

## Diversity of Fish Fauna in Gediz Estuary Lagoons (Izmir Bay/Aegean Sea)

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**Abstract:** In order to establish the present fish fauna in Gediz estuary lagoons, sampling was conducted in the 4 stations, one inside Gediz river mouth and 3 in the lagoons during 2004. In the first station, a commercial trawling with 44 mm codend mesh size to determine fish fauna was used and sub marine observations or beach seine of 1 mm mesh size employed to establish fish fauna in the lagoons, Kırdeniz, Homa and Çilazmak, which are relatively shallow. In addition some physicochemical parameters such as temperature, salinity, dissolved oxygen, pH and chlorophyll-a which all play significant roles were measured for each stations monthly. As the result of the research, 56 fish species of 24 families were found from the 4 stations. According to a Bray-Curtis similarity index and multi dimensional scaling analysis in relation to the lagoons, 2 groups are formed based on diversity of fish fauna; Kırdeniz, Homa and Çilazmak are similar to one another in diversity of species, with the first station being different from them.

**Key words:** Fauna, fish, lagoon, gediz estuary, Izmir bay, Aegean Sea

### INTRODUCTION

Estuarine environments are vital habitats for many species of fish, crustaceans and molluscs, serving as spawning grounds, nurseries, feeding grounds and important for early growth and/or physiological preparation of migration. Estuaries are also of great importance in biodiversity and it is important to note that most species found there attract attention both in direct and indirect commercial interests (Élie, 1997).

The largest river into Izmir bay, Gediz has a great influence on marine ecosystem of the bay itself, whose water has long been contaminated by increasingly growing industrialization, air pollution, human settlements and agricultural processes and running into the inner bay to affect the marine ecosystem since 1980's (Sunlu *et al.*, 2002; Tatlıdil, 2002). In addition to adversities caused by the pollutants, sediments carried away by the river gradually fill the north part over years. Increased shallowness and high temperature in summer allows salinity to elevate, threatening organisms in the estuary. Recent droughts and overconsumption of water from the river in farming in Aegean basin has caused the river to flow to greatly decrease during summer months in particular. Therefore, reedy areas and marshlands are exposed to the danger of evaporation/dehydration.

The lagoons between land and sea are under the influence of both marine and territorial factors, constituting a transition process from sea to fresh water. Because of their mobility and impact at various trophic

levels, fish play an important biological part in the functionality of an estuary. Fish occupy estuarine areas at different phases of their life cycle, either using these habitats temporarily for reproduction, as transition zones or occasionally for feeding or on a more permanent basis (Vicente, 1997). Estuaries are unique areas not only because of their landscape value but also due to the fact that they are of fundamental importance as feeding and spawning grounds and as nurseries for juveniles of many marine species. In addition, estuaries often are part of the local traditional fishing grounds (Vieira *et al.*, 2002). That's why lagoons are of great ecological value as shallow waters.

Previous studies made in the lagoons of Gediz estuary are mainly related to fish fauna in Homa lagoon (Alpbaz and Kınacıgil, 1988; Korkut and Gamsız, 1995; Akyol, 1999; Kaya *et al.*, 2000; Akyol and Kınacıgil, 2001; Acarlı, 2006; Bayhan and Acarlı, 2006; Ilkyaz *et al.*, 2006). However, there are no studies conducted involving fish diversity and similarity index of Kırdeniz and Çilazmak lagoons in the estuary. This research established fish fauna in the lagoons of Gediz estuary, interpreted and compared their lagoonal distributions with some physicochemical parameters.

### MATERIALS AND METHODS

The river Gediz is the second biggest river after Büyük Menderes flowing to Aegean Sea from western Anatolia, with a length of 401 km and a water reservoir of

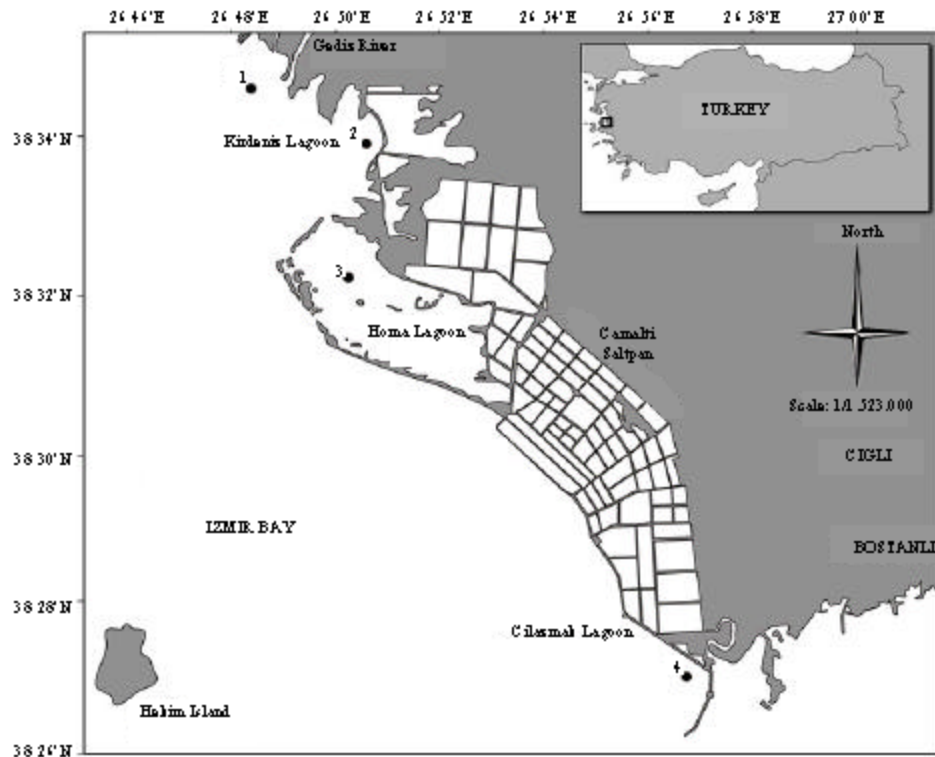


Fig. 1: Map of the study area (Izmir Bay/Aegean Sea)

17,500 km<sup>2</sup>. It forms an estuary of some 40,000 ha. This study aimed at identifying fish species inhabiting in Gediz estuary conducted samplings in the 4 stations: Gediz river mouth, Kirdeniz, Homa and Çilazmak lagoons (Fig. 1).

The first station located in river mouth was chosen to compare it with the lagoons in fish fauna, with a 10-15 m depth and muddy ground. In 2004, 4 trawls were set and hauled for 30 min with the catch being sorted into fish species. The commercial trawl netting hauled had a 44 mm codend mesh size. Being very shallow, the other stations conducted submarine observations and beach seine of 1 mm mesh size was used to identify fish species.

Similarity relationships of the species to in the lagoons were established by Bray-Curtis and multi dimensional scaling with Biodiversity professional ver.2 and Istatistica ver.7 programs being employed for this purpose.

Some physicochemical parameters such as temperature, salinity, dissolved oxygen, pH and Chlorophyll-a which all play significant roles were measured for each stations monthly. Water temperature plus pH, dissolved oxygen (DO) and salinity (%S) were measured by Hanna Instruments HI 8314, Winkler and Mohr-Knudsen methods respectively. Turner Designs 10-AU Fluorometre established chlorophyll-a (Chl-a).

## RESULTS AND DISCUSSION

Fish established in the lagoons in and around Gediz river into sea consist of best known species in Aegean Sea fish fauna (Bilecenoglu *et al.*, 2002). A total of 56 fish species of 24 families were identified in the four stations where the study was conducted. Considering the distribution of the species captured in the lagoonal area by the stations, that richest in number of species was the station 2 with 45 followed by station 1 with 30, 4 with 25 and 3 with 22 (Table 1). The lagoons quite shallow in depth have great number of species established, the very reason for which is that there is no definitive border between the sea and the lagoons. It is difficult to definitely establish the border of all the lagoons with the sea but Homa. The lagoon Çilazmak the third rich in species is out of service due to shallowness, negligence and deficiency in commercial fisheries.

Multi dimensional scaling and Bray-Curtis analysis established 2 different results to explain the similarity relationships of the fish species in the stations with 2, 3 and 4 similar to one another and 1 different from them (Fig. 2 and 3).

Chlorophyll-a to affect productivity of the lagoons and therefore indicate primary productivity was

Table 1: Distribution of fish species by the stations

Fish species	Stations			
	Gediz river	Kirdeniz lagoon	Homa lagoon	Çilazmak lagoon
<b>Scyliorhinidae</b>				
<i>Scyliorhinus canicula</i>	+	-	-	-
<b>Rajidae</b>				
<i>Raja clavata</i>	+	-	-	-
<b>Clupeidae</b>				
<i>Sardina pilchardus</i>	+	+	+	-
<i>Sardinella aurita</i>	+	+	-	-
<b>Engraulidae</b>				
<i>Engraulis encrasicolus</i>	+	+	+	+
<b>Belonidae</b>				
<i>Belone belone</i>	+	+	+	-
<b>Cyprinodontidae</b>				
<i>Aphanius fasciatus</i>	-	+	+	+
<b>Syngnathidae</b>				
<i>Hippocampus hippocampus</i>	-	+	+	-
<i>Syngnathus acus</i>	-	+	+	+
<b>Serranidae</b>				
<i>Serranus cabrilla</i>	-	-	-	+
<i>Serranus hepatus</i>	+	+	-	-
<i>Serranus scriba</i>	-	+	-	+
<b>Moronidae</b>				
<i>Dicentrarchus labrax</i>	+	+	+	+
<b>Carangidae</b>				
<i>Trachurus mediterraneus</i>	+	-	-	-
<i>Trachurus trachurus</i>	+	-	-	+
<b>Sparidae</b>				
<i>Boops boops</i>	+	+	-	+
<i>Diplodus vulgaris</i>	+	+	-	-
<i>Diplodus annularis</i>	+	+	+	+
<i>Diplodus puntazzo</i>	+	+	-	-
<i>Diplodus sargus</i>	+	+	-	-
<i>Sarpa salpa</i>	-	+	-	-
<i>Sparus aurata</i>	+	+	+	+
<i>Lithognathus mormyrus</i>	+	+	+	-
<i>Pagellus acarne</i>	+	-	-	-
<i>Pagellus erythrinus</i>	+	-	-	-
<b>Centracanthidae</b>				
<i>Spicara smaris</i>	+	-	-	-
<i>Spicara maena</i>	+	+	-	+
<b>Labridae</b>				
<i>Coris julis</i>	-	+	-	-
<i>Symphodus cinereus</i>	-	+	-	+
<i>Symphodus mediterraneus</i>	-	+	-	-
<i>Symphodus ocellatus</i>	-	+	-	-
<i>Symphodus roissali</i>	-	+	-	-
<i>Symphodus rostratus</i>	-	+	-	-
<i>Symphodus tinca</i>	-	+	-	+
<b>Uranoscopidae</b>				
<i>Uranoscopus scaber</i>	+	-	-	-
<b>Scombridae</b>				
<i>Scomber japonicus</i>	+	+	-	-
<b>Gobiidae</b>				
<i>Gobius bucchichi</i>	-	+	-	-
<i>Gobius niger</i>	+	+	+	+
<i>Pomatoschistus sp.</i>	-	+	+	+
<i>Zosterisessor ophiocephalus</i>	-	+	+	+
<b>Blenniidae</b>				
<i>Blennius sanguinolentus</i>	-	+	-	+
<i>Parablennius tentacularis</i>	-	+	-	+
<i>Lipophrys pavo</i>	-	+	+	+
<b>Mugilidae</b>				
<i>Chelon labrosus</i>	-	+	+	-
<i>Liza aurata</i>	-	+	+	-
<i>Liza ramada</i>	-	+	+	+
<i>Liza saliens</i>	-	+	+	-
<i>Mugil cephalus</i>	-	+	+	-
<b>Atherinidae</b>				
<i>Atherina boyeri</i>	+	+	+	+

Table 1: Continued

Fish species	Stations			
	Gediz river	Kirdeniz lagoon	Homa lagoon	Çilazmak lagoon
<b>Scorpaenidae</b>				
<i>Scorpaena porcus</i>	-	-	-	+
<i>Scorpaena scrofa</i>	-	+	-	-
<b>Triglidae</b>				
<i>Lepidotrigla cavillone</i>	+	-	-	-
<b>Citharidae</b>				
<i>Citharis linguatula</i>	+	+	-	-
<b>Bothidae</b>				
<i>Arnoglossus laterna</i>	+	+	-	+
<i>Buglossidium luteum</i>	+	+	+	+
<b>Soleidae</b>				
<i>Solea solea</i>	+	+	+	+

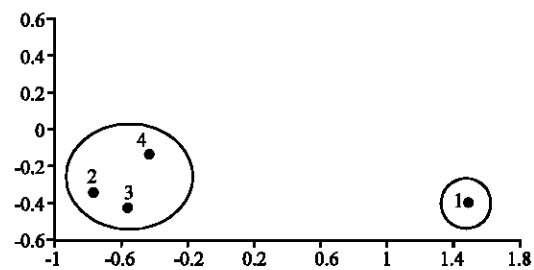


Fig. 2: A multi dimensional scaling (MDS) analysis to represent the correlations in the stations (1-Gediz river 2-Kirdeniz lagoon 3-Homa lagoon 4-Çilazmak lagoon)

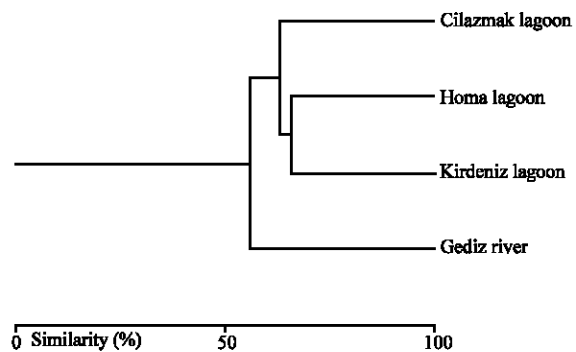


Fig. 3: Dendrogram of similarity between the stations based on the fish species

established to be of highest value followed by Homa and Çilazmak lagoons (Fig. 4), which also resembles list of species diversity in a full consistence. Therefore, amount of chlorophyll-a found in the lagoons can be said to have an effect to increase species diversity.

The highest value in annual dissolved oxygen (DOD) distributions was found in Çilazmak lagoon in march 2004 ( $17.0 \text{ mg L}^{-1}$ ) (Fig. 4). All the others but Çilazmak are similar in yearly mean DOD values. However, all the lagoons showed no significant difference in terms of annual mean water temperature and pH (Table 2).

Table 2: Minimum, maximum and mean values of some physicochemical parameters according to the stations

Physicochemical parameters	Stations											
	Gediz river			Kırdeniz lagoon			Homa lagoon			Çilazmak lagoon		
	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean
Chlorophyll-a ( $\mu\text{g L}^{-1}$ )	0.74	3.32	1.71	0.64	9.94	2.53	0.04	6.85	2.10	0.45	2.84	1.19
Temperature ( $^{\circ}\text{C}$ )	9	28	19.92	10	33	19.33	9	29	19.04	10	32	21.75
Salinity (%)	0.29	35.97	17.04	24.57	38.95	33.02	24.96	52.60	36.07	28.37	38.99	34.70
Dissolved oxygen ( $\text{mg L}^{-1}$ )	4.8	10	6.18	0	10.8	7.12	4.8	12.4	7.61	6.8	27.6	12.53
PH	7.56	8.53	7.98	7.43	8.72	8.09	7.85	8.27	8.10	7.92	8.59	8.25

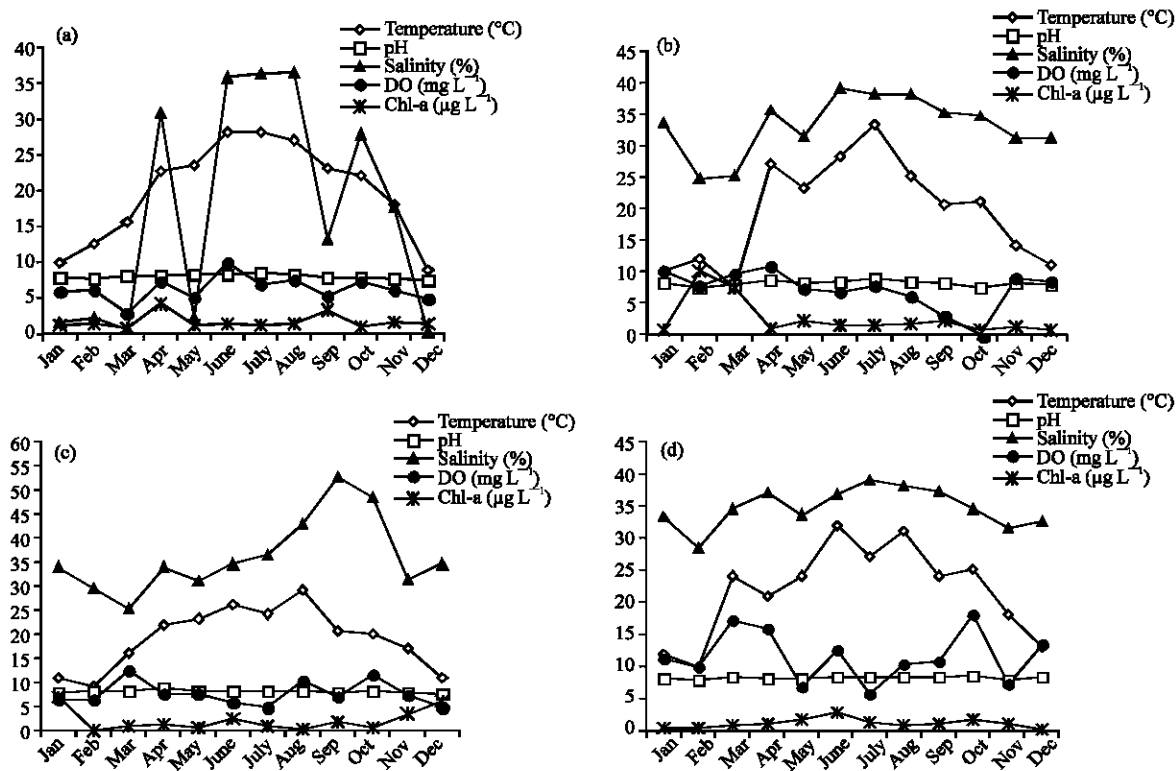


Fig. 4: Monthly variations of some physicochemical parameters by the stations (1-Gediz River 2-Kırdeniz lagoon 3-Homa lagoon 4-Çilazmak lagoon)

With the lagoons in salinity elevation during summer months compared, 3 was highest followed by 2 and 4 stations (Fig. 4). Low salinity seen in station 1 in December, January, February and March was accounted for by increased flow in the river due to precipitation. A typical example of salinity increase in summer is Homa lagoon, where highest salinity value was established to be 52.6% in September by the study concerned. Because of such a high salinity to affect species distribution in the lagoons, Homa remains down in the list in species diversity as compared to the others. In addition shallowness and salinity increase caused by hot weather in summer creates fluctuations in the number of the species rich in value of commercial fisheries (Fig. 5) (Acarli, 2006).

Such commercially valuable fish species as *Dicentrarchus labrax*, *Lithognathus mormyrus*, *Sparus aurata*, *Liza aurata*, *Liza ramada*, *Liza saliens*, *Chelon labrosus*, *Mugil cephalus* and *Solea solea* caught in and around lagoonal site of Gediz river by the fishermen contribute greatly to the local livelihood. In addition pelagic species such as *Sardina pilchardus*, *Sardinella aurita*, *Engraulis encrasicolus* and *Atherina boyeri* found there constitute basic nutrient source of many native and immigrant birds in the lagoons and Birds Paradise in Çamaltı saltpan. Especially migrating species feed on such natural sources there (Sıkı, 1988).

Because marshland and farming areas have been lost to settlements caused by the increased demand for

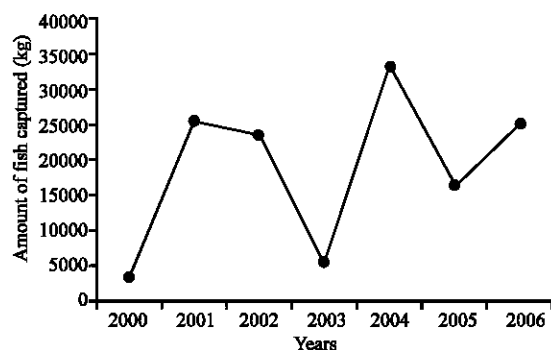


Fig. 5: Amount of fish captured from Homa lagoon between 2000-2006

housing purposes constructions in and around Bostanlı and Cigli within reach of the lagoonal area, people are gradually interested in the site, which implies that the lagoonal location not previously exposed to human activities undergoes pressures from industries and settlements. Organic, inorganic and agricultural pesticides particularly contaminate the water of river Gediz to flow into sea through the territories on which farms and facilities are established, affecting the lagoons and Izmir Bay (Anonymous, 1999), which is typically exemplified by a hermaphrodite individual encountered in lagoon Homa (Bayhan and Acarli, 2006).

Finally, in order to protect natural fish reserves without disturbing delicate ecosystem balances in the lagoonal area of great importance both for fisheries and migrating species in the tributary of Gediz, it seems necessary to control construction of settlement around the lagoons, take some measures to protect shallowness and over salinity, prevent fishermen from over exploiting and avoid all sorts of pollutant risks.

## REFERENCES

- Acarlı, D., 2006. Studies on fisheries and improving its fishery in Homa lagoon. Ege Üniversitesi Fen Bilimleri Enstitüsü, Ph.D Thesis, pp: 153.
- Akyol, O. and H.T. Kınacıgil, 2001. Comparative Body and Otolith Morphometrics of Mugilidae in Homa Lagoon (Izmir Bay, Aegean Sea). Acta Adriatica, 42 (2): 3-13.
- Akyol, O., 1999. Investigations on population characteristics of *Mugil cephalus* (Linnaeus, 1758) and *Liza saliens* (Risso, 1810) in the Homa lagoon (Izmir Bay, Aegean Sea). E.U. J. Fish. Aquatic Sci., 16 (3-4): 391-419.
- Alpbaz, A. and T. Kınacıgil, 1988. Homa Dalyanı'nın Balık Verimliliği ve Balık Faunası Üzerine Bir Çalışma, E.Ü. Su Ürünleri Yüksekokulu Dergisi, 5 (17-18): 31-56.
- Anonymous, 1999. Sulak alanların yönetimi projesi Gediz Deltası sulak alan yönetim planı alt projesi. T.C. Çevre Bakanlığı Koruma Genel Müdürlüğü ve E.Ü. Su Ürünleri Fakültesi, Proje no: 97K100020, Final raporu, Cilt: I ve II, pp: 490.
- Bayhan, B. and D. Acarlı, 2006. Hermaphrodite thinlip mullet *Liza ramada* (Risso, 1810) (Teleostei: Mugilidae) from Homa Lagoon (Izmir Bay-Aegean Sea). Aquac. Res., No. 37, pp: 1050-1052.
- Bilecenoglu, M., E. Taskavak, S. Mater and M. Kaya, 2002. Checklist of the marine fishes of Turkey. Zootaxa No. 113, pp: 194.
- Élie, P., 1997. L'impact d'un Barrage d'Estuaire Sur la Migration des Poissons Amphihalins: Solutions de Réhabilitation et Premiers Résultats. In: Auger C. and J.L. Verrel (Eds.). Les estuaires français: Évolution naturelle et artificielle, Paris, pp: 141-1156.
- Ilkyaz, A.T., K. Fırat, Ş. Saka and H.T. Kınacıgil, 2006. Age, Growth and Sex Ratio of Golden Grey Mullet, *Liza aurata* (Risso, 1810) in Homa lagoon (Izmir Bay, Aegean Sea). Turk. J. Zool., No. 30, pp: 279-284.
- Kaya, M., M. Bilecenoglu and O. Özyayın, 2000. Growth Characteristics of the leaping mullet (*Liza saliens* RISSO, 1810) in Homa lagoon, Aegean Sea, The Israeli. J. Aquaculture-Bamidgeh, 52 (4): 159-166.
- Korkut, A.Y. and K. Gamsız, 1995. Izmir Homa (Süfâ) Dalyanı'ndan yakalanan kastaros kefal balıklarında (*Liza saliens* Risso, 1810) yaş, boy, ağırlık ve gonad ağırlıkları üzerinde bir araştırma. E.U. J. Fish. Aquatic Sci., 12 (3-4): 231-237.
- Sıkı, M., 1988. Çamaltı Tuzlası, Homa Dalyanı Kuş Türleri. Doğa Türk Zooloji Dergisi, 3 (12): 272-283.
- Sunlu, U., O. Egemen, S. Sunlu and A. Basaran, 2002. Investigation on the pollution of Gediz River deltaic zone (Izmir Bay, Turkey). Coastal zone management in the Mediterranean region. CIHEAM/IAMB-EU DG XII, Series A, Number, 53: 57-63.
- Tatlıdil, E., 2002. Investigation on the pollution of Gediz River deltaic zone (Izmir Bay, Turkey). Coastal zone management in the Mediterranean region. CIHEAM/IAMB-EU DG XII, Series A, Number, 53: 213-224.
- Vicente, M.J.D., 1997. Abundância, diversidade e estruturas das comunidades ictiológicas da foz do Rio Itajaí-Açú (S.C., Brasil), Relatório de estágio do curso de licenciatura em Biologia Marinha e Pescas, Universidade do Algarve, Faro.
- Vieira, L., C. Bexiga, R. Sá, P. Veiga and K. Erzini, 2002. Abundance and diversity of the fish fauna of the Guadiana River Estuary and the Castro Marim Salt Marsh (SE Portugal). Littoral 2002, The Changing Coast. EUROCOAST/EUCC, Porto-Portugal Ed. EUROCOAST-Portugal, pp: 231-234. ISBN 972-8558-09-0.