

Using iNaturalist to learn more about echinoderms

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Context

Echinoderms are among the most conspicuous and abundant marine invertebrates. Several species of echinoderms undergo important demographic fluctuations, with important ecological consequences, for reasons that are not always well understood (e.g., crown-of-thorns outbreaks, *Diadema antillarum* die-off, starfish-wasting-syndrome, reviewed in Uthicke et al. 2009). In addition, many species are targeted by unregulated fisheries (e.g., Purcell et al. 2014).

Despite these factors, echinoderms have not received a lot of taxonomic attention, and many large species remain undescribed and/or poorly known. Regularly, field guides illustrate undescribed species, and divers commonly photograph new or poorly known species.

With recent technological advances, it has become increasingly easier to document species encountered in nature. For instance, smartphones can, with the single touch of the screen, take a picture while associating the exact geographical location and time of the observation. Digital cameras have made underwater photography much more accessible, and many divers now document the species they encounter by sharing their pictures on social media websites.

Our knowledge of echinoderms could therefore be improved by aggregating user observations of these organisms, while, at the same time, educating the public about the diversity and natural history of these fascinating organisms.

What is iNaturalist?

iNaturalist (<http://inaturalist.org>) is a website that allows users to submit observations about any species (on land or underwater), along with images, GPS coordinates and ancillary information about the habitat or natural history (Figure 1). Once submitted, the observations can be further identified by the community and validated by "curators" (users with recognized knowledge of a given taxonomic group whose opinion can be trusted). This mechanism allows users to hone their identification skills, learn about the organisms, and communicate with each other. Observations, in turn, provide a wealth of information about distribution, variation, abundance, and other aspects of natural history.

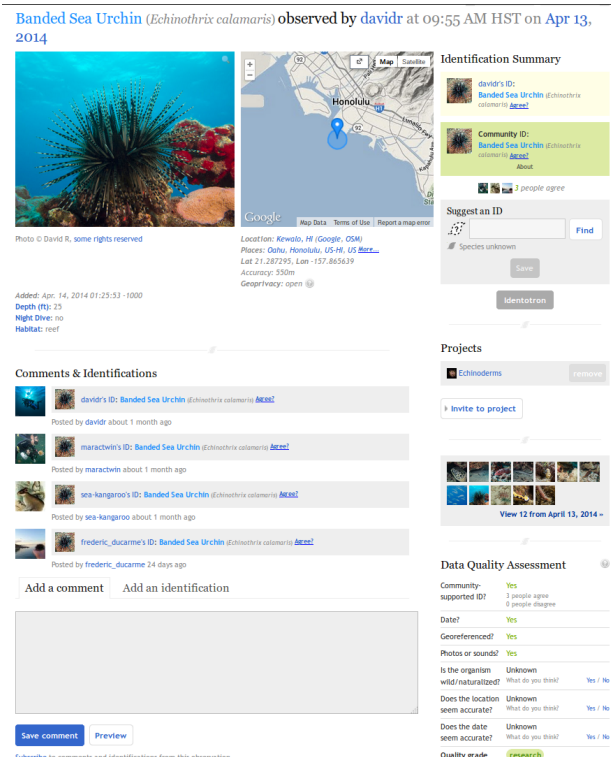


Figure 1: Example of an user-submitted observation

The Echinoderm project on iNaturalist

We started a project on Echinoderms (<http://inaturalist.org/projects/echinoderms>) to gather observations worldwide, and across taxa. Our goal is to improve our knowledge of species distributions, variation, and biology, and to educate the public about the diversity of echinoderms. This platform provides a great outreach tool facilitating communication between scientists and naturalists. Because iNaturalist is easy to use and has applications for mobile devices, it can also be used during organized citizen science initiatives such as Bioblitz, or class field trips.

Beyond outreach, iNaturalist can be a useful tool for scientists. Echinoderms are among the few mobile invertebrate regularly recorded in coral reef ecosystem monitoring. By submitting species observations on iNaturalist, data will be archived, accessible, and shareable with the community. Additionally, it is also an opportunity to obtain accurate identification for the species encountered with the help of the community.

The aggregated data is made openly available and can be used by scientists to study demographic and spatial patterns, or even to infer distributions using ecological niche modeling. For instance, recent taxonomic research on sea cucumbers has shown that species can be told apart based on their color patterns (e.g., Kim et al. 2013; Kerr 2013). However, taxonomic confusion through the years has hindered our knowledge of species distributions, as the incorrect species names have extensively been used in the literature. Having photographic evidence associated with geographical data will allow to validate geographical distributions once taxonomic research has clarified species limits. Furthermore, iNaturalist could be very useful to track through space and time changes in species abundance during a crown-of-thorns outbreak for instance.

Present and future observations

Since the beginning of the project in March 2014, over a hundred users have already contributed 850+ echinoderm observations worldwide. Currently, large and abundant species from the intertidal of the Western United States dominate, reflecting the development of iNaturalist in California (Figure 2). However, underwater sightings from the Caribbean and the Indo-West Pacific also represent a large proportion of the observations and indicate the potential of iNaturalist to document marine invertebrate biodiversity.

We aim at expanding both taxonomic and geographic coverage. Many species of echinoderms can be found associated with coral reefs, and for most, their geographical distribution is poorly known. Reef scientists can improve our knowledge of their distribution by reporting the species they see in the field. Additionally, we are in the process of advertising the project to the SCUBA diving community and through citizen science initiatives to increase participation.

We welcome everyone to submit their echinoderm observations, or help curating the records submitted to the project. Don't hesitate to join us!



Figure 2: Global distribution of observations recorded by iNaturalist users as of May 29th, 2014 per class

Methods

This article is open-source (CC-BY), fully reproducible and available on github (<http://github.com/fmichonneau/inat-paper>). It was made possible using R (R Development Core Team, 2014) complemented with the packages ggplot2 (Wickham, 2009), knitr (Xie, 2014), taxize (Chamberlain and Szöcs, 2013; Chamberlain et al., 2014), and wesanderson (Ram, 2014).

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