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Distribution of Exotic Comb Jelly Mnemiopsis Leidyi (A. Agassiz, 1865) in the Southeast of the Caspian Sea (Mazandaran-Goharbaran)

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Abstract: The invasive species comb jelly *Mnemiopsis leidyi* was introduced into the Caspian via the ballast water into the Caspian Sea in 1998. Distribution, biomass and abundance studies of the comb jelly *M. leidyi* were conducted in the southeast region of the Caspian Sea (Mazandaran-Goharbaran) in 8 stations with deep Profile stations of 5, 10 and 15 m in 2013. *M. leidyi* was collected with a METU net having a mouth opening of 0.2 m^2 and mesh size of 500 µm. *M. leidyi* was observed at all stations all over the sampling periods during January to December 2013. There was a seasonal pattern of ctenophore density, the maximum being observed in autumn (August and September), and the minimum in the winter months. The highest abundance and biomass (wet weight) of *M. leidyi* were recorded with 71.8 ± 8.2ind.m^{-3} and 1.9 ± 1.0g.m^{-3}, while the minimum were in winter with 14.4 ± 2.0ind.m^{-3} and 0.3 ± 0.01g.m^{-3}. The highest monthly mean *M. leidyi* abundance and biomass were 128.3 ± 25.2 ind.m^{-3} in September and 3.1 ± 1.2g.m^{-3} in August. During the whole study period and at all stations, small individuals (<5 mm in length) and the Cydipid stage constituted 90.4% of all individuals, whereas 6.3% of the individuals were 6–10 mm in size.

Keywords: Caspian Sea, Distribution, *Mnemiopsis Leidyi*, Abundance and Biomass

1. Introduction

The Caspian Sea is a unique ecosystem that is not associated with the ocean, but has more or less the characteristics of the seas. Studies in the southern Caspian Sea showed that the comb jelly *Mnemiopsis leidyi* abundance increased in the warm season that this phenomenon is more evident, especially in the beginning of its offensive [8], [9], [10], [13], [14], [15], [17], [18], [20], [22]. Summer-autumn long-term population studies showed that the comb jelly abundance and biomass decreased 66% compared to the early invasion of the animal [14]. *M. leidyi* invasion into the Caspian Sea is an important environmental phenomena that are seriously threatened the ecosystem. The comb jelly feeds on the zooplankton that has highly reproduction. Before the invasion of *Mnemiopsis* minimum and maximum concentration of chlorophyll A were observed in the months of October 1997 and December 1998 in the southern Caspian, respectively, but after the invasion of *Mnemiopsis* by increasing the level of chlorophyll A in August 2001, *Mnemiopsis* biomass rose, and again its biomass were minimized in the cold months when chlorophyll A reduced [9]. Decline in zooplankton biomass has been accompanied by an increase in phytoplankton, which the zooplankton-feeder fish nutrition severely decreased as a result of the invasion of *Mnemiopsis* [16].

This species because of the zooplankton feeding was assumed as other pelagic animal's competition for the Caspian Sea would cause a serious risk. Initially, *Mnemiopsis* population was increased sharply, and then now entered a phase of adjustment with its fluctuating biomass and density [14].

Kilka (*Clupeonella* spp.) catch has increased to 85 to 95 thousand tonnes in the southern Caspian Sea in 1992 to 1999,

but after the invasion of *M. leidyi* Kilka catch of showed a rapid declined in 2000 and reached to 15 thousands tonnes in 2003 and nowadays (2013-2016) its catch was fluctuated between 15-20 thousand tons [6], [7]. Given that now the *Mnemiopsis* is in the stage of adaptations [5], to study of ecosystem awareness, it is necessary to monitor the abundance, biomass and distribution of *Mnemiopsis* in coastal and offshore waters.

As opposed to the Black Sea and the oceans, the Caspian Sea is not a location for shipping purposes, but due to the closure of the ecosystem Caspian Sea has a potential for high risk to introduction of many non-native aquatic species [1]. In recent years, many aquatic species have been introduced from the Black Sea into the Caspian Sea that had great success in disseminating and passive switching in the Caspian Sea. One of the invasive species was the comb jelly *Mnemiopsis leidyi* that made many changes in the Caspian Sea biodiversity [14].

Mnemiopsis invasion caused serious changes in different ways, first to its omnivorous feeding behavior from the common food recourse, zooplankton and then feeding on larvae and eggs of pelagic fishes. On the other hand, this new invader logging into the Caspian Sea ecosystem reduce food sources, the closure of fishing nets, fish escape due to the effects of exposure (the phenomenon of fluorescence) at night, feeding on fish eggs and larvae incomplete and network disruptions of sea life.

In recent years, after the invasion of the comb jelly into the Caspian different ecological studies were conducted by Caspian riparian researchers on the distribution and population dynamics of *Mnemiopsis* [2], [5], [14], [15], [16], [21], [23], [24], [25], [27]. *Mnemiopsis* monitoring studies were started in 2000 with 24 sampling stations along the southern of the Caspian Sea along the 6 transect at depths of 5, 10, 20, 50 and 100 meters. Studies indicated that the comb jelly increased during warm seasons (late spring, summer and early autumn) in the southern Caspian Sea significantly and almost they spend winter time (wintering) at Iranian coast of the Caspian Sea [18]. Most of the jellies were observed in surface layers (0-20 m) of water

Studies in the northern and central of the Caspian Sea indicated that the comb jelly completely went out or disappeared during winter time and only roses in summer and autumn [26], [27], [28].

There are few publications on *M. leidyi* of the Southern Caspian Sea, and most of these are either national reports or local literature (e.g. [2], [5], [10], [13], [17], [18], [19], [20], [22], [23], [24], [25].

The results of all researches on density and biomass indicate that the comb jelly had a maximum biomass in 2001 with more than 1 $kg.m^{-2}$ in the southern Caspian Sea. Then for various reasons, including lack of food, abundance and biomass of comb jelly decreased sharply.

2. Materials and Methods

Distribution, biomass and abundance studies of the comb jelly *M. leidyi* were conducted in the southeast region of the Caspian Sea (Mazandaran-Goharbaran) in 8 stations with deep Profile stations of 5, 10 and 15 m in 2013. Selected sampling sites took place according to the survey of biotic and abiotic factors study in southeast of the Caspian Sea project (Figure 1).

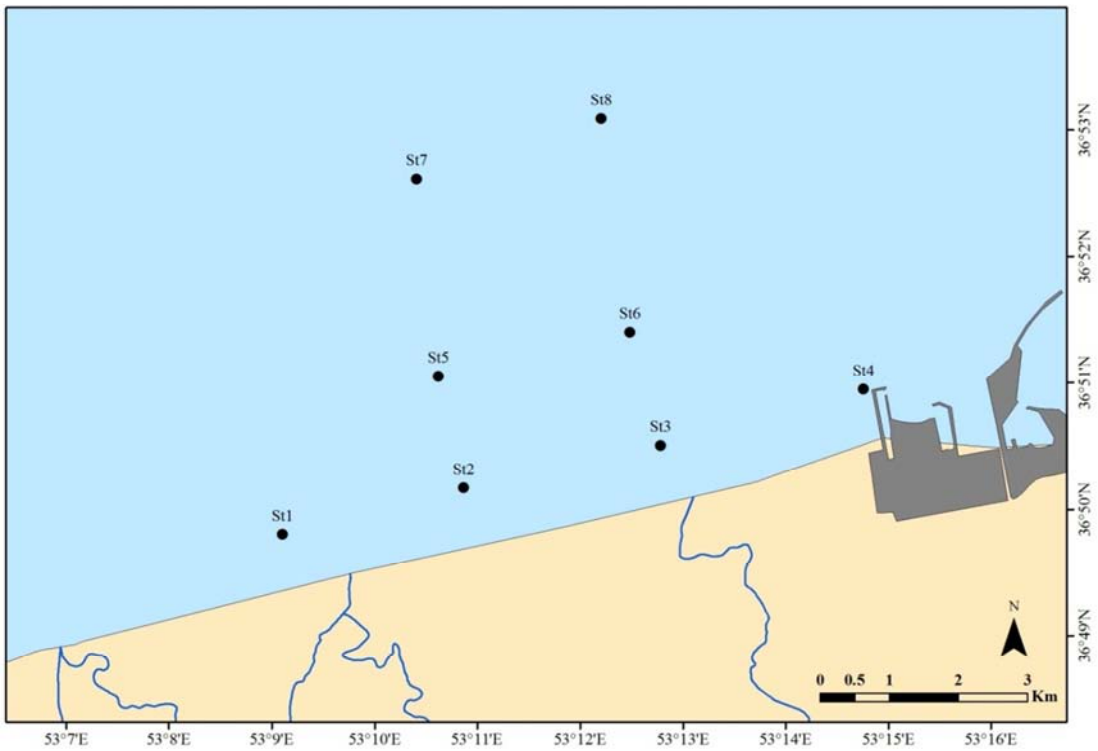

Figure 1. *Distribution of sampling stations in southeast of the Caspian Sea (Mazandaran-Goharbaran) in 2013 (Mazandaran-Goharbaran).*

M. leidyi was collected with a METU net having a mouth opening of 0.2 m^2 and mesh size of 500 µm, from the same depth intervals as the Juday net [12]. The body length of each individual with lobes was measured onboard and the density of *M. leidyi* (per m^3) was calculated from the net diameter and the tow depth. At the three shallowest stations, hauls were taken from the bottom to the surface at each (i.e. from 5–0 m, 10–0 m and 15–0 m). The ctenophores were sorted in length groups at 5 mm intervals up to 35 mm, to determine the abundance of different size groups. In order to define reproductive individuals, lengths were categorized into two groups, 15 mm and 16–35mm [4]. Length measurements were converted to weight/biomass (wet weight per m^3) using the following equation [12] $W = 0.0011 \times L2.34$; where W is wet weight of *M. leidyi* in mg and L is the length in mm.

In this study, two groups of variables, the independent variable (stations, seasons, depths and layers) and the dependent variable (Abundance and biomass of *Mnemiopsis*, zooplankton) was considered. For statistical analysis of parametric analysis of variance ANOVA (Tukey test on normalized data) was used [3], [29].

3. Results and Discussion

Mnemiopsis leidyi was observed at all stations all over the sampling periods during January to December 2013. There was a seasonal pattern of ctenophore density, the maximum being observed in autumn (August and September), and the minimum in the winter months. The highest abundance and biomass (wet weight) of *M. leidyi* were recorded with 71.8 ± 8.2ind.m^{-3} and 1.9 ± 1.0g.m^{-3}, while the minimum were in winter with 14.4 ± 2.0ind.m^{-3} and 0.3 ± 0.01g.m^{-3} (Figure 2). The means of abundance and biomass during the whole study period were 35.1ind.m^{-3} and 0.8g.m^{-3}, respectively.

The highest monthly mean *M. leidyi* abundance and biomass were 128.3 ± 25.2 ind.m^{-3} in September and 3.1 ± 1.2g.m^{-3} in August. Minimum abundance and biomass values were observed in January 6.2 ± 0.9 ind.m^{-3} and 0.1 ± 0.01g.m^{-3} (Figure 3).

During the whole study period and at all stations, small individuals (< 5 mm in length) and the Cydipid stage constituted 90.4% of all individuals, whereas 6.3% of the individuals were 6–10 mm in size. The largest individuals (31–35 mm) made up only 1.5% of the total abundance (Figure 4). It is noteworthy that the *Mnemiopsis* maximum size was found during the 2001-2006 cruises with 70 mm (Roohi et al., 2010).

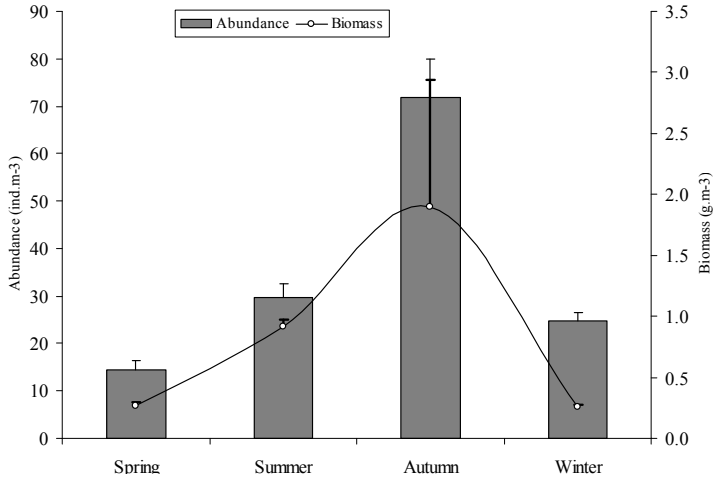

Figure 2. *Monthly variations in the abundance and biomass of Mnemiopsis leidyi in the southeast of the Caspian Sea (Mazandaran-Goharbaran) in 2013 (values are depth andstation averages).*

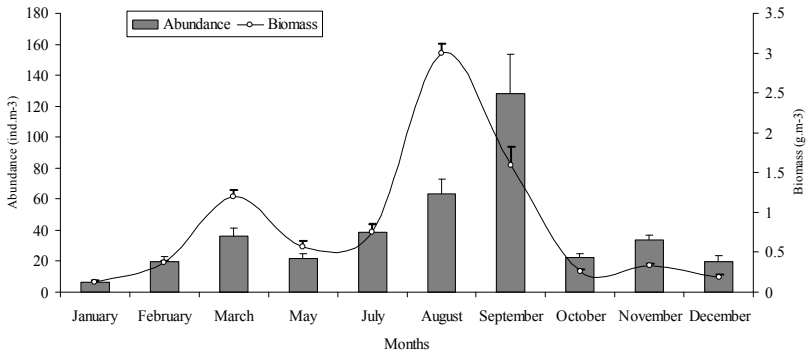

Figure 3. *Seasonal changes in Mnemiopsis leidyi abundance and biomass in the southeast of the Caspian Sea (Mazandaran-Goharbaran) in 2013 (values are depth and station averages).*

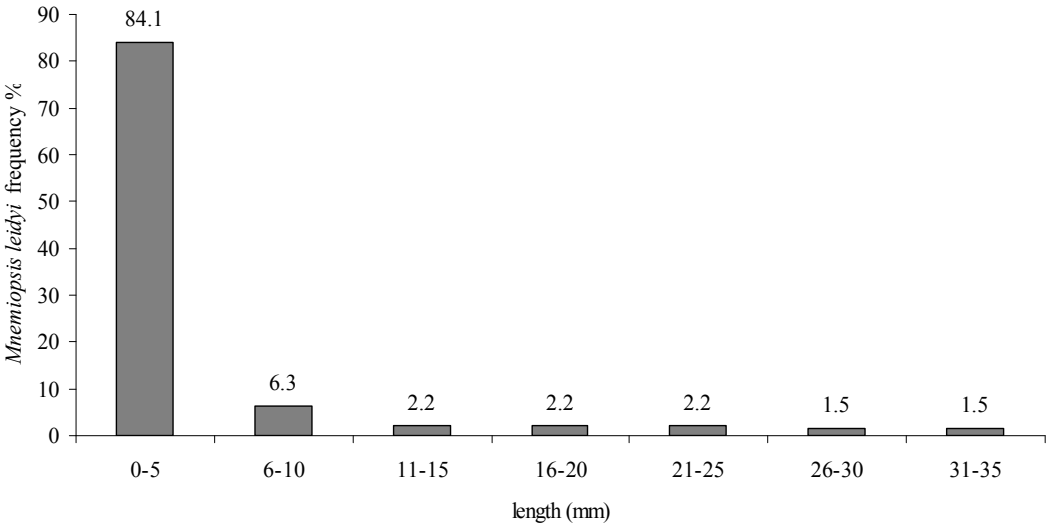

Figure 4. *Percentage (%) contributions of different size ranges of Mnemiopsis leidyi to the total abundance in the southeast of the Caspian Sea (Mazandaran-Goharbaran) in 2013.*

There was not significant differences between station ($p>0.05$) in terms of the ctenophore abundance and biomass but themaximum was reported at station 7 with 46.8 ± 7.7 ind.m^{-3} in and 0.7 ± 0.1g.m^{-3}, respectively (Figure 5).

Comparing the recent data with the data during 2001-2006 showed there was a 10 times decreased in *M. leidyi* abundance and biomass [14], [17],[19].

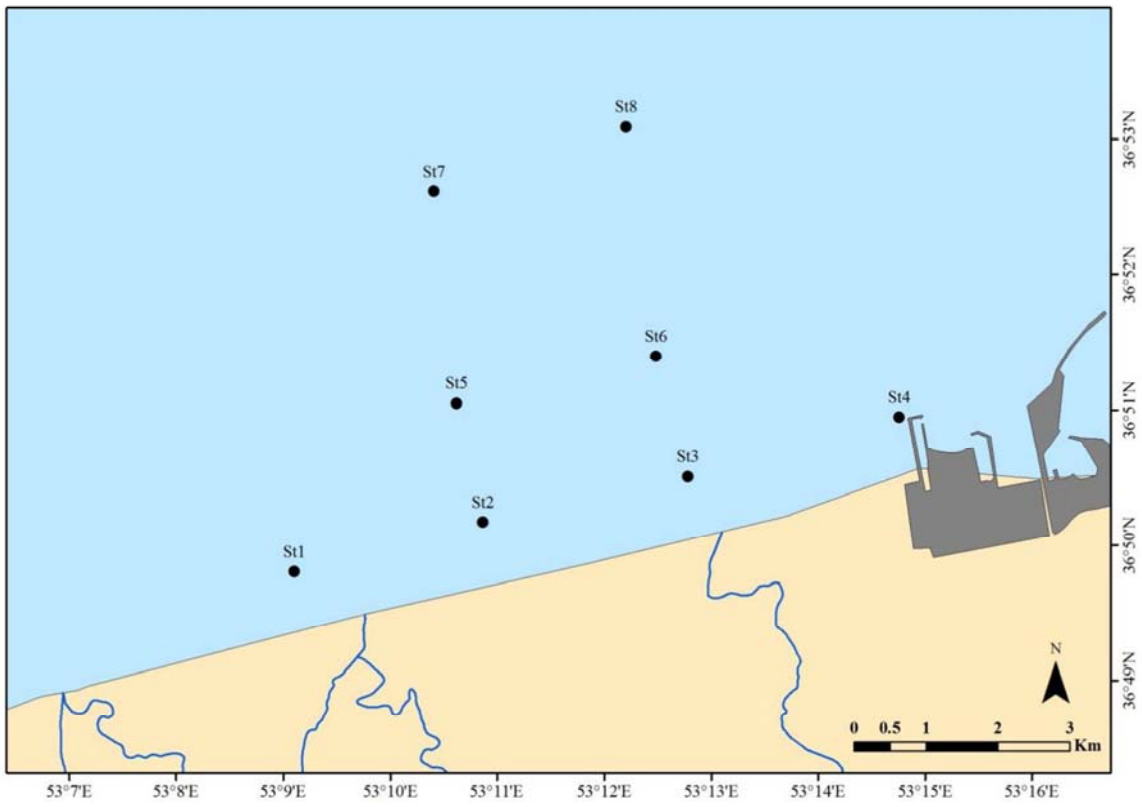

Figure 5. *Contributions of Mnemiopsis leidyi abundance in the southeast of the Caspian Sea (Mazandaran-Goharbaran) in 2013.*

We have compared our findings with the previous investigations, as this was the only study comparable with the present investigation in terms of sampling and methodology [13], [17], [18], [19], [20], [22]. All of the researchers expressed that the invasive ctenophore *M. leidyi*, which was transported from the Black Sea [30] into the Caspian Sea at the end of the 1990, has negatively affected the ecosystem of the Caspian Sea. In addition, the data of our investigations, compared with previous studies, showed coincided with a decline in the abundance and biomass of the ctenophore due to many reasons. It seems the sharp decreased of *Mnemiopsis* abundance could be

related to the decreasing of ova reproduction; on the other hand, decreasing of food ability (zooplankton) could be the main reason of *M. leidyi* declined in the southern Caspian Sea [4], [6], [8], [9], [11], [26].

4. Conclusion

Results of the current study suggest that *M. leidyi* exists in all stations with low abundance and biomass comparing with its initial years of invasion. In spite of knowing that there was a not significant difference between stations in terms of the ctenophore abundance and biomass but the some of the regions was reported to have more abundant of *Mnemiopsis* especially the area of deeper station with larger sized. It was noticed that the maximum size of *M. leidyi* was found in earlier year (70 mm in 2001), while in present study, the biggest size of *Mnemiopsis* was reported up to 35 mm and the small individuals and the Cydipid stage constituted more than 90% of population.

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