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Harvest, export and economic status of freshwater crayfish (*Astacus leptodactylus* Esch.1823) in Turkey

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This study was carried out on the export and economic status of freshwater crayfish (*Astacus leptodactylus* Esch. 1823) in Turkey. Due to the fact that there is a very low domestic consumption of freshwater crayfish in the country, Turkey had been the largest provider of *A. leptodactylus* to Western Europe from 1970 until 1986. The peak production of the country was attained in the early 1980s, with over 5.000 tons being exported in 1984. After the occurrence of crayfish plague in Turkish waters, crayfish stocks reduced dramatically and harvest declined from approximately 5.000 (in 1984) to 200 (in 1991) tons annually. The harvest of crayfish in Turkey between 2005 and 2009 was 809, 797, 816, 783 and 734 tons, respectively and the commercial values of crayfish, based on these years were 3.033.371, 3.209.396, 3.381.094, 3.366.426 and 2.713.494 USA dollars. The harvest of crayfish in total was 13.648 tons from 2000 to 2009 in Turkey, and the total commercial value was approximately 40.343.870 USA dollars. Majority of crayfish harvest has been exported to European countries and especially Sweden.

Key words: *Astacus leptodactylus*, freshwater crayfish, harvest, exports, economy, Turkey.

INTRODUCTION

Turkey has important inland waters ecosystems in terms of biological diversity with its rivers covering an area of around 10.000 km² (1.6% of the country's total surface area) and lakes. In the country, there are 7 drainage basins including 26 river basins, with an estimated groundwater volume of 94 billion km³. Turkey's inland waters potential comprises 33 rivers (177.714 km), 200 lakes (906.118 ha), 159 dams (342.377 ha) and 750 ponds (15.500 ha). Nine of Turkey's rivers are more than 500 km long: Kızılırmak, Fırat, Sakarya, Murat, Aras, Seyhan, Dicle, Yeşilirmak and Ceyhan rivers. There are 236 species and subspecies of 26 families in the inland fish fauna of Turkey. The most important species are *Alburnus tarichii* and *Cyprinus carpio*. Snail, frogs and crayfish are important export species (Harlıoğlu, 2011).

The only native (indigenous) freshwater crayfish species of Turkey is the narrow-clawed crayfish, *Astacus*

leptodactylus (Holthuis, 1961; Geldiay and Kocataş, 1970; Köksal, 1988; Harlıoğlu, 2004; Harlıoğlu and Güner, 2006, 2007; Güner, 2006, 2007). *A. leptodactylus* is widely distributed in lakes, ponds and rivers throughout the country (Köksal, 1988). It has also been uncontrollably transferred in recent years into many freshwaters in Turkey to establish new populations and to restore the crayfish stocks devastated by the plague disease (*Aphanomyces astaci*) (Harlıoğlu and Harlıoğlu, 2004). Therefore, the distribution of all populations of *A. leptodactylus* in Turkey is not known completely. However, the majority of crayfish are localized in Anatolia in the west and the Keban Dam Lake in the far east of Turkey (Harlıoğlu, 2008). In addition, in recent years, *A. leptodactylus* has expanded its distribution in the east of Turkey. For example, it has also been harvested from Çıldır Lake (Ardahan) for commercial trade. Most of these localities are lakes, but many crayfish populations are also found in dams, reservoirs and ponds. A few populations are found in river and streams. In addition to *A. leptodactylus*, more recently, the presence of *Austropotamobius torrentium* (Shrank, 1803) was observed

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Table 1. Harvest values of *A. leptodactylus* (in tonnes) in Turkish cities between 2000 and 2009 (Anonymous, 2000 – 2009).

City	Year										Total (from 2000 - 2009)
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	
Afyon	7	6	12	23	29	-	-	-	-	-	77
Aksaray	8	5	6	9	9	-	5	4	3	2	51
Ankara	342	323	373	413	416	249	297	299	293	276	3.281
Balikesir	10	9	16	27	31	31	3	2	2	2	133
Bolu	-	-	-	-	-	2	3	2	2	2	11
Burdur	5	5	7	13	16	5	4	3	3	3	64
Bursa	607	527	557	596	589	158	18	15	12	9	3.088
Çanakkale	5	3	3	6	7	-	-	-	-	-	24
Denizli	58	62	74	95	97	12	11	9	9	6	433
Edirne	-	-	-	-	-	-	16	15	12	9	52
Elazığ	16	-	-	-	-	27	36	45	38	35	197
Erzincan	-	-	-	-	-	-	4	4	3	3	14
Eskişehir	36	96	116	139	132	3	2	2	2	2	530
Isparta	198	207	237	268	370	165	175	197	195	190	2.202
İstanbul	14	-	-	-	-	-	-	-	-	-	14
Kırıkkale	18	12	14	17	22	-	-	-	-	-	83
Kırşehir	157	107	129	145	177	32	199	199	192	183	1.520
Kocaeli	10	8	-	-	-	-	-	-	-	-	18
Konya	73	182	202	249	241	123	15	13	11	9	1.118
Kütahya	-	-	47	56	55	2	-	-	-	-	160
Sakarya	5	3	5	8	9	-	-	-	-	-	30
Samsun	112	79	96	119	117	-	1	1	1	-	526
Tunceli	-	-	-	-	-	-	5	4	3	2	14
Zonguldak	-	-	-	-	-	-	3	2	2	1	8
Total	1.681	1.634	1.894	2.183	2.317	809	797	816	783	734	13.648

Negative sign (-) indicate that harvest was not carried out.

in the Velika River and Madara River in the European part of Turkey (Trontelj et al., 2005; Machino and Holdich, 2006; Harlioğlu and Güner, 2006, 2007). However, as being a threatened species and its relatively small size make *A. torrentium* of little commercial interest (Harlioğlu and Güner, 2007).

Artificial culture of *A. leptodactylus* is still not carried out in Turkey. All production is obtained from the wild harvest. The harvest of *A. leptodactylus* from nature in Turkey varied from 3.885 to 7.936 tons between 1976 and 1984 (Köksal, 1988). As a result of the crayfish plague, the harvest of *A. leptodactylus* was reduced severely in most populations in Turkey after 1985 (Köksal, 1988; Bök, 2006; Harlioğlu and Harlioğlu 2009), and was forbidden between 1986 and 1990. Moreover, the harvest was only 320 tons in 1991. Although, there have been fluctuations in previous years, the harvest of *A. leptodactylus* in Turkey has enlarged steadily especially between 1995 (551 tons) and 2004 (2.317 tons). However, the harvest started to reduce again after 2004. It was 809 tons in 2005, 797 tons in 2006, 816 tons in 2007, 783 tons in 2008 and 734 tons in 2009 (Anonymous, 2000 to 2009).

Researches in Turkey about *A. leptodactylus* generally

focused on its biology, catch and disease. However, there have been just few studies carried out on the economics of *A. leptodactylus*. In this study, we presented data on the exports and economic status of *A. leptodactylus* in Turkey from 2000 to 2010.

HARVEST EXPORT AND ECONOMIC STATUS OF CRAYFISH

Crayfish harvest first started in Turkey in 1961 and the catch were exported live until 1968 (Merzeci, 2009). More than 20 million USA dollars revenue was obtained from crayfish exports until 1985. After the crayfish disease in Turkey in 1985, stocks dropped rapidly and production, which totaled 7.936 tons in 1984, decreased to 324 tons in 1992, thus decreasing the exportation revenue from 20 million to 2.85 million USA dollars (Köksal et al., 2003). According to the data of Fisheries Statistics of Turkey, crayfish harvest was carried out in 24 recorded cities in Turkey during the year 2000 to 2009, but crayfish harvest has not been applied regularly from all cities every year (Table 1). Ankara has the most intense production. A total of 3.281 tons crayfish was harvested in 10 years in

Table 2. Purchased crayfish amount in different cities in Turkey in 2010 (Anonymous, 2010b).

City (Lake or Dam Lake)	The purchased crayfish amount (kg)
Manisa (Alaşehir Lake)	20.473
Kırşehir (Hirfanlı Dam Lake)	30.405
Denizli (Çivril Lake)	166
Elazığ (Keban Dam Lake)	17.901
Aksaray (Maymasın Dam Lake)	930
Kütahya (Porsuk Dam Lake)	3.920
Afyon	106
Edirne (Yeni Karpuzlu)	27.284
Amasya	2.627
Kayseri (Sarmısaklı Dam Lake)	892
Ardahan (Çıldır Lake)	65.430
Konya (İvriz Dam Lake)	293
Isparta (Eğridir Lake)	50.315
Samsun (Bafra Lake)	337
Total	221.079

Table 3. Crayfish harvest, exports and trade value in different years in Turkey (Anonymous, 2000-2010, Anonymous, 2010a).

Year	Harvest (kg)	Price (USA dollar/kg)	Total trade value (USA dollar)	Export (kg)	Export trade value (USA dollar)
2000	1.681.000	2.29	3.846.682	758.000,00	2.592.082,37
2001	1.634.000	1.09	1.783.965	1.181.368,00	4.062.788,82
2002	1.894.000	2.42	4.583.182	726.815,80	3.905.122,72
2003	2.183.000	3.26	7.106.891	691.196,00	4.713.610,43
2004	2.317.000	2.94	6.819.370	845.891,00	5.721.421,74
2005	809.000	3.75	3.033.371	725.648,02	4.887.042,03
2006	797.000	4.03	3.209.396	164.685,26	1.661.371,04
2007	816.000	4.76	3.881.094	182.246,00	2.186.857,03
2008	783.000	4.30	3.366.426	305.260,60	2.931.478,08
2009	734.000	3.70	2.713.494	240.905,40	2.221.116,38
2010	-	-	-	200.928,30	2.862.999,85
Total	13.648.000		40.343.870	6.022.944,38	37.745.890,49

Negative sign (-) indicate that data was not published.

this city. The other cities containing the most intense production are Bursa (3.088 tons), Isparta (2.202 tons), Kırşehir (1.520 tons) and Konya (1.118 tons), respectively. It is important to mention that while production is conducted every year in some cities (example Ankara, Bursa, Isparta and Kırşehir), it is not conducted every year in all other cities (Table 1). In 2010, the majority of crayfish caught in Turkey was purchased and exported by ORVESA Ltd. Company. Ardahan, Isparta, Kırşehir, Edirne, Manisa and Elazığ were the main crayfish production cities. The total purchased crayfish amount was 221.079 kg in that year (Table 2). However, being the only one firm in crayfish export causes a decrease in profitability to catch crayfish and determination of crayfish price in Turkey. For this reason,

at present crayfish harvest is not interesting very much for fishermen of some populations. If there were a good competition between crayfish exporters to buy crayfish, cray fishermen would have good opportunity to catch crayfish.

The amounts of crayfish harvest in Turkey between the years 2000-2009, and their commercial value are given in Table 3. The crayfish production was 1.681.000 kg in 2000, 1.634.000 kg in 2001, 1.894.000 kg in 2002, 2.183.000 kg in 2003 and 2.317.000 kg in 2004. On the other hand, crayfish harvest showed a sharp decrease after 2004. It was 809.000 kg in 2005, 797.000 kg in 2006, 816.000 kg in 2007, 783.000 kg in 2008 and 734.000 kg in 2009. Therefore, between 2000 and 2009 the average sale price of crayfish in Turkey varied between

Table 4. Crayfish export of Turkey by countries between 2000- 2010 (kg year⁻¹) (Anonymous 2010a).

Country	Year											Total
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
Sweden	286.947	653.479	442.494	513.844	563.438	265.336	154.649	182.141	194.770	123.905	193.820	3.574.823
France	295.380	286.325	141.799	67.540	41.255	6.705	-	-	-	100	1.750	840.854
Belgium	79.440	36.155	96.160	33.105	63.735	36.900	-	-	-	-	1.000	346.495
Netherlands	-	-	304	22.044	-	-	-	-	-	-	-	22.348
Italy	36.769	31.915	32.860	24.615	17.447	29.692	-	-	-	1.100	2.450	176.848
Luxembourg	42.070	148.665	-	20.730	-	-	-	-	-	-	-	211.465
Germany	16.380	12.754	2.800	6.333	1.350	-	-	-	-	-	900	40.517
Greece	-	-	-	1.600	61	-	110	-	169	846	1.008	3.794
Spain	20	8.000	676	-	-	-	-	105	-	-	-	8.801
USA	-	-	-	-	158.400	387.015	9.926	-	110.321	114.954	-	780.616
Ireland	-	3.600	-	-	-	-	-	-	-	-	-	3.600
Austria	400	225	-	645	-	-	-	-	-	-	-	1.270
Canada	-	250	-	450	175	-	-	-	-	-	-	875
Romania	-	-	410	-	30	-	-	-	-	-	-	440
Switzerland	300	-	-	-	-	-	-	-	-	-	-	300
Malta	-	-	-	290	-	-	-	-	-	-	-	290
Turkmenistan	-	-	9.312	-	-	-	-	-	-	-	-	9.312
Israel	300	-	-	-	-	-	-	-	-	-	-	300
TOTAL	758.006	1.181.368	726.815	691.196	845.891	725.648	164.685	182.246	305.260	240.905	200.928	6.022.948

years. For instance, the commercial value of 1 kg of live crayfish was approximately 2.29 USA dollars in 2000 and 1.09 USA dollars in 2001, but it was more than 2.42 in 2002, 3.26 in 2003, 2.94 in 2004, 3.75 in 2005, 4.03 in 2006, 4.76 in 2007, 4.30 in 2008 and 3.70 USA dollars in 2009. Therefore, the total commercial value of 13.648.000 kg *A. leptodactylus* between 2000 and 2009 was 40.343.870 USA dollars in Turkey, (Table 3). Majority of the crayfish harvest of Turkey has been exported to European countries and especially Sweden. The largest exports have been made to, France, Belgium and Italy in Europe. Between 2000 and 2010, 3.574.823 kg *A. leptodactylus* was exported to Sweden, 840.854 kg was exported to

France, 346.495 kg was exported to Belgium, 211.465 kg was exported to Luxembourg and 176.848 kg was exported to Italy. In the same years, other important crayfish exporter countries were Germany (40.517 kg), Holland (22.348 kg) and Spain (8.801 kg). In addition, a total of 780.616 kg crayfish export was made to the USA in 2004, 2005, 2006, 2008 and 2009. Moreover, 9.312 kg of crayfish export was made to Turkmenistan in 2002 (Anonymous, 2010a) (Table 4).

Crayfish are exported in Turkey in three different varieties; fresh (not frozen), frozen and conserved. While some countries purchase crayfish in these three different conditions, some countries purchase only crayfish that are not

frozen, and some only purchase conserved. A total of 6.022.650 kg crayfish was exported from Turkey between 2000 to 2010. The bulk of crayfish (frozen, not frozen or fresh form) was purchased from Turkey by Sweden between 2000 and 2010. In these years, Sweden purchased 1.025.433 kg of frozen crayfish, 18.358 kg of not frozen (fresh) crayfish and 2.531.033 kg of conserved crayfish, all totaling 3.574.823 kg. After Sweden, France took the second place with 840.854 kg. That of USA, Belgium and Italy was 780.616, 346.495 and 176.848 kg, respectively. The countries that purchased crayfish from Turkey between 2000 and 2010, and their purchase forms are given in Table 5.

Table 5. Frozen, unfrozen and canned crayfish exports by countries from Turkey between 2000 - 2010 (Anonymous, 2010a).

Country	Frozen (kg)	Unfrozen (kg)	Canned (kg)	Total (kg)
Sweden	1.025.433	18.358	2.531.033	3.574.823
USA	-	-	780.616	780.616
France	10.640	767.070	63.144	840.854
Italy	7.176	149.672	20.000	176.848
Spain	696	1.105	7.000	8.801
Germany	1.883	38.434	200	40.517
Belgium	17.030	329.465	-	346.495
Luxembourg	38.895	172.570	-	211.465
Netherlands	22.348	-	-	22.348
Greece	1.799	1.995	-	3.794
Turkmenistan	9.312	-	-	9.312
Ireland	-	3.600	-	3.600
Austria	-	1.270	-	1.270
Canada	-	875	-	875
Romania	-	440	-	440
Switzerland	-	300	-	300
Malta	-	290	-	290
Israel	-	300	-	300
Total	1.135.212	1.485.743	3.401.993	6.022.948

DISCUSSION

Crayfish have been harvested for food for thousands of years. Their fragments and gastroliths have been found in aboriginal cooking hearths about 28.000 years old (Jones, 2004). It is known that the noble crayfish, *Astacus astacus*, have been harvested in Europe since as far as the 13th century (Skurdal and Taugbol, 2002). Today there are important fisheries for wild caught crayfish in many countries, and crayfish aquaculture has been becoming increasingly important (Lawrence and Jones, 2002; Lewis, 2002; Skurdal and Taugbol, 2002).

Freshwater crayfish demand for human consumption in Europe may be as much as 10, 000 tonnes per year (Ackefors, 2000; Harlioğlu and Harlioğlu, 2004). According to the data of Istanbul Exporters' Associations, Sweden (3.574.823 kg) and France (840.854 kg) were at the top of the countries importing crayfish from Turkey from 2000 to 2010 (Anonymous, 2010a). In addition, after processing, approximately 200 tons of *A. leptodactylus* was exported to European countries, especially Sweden, in 2010 (Anonymous, 2010b). According to export figures from Isparta Provincial Directorate of Agriculture, 209.126 kg was processed and live *A. leptodactylus* were exported in 2009 from Isparta (Anonymous, 2010c). These figures are parallel with exporters companies purchase figures and official records.

In Turkey, domestic consumption of crayfish is still very small. This has probably been due to the food preference habit of Turkish people who do not eat it as food. However, domestic consumption of freshwater crayfish has been increasing in Turkey in recent years. For

example, 200 to 240 tons of the crayfish caught in Turkey in 2009 and 2010 have been exported, and the remaining 500 to 600 tons stay in Turkey. It is hard to imagine that the remained crayfish has been consumed in Turkey. However, changes in crayfish consumption habits of Turkish people and demand of touristic places are believed to have positive effect on this increase. As a result of this increase in crayfish demand in Turkey, supermarkets have started to sell crayfish on their fish stands in recent years. On the other hand, there were approximately 20 companies, which dealt with crayfish trade in Turkey until 1985, however, in recent years, these number dropped to two (Merzeci, 2009). Prohibition of freshwater crayfish exportation to some countries and occurrence of crayfish plague in Turkey played an important role in the decrease of company numbers and exports values.

The commercial importance of *A. leptodactylus* has caused attempts to introduce freshwater crayfish wherever possible, and so its distribution area has been considerably expanded in Turkey. For this reason, its distribution and actual harvest level in the country are not fully known at present (Harlioğlu, 2004). After the occurrence of crayfish plague in Turkey, in order to increase crayfish production uncontrolled *A. leptodactylus* stockings have been carried out in many water bodies throughout Turkey (Harlioğlu, 2008). When Tables 1 and 2 are compared, it is observed that significant amounts of freshwater crayfish are caught from new population of *A. leptodactylus* (Karpuzlu Pond and Çıldır Lake). It is therefore thought that crayfish harvest new production areas may bring about an important increase in annual

crayfish production of Turkey.

In conclusion, although Turkey has a great potential to increase crayfish production, harvest and export values are not satisfactory at present. However, it is clear that an increase in crayfish harvest paralleled by export rate will cause an increase in more revenue for Turkish economy as was the case in the past.

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