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Marine gelatinous zooplankton of the Egyptian waters: a review

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Abstract

Gelatinous plankton is formed by representatives of cnidarians (true jellyfish), ctenophores (comb jellies) and tunicates (salps). Gelatinous groups are a conspicuous, but relatively little studied component of marine ecosystems; in recent years its importance in pelagic food webs has gained increased awareness. They are essential components of the marine food web, relaying primary production from microbial algae to fish and seabirds. Gelatinous zooplankton may cause substantial mortality of fish eggs and larvae. This may play an important role in decreasing fishing stock of commercial fisheries, and they are an important variable in fisheries science and that it cannot be overlooked. The objective of this paper is to review a current knowledge on gelatinous zooplankton in the Egyptian waters of Mediterranean and Red Seas.

Key words: Gelatinous zooplankton, Jellyfish, Cnidarians, Ctenophores, Red Sea, Mediterranean Sea.

1. Background

Jellyfish is the descriptive common name first attributed in the mid-1800s to various medusae and since the 1990s also considered to include the ctenophores and siphonophores on the basis of atrophic equivalence (Mills, 1995). The popular name "jellyfish" reflects the prominence of the mesoglea. The name has no accurate zoological definition, and though the two super classes Cubomedusae and Scyphomedusae, might be considered the "true" jellyfish. The name is sometimes applied also to hydromedusae, siphonophores, and some other gelatinous plankton such as ctenophores and slaps. The great benefit of the term its figurative simplicity however has led to confusion as ‘jellyfish’ also has been applied to other gelatinous aquatic animals (Brotz *et al*., 2012).The problem is that occasional broader usage can imply functional or other equivalence that does not exist, increase ambiguity about the attributes of jellyfishes and blur potentially important distinctions from other gelatinous aquatic animals already known collectively as gelatinous zooplankton (Hamner & Dawson, 2009).

Gelatinous macro zooplankton, consist of Cnidaria (true jellyfish), Ctenophora (comb jellies) and Chordata (thaliaceans or pelagic tunicates). The representatives of these three phyla are grouped together because of their gelatinous bodies constituting the bulk of gelatinous macro zoo-plankton and, together, make up what we call “jellyfish” (Boero *et al*., 2008). These diverse species nonetheless differ in their evolutionary histories and may have distinct morphologies, life histories, ecologies and other traits (Duarte *et al.*, 2014).The modern popular perception that gelatinous zooplankton are position most uniquely among metazoan so take advantage of future global change (Mills, 1995) raises the following question; In what circumstances is being gelatinous beneficial in the plankton? First, the evolution of a planktonic lifestyle and gelatinous body plan could be driven by ecological benefits derived from feeding, distribution, predator avoidance (e.g., being invisible), or breaking cycles of parasitism (Hamner & Dawson, 2009).

The fossil record tells us that true jellyfish are the oldest animals among those that are still living today, being represented in fossils that date back to the Pre-Cambrian; they are referred to the phylum Cnidaria (Cartwright *et al.*, 2007).Gelatinous species range from the surface to great depths in every sea, and in sizes from microns to meters. Gelatinous zooplankton are widely heralded as key members of ocean ecosystems, yet their ecological, roles are often grossly oversimplified and misunderstood. Often they are too fragile and damaged to record or identify in traditional plankton nets and trawls, or they are simply ignored.

The following sections contain a knowledge account of important phyla, summarizing the information that isrelevant for the scopes of this review.

1.1. Cnidarians

The true jellyfish are the planktonic stages of three cnidarian classes: the Hydrozoa, the Scyphozoa, and the Cubozoa. Most Scyphozoa and all Cubozoa fall within the category of macro- and even mega zooplankton, since they are large enough, as adults, to be perceived by the naked eye, ranging from 2 mm (e.g. some small medusae) to 2 m in bell diameter, and several meters of tentacle length, of the largest medusae. Some Hydrozoa are macroplankters too, but many species belong to the mesozooplankton, being smaller than 2 mm. Gelatinous mesozooplankton is usually not perceived by a casual observer, unless when its representatives reach high densities (Boero, 2013).

Cnidaria is an ancient and diverse phylum containing 10,211 species worldwide and 752 species in the Mediterranean Sea inhabiting exclusively aquatic and mostly marine environments (Coll *et al.*, 2010; Appeltans*et al.*, 2012). Many cnidarians are distributed in shallow waters as they are in a symbiotic relationship with endosymbiotic algae for food and calcification (Muscatine & Porter, 1977). Cnidarians do have stinging cells armed with cnidocysts; they move by jet propulsion, contracting their bells or umbrellas. The umbrella usually carries tentacles on its margin and has a manubrium hanging in its cavity. The mouth lies at the end of the manubrium. The tentacles catch the prey and bring it to the manubrium (Boero, 2013).

The diversity of the hydromedusan fauna augments between 500 and 800 m depth (Kramp, 1968). Hydromedusae are among the main predators of the ocean and constitute a significant but often underestimated constituent of the pelagic deep fauna. Data about their composition, distribution, trophic relations and relationships with other oceanic strata are very scarce, and are based on limited observations. They seem to play a much more important role in oceanic transfer of energy than previously thought. The knowledge of the deep-sea Hydroidomedusae fauna is still incomplete and biased evenfor the polyp stage. The depth and vertical distribution of hydromedusae are often uncertain owing to the sampling methodology, generally only the upper limit oftheir vertical distribution is known and it is practically impossible from literature to distinguish between meso- and bathypelagic species. Furthermore, the sampling with plankton nets, even at discrete depths, damage or break up most of the delicate specieswhich then cannot be properly identified (Boero, 2013).

Jellyfish exhibit reproductive and life history strategies (e.g., single-parent reproduction, high reproductive capacity, short maturation times) that allow them to quickly reach “bloom concentrations” (“blooming” is here defined as suddenly and rapidly occurring en masse) in the pelagic phase when environmental conditions are favorable (Hamner & Dawson, 2009).The controlling predatory influence jellyfish blooms can exert on zooplankton populations often results in cascading effects throughout the local food web (Burrell & Engel, 1976). In addition, jellyfish blooms can have detrimental economic effects on fisheries, sting swimmers, and clog intakes of power and water desalinization plants (Purcell *et al*., 2007; Purcell, 2012).

1.2. Ctenophores

Ctenophores are a small, well defined phylum of bi-radially symmetrical animals with over 200 currently known species distributed worldwide. They are exclusively marine, planktonic or benthic includes 7 orders, and comprise a significant portion of the planktonic biomass in their range (Appeltans *et al*., 2012). They are solitary organisms with gelatinous soft bodies. The general body plan is closely to cnidarian, but more advanced than that of Cnidaria (Harbison & Arai, 1986).

Gelatinous macro zooplankton is usually equated to stinging jellyfish, and its presence causes major concern about own safety in non-marine biologists, due to fear of potential stings. Many members of gelatinous zooplankton, however, are not cnidarians, and do not sting. The ctenophores do not have a bell and a manubrium, and do not move by pulsations, they just share a gelatinous appearance with the cnidarians. Ctenophores move by ciliary propulsion, through what zoologists call “ctenes” or combs; hence the popular name: comb jellies (Boero, 2013). They can be a few centimeters, or even 50 or more centimeters, being globular, or similar to a dirigible, or ribbon like. Ribbon like ones, of the genus *Cestum*, can move also by snake like movements, but the other members of the group usually glide, appearing motionless and, in spite of that, moving. Their bodies are characterized by iridescent glows that are caused just by the flapping combs, the propulsors of the animal (Boero, 2013).

In coastal waters, ctenophores can reach great abundances. They feed at high rates on zooplankton and ichthyoplankton, and thereby may be detrimental to fish populations (Purcell & Arai, 2001). Ctenophores are well adapted to utilize favorable food conditions, such as patches of zooplankton, with feeding rates not saturating until at very high food levels (Greene *et al*., 1986). Due to their high fecundity and rapid growth potential (Reeve & Walter, 1978), they can quickly increase their abundance and predation rates and thereby act as key organisms in marine pelagic ecosystems by controlling the density of prey (Purcell & Arai, 2001).Ctenophores are among the most difficult marine animals to study, and represent the greatest challenge to conventional oceanographic sampling standard (Harbison & Miller, 1986).

1.3. Chordata (Subphylum Tunicata)

Pelagic tunicates comprise the Thaliacea and the Larvacea, or Appendicularians which belong to subphylum Tunicata, members of the phylum Chordata. The Larvacea are of small size, but can be present in very high quantities. The Thaliacea, namely salps, doliolids and pyrosomes, are of much larger size. Pyrosome are colonial forms while salps form chains reaching several meters in length. Pelagic tunicates are much different from both Cnidaria and Ctenophora in their feeding habits; they are filter feeders upon protists (usually phytoplankton), bacteria and even viruses. Their life cycles are holoplanktonic and involve both sexual and asexual reproduction, with the possibility of high biomass increases due to formation of large colonies. Apparently, just as for ctenophore, the pelagic tunicates do not have benthic stages (Boero, 2013).

2. Gelatinous zooplankton in the Egyptian Red Sea

The Red Sea, also known as Bahr al Ahmar in Arabic, is a semi-enclosed, elongated warm body of water about 2,000 km long with a maximum width of 355 km, a surface area of roughly 458,620 km^2, and a volume of 250,000 km^3(Head, 1987). The Red Sea includes about 3.8 % of the world's coral reefs. The Red Sea is bounded by nine countries and incised by numerous coastal lagoons and a large number of islands and extensive groups of shoals, and at its northern end is bifurcated by the Sinai Peninsula into the Gulf of Aqaba and the Gulf of Suez (Head, 1978; Najeeb and Ian, 2015)

Although gelatinous zooplankton have an essential role in marine food chains, relatively few systematic seasonal studies have been conducted in the Red Sea. Red Sea is poor in gelatinous zooplankton. Dowidar (2003) recorded that gelatinous zooplankton represent about 2% of the total zooplankton density. Recently, Zaghloul (2017) revealed higher abundance of gelatinous zooplankton recorded 22% of the overall zooplankton density. Only26 siphonophore species were reported by Halim's review (1969). Dowidar (2003) recorded 29 cnidarian species (16 Hydromedusae 11 Siphonophore, and 2 Scyphomedusae) and one ctenophore species in the northern Red Sea and Gulf of Aqaba. Zaghloul (2017) reported 24 species of them 18 belong to Hydromedusae, 3 are Scyphomedusae and 3 species belong to phylum Ctenophora. In the Red Sea, seasonal bloom of Scyphomedusae, *Aurelia aurita*, Siphonophore, *Diyphs chamissonis*, and Hydromedusa, *Aglaura hemistoma* have been documented (Alamaru *et al*., 2009; Zaghloul 2017). The previous studies on the gelatinous zooplankton in the Red Sea reported 75 Hydromedusae species, six Scyphomedusae species and one species of ctenophores. Zaghloul (2017) recorded 13 species as a new record of gelatinous zooplankton community in the Egyptian Red Sea to increase the whole species number in Red Sea to be 85 Hydromedusae species, seven Scyphomedusae species and three species of Ctenophora.

3. Gelatinous zooplankton in the Egyptian Mediterranean Sea

The Mediterranean Sea is located between Europe, Asia, and Africa. Excluding the Black Sea, it covers 2,542,000 Km^2, with an average depth close to 1,500 m and a maximal depth of 5,121 m in the Ionian Sea. The Mediterranean Sea is an almost closed basin, connected with the Atlantic Ocean via the Strait of Gibraltar, with the Red Sea via the Suez Canal, and with the Black Sea via the Bosphorous and the Dardanelles Straits. Surface temperatures range between 11-13°C in winter and 25-30°C in summer, determining cold temperate to warm-temperate conditions in the cold season, and tropical conditions in the warm one. Deep-water temperature is about 13°C and, normally, this is also the surface temperature in winter, when the basin becomes homoeothermic. Summer thermoclines divide the variable surface waters from the more stable, deep waters (Bouillon *et al*., 2004).

Despite the ecological importance of the gelatinous marine zooplankton in the marine food web (Purcell & Kremer, 1983), knowledge of the gelatinous zooplankton in the Egyptian Mediterranean waters is far from complete. The previous studies on zooplankton population in the Egyptian Mediterranean waters have tended to focus mainly on copepods, the major zooplankton component. Other groups such as siphonophores and hydromedusae were regarded as being of secondary importance in terms of numerical abundance and hence not treated in detail (Dowidar& El-Maghraby, 1973). Dowidar and El-Maghraby (1970) added six species of hydromedusae from the coast off Alexandria.

Pelagic cnidarians constitute a permanent component of the holoplankton in the south eastern Mediterranean. Hussein (1977) found that siphonophores constitute about 85% by number of cnidarians while Hydrozoa constitute about 2.6% of the average density of all zooplankton in the Egyptian Mediterranean waters. Dowidar (1981) performed a qualitative and quantitative investigation on the pelagic coelenterates of the Egyptian Mediterranean waters. The ecology and distribution of major zooplankton groups other than copepods, in particular hydromedusae, siphonophores, amphipods, decapods and pelagic tunicates occurring in the Mediterranean shelf waters off the Egyptian coast were studied by Zakaria (1992) within the framework of the project "Biological productivity of the South eastern Mediterranean in the post-High-Dam period".

4. Gelatinous zooplankton bloom and migration

By the pulsed nature of their life cycles, gelatinous zooplankton come and go seasonally, giving rise in even the most undisturbed circumstances to summer blooms. Even holoplanktonic species like jellyfish and ctenophores increase in number in the spring or summer when planktonic food is available in greater abundance. Beyond that basic life cycle-driven seasonal change in numbers, several other kinds of events appear to be increasing the numbers of jellies present in some ecosystems (Purcell *et al.*, 2007). Jellyfish blooms are a conspicuous feature in the oceans. The problem of gelatinous zooplankton blooming in the Mediterranean and Red Seas remains complex.

Gelatinous zooplankton distribution and migration are affected by both biotic and abiotic factors. The climate variability and anthropogenic activities have great impacts on community composition. The most factors are represented by increasing water temperatures and on the other side, the ballast water regarded as the main factor affecting the introduction of non-indigenous aquatic organisms. A ballast water tank canthus function as an incubator during the cruise for some species. This fact may have some impact on the release of non-indigenous species in the destination harbor or in near coastal waters where the ballast tanks are emptied (Purcell *et al*., 2007).

The blooming and migration of gelatinous zooplankton in the Egyptian waters in both seas may have both positive and negative outcomes on the marine ecosystem of the Mediterranean and Red Sea depending on the species. The positive impact is enriching the biodiversity of both seas as the well diversified ecosystem become more stable and healthier. The negative impact happens when the occurrence of alien species might threat the diversity or abundance of the native species of both seas. Another negative impact is concerned with the human activities, health and/or economic interest

Monitoring program is needed to record the recent erythrean gelatinous species in the Egyptian waters and follow up the distribution and abundance of those previously recorded as alien species in the Egyptian Mediterranean and Red Sea waters to assess their impacts on the native biodiversity of both seas. The monitoring program must be accompanied with studies on the feeding habits of these gelatinous species to detect the role of these species in the food web and to understanding how gelatinous zooplankton populations will behave because these are the most predator of fish larva and fish egg, In this way, a more advanced technique should be developed for identification such as DNA analysis to reach the species level.

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