

Sensory Ecology, Winter 2011
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COURSE SYLLABUS

We are all familiar with vision, hearing, touch, taste, and smell, the sensory modalities we depend on most when we interact with our environment. What about sensing magnetic fields for navigation? And electroreception, the ability to sense electrical fields, what about that? Some animals “see” images by the heat they give off. How in the world do they do that? Some pelagic birds navigate across the entire Pacific using smell and some cetaceans communicate over hundreds of miles by sound. In this course we explore the senses, the familiar ones and the ones that are special to aquatic animals, with emphasis on the adaptations of sensory systems to aquatic life and on the importance of sensory systems to the ecology of marine animals. We will look into mechanisms at the cellular level and the neuro systems level, and we will study the role of sensory adaptations in behavior and ecology.

TOPICS

The sensory world

- The kinds of information that the world presents that can be utilized by biological sensors, and how information theory helps us understand its structure
- The nature of aquatic information channels and the importance of channel “noise”
- The need to “transform” energy in the environment in order to make it available to biological sensors
- The nature and importance of “energy filters” in sorting “important” elements in the energy impinging on an organism

Photoreception

- The quantum nature of photons
- The electromagnetic energy spectrum and what it means for organisms
- The variety of photoreceptors nature has devised

Primitive cellular photoreception

Vertebrate photoreceptors

- The mechanism of sensory transduction.
 - Quantum efficiency
- Specializations for aquatic life
 - The watery visual world
 - Bioluminescence – how it works and what it means
 - Color vision in mate selection in fishes
 - Adaptations for seeing at very low light levels
 - The role of visual adaptations in resource partitioning

Heat detectors and “seeing”

The strange case of the octopus eye

Arthropod vision

- Photoreceptor types and mechanisms of sensory transduction

Neural adaptations for visually guided behaviors
UV, IR and polarization detection

Olfaction and taste (chemosensation)

The distinction between olfaction and taste
The variety of cellular mechanisms among the vertebrates and invertebrates
Pheromones, detection at the absolute limit of sensitivity
The ecological importance of olfaction, for example in mate and habitat selection, and the essential role of olfaction for navigation in pelagic birds
Behavioral consequences of chemical pollution in aquatic environments

Hearing

Comparison of auditory organs in verts and inverts
Cellular mechanism of vertebrate hearing – the hair cell and sensory transduction
Hearing in marine environments
 Hearing in fishes – otolith organs and swim bladders
 Hearing in dolphins and whales
 Cetacean auditory capabilities, biological sonar
 Man made noise in the cetacean sensory channel and its effects on behavior
 Implications of the recent US Supreme Court decision
Auditory communication in cetaceans, lobsters, fishes, and seals – methods of sound production and reception and the varied ecological roles

Mechanoreceptors and touch

Near-field motion detection in fishes
 Neuromasts, lateral lines and fish behavior
Arthropod mechanoreceptors and neural mechanisms of fast escape responses

Electroreception

Electric field production and reception in fishes
Cellular mechanisms – ion channels and receptor cells
Role in guiding behavior (mating, navigation and predation)
The odd story of platypus electroreception

Magnetoreception

Prevalence in bacteria, birds and inverts
Mysteries surrounding mechanism
Importance to navigation