Classification of Bio-Pollution Caused by *Mnemiopsis leidyi* on Habitat Traits in Southern Parts of Caspian Sea

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Extended Abstract

Introduction

Since 1980s, the *Mnemiopsis leidyi* (*M. leidyi*) was affected on the Black Sea ecosystems. This invasive species has a negative impact on many fish biomass of the Black Sea due to competition feeding on edible zooplankton and fish eggs and larvae of Anchovies. At the same time, the possibility of arriving was estimated into the sensitive ecosystems such as the Caspian Sea. Then, this species was observed in the Caspian Sea during November in 1999. In the Black Sea, some details of impact of *M. leidyi* were studied on communities, habitats and ecosystems and ultimately "biological pollution levels (Bio-Pollution Level, BPL) during arrival, establishment, and expansion and adjustment process from1980 to 2000. In this assessment, impact of invasive species on communities, habitats and ecosystems were classified into five groups (no effect, weak, moderate, strong and extreme). In the recent years, *M. leidyi* was making problems such as reducing the amount of zooplankton, an increase of nutrients at water column and snow bed (Eutrophication). However, no quantitative estimation has been done for ranking the impacts in the Iranian basin of Caspian Sea. Therefore, this study is conducted to evaluate the impact of *M. leidyi* on habitat in term of environment parameters.

Materials and Methods

Data of physic-chemical parameters (as habitat straits) from 1996 to 2011were applied in this research. These years were classified into two groups: before introduction of ctenophore (1996-2000) and after introduction of ctenophore (2001-2011) and also these two periods were grouped into three assessment periods which included the years of 1996-2000, 2008-2011 and 2008-11, respectively. In this study, the years before the introduction of ctenophore is considered as a un-disturb ecosystem and the data for these years used as reference data (Reference Value). The maximum studied depth was also 20 meter; it is because of the high density of ctenophore which was recorded up to 20 m deep.

A variety of habitat modification activities of alien species may be ranked from no noticeable alterations in benthic or pelagic environment to massive impacts causing irreversible changes. These are classified into five groups: no habitat alteration (H0), alteration of a habitat (s) but no reduction of spatial extent of a habitat(s) (H1), alteration and reduction of spatial extent of a habitat(s) (H2), alteration of a key habitat, severe reduction of spatial extent of habitat(s); loss of habitat(s) within a small area of the assessment unit (H3) and loss of habitats in most or the entire assessment unit, loss of a key habitat.

Results and Discussion

Since the late 1960s, like many marine environments, increasing anthropogenic activities has been a major cause of instability and disturbance in the Caspian Sea environment, therefore, the *M. leidyi* restructured not only increase in its distribution in the Caspian Sea but also it sometimes will have high abundance. The present paper was conducted to change habitat of the Caspian Sea, namely in terms of physicochemical parameters and

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nutrient in the south Caspian Sea region over coastal areas of Iran which are examined quantitatively (numerical).

Environment parameters showed obvious changes after introduction of *M. leidyi* to the reference value (years before introduction into the Caspian Sea). The statistical analyses showed the significant difference among mean values of physico-chemical parameters ($P<0.05$) during 3 defined periods. Meanwhile, in T-test, significant difference of parameters is observed between before/after introduction of *M. leidyi* into the Caspian Sea. The excretion of nutrients and secretion of mucus by *M. leidyi* could increase the nutrient content of Caspian Sea. However, the nutrient content (except organic nitrogen) showed decreasing trend from 2008-2011. It was due to consumption of the nutrient by massive phytoplankton reproduction in the years. High abundance of primary producer and photocentetic organisms increased the water oxygen dissolved and carbon dioxide. However, pH of water didn't change significantly due to high buffered water of Caspian Sea. Large part of excretion material by *M. leidyi* is contained of dissolved organic carbon and nitrogen and a little part is from organic phosphorus. Meanwhile, rate of phosphorus turnover is faster than carbon and nitrogen elements. Thus, as it was expected, inorganic phosphorus decreased and organic nitrogen increased from 1998 to 2011. *M. leidyi* can affect quality both in water and sediment and change the habitats. Meanwhile, these two habitats (water and sediment) have mutual effects.

The expected levels of organic matter was increased in the bed with a bed of snow (create mucus from *M. leidyi*). Although, the information related to the percent of the total organic matter was not completed and there is a lack of information especially in the early years of the second period (the years 2001 and 2002), but its percentage increase since 1998 (the first period) to the year 2003 (second period). Although, compared to the year 2003 a decline is observed, but the data are not substantially decreasing relative to the reference values.

In fact, slope of trend lines showed slow changes in each parameter in figures, but comparative values of the environmental parameters changes more clearly in the year before introduction of *M. leidyi* (Reference value). Impact on habitats and ecosystem process became evident at later stages of an invasion. As the results showed, even at the presence and bloom of ctenophore the impact on habitat is classified in H0 during 2001-02. Evidences of impact on habitat is increased over the years and shifted to the ranks H2, H3 and finally H4 during 2005-06. Even in this period, biomass of big eyes and anchovies of fishes are severely destroyed. In the adaptation phase (2008-2010), habitat changes were classified from H2 to H3 according to the decreasing of ctenophore density.

Evaluation of South-Eastern and Eastern regions of the Caspian Sea indicated that this part of the sea based on habitat features. It was ranked H0-H4 in 2004, and the effects of *M. leidyi* were multiple levels and it was the expression of biological contamination. Similar condition showed that the stage adaptation of the Black Sea occurred in 2000 about 20 years after the introduction of the *M. leidyi* in the Black Sea. Also, because of differences between the Black Sea and the Caspian Sea such strong predatory *Beroe ovate* are feeding *M. leidyi* a significant decrease since 1997 in the Black Sea. The abundance of *M. leidyi* was reached the maximum level in the Caspian Sea until 2002. The maximum level of *M. leidyi* was registered about 7 years after the first observation of invasive comb jelly in the Black Sea, while this condition was happened about 3 years after the first introduction of *M. leidyi* in the Caspian Sea.

Some studies showed that the maximum rate of invasive *M. leidyi* in the Black Sea in 1989 is coincided with the expansion of the fourth level of pollution or habitat (H4), respectively. The fourth level of pollution (H4) in the Caspian Sea in 2006 was calculated about four years after the expansion of the *M. leidyi* (in 2001 and 2002).

Shorter time to reach various stages of habitat pollutions and the biological contamination level (BPL) in the Caspian Sea compared to the Black Sea indicates that the Caspian ecosystem is very fragile due to its semi-enclosed compared to the Black Sea which is connected to open Seas.

Conclusion

There are some evidence about the increases of eutrophic level (from oligotrophy to meso-eutrophy), increases of dissolved oxygen, algal bloom, increases/decrease of Shannon diversity index in phytoplankton/ zooplankton and increase of sediment-feeders of macro-benthos in different years of third period of study (2007-10). This indicates the stress and disturbance in Caspian Sea environment. The engineering of these events was mainly by M. *leidyi.* In Caspian Sea, maximum abundance of M. *leidyi is* observed in 2001-2 (about 3 years after the introduction of the invader) and class H4 is calculated for years of 2005-6, approximately 4 years after *M. leidyi* blooming in 2001-2. While in the Black Sea, the maximum abundance of *M. leidyi* and class H4 of the impact were happened 7 years after arrival of the invader into the ecosystem. It seems that the semi-closed system of the Caspian Sea is more sensitive than Black Sea.

Finally, there are other factors of impacts including an increase of sea level, river flows fluctuation, oil and gas production, chemical pollution, eutrophication, and other biological invasion, diseases, natural tectonic

activity and climate changes on habitats and ecosystem of Caspian Sea. These factors have overlap with the biological invasion of *M. leidyi.* Therefore, the scaling of these factors and determination of their weights in impact process is key tasks of a regional habitat protection of the Caspian Sea.

Keywords: Caspian Sea, ctenophore invader, habitat, Iranian coast, physico-chemical parameters.