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Biological Data Derived from Sturgeon (*Acipenser stellatus*, *Acipenser gueldenstaedtii* and *Huso huso*) by-Catch along the Coasts of the Southern Black Sea (Turkey)

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Abstract

In this study, some basic bio-ecological features such as growth, reproduction and feeding of three sturgeon species (*Acipenser stellatus, Acipenser gueldenstaedtii and Huso huso*) are presented. The mean and range of total length were recorded as 57.3 (17.0–143.0) cm for *A. stellatus*, 58.9 (29.0–200.0) cm for *A. gueldenstaedtii* and 82.2 (33.0–359.0) cm for *Huso huso*. The mean and range of total weight were 2121.4 (42–16,000) g, 4073.8 (100–35,000) g and 49,090.4 (128–353,000) g for the three species, respectively. The value 'b', a basic parameter of the length-weight relationship was estimated as 2.09 for *A. stellatus*, 2.95 for *A. gueldenstaedtii* and 3.51 for *Huso huso*. Analysis of stomach contents revealed that the sturgeons fed mostly on benthic and benthopelagic macrofauna along the southeastern Black Sea. Catches in the rivers as well as gonad development of fish caught in the vicinity of the estuaries indicated remaining fish still enter Yesilirmak and Sakarya for spawning. The spawning migration especially in the Yesilirmak occurs mainly in the period from April to June.

Keywords: Sturgeon species, bio-ecology, Southern Black Sea coasts.

Güney Karadeniz Kıyılarında Hedef Dışı Avdan Elde Edilen Mersin Balıkları (*Acipenser stellatus*, *Acipenser gueldenstaedtii* ve *Huso huso*)'na Ait Biyolojik Veriler

Özet

Bu araştırmada; üç farklı mersin türünün (*Acipenser stellatus, Acipenser gueldenstaedtii ve Huso huso*) büyüme, üreme ve beslenme gibi bazı temel biyo-ekolojik özellikleri sunulmuştur. Ortalama boy ve dağılım aralığı sırasıyla; *A. stellatus* için 57,3 (17,0-143,0) cm, *A. gueldenstaedtii* için 58,9 (29,0-200,0) cm ve *Huso huso* için 82,2 (33,0-359,0) cm, olarak kaydedilmiştir. Bu üç tür için ortalama ağırlık ve dağılım aralığı ise türler için sırasıyla 2121,4 (42-16000) g, 4073,8 (100-35000) g ve 49090,4 (128-353000) g olarak bulunmuştur. Boy-ağırlık ilişkisinin temel parametrelerinden olan '*b katsayısı*' *A. stellatus* populasyonu için 2,09, *A. gueldenstaedtii* için 2,95 ve *H. huso* için ise 3,51 olarak hesaplanmıştır. Mide içeriği analizi, Güney Karadeniz sahili boyunca mersin balığı türlerinin büyük ölçüde bentik ve bentopelajik makrofauna üzerinden beslendiğini göstermektedir. Hem nehir ağızlarında yakalanan bireylerin gonad gelişimleri hem de nehirlerde elde edilen örnekler popülasyonun halen Yeşilırmak ve Sakarya nehirlerine yumurtlamak için girdiğini göstermektedir. Üreme göçleri, özellikle de Yeşilırmak üzerindeki, yoğun olarak Nisan-Haziran döneminde gerçekleşmektedir.

Anahtar Kelimeler: Mersin balığı türleri, biyo-ekoloji, Güney Karadeniz kıyıları.

Introduction

Sturgeons in the Black Sea are threatened by extinction. Despite their significant commercial importance, the basic literature is lack of studies on the bio-ecological features of sturgeon populations. Geldiay and Balık (1988) recorded the taxonomic characteristics of sturgeon species distributed along the Turkish coasts and Edwards and Doroshov (1989) the current status of sturgeon populations. In the last seven decades southern Black Sea stocks of sturgeons were heavily exploited resulting in a significant reduction in regional biodiversity. In the 1970s, prior to or at the onset of the dam construction on the large rivers, five sturgeon species (*Huso huso, Acipenser gueldenstaedtii, Acipenser stellatus, Acipenser sturio, Acipenser nudiventris*) were inhabiting the rivers and the coastal waters (Çelikkale *et al.*, 2003). By the end of the 1980s the number of species had decreased to four (*H. huso, A. gueldenstaedtii, A. stellatus, A. sturio*) *(*Edwards and Doroshov, 1989) and by the early 2000s only three species remained (*H. huso, A.*

gueldenstaedtii, A. stellatus) (Zengin *et al.*, 2010). *A. sturio* and *A. nudiventris* are considered extinct in Turkish waters today. The three sturgeon species currently inhabiting the Turkish coasts, the stellate sturgeon (*A. stellatus*), Russian sturgeon (*A. gueldenstaedtii*) and Beluga (*H. huso*) are listed by the IUCN as critically endangered (IUCN, 2011).

Currently, the relative contribution of the three species in the sturgeon by-catch along the Turkish coasts is 36.9% for *A. stellatus*, 35% for *A. gueldenstaedtii* and 28.1% for *H. huso* (Zengin *et al.*, 2010).

In this study, some basic population parameters such as age, reproduction and feeding habits were investigated for the three sturgeon species and the findings are discussed.

Materials and Method

Study Area

This study was performed along the Turkish Black Sea coast from Bulgaria to Georgia, where commercial trawler fishery was intense between 2005 and 2009. Direct observations were also made along three major rivers (Yesilirmak, Kizilirmak and Sakarya) where sturgeon populations were spawning previously (Figure 1).

Sampling

The limited number of specimens in this study mainly results from the very small population sizes as well as from the prohibition of legal sturgeon fishery, for conservation purposes. Therefore, the sampling procedure was based on incidental catches. The study was carried out though: (1) Direct collaboration established with 'Fishery cooperatives' and commercial fishermen throughout the Black Sea coast providing data regarding incidental sturgeon captures. (2) A local contact team' of the provincial and district Directorates of Agriculture was formed (*Rize, Giresun, Ordu, Çarşamba, Samsun, Bafra, Karasu*). The contact team collected the data directly from live or dead (from fisherman or salesman) sturgeon samples. In addition, data were also collected from incidental bycatch or fish that were put up for sale illegaly. (3) Field observations were carried out by researchers, for a week per month from April to June and from October to December in the Yesilirmak, Kizilirmak and Sakarya rivers. Surveys were carried out in the villages along the rivers to determine sturgeon captures to gain information on adult populations during spawning migration in the spring and on juveniles following spawning in late summer and fall. Experimental catch trials were carried out using nets with different mesh sizes on river mouths (coastal waters).

All data were recorded on a standard 'Survey-Data Record Form'. The variables in the form were: (1) The habitat/locality where the sample was caught/observed (sea, estuary or river) (2) date of capture (day/month/year), (3) species, (4) total length (cm), (5) total weight (6) sex (M/F), (7) gonad weight (g) and (8) gonad developmental stage (Detlaff, 1993, Hochleitner and Gessner, 2001). As we used data from incidental catches reported by fishermen, data quality in some cases was poor and only length or weight measurement could be obtained and recorded for some individuals.

Identification of Species

Morphological characteristics were used for identification of species. Mainly, the head shape, the position of the mouth, the shape and structure of the

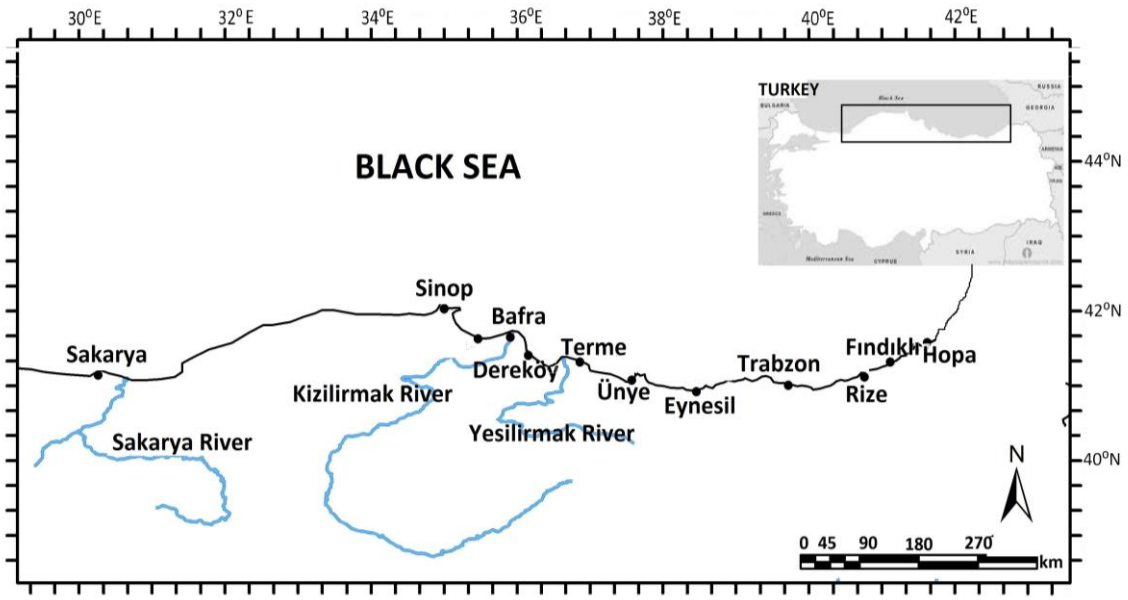

Figure 1. Map of the study area (upper right) and of the main focal area for surveys adjacent to the spawning rivers.

barbels and the habitus provide distinct features for practical identification, using the identification key provided by Holcik (1989). To ease the identification by fishermen of the three predominant species (*H. huso*, *A. gueldenstaedtii*, *A. stellatus*) distributed along the Turkish coast, a 'species identification brochure' was printed and delivered to all contact points and staffs.

Analysis of data

Length-weight relationships

As basic parameters, length- and weight-frequency distributions as well as length-weight relationships were estimated for each of the three species. The length-weight relationship was estimated from the log-transformed equation of the exponential regression model: $W=aTL^b$ (Ricker, 1975), where W is the total body weight (g), TL is the total length (cm) and a and b are the constant and slope of the regression model, respectively.

Ageing

The first ray of the pectoral fin was used for age determination (Rien and Beamesderfer, 1994; Rossiter et al, 1995).

Reproductive Features

In total, 44 specimens were sexed and variables regarding reproductive features such as type of habitat at catch, gonad maturity stages, gonad weight, egg diameter and ovarian tissue were determined in these individuals. Gonad maturity stages were correlated with the habitat and the date of capture in order to assess the probability of an individual participating in a spawning migration.

Since the number of individuals per species was insufficient to estimate mean gonadosomatic indices (GSI), the available data were evaluated individually in order to obtain evidence for the time of freshwater entry and upstream migration. Therefore, dates of capture for adult individuals with ripening gonads in coastal habitats (near shore waters, estuaries and lower river sections) have special importance in evaluation.

The gonads were examined macroscopically and classified according to the 'specific index' by Dettlaff *et al.*, (1993) using gonad size, colour and shape of the gonad, as well size of eggs, coloration, and shape (Hochleitner and Gessner, 2001). In the present study, egg size was able to be measured only in two *H. huso* specimens. One fish was obtained from the freshwater (Yesilirmak, 9 May 2007) and one from the sea (Yesilirmak estuary, 9 February 2009). Egg size was measured using a binocular microscope to the nearest 0.1 mm.

The method of histological tissue preparation suggested by Van Eenennaam and Doroshov (1998) was applied for microscopic examination of egg developmental stages in ovarian tissue.

Stomach Contents

Stomach contents were obtained from dead fish by surgical removal. The contents were stored deep frozen for all specimens. Due to the fact that the number of available samples was very limited, no quantitative evaluation could be done. The contents of all full stomachs were classified and all individual prey was identified systematically. Undigested, semi-digested and other definable food items were counted and weighted.

Results

Length and Weight Distributions

The length and weight distributions of the three sturgeon species caught are given in Figure 2a and Figure 2b, respectively. The descriptive statistics for the mean length and weight of three sturgeon species are presented in Table 1. The mean length and weight were 58.90 (±2.49) cm and 1024.13 (± 101.98) g for *A. stellatus*, respectively. The mean length and weight were also estimated for *A. gueldenstaedtii* as 58.50 (±3.14) cm and 1647.34 (±456.18) g and for *H. huso* as 80.80 (±8.37) cm and 17843.50 (±6867.36) g, respectively. An individual of *H. huso* having a maximum length of 359 cm and weight of 353 kg is not included in Figure 2 for its extreme values.

Regardless of species the number of juvenile individuals in the catch reported was significantly higher than that of adult fish. Nearly 70% of the total *A. stellatus* specimens was juvenile. The percentages of juveniles were 90% for *A. gueldenstaedtii and* 80% for *H. huso*.

Length-Weight Relationship

The parameters of the length-weight equation were estimated by linear regression using log-transformed data of TL and W and presented in Table 2. The estimated values of 'b' were 2.95 for *A. gueldenstaedtii*, 2.09 for *A. stellatus* and 3.51 for *H. huso*. The 'b' value was significantly different from '3.0' within 95% confidence limits in *H. huso* and *A. stellatus* but not different for *A. gueldenstaedtii*.

Reproductive Features and Migration

In a total of 44 specimens sex was determined. Of these, 12 were *A. gueldenstaedtii*, 10 were *A. stellatus* and 22 were *H. huso*. Among individuals in which the sex could be determined, the sex ratio (M:F) was 1:3 in *A. gueldenstaedtii*, 1:1.5 in *A. stellatus* and 1:1.5 in *H.huso*.

Two of the *A. gueldenstaedtii* individuals that were successfully identified as females revealed gonads at

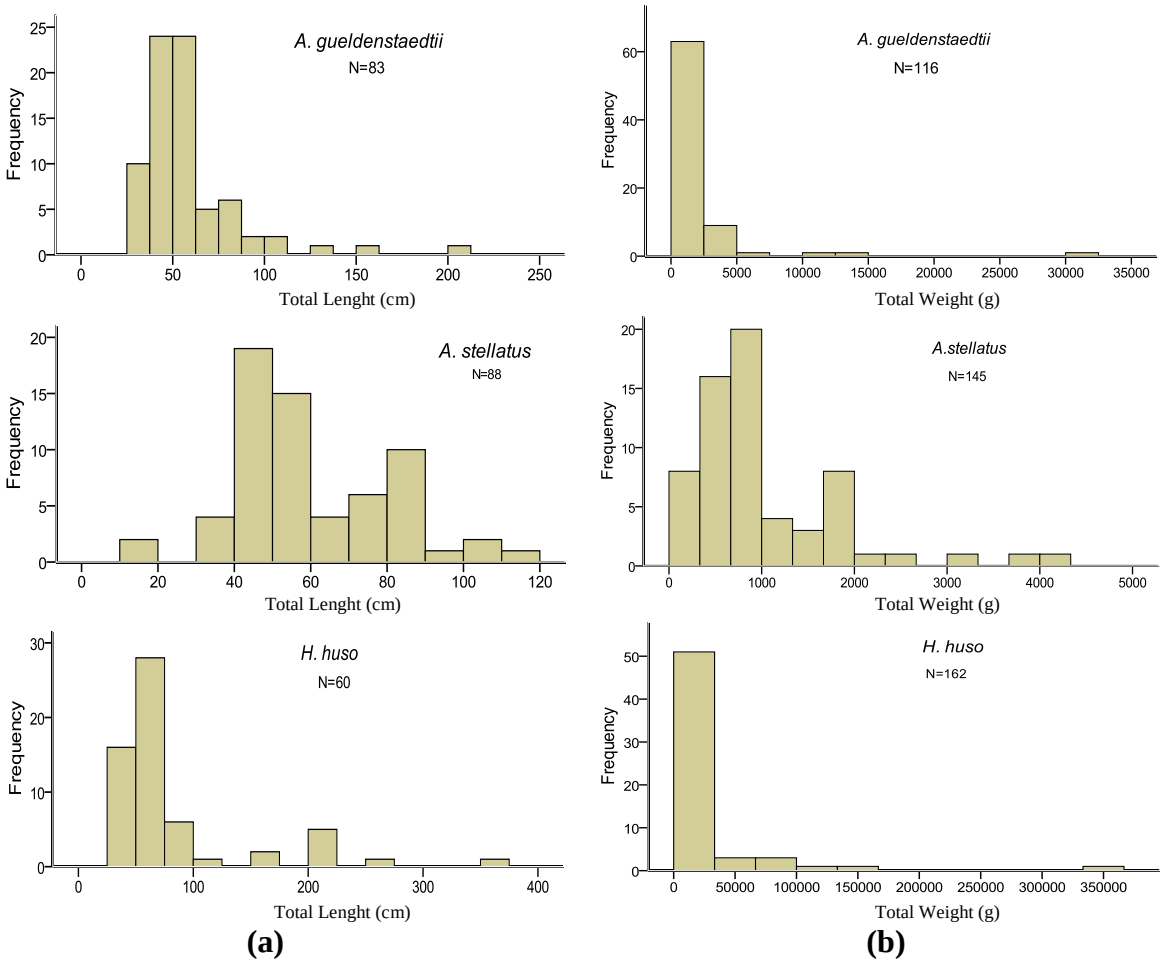

Figure 2. (a) The total length, (b) total weight distributions of three sturgeon species landed as bycatch in commercial fisheries along the Southern Black Sea coast between 2005 and 2009 (pooled data).

Table 1. The descriptive statistics for total length (cm) and body weight (g) of the three sturgeon species during 2005-2009 (pooled data) (SE: standart error)

Species	N	Mean total length±SE (min-max)	N	Mean body weight±SE (min-max)
A. stellatus	88	57.3±2.39 (17-143)	145	2121.4±85.89 (42-16000)
A. gueldenstaedtii	83	58.9±3.14 (29-200)	116	4073.8±456.18 (100-35000)
H. huso	60	82.2±8.37 (33-359)	162	49090.4±6867.36 (128-353000)

Table 2. Length-weight relationship parameters with N=number of individuals, a=constant, SE_a=standard error of a, b=slope, SE_b=standard error of b and R^2=coefficient of determination

Species	N	a	SE_a	b	SE_b	R^2
A. gueldenstaedtii	76	-2.267	0.189	2.946	0.108	0.909
A. stellatus	55	-2.834	0.326	2.090	0.186	0.845
H. huso	60	-3.239	0.144	3.509	0.078	0.972

maturity stage IV. Both specimens were caught in May, one in the Yesilirmak and the other in Sakarya (in the river). Three *A. stellatus* individuals were reported at maturity stage IV. Two of them were captured in April from Eynesil (Figure 1) in inshore habitat and a second individual from the Yesilirmak estuary. The third inividual was captured in May in the Kizilirmak estuary. In total, six *H. huso* individuals were caught in maturity stage IV, three from the Yesilirmak and the other three from inshore waters off the Yesilirmak estuary (Table 3).

Analysis of Stomach Contents

The results obtained from analysis of stomach contents revealed a predominance of benthic and

Table 3. Individual data on sturgeon bycatch along the Turkish Black Sea coast (*TL: total length, W: total body weight, GW: gonad weight, GMS: gonad maturity stage, N:no of specimen*)

Species	Catch date	Locality	Habitat	Depth (m)	TL-W (cm-kg)	Sex	GW (g)	GMS
	09.04.04	Hopa	Sea	32	?-27	F	-	-
	15.03.05	Yakakent	Sea	21	150-14.5	F	2000	III
	15.04.05	Kızılırmak	Sea	18.3	200-30	F	3600	III
	22.08.05	Yeşilırmak	Sea	12	?-10	M	-	-
	01.09.05	Yeşilırmak	Sea	11.5	?-20.3	M	-	-
A. gueldenstaedtii	10.04.07	Kızılırmak	Sea	32	?-27	F	5000	III
(N=12)	14.05.07	Yeşilırmak	River	-	?-35	F	8500	IV
	30.05.07	Sakarya	River	-	?-14	F	-	IV
	24.10.07	Samsun	Sea	-	?-25	F	3000	III
	25.11.07	Samsun	Sea	-	?-25	F	3500	III
	02.12.07	Dereköy	Sea	77.8	107-5.5	F	92	I
	20.05.08	Yeşilırmak	River	-	98.5-6.5	M	-	-
	25.03.05	Terme	Sea	95.2	80.2-2.6	F	-	I
	10.04.06	Eynesil	Sea	R. mouth	?-16	F	4600	IV
	24.04.07	Eynesil	Sea	68.6	?-6	F	1125	III
	26.04.07	Yeşilırmak	Sea	R. mouth	?-6.5	M	2400	IV
A. stellatus	15.05.07	Kızılırmak	Sea	58.5	?-6.6	M	-	IV
(N=10)	22.09.07	Ünye	Sea	-	?-7.2	F	-	-
	10.03.08	Sakarya	Sea	R. mouth	?-14.5	F	-	III
	24.04.08	Trabzon	Sea	-	110-5.2	M	-	-
	24.04.08	Trabzon	Sea	-	?-4.1	M	-	-
	25.10.08	Dereköy	Sea	-	101-2.8	-	-	I
	15.03.05	Sinop	Sea	106	?-23	M	-	-
	25.03.05	Yeşilırmak	Sea	R. mouth	?-168	F	21000	IV
	16.04.05	Kızılırmak	Sea	50.3	?-18.7	F	2700	II
	02.06.05	Yeşilırmak	River	-	?-77.5	F	16000	IV
	15.02.06	Yeşilırmak	Sea	73.2	?-150	F	-	II
	18.02.06	Terme	Sea	104.3	?-300	M	-	II
	10.06.06	Rize	Sea	-	?-23	M	3000	III
	0?.06.06	Yeşilırmak	River	-	-	F	30000	IV
	14.01.07	Yakakent	Sea	80	?-80	M	3500	-
	17.04.07	Hopa	Sea	73.2	?-32	F	-	III
	09.05.07	Yeşilırmak	Sea	R. mouth	170-60	F	9700	IV
	10.05.07	Yakakent	Sea	32	?-60	M	?	III
Huso huso	16.06.07	Yeşilırmak	River	-	?-42	F	7400	IV
(N=25)	28.09.07	Fındıklı	Sea	38	215-68	M	-	II
	0?.09.07	Samsun	Sea	-	160-55	F	-	II
	03.12.07	Kızılırmak	Sea	91.4	220-90	M	2152	II
	24.12.07	Samsun	Sea	-	?-21	F	-	-
	26.01.08	Terme	Sea	110	265-152	M	2873	II
	15.02.08	Terme	Sea	91.5	?-21	F	-	III
	24.02.08	Terme	Sea	100.6	359-353	F	18500	II
	07.09.08	Terme	Sea	22	205-102	M	2450	II
	19.09.08	Yeşilırmak	Sea	23	?-210	F	-	II
	25.01.09	Terme	Sea	17	200-68	F	1320	II
	02.02.09	Yeşilırmak	Sea	-	?-145	M	-	-
	09.02.09	Yeşilırmak	Sea	R. mouth	?-240	F	35000	IV

benthopelagic fauna (Table 4). Stomachs of *A. gueldenstaedtii* mainly contained benthic crustaceans (shrimps, crabs) and molluscs(striped venus (*Chameleo gallina*), Mediterranean mussel (*Mytilus galloprovincialis*) and white mussel (*Anadara cornea*). In A. *gueldenstaedtii* a dominance of molluscs over other benthic organisms comprising 78% in terms of number and 76% in terms of weight was revealed. Crustaceans (*Crangon crangon* and *Liocarcinus depurator*) contributed 22% in numbers and 24% in weight respectively.

Prey items in *H. huso* stomachs mainly comprised pelagic fish species (*Engraulis encrasicolus*, *Trachurus trachurus*, *A. pontica* etc), which reached 73% in number and 60% in weight. Demersal fish species (*Merlangius merlangus euxinus*, *Uranoscopus scaber*, *Gobius niger*, *Mullus barbatus)* and molluscs and crustaceans, contributed 25% in number and 40% in weight.

Age Determination

The length range was 45.0–101.0 cm and the weight range was 182–2085 g among 6 *A. stellatus* that were also aged. The youngest was 1 year old, an individual 45.0 cm in length and 182 g in weight, and

Table 4. Stomach contents of sturgeons landed as bycatch along the Turkish Black Sea coast between 2006 and 2009 (*TL: total length, W: total body weight, N: number of prey items, w: weight of prey items*)

Species	Catch date	Locality	Depth (m)	TL (cm)	W (kg)	Stomach contents		
						Prey name	N	w (g)
A. gueldenstaedtii	8.10.06	Samsun	7.5	71	1.6	*C. gallina*	1	1.4
	2.12.07	Dereköy	77.8	107	5.5	*C. gallina*	4	4.8
						A. cornea	1	1.3
						M. galloprovincialis	1	3.5
						C. crangon	2	3.4
H. huso	12.8.07	Yeşilırmak	Coastal	41.7	0.2	*C. gallina*	1	1.2
	3.12.07	Dereköy	93.3	220	90	*C. gallina*	1	0.9
						E. encrasicolus	78	741
	26.1.08	Terme	110	265	152	*E. encrasicolus*	88	834.6
						T. t. mediterrenaus	9	148.5
	24.2.08	Yeşilırmak	100.7	359	353	*E. encrasicolus*	129	1233.
						T. trachurus	2	733.7
						M. m. euxinus	2	31.2
						G. niger	3	29.1
	7.09.08	Terme	22	205	102	*U. scaber*	21	1150
						G. niger	12	45
						M. barbatus	1	40
						A. pontica	1	102
						L. depurator	2	8.4
	25.1.09	Terme	22	185	68	*M. m. euxinus*	65	745
						C. crangon	1	1.9
	7.09.09	Yeşilırmak	Coastal	-	240	*Pebble*	3	68

the oldest individual was 7 years old, with a length of 101.0 cm and a weight of 2085 g. In this study, only 3 *A. gueldenstaedtii* specimens were aged. The youngest was a 6-year-old individual (72.5 cm, 1644 g) and the oldest was 13 years old (125 cm, 9518.0 g).

In total, 5 *H. huso* individuals were aged. The lowest age estimate for 5 *H. huso* was 1 year, an individual with 40.5 cm in length and 286.4 g in weight. The oldest individual was a 37-year-old female 359 cm in length weighing 353 kg.

Discussion

TL-W Relationships and Growth

The parameter estimates for TL-W relationship implied an isometric growth for *A. gueldenstaedtii* and *A. stellatus*, however, a positive allometry for *H. huso*. The results of this study regarding length and weight parameters were in good agreement with those from the northwestern Black Sea and Danube estuary. The maximum length and weight values recorded in three sturgeon species, *A. stellatus*, *A. gueldenstaedtii* and *H. Huso* from the northwestern Black Sea were 100–120 cm and 6–8 kg, 150–200 cm and 40–70 kg, and 200–256 cm and 145–300 kg, respectively (Vassilev and Pehlivanov, 2003; Ciolac and Patriche, 2005).

The age range was 4–13 years for the population of *A. stellatus* distributed along the downstream Danube Basin (Ciolac and Patriche, 2005). The older individuals in Danube basin may be an indicator of a better conserved population.

Legeza (1973) recorded the mean length and weight for males 9–10 years old as 152.2 cm and 24.5 kg and for females as 167.3 cm and 31.8 kg, respectively.

Deviations between the mean age and the mean size of the fish used in this study and the studies by Legeza (1973), Ciolac and Patriche (2005) indicate that the fish occurring along the Turkish coast mostly comprise feeding juveniles. The results represent the poor status of the sturgeon stocks in the Black Sea. It can be considered that the specimens do not represent the whole age structure of the population.

Reproduction

In this study, adult sturgeons were found in coastal waters and in estuaries of the Yesilirmak, Kizilirmak and Sakarya rivers between March and May. All sturgeons captured from streams were fully mature while those from marine environments were immature or semi-mature during the early-spring, winter and fall periods. These data supported the fact that adults, although very limited in numbers, move to the southern Black Sea coasts and still attempt to migrate upstream.

The monthly mean values of water temperature in the Yeşilırmak river starting from January were 7.9, 4.0, 9.4, 12.9, 16.8, 20.1, 21.2, 23.7, 24.7, 18.5, 14.6 and 8.7 °C between 2006 and 2009 (Alkan *et al.*, 2010). In accordance with these data, adults of the *A. gueldenstaedtii* population may migrate in rivers at an optimum water temperature of 12.9–16.8 °C, most probably in the period between April and May.

Geldiay and Balık (1988) indicated the spawning period for the Black Sea coasts was April–June.

According to the catch data from the rivers, migration of *H. huso* individuals' inhabiting the Yesilirmak, takes place between May and June. In these months, the temperature of the freshwater was 16.8-20.1 °C (Alkan *et al.*, 2010). These data were not in accordance with those from the Danube Basin. The migration of *H. huso* in the Danube River started in mid-April and lasted until the end of May between water temperatures of 10.0–17.0 °C (Ciolac and Patriche, 2005).

As considered above, though no *A. stellatus* was encountered along the three rivers (Sakarya, Kizilirmak and Yesilirmak), adults were captured near estuaries and shore waters between March and April. This period is similar to the migration period in the Danube (Ciolac and Patriche, 2005).

Feeding

In feeding strategies, many factors such as food preferences, behaviour, characteristics of the feeding habitat, season, water temperature, abundance and distribution of prey items and species of predators are determinative (Polyaninova, 1996).

H. huso feeds predominantly on benthopelagic species (horse mackerel, whiting, goby and stargazer) while *A. gueldenstaedti* prefers mostly benthic crustaceans (shrimps and crabs) and molluscs (striped venus, Mediterranean mussel and white mussel).

Schmutz (2006) reported that *H. huso* migrating towards Black Sea near shore waters for feeding consumed gobies, anchovy, shrimps and crabs but in winter additionally tended to eat red mullet, whiting, plaice and molluscs (*Modiola*). In this study, similarly it is observed that *H. huso* fed on anchovy especially in winter months besides horse mackerel, whiting and gobies.

A typical characteristic of *H. huso's* feeding strategy is their extreme opportunism compared to other sturgeons and their appetite (as carnivores) for nearly every item of available macrofauna without any selectivity (Berg, 1948). The predominant occurrence of anchovies in the stomach contents of the *H.huso* suggested a possible relation between anchovy populations and the Fall-Winter migration of *H. huso* along the southern Black Sea. By contrast, *A. gueldenstaedtii* had a feeding regime mostly based on benthic organisms (Berg, 1948; Zolotarev *et al.*, 1996).

In conclusion, even though still maturing sturgeons are clearly attempting to enter the rivers, it is not yet known whether they accomplish spawning or not. If we really intend to conserve these old inhabitants of the Black Sea, some urgent obligations arise, such as the improvement of ex situ conservation studies for all sturgeon species, the monitoring of the upward migration behaviour of sturgeons to figure out the major obstacles against the migration, and the implementation of a habitat restoration plan focusing on the construction of actively operating dam passages.

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