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Short Communication

Blue button (Cnidaria: Hydrozoa) distribution and trends in the Mexican Atlantic, based on field surveys and open-access data

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ABSTRACT. Access to digital technology and software allows the production of a significant amount of biodiversity data, including citizens' species records, combined with field monitoring and standardized surveys, which are valuable to biological sciences; these data can help to know the distribution of organisms like medusozoans. We compiled records of the presence of *Porpita porpita* from open-access databases, scientific articles, and field observations to know their current distribution on the Mexican Atlantic for the first time. The yearly records of *P. porpita* increased over time, adding up to 22 records, of which 18 were assigned to citizen science. Most records correspond to 2011-2022, from April to May, and the Veracruz and Quintana Roo states. The records of the species in warm months and states with long shores can be related to an increase in touristic activities and observations by citizens. On the Mexican Atlantic, it is suggested that the use of digital technological devices under citizen science practices for recording *P. porpita* and its compilation in open-access databases acts as the principal method for tracking the distribution of this species. This work evidenced the need for a solid research framework of knowledge for *P. porpita* in the Mexican Atlantic, and future research could combine citizen science records and fieldwork records and improve the relationship between biological and oceanographic data to understand their spatial-temporal distribution patterns.

Keywords: *Porpita porpita*; Medusozoa; Capitata; pleustonic cnidarian; free-floating species; databases; Mexican Atlantic coast

The technology and software of our days have allowed the generation of a significant amount of biodiversity data, helpful to biological sciences (Dickinson et al. 2012, Ivanova & Shashkov 2021, Gueroun et al. 2022). Data about observations of organisms recorded by citizens is of immense value to ecological, evolutionary, and conservation research (Tiago et al. 2017, Petrovan et al. 2020, Robinson et al. 2020). The biodiversity information from citizen science frequently is opportunistic data, only presence records of organisms without a sampling design, and without a method to standardize (Van Strien et al. 2013, Karppinen et al. 2022). However, the alliance of citizen science, field monitoring, and standardized surveys has revealed an increase in the spatial range of some species, distribution trends, and the distinct phenologies of populations in different ecoregions (Van Strien et al. 2013, Robinson et al. 2020, Gueroun et al. 2022).

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The opportunistic data is a valuable tool to answer one of the main questions of ecology, knowing the species distribution to solve biodiversity conservation and management in the face of climate change (Dickinson et al. 2012, Tiago et al. 2017, Ivanova & Shashkov 2021. Some ways of application from citizen science records to the conservation of biodiversity are monitoring the decline of species (Petrova et al. 2020), building forecasts of management programs (Bradter et al. 2021), and detecting invasive alien species (Mannino & Balistreri 2018). This tool has been used for zooplanktonic species, including the medusozoans (e.g. Nordstrom et al. 2019, Marambio et al. 2021, Gueroun et al. 2022, Nascimento et al. 2022), which play an essential role in the trophic web because they are renowned for their predation potential on copepods, fish eggs and larvae, small fishes, and other gelatinous planktonic taxa (Purcell 1999) and transfer the matter and energy to other trophic levels as prey of organisms like fishes, sea turtles, and seabirds (Schiariti et al. 2018).

Of the medusozoans (Cnidaria, Medusozoa), the class Hydrozoa is the most diverse group, counting 91% approximately (3874 species) of the total species of Medusozoa (WoRMS Editorial Board 2023). The hydrozoans present different morphologies according to live cycles, found in the medusa, polyp, polygastric, or eudoxid stage (Marques & Collins 2004, Mills et al. 2007). The medusae are generally planktonic; however, some colonies of polyps are also, for example, members of the family Porpitidae, genus *Porpita* (Calder 2010). These hydrozoans in marine and freshwater ecosystems are predators of phytoplankton and zooplankton groups (Wintzer et al. 2011, Deserti et al. 2017, Di Camillo et al. 2017). The presence of these hydrozoans can be helpful in nature and human well-being because they reflect the conservation status of the marine ecosystem and are bioindicators of hydrographic conditions (Bieri 1977, Edwards 2012, Yilmaz et al. 2020). Notably, the occurrence on the shores and offshores of the blue bottom *Porpita porpita* have been poorly studied, associating this phenomenon with marine currents and winds (Pandya et al. 2013, Chowdhury et al. 2016, Sahu et al. 2020).

In this context, although Mexico has a platform that hosts records of marine species (https://www.naturalista.mx) and a website for the dissemination of medusozoans (https://medusozoamexico.com.mx), which encourages the general public and make these organisms known, consequently increasing the number of observations, today, the available data have been few used. For this reason, we recompiled records of the presence of *P. porpita* on open-access databases and complemented them with literature surveys and occasional observations on the Atlantic coast.

The records of the hydrozoan *P. porpita* to November of 2022 were obtained from open-access databases: GBIF (iNaturalist 2022, Orrell 2022), OBIS (NMNH 2001), and Naturalista (Naturalista 2021) to approximate the distribution of *P. porpita* on the Mexican Atlantic coast (Gulf of Mexico and Caribbean Sea), following the search term "*Porpita porpita*". Additionally, some records were acquired through occasional encounters (Medusozoa México collaborators or the general public) and scientific articles about the presence of the hydrozoan along the coast of the Mexican Atlantic. A total of 35 data were filtered, selecting only the georeferenced and dated data, and was removed duplicate records. Three OBIS records were discarded because they did not match the geographic data with the source referenced (Behre 1950) in Calder & Cairns (2009).

The occurrence data of *P. porpita* on the Mexican Atlantic coast were divided per decade (1932-2022) and represented in maps using ArcMap v.10.5 software. We graph the yearly and accumulated records through time, from the first record to 2022. In addition, we plotted a bar graph including the number of hydrozoan records ordered by month and the State of Mexico, with the software environment of R v.4.1.3 (R Core Team 2022) with the package ggplot2 (Wickham 2016).

A total of 23 records of *P. porpita* were found in the Mexican Atlantic, of which 18 were obtained from records of open-access databases, four occasional encounters (Figs. 1-2), and one in scientific articles (Fig. 2). Only two records have preserved specimens, one from 1932 (Orrell 2022), and another was a product of an investigation realized from 1999 to 2000 (Gasca et al. 2003). All other records were from human observations. From the human observations, 12 were from the GBIF database, five were from the Naturalista Investigation grade, and four were from Medusozoa México (Fig. 2).

The 1931-1940 and 1991-2000 periods showed one record each, while from 2011 to 2020, increased to 16 records of *P. porpita*. The year with the most records was 2018, with five records, followed by 2015, with four (Fig. 3a). The months with the most records were May and April, with four records each, while February did not have an occurrence of *P. porpita*. Regarding states, Quintana Roo had the highest number of records, with eight; Yucatán the lowest, with only one record; in Tabasco, the species has not been recorded yet (Fig. 3b).

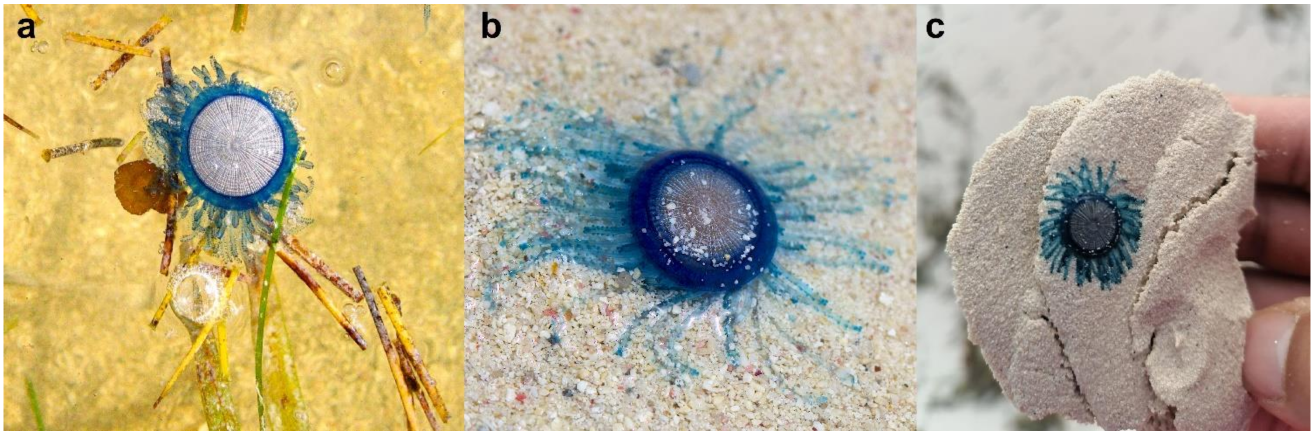

Figure 1. Colony of the hydrozoan *Porpita porpita*. a) Xcalak beach (2006). Photograph by Laura Carrillo, b) Mahahual Beach (2017). Photograph by Carmen Rosas, c) Puerto Morelos Beach (2021). Photograph by Eden Magaña-Gallegos.

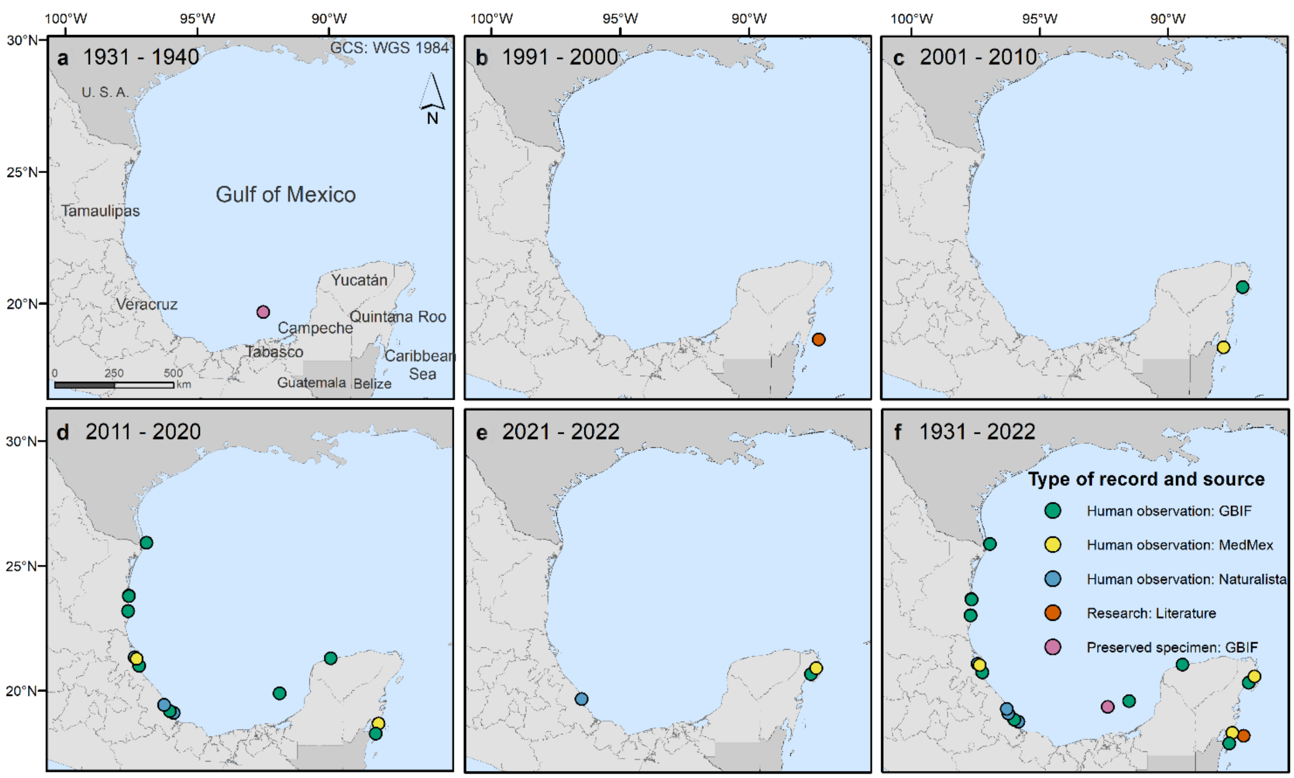

Figure 2. a-f) Records of *Porpita porpita* in the Mexican Atlantic per decade and accumulated from 1931 to 2022. Decades without records were not represented in this figure. Each point color represents the type and source of the record.

The increase in records of *P. porpita* through time can be attributed to the use of technological devices and software development because access to smartphones, cameras, and GPS facilitates the registration of organisms by non-experts in the field, combined with the stranding behavior of the species that makes it accessible to people on the beach, and the easy identification at a glance of the blue button jellyfish in comparison with other medusozoans (e.g. *Aegina* spp. and *Aurelia* spp.; Lindsay et al. 2017, Scorrano et al. 2017, Lawley et al. 2021), this leads to that more than half of the total records of the colonial hydrozoan in the Mexican Atlantic were from biodiversity open-access databases generated through citizen science. The current

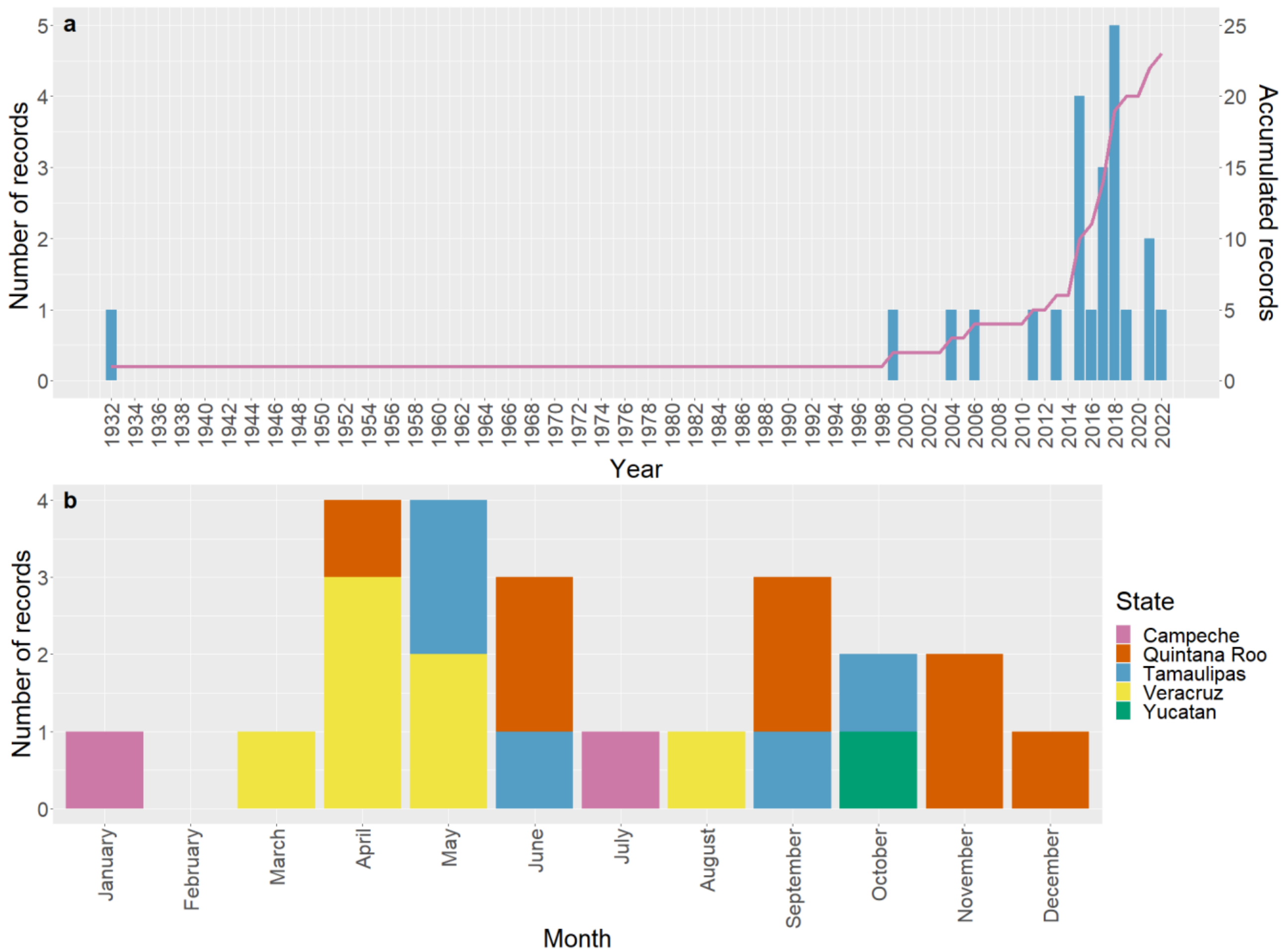

Figure 3. Number of records of *Porpita porpita* in the Mexican Atlantic. a) Through time per year (blue bars) and the number of accumulated records (pink line), b) by month and state, each color represents a different state.

distribution status of other free-floating species in Mexico, such as *Velella velella* (sea raft), is known from citizen science records (De la Cruz-Francisco & Mendoza-Becerril 2022).

These databases can play a crucial role in the evolutionary, ecological, and conservation research of *P. porpita* since they bring access to taxonomic revisions (Telenius 2011), niche modeling (Telenius 2011, Tiago et al. 2017, Robinson et al. 2020), population monitoring declining (Petrovan et al. 2020), and forecasts of management programs to mention a few examples (Bradter et al. 2021). However, sometimes, it is necessary to do an exhaustive search of original resources and review each georeferenced record, as in the case of records in the OBIS database in this study; a similar situation is mentioned in other studies (e.g. Lindsay et al. 2017).

The months with the higher number of records of the blue bottom were on the warm months of April and May and followed a similar pattern of the sightings records of another pleustonic and stranding hydrozoan, *V. velella* (De la Cruz-Francisco & Mendoza-Becerril 2022). They are coinciding with second holiday periods with more tourism (SECTUR 2023), which cause an increase in the records of the hydrozoan as a consequence of the potential improvement in the sighting's effort and the stranding phenomenon of the life cycle of these pleustonic species. The states with the most records match the states with the most extended total length of the Mexican Atlantic littoral and with more tourism, 745 km/600,000 Veracruz, and 1176 km/1,600,000 Quintana Roo (INEGI 2023, SECTUR 2023, SEDECOP 2023).

The data product from open-access databases represents an important contribution to analyzing the spatial-temporal distribution of medusozoans given that encounters with these planktonic animals are occasional and, consequently, the study of their biology and ecology is limited (Gatt et al. 2018). The jellyfish records from open-access databases have been used to study the abundance and temporal variation of several species (e.g. *Pelagia noctiluca*, *Cotylorhiza tuberculata*, *V. velella*, and *Rhopilema nomadica*) and relate its presence with the environmental variables like temperature, nitrates, and phosphates (Gatt et al. 2018) or wind and marine currents (Gutiérrez-Estrada et al. 2021, Edelist et al. 2022). In the case of *P. porpita*, its presence has been related to the wind circulation and marine currents (Pandya et al. 2013, Chowdhury et al. 2016, Sahu et al. 2020), nevertheless to the Mexican Atlantic has not count enough records to approximate the hydrozoan distribution and relate with oceanographic data to understand their distribution patterns yet.

A key point in using species records generated by open-access data in the study of medusozoans is the search and the automation of a method to normalize and standardize the data to decrease the bias from surveys without sampling design and different sampling efforts (Gutiérrez-Estrada et al. 2021). Furthermore, the need for divulgation material and implementing programs that approximate the knowledge of diverse jellyfish species to the general public for its identification on the shores (Gatt et al. 2018) is essential to generating a medusozoan presence database in México.

For example, MedusApp is a Spanish software for smartphones that permits the record of jellyfish with abundance and coordinates by citizens; the app counts with descriptions and images that can be used to identify diverse species (Blasco-Talaván et al. 2016). Regarding México, the website Medusozoa México (https://medusozoamexico.com.mx) is a source of divulgation material that can approximate the medusozoans to non-experts or interested people.

Using opportunistic data from open-access databases is the first approach to knowing the distribution of *P. porpita*. However, the integration between citizen science and monitoring fields is of great importance to the study of the biology and ecology of pelagic medusozoans, not only to know its distribution but to analyze its role in ecosystems and impacts on human activities like tourism, fisheries, and mariculture (Gutiérrez-Estrada et al. 2021, Edelist et al. 2022).

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