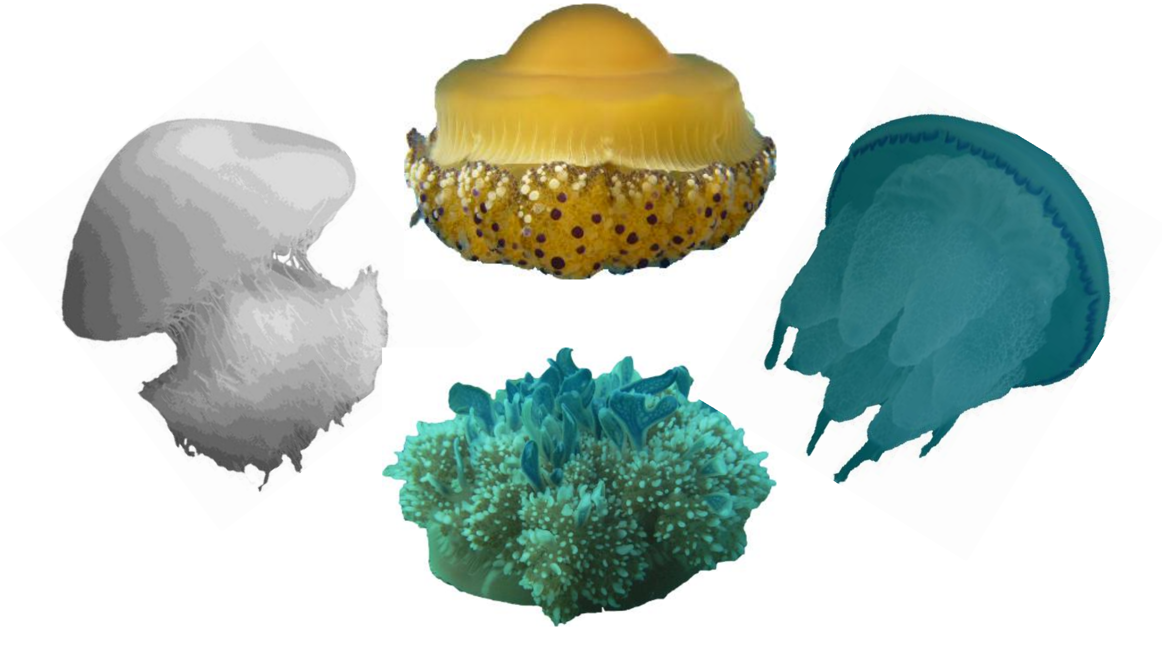
# WORKSHOP ON JELLYFISH AND OTHER GELATINOUS SPECIES IN TURKISH MARINE WATERS

## 20-21 May 2011
## Bodrum, Muğla – TURKEY



**Edited by**
**Cemal TURAN**
**and**
**Bayram ÖZTÜRK**

TURKISH MARINE RESEARCH FOUNDATION
**Publication Number: 34**

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ISBN-978-975-8825-27-1

Citation: TURAN, C and ÖZTÜRK, B. (Eds) 2011. First National Workshop on Jellyfish and Other Gelatinous Species in Turkish Marine Waters. Published by Turkish Marine Research Foundation, Istanbul, TURKEY, 2011. Publication number: 35

Available from: Turkish Marine Research Foundation (TUDAV)
P.O Box 10 Beykoz / ISTANBUL, TURKEY
Tel: 0216 424 07 72
Fax:0216 424 07 71
E-mail: tudav@tudav.org
Web site: www.tudav.org

Printed by: Metin Copy Plus. (Tel: 0212 527 61 81)

# CONTENTS

# PREFACE

Jellyfish and other gelatinous species have become one of the important issues due to several reasons, such as impacts on the fisheries, tourism, human health and to the entire Black and Mediterranean biota directly. While Turkey has a long coastline, we have to be prepared for all ecological changes and impacts on the fisheries and others.

The aim of this workshop is to exchange information between scientists, decision makers, fishermen and others for monitoring jellyfish and other gelatinous of mostly Indo-Pacific origin. In addition to discussing the establishment of a national databank, we should plan our future studies regarding this topic.

As an NGO, we are very happy to serve as a facilitator for this workshop of respected scientists and experts. I'm very grateful to the fellow researchers who have come to make their presentations in Bodrum. I also thank specially **Prof. Dr. Cemal Turan**, who made much effort for organizing this first national workshop on jellyfish and other gelatinous species in Turkey.

Finally,I'm very much thankful to **Mr. Yaşar Yıldız** and **Mr. Erhan Özcan** director and deputy director of the Bodrum underwater Archeological museum who have provided with us their lowely saloon for the workshop. I should not forget also **Mr. Tufan Turanlı** for his kind logistic support .

**Prof. Dr. Bayram ÖZTÜRK**
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# Jellyfish Bycatch Data by Purse Seine, Trawl and Net Fisheries during March-April 2011 in the Mediterranean Coast of Turkey

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## ABSTRACT

Jellyfish can adversely affect commercial fisheries by clogging nets, by feeding on the young age-classes of fish. Jellyfish baycatch data with different fishing gears, purse seiner, trawl and gillnet&trammel net, were investigated in the Iskenderun, Mersin and Antalya Bays, the Eastern Mediterranean coast of the Turkey. Only *Rhopilema nomadica* Galil, 1990 was observed in all fishing gears for the three study areas. *R. nomadica* comprised 49% (1237.7 kg) of the total catch (2534.685 kg.) at trawling for Northeastern Mediterranean Sea. *R. nomadica* represents 62% of the total catch of purse seine in Northeastern Mediterranean Sea. *R. nomadica* comprised 37% (150,5kg) of the total catch (408,814 kg) at gillnet&trammel net for Northeastern Mediterranean Sea. In general *R. nomadica* represent 60% (18388,2 kg) of the total catch (30489,87 kg.) for all fishing gears in the eastern Mediterranean coast of Turkey during March-April 2011.

## INTRODUCTION

Jellyfish populations are proliferating in the Mediterranean Sea and that their socio-economic impacts is getting increased. Jellyfish are causing problems in fisheries across the world. The overfishing of their predators has caused a huge influx of jellyfish in coastal fishing areas. They tend to get caught up in fishing nets in large numbers and reduce the number of fish that can be caught. They also tend to entirely destroy fishing nets thus causing monetary damage. Though jellyfish have been getting much attention, there is limited data on them.

Jellyfish clearly play an extremely important role in the processing of energy in fisheries-based ecosystems. Description of jellyfish with a set of appropriate functional groups will certainly help better understand their role in food webs and their effects on ecosystems. Jellyfish populations are opportunistic, and can respond promptly to changes in physical and biological conditions, both by changes in the rates of production of young jellyfish from the benthic polyp stage (Purcell et al., 1999), and by increased feeding and growth in good conditions (Purcell, 1992).

Although fishing gears used are rarely suitable for accurate quantitative sampling of jellyfish, when the equipment and methods are strictly controlled and records of these by-catch events can provide good relative index of the distribution and abundance of large scyphozoan medusae (Purcell, 2009). Broad-scale datasets are not only useful for jellyfish research, but to everyone with an interest in developing a better understanding of the effects of climate and other environmental and biological factors on oceanic ecosystems, a critical element in the development of an ecosystem-based approach to fisheries management (Bastian et al., 2010).

Iskenderun Bay, Mersin Bay and Antalya Bay have the largest number of erythrean species along the Turkish coast. Moreover, generally many of the erythrean aliens had been first recorded from the Iskenderun Bay before spreading along the Turkish coast.

There is little doubt that many other fisheries surveys result in a jellyfish by-catch without it being recorded on a regular basis. Most of the time, the catch is not recorded at all and jellyfish are simply discarded (Bastian et al., 2010)

In the present study the jellyfish baycatch data with different fishing gears, purse seiner, trawl and Gillnet&Trammel net, were investigated in the Iskenderun, Mersin and Antalya Bays, the Eastern Mediterranean coast of the Turkey.

## MATERIALS AND METHODS

Jellyfish baycatch data were collected from commertial trawl, purse seine, trammel nets and gill nets along the Eastern Mediterranean coast of Turkey (Iskenderun Bay, Mersin Bay and Antalya Bay) in March-April 2011. Biomass values from the fishing gears of purse seine, trawl and nets were calculated for the three regions in eastern Mediterranean coast of Turkey. Region 1 comprises the Iskenderun Bay of the Eastern Mediterranean. This region includes the coast of Hatay and Adana. Region 2 includes the coast of Mersin. Region 3 covers the coast of Antalya. All data were measured on the boats.

## RESULT AND DISCUSION

Abundance of jellyfish bycatch during the three fishing gear survey in the Iskenderun, Mersin and Antalya bays, Eastern Mediterranean coast of the Turkey, was given below. Only *Rhopilema nomadica* Galil, 1990 was observed in all fishing gears for the three study areas.

## *Trawl*

Operation was performed with 25 trawling in the Northeastern Mediterranean including 8 for İskenderun, 10 for Mersin Bay and 7 for Antalya (Table 1). *R. nomadica* represents 15% of the total catch in Antalya Bay. The total catch weight of this species 40 kg in Antalya Bay and totally 233,25 kg catch were accomplished. A total 724 kg *R. nomadica* were collected in Mersin Bay and representing 46% of the total catch. The total catch weight of all operations was 694,78 kg in İskenderun Bay and a total 473,7 kg *R. nomadica* were captured in İskenderun Bay, representing 68% of the total catch.
The ratios of *R. nomadica* at trawling for the three Bays of the eastern Mediterranean are given Figure 1.


**Figure 1.** Ratio of *R. nomadica* in the total catch by trawling in the Bays of Antalya, Mersin and İskenderun.

The *R. nomadica* comprised 49% (1237.7 kg) of the total catch (2534.685 kg.) in Northeastern Mediterranean Sea.

**Table 1.** Fishing gear, number of operations and the catch amounts.

| Operation Area | Fishing Gear | Number of operations | Total Catch (kg) |
|---|---|---|---|
| İskenderun Bay | Trawl | 8 | 964,78 |
| | Purse Sein | 6 | 10173,5 |
| | Gillnet&Trammel Net | 6 | 227,954 |
| Mersin Bay | Trawl | 10 | 1566,655 |
| | Purse Sein | 11 | 11013,52 |
| | Gillnet&Trammel Net | 5 | 77,67 |
| Antalya Bay | Trawl | 7 | 273,25 |
| | Purse Sein | 6 | 6359,35 |
| | Gillnet&Trammel Net | 7 | 136,19 |

## *Purse Seine*

Operation was performed on a total of 23 purse seine in the northeastern Mediterranean, including 6 operations in İskenderun Bay, 11 operations in Mersin Bay and 6 operations in Antalya Bay. Ratio of *R. nomadica* from purse seine fishing for the Eastern Mediterranean is given at Figue 2.

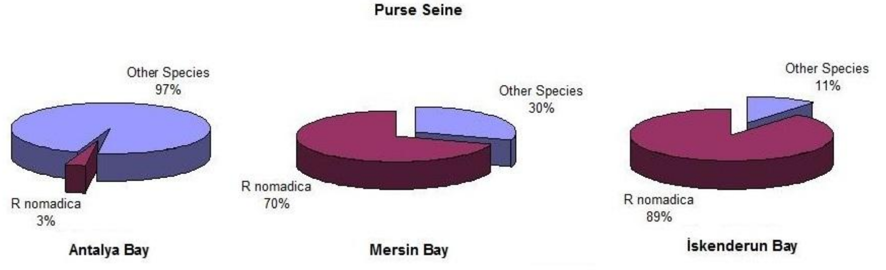


**Figure 2.** Ratio of the *R. nomadica* in the total catch by purse seine fishing in the Bays of Antalya, Mersin and Iskenderun

*R. nomadica* represents 3% of the total catch in Antalya Bay. A total 6359,35 kg catch was achieved and *R. nomadica* comprised 220 kg of total catch in Antalya Bay. The total catch weight of all species was 11013,52 kg in Mersin bay. A total 7750 kg of *R. nomadica* was captured in Mersin bay, and *R. nomadica* represented 70% of the total catch. A total 9030 kg of *R. nomadica* were collected in the İskenderun Bay, and *R. nomadica* represented 89% of the total catch.

The *R. nomadica* represents 62% of the total catch of purse seine in Northeastern Mediterranean Sea. Total catch weight of *R. nomadica* was in Northeastern Mediterranean Sea, total catch weight being 27546,37 kg.

The *R. nomadica* comprised 62% (17000 kg) of the total catch (27546,37 kg.) in Northeastern Mediterranean Sea (Table 1).

## *Gillnet and Trammel Net*

Operations were performed with a total of 18 gillnet and trammel nets in the Northeastern Mediterranean, including 6 operations in İskenderun, 5 operations in Mersin Bay and 7 operations in Antalya Bay. Ratio of *R. nomadica* from gillnet and trammel net for the Eastern Mediterranean is given in Figure 3.

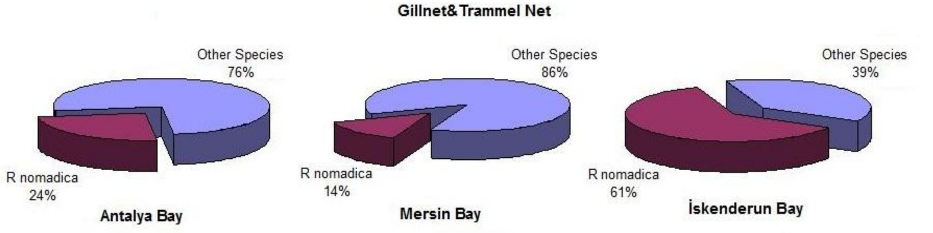


**Figure 3.** Ratio of the *R. nomadica* in the total catch by gillnet and trammel net fishing in the Bays of Antalya, Mersin and Iskenderun.

The total catch weight of all species was 136,19 kg in Antalya Bay. A total 33 kg of *R. nomadica* was captured, representing 24% of the total catch in Antalya Bay. *R. nomadica* represented 14% of the total catch in Mersin Bay. The catch weight of this species was 10,5 kg of the total 77,67 kg catch. A total 140 kg of *R. nomadica* were collected in İskenderun Bay, representing 61% of the total catch.

The *R. nomadica* represented 37% of the total catch in Northeastern Mediterranean Sea. Total catch weight of *R. nomadica* was 150,5 kg in Northeastern Mediterranean Sea, total catch weight being 408,814 kg.

The *R.. nomadica* comprised 37% (150,5 kg) of the total catch (408,814 kg) in Northeastern Mediterranean Sea (Table 1).

## *All Fishing Gears*

Rates of jellyfish from all fishing gears for the Iskenderun, Mersin and Antalya Bays are given Figure 4. The *R. nomadica* represent 4% (293 kg.) of the total catch (6475,79 kg) in Antalya Bay. The total catch weight of all species was 12657,85 kg in Mersin bay. A total 8484,5 kg of *R. nomadica* were captured, representing 67% of the total catch in Mersin bay. A total 9643,7 kg of *R. nomadica* were collected in İskenderun Bay, representing 87% of the total catch.

In general *R. nomadica* represent 60% (18388,2 kg) of the total catch (30489,87 kg.) in Northeastern Mediterranean Sea.


**Figure 4**. Ratio of all fishing gear used for the totaal catch in the Antalya, Mersin and İskenderun regions

During the present study large aggregations of alien jellyfish, *Rhopilema nomadica,* have been observed in three different localities along the Mediterranean Sea coast of Turkey during March and April 2011. the stinging jellyfish species, *R. nomadica*, entered through the Suez Canal in the 1970s (Galil et al., 1990). Large aggregations of this jellyfish were observed starting from the 1980s along Israeli coasts (Lotan et al., 1992) and annual blooms occurred during summer from 1989 to 1992; afterwards *R. nomadica* rapidly spread in the eastern Mediterranean Basin migrating towards Lebanon, Syria and then Turkey (Lotan et al. 1994).

*R. nomadica* was first recorded off the coast of Mersin in Turkey in 1995 (Kideys and Gücü, 1995), and in Iskenderun Bay (Avsar et al., 1996). Later, a single specimen was observed off the coast of Finike, Turkey in August 2006 (Öztürk and İşinibilir, 2010).

*R. nomadica* has nearly a spherical icy-blue-colored umbrella, thickest centrally and minutely granulated externally, whose margins are divided into 64 rounded lappets; from arm disc sides arise eight pair of large scapulets, distally provided with long filaments, arise (Galil et al., 1990). The bell size of this jellyfish can range from 10 to 80 cm in diameter and the whole medusa can have a weight of 40 kg. This species, existing in huge numbers, poses a big threat to humans producing burning, pain and redness of the affected skin.

Jellyfish are also causing problems in fisheries. They tend to get caught up in fishing nets and large numbers and reduce the number of fish that can be caught. They also tend to entirely destroy fishing nets causing monetary damage.

Jellyfish populations may be increasing in response to environmental changes (e.g. climate change, eutrophication, overfishing). These increases may ultimately affect commercially important fish stocks. In order to address this issue, it is critical to understand rather broad distribution and abundance of jellyfish (Bastian et al., 2010).

The large aggregation of the population of *R. nomadica* off the Levantine coast of Turkey have negative consequences on fisheries. The blockage of nets of fishermen by individuals of *R. nomadica* created major economical losses.

**Acknowledgements**

Thanks are due to the Ministry of Agriculture and Rural Affairs, General Directorate of Agricultural Research (TAGEM-09/AR-GE/11) for financial support.

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# Reproduction Dynamics of *Beroe ovata* Mayer 1912 in Sinop Harbour

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## ABSTRACT

Development of *Beroe ovata* in the Black Sea caused biomass of *Mnemiopsis leidyi* decreasing, in pelagic fish stocks particularly trading anchovy (*Engraulis encrasicolus ponticus*) and zooplankton recovery. Spawning dynamics of *B. ovata* should be examined due to limiting impact of *B. ovata* on abundance of *M. leidyi* in the Black Sea. Because of this, the most important is egg production with respect to size of ctenophore, seasonality, and periodicity.

The study was carried out off Sinop in the southern Black Sea during September-December 2003. Factors affecting the egg production of *B. ovata* were experimentally studied. We aimed to estimate spawning dynamics of freshly caught *B. ovata* of different length groups at the laboratory. Therefore fecundity of *B. ovata* was observed in three different sets of the experiments aimed to study dynamics of egg number in a clutch of different size ctenophores from day to day; to study the *Beroe* fecundity biweekly and to study in to examine diurnal variation of egg number. The number of eggs generally increased with the size ctenophore with length between 40 to 70 mm. Maximum egg productions was determined on $26^{th}$ September for individuals of 70 mm (870±348 eggs) long in periodical experiment. There was no significant difference in the *B. ovata* egg diameters in sampling periods except 11th October. Average diameter of egg was determined about 0.45 mm throughout the all observations.

## INTRODUCTION

The invasion of alien species has become a great problem for many seas of the world and more evidence is provided on their damaging effect on ecosystems (Vinogradov et al. 1989, Harbison et al. 1978). For example in the Black Sea, ctenophore *Mnemiopsis leidyi* that was introduced with ballast water from ships at the beginning of the 1980s was a real stress for the ecosystem (Zaitsev & Aleksandrov 1997, Caddy & Griffthy 1990).

With introduction of *M. leidyi* the biomass of fodder mesozooplankton had sharply declined (Vinagradov et al. 1989, Kideys et al. 2000). The stocks of zooplanktivorous fish (anchovy, sprat) dropped due to competition with *M. leidyi* for food and predation by *M. leidyi* on fish eggs and larvae (Tsikhon- Lukanina et al. 1993, Shiganova et al. 1998, Shiganova & Bulgakova 2000, Shiganova et al. 2000a).

In October 1997, another ctenophore, *B. ovata*, a predator of *Mnemiopsis*, had appeared in shallow waters of the northwestern Black Sea (Konsulov & Kamburska 1998, Zaitsev 1998), and in September 1999 it was found in the Crimean region and in the northeastern Black Sea (Finenko and Romanova,. 2000, Shiganova et al. 2000b, Vostokov et al. 2000, Vinogradov et al. 2000).

In 1999 the population of *M. leidyi* sharply decreased throughout the Black Sea due to *Beroe* appearance and the lowest summer biomass of *M. leidyi* (estimated as 12 $g/m^2$ in the southern Black Sea) was recorded since its population explosion 10 years before (Kideys & Romanova 2001). Zooplankton populations started to recover from 1996 and species diversity increased - some species that had disappeared from samples in the early 1990s made a comeback. Numbers of immature anchovy, as well as total fishery dominated by this fish also began to rise (Kideys 2002, Kideys et al. 2000, Kideys & Romanova 2001, Shiganova et al. 2003, Shiganova et al. 2004).

The deliberate introduction of the new comb jelly *B. ovata* as a biocontrol agent was being considered by GESAMP had been proposed for the introduction as potential predator for *M. leidyi* into the Black Sea. Although mechanisms underlying previous fluctuations in *M. leidyi* populations had taken some unraveling, the contribution of *B. ovata* to the precipitous collapse of *M. leidyi* populations in 1999 was quite clear because it is easy to see what the transparent comb jelly is eating. A number of different research studies concluded that *B. ovata* was feeding exclusively on other comb jelly species and, because of its relative abundance, predominantly on *M. leidyi* (Arachkevich et al. 2001, Finenko et al. 2003, Shiganova et al. 2001, Shiganova et al. 2000b).

*M. leidyi* shows a seasonal distribution with lower values in winter (Shiganova et al. 1998). In period before the appearance of *B. ovata M. leidyi* notably occurred in Sevastopol Bay (Finenko & Romanova, 2000). After *B. ovata* invasion occurrence of *M. leidyi* high biomass is limited to only 2 months. When it reaches peak values in a month or so; *B. ovata* starts to increase sharply and in the following 2 weeks this predator controls the levels of *M. leidyi* very efficiently. After the disappearance of *B. ovata* in late autumn, the *M. leidyi* biomass again increases but it keeps on a lower level than in previous years (Finenko et al. 2003, Kideys et al. 2003, Shiganova et al. 2004).

The quantification of the top-down control mechanism exerted by *B. ovata* is important to understand ecosystem changes occurring in the pelagic ecosystem of the Black Sea. After *B. ovata* introduction to the Black Sea, biomass level of *M. leidyi* decreased and in pelagic fish stock especially anchovy (*Engraulis encrasicolus ponticus*) has been determined a recovery. Meantime in the Caspian Sea the crisis in the catches of the commercial fish Kilka is continuing. Because of this in Iran was fairly important to propagate *B. ovata*. The present study is valuable from the point of view of determining when and how long reproduction is high in *B. ovata* spawning. In the study, reproduction of ctenophore *B. ovata* was determined in different periods. The investigation aimed to determine whether there is timely different effect in reproduction or not.

*B. ovata* was collected during 4 months: September – December in 2003. Decreasing of *M. leidyi* biomass was observed when *B. ovata* was found in Sinop Bay in September (Birinci-Ozdemir 2005). The population of *B. ovata* consisted 50-100 mm size range dominantly. Reproduction was development in early autumn and *B. ovata* size group <10 mm increased in September- October in 2003 (Bat et al. 2005). In the present study, we aimed that reproduction of *Beroe ovata* in Sinop Harbour between September and December 2003.

## MATERIALS AND METHODS

The experimental study was carried out in laboratory of Sinop Fisheries Faculty at the, Turkey, on the southern Black Sea coast from 11$^{th}$ September to 28$^{th}$ December 2003. The samples were collected in Sinop Bay using a large hand net and were transferred to plastic cups with sea water. *B. ovata* was not sampled in November due to the condition of the weather. In the laboratory each single ctenophore after catching was carefully transferred into 4 liters transparent plastic aquariums filled with seawater (salinity of 18‰) filtered through a 180 μm mesh. *B. ovata* was not fed during the experiments to estimate dynamics of spawning of freshly collected ctenophores. In both series water in the aquariums was changed daily and number of eggs and larvae was counted every day (see Table1).

**Table 1.** Temperatures of surface water in sampling date in Sinop Bay.

| Sampling Date | Temperature °C | *Beroe* number | Size range, mm |
|---|---|---|---|
| 11 September 2003 | 21.44 | 27 | 14-118 |
| 26 September 2003 | 19.52 | 21 | 14-80 |
| 11 October 2003 | 18.08 | 21 | 20-80 |
| 02 December 2003 | 13.91 | 15 | 20-60 |
| 28 December 2003 | 11.16 | 15 | 20-60 |

Lengths of the animals were measured with ruler directly in the experimental vessels. The experimental temperature was kept as ambient temperature. In additional diameters of 15 eggs were measured using a micrometric scale in every period between September and December.

## RESULTS AND DISCUSSION

Length distribution in different periods; *B. ovata* population were dominant between 20 mm and 40 mm in September as individuals having 50-60 mm long were in December (Fig. 1).

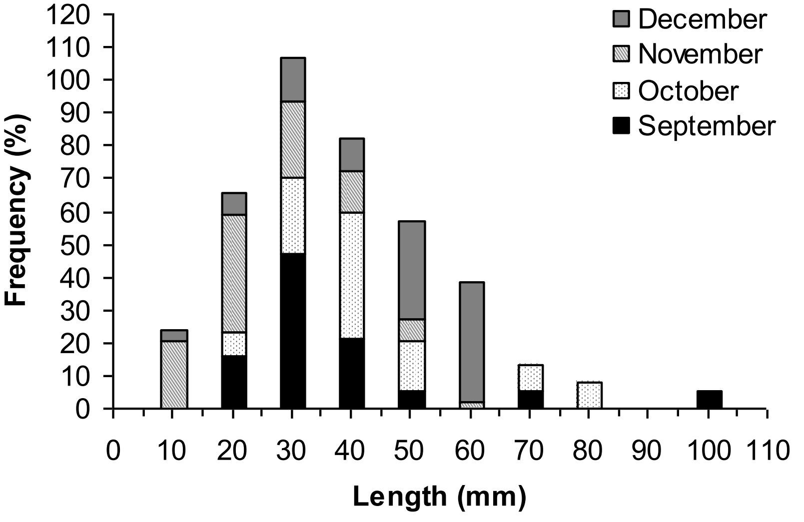


**Figure 1.** Size structure of *Beroe ovata* population in September – December 2003.

### *Reproduction Dynamics of B. ovata in Different Periods*

The high number of eggs was observed in *B. ovata* of 40 - 70 mm length in different periods. The highest egg number in the experiment was found at length of 70 mm (8700 eggs on 26$^{th}$ September), minimum number were in ctenophores of 20 mm and 30 mm length. Similar reduce in egg production was observed in the big size individuals. Though 20 mm and 30 mm ctenophores did not produced eggs, in our experiments, some individuals of 14 mm length was observed to have 1850 eggs (Table 2).

**Table 2.** Number of eggs of *Beroe ovata* depending on body length in different periods.

| Date/length (mm) | 11 Sep. | 26 Sep. | 11 Oct. | 02 Dec. | 28 Dec. |
|---|---|---|---|---|---|
| **14** | 1850 | 0 | 5 | * | * |
| **20** | * | * | * | 0 | 1 |
| **30** | 16±4 | 0 | 0 | 836±369 | 0 |
| **40** | 7392±1062 | 342±83 | 164±36 | 2 | 0 |
| **50** | 2164,5±488 | 2665±135 | 1052±102 | 314±13 | 1 |
| **60** | 7650±765 | 2508±584 | 348±42 | 322±15 | 2 |
| **70** | 993±386 | 8700±348 | 1809±374 | * | * |
| **80** | 3650±450 | 3100±364 | 18±3 | * | * |
| **118** | 2520 | * | * | * | * |

* no individuals found

The egg numbers in the same size group in different time was found significant difference ($P<0.05$) as to statistical. Egg production decreased from September to December in *B. ovata* of different size groups. Maximum eggs numbers according to periods: On 11th September above 7392 eggs were determined in the individuals with body lengths of 40. Whereas 7650 eggs were determined in the individuals with body lengths of 60 mm. Length size 70 mm of individuals was determined 8700 eggs on 26th September. On 11th October 50 mm and 70 mm length size of individuals were counted 1052 and 1809 eggs, respectively. On the 02nd December high eggs number was observed length size 30 mm (836 eggs). On 28th December production of eggs quite decreased for individuals of 50 mm and 60 mm long (1 or 2 eggs) and the other individuals were not laid. The biggest ctenophore having size of 118 mm yield 2520 eggs, this value was low when compared to other smaller individuals (Table 2).

The highest number of larvae was obtained as length size determined high eggs number (Table 3). In suggested source this parallelism was to mature eggs laid firstly by individuals.

**Table 3.** Number of larvae (B) of *Beroe ovata* depending on body length in different periods.

| **Date/length (mm)** | **11 Sep.** | **26 Sep.** | **11 Oct.** | **02 Dec.** | **28 Dec** |
|---|---|---|---|---|---|
| **14** | 18 | 0 | 0 | * | * |
| **20** | * | * | * | 0 | 0 |
| **30** | 0 | 0 | 0 | 1 | 0 |
| **40** | 0 | 77±13 | 6±2 | 0 | 0 |
| **50** | 19±5 | 65±14 | 17±8 | 64±10 | 0 |
| **60** | 131±15 | 350±42 | 52±11 | 5±0 | 0 |
| **70** | 105±9 | 554±36 | 64±16 | * | * |
| **80** | 330±28 | 0 | 15±6 | * | * |
| **118** | 0 | * | * | * | * |

* no individuals found.

Egg production was the highest in September, in the beginning of *B. ovata* reproduction. Egg and larva production decreased in December. In last two period some individuals reproduced a few eggs but they did not develop in (Tables 2 and 3). Average egg number of *B. ovata* in the all periods was high in individuals with lengths from 40 mm to 80 mm. Maximum average eggs number was found 3834 at the long size 70 mm (Fig.2).

Shiganova et al. (2004) found *B. ovata* smaller than 40 mm did not reproduce. Collected individuals of *B. ovata* of 48-70 mm length, which were at high prey concentration in natural conditions, had fecundity (egg production per day) of 513-3000 eggs at salinity of 17‰ and temperature 23°C. The number of eggs is a function of food supply, so we can say that in Sinop Bay in autumn 2003 *B. ovata* had much better food conditions than in1999 in the northeastern Black Sea. In Sevastopol Bay in 2003 intensive reproduction of *B. ovata* started in the beginning of September: the average fecundity of the most actively reproducing part of the population with body lengths of 35 –70 mm was 4500 ± 250 eggs in a clutch. All the eggs were viable and developed into larvae. The period of intensive reproduction lasted about 2 weeks; afterward the fecundity and the percentage of the reproducing ctenophores decreased significantly. By the end of September the egg number in a clutch decreased from 4500 to 500 eggs and the share of reproducing *B. ovata* decreased to 40 – 50% of adults (Finenko et al. 2006).

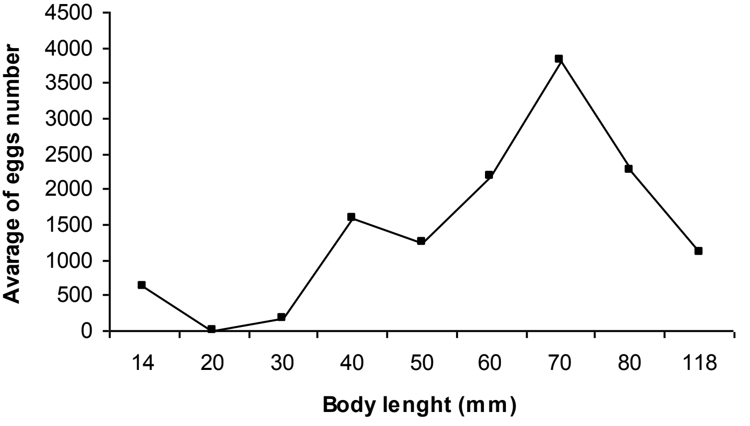


**Figure 2.** Average eggs number in *Beroe ovata* depending on body length in different periods.

In periodically experiments high eggs production was observed in September and early October. We took 1850 eggs from length of 14 mm *B. ovata* on the 11 September; this value was very high for small size. Finenko et al. (2003) found similarity in their study. In the autumn of 1999 the spawning period in the eastern Black Sea was observed in September-October with maximum at the beginning of October (Arashkevich et al. 2001).

In the present studty there was no significant differences (p=0,25 ) between the diameter of *B. ovata* eggs in sampling periods except October. On the 11th October diameter of eggs was evaluated on average as 0.62 mm. This value was higher than other periods. We determined the average diameter of eggs about 0.45 mm throughout the all samples. Minimum diameter of eggs was measured 0.37 mm on 26th September (Fig. 3).

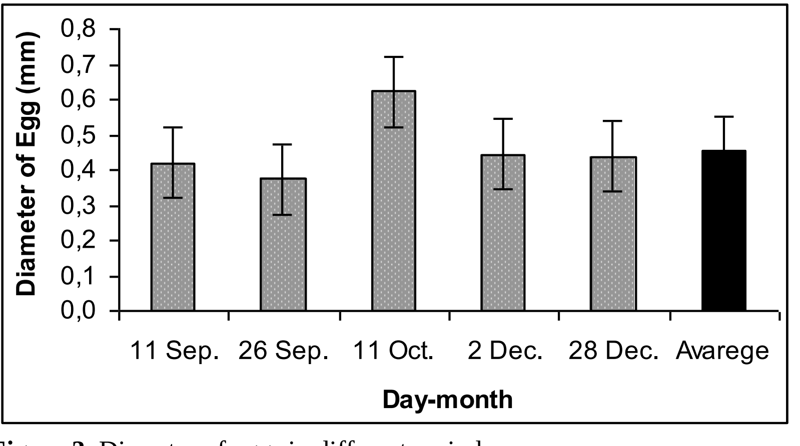


**Figure 3.** Diameter of eggs in different periods.

In Finenko et al. (2003) laboratory experiments the Black Sea *B. ovata* at salinity of 18 ‰ started reproduction at a size of 12–13 mm of body length. Under controlled food conditions during 10 days when daily weight specific rations averaged 20 - 108% of *B. ovata* wet weight, they had 4–6 clutches and the total number of eggs laid by one ctenophore ranged from 2066 to 4220 or from 0.2 to 1.6% of body weight (0.02–0.16% per day).

Arashkevich et.al. (2001) and Finenko et al. (2003) carried same studies with present investigate. Production of eggs and larva of *B. ovata* was investigated at different temperature. Clutch size of animals depends on the body length and development rate and viability of eggs were examined in experiment (Arashkevich et al. 2001). Ingestion and growth rates as well the gross growth efficiency of *B. ovata* were estimated from laboratory experiment. Daily egg production of ctenophores was determined by fed *M. leidyi* (Finenko et al. 2003). Kideys et al. (2003) examined factor of salinity affecting the egg production of *Beroe ovata*

## *Conclusion*

Laboratory experiments performed in the southern Black Sea showed that egg production is highest during the first 24 hours following the sampling and spawning rate decreases dramatically with every other day. In addition this egg production was high in late September and early October in 2003 But climate changes and warming sea water affect on reproduction time, period and feeding quantity of gelatinous macrozooplankton. Because of this, studies in the Black Sea is important to followed variation of ecosystem. *Beroe ovata* and its impact on plankton community are valuable in the Black Sea.

**Acknowledgements.** This study was supported by T.C. Basbakanlik DPT (T.R. Prime Minister State Planning Organization), Project Number 2002 KI20500 (TAP-S013).

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# The Eco- Physiology, Abundance and Vertical Distribution of *Pleurobrachia pileus* (O. F. Müller, 1776) off Trabzon, the South Eastern Black Sea, during 2001-2002

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## ABSTRACT

At the laboratory, the gastric emptying in *Pleurobrachia pileus* fed on *Artemia salina* at different temperatures (12 and 17 ˚C) was investigated. The emptying was best described by an exponential function in such that: $N_1 = N_0 e^{-0.951.t}$ ( $r^2$ =0.75, p<0.001, n=20). Where $N_0$, initial number of *Artemia salina* ingested. T is the duration from $N_0$ to $N_1$. It was found that the emptying time of *Artemia salina* ingested (from 2 to 19) varied from 0.6 to 2.93 h. It was also found that gastric emptying time (h) in *Pleurobrachia pileus* (W = 0.38 ± 0.18 g, L = 0.88 ± 0.29 cm, n= 20) fed on *Artemia salina* increased linearly by increasing number of *Artemia* ingested.

Clearance rate in *Pleurobrachia pileus* (W = 0.38 ± 0.18 g, L = 0.88 ± 0.29 cm) was also studied. The result indicates that there is a significant correlation between container volume and the clearance rate for the stated experimental conditions. The clearance rate increased as container volume increased. It was also varied 0.29-7.59 L/ day/ predator with the average of 2.77±2.40 L/ day/ predator (n= 20).

In the field, abundance and vertical distribution of *P. pileus* by months were investigated. The stomach contents were also studied. Microscopic analysis of stomach contents showed that calonoid copepods (52%), *Sagitta setosa* (14%) are the main prey items. However in the winter they were *Pseudo-nitzchia sp.* (43%). *Calanoid copepods* (23%), *Sagitta setosa* (11%), nauplii (5%), *Ceratium sp.* (3%), fish eggs (2%).

# INTRODUCTION

The drastic changes in the ecosystem of the Black Sea after the introduction of *Mnemiopsis leidyi* in the early 1980s have stimulated numerous recent studies. Plankton studies in the Black Sea have mainly dealt with horizontal and vertical distributions, morphology, tropic relationship, predation, ecological roles and methods for controlling the *Mnemiopsis leidyi* population (Shushkina and Musayeva 1983, Vinogradov et al. 1989, Zaika and Sergeeva 1991, Harbison and Volovik 1993, Zaitsev 1993, Lebedeva and Shushkina 1994). It has been claimed that *Mnemiopsis leidyi* outbreak has led to substantial economic losses. A sharp decline in the stocks of zooplanktonivorous fish, namely anchovy, sprat and mackerel in the Black Sea (Kideyş 1994). Bilio and Niermann (2004) and Bilio (2004) have shown that the decline in the anchovy stocks should be outcompeted by the ctenophore. In the face of such problems, a number of researchers have focused their studies on the abundance and ecological impact of jellyfishes in the Black Sea and suggested on possible courses of action. Vinogradov et al. (1985) first reported the extensive vertical distribution of *Pleurobrachia pileus* in the open water of the Black Sea. Researchers focused on various sectors of the Black sea, especially Novorosyisk, Odessa, Sevastapol and Crimean coasts, and the open Black Sea (Vinogradov et al. 1989, Shushkina and Musayeva 1990a, b; Vinogradov 1990; Shushkina and Vinogradov 1991a,b; Zaika and Sergeeva 1991; Vinogradov et al. 1992; Volovik et al. 1993).

In order to allow to quantification of the possible effect of a predator in the food web, gastric emptying process, mainly emptying rate and time should be studied. The rate at which a meal passes through stomach [gastric emptying rate, GER, g $h^{-1}$] and the total clearance time [gastric emptying time, GET- h] had been measured in a variety of fish species (Grove et al 1985, Seyhan 1994). They were used to evaluate the relationship between many of the characters, such as fish size and temperature and quality of food in stomach samples, taken sequentially can be used to estimate natural feeding rates if the gastric emptying rates are known (Seyhan and Grove 1998). Numerous factors modify GERs (Seyhan et al 2003; Kapoor et al 1974, Mazlum and Seyhan 2007, Fänge and Grove, 1979) and GETs and have been reviwed by Kapoor et al (1974) and Fänge and Grove (1979). However it is becoming clear that more attention should be given not only to fish, but also to the other marine and freshwater animals including gastropods (Seyhan et al, 2003) and jellyfish (Mazlum and Seyhan, 2007) that are believed to be playing an important role in the pertinent system.

Gelatinous zooplankton may substantially affect pelagic food webs by exerting a top-down control on their ecosystems (Kideys and Romonova 2001, Mutlu et al 1994). The drastic changes in the ecosystem of the Black Sea after the introduction of *Mnemiopsis leidyi* in the early 1980s have stimulated numerous recent studies (Mutlu and Bingel, 1999). In the summer of 1989 peak biomass levels of this ctenophore were up to 1.5-2 kg wet weight $m^{-2}$ total close to 1 billion tons for the entire sea (Vinogradov et al., 1989). Simultaneously there were sharp decreases in the quantity of prey zooplankton (Kideys and Romonova, 2001; Kovalev et al., 1998a, b; Kideys at al., 2000), and in commercial fishery catches (Kideys and Romonova, 2001; Kideys, 1994; Kideys et al. 1998; Kideys et al. 1999). These enormous biomass levels of *Mnemiopsis leidyi* steadily decreased in subsequent years (Kideys and Romonova, 2001; Mutlu et al., 1994). Plankton studies in the Black Sea have mainly deal with horizontal and vertical distributions, morphologytrophic relationship, predation, ecological roles and methods for controlling the *M. leidyi* population (Mutlu and Bingel, 1999; Shushkina and Musayeva, 1983; Vinogradov et al., 1989; Zaika and Sergeeva, 1991; Harbison and Volovik, 1993; Zaitsev, 1993; Lebedeva and Shushkina, 1994). Vinogradov et al. (1985) first reported the extensive vertical distribution of *Pleurobrachia pileus* in the open water of Black Sea. The average biomasses of *Mnemiopsis leidyi*, *Pleurobrachia pileus* and *Aurelia aurita* were approximately the same (200 g wet wt $m^{-2}$ ) in 1992 and 1993. *P. pileus* biomass doubled between 1990/91 and 1993. *P. pileus* like *M. leidyi* is an important predator on the copepod community.

*Pleurobrachia pileus* feeds preferentially upon copepods. *Pleurobrachia* fishes for prey by slowly swimming in arcs, trailing relaxed tentacles. When comb plate beating nearly ceases, the animal becoms completely still or sinks slightly. Feeding does notoccur unless the animal is in this relaxed state. Copepod which contacts the tentacles becomes ensnared in the sticky discharge from the colloblasts. The tentacle contracts stongly possibly in response to mechanical stimulation by the prey, and pulls the prey closer to the body (Moss, 1991). *Pleurobrachia pileus* feeds on a wide range of food items including Copepode, Cladocera, Mollusca, fish eggs and larvae and other taxa (Mutlu & Bingel, 1999).

Mazlum and Seyhan (2007) have studied that the feeding physiology of *Mnemiopsis leidyi* fed on *Artemia salina* were investigated under laboratory conditions. Multifactorial experimental designs were used to study the factors affecting gastrovascular emptying in *M. leidyi*. A high correlation was found between number of prey ingested and digestion time. Modelling of gastric emptying time (GET, h) of *M. leidyi* fed on Artemia salina was attempted to describe the effect of animal size, prey number, container volume and temperature on the digestion time.

Therefore, the present study presents the clearance-rate, digestion time and rate of *P. pileus* based on the stated laboratory conditions. An attempt has also been made to model digestion time–rate and clearance rate in the Black Sea ctenophore, *P. pileus*. This study, vertical distributions and abundance of the invasive ctenophore *P. pileus* in the South Eastern Black Sea were evaluated by using data collected at stations during the April 2001 to July 2002.

## MATERIALS AND METHODS

### *Abundance and Vertical Distribution*

Samples for studying the abundance and vertical distribution of *P. pileus* Müller, 1776 in the Eastern Black Sea were collected from April 2001 through July 2002. Macrozooplankton surveys were conducted on board the R.V. “DENAR-1”.

While the station 1 (41º 20' 00''E- 41º 01' 10''N) is 6 miles far from shore and has the maximum 800 m depth (Fig.1). To estimate vertical distribution of the organisms, a single Hensen opening-closing net (0.75 m net diameter, 200 µm mesh) was used. Vertical hauls in the open station were made from with oxygen upper layer (150 m) to 75 m and than 75 m to the surface (75-0 m). On board, soon after arrival the laboratory, gelatinous organisms were immediately preserved in %5 formalin buffered with borax. In the laboratory, stomach contents of 377 individuals of *P. pileus* were examined.

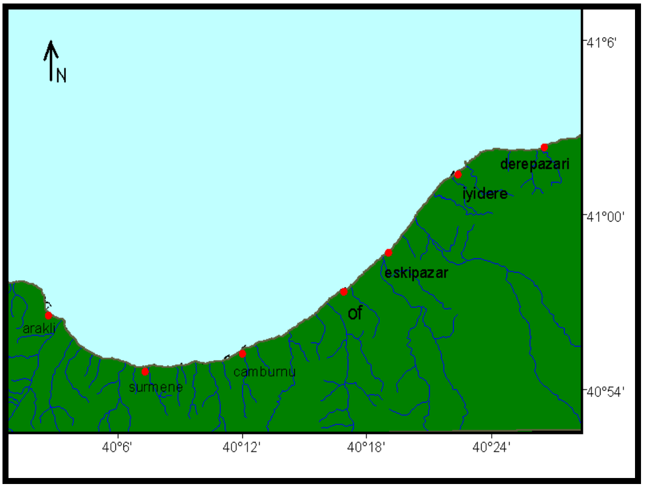


**Figure 1.** Sampling stations at the Eastern Black Sea

The gastrovascular cavity of each specimen was dissected under a binocular microscope by making an incision with a dissecting needle from the mouth through the cavity (Mutlu and Bingel 1999).

Stomach contents were identified to the lowest possible taxonomic level and individual food items were enumerated. The frequency of occurrence and numerical abundance were calculated to provide estimates of the qualitative and quantitative importance of the prey. Hydrographic data were obtained by an Aanderaa RCM 9 CDT instrument. Individual weights of ctenophores were also measured with electronic balance.

***Digestion time and rate***

Feeding experiments were conducted during October – December 2003 using two series of experiments. *P. pileus* was collected by the hand with net in the water column of 1 meter off Trabzon, eastern Black Sea. While the station 2 (40º 13' 00'' E - 40º 56' 30'' N) is chosen near the shore and has the maximum 10-15 m depth (Fig.1). They have been carried to the laboratory with a small tank in 10-15 minutes time where they were kept in a holding tank (10 l) which was slightly aerated. All experiments were carried out in the light at different temperature (12 ºC and 17 ºC) using containers of 1 l capacity.

A number of experiments were conducted to examine the emptying process in the *P. pileus* fed on *Artemia salina* nauplii. First we focused on the gastric emptying, and then we examined two factors which could have an affect on gastric emptying time and rate, namely the animal size (0.3-1.3 cm, 0.113-0.780 g WW), the *A. salina* nauplii ingested and temperature. The ctanophores were starved for 24 h before the experiment to ensure that they had no prey in their guts (Heeger and Möller, 1987).

Initial prey number was set as 250 for 1 liters of the container size. The ctenophores were placed individually in the experimental containers with stated number of prey items with initially placed; they were given a stated 32-55 minutes for all animals to feed. When the feeding stopped, the ctenophores were placed in Petri dishes filled with seawater under a stereomicroscope (10×40, 40×40) which allowed inspection of the content of the gastro vascular cavity (or pharynx) through the transparent body segments between the ‘combs’ (Kuipers et al 1990). The complete time taken for the digestion of the prey items in the gastro vascular pour was continuously recorded and experiment was carried out until all prey items to have been digested. Also the stomach content was checked in a microscope every 10-15 min. in the beginning and every second minute when stomach content began to disappear for estimation of gastric emptying rate.

The data were used to calculate instantaneous prey mortality rates according to the fallowing equation:

$$N_1 = N_0 \exp(-mt)$$

Where $N_1$ is the final number of *A. salina* is in the stomach of *P. pileus*, $N_0$ is the initial number of prey is in the stomach of *P. pileus*, *m* is the instantaneous prey mortality rate and *t* is the duration of experiment (Chandy and Greene, 1995; Gibbons and Painting, 1992)

### *Clearance rate experiments*

A modeling for clearance rate of *P. pileus* fed on *A. salina* were attempted using equal densities (250 number/ container), volume of the container (100 ml and 1 L.), the animal size ranged from 0.3 mm to 1.3 mm with average of 0.88 ± 0.29 mm (n = 20), the wet weight ranged from 0.113-0.78 g with average of 0.38 ± 0.18 g (n = 20) and using different temperature (12 ºC, 17 ºC).

Clearance rate represented (L/ day/ predator) is the volume of the water from which prey items were removed over a time interval assuming a constant clearance rate by the animal size, and therefore an exponential decline in prey density during the experiment (Garcia and Durbin, 1993). The clearance rates for the prey (*A. salina*) was then estimated from the experiments conducted as follows.

$$CR = \{(In(ni) - In(nf))\ V\}N/t\}$$

Where *CR* is the clearance rate, *ni* is the initial number of prey, *nf* is the final number of prey, *V* is the container volume, *N* is the animal size and t is the experimental time (Vinogradov et al, 1989; Mazlum, 1998).

## RESULTS

### *Abundance and vertical distribution*

At the depth of up to 150-75 m *P. pileus* were found more abundant then other species concerned especially in spring ( April 2001- 145 ind./m$^2$, April and May 2002- 204 ind./ m$^2$). From the depth 150-75 m, *P. pileus* was found more abundant than the surface waters studied (Fig. 2).

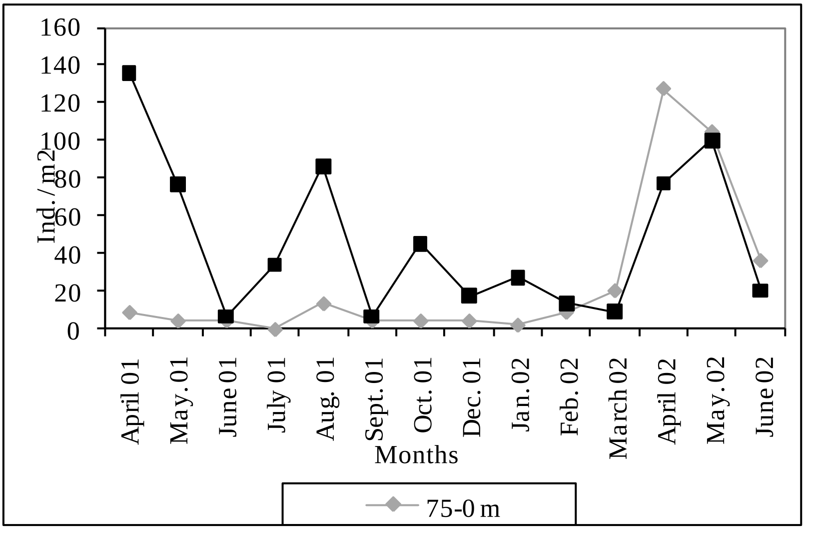


**Figure 2.** Monthly vertical distributions of *Pleurobrachia pileus*

The abundance of *P. pileus* increased from winter through spring to a peak in summer. The mean abundance during a sampling period was 95.6 ind./m$^2$, while the maximum abundance was 428 ind./m$^2$ in July 2002. Mean body lenght of *P. pileus* did not exceed 1.6 cm (0.05-1.6 cm) (Fig.3).

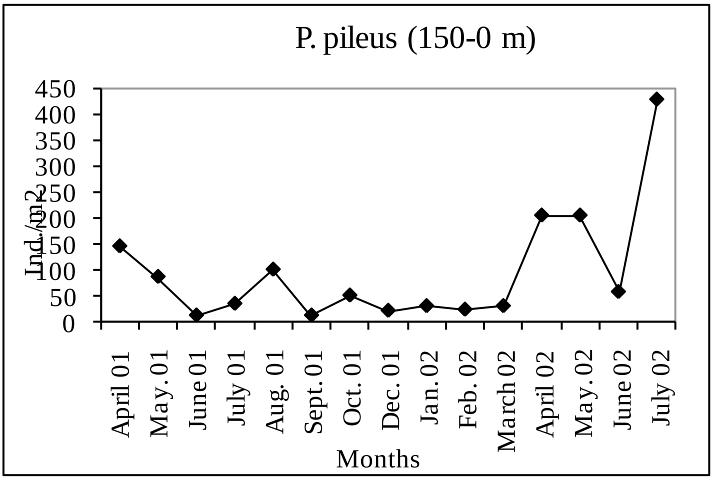


**Figure 3.** Monthly vertical distributions of *Pleurobrachia pileus* (150-0m)

***Digestion time and rate***

Digestion time of the *A. salina* fed to *P. pileus* was determined using different temperatures (12 ºC and 17 ºC). It was found that a linear relationship was observed (Fig. 4) with a high correlation factors ($r^2$ = 0.88, n = 20) between prey densities and the time required to clear the gastrovascular pour indicating that digestion time increases as the number of prey increases. However, a considerably low p was also obtained when the effect of temperatures (p = 0.064, n = 20) on digestion time. It is considered, it is closer to % 95 limits. This is thought to be because of the the temperature range is not high used in laboratory experiments.

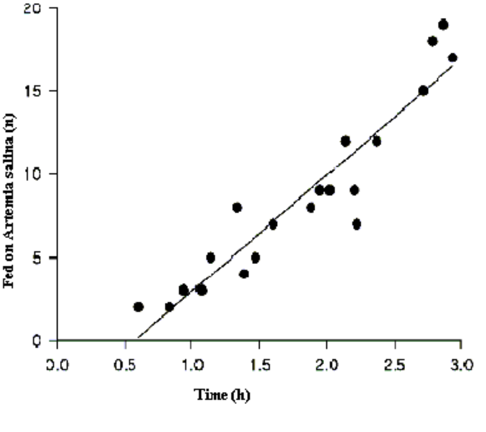


**Figure 4.** Gastric emptying time of *P.pileus* fed on *Artemia salina*

All data have been pooled and an attempt has also been made to account the gastric emptying rate in *P. pileus* fed on *A. salina*. The emptying was best described by a exponential function in such that: $N_1 = N_0 e^{-0.951.t}$ ($r^2$ =0.75, p<0.001, n=20) Where $N_0$, initial number of *Artemia salina* ingested. T is the duration from $N_0$ to $N_1$ (Fig. 5). All data has been using gastric emptying rate value found that 0.35 ± 0.02 ($r^2$ = 0.69, n = 20).

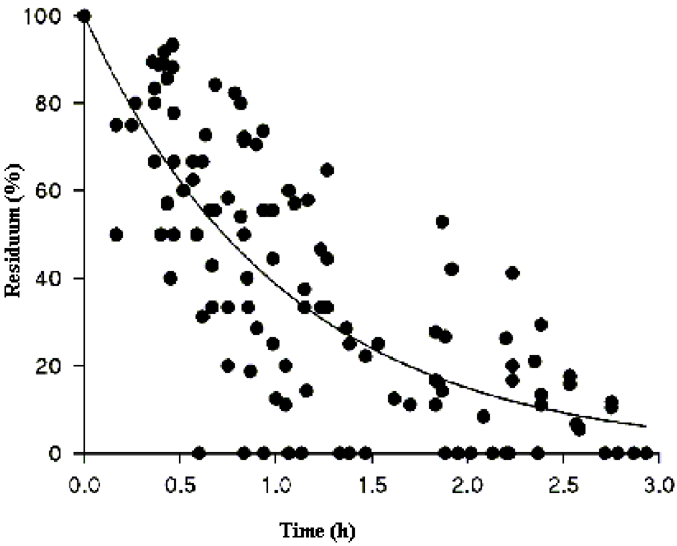


**Figure 5**. Percantage residuum of prey numbers in % in the gut of *P.pileus* after firs feeding with *Artemia salina*. The reduction through time was best described by an exponential function.

***Clearance Rate***

Clearance rate was also studied by looking at the factors affecting and it was found that the container volume have significantly affected the clearance rate such that when the container volume (V) increased clearance rates also increased. The result indicated that there was a significant correlation between container volume and the clearance rate for the stated experimental conditions. The clearance rate was increased as container volume was increased (Fig.6). The clearance rate also varied 0.29-7.59 L/ day/ predator. The average of 2.77±2.40 L/ day/ predator (W = 0.38±0.18, L = 0.88±0.29, n= 20).

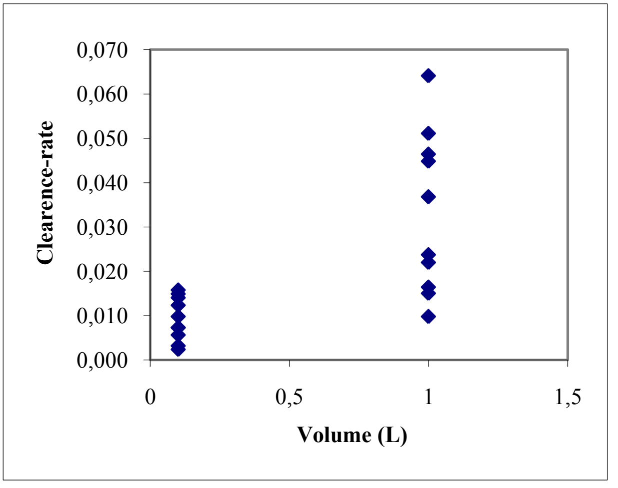


**Figure 6.** Relationship between prey density and number of prey ingested. Note that the number of *Artemia*.Ingested increases with increasing prey density irrespective with all two container volumes (100ml, 1L).

### *Stomach Contents*

The stomach contents of *P. pileus* classified by higher taxonomic categories consisted mainly of *Calanoid copepoda* (52%), *Sagitta setosa* (14%), *Ceratium sp*. (13%), fish eggs (4,5%), *Oikopleura dioica* (3,87%) and *Balanus nauplii* (1,04%) have made a small but noticable contribution to the *P. pileus* their diet.The stomach of *Pleurobrachia pileus* fed on *Sagitta setosa* and *Calanus euxinus* in the field is also given in Figure 7.

Main prey items in the winter however was *Psudo-nitzchia sp*. (43%), *Calanoid copepoda* (23,22%), *Sagitta setosa* (11,76%), nauplii (5%), *Ceratium sp*. (3%), fish eggs (2%) and their remains were found in the stomach as well.

Prey items in the spring however was *Calanus euxinus* (33-36%), copepod eggs (11,34%), *Calanoid copepoda* (9,5-31%), *Sagitta setosa* (2-35%), *Ceratium sp*. (4-23,5%), fish eggs (3,85-5,9%), *Oikopleura dioica* (3,87%) and *Balanus nauplii* (1,04%) were found in the stomach as well.

In the summer of stomach contents *Calanoid copepod* (21,5-71,23%), *Calanus euxinus* (17,64-18,28%), fish eggs (18,15%), *Sagitta setosa* (17,72%), copepod eggs (9,35%), *Ceratium sp*. (1,79-25%), *Oikopleura dioica* and Mollusca egg (1,3-2,6%). The stomach contents of *P. pileus* in the autumn consisted mainly of *Calanoid copepoda* (45,90%), *Calanus euxinus* (41,18%) and *Sagitta setosa*.

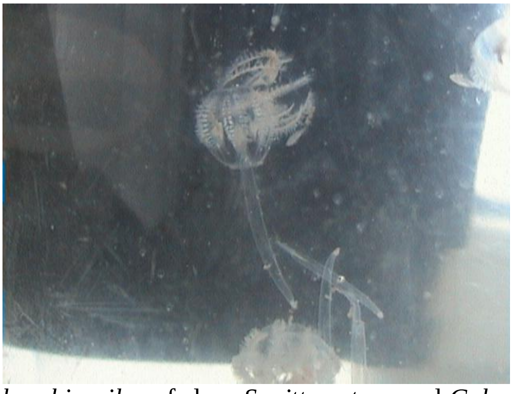

**Figure 7.** *Pleurobrachia pileus* fed on *Sagitta setosa* and *Calanus euxinus* in the field.

## DISCUSSION

It has been reported that *P. pileus* acts as serious competitors for copepoda with pelagic fish and the planktonic larval stages of most fish. Harbison et al. (1978), state that like most lobate ctenophores, *M. leidyi* feeds superfluously. Gastric emptying time of different prey items has been studied in both Ctenophore and Scyphomedusae (Annisky et al., 1998; Monteleone and Duguay, 1988; Arai, 1997; Tsikhon-Lukanina et al 1993). However the results are not consistent. Purcell et al (1994) stated that bay anchovy eggs and zooplankton prey had similar digestion times. They also reported that the digestion time of anchovy eggs and copepods fed on cyphomedusae, *C. quinquecirrha*, was not affected neither by prey number nor by the animal size.

A considerable number of papers report on digestion time of *P. pileus* (Martinussen & Båmstedt 2001). Digestion time was found to decrease with increasing food concentration and size of predator (Purcell 1983; Costello 1988; Monteleone & Duguay 1988; Purcell & Cowan 1995; Martinussen & Båmstedt, 2001) and to increase with increasing size and number of prey (Reeve1980; Purcell 1989; Martinussen & Båmstedt 1999) and increasing metabolic rate (Biggs 1977; Purcell 1983).

A number of experiments were conducted to examine the emptying process in the *P. pileus* fed on *Artemia salina nauplii*. First we focused on the description of gastric emptying, and then we examined two factors which could have an affect on gastric emptying time and rate, namely animal size and the number of ingested prey.

Gastric emptying time in *P. pileus* fed on *Artemia salina nauplii* at different temperatures (12 and 17 °C) was investigated. The emptying was best described by a exponantial function in such that $N_1 = N_0 \, . \, e^{-0.951 \, .t}$ ($r^2 = 0.77$, $p < 0.001$, $n = 20$). It was found that the emptying of *Artemia salina nauplii* ingested (from 2 to 19) varied from 0.6 to 2.93 hours. It was also found that gastric emptying time (h) in *P. pileus* (W= 0.38± 0.18 g, L= 0.88 ± 0.29 cm, n= 20) fed on *Artemia salina nauplii* increased linearly by increasing number of Artemia ingested.

Diets of gelatinous predators; barnacle larvae, copepods, Euphausiid eggs, Euphausiid larvae, *Oikopleura dioica* was been used by Larson (1987a,b). According observations during 1980-1981 for *P. bachei*, digestion time ranged from 3 to 4 hours depending on prey taxa. These data show that medusae and ctenophores are important predators of meso zooplankton. They feed on the eggs and the larvae of commercially important euphausiids and they may compete with salmon and other juvenile fishes for these some prey (Larson, 1987a, b).

Digestion time was found to decrease with increasing food concentration and size of predator (Purcell 1983; Costello 1988; Monteleone & Duguay 1988; Purcell & Cowan 1995; Martinussen & Båmstedt 1999) and to increase with increasing size and numberof prey (Reeve 1980; Purcell 1989; Martinussen & Båmstedt 1999).

Clearance rate in *P. pileus* fed on *Artemia salina* was also investigated. The result indicates that there is a significant correlation between container volume and the clearance rate for the stated experimental conditions. The Clearance rate also varied 0.29-7.59 L/day/predator. The average of 2.77±2.40 L/day/predator.

It has been reported that *P. pileus* there is a volume beyond wich clearance becomes independent of container size. For *P. pileus* of 10-15 mm, this is probably somewhere between 40 and 60 l, but will of course vary with predator size. Although Miller & Daan (1989) noted that prey type was more important in determining the clearance rates of *P. pileus* than container volume, their number of trials in different size containers was small. Certainly, their mean clearance rates in 4 l (3.3 .day$^{-1}$) were lower than those at 8 (5.01 l .day$^{-1}$) or 16 l (5.0 l .day$^{-1}$), which in turn were not that different from each other suggesting the attainment of a ceiling filtration rate. While similar results results were shown by Monteleone & Duguay (1988) for the lobate ctenophore *M. leidyi*, their data were best described by Ivlev' s (1961) equation, where small changes in volume of the smaller containers elicited proportional clearance responses (Gibbons and Painting, 1992).

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# Distribution of gelatinous zooplankton in the southern Marmara Sea during 2006-2007

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## ABSTRACT

In this study, spatial and seasonal distributions of six gelatinous zooplankton (*Aurelia aurita*, *Chrysaora hysoscella*, *Rhizostoma pulmo*, *Mnemiopsis leidyi*, *Beroe ovata* and *Pleurobrachia pileus*) were evaluated using data obtained from 4 cruises to the southern Marmara Sea carried out In July 2006, October 2006, March 2007 and June 2007. *Mnemiopsis leidyi* was always present except March 2007. The appearance of *Beroe ovata* resulted in a sharp decrease of *M. leidyi* abundance. *Beroe ovata* was found only in October 2006 sampling area, with the highest abundance (4.3 ind.m$^{-3}$). The maximum abundance of *Pleurobrachia pileus* was in June 2007 (9.5 ind.m$^{-3}$). *A. aurita* was absent in March 2007. *Chrysaora hysoscella* and *Rhizostoma pulmo* was observed only in July 2006 and June 2007.

## INTRODUCTION

Gelatinous zooplankton may excessively affect pelagic food web by exerting a top-down control on their ecosystems (Mountford 1980). This has been well documented estuaries and enclosed seas (Kremer and Nixon 1976, Mutlu 1999, 2001, Mutlu and Bingel 1999). Several investigators provided data on the abundance on the gelatinous zooplankton in the Marmara Sea (Shiganova et al 1995, Tarkan et al 2000, Isinibilir and Tarkan 2000, İşinibilir 2004, Isinibilir et al 2004, Isinibilir 2007, Mavili 2008, Isinibilir 2009, Isinibilir et al 2010). Until very recently, six species of gelatinous zooplankton were present in the Marmara Sea: three scyphozoan medusae [*Rhizostoma pulmo*, *Aurelia aurita* and the new invader *Chrysaora hysoscella*] and three ctenophores [the indigenous *Pleurobrachia pileus* and the invaders *Mnemiopsis leidyi* and *Beroe ovata*]. The arrival of the ctenophore *Mnemiopsis leidyi* from the western Atlantic to the Black Sea with ballast water at the end of the 1980s accelerated several adverse events

(Vinogradov et al 1989, Kideys et al 1999, Kideys et al 2000). Via the surface currents flowing from the Black Sea through the Bosphorus, *Mnemiopsis leidyi* must have immediately invaded the Marmara Sea following their respective occurrence in the Black Sea (Shiganova et al. 1995). *Beroe ovata* was first observed in the Marmara Sea in 1992 (Shiganova et al 1995). The first appearance of *Chrysaora hysoscella* in the Marmara Sea was recorded in the Erdek Bay during August-September of 2000 (İnanmaz et al 2002). The jellyfish *R. pulmo* inhabits near-shore and in polluted regions (Shuskina et al., 2000). The most recently, *Liriope tetraphylla*, *Aglaura hemistoma*, *Solmundella bitentaculata*, *Neoturris pileata* and *Paraphyllina ransoni* were recorded in the Marmara Sea (Isinibilir et al, 2010).

The Marmara Sea, connected to the Black and Aegean seas by the Strait of Istanbul and Dardanelles straits, is an inland sea forming a transition zone between the Black Sea and the Mediterranean Sea. As a result of the positive water balance in the Black Sea, its water masses are transferred into the Marmara Sea through the Strait of Istanbul, forming a brackish upper layer (15-20 m) with a salinity of 22-26 ‰. Below this upper layer, a more saline (~39 ‰) the Mediterranean Sea water flows towards the Black Sea, with a constant temperature of about 15 ºC throughout the year (Besiktepe et al.1994). Dissolved oxygen (DO) concentrations are between 7.4-10.7 mg $l^{-1}$ in the upper layer, and 1.1-1.5 mg $l^{-1}$ in the lower layer (Unluata et al 1990).

The aim of the present study is to provide information on the seasonal dynamics of abundance of gelatinous zooplankton in the southern Marmara Sea.

## MATERIALS AND METHODS

Gelatinous zooplankton were collected vertically during daytime by a WP2 closing net (200 µm mesh, 0.57 m diameter) from the interface to the surface at monthly with one haul at 10 stations (Fig. 1) during the cruises of R/V Yunus-S in July 2006, October 2006, March 2007 and June 2007. Zooplankton were taken only from four stations (at stations 1, 3, 6 and 10). The Bandırma Bay is represented by stations 1, 2; Kapıdağ Peninsula by 3; the Erdek Bay by 5, 6, 7; and the Dardanelles part by 9 and 10, as shown in Fig. 1. Gelatinous zooplankton specimens were identified and measured immediately on board.

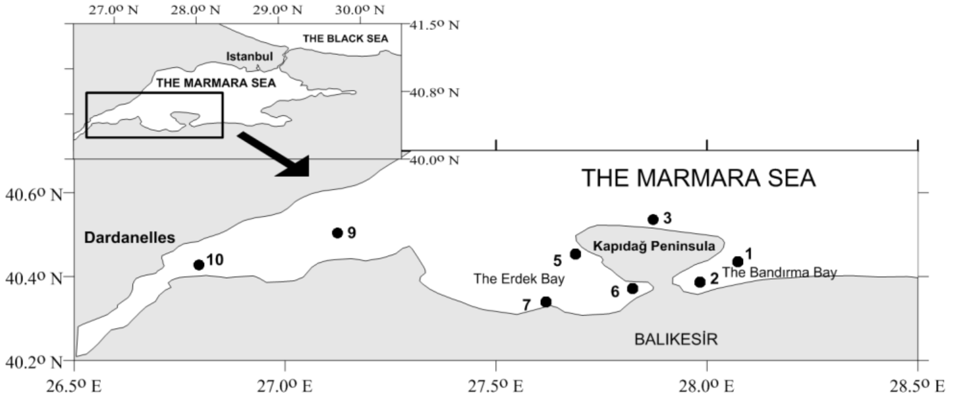


**Figure 1.** Location of sampling stations

# RESULTS

Seasonal changes in water temperature are shown in Figure 2. The maximum value of 24.8 °C was recorded in Bandırma Bay (at station 2) in June 2007, while a minimum of 8.9 °C was registered in the Dardanelles (at station 10) in March 2007. The temperature in June 2007 was higher than in July 2006.

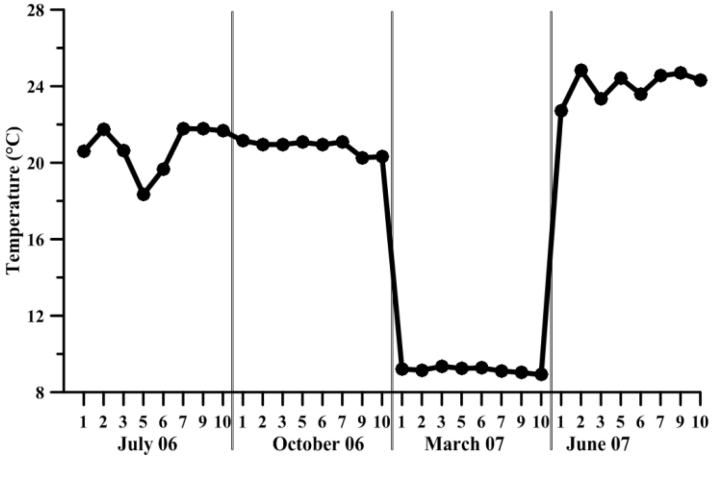


**Figure 2.** Seasonal fluctuations of temperature in the upper layer at stations in the Southern Marmara Sea.

*Mnemiopsis leidyi* was always present in all seasons, except March 2007 (Figure 3). In July 2006, the distribution of *M. leidyi* shifted further to the west.

The average abundance was 1.3 ind.$m^{-3}$. The maximum abundance of *M. leidyi* was 4.4 ind.$m^{-3}$. In October 2006, *M. leidyi* was found mainly in the Erdek Bay. Mean abundance was 0.2 ind.$m^{-3}$. The maximum individual number (1.2 ind.$m^{-3}$) were found in the inner part of the Erdek Bay. In March 2007, *M. leidyi* was totally absent in all stations. In June 2007, the distribution of *M. leidyi* was found almost all stations. Maximum length of *Mnemiopsis leidyi* was found in July 2006 (130 mm).

*Beroe ovata* was absent in July 2006, March and June 2007 (Figure 3). In October 2007, *B. ovata* was mainly distributed in the waters of Erdek and Bandırma Bay. Mean abundance of *B. ovata* was 1.02 ind.$m^{-3}$. Maximum abundance (4.3 ind.$m^{-3}$) was found in the Erdek Bay (at station 6). Maximum length of *Beroe ovata* was 130 mm.

*Pleurobrachia pileus* was absent in October 2006 (Figure 3). In July 2006, the distribution of *P. pileus* decreased from Bandırma Bay to the Dardanelles. Mean abundance of *P. pileus* was 2.7 ind.$m^{-3}$ in July 2007. The maximum abundance of *P. pileus* was 9.6 ind.$m^{-3}$ in June 2007. In March 2007, *P. pileus* was just found at station 1, 6 and 10. In June 2007, the distribution of *P. pileus* was found just in the Bandırma Bay and the Kapıdağ Peninsula. Maximum length of *Pleurobrachia pileus* was found in March 2007 (21 mm).

*Aurelia aurita* was always present in all seasons except March 2007 (Figure 3). In July 2006, *A. aurita* was found mainly in the Bandırma and Erdek Bay. Maximum abundance (7.3 ind.$m^{-3}$) was found in the eastern part of the Erdek Bay in July. In October 2006, the mean abundance was 0.2 ind.$m^{-3}$. In June 2007, the maximum abundance (11.0 ind.$m^{-3}$) of *A. aurita* was found in the eastern part of the Erdek Bay. Maximum length of *Aurelia aurita* was found in June 2007 (210 mm).

Furthermore, *Chrysaora hysoscella* was observed in the Bandırma Bay and the Dardanelles in both July 2006 and June 2007. *Rhizostoma pulmo* outburst was seen in the Erdek Bay in both July 2006 and June 2007.

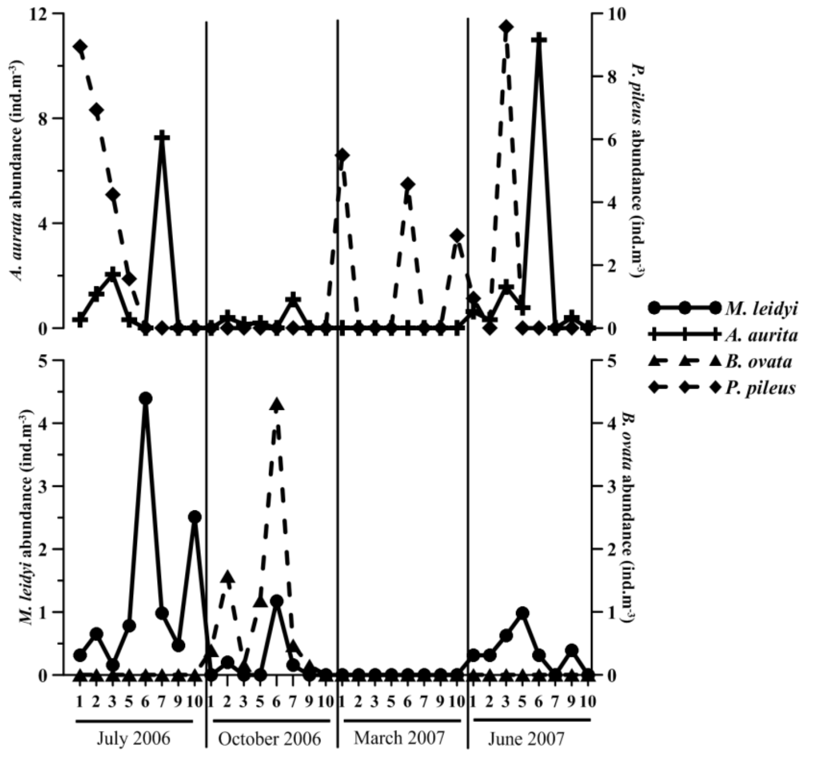


**Figure 3.** Seasonal fluctuations of gelatinous macrozooplankton at stations in the Southern Marmara Sea.

The mesozooplankton exhibited significant seasonal distribution by regions (Figure 4). The maximum mesozooplankton abundance was recorded at station 10 in July 2006 (67457.5 ind.m$^{-3}$), particularly due to high cladocera abundance (57338.6 ind.m$^{-3}$). The minimum abundance was in March 2007 at station 10 (825.7 ind.m$^{-3}$). Copepods were the most abundant in October 2006.

## DISCUSSION

Six species of gelatinous macrozooplankton were found in the southern Marmara Sea: three scyphozoan medusae *Aurelia aurita, Chrysaora hysoscella, Rhizostoma pulmo* and three ctenophores *Mnemiopsis leidyi, Beroe ovata* and *Pleurobrachia pileus*. In investigated area, the abundance of *M. leidyi*, *P. pileus* and *A. aurita* peaked in summer but *B. ovata* had high quantity in autumn. *Chrysaora hysoscella* and *Rhizostoma pulmo* were observed only in summer periods. But in Black Sea, it was found that *M. leidyi* had high quantity in winter times, but abundance of *A. aurita* and *P. pileus* increased in summer times in the Black Sea

(Mutlu,1999, Mutlu and Bingel 1999, Mutlu 2001). Isinibilir (2004) noticed for Izmit Bay in the Marmara Sea that *Rhizostoma pulmo* had high abundant in late summer and autumn.

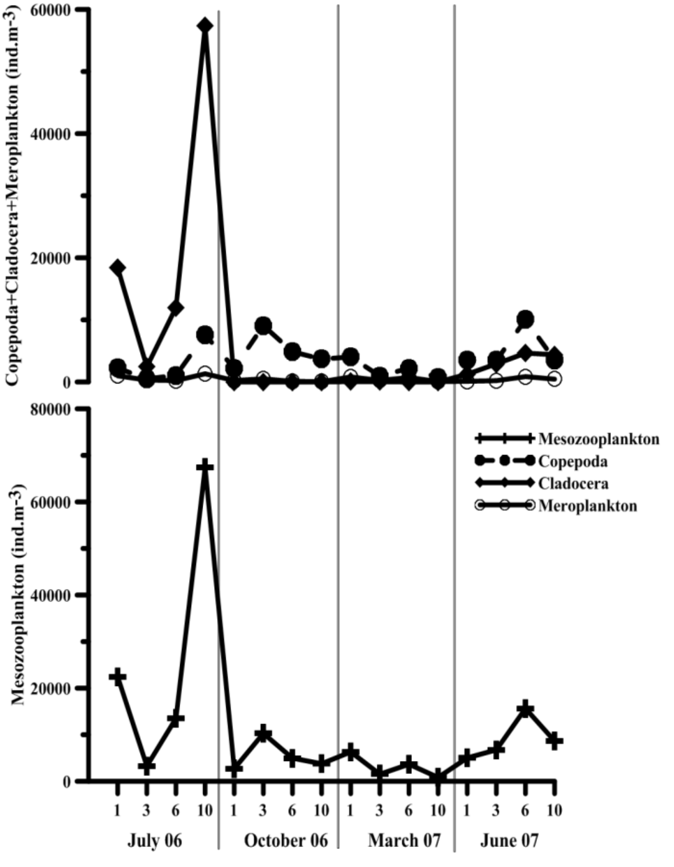


**Figure. 4.** Seasonal fluctuations of mesozooplankton, copepod, cladocera and meroplankton at stations in the Southern Marmara Sea.

As revealed in this study, after the *B. ovata* appearance, sharp decreases occurred in *M. leidyi* quantity in October 2006. Isinibilir (2007) informed in the Izmit Bay in the north eastern Marmara Sea that the abundance of *M. leidyi* was limited in summer by *B. ovata*. Finenko et al (2001) demonstrated for the Black Sea area of Sevastopol that *B. ovata* could control the *M. leidyi* stocks. Kremer and Nixon (1976) also noticed that a reduction of *M. leidyi* biomass coincided with an increase in *B. ovata* abundance. Furthermore, *Mnemiopsis leidyi* reached the highest abundance in summer when the temperature was high, similar to the pattern observed in the Black Sea and the Caspian Sea (Shiganova 1998, Finenko et al. 2003, Roohi et al. 2008). Starting in spring, when the low values were observed, *P. pileus* showed marked increases in abundance until summer, when the maximum values occurred. Mutlu and Bingel (1999) found a similar trend in the seasonal abundance of *P. pileus*. *Aurelia aurita* showed high quantity in July 2006; after a sharp decrease in October 2006 to March 2007, a peak occurred in July 2007. Similar results have been reported in the Black Sea (Mutlu 2001). Mutlu (1999, 2001) noticed that when *M. leidyi* was predominantly present, *A. aurita* were rare, and vice versa. *A. aurita* and *M. leidyi* inhabit the same layer and compete for the same planktonic food (Mutlu 1999, 2001).

The high temperature in July 2006 (Figure 2) was favorable to *Mnemiopsis leidyi*, and bloom events were expected. In spite of high temperature in June 2007, the abundance of *Mnemiopsis leidyi* remained relatively low. This may be not only a long-lasting effect of the *Beroe ovata* pressure but also the effect of new invader *Liriope tetraphylla* which was first recorded in 2005 in the Marmara Sea (Isinibilir et al 2010).

The Marmara Sea is exposed to invasive of gelatinous zooplankton because of its tropic structure (Isinibilir 2004, Isinibilir et al. 2010). In last decade, quantity of gelatinous zooplankton was increased in the Sea. İşinibilir (2010) informed that the number of gelatinous zooplankton has reached a total of 51 in the Marmara Sea. Under certain environmental conditions, the local abundances of jellyfish can increase and hereby they can not only severely damage and shift the structure of zooplankton communities but also feeding directly on larval and juvenile stages of commercially valuable fish (Titelman and Hansson 2006). Local fisheries in the Marmara Sea are very important, especially Erdek and Bandırma Bay and may be effected by increasing gelatinous zooplankton. As a conclusion, gelatinous zooplankton species in the Marmara Sea should be investigated in order to predict potentially their effects on valuable fisheries resources.

**Acknowledgments.**
This work was supported by TÜBİTAK (105Y039). We wish to thank crews of R/V "Yunus S" for their supports and assistances at sea.

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# Daily Reproduction of *Beroe ovata* Mayer 1912 (Ctenophore: Tentaculata) in Sinop Coasts of the Black Sea, Turkey

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## ABSTRACT

In order to determine the characteristics of egg production *Breoe ovata* were exampled on September 2002 in Sinop coast of the Black Sea. A total of 183 individuals were collected and good-looking individuals selected for the experiment. Average length and volume were calculated 26.5 ±9.55 mm, 5.9 ±4.63 mm, respectively. Daily reproduction of *Beroe ovata* was 1229±441 eggs. Length-volume and length- fecundity relations of *B. ovata* were determined as $V= 0.0087L^{1.94}$ ($r^2$= 82, N= 183) and $F= 0.0005L^{4.0368}$ ($r^2$= 89, N= 53), respectively.

## INTRODUCTION

During the past 20-30 years, the ecosystem of the Black Sea has experienced catastrophic impacts of both anthropogenic and climatic origin. These impacts have resulted in significant changes involving micro and mesoplankton as well as gelatinous macrozooplankton. In estuaries, bays and coastal waters planktonic ctenophores often constitute the most visible component. Gelatinous zooplankton groups whose body tissues are very waters. They have high growth and fecundity rates and capacity for self-fertilization, which can result in sudden population outbursts in nature and can severely deplete copepod food resources. On the order hand, the vulnerability of the newly hatched larvae to destruction by larger copepods (Stanlaw *et al*., 1981) provides the potential for prey control of the predator population.

In the Black Sea, macroplankton are represented by two autochthonous species of jellyfishes (*Aurelia aurita* and *Rhizostoma pulmo*) and two common species of invasive ctenophores (Mutlu, 1999; Kideys and Romanova, 2001), the mass development of *Mnemiopsis leidyi* has been observed since 1988, and *Beroe ovata*, which has developed since the autumn of 1999. *Beroe ovata* seemed to penetrate into the Black Sea from the Atlantic Ocean. This ctenophore consumes other ctenophores, mainly Lobata (Finenko *et al.,* 2001, 2003; Shiganova *et al.*, 2000 and 2001; Purcell *et al*., 2001).

While the role of *M. leidyi* in plankton decreased and the role of *Aurelia* increased. The results of the intensive grazing of the population of *M. leidyi* (especially young specimens) by *B. ovata* may be as equally important for the entire Black Sea ecosystem, the structure and productivity of its communities, as the mass development of *M. leidyi* was in 1988-1991 (Shushkina *et al.,* 2000).

By analyzing the long-term distribution of *M. leidyi*, it has already been observed that the biomass of this ctenophore has been decreasing since the appearance of its predator *Beroe ovata* in the Black Sea (Kideys and Romanova, 2001).

A comparison of mean daily specific growth rate of the *M. leidyi* population for the year in Sevastopol Bay (3.9% of population biomass;) with predatory impact of *B. ovata* population on *M. leidyi* (2-53%) showed that in inshore waters of the Black Sea, despite their low numbers, the *B. ovata* population may control abundances of their prey population in certain periods (Finenko *et al.*, 2003).

In this study in daily reproduction of *B. ovata* was observed.

## MATERIALS AND METHODS

Before the experiment was started, eight plastic bottles with 5 liters were prepared in the laboratory. Three liters filtrated sea water through a 100 µm filter was put into these bottles before *Beroe* have been added. Every three hours a *Beroe* was taken out from the bottle and transferred different bottle. Then, the bottle was filled again and the procedure was repeated. The eggs collected from the sieve were washed in a 200 ml vessel and all the samples were countered under a dissecting stereo microscope. The experiments were conducted under the light and room temperature. The temperature and salinity were 24 $^{o}$C, and 18%$_{o}$, respectively.

At the end of the experiment diameters, lengths and volumes of all *Beroe* were measured. The size of animals was measured with a ruler right in the experimental vessel. Body volume was identified by water displacement from calibrated cylinder.

## RESULTS

*Beroe* eggs turned into larvae within 24 hours. From egg to larva has been a quick transition. The experimental results were shown on Table 1.

**Table 1.** Daily dynamics of *Beroe ovata* egg production.

| Size groups (mm) | Time | | | | | | | | Total Egg |
|---|---|---|---|---|---|---|---|---|---|
| | 11.00-14.00 | 14.00-17.00 | 17.00-20.00 | 20.00-23.00 | 23.00-02.00 | 02.00-05.00 | 05.00 - 08.00 | 08.00 - 11.00 | |
| 30x25 | 6 | 0 | 0 | 0 | 0 | 2 | 4 | 2 | 14 |
| 30x30 | 330 | 200 | 147 | 136 | 159 | 192 | 199 | 180 | 1543 |
| 35x30 | 32 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 34 |
| 40x35 | 121 | 98 | 72 | 111 | 160 | 105 | 135 | 94 | 896 |
| 40x30 | 411 | 259 | 120 | 204 | 362 | 116 | 93 | 14 | 1579 |
| 45x35 | 613 | 540 | 0 | 16 | 792 | 888 | 469 | 139 | 3457 |
| 40x40 | 441 | 623 | 350 | 344 | 370 | 179 | 8 | 1 | 2316 |

Reproduction of *B. ovata* was investigated every 3 hours periods in one day. In the experiment individuals was found only between 30 - 40 mm. First three hours ($11.^{00}$-$14.^{00}$) was showed high eggs number. After this production of eggs decreased a little bit at the next three hours ($14.^{00}$- $17.^{00}$) eggs number was greatly diminish. The eggs number was again increased in intervals $23.^{00}$- $02.^{00}$ and $02.^{00}$- $05.^{00}$.

While total maximum egg production was 3457 (in 45x35 mm size groups), total minimum egg production was 14 (in 30x25 mm size groups). Daily reproduction of *Beroe ovata* were 1229±441 eggs.

Among 183 individual of *B. ovata* with the 16 length groups were measured. Most abundant individuals of 35 mm size (35%). Among *B. ovata* populations were very much sampled for groups of lengths from 25 mm to 45 mm. Smaller than 25 mm and bigger than 45 mm individuals were sampled too few (1-5%) (Figure 1).

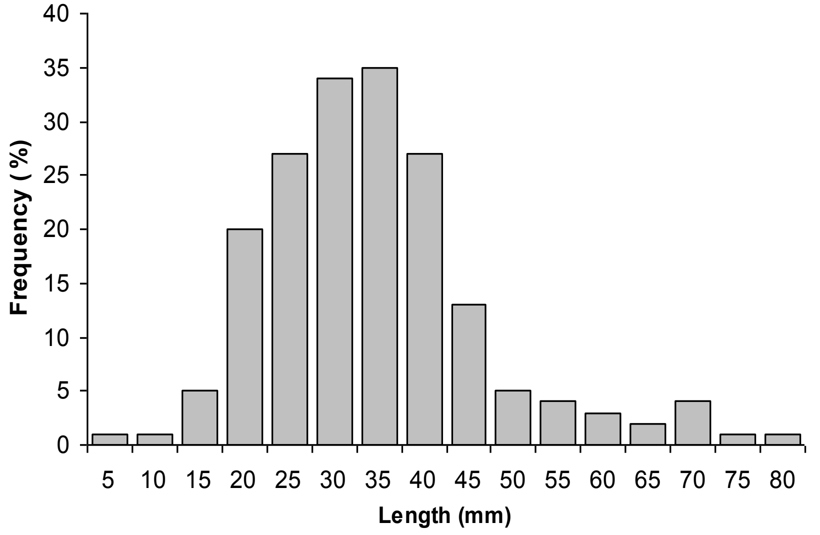


**Figure 1**. Size structure of *Beroe ovata* population.

In sampling 183 individual were caught. Its lengths sampled from 5 to 60 mm, volume changed from 1 to 20 ml. Average length and volume were calculated 26.5 ±9.55 mm, 5.9 ±4.63 mm, respectively (Figure 2).

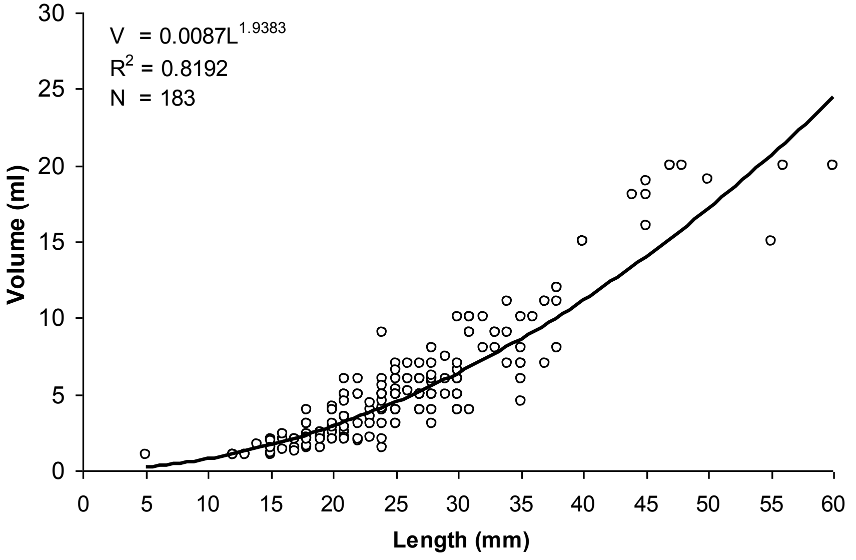


**Figure 2.** Volume- length relation of *Beroe ovata*.

Length-volume relations of *B. ovata* were determined as:
$V= 0.0087L^{1.94}$ ($r^2$= 82, N= 183, Figure 2).

Development stages of the *Beroe ovata* were investigated in 4 categories in 24-hour time period. Development stages of the *Beroe ovata* were observed over stage II from 44 mm to 54 mm (Figure 3).

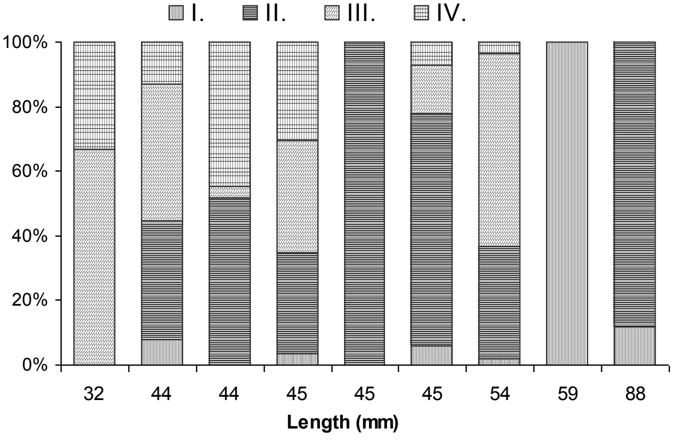


**Figure 3.** Development stages of the *Beroe ovata* (I: Egg; II: Cleavage; III: Larva in membrane; IV: Free swimming larva)

Length- fecundity relations of *B. ovata* were determined there is a relation as:
$F= 0.0005L^{4.0368}$ ($r^2$= 89, N= 53, Figure 4).

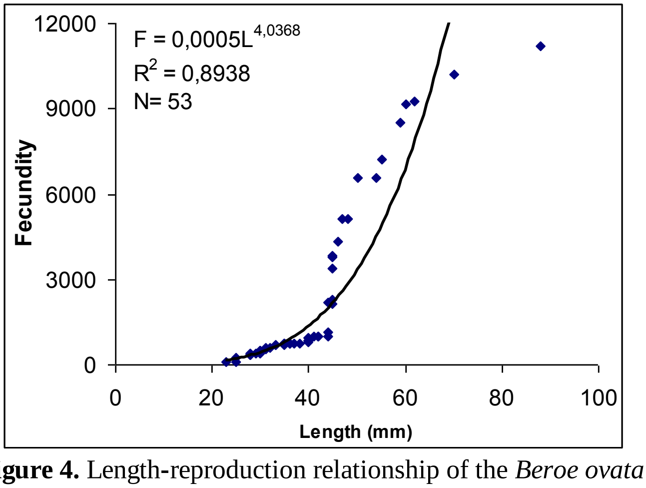


**Figure 4.** Length-reproduction relationship of the *Beroe ovata*.

## DISCUSSION

Total maximum egg production was 3457 in 45 mm length. Birinci-Ozdemir *et al.* (2005) high of egg amount to *B. ovata* individual with 40-80 mm length class were determined. At 60 mm length individual as maximum 9800 for egg amount investigated.

Although Kideys *et al.* (2002) were able to reproduce *Beroe* into eggs and on a few occasions into larvae, larval development experiments were not successful in the laboratory. However it was still possible that successful development may take place in field conditions.

In conclusion, maximum eggs production was determined at *B. ovata* length size of 40- 70 mm. High reproduction potential of *B. ovata* was established especially in September: individuals lied about 10000 eggs. Eggs production of *B. ovata* was showed every 3 hours and maximum reproduction was realized in first ovulate and night ($23.^{00}$-$02.^{00}$).

**Acknowledgements**
This study was supported by T.C. Basbakanlik DPT (T.R. Prime Minister State Planning Organization), Project Number 2002 KI20500 (TAP-S013).

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Stanlow, K.A., Reeve, M.R., Walter, M.A., 1981. Growth, food and vulnerability to damage of the Mnemiopsis mccradyi in its early life history stages. Limnol. Oceanogr., 26 (2): 224-234.

# The New Location Record of *Cassiopea andromeda* (Forsskål, 1775) from the Gulf of Antalya, Levantine coast of Turkey, Eastern Mediterranean

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## ABSTRACT

The present paper reports the new location record of the "Upside-down jellyfish", *Cassiopea andromeda* (Forsskål, 1775), (Cnidaria: Scyphozoa, Rhizostomeae) from the Gulf of Antalya. During a seasonal trawl survey carried out between August, 2009 and April, 2010, a single specimen of *C. andromeda* was caught by a commercial trawler as bycatch at the depth of 25m, from between the Sıçan Island and Great Harbour of Antalya in November, 2009.

## INTRODUCTION

By now, nine species of Scyphomedusae, including four alien species were reported from the Levantine Sea (Galil et al., 2010; Öztürk and İşinibilir, 2010). *C. andromeda* is the first Scyphozoan species entered the Mediterranean Sea via the Suez Canal (Galil et al., 1990) and the first Turkish record consisted of a single specimen from Fethiye (Bilecenoğlu, 2002). Subsequently, six specimens from the Bay of İskenderun (Çevik et al., 2006) and an established population was reported from the Ölüdeniz Lagoon (Özgür and Öztürk, 2008). The presence of this species was recently reported from Malta, Central Mediterranean Sea (Schembri et al., 2010). We report the presence of the species from the Gulf of Antalya. The Gulf of Antalya locates in the Northeastern Levantine Basin and is highly susceptible to invasions by aliens due to the proximity to the Suez Canal (Figure 1).

## MATERIALS AND METHODS

During a seasonal trawl survey carried out between August, 2009 and April, 2010, a single specimen of *C. andromeda* was caught by a commercial trawler as bycatch at the depth of 25m, from between the Sıçan Island and Great Harbour of Antalya in November, 2009. The tow co-ordinates were 36°46'N 30°35'E to 36°48'N 30°36'E. The specimen was preserved 4% formalin and kept in the Akdeniz University, Faculty of Fisheries.

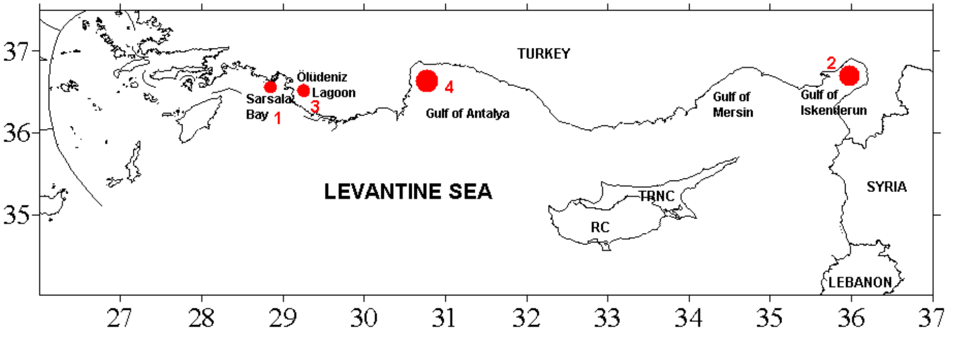


**Figure 1.** The location records for the distribution of the alien Scyphozoan species, *C. andromeda* in the Turkish coast of the Levantine Sea (**1.** Bilecenoğlu, 2002; **2.** Çevik et al., 2006; **3.** Özgür and Öztürk, 2008; **4.** This study).

## RESULTS AND DISCUSSION

The alien species introduced to the Levantine Sea, generally first colonized in the lagoons or estuarine habitats and polluted harbors where are environments with low biodiversity (Galil, 2000). *C. andromeda* also reported to prefer warm, shallow and sheltered waters (Schembri et al., 2010). The species was found from between the entrance of the Great Harbor of Antalya and the Sıçan Island where there is a deep sewage water discharge. Secchi disk depth was measured as 8 m. Both the surface and bottom water temperature was 22.9°C, salinity 38.3 psu and the dissolved oxygen 8.44 mg/l in the sampling station, in November, 2009. The diameter of the umbrella of the specimen was 83 mm.

Our recent research revealed that *C. andromeda* is also present in the Gulf of Antalya. Like other jellyfish, *Cassiopea* is armed with nematocysts which stings may cause welts, rashes, itching, vomiting and skeletal pains depending on the person's sensitivity to the nematocyst toxin (Eldredge and Smith 2001). Further studies are necessary to determine if the species has adapted and constituted a population in the region where is a popular tourist destination. This is especially of great concern as it may annoy bathers and impact tourism.

**Acknowledgements**
The authors indebted to Prof. Dr. Bayram ÖZTÜRK and Prof. Dr. Ferdinando BOERO for their comments and Captain Akın AKYAR and the crew of the commercial trawl vessel "AKYARLAR" for their help in collecting the fish samples.

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# A Familiar Organism in Muğla Region, the Aegean Sea *Cotylorhiza tuberculata* (Maori, 1778)

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## ABSTRACT

There are indications that pelagic cnidarians have increased in abundance throughout the world. Jellyfish clearly play an extremely important role in the processing of energy in fisheries-based ecosystems. Since 650 million years, jellyfish have maintained their presence in the almost all the seas of the world. The first that comes to mind poisons of jellyfish but there are many negative effects of these animals. Economical point of view, jellyfish is hazardous for the aquaculture cages. These animals aggregate and bung up fishing nets. *Cotylorhiza tuberculata* is one of the pretty looking jellyfish in the Mediterranean Sea. Middle of the umbrella is red collared and periphery is yellow. It seems like bouquet with violet tentacles, under the umbrella. *C. tuberculata* is commonly distributed in South Italy coasts, Greece and Turkey (especially in Muğla coasts).

## INTRODUCTION

Most jellyfish in mid and latitudes display annual blooms in abundance that reflect seasonal population processes (Fraser, 1970), and these may be exaggerated by physical aggregation at oceanographic discontinuities (Graham et al., 2001) and adjective processes (Schneider, 1987; Greve, 1994). Blooms also occur naturally at periods longer than 1 year, and these have been attributed to climatic events (Goy et al., 1989; Lynam et al., 2004, 2005a). When jellyfish bloom they have a pronounced impact on an ecosystem (Brodeur et al., 2002) and its pelagic fisheries (Möller, 1984; Travis, 1993; Lynam et al., 2005b).

During past years, in several Mediterranean Countries many searchers have studied biology, ecology and morphology of jellyfish. In reality, toxic of jellyfish properties are a worldwide health problem owing to the nematocyst sting, which causes irritative and/or toxic effects on human skin, as erythema accompanied by swelling, redness and vesicles as well as further dermonecrotic, neurotoxic and cardiotoxic complications in sensitive subjects. Fishermen and bathers are particularly exposed to these effects, extremely dangerous in some sea zones where species lethal also for humans . In consequence of the well-known problems caused by the bloom of Scyphomedusae that occurred during the last decades and affected nearly the whole Mediterranean, many authors have concerned themselves with this phenomenon that, owing to the repercussions on touristic and fishing activities, involves both economic and health aspects (Carli et al., 1995).

In the Eastern Mediterranean Sea, Piccinetti Manfrin and Piccinetti (1984) showed the frequency of *Pelagia noctiluca* in Egyptian and Greek waters during 1983; Dowidar (1984) reported the occurrence of *Pelagia noctiluca, Aurelia aurita* and other jellyfish species along the Egyptian coast line during summers of 1966, 1970 and 1982; Bingel (1991) and Bingel *et al.* (1991) studied jellyfish distribution along Turkish coasts; Lakkis (1991) recorded proliferations of *Rhizostoma pulmo* during 1986 in Lebanese coastal waters. Recently, the occurrence of a new species coming from the Red Sea, namely *Rhopilema nomadica*, was noticed (Galil and Spanier, 1990); Galil *et al.*, 1990).

The life history of a stationary population of *Cotylorhiza tuberculata* (Maori, 1778) was studied on the Ionian island of Lefkada, Greece, in 1980 and 1981. Occurrence, growth, maturation, and aging of medusae indicated an annual life cycle of this rhizostomous jellyfish (Kikinger, 1992).

Since 1995, *Cotylorhiza tuberculata* occurred in large numbers in summer time and reached peak abundance in summer of 1997 in the Mar Menor coastal lagoon, Spain. The two main species of jellyfish (*Rhyzostoma pulmo* and *Cotylorhiza tuberculata*) reached annual mean densities of 0.45 and 2 individuals per 100 $m^3$, respectively, in 1997, with local maximum densities of the second species that reached 40 individuals 100 $m^{-3}$ and a total population estimated at 46.98 million of individuals (Pérez-Ruzafa., 1989). *Rhyzostoma pulmo* started to increase in May, while *Cotylorhiza tuberculata* peaked in abundance in June and July, reaching more than 12 individuals per 100 $m^3$ (P´erez-Ruzafa, et al., 2002).

The semi-enclosed Bay of Vlyho hosts a stationary population of *Cotylorhiza tuberculata* (Cnidaria: Rhizostomeae) with a seasonal lifecycle (Kikinger 1992).

In 2006, *C.tuberculata* was found in Güllük and Gökova Bays. Especially in Güllük Bay, abundance of *C.tuberculata* was 4-5 ind./$m^2$ in August and September (Öztürk, et al., 2006). According to our observations, in August 2007 *C.tuberculata* was encountered numerous numbers in inner part of Gökova Bay (3 ind./$m^2$). Also, this species was determined with 2 ind./$m^2$ abundance value in Milas-Kıyıkışlacık, in 2010.

***Species characteristics of Cotylorhiza tuberculata***

*Cotylorhiza tuberculata* is a jellyfish species, also known as the Mediterranean jelly or fried egg jellyfish. It is commonly found in the Mediterranean Sea, Aegean Sea and Adriatic Sea. It can reach 35 cm in diameter (Kramp, 1961). Morphologically it is characterized by a flattened region along its margin and has a dome at the center of its umbrella giving it the appearance of a large fried egg. It has eight oral arms which are brittle, short and fused proximally (Kikinger, 1992).

Each mouth-arm bifurcates near its base and branches several times (Kramp, 1961). Numerous blue or purple tipped appendages are located between each of the oral arms. These colors are due to the presence of unicellular symbiotic algae (zooxanthellae). There are many, variable-length tentacles attached to eight lappets (Kikinger, 1992). The marginal lappets are elongated and subrectangular. In addition to some larger appendages there are many short, club-shaped ones that bear disk-like ends (Kramp, 1961).

*Cotylorhiza tuberculata* belongs to the Order Rhizostomae and Family Cepheidae. It is found in aggregations in the open water of the high seas and along coastlines (Kikinger, 1992).

The life span of the medusae is about half a year, while scyphistomae are potentially perennial. The observed annual metagenetic cycle is interpreted as a life history adaptation to a highly seasonal environment. Strobilation occurs during spring and summer. Rapid growth leads to medusa diameters of up to 40 cm within 6 months. The medusae are potentially autotrophic due to their zooxanthellae. The gonochoristic medusae exhibit sexual dimorphism, and spermatozoa are released as spermatozeugmata. Fertilization is internal, with embryogenesis taking place inside the female moutharm canals. The life span of the medusae is limited by deterioration of somatic tissue to about half a year; no medusae of the bay population survive winter. The planula is the only stage within the metagenetic cycle without zooxanthellae, and infection with algal symbionts occurs in scyphistomae. It migrates vertically while various juvenile fishes (*Seriola dumerili*) are associated with it. These fishes takes refuge with *C.tuberculata* for housing and preserving. *C.tuberculata* moves near the sea surface and closes to coasts at night. Cotylorhiza tuberculata feeds on zooplankton or plankton in general (Kikinger, 1992). Although, C.tuberculata is one of the huge jellyfish species in Turkey, this jellyfish's sting has very little or no effect on humans.

Scyphozoan jellyfish share many morphological, behavioural and life history characteristics that determine their successful survival and reproduction in coastal marine environments (Arai, 1997). However, their ecological importance within these environments is often grossly underestimated because of a paucity of information regarding their life history and general ecology (Mills, 2001).

The jellyfish bloom in the Mediterranean Sea was observed over several years in order to ascertain the distribution and thickening of Scyphomedusae (Carli et al., 1995). Some Authors (Goy, 1984; Vucetic, 1984) think that jellyfish bloom is a natural fluctuation of the population, nevertheless it has also been assumed that the jellyfish bloom is correlated with nutritional factors (Lakkis, 1991) or water circulation, particularly with the "intermediate Levantine" and perhaps the Atlantic surface current (Vucetic, 1984).

In this study, general features of *C.tuberculata* and data about presence of this species in the Mediterranean Sea were informed. In the future, abundance and biomass values and reasons of appearence in Turkish Seas of *C.tuberculata* will be detected.

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# Recent occurrence of indopacific jellyfish *Rhopilema nomadica* in North–Eastern Levantine Sea

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## ABSTRACT

Jellyfish blooms in worldwide may be a signal of unusual environmental conditions thus monitoring of their presence is considered to be important. *Rhopilema.nomadica* is one of the largest jellyfish species in Mediterranean with hazardous effect to human. In the present study their spatial and temporal distribution has been analyzed based on the records from fisheries surveys carried out between 2009 and 2001.

## INTRODUCTION

In the last few decades large swarms of scyphomedusan species - *Rhopilema nomadicawas* observed in Levantine Sea. In common with jellyfish blooms occurring worldwide several environmental or anthropogenic factors may be causing their unusual occurrence. As such, anthropogenic effects on marine environments like overfishing or pollution, results in ecological gaps or changes in the energy allocation pattern within the pelagic environment. These changes may sometimes lead to rapid proliferation of the jellyfish populations (Purcell et al., 2007). Climatic variables that may cause eutrophication or regional regime shift may also favor increases in jellyfish biomass and dispersal. This phenomenon was observed in heavily exploited and eutrophicated Black Sea where non-indigenous jellyfish species was invaded whole pelagic realm, reaching very large biomass (Oguz et al., 2008).

Mediterranean Sea is less productive than Black sea, however eutrophic basins such as Adriatic sea are periodically invaded by jellyfish populations (Malej and Malej, 2004). Despite being one of the most oligotrophic water mass in the world, Levantine sea has also exhibited periodic blooms of a scyphomedusan species. A relation between pollution and swarming of *Rhizostoma pulma* in the coastal waters of Mersin Bay was pointed out by (Binge1 et al. 1991).

*R.nomadica* is one of the largest jellyfish species in Mediterranean, attaining a bell diameter of 100 cm and a wet weight of 15 kg. The occurrence of this large and stinging jellyfish species was first identified in Mediterranean by (Galil et al. 1990) although it is known to exist in Mediterranean since late 1970's. While it's ecological aspects remains unclear the occurrence of *R.nomadica* became more and more frequent threatening fishermen and bathers by clogging the nets and because of painful stings..

*R.nomadica* as being a scyphozoan, can asexually produce massive amounts of planktonic medusae and depending upon environmental conditions or food availability they can remain dormant for extended periods (Graham and Bayha, 2007). Their life-cycle described by (Lotan et al., 1992) and denoted that their high reproductive potential could lead to population explosion. Variety of factors that changes environmental conditions, may be enhancing their populations and it was discussed by (Lotan et al., 1994) that the *R. nomadica* population is controlled by seasonal changes in water temperature regimes.

During the fishery surveys carried out by the Middle East Technical University Institute of Marine Sciences in Levantine sea upon remarkable increase of *R. nomadica* in the catch its occurrence has been recorded quantitatively. Thepresent work evaluates the *R.nomadica* records collected in Northeastern Levantine basin between 2009 and 2011 by means of distribution pattern and temporal occurrence. In Northeastern part of Levantine sea demersal trawl surveys are being carried out since 1980's and since April 2009 a new series of surveys focused on small pelagic species were started using mid water or semi-midwater trawls. The appearance of *R. nomadica* was started in early 2009 and the highest outbreak was recorded in July 2009 following the outbreak in Israeli waters in June 2009. This was the first large swarm after their massive appearance in 1995 in Mersin Bay (Kideys and Gucu, 1995) and extended to a larger area towards west of Antalya (Ozturk and Isinibilir, 2010).

## MATERIALS AND METHODS

Sampling was carried out from January 2009 to April 2011 on the coast of Turkey, north-eastern Levantine Sea with the RV 'Lamas'and Bilim2 (Figure 1). Nearly 300 trawl hauls in 24 surveys between 5 and 230 m depth were conducted using different trawl configurations, 265 of them were taken into account. The sampling design was set for the fisheries surveys and no intention was specifically made to sample *R.nomadica*. We started to collect the records of jelly fish only after July 2009 when their presence noticeably increased. Although there are photographic evidence ( figure 2) of their existence from January, March and April 2009 surveys, only individuals caught after July 2009 were weighted and counted, recorded onboard and so that their thematic maps of distribution could be created. ,As almost all individuals were intact, it is assumed that the surface dwelling *R.nomadica* were caught at the end of the trawl operation while the net is hauled near to the surface just before recovery.

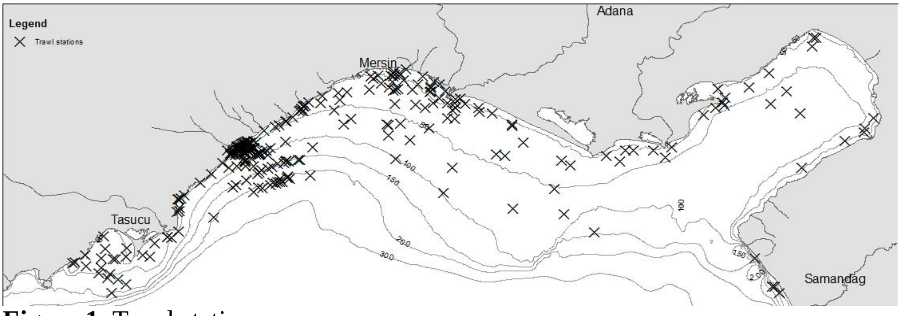


**Figure 1**. Trawl stations

January 15, 2009 March 18, 2009 April 2009

**Figure 2.** Photographs of the *R. nomadica* individuals before July 2009 outbreak.

## RESULTS

*R.nomadica* were almost the only jellyfish samples caught in the trawl nets. Due to their very rare occurrence in the catch they were not recorded before 2009. The species was observed with varying densities in 13 out of 18 fisheries surveys.

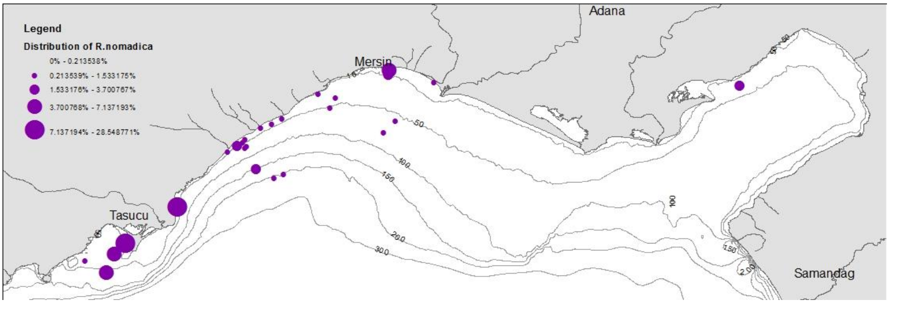


**Figure 3**. Locations and relative quantities as percentages of total biomass.

**Table 1.** Inventory of trawl surveys and the catch of *R. nomadica*

| Date | No of Trawls | Total weight (gr) | Weight per haul (gr) |
|---|---|---|---|
| 2009_7 | 6 | 30705 | 5117.5 |
| 2009_8 | 0 | | |
| 2009_9 | 17 | 2750 | 161.7647 |
| 2009_10 | 30 | | |
| 2009_11 | 6 | | |
| 2009_12 | 16 | 350 | 21.875 |
| 2010_1 | 13 | 4650 | 357.6923 |
| 2010_2 | 8 | 68130 | 8516.25 |
| 2010_3 | 14 | 25870 | 1847.857 |
| 2010_4 | 9 | | |
| 2010_5 | 6 | | |
| 2010_6 | 28 | | |
| 2010_7 | 0 | | |
| 2010_8 | 0 | | |
| 2010_9 | 6 | | |
| 2010_10 | 18 | | |
| 2010_11 | 9 | 4150 | 461.1111 |
| 2010_12 | 10 | | |
| 2011_1 | 18 | | |
| 2011_2 | 18 | 65320 | 3628.889 |
| 2011_3 | 8 | 6880 | 860 |

In July 2009 relatively large amount of jellyfish individuals were caught by trawl nets, nevertheless dense swarms of *R.nomadica* were observed visually in Mersin Bay in inshore areas approximately within 0-20 m bathymetric contour. High number of strandings on the beach of METU-Institute of Marine sciences was also observed in this period. In the following surveys the number *R.nomadica* were declined rapidly however two new outbreaks were observed during late winter – early spring periods in 2010 and 2011.

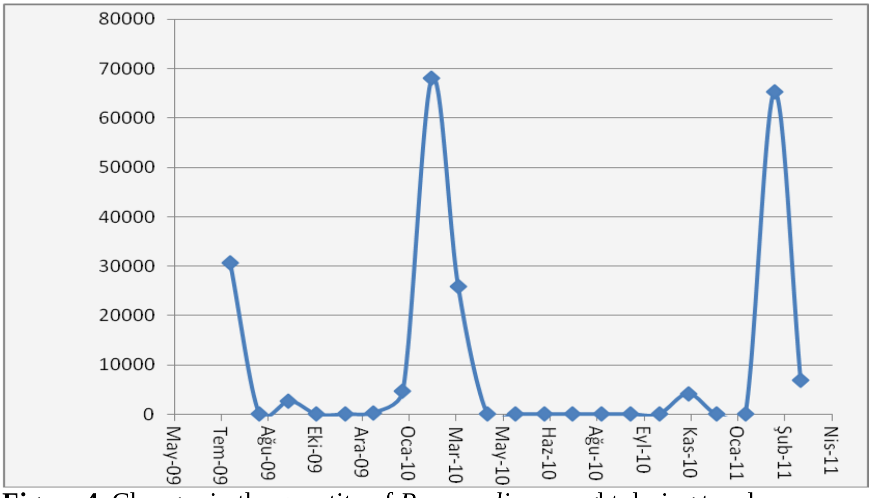


**Figure 4.** Changes in the quantity of *R. nomadica* caught during trawl surveys

The maps of outbreak periods are given in seasonal maps ( Figure 4). While no jellyfish were observed in summer and fall 2010, the outbreak period of summer 2009, winter 2010 and winter 2011 are visible.

**Figure 5.** Catch of *R.nomadica* in winter 2010 period

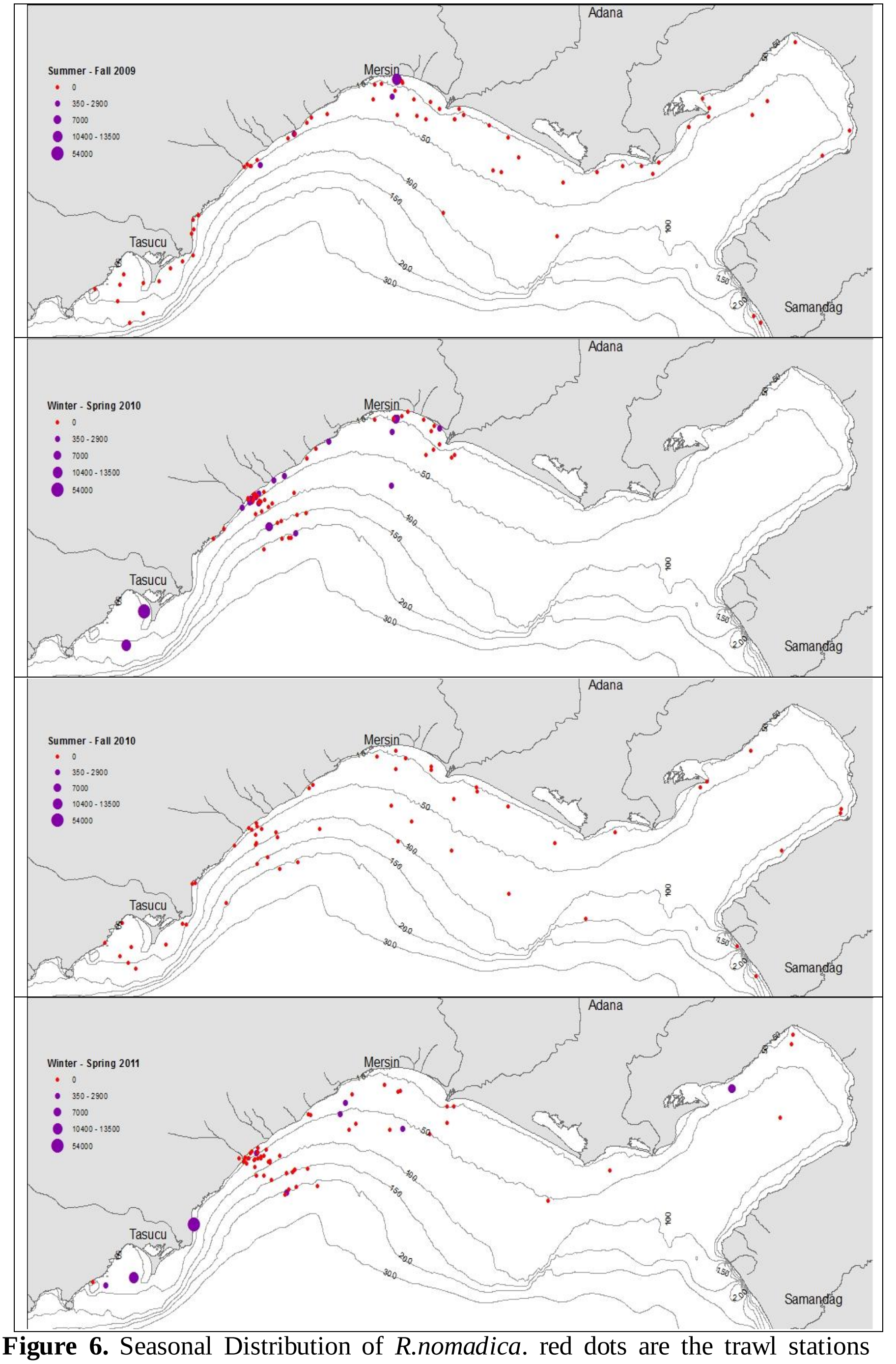


**Figure 6.** Seasonal Distribution of *R.nomadica*. red dots are the trawl stations where no *R.nomadica* individuals were observed.

## DISCUSSION

After the first mass occurence of *Rhopilema nomadica* in 1995 ( (Kideys and Gucu, 1995) in Turkish waters a significant bloom was never took place until summer 2009. The distribution pattern of the summer bloom in 2009 by means of geographical expansion, the route and timing was very similar to the one in 1995, although it was never extended through Antalya in 1995. It is probably the same unknown reason which was triggered both blooms in 1995 and 2009. However the winter blooms in 2010 and 2011 has an unusual characteristic (figure 6). By (Lotan et al., 1994) temperature was considered as main factor effecting the strobilation and it was argued that winter temperatures are diminishing or inhibiting the reproduction. The winter occurrence of the species which coincides with the coldest period of the seawater in study area raises new questions about the factors effecting the reproduction success of the *R.nomadica*. Another remarkable point is that in the summer of 2010 the swarms of R.nomadica were disappeared in contrast to the situation in February – March 2010. This change in cycle may be a relief for the tourism but their occurrence should be monitored continuously for better understanding.

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# Jellyfish Monitoring Programme in North Cyprus

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## ABSTRACT

Jellyfish blooms are reaching to levels threatening marine ecosystems. Nonetheless, economic sectors can be negatively affected by the hazardous jellyfish blooms. Eastern Mediterranean waters are olygotrophic. The waters of North Cyprus have the poorest biological productivity among the Eastern Mediterranean waters, due to the fresh water input which is about zero levels. However, jellyfish has been observed in North Cyprus waters. Jellyfish have been monitored and controlled routinely in the coastal areas by EMU-URIC since 2008. Furthermore, the notifications of other institutions, fishermen and volunteers about the jellyfish are appreciated. In this study, the presences of *Pelagia noctiluca* (Forsskal, 1775), *Cassiopea andromeda* (Forsskal, 1775), *Aurelia aurita* (Linnaeus, 1758),*Rhizostoma pulmo* (Macri, 1778), *Rhopilema nomadica* Galil, 1990 from Cnidaria and *Mnemiopsis leidyi* (Agassiz 1865) from Ctenophora in the waters of North Cyprus are recorded. Being different from other species, it is observed that *Rhopilema nomadica has* reached to higher population levels in July and August of 2009 and this affected the marine tourism of North Cyprus negatively.

## INTRODUCTION

*Jellyfishes*

Free swimming pelagic members of phylum Cnidaria (medusa) and planktonic members of the phylum Ctenophora are commonly called as “Jellyfish”. Medusa refers to bell shaped and active swimming stage in the phylum Cnidaria (Richardson et al, 2009). Although they are not closely related, medusa and planktonic members of cnidarians share many characteristics including their gelatinous nature and their role in aquatic environments (Mills, 2001).

Although, phyla Cnidaria and Ctenophora are common for all seas of the world, and even dense aggregations are accepted as a natural feature of some of healthy pelagic ecosystems, jellyfish blooms appear to be induced by human activities. Jellyfish blooms can be directly or synergistically effective on marine environment which may have negative impacts on ecosystem. Besides ecosystem health, it has been reported that jellyfish blooms have negative impacts on several business sectors like tourism and fisheries. Some of the possible causes for jellyfish blooms which have been widely reported are: climate chance, overfishing, eutrophication, translocation and habitat modification (Mills, 2001; Richardson et al, 2009).

*Eastern Mediterranean and North Cyprus*
Azov (1991) states that the Eastern Mediterranean has low productivity and extreme oligotrophy. Additionally, further oligotrophic conditions are ascendant for the Levant Basin, which includes the island of Cyprus, as the waters of the island defined as ultra-oligotrophic (Krom et al. 2005) or exceptionally oligotrophic (Herut et al. 2000). Consequently, the basin is considered to have "clean and clear waters" and is favoured by the tourism sector. However, the clearness of these waters indicate low levels of biological productivity and vertical flux which are almost three and nine times lower respectively, when compared with Western Mediterranean waters (Turley, 1999).

## MATERIALS AND METHODS

The data presented in this study are collected in the routine marine surveys carried out monthly by EMU URIC since
2008. These surveys are still underway in order to monitor the general status of ecosystem, especially habitats and biodiversity and to assess the pollution and presence of invasive species.

In order to determine jellyfish presence in the study area, detailed underwater surveys using photographic and video imaging techniques were carried out. While conducting the underwater survey, traditional SCUBA and skin diving techniques were applied. Underwater surveys were performed as underwater visual censuses (UVC) which is widely applied for evaluation of macro biodiversity and biomass with similar procedures which were used in this study (Bellwood, 1988; Cappo and Brown, 1996; Cheal and Thompson, 1997; De Girolamo and Mazzoldi, 2001; Lincoln Smith, 1988; Lincoln Smith, 1989; Mazzoldi and De Girolamo, M, 1998; Russ, 1985;Samoilys, 1992; Samoilys and Carlos, 2000; Sanderson and Solonsky, 1986; Vacchi and La Mesa, 1999; Watson and Quinn, 1997). Besides, Underwater Visual Census (UVC) Technique can be used to identify the habitat structure and condition and is an appropriate technique for shallow coastal habitats (those that have heterogenous substrata like artificial reefs, stones and corals) with no or minimum impact on the environment.

During the survey, observers use a water-proof PVC notebook and a census book with drawings of those species that are assumed to be observed/recorded in the area. A camera and a housing system of lightning were used during underwater imaging. All data collected using a GPS were recorded with space and time setting. UVC technique applied in the monitoring surveys was in the form of transect census. In order to obtain abundance data to make evaluations, SCUBA equipped divers applied 100-meter transects in each line.

For the purpose of determining jellyfish abundance a density scale is generated. The abundance of each species for each 100-meter transect is evaluated in 6 classes as: “very rare” (1 specimen), “rare” (2-5 specimens), “abundant” (5-10 specimens), “dense” (10-20 specimens), “very dense” (20<specimens), and “bloom” (not countable) according to recorded individuals.

In this study, the locations of the jellyfish observed are recorded as well as their densities. The records of locations are performed in according to the geographical structure of the island and the positions of the jellyfish in the coastal zone. Study site is separated into two main areas as north and north east coasts for the location determination according to the geographical structure of the island (Figure 1). Depth of the location has been taken into consideration in order to evaluate the location in the coastal zone. Individuals recorded at depth less than 2 meters accepted as shore, individuals recorded between 2-10 meters accepted as near shore, and individuals recorded at the depths of more than 10 meters as pelagic specimens. The habitat types are recorded where these animals found in and/or in relation if such information is relevant. The reason for determination of positions at the coastal zone is to alert and provide information which would be important for institutions specifically related with public health and marine tourism. In addition, public, fishermen and state and other institutions’ notifications are also appreciated and UVC techniques applied apart from scheduled monitoring surveys by EMU URIC.

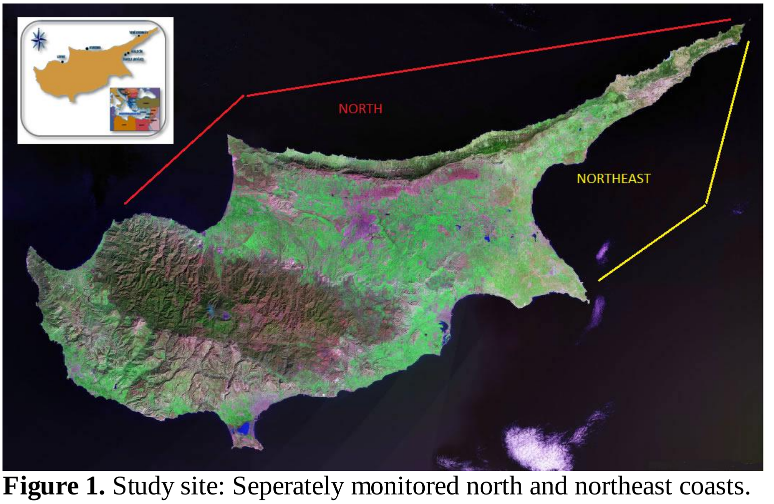


**Figure 1.** Study site: Seperately monitored north and northeast coasts.

## RESULTS AND DISCUSION

In this study, the presences of *Pelagia noctiluca* (Forsskal, 1775), *Cassiopea andromeda* (Forsskal, 1775), *Aurelia aurita* (Linnaeus, 1758),*Rhizostoma pulmo*

(Macri, 1778), *Rhopilema nomadica* Galil, 1990 from Cnidaria and *Mnemiopsis leidyi* (Agassiz 1865) from Ctenophora in the waters of North Cyprus were recorded during surveys between 2008 and May 2011 monitoring period.

*Pelagia noctulica*

Individuals of *Pelagia noctulica* were observed during 2008 and 2009 monitoring surveys in December and January at north and in February 2010 at north east coasts. According to abundance data, species found in shore and the abundance level were recorded as rare in 2008 and very rare in near shore in 2009 and 2010.

*Cassiopea andromeda*

The presence of *Cassiopea andromeda* was observed at all years throughout the monitoring surveys. Individuals of the species were recorded in December, January, February, March, April, May, June, July and August at both north and north east coasts, with abundances as very rare and rare in UVC transects. Individuals of the species were recorded only inside the marinas and fishermen shelters located at both north and north east coasts .

*Aurelia aurita*

Aurelia aurita was found to be very common and recorded at all years during the monitoring surveys. Individuals were recorded at both north and north east coasts in December, January, February and March as rare and/or abundant according to the scale used in this study. Individuals observed in shore, near shore and pelagic in UVC transects.

*Rhisostoma pulmo*

*Rhisostoma pulmo* species have been observed throughout all years that monitoring surveys were conducted. As a result of the research, it has been observed that these species have been recorded especially in March, April, May, June, July and August in north and north east coast in abundance of rare and/or very rare. These species, apart from the ones found in the north east coast in August 2009 have been recorded as pelagic.

*Rhopilema nomadica*

*Rhopilema nomadica* species have been recorded as pelagic species in March, April and May of 2009 as very dense; in June very dense pelagic and as dense in July and August for those species, which have been observed close to the shore. The same developments have been observed with one month intervals in the north eastern coasts. These species have been observed as rare or very rare as well as dense pelagic in north and northeast coasts April, May, June and July in 2010. In March, April and May of 2011, the same species were recorded as pelagic in north and north east costs and abundant in close to shore or on shore areas.

It was this species that caused serious injuries to people for two months in 2009. Marine tourism – especially in August – was negatively affected due to these species.

*Mnemiopsis leidyi* and other Ctenophora species have been observed as rare in north and north east waters throughout the year and abundant pelagic in areas close to shore in December, January, February and March.

Conclusions:

Based on the information obtained at the monitoring work, it has been concluded that the jellyfish species identified in North Cyprus does not display dense aggregations or populations (bloom). Among all the species, *Rhopilema nomedica* had a significant density increase in the summer months of 2009 and it was also observed that the said species had reached to the shores. Nonetheless, it was also observed that tourism, which is considered to be one of the locomotive sectors, was negatively affected by the increase.

It is believed that the species of jellyfish identified in North Cyprus are not fertile due to the fact that the waters around are low in biological productivity. Moreover, the increase in the density of jellyfish populations are due to currents from neighbouring regions. In this respect, the most effective region is the Iskenderun Bay as Avşar (1996) argues. It is because as the jellfish departs from the bay, their density decreases further argues the author. In this study, *Rhopilema nomadica* has also been observed in bloom level at Iskenderun Bay while it was observed highly dense in North Cyprus coasts in 2009. Furthermore, the fact that the said species were first observed in north coast and then in north east coast is a supporting fact to this notion. As a conclusion, even though the North Cyprus waters are low in jellyfish productivity, it is believed that the waters are highly susceptible to population increases within the region.

**Acknowledgements**

I would like to acknowledge C. H. Çicek and A. Türkmen for their valuable suggestions in writing and editing this article; to K. D. Tözer, A Kusbeci, İ. Beyoğlu, C Muhtaronbaşı, M. Kayıkçı for providing valuable and continuous data used in this article; and would like to thank TRNC Ministry of Agriculture and Natural Resources and TRNC Ministry of Tourism Environment and Culture and their staff at Husbandry Department and Environmental Protection Department for their valuable help to provide data.

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# Occurrence and Abundance of Lessepsian Jellyfish *Cassiopea andromeda* (Forsskal, 1775) in Iskenderun Bay, the Northeastern Mediterranean Sea

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## ABSTRACT

Upside-down jellyfish *Cassiopea andromeda* has been observed densely populations along the Iskenderun Bay in November 2010 and December 2010 at a depth of 3-10 m. *C. andromeda* was sampled from the 3 stations (Cevlik, Konacık and Iskenderun harbours) where the abundance varied between 2 and 3 ind./m$^2$ and the size range of individuals collected were 10.2-20.9 cm. With these localities *C. andromeda* started and establishing its populations in the Northeastern Mediterranean coast of Turkey.

## INTRODUCTION

The Suez Canal is the most important introduction route for Erythrean organisms inhabiting the Mediterranean (Bianchi 2007). To date only two invasive scyphozoan species (*Rhopilema nomadica* and *Cassiopea andromeda*) have been reported from the Turkish coast of the Mediterranean. Upside-down jellyfish, *Cassiopea andromeda* (Forsskal, 1775), is not native to the Mediterranean, but was one of the first lessepsian jelly fish that entered the Eastern Mediterranean through the Suez Canal (Patrick et al. 2010). *C. andromeda* belongs to the Cassiopeidae family. It is widely distributed and found in warmer parts of the Atlantic and Pacific, including the Red Sea where it occurs in shallow lagoons, intertidal sand flats and mangroves (Galil et 1990, Holland et al. 2004, Cevik et al. 2006).

The first report of *C. andromeda* in the Mediterranean was given from Cyprus by Maas (1903), and later it was found in the southern Aegean Sea (Schäffer 1955), and in Lebanon (Goy et al. 1988) and in Israel (Spanier 1989). C. *andromeda* was recorded for the first time in the Mediterranean coast of Turkey in

2002 from Sarsala Bay (Fethiye) (Bilecenoğlu 2002), and later in July 2005 six specimens were reported from the Iskenderun Bay, Northeastern Mediterranean Sea (Çevik et al. 2006). Following, Özgür and Öztürk (2008) indicated the presence of an established population of *C. andromeda* in the Ölüdeniz Lagoon, southern Aegean Sea coast of Turkey.

The upside-down jelly fish *C. andromeda* is a common lessepsian jellyfish species in the Levantine and Aegean Seas, (Galil et al. 1990, Çevik et al. 2006, Özgür and Öztürk 2008). In this paper we present occurence, distribution and abundance of *C. andromeda* in Çevlik, Konacik and Iskenderun Harbour in Iskenderun Bay. With these localities this species have started spreading and established its populations in the Northeastern Mediterranean coast of Turkey.

## MATERIALS AND METHODS

Iskenderun Bay, located along the northeastern Levantine Basin, is 65 km long and 35 km wide, covering an area of approximately 2275 $km^2$, and has an average depth of 70 m (Iyiduvar 1986). Iskenderun Bay has a euphotic water column and nutrition amounts are 2-4 times higher than offshore. There neither is a thermal stratification nor is there significant eutrophication, because of the dynamic structure of the Bay (Yılmaz et al. 1992). Since it has a large junction with offshore waters, it is not affected by the wind and deep currents. During the November and December 2010, diving were performed and we observed 10-15 alive *C. andromeda* from the intertidal to depth of 3-10 m in the warm temperate water (16-18 ºC) on coast of 3 stations, Cevlik (36° 07’ 36.08″ N, 35° 54′ 53.67″ E), Konacık (36° 21′ 33.83″ N, 35° 49′ 03.45″ E ) and Iskenderun (36° 35′ 42.20″ N, 36° 11′ 23.63″ E) harbours in the Northeastern Mediterranean (Iskenderun Bay) (Figure 1).

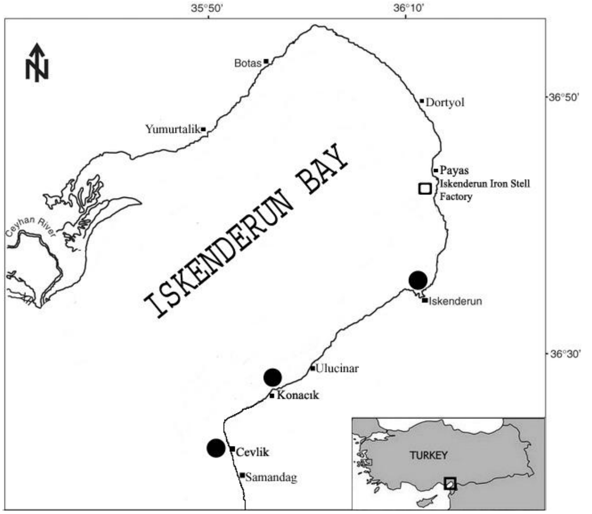


**Figure 1.** Distribution of *Cassiopea andromeda* (Forsskal, 1775) in the Northeastern Mediterranean (Iskenderun Bay): ●, newly record localities; □, previous record locality.

Where the abundance varied between 2 and 3 ind./$m^2$ and the size range of individuals collected were 10.2-20.9 cm. The specimens photographed were fixed in 4 % formaldehyde and deposited in the Department of Basic Sciences of Fisheries Faculty of the Mustafa Kemal University, Turkey (Figure 2).

**Figure 2.** Aboral view of a specimen of *Cassiopea andromeda* collected from Iskenderun Harbour, Turkey on December 2010, from a depth of 3 m.

## RESULTS AND DISCUSSION

*C. andromeda* is entirely marine, none have been observed in fresh or brackish water. It seems to prefer warm, well-lit, shallow and sheltered waters with muddy or fine sand bottoms, to permit exposure of the photosymbionts disposed in its oral arms (Verde & McCloskey, 1998). These areas in Cevlik, Konacık and Iskenderun where the aggregation occurred conform to this habitats type.

*C. andromeda* is not highly dangerous because their sting is very mild. Although there has not been any record on hospitalized events of *C. andromeda* stings, this jellyfish stinging cell can possibly cause discomfort on thin or sensitive skin, as well as the eyes and lips. Morever, *C. andromeda* do not normally swim in the water but lie on the bottom with their umbrella facing and touching the substratum and their arms, which are short and shrubby, pointing towards the surface – hence the common name of Upside-down Jellyfish. *C. andromeda* feeds on copepods, cladocerans, mollusc larvae and on pelagic fish eggs and larvae also.

The erythrean aliens are thermophilic, originating in tropical waters. It stands to reason that rising sea-water temperature enhances the reproduction, growth, and survival of the Erythrean aliens, and provides them with a distinct advantage over the native Mediterranean biota (Galil 2007).

At present, biological invasions of lessepsian species are a significant environmental problem. Lessepsian immigrants in the Northeastern Mediterranean coast of Turkey have accelerated in recent years. It can be speculated that such a successful adaptation to the prevailing environmental conditions has been facilitated by general climatic changes.

Iskenderun Bay (northeastern Levant Sea) has the largest number of erythrean alien species along the Turkish coast. Moreover many of the Erythrean aliens had been first recorded from Iskenderun Bay before spreading along the Turkish coast. Although many of the newly reported species are Lessepsian immigrants spreading in the Iskenderun Bay (Northeastern Mediterranean Sea), also the role of shipping is gaining another significance as a vector of alien species' transfer in the Northeastern Mediterranean Sea.

Consequently, the present paper reported distribution and abundance of *C. andromeda* along the coast of Cevlik, Konacık and Iskenderun harbours in the Northeastern Mediterranean Sea, Turkey. The upside-down jellyfish *C. andromeda* probably have successful established population in this area.

**Acknowledgements**

Thanks the Ministry of Agriculture and Rural Affairs, General Directorate of Agricultural Research (TAGEM-09/AR-GE/11) for financial support.

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# Importance of Jellyfishes and Their Distribution around the Çanakkale Strait

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## ABSTRACT

In this study the jellyfish species which have been observed around the Çanakkale Strait for 2008 was examined. *Rhizostoma pulmo* and *Aurella aurita* existence are well known around the Marmara Sea, but *Cotylorhiza tuberculata* was determined as three samples in 2010 September but *Chrysaora hysoscella* was absent in this period. However, *C. hysoscella* was dominant during summer period in 2009. In the research, these jellyfish and their importance in terms of public health and medical above are discussed and the current situation of jellyfishes around the Dardanelles is given.

## INTRODUCTION

As the earliest multicelled animals that survived the Precambrian period, which included sea anemones, corals, and jellyfish, had sac-like bodies and a simple digestive system with a mouth without anus. They used tentacles armed with stinging cells (www.jellyfishfacts.net). Most jellyfish are fairly harmless and don't attack humans. However, they usually have stingers (though there are some that don't) that provide protection and help procure food. These stingers have low toxicity levels and are normally harmless to humans. In spite of this, quite a few jellyfish stings can cause a great deal of discomfort, if not always pain, and can even lead to death. Hence, it is important to recognize the different varieties of jellyfish and identify the ones to avoid. This unusual creature is not actually a fish, but an invertebrate from the Coelenterate phylum (the same phylum as coral, also called Cnidaria). It comprises a 'bell', made up of a jelly-like substance, as well as tentacles and oral arms (sometimes called 'flaps'), which are used to eat its prey.

Jellyfish inhabit oceans around the world, mostly in coastal waters, although there are some amazing deep sea dwellers that generate spectacular light shows through bioluminescence (Piraino et al, 2010). Some jellyfish live in fresh water rivers and lakes. *Aurelia aurita*, *Rhizostoma pulmo* occurs from Spring to Autumn as density (Alparslan, 2001; Muhammed, 2007) almost every year in this region. *Chrysaora hysoscella* determined as a dominant jellyfish around Çanakkale Strait in 2009 (Alparslan et al, 2009). We obtained three samples of

*Cothylorhiza tuberculata* around Güzelyalı station around Çanakkale Strait in 2010. We find *Aurelia aurita* and *Rhizostoma pulmo* from Spring to Autumn every year but *Chrysaora hysoscella* and *Cothylorhiza tuberculata* show different composition. For example, Although we encounter *Chrysaora hysoscella* in 2009, this jellyfish was absent in 2010.

## MATERIALS AND METHODS

We are monitoring jellyfish in different stations (Kepez Limanı, Çanakkale Marina,.Kordon Balıkçı Barınağı, Astsubay Orduevi Önü). Researches has been realisied using Zodiac Boat, Scuba Diving and Manta Tow Technique. On the other hand the, phsico-chemical parameters are to be obtained by means of YSI probe with seasonal in all reasearch stations.

**Figure 1**. Çanakkale Strait and the observed stations.

## RESULTS AND DISCUSSION

We obtained three samples of *Cothylorhiza tuberculata* around Guzelyalı station around Çanakkale Strait in 2010. We find *Aurelia aurita* and *Rhizostoma pulmo* from Spring to Autumn every year but *Chrysaora hysoscella* and *Cothylorhiza tuberculata* show different composition. For example, in spite of we catch *Chrysaora hysoscella* in 2009, this jellyfish was absent in 2010. Diving Clubs, Recreational Regions and Medical Offices should be very sensitive on poisonous jellyfish. At the same time universities and scientific departments should contact each other during years. Meanwhile we have to give and share newest information with people and it is very useful performing national, international workshops and symposium on this target.

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# The Winter Aggregation of *Aurelia aurita* (Linnaeus, 1758) in the Gulf of Antalya, Levantine coast of Turkey, Eastern Mediterranean

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## ABSTRACT

The present paper reports the mass winter aggregation of the "Moon jellyfish", *Aurelia aurita* (Linnaeus, 1758), (Cnidaria: Scyphozoa, Semaeostomeae) in the Gulf of Antalya, in February, 2010. During a seasonal trawl survey carried out between August, 2009 and April, 2010, the specimens of *A. aurita* were caught by the commercial trawler as bycatch and their abundance and biomass (wet-weight) were recorded.

***Keywords:*** *Aurelia aurita, winter aggregation,* trawl survey, Gulf of Antalya, Mediterranean Sea.

## INTRODUCTION

Among the nine species of Scyphomedusae reported from the Levantine Sea, five of them are native (*Aurelia aurita*, *Rhizostoma pulmo*, *Pelagia noctiluca*, *Cotylorhiza tuberculata* and *Chrysaora hysoscella*) and four are alien species (*Cassiopea andromeda*, *Phyllorhiza punctata, Rhopilema nomadica*, *Marivagia stellata* gen. et sp. nov.) (Galil et al. 2010; Öztürk and İşinibilir 2010).

*A. aurita* is one of the most common jellyfishes in the Mediterranean Basin (Würtz 2010) and is cosmopolitan from northern boreal to tropical waters (Russell 1970). It is an inshore schyphozoan species and mass occurrences of *Aurelia* medusae have been a socio-economic problem since at least the 1960s (Toyokawa et al. 2000).

There are many studies reporting the biomass increases of *A. aurita* as a result of eutrophication and/or other anthropogenic effects (Arai 2001). The Gulf of Antalya locates in the highly oligothrophic Northeastern Levantine Basin and by now, there have been no records of an aggregation of *A. aurita* in the Gulf. We report the winter aggregation of the species in February, 2010 from the Gulf of Antalya.

## MATERIAL AND METHOD

During a seasonal trawl survey carried out between August, 2009 and April, 2010, specimens of *A. aurita* entangled in net were counted and their biomass (wet-weight) was measured on board. The survey was carried out between the depths of 25-200 m and the samples were collected day time with 2.5 NM/h average trawling speed. The cod-end mesh size was 22 mm (knot to knot). A total of 30 hauls were conducted seasonally with a commercial fishing vessel and the duration of each haul was limited to an hour. The geographical coordinates of 30 trawling stations vary between N36° 52' 48.5 - 36° 23' 00.0''; E31° 32 32.2' - E30° 31' 11.3''.

The aim of the trawl survey was not to sample or monitor the jellyfish; however the large individuals of the medusae were entangled in the net. Since the jellyfish are not caught during towing while the net is on the bottom, it is not reasonable to calculate the abundance and biomass of the jellyfish according to swept area method. Most probably the specimens were entangled to the net in the short period when the trawl is hauled back from the seabed and when the codend is at the surface that is to say for about in ten to fifteen minutes that can vary according to the bottom depth. Thus, we prefer to give the exact number of individuals and biomass according to the stations just to give an idea on the aggregation of the large individuals of the species.

## RESULTS AND DISCUSSION

In August, 2009, 2 specimens of *A. aurita* were found in a haul among 30 trawl trials. The specimens were 38-40 cm in diameter and 2500-2600 g in wet-weight, respectively. The surface water temperature was 29.4°C, bottom 28.6°C, and the salinity was 38.3 psu.

Later, in November, 2009, the species was not observed in the nets. In February, 2010, the presence of the species was observed in the codend of 15 hauls (50%). The total biomass (wet-weight) of the 145 specimens was 71850 g and the average biomass was 496 g. The average diameter of the umbrella was 20 cm. However, again in April, 2010, no specimens were found in the nets.

Among the total of 145 individuals entangled in the trawl net in February, 2010, 67 of them were caught from the Serik Station where *A. aurita* was found in all 6 hauls. Also, 49 specimens were caught from the Manavgat Station where *A. aurita* was present in three of six hauls (50% presence) (Figure 1).

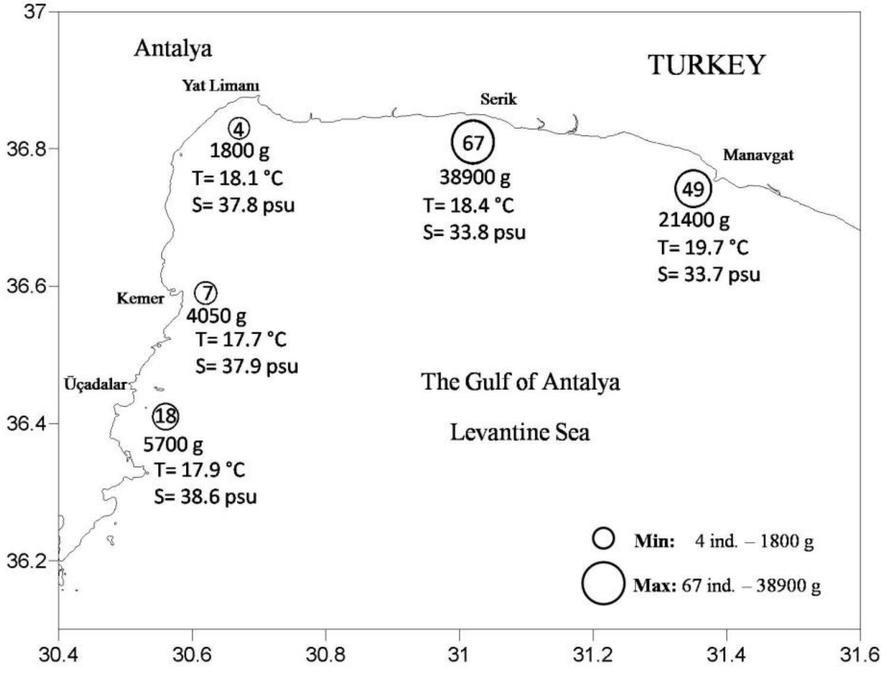


**Figure 1.** The total number and biomass (wet-weight) of *Aurelia aurita* individuals entangled in the trawl net according to the trawling stations with the average temperature and salinity values in the Gulf of Antalya, in February, 2010.

*A. aurita* populations around the world are characterized by a great diversity in population and life history characteristics however generally it is reported that the biomass and abundance of *A. aurita* peaked in late spring and summer in the Mediterranean and Black Sea (Purcell 2005; Lucas 2001; Mutlu 2001). Although, the abundance of *Aurelia* medusae was commonly stated to be low from autumn to winter, large specimens (>20cm) were also reported to be found with the small young specimens in April that is to mean, some medusae apparently survived through winter (Purcell 2005; Toyokawa et al. 2000).

The optimum temperature range for *A. aurita* is reported to vary between 9-19℃ (Lucas and Lawes 1998; Hansson 1997). In February, 2010, the average surface and bottom water temperature was 18.0-17.9℃ respectively in the Gulf of Antalya. So, it can be expected that *A. aurita* can best survive in the winter conditions in the Gulf of Antalya.

Eutrophication may be associated with an increase in numbers of the medusae. Marine eutrophication can occur as a result of natural processes such as upwelling and river inflow, however, modern concerns are centered on ‘cultural’ or anthropogenic eutrophication (Arai 2001; Purcell 2005). The possible reason of higher abundance of jellyfish in the Eastern part of the Gulf of Antalya may be the increased nutrients due to river inputs, addition of sewage, forest cutting and fertilizer use on adjoining land mostly exist in the eastern side of the Gulf.

The effects of the increasing nutrients also cannot be evaluated separately from the direct and indirect effects of other anthropogenic activities, including industrial pollution, construction and dredging, overfishing, introductions and climate change (Purcell and Arai 2001).

The results of our study revealed that *A. aurita* constituted a winter aggregation in the Gulf of Antalya that was not reported from the region before. The reason for the sudden mass occurrence of medusae is not clear and our records are semi-quantitative. However the events of jellyfish blooms should be recorded for correlating changes in jellyfish abundance with climate variations.

Further studies are obviously necessary to determine the factors affecting the blooms and consequently the ecosystem changes.

## Acknowledgements

The authors indebted to Captain Akın AKYAR and the crew of the commercial trawl vessel "AKYARLAR" for their help in collecting the samples.

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# A Short Note on the Jellyfish at the Gökçeada Island, the North Aegean Sea, Turkey

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## ABSTRACT

Gökçeada is the biggest island of Turkey and situated in the Northern Aegean Sea. This island is located between the Marmara and Aegean Seas and under the influence of different types of water salinity and temperature of the adjascent seas. During 2008 and 2009, five jellyfish species were reported around the island. Theese are; *Aurelia aurita* (Linnaeus, 1758), *Rhizostoma pulmo* (Macri, 1778), *Cothylorhiza tuberculata* (Macri, 1778), *Chrysaora hysoscella* (Linnaeus, 1767) *and Pelagia noctiluca* (Forsskål, 1775). Among five species, *Aurelia aurita* and *Cotylorhiza tuberculata* were the dominant species.

## INTRODUCTION

The issue on jellyfish has become important for various reasons in the Aegean Sea. First of all, this sea is one of the most popular holiday destinations for both Turkish and foreign visitors and unexpected blooms may adversely affect national and local economy. Besides, more jellyfish are found in the gillnet and purse seines, thus causes the damage to the fishermen in recent years, although fisheries is one of the traditional and major activities in the area. In addition, signals of climatic changes and temperature anomalies have been also reported recently from the Mediterranean and Black Sea basins. The Gökçeada Island is rich in marine biodiversity, e.g. 144 fish species have been reported by Ulutürk (1987), 34 sponge species by Erguven et al. (1988). However, only a little information is found on jellyfish species around the Gökçeada Island in the Northern Aegean Sea, although there has been some studies on the gelatinous species, such as Tarkan (2000) and İşinibilir and Tarkan (2002).

## MATERIALS AND METHODS

Snorkeling and scuba divings were conducted at three stations around the Gökçeada Island in 2008- 2009 summer season (see Figure 1) in order to understand the jellyfish fauna of the island during summer as a part of the marine biodiversity survey.

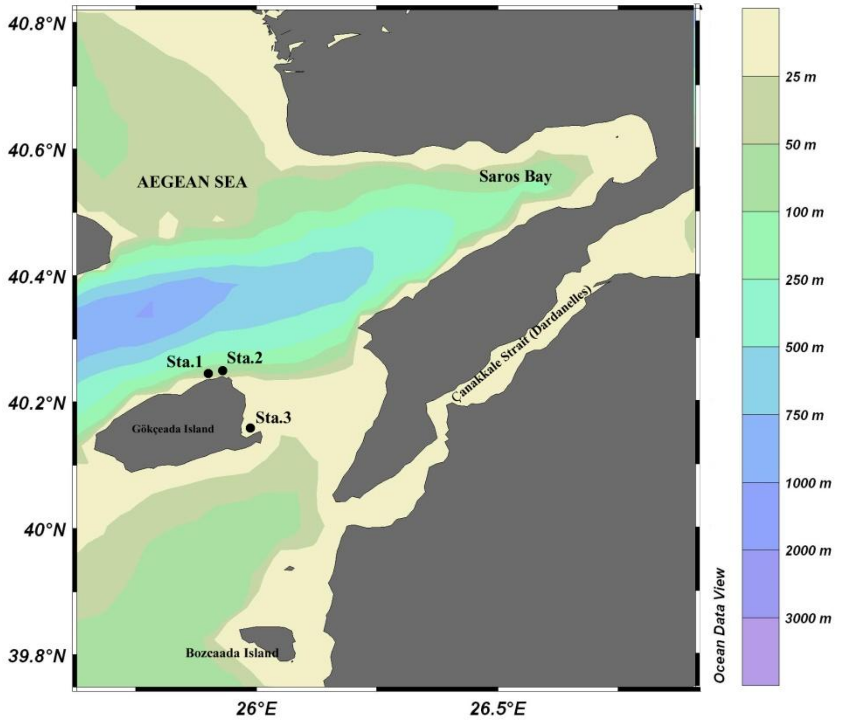


**Figure 1**. Gökçeada Island and diving stations (Sta.1: Kaleköy, Sta. 2:Yıldız Koy and Sta. 3: Aydıncık)

## RESULTS AND DISCUSSION

Totally, five jellyfish species were found at the Gökçeada island during the survey. These species were *Aurelia aurita, Rhizostoma pulmo, Cothylorhiza tuberculata, Chrysaora hysoscella and Pelagia noctiluca.* All the species are known from the Mediterranean Sea. *Pelagica noctiluca* also reported as a cosmopolitan species in tropical and subtropical seas and rare along the Mediterranean coast of Israel (Galil et al. 1990). Table 1 shows the areas and months they were observed. They were all seen from the shore up to 300 m off shore. The most common species were *A. aurita* and *C. tubercula,* which were found at all localities and all three months. *C. hysoscella* was less observed, only in August, from the area between Kalekoy and Yıldız Koy Marine Park. *R. pulmo* as well as *Pelagia noctiluca* were not seen at Aydıncık (Kefalos). All jellyfish species were usually distributed in the upper layer in between 1- 20 meter.

Besides these jellyfish species above, two ctenophore species were also observed, namely *Mnemiopsis leidyi* and *Beroe ovata* around the island during the study period. Among these species *M. leidyi* were reported by Tarkan (2000) and İşinibilir and Tarkan (2002).

Mavili (2008) reported that *A. aurita* and *R. pulmo* are widely distributed in the Marmara and Northern Aegean waters. In addition, he reported *M. leidyi* and *B. ovata* from the Marmara and Northern Aegean Sea. Balık (1973) reported that *R. pulmo* feeding on juvenile of sardine and other fish species in the Aegean Sea.

A long term monitoring study is needed to understand the distribution, abundance and biomass of jellyfish and other gelatinous species to predict impacts on and interaction with marine biodiversity, and consequently fisheries and other commercial activities. In addition, a monitring study should be continued in winter seasons as well.

Lastly, although no alien nor invasive jellyfish species was reported in this study, the northern Aegean Sea, being the passage area between the Marmara–Black Sea and the Mediterranean, is the critical area for the expansion of such species. It is, therefore, important to recognize those alien species which have been reported in the Aegean or Mediterranean Sea and understand how and when they are spreading in these waters.

**Table 1.** Observation of jellyfish species at the Gökçeada Island in 2008-2009.

| **Jellyfish species** | **Observed locations** | | | **Observed months** | | | S or A* |
|---|---|---|---|---|---|---|---|
| | Kaleköy | Yıldız Koy Marine Park | Aydıncık (Kefalos) | June | July | August | |
| *A. aurita* | + | + | + | + | + | + | S and A |
| *R. pulmo* | + | + | - | - | + | + | S and A |
| *C. tuberculata* | + | + | + | + | + | + | S and A |
| *C. hysoscella* | + | + | - | - | + | + | S |
| *P. noctiluca* | + | + | - | - | - | + | S |

S or A* : Single animals or aggregations.

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## Progresses In Turkish Jellywatch Programme

Since large parts of marine waters are increasingly disturbed and overfished, it is evidently reported that energy that previously went into production of fishes may be switched over to the production of pelagic Cnidaria or Ctenophora (Mills, 1995). Commercial fishing efforts continue to remove top-predator fishes throughout the world oceans (Pauly et al., 1998), and it seems reasonable to watch concomitant trends in jellyfish populations, as jellyfish typically feed on the same kinds of prey as do many either adult or larval fishes (Mills, 2001). Increases in jellyfish populations occure with native species blooms in local or regional ecosystems. Moreover increases in jellyfish can be the result of recent introductions followed by population explosions of nonindigenous species into coastal ecosystems. From an ecosystem perspective, the apparent increase and synchrony of jellyfish outbreaks in Mediterranean basin are sending warning signals of a potential phase shift from a fish to a “gelatinous sea".

CIESM (The Mediterranean Science Comission) initiated The International JellyWatch Programme (http://www.ciesm.org/marine/programs/jellywatch.htm) in 2008 to gather for the first time baseline data on the frequency and extent of jellyfish outbreaks across the Mediterranean Sea. The CIESM executed a successfull pilot test phase involving a few countries, a common, standardized protocol including systematic recording of presence/absence data has been adopted for both coastal and open sea sightings of jellyfish swarms in the whole Basin, enabling an unbiased assessment of the geographic and temporal scale of these mass events so as to allow in time trend analysis and short term forecasting of jellyfish bloom transport.

Turkish JellyWatch Programme was initiated in 2010 with the TAGEM project “The Effects of Global Climate Change on Fish Populations in the Eastern Mediterranean Sea” supported by Ministry of Agriculture and Rural Affairs of Turkey. A web page of jellywatch programme was created as www.denizanasi.org. Information on jellyfish species and their distribution in Turkish marine waters are given in the web page. Jellyfish repor form was also expanded in the web page of Turkish JellyWatch programme on the bases of CIESM JellyWatch programme. Data on ccurence and blooms of jellyfish and other gelatinous species have been collected.

The International CIESM JellyWatch Programme have included Anatolian south east coast of Turkey as one of Local Jellywatch Focal Points. Turkish JellyWach programme is in coordination with the International CIESM JellyWatch Programme. Thanks to Dr. Frederic Briand, Director General, CIESM for inclusion of Turkey to the programme.

Dr. Cemal Turan
Turkish JellyWatch Programme Leader
Turkish Focal Point of the International CIESM JellyWatch Programme