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A bloom of an edible scyphozoan jellyfish in the Red Sea

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Abstract A bloom of the edible jellyfish *Cephea cephea* (Forskål, 1775) in the Red Sea is reported here from archived photographic evidence. Animals (10–20 cm wide) were observed in seven different reefs and accumulated at high densities on some beaches of Marsa Alam, Egypt. Various coral reef fishes preyed on this temporary resource. Although the jellyfish is native to the Red Sea, this is the first record of such an event in this ecosystem, and only the second record of this phenomenon since the 1800s.

Keywords *Cephea cephea* · Fish predation on jellyfish · Gelatinous zooplankton · Scyphozoa

Introduction

Large gelatinous zooplankton blooms are increasing in frequency worldwide as a result of eutrophication, species introductions, and climate change, among other possible factors (Mills 2001; Purcell et al. 2007; Richardson et al. 2009; Purcell 2012; Boero 2013). The negative effects of such blooms are many. In addition to changing the structure and dynamics of open water food webs, blooming species can clog

the intakes of cooling systems in power plants, obstruct fishing nets, and reduce stocks of commercially important fishes by feeding on eggs and larvae (Purcell et al. 2007; Dong et al. 2010).

While blooms of several jellyfish (Scyphozoa), comb jellies (Ctenophora), and salps (Thaliacea) have been well documented (Dong et al. 2010; Purcell 2012), information for many species remains scarce (Mills 2001). This has motivated the establishment of observation networks in which the public can record jellyfish sightings and bloom locations (<http://jellywatch.org/>, <http://www.mcsuk.org/sightings/jellyfish.php>). Large gelatinous zooplankton blooms have been reported most often from semi-enclosed marine water bodies, but this may be an artifact of fishing and ocean traffic routes, as open ocean and deep water species may also form aggregations (Mills 2001; Omori and Nakano 2001; Dong et al. 2010). Apparent links between blooming dynamics and asexual stages of jellyfish have also motivated studies on the factors controlling specific parts of jellyfish metagenetic life cycles (Mills 2001; Schiariti et al. 2014) and the development of comprehensive keys for ephyrae of blooming species (Strachler-Pohl and Jarms 2010).

In the Red Sea, seasonal blooms of gelatinous zooplankton have been documented, with *Aurelia aurita* being the most common jellyfish observed (Alamaru et al. 2009). Pelagic tunicates and ctenophores also become abundant in some areas during the spring and early summer months (Cruz-Rivera, personal observation), but relatively little is known about the biology of large gelatinous zooplankton in the Red Sea, including commonly seen jellyfish such as *Cephea cephea*. Some published works have argued that this and other species in the genus *Cephea* are capable of forming blooms (Dawson and Hamner 2009; Hamner and Dawson 2009). However, clear evidence to support this assumption is needed. *Cephea cephea* is an edible species that is harvested in

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Southeast Asia (Omori and Nakano 2001), with a distribution comprising the Indo-Pacific and Red Sea (Mayer 1910; Tokioka 1964; Kramp 1970; Gershwin 2003). Although commonly seen, no instances of large aggregations for the Red Sea were found in the literature.

Here, a bloom of *C. cephea* in the Red Sea coast of Egypt is documented. While the bloom occurred in 2011, the publication of these observations has been hindered by the assumption that *C. cephea* blooms are a well-known fact. Review of the literature on this species, in English, Spanish, German, and Arabic, back to the early 1900s revealed otherwise.

Materials and methods

Biodiversity surveys were conducted in the area of Marsa Alam (25°04'N, 34°54'E), on the coast of the Egyptian Red Sea (Fig. 1), during the late summer (September) of 2011, as part of a large-scale assessment of the local marine resources. Surveys were conducted through the National Institute of Oceanography and Fisheries, in association with Port Said University, Suez Canal University, and the Egyptian Environmental Affairs Agency. During visual fish surveys at various reefs, a high abundance of jellyfish was noted and photographic evidence of these events was collected. Observations also showed that reef fishes preyed on these jellyfish. Thus, we contacted the manager of Red Sea Diving

Safari (Marsa Shagra) to seek out volunteers among divers who frequented these reefs as part of their tours, who could provide photographic observations of this phenomenon. The reefs are located within a protected region of the Red Sea, thus precluding the collection of specimens or trawling to obtain specific jellyfish population densities. Given the impossibility of collecting animals, identification of the jellyfish was done based on high-resolution photographs of various parts of the animals from diverse angles. Details of the umbrellar margin, lappets, rhopalar clefts, dorsal dome, size and number of protuberances (warts or papillae), oral surface features, and general body morphology were compared to the descriptions and figures provided by Mayer (1910) and Tokioka (1964). The taxonomy of this genus has been greatly simplified since the original descriptions, which recognized a number of varieties and species, with only two species confirmed according to modern standards (Gul et al. 2015; WoRMS 2015).

Results

Cephea cephea blooms were observed at Abu Dabbab, Al Ghadeer, Marsa Alam, Shagra Bay, Qul'an, Sharm El Fujiri, and Abu Ghosun (Figs. 1 and 2a, b) during September 16–20, 2011. This encompasses reefs up to 92 km apart (Fig. 1). Jellyfish were approximately 10–20 cm in diameter (Fig. 2c) and provided an opportunistic food source for a diverse array

Fig. 1 Locations of the reefs where *C. cephea* blooms were observed during September 2011

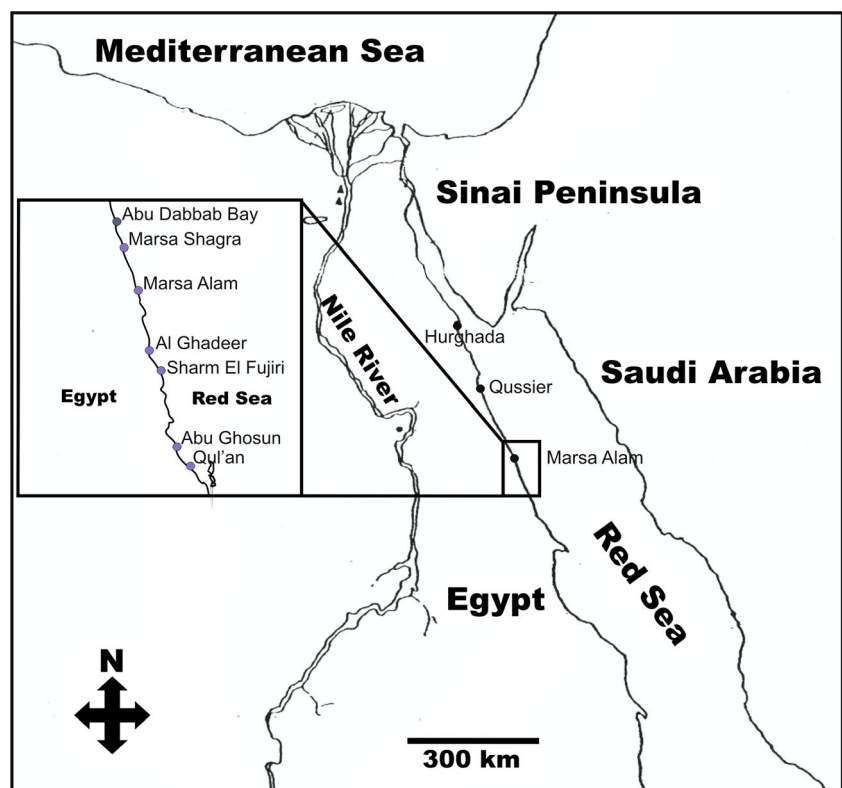
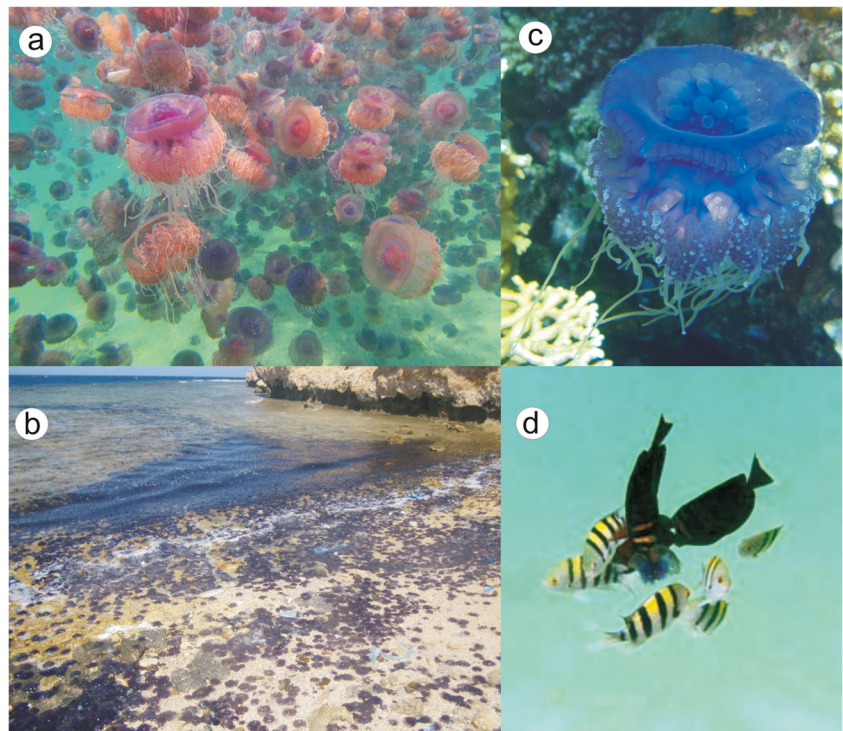


Fig. 2 Aggregations of *Cephea cephea* at Qul'an (south Marsa Alam, 24°21'37"N, 35°17'52"E) (a). Tens of thousands of jellyfish washing ashore in Sharm El-Fujiri (2°45'21"N, 35°4'4"E) (b). Detail of an individual *C. cephea* showing the characteristic large protuberances on its dorsal dome (c). Tangs (*Zebrasoma desjardini*) and sergeant majors (*Abudefduf vaigiensis*) feeding on a *C. cephea* (center) at Marsa Shagra (25°14'47"N, 34°47'34"E) (d)



of coral reef fishes (Fig. 2d), primarily sergeant majors (*Abudefduf vaigiensis*), butterflyfish (*Chaetodon auriga* and *C. fasciatus*), rabbitfish (*Siganus rivulatus* and *S. stellatus*), and tangs (*Zebrasoma desjardini*). Other fish that were infrequently seen biting *C. cephea* included the emperor angelfish (*Pomacanthus imperator*), the orange-lined triggerfish (*Balistapus undulatus*) and the Suez fusilier (*Caesio suevica*). Because the reefs were within an area designated as a Red Sea reserve, we could not perform tows to directly estimate *C. cephea* densities, but assessments from photographs suggested densities of up to 20 individuals/m³ in some reefs.

Discussion

Blooms of *Cephea cephea* occurred at various reefs in the Egyptian Red Sea during the summer of 2011. Surveys have not observed *C. cephea* outbreaks during following years, underscoring the variability of these events. A number of coral reef fish preyed on the jellyfish, similar to previous observations during *Aurelia aurita* blooms elsewhere (Cruz-Rivera and Abou El Hassan, unpublished). Other studies have indicated the consumption of large gelatinous zooplankton by crustaceans, gastropods, cephalopods, fish, seabirds, sea turtles, and even corals (Harrison 1984; Heeger et al. 1992; Choat et al. 2002; Arai 2005; Crossman et al. 2005; Alamaru et al. 2009; Heaslip et al. 2012; Hoeksema and Waheed 2012). Our observations expand on the evidence that various tropical reef fish supplement their diets with these

ephemeral resources, including species like tangs and rabbitfish, which are largely considered herbivores (Choat et al. 2002; Crossman et al. 2005).

While *C. cephea* was described in 1775 by Forskål (1775), the first experimental insights into its life cycle appeared almost 200 years later (Sugiura 1966), and only a handful of works are available on its biology or ecology (e.g. Mayer 1910; Tokioka 1964; Ohtsuka et al. 2009; Schiariti et al. 2014). Although this species has been generally assumed to form blooms, the literature on this aspect is inconsistent. Hamner and Dawson (2009) place the genus *Cephea* among those capable of forming blooms, but they cite Omori and Nakano (2001) as their support. Yet, the latter authors only state that *Cephea cephea* is among 11 species worldwide exploited for consumption (which only requires a species to be common) and never make any statements regarding bloom formation. Also supporting the unusual nature of the bloom described here, these same authors characterize areas where jellyfish blooms are common as having large tidal ranges, being semi-enclosed, experiencing freshwater inflow, and being bordered by mangroves (Omori and Nakano 2001). None of these characteristics match the areas where our observations were made. The case is similar for the congeneric *C. conifera*, which has been recorded in areas where other jellyfish bloom, but for which no data on bloom formation exist (Dong et al. 2010).

Using a phylogenetic analysis, Dawson and Hamner (2009) argued that zooxanthellate *Cephea* species do not form blooms, whereas non-photosynthetic ones (like *C. cephea*) do.

While this is possible, *C. cephea* polyps have zooxanthellae (Sugiura 1969; Schiariti et al. 2014), whereas the medusae do not, making the assignment of this species to either group ambiguous. Furthermore, from the four species of *Cephea* recognized by most researchers, one has not been taxonomically confirmed (*C. octostyla*) and another (*C. conifera*) is considered by some researchers to be a morphotype of *C. cephea* (WoRMS 2015). Given the small number of species in the genus (possibly only two), a comparison between photosynthetic and non-photosynthetic species is not supported. Considering the above, the observations documented here are the first evidence of *C. cephea* blooms in the Red Sea. Only one previous observation suggests an aggregation behavior for this species. In the description of *Cephea cephea* var. *dumokuroa*, Mayer (1910) states: “A large swarm of these medusae was found upon the surface off Vanua Mbalavu Island, Fiji Islands, on November 25, 1897.”

The ecological effects of such blooms on Red Sea plankton communities and on trophic transfer between the water column and benthos, through fish consumption, remain to be quantified. The ultimate mechanisms leading to this bloom are unknown, but the lack of previous records suggests that this is not seasonal. Recently, the variables controlling strobilation and ephyra release in several jellyfish, including *C. cephea*, have been assessed as a way of understanding bloom dynamics (Schiariti et al. 2014). As eutrophication, habitat degradation, and climate change continue to affect the Red Sea (Hawkins and Roberts 1994; Pandolfi et al. 2003; Rinkevich 2005), monitoring the frequency of gelatinous zooplankton blooms may provide key information on the consequences of these changes. Furthermore, an increase in the frequency of blooms of *C. cephea* and other jellyfish in the Red Sea may enhance the opportunity for such species to be transported through the Suez Canal into the Mediterranean. Lessepien introductions have already occurred for a number of scyphozoan jellyfish (Boero 2013) and are predicted to increase with the recent expansion of the Canal (Galil et al. 2015).

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