by mental glands have a pivotal role in intraspecific communication in turtles, functioning as pheromones. However, many turtle species have never been assessed for mental gland presence, and their chemical composition has only been superficially studied. In the first phase of the project we plan to survey a large number of turtle species to map the presence (or absence) of mental glands across the turtle phylogeny, inferring how this trait changed over time. We will also determine the anatomy and histology of mental glands in several previously unstudied turtle species. Next we will select a representative subset of turtles with mental glands in which we will determine the lipid composition of pheromones, taking into account their phylogenetic affinities. This will allow a test of whether pheromones evolved in sync with the climatic and geophysical conditions of their habitats, and will provide an evolutionary perspective on how pheromones have evolved in this group. In some selected species we will also study the protein component of pheromones, determining for the first time the full range of compounds (lipids and proteins) that compose pheromone secretions in turtles.