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From Sand to Bell: Novel Predation of Scyphozoans by the Giant Caribbean Sea Anemone *Condylactis gigantea* (Weinland, 1860) from the Western Atlantic

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Abstract: Predation is a fundamental ecological process that shapes marine ecosystem dynamics. This study reveals a novel predator–prey interaction between the giant Caribbean sea anemone *Condylactis gigantea* and the two jellyfish species *Cassiopea* sp. and *Aurelia* sp., challenging traditional understanding of sea anemone feeding habits. Observations from citizen science platforms and field recordings documented *C. gigantea* successfully capturing and consuming these gelatinous marine organisms. The research highlights the trophic plasticity of *C. gigantea*, demonstrating its ability to prey on larger gelatinous organisms beyond its traditionally known diet. This predation event represents a possible benthic–pelagic coupling mechanism and underscores the value of citizen science in capturing rare ecological interactions.

Keywords: benthic–pelagic coupling; citizen science; jellyfish; marine food webs

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1. Introduction

Predation is a fundamental ecological process that shapes species distribution, abundance, and community dynamics in marine ecosystems [1–3]. Marine organisms, particularly cnidarians, play complex roles in these ecological interactions, serving simultaneously as predators and prey in intricate food web networks [4–6]. Benthic cnidarians, such as sea anemones, have been increasingly recognized as important yet often overlooked predators of gelatinous organisms like jellyfish, contributing significantly to the structure of marine communities [7]. Understanding these predator–prey relationships is particularly crucial in coastal ecosystems, where benthic predators can influence both bottom-dwelling and water column communities through their feeding activities [8]. These trophic interactions between benthic and pelagic organisms represent important pathways for energy transfer in marine food webs and may play a key role in regulating jellyfish populations in coastal waters [9].

Historically, jellyfish (Class Schyphozoa) were considered a “trophic dead-end” in marine food webs due to their gelatinous bodies being perceived as low in nutritional value and rarely consumed by predators [10]. Recent studies have revealed that jellyfish support complex trophic webs through diverse predator–prey relationships [11]. The moon jellyfish *Aurelia aurita* (Linnaeus, 1758), a cosmopolitan and ubiquitous species, is frequently consumed by benthic cnidarians including medusa-eating anemones, dahlia anemones, and mushroom corals [7,12,13]. Similarly, the upside-down jellyfish *Cassiopea* spp. Péron & Lesueur, 1810, supports a diverse predator guild including butterflyfish, nudibranchs, fire worms, medusivorous sea anemones, marine reptiles, and slipper lobsters [14–18]. This extensive predation network challenges the traditional notion of jellyfish as "trophic dead-ends" [8,11]. The full extent of these predator interactions remains an active area of research [19].

As jellyfish blooms increase due to climate change and eutrophication, these interactions underscore the need to reevaluate jellyfish's ecological roles and their contributions to energy flow in marine ecosystems [20]. However, studying these interactions is challenging due to two characteristics of jellyfish populations: first, the episodic mass deposition of dead jellyfish to the seafloor ("jelly falls"), which creates temporary but significant pulses of organic matter; and second, the seasonal and spatially variable occurrence of jellyfish populations, which appear and disappear from specific areas based on environmental conditions [21]. These characteristics have resulted in a paucity of literature focused on documented predation interactions between predators and prey, especially in nearshore marine ecosystems, where jellyfish predation events have been less frequently described but may pose an important benthic–pelagic energy pathway in nearshore food webs [14].

Citizen science is a tool that can be used to increasingly explore and identify novel species interactions and natural history observations, such as jellyfish predation events. Platforms like iNaturalist®, eBird, and Project Noah provide critical interfaces between professional scientists and a global network of observers, who collectively contribute valuable ecological data [22,23]. Such contributions are particularly important in coastal ecosystems, where biodiversity is high. Yet, formal monitoring of these complex trophic interactions, particularly in coastal areas where anthropogenic pressures are pronounced, can be logistically challenging [24]. By bridging the gap between anecdotal observations and formal scientific inquiry, citizen science enables the capture of ecological phenomena across broader temporal and spatial scales [25].

Herein, we describe novel predation events in which the giant Caribbean sea anemone *Condylactis gigantea* (Weinland, 1860) consumed two different species of jellyfish (moon jellyfish, *Aurelia* sp.) and the upside-down jellyfish (*Cassiopea* sp.) that were reported using citizen science tools. *C. gigantea* is a well-recognized predator and ecosystem engineer capable of capturing small marine organisms using nematocysts [26,27]. While traditionally described as preying on gastropods and echinoids, sea anemones have demonstrated a broader predatory capacity, with at least eighteen documented species preying on jellyfish, including *Entacmaea medusivora* Fautin & Fitt, 1991, in Palau and *Anthopleura xanthogrammica* (Brandt, 1835) in the North Pacific [7,28]. To our knowledge, this is the first documented instance of *C. gigantea* consuming jellyfish species. To this end, these observations underscore both the novelty of new natural history observations regarding the diet of *C. gigantea* as well as highlight the importance of using citizen science tools to better understand the natural history of ecologically important marine species and their interspecific interactions.

2. Materials and Methods

2.1. Cassiopea Predation Observation

The first predation event was observed and recorded by a citizen scientist on the iNaturalist® platform (https://www.inaturalist.org/, accessed on 17 August 2024) in Layton, Florida, USA (24°49′40.8″ N; 80°48′52.5″ W), on 20 August 2021. The observation included a series of high-resolution photographs capturing *C. gigantea* actively consuming a specimen of *Cassiopea*. The jellyfish was in close contact with the tentacles of the anemone, which were extended and appeared to be stinging and immobilizing the prey.

Species identification was performed using detailed morphological characteristics described in the comprehensive taxonomic literature. For *C. gigantea*, identification followed González-Muñoz et al. [27], based on several diagnostic features. The specimen exhibited a smooth, cylindrical column with a broad, flat oral disc; long tentacles were arranged in multiple cycles around the oral disc, displaying the characteristic pinkish coloration with distinctive magenta tips, extending up to 7 cm when fully expanded. The column showed a brown coloration with white spots, and a well-developed, circular pedal disc was firmly attached to the substrate.

For *Cassiopea*, identification followed the morphological features presented by Morandini et al. [29]. The specimen displayed a flat, disk-like bell, with numerous small lappets along the margin. The specimen exhibited the green coloration resulting from symbiotic zooxanthellae, with a distinctive ring pattern on the exumbrella surface.

The anemone *C. gigantea* was found settled on a sandy–coarse sediment. No information on the depth of the site was available. We examined observational data from iNaturalist® to assess the frequency of this predator–prey interaction between *C. gigantea*, *Aurelia*, and *Cassiopea*. We searched the platform using keywords such as "*Condylactis gigantea*", "*Aurelia*", and "*Cassiopea*" to identify relevant records until December 2024, focusing on the geographic region where both species are distributed (Western Atlantic). Each observation was screened manually for photographic or descriptive evidence of predation interactions involving *C. gigantea*. Readers can replicate this search by visiting the iNaturalist website (https://www.inaturalist.org/), entering the search term "*Condylactis gigantea*", filtering the results by the Western Atlantic region and the specified time frame, and reviewing the observations for evidence of predation interactions.

2.2. *Aurelia* Predation Observation

The second predation event was documented in June 2015 in Ensenada de Santa Maria (22°39′13.1″ N; 78°59′49.1″ W), southeast of the Santa María key, on the north-central coast of the Cuban archipelago, where a specimen of *C. gigantea* was observed preying on *Aurelia* sp. jellyfish, providing further evidence of its predatory capability on gelatinous organisms. This observation was recorded via video by one of the authors (Video S1). This place is a vast seagrass with sandy–muddy bottom, sheltered by the mangroves where *C. gigantea* and *Cassiopea* sp. reside [30], but *Aurelia* sp. is only seen occasionally.

For *Aurelia* sp., we followed the identification criteria of Jarms and Morandini [31], based on key morphological features. The specimens exhibited the characteristic translucent, saucer-shaped bell. Four distinctive horseshoe-shaped gonads, clearly visible through the translucent bell, were arranged in a clover-leaf pattern. While the specimens displayed features consistent with *Aurelia*, identification was made to genus level only, as species-level identification within this cryptic genus requires detailed genetic analysis [32].

To ensure consistency and to determine if similar predation events had been previously recorded, we conducted a search on the iNaturalist platform using the same methodology as described for the *Cassiopea* predation event.

2.3. Trophic Dynamics of *C. gigantea*

The construction of the trophic dynamics network for *C. gigantea* was developed through a comprehensive synthesis of the existing ecological literature and novel predation observations. To systematically review the literature, we used search terms such as "*Condylactis gigantea*", "sea anemones predation", "cnidarian feeding ecology", "benthic–pelagic coupling", and "jellyfish predation" to query databases including Web of Science, Scopus, and Google Scholar. We focused on peer-reviewed articles, book chapters, and relevant gray literature published up to December 2024. Studies were included based on whether they documented prey types consumed by *C. gigantea*, described its feeding strategies, or provided ecological context for its role in marine food webs. Relevant full-text articles were reviewed to extract data on the prey spectrum and feeding behaviors of this species.

3. Results

The giant Caribbean sea anemone *C. gigantea* can be observed enveloping the bell of a *Cassiopea* jellyfish using its tentacles in the iNaturalist image (Figure 1). The tentacles of *C. gigantea* are wrapped around the bell and oral arms of a *Cassiopea* jellyfish, suggesting active immobilization through stinging. Mucus rings were observed on the tentacles of *C. gigantea*, indicating active predation on its prey.

Figure 1. Giant sea anemone *Condylactis gigantea* predating an upside-jellyfish *Cassiopea*. (1) Mucus ring in the sea anemone; (2) tentacle of *Cassiopea*. Photo taken from iNaturalist®, credits to D.M. Durieux.

In addition, *C. gigantea* was also observed enveloping and preying on two approximately 20 cm *Aurelia* sp. jellyfish. Both moon jellyfish were contracting the bell while being consumed by the anemone (Figure 2, Video S1). The anemone's tentacles were actively engaged in capturing and immobilizing this jellyfish, indicating a predatory behavior like that observed with *Cassiopea*.

The search of information in the databases returned 40 articles with information related to the giant anemone *C. gigantea* (e.g., feeding strategies of sea anemones, ecological function, benthopelagic coupling review, taxonomic list, etc.). However, only three of these articles contained relevant information on the feeding strategies of the giant anemone. Among the taxa reported in its diet are echinoderms, gastropods, and small fishes. Only one of these papers specifically documented the ingestion of a sea urchin *Diadema antillarum* by the giant anemone in captivity [33], where the authors described the incredible ability of

C. gigantea to ingest a large urchin, much larger than the anemone. The other two papers only mentioned in a general way some possible prey of the anemones, mentioning big taxa like small fish, gastropods, and echinoderms but not specific species [26,34].

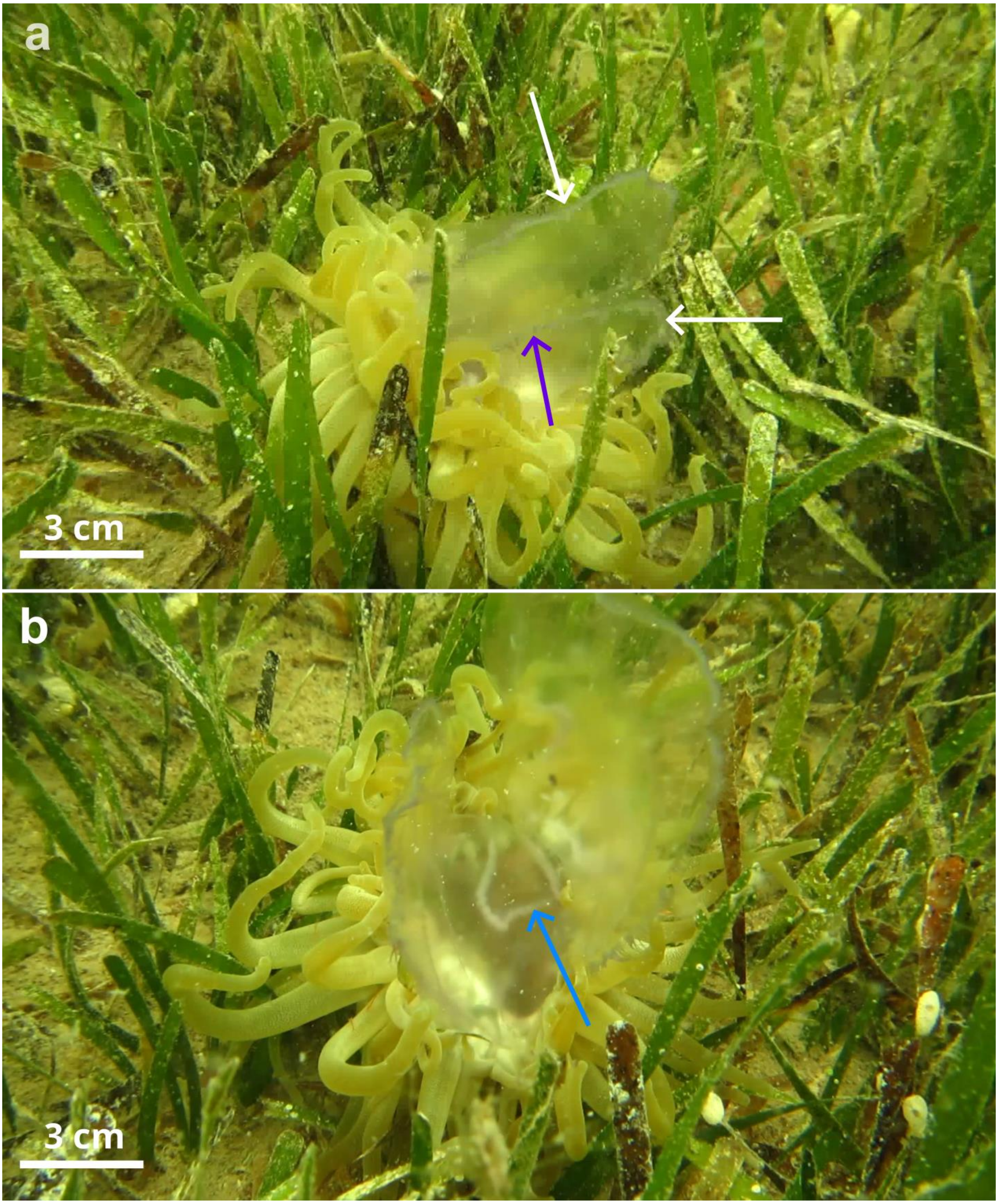

Figure 2. Giant sea anemone *Condylactis gigantea* predating moon jellyfish *Aurelia* sp. in Ensenada de Santa Maria, Cuba. (**a**) *Aurelia* sp. individuals (white arrow), with the subumbrella tentacles (purple arrow); (**b**) visible gonads (blue arrow). Photo credit: J.I. Hernández-Albernas.

4. Discussion

The observation of *C. gigantea* preying on both *Cassiopea* sp. and *Aurelia* sp. emphasizes its trophic plasticity. The analysis of similar observations on the iNaturalist® platform revealed only one record of *C. gigantea* consuming *Cassiopea*, further supporting the novelty of this finding. At the same time, this demonstrates the utility of using citizen science tools to document previously undescribed interspecific interactions. This novel predator–prey relationship challenges the conventional view of the feeding habits of sea anemones, demonstrating their capacity to exploit larger gelatinous prey [35,36]. Traditionally, sea anemones were thought to primarily consume smaller organisms, making these natural history observations notable [36]. Marine cnidarians, especially benthic forms, are known for their opportunistic feeding habits and diverse dietary range, preying on various resources from mesoplankton to large motile organisms [37]. However, this is a large and diverse group where all possible feeding strategies are still poorly understood, particularly for anemones and, in this case, for *C. gigantea*. In the 1970s, two studies briefly documented the diet of *C. gigantea*, noting small fish and benthic organisms (echinoids and gastropods) as part of its diet [26,34]. However, these works only mentioned these large groups as possible prey of the giant Caribbean sea anemone without detailing further specific species or feeding strategies. More recently, in 2001, Santana et al. [33] revealed the capacity of the anemone in captivity to prey on a bigger sea urchin, demonstrating the remarkable predatory versatility of sea anemones and reflecting their opportunistic diet and ability to feed on a wide range of prey, positioning *C. gigantea* as a more complex predator within coral reef ecosystems. The fact that *C. gigantea* was observed feeding on two moon jellyfish at the same time confirms its predatory nature and its high capacity to ingest large prey. These findings suggest sea anemones play more nuanced roles in marine food webs than traditionally recognized.

Caribbean sea anemones, particularly *C. gigantea*, remain understudied in ecological and physiological research. Holte [38] highlighted significant knowledge gaps in their recruitment, fecundity, and population dynamics. As critical components of Caribbean coral reef ecosystems, these anemones function as suspension feeders that mediate benthic–pelagic interactions [39]. *C. gigantea* serves as a complex ecological hub, hosting a diverse symbiotic network that includes endosymbiotic algae (*Symbiodinium* spp.), 37 species of facultative reef fish, and multiple obligate and facultative crustacean species [40,41]. Notably, *C. gigantea* demonstrates metabolic flexibility by hosting multiple *Symbiodinium* clades (A, B, and C), potentially enabling adaptation to variable light conditions [42]. These characteristics challenge traditional understandings of anemone ecological roles, revealing their potential for complex interactions within marine food webs.

From an energetic perspective, this predation event represents a novel pathway of energy transfer between pelagic and benthic realms [24]. When *C. gigantea* consumes *Cassiopea*, it effectively transforms the energy stored in the jellyfish's biomass, including energy accumulated through photosynthetic symbionts, into a form directly usable by benthic organisms. *Cassiopea* plays a crucial role in tropical coastal ecosystems, acting as a conduit for primary production due to its symbiotic relationship with zooxanthellae [43]. By preying on these jellyfish, *C. gigantea* not only controls population dynamics but also facilitates a direct energy transfer that was previously unrecognized in these ecosystems.

The role of citizen science in documenting these rare predator–prey interactions with macro-organisms is significant, as these interactions are more readily observable by non-experts compared to symbiotic relationships with microalgae. Platforms like iNaturalist® enable non-experts to contribute valuable observational data, filling gaps in traditional scientific research. While previous studies have shown that citizens can provide extensive datasets that enhance our understanding of species distributions and behaviors [22,44,45], this study demonstrates how researchers can uncover novel predator–prey relationships [39]. In marine ecosystems, citizen science platforms serve as potential early warning systems for shifting species distributions, behavioral adaptations, and ecosystem responses to climate change [46]. The continuous, widespread nature of citizen observations allows researchers to track changes in real time, potentially detecting novel species interactions, range expansions, or behavioral modifications before they become apparent in traditional scientific surveys [47,48]. This temporal and spatial coverage is particularly valuable for monitoring marine ecosystems, where climate-driven changes can occur rapidly and may be missed by conventional sampling methods [49].

Citizen science has proven to be a valuable tool in ecological research, offering unique opportunities to gather extensive data and document various interactions [45,46]. Our findings highlight that citizen science platforms provide unique opportunities to document rare ecological interactions, and they add to our growing but still limited understanding of *Cassiopea* ecology, as recently reviewed by López-Figueroa et al. [19]. These observations underscore the synergistic relationship between citizen science and traditional research in advancing our understanding of marine ecosystems. In conclusion, the identification of *C. gigantea* as a predator of both *Cassiopea* sp. and *Aurelia* sp. not only expands our understanding of marine food webs but also highlights the important role of citizen science in documenting and interpreting species interactions in coastal ecosystems. These anecdotal contributions from citizen scientists and local observers who interact with these ecosystems daily offer invaluable insights into behavior, distribution, and environmental changes over time. As we face unprecedented changes in marine environments, integrating citizen science into research frameworks is crucial for developing accurate models of ecosystem function and informing conservation strategies [49]. Discoveries like the predation of jellyfish by *C. gigantea* are pivotal in bridging the gaps between scientific knowledge and community-driven ecological stewardship. These observations underscore the synergistic relationship between citizen science and traditional research in advancing our understanding of marine ecosystems.

Supplementary Materials: The following supporting information can be downloaded at https://www.mdpi.com/article/10.3390/d17020111/s1. Video S1: Video showing the sea anemone *Condylactis gigantea* actively preying on two *Aurelia* jellyfish.

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