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Intrusion of *Mnemiopsis mccradyi* (Ctenophora: Lobata) into the Mediterranean Sea

With 2 Text-Figures and 1 Table

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Abstract

[Kideys, A. E. & Niermann, U. (1993): Intrusion of *Mnemiopsis mccradyi* (Ctenophora: Lobata) into the Mediterranean Sea. — Senckenbergiana marit., 23 (1/3): 43–47, 2 figs., 1 tab.; Frankfurt a. M.]

The first appearance of *Mnemiopsis mccradyi* in the Mediterranean Sea is reported. This species is endemic in the Atlantic coastal waters of North America. In 1987 it invaded the Black Sea and the Sea of Azov, where it caused severe changes in the ecosystem which probably resulted in the collapse of the pelagic fisheries. *Mnemiopsis mccradyi* has now been discovered along the Mersin coast in the eastern Mediterranean Sea with a maximum abundance of 1.1 individuals m^{-3}, which is much lower than the abundance reported in the Black Sea (> 30 individuals m^{-3}). Considering the ctenophore to be competitive only at high food concentrations, one can suggest that its spread in the oligotrophic Mediterranean will not cause as great a problem as in the Black Sea, except in some eutrophic coastal areas.

Kurzfassung

[Kideys, A. E. & Niermann, U. (1993): Einwanderung von *Mnemiopsis mccradyi* (Ctenophora: Lobata) in das Mittelmeer. — Senckenbergiana marit., 23 (1/3) 43–47, 2 Abb., 1 Tab.; Frankfurt a. M.]

Das erste Auftreten von *Mnemiopsis mccradyi* im Mittelmeer wird mitgeteilt. Diese Art ist endemisch in den atlantischen Küstengewässern von Nordamerika. 1987 wurde sie in das Schwarze und das Asowsche Meer eingeschleppt, wo sie weitreichende Veränderungen im Ökosystem hervorgerufen und wahrscheinlich mit zum Zusammenbruch der pelagischen Fischerei in diesen Gewässern geführt hat. *Mnemiopsis mccradyi* wurde in jüngster Zeit auch entlang der Küste des östlichen Mittelmeeres bei Mersin gefunden. Die maximale Abundanz ist mit 1.1 Individuen pro m^3 jedoch deutlich niedriger als im Schwarzen Meer mit > 30 Individuen pro m^3. Da diese Ctenophore nur bei hohem Nahrungsangebot konkurrenzfähig ist, kann man davon ausgehen, daß sie, ausgenommen in einigen eutrophen Küstengebieten, im oligotrophen Mittelmeer nicht so große Schäden verursachen wird wie im Schwarzen Meer.

Introduction

The genus *Mnemiopsis* is native to the Gulf and Atlantic coast of the United States of America (Mayer 1912). The two most abundant species are *M. mccradyi*, found from tropics to South Carolina, and *M. leidyi*, found north of South Carolina (Mayer 1912). Both species can occur in dense swarms in summertime up to 50 individuals m^{-3} (Baker & Reeve 1974; Kremer & Nixon 1976). *M. mccradyi* was accidentally transported to the Black Sea in 1987 in the ballast water of grain-carrying ships from U.S. ports (Vinogradov et al. 1989). The species was first described as *M. leidyi*, then redfined as *M. mccradyi* (Zaika & Sergeeva 1990). This is not unexpected, since there is still some controversy as to whether even these two species are separate or same (Konovalov,

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pers. comm.; Reeve, pers. comm.). In the autumn of 1987, the ctenophore spread all over the northern coast of the Black Sea and in the summer of 1988, it reached a biomass of 1.5–2 kg m^{-2} (Vinogradov et al. 1989). The total biomass of *M. mccradyi* in the eutrophic waters of the Black Sea was calculated as 800 million tons in August/September 1989 (Vinogradov 1990). The structure of the planktonic community in the Black Sea and later in the Sea of Azov was altered by this invasion and the quantities of copepods and other foraging zooplankters were diminished 15–40 fold (Shushkina & Musayeva 1990; Volovik et al. 1991). The occurrence of *M. mccradyi* in the northwestern Black Sea and the Sea of Azov coincided with the catastrophic decline of sprat, anchovy and horse mackerel, species which have small pelagic eggs and larvae (Caddy 1992; Volovik et al. 1991). It is suggested that, by consuming either anchovy's food or its eggs and larvae, *M. mccradyi* played a main role in the decrease of anchovy catches in Turkish water from 295 thousand tones in 1988 to 97 and 50 thousand tones in 1989 and 1990 respectively (Die 1991; Caddy 1992).

Mnemiopsis mccradyi has long been documented as an effective predator on zooplankton, as well as fish eggs and larvae. Concomitant with the appearance of *M. mccradyi*, a reduction in the numbers of other zooplankton (particularly copepods) has often been observed (Burrell & van Engel 1976; Mountford 1980).

The high fecundity (average 8000 eggs within 23 days), the short generation time of 13 days and the ability to self fertilize could be the explanation for the sudden appearance of *M. mccradyi* in bloom proportions in environments with high food concentrations (Baker & Reeve 1974). Under optimal conditions the growth rate of *M. mccradyi* doubles daily which is comparable with that of phytoplankton (Reeve et al. 1978).

Some coastal regions along the Mediterranean coast of Turkey are partly eutrophic, which could offer *M. mccradyi* satisfactory feeding grounds. In this paper we report the first appearance of *M. mccradyi* in the Mediterranean, along the Mersin coast of Turkey.

Materials and Methods

The Institute of Marine Sciences of Erdemli is situated 7 km west of the city (Fig. 1). The sea area in front of the Institute is influenced by the small river Lamas which flows into the sea about 800 m west of the Institute.

A large aggregation of *Mnemiopsis mccradyi* was first detected during snorkel diving in the harbour of the Marine Science Institute on the 19th of May 1992 (Uysal & Mutlu 1993). Some *Mnemiopsis* specimens were collected with hand-held jars from a small boat in the harbour, for taking photographs (Fig. 2). Identification was carried out following Agassiz (1860), Mayer (1912), Smith (1964) and Gosner (1971).

On the 27th and 28th of May, two surveys were carried out with the research vessel "Erdemli" to estimate the local abundance of the ctenophore. On the first day, samples were taken from 5 stations in front of the Institute up to 3 miles offshore. On the second day the coast between the Institute to Mersin city (ca. 27 nautical miles eastward of the Institute) was transected within 1 mile distance from the coast. Along the transect 9 samples at 7 stations were taken at every five miles intervals. The maximum water depth was 34 m.

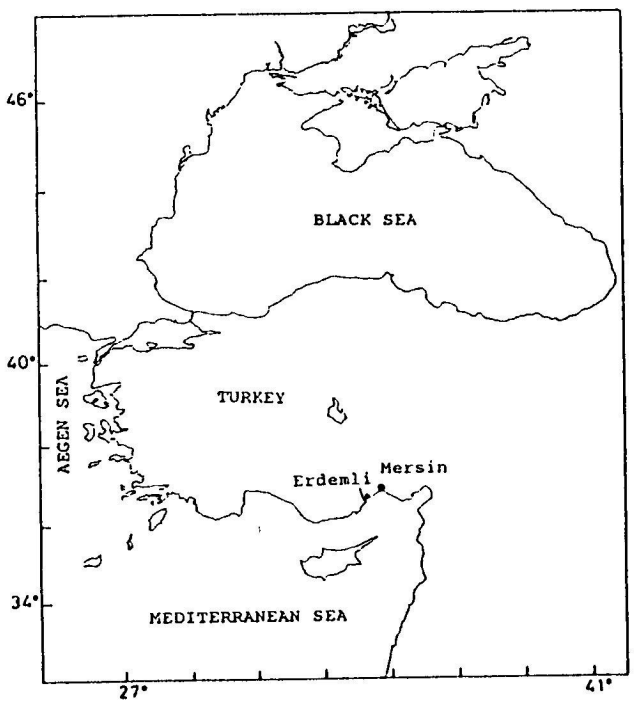

Fig. 1. Area of investigation along the eastern Turkish coastal waters of the Mediterranean Sea.

Abb. 1. Untersuchungsgebiet an der östlichen Mittelmeerküste der Türkei.

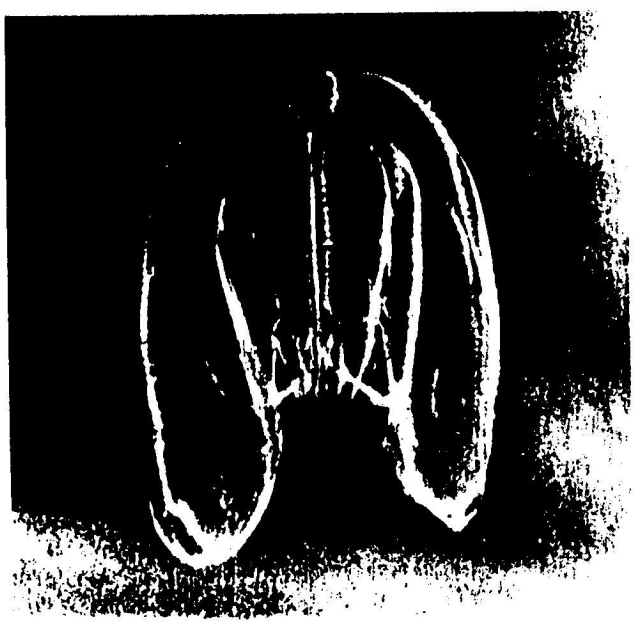

Fig. 2. The Ctenophore *Mnemiopsis mccradyi*.

Abb. 2. Die Rippenqualle *Mnemiopsis mccradyi*.

A WP3 net (aperture 500 μm, opening diameter: 1 m) was towed horizontally with a speed of 1.5 knots at 1–2 m below sea surface for 15 minutes. The volume of filtered water was calculated as 545 m^3. At each station, the numbers of specimens were counted and the total volume of *M. mccradyi* was determined using a graduated cylinder. The total weight of *M. mccradyi* from the first survey was determined in the laboratory.

Measurements of temperature and salinity were carried out using the high resolution Sea-Bird Electronics Model SBE 9 CTD system. Secchi disc depths were also measured.

Results

The stratification of the water column was not strongly pronounced. Due to the cold water flow of the Lamas River, the temperature and salinity of the sea surface changed quickly near the Institute (see Stat. 1 in Tab. 1). Temperature and salinity ranged between 22.0–23.4°C and 35.8–37.8 ‰, respectively.

The Secchi disc depth was low (3–5 m) due to a bloom of *Nitzchia delicatissima* in the sea, which appeared as a yellow-greenish colour over the inner surface of the plankton net after each tow.

During both cruises no other Ctenophora except *Mnemiopsis mccradyi* were caught. The distribution of *M. mccradyi* was patchy. Its numbers varied between 25–597 individuals per tow (0.01–1.10 individuals m^{-3}) in front of the Institute (2 × 13 miles area; Table 1). *M. mccradyi* was less abundant during the second day of sampling (28th May) along the coast between the Institute and Mersin. However, at three locations, in front of the Institute, off Erdemli and off Mersin, *M. mccradyi* occurred in higher numbers (0.15 to 0.32 individuals m^{-3}) than at the stations located along the less populated coastal rural areas (maximum 0.03 individuals m^{-3}; Tab. 1). The highest number (0.32 individuals m^{-3}) was obtained close to the main wastewater discharge point of Mersin city.

Table 1. Sampling data for *Mnemiopsis mccradyi* in the Mersin area in May 1992. — Station 1 was sampled 3 times; stations 9 and 10 were sampled twice each.

Tabelle 1. Stationsdaten für das Probennahmegebiet bei Mersin im Mai 1992, östliches Mittelmeer. — Stat. 1 wurde dreimal, Stat. 9 und 10 jeweils zweimal beprobt.

Station number (no)	distance from Institute (nm)		Time (h)	Depth total (m)	Depth Secci (m)	temp (°C)	salinity (‰)	*Mnemiopsis mccradyi* number (m^{-3})	volume (m^{-3})	weight (m^{-3})
27th May										
1	0.2	offshore	11:15	14	-	22.9	37.8	1.10	3.31	3.31
1	0.2	offshore	14:12	15	-	22.4	36.5	0.05	-	-
2	3.0	offshore	12:00	33	-	22.2	37.4	1.07	7.36	7.30
3	3.0	offshore	13:00	31	-	22.0	37.2	0.31	2.26	2.25
4	0.4	offshore	13:30	18	-	22.2	36.6	0.16	0.61	0.61
28th May										
1	0.2	offshore	10:00	11	4.0	22.0	37.8	0.15	0.57	-
5	5	Erdemli	11:05	11	3.0	22.9	36.6	0.21	0.62	-
6	10	east	12:03	9	3.0	23.2	36.0	<0.01	0.01	-
7	15	east	13:03	10	3.0	23.1	35.8	0.01	0.07	-
8	20	east	13:57	19	4.0	23.7	36.2	<0.01	0.01	-
9	25	east	15:10	20	4.0	23.0	7.3	0.01	0.10	-
9	25	east	15:35	20	4.0	-	-	0.03	0.16	-
10	27	Mersin	16:12	20	2.5	23.4	36.9	0.19	1.12	-
10	27	Mersin	16:37	12	2.5	23.3	36.5	0.32	2.40	-

Discussion

There are 17 species of ctenophores occurring in the Mediterranean Sea (Tregouboff & Rose 1978). The genus *Mnemiopsis* has not been reported previously.

Mnemiopsis mccradyi has been reported to tolerate a wide range of salinity (10–70 ‰) and temperature (1.3–28.8°C) (Perkins 1974; Burrell & van Engel 1976). Therefore, it is not surprising that *M. mccradyi* was able to survive well in the much warmer and more saline waters of the Mediterranean in comparison to the Black Sea and the North Atlantic. The distribution of *M. mccradyi*

seems to be independent of temperature and salinity gradients observed in the present study.

The population density (< 0.01–1.1 individuals m^{-3}) found in our survey is much lower than that found either in the native place of occurrence (North Atlantic) or in the Black Sea. KREMER & NIXON (1976) found more than 50 individuals m^{-3} of *M. leidyi* during summer peak densities in Narragansett Bay. In the Black Sea, in 1988, up to 227–550 individuals of *M. mccradyi* occurred per square meter, (VINOGRADOV et al. 1989), which was recalculated by us to be a density of 31 individuals m^{-3}. Very high abundances of *M. mccradyi* of 300–600 individuals m^{-3} (including larvae) have been observed in the Bight of Varna, Bulgaria, in May 1992 (A. KONSOLOV, pers. comm.).

Since we started to sample in the second half of May, we may have missed higher abundance levels of the ctenophore. Investigations in 1984/85 demonstrated that the main zooplankton bloom occurred between March and May (GUCU et al. 1991). Since there were no regular plankton surveys in the Mersin area, we do not know the exact date for the very first occurrence of *M. mccradyi*. However, we did not observe the species during plankton hauls in the middle of March. Thus, the initial occurrence of *M. mccradyi* can be dated between the end of March and early May, 1992. The high population densities found near the mouth of the Lamas River and the two biggest towns (i.e. Erdemli and Mersin) in the study area could be explained by the high affinity of *M. mccradyi* for organic matter. Mersin, due to the intensive agriculture around it, and to a lesser extent Erdemli, are characterized by a high degree of organic pollution because of the large population of the cities. Thus, it was not surprising that the highest numbers were obtained close to the main discharge of waste water.

Mersin is one of the most important ports of Turkey, harboured by many ships throughout the year. The transport of *M. mccradyi* to the Mediterranean is possible either via some of the ships carrying goods from the Black Sea ports or via currents through the Bosphorus, the Sea of Marmara, the Dardanelles and the Aegean Sea. In the Bosphorus we have already observed high numbers of *Mnemiopsis* during a hydrographic cruise in July 1992, and dense assemblages of *Mnemiopsis* were reported by divers in the Sea of Marmara in June 1992. A survey along the Mediterranean and Aegean coasts of Turkey is needed to learn in greater detail about the distribution of *M. mccradyi*, which may help understanding the mode of its transport into this area. It appears highly possible that this euryhaline and eurythermal organism may spread over all the Mediterranean Sea via a suitable surface current regime.

The occurrence of this voracious predator will certainly adversely affect the quantity and composition of plankton (including the planktonic stages of benthic and pelagic animals) in the Mediterranean Sea. Since *M. mccradyi* has been reported to be of disadvantage at low food densities (REEVE et al. 1978), the impact is expected to be lower in the open oligotrophic waters of the Mediterranean Sea than in the Black Sea. However, the eutrophic coastal areas of the Mediterranean are in danger of invasion by this ctenophore. We, therefore, suggest that the occurrence and distribution of *Mnemiopsis mccradyi* off the coasts of the Mediterranean countries should be closely monitored.

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References Cited

AGASSIZ, L. (1860): Ctenophora. — Contrib. natur. Hist. U.S., 3: 269.

BAKER, L. D. & REEVE, M. R. (1974): Laboratory culture of the lobate ctenophore *Mnemiopsis leidyi* with notes on feeding and fecundity. — Mar. Biol., 26: 57–62.

BURRELL, V. G. & VAN ENGEL, W. A. (1976): Predation by and distribution of a ctenophora, *Mnemiopsis leidyi* A. AGASSIZ, in the York River estuary. — Estuar. coast. mar. Sci., 4: 235–242.

CADDY, J. F. (1992): Update of the fishery situation in the Black Sea, and revision of the conclusion of the 1990 GFCM studies and reviews no. 63, by CADDY & GRIFFITHS: "A perspective on recent fishery related events in the Black Sea". — GFCM Stud. and Rev., 6: 71 pp.

GOSNER, K. L. (1971): Guide to identification of marine and estuarine invertebrates — Cape Hatteras to the Bay of Fundy. — New York (Wiley).

GUCU, A. C. & BINGEL, F. & UNSAL, M. (1991): Zooplankton population and its time series in the northern Cilician Basin — Turkish coast. — Doga, Turk. J. Zool., 15: 202–210.

DIE, (1991): Fishery Statistics. — State Inst. Statit., Printing Div., Ankara, Turkey.

KREMER, P. & NIXON, S. (1976): Distribution and abundance of the Ctenophore *Mnemiopsis leidyi* in the Narragansett Bay. — Estuar. coast. mar. Sci., 4: 627–639.

KREMER, P. (1977): Respiration and excretion by the ctenophore *Mnemiopsis leidyi*. — Mar. Biol., 44: 43–50.

MAYER, A. G. (1912): Ctenophores of the Atlantic coast of North America. — Carnegie Inst. Washington Publ., 162.

MOUNTFORD, K. (1980): Occurrence and predation by *Mnemiopsis leidyi* in Barnegat Bay, New Jersey. — Estuar. coast. mar. Sci., 10: 393–402.

PERKINS, E. J. (1974): The biology of estuaries and coastal waters. — 678 pp.; New York (Academic Press).

REEVE, M. R. & WALKER, M. A. & IKEDA, T. (1978): Laboratory studies of ingestion and food utilization in lobate and tentaculate ctenophores. — Limnol. Oceanogr., 23 (4): 740–751.

SHUSHKINA, E. A. & MUSAYEVA, E. I. (1990): Structure of planktonic community of the Black Sea epipelagic zone and its variation caused by invasion of a new ctenophore species. — Oceanol., 30 (2): 225–228.

SMITH, R. J. (1964): Keys to Marine invertebrates of the Woods Hole region. — 208 pp.; Randolph, Mass. (Spaulding).

TREGOUBOFF, G. & ROSE, M. (1978): Manuel de planctonologie Mediterraneenne, 1, Text: 587 pp.; Paris (Centre nat. Rech. sci.).

UYSAL, Z. & MUTLU, E. (1993): Preliminary note on the occurrence and biometry of ctenophoran *Mnemiopsis leidyi* invaded Mersin Bay. — DOGA-TU. T. Zool., (in press).

VINOGRADOV, M. YE. (1990): Investigation of the pelagic ecosystem of the Black Sea (44th Cruise of the R/V Dimitriy Mendeleyev, 4 July-17 September 1989. — Oceanol., 30 (2): 254–256.

VINOGRADOV, M. YE. & SHUSHKINA, E. A. & MUSAYEVA, E. I. & SOROKIN, P. YU. (1989): A newly acclimatized species in the Black Sea: The ctenophore *Mnemiopsis leidyi* (Ctenophora: Lobata). — Oceanol., 29 (2): 220–224.

VOLOVIK, S. & LUTS, G. & MIRZOYAN, Z. & PRYAKHIN, J. & ROGOV, F. & STUDENIKINA, E. & REVINA, N. (1991): Introduction of the ctenophore *Mnemiopsis* to the Azov Sea: Preliminary assessment of the effect. — Rybn. Khoz., 1: 47–49. — [Original in Russian: Vselenie grebnevika mnemiopsisa v Azovskoe more: Predvaritel'naya otsenka posledstvij.]

ZAIKA, V. E. & SERGEEVA, N. G. (1990): Morphology and developement of ctenophore-colonizer *Mnemiopsis mccradyi* (Ctenophora, Lobata) in the Black Sea. — Zool. Zh., 69 (2): 5–11. — [Original in Russian: Morfologiya i razvitie grebnevika-vselentsa *Mnemiopsis mccradyi* (Ctenophora, Lobata) v usloviyakh Chernogo morya.]