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## Review Article

### Review on the Caspian Shemaya, *Alburnus chalcoides* (Güldenstädt, 1772)

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**Abstract:** *Alburnus chalcoides*, Caspian Shemaya, is found in the river systems of the Aral, Black and Caspian sea basins and is an economically valuable cyprinid from the southern Caspian Sea. This species has been reported as near threatened species in this basin due to damming, over and illegal fishing, destruction of its spawning grounds and water pollution. The Caspian Shemaya is an important species ecologically and economically, but information about its biology and ecology is widely scattered. Hence, in this review, its taxonomy, general characteristics and morphology, distribution, habitat and ecology, age and growth, reproduction, conservation status and threats in the southern Caspian Sea is summarized, and a bibliography on this fish is provided.

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## Introduction

*Alburnus* Rafinesque, 1820 is a widespread genus of the family Cyprinidae with about 39 recognized species distributed in the Europe and west Asia (Bogutskaya, 1997; Bogutskaya et al., 2000; Freyhof and Kottelat, 2007a, b; Kottelat and Freyhof, 2007; Özulug and Freyhof, 2007; Coad, 2009; Bug et al., 2010; Khataminejad et al., 2013a, 2013b; Mousavi-Sabet et al., 2013, 2015). This genus has eight confirmed species in Iranian inland waters, including *A. chalcoides* (Güldenstädt, 1772), *A. filippii* Kessler, 1877 and *A. hohenackeri* Kessler, 1877 in the south Caspian Sea basin, *A. atropatenae* Berg, 1925 in the Urmia Lake basin, *A. mossulensis* Heckel, 1843, *A. zagrosensis* Coad, 2009 and *A. caeruleus* Heckel, 1843 in the Tigris river basin and *A. amirkabiri*, Mousavi-Sabet et al., 2015 in the Namak Lake basin (Mousavi-Sabet et al., 2014, 2015). In addition, *A. doriae* de Filippi, 1865 and *A. maculatus* Keyserling, 1861 have uncertain provenance and validity from Iran (Coad, 2009).

*Alburnus chalcoides*, Caspian Shemaya, is found in the river systems of the Aral, Black and Caspian sea basins (Bogutskaya, 1997). This species was described as *Chalcalburnus chalcoides*, but Bogutskaya (1997), Bogutskaya and Naseka (2004) and Kottelat and Freyhof (2007) suggested that the genera *Alburnus* and *Chalcalburnus* are the same. Thus, these two genera were merged into one genus i.e. *Alburnus*. Therefore, this species is considered as phenotypic variant of *A. chalcoides*.

The Caspian Shemaya inhabits southern coasts of the Caspian Sea from east to west (Patimar et al., 2010), and is morphologically varied from those of the Black and Aral sea basins (Berg, 1949; Bogutskaya, 1997). *Alburnus chalcoides* is a commercial or semi-commercial species in Iran (Sattari et al., 2004). There are some studies on different biological and ecological aspects of *A. chalcoides* in the southern Caspian Sea basin (Svetovidov, 1945; Darabi, 1999; Rajabi Nezhad and Azari Takami, 2001; Mohsen

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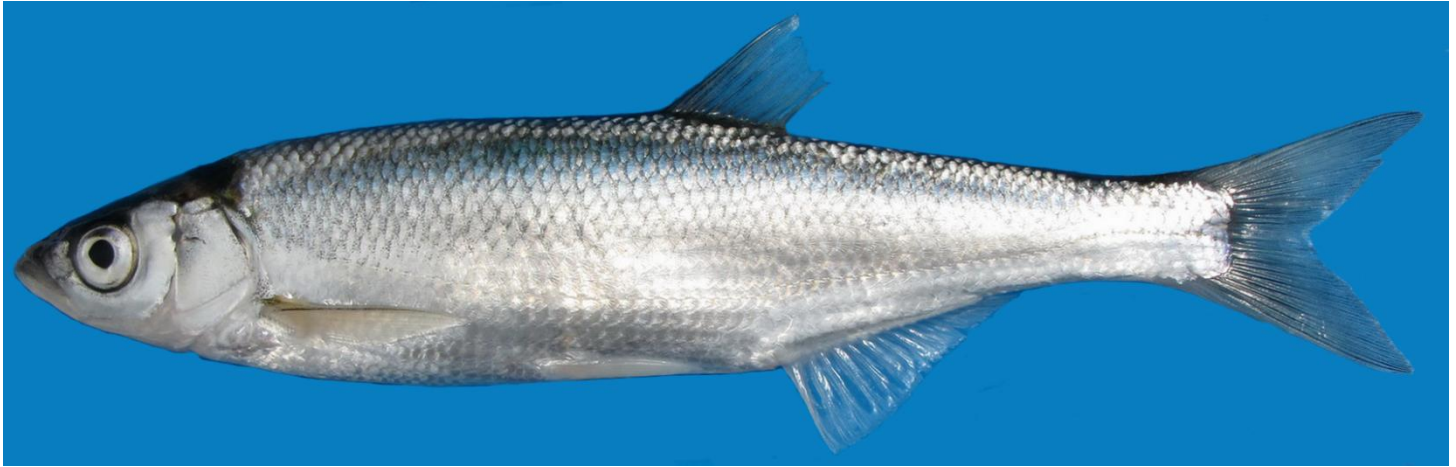


Figure 1. *Alburnus chalcoides* (Güldenstädt, 1772) from Shalmanroud.

Zadeh and Bahadori, 2001; Azari Takami and Rajabi Nezhad, 2002; Bagherian and Rahmani, 2007; Rahmani, 2006; 2008; Bagherian and Rahmani, 2009; Shirvani and Jamili, 2009; Rahmani et al., 2009; Patimar et al., 2010; Khataminejad et al., 2013b; Mousavi-Sabet et al., 2014), but they are widely scattered. Therefore, the aim of this study is to summarize the ecology and biology of this valuable species in the southern part of the Caspian Sea.

**Morphology:** The body is elongated, compressed, and moderately deep with moderate size. The mouth is terminal without barbels. Its abdomen has an obvious scaleless sharp keel from vent to throat. There is a well-developed pelvic axillary scale. The branched rays of the dorsal fin 7-9, branched rays of the anal fin 12-19 after 3 spines, lateral line scales 54-74, gill rakers 18-25 and total vertebrae 42-45 (Svetovidov, 1945; Coad, 2015).

Unlike other populations of the Caspian Shemaya which the last unbranched rays in their dorsal fin are soft, those rays of Iranian Caspian Shemaya transformed as a smooth sharp spine (Svetovidov, 1945). In deepest part of the body, a narrow dark band runs in both sides of body from the head to the caudal fin (Coad, 2015). Inferior mandible is protruded. This species has two rows of the pharyngeal teeth with formula of 2.5-5.2 and rarely 2.4-5.2, 2.5-4.2 and 2.5-5.3 (Svetovidov, 1945; Coad, 2015). Their teeth are protracted, thin, curved inward, and well-hooked at the tip. In addition, the

teeth are strongly serrated on the anterior border of their length, and have a narrow and concave surface. Its swim bladder is pointed posteriorly and its gut is elongated s-shape (Svetovidov, 1945; Coad, 2015). The Caspian Shemaya has a metallic silvery body and its dorsal part bears a contrasting olive-green colour (Fig. 1). Both dorsal and caudal fins are grayish, and the pectoral, ventral, and anal fins are colorless to whitish. The iris is bright silver and its peritoneum is light brown in colour (Coad, 2015). In adults, its Standard Length (SL) is 14.20-19.99 cm (Svetovidov, 1945). Its average Total Length (TL) is 15.06 cm in males (1-4 years) and 17.57 cm in females (1-5 years) and the average weight is 24.7 g and 41.7 g in males (1-4 years) and females (1-5 years), respectively (Rahmani et al., 2009). The reported maximum TL in Siahroud River (central of the south Caspian Sea basin) is 24.20 cm and in the Gorganroud River (the southeastern of the south Caspian Sea basin) is 24.30 cm, both being a five-year-old female (Patimar et al., 2010). The reported maximum TL of males in Siahroud River is 21.30 cm and in Gorganroud River is 20.75 cm. All fish with TL  $\geq$  21.30 cm and  $\geq$  20.80 cm in Siahroud and Gorganroud rivers were female (Patimar et al., 2010). This needs to be noted that the sex ratio reduces with increasing TL. Bagherian and Rahmani (2007, 2009) examined morphology of two populations, from Haraz and Shiroud rivers. Their results showed that the males and females between the two populations were morphologically different.

Rahmani et al. (2007) pointed out that these two populations are almost separable based on meristic characters. Rahmani et al. (2006) showed that the populations of Gazafrud and Haraz rivers are separated using morphometric characters but not by meristic ones. Rahmani et al. (2009) used the 18S rRNA gene and found populations from Haraz, Shiroud and Gazafrud rivers are homogenous. *Alburnus chalcoides* shows a remarkable morphological variation in the southern part of the Caspian Sea that maybe related to their adaptation to different habitats (Mohadasi et al., 2013, 2014).

**Distribution:** *Alburnus chalcoides* inhabits almost all Iranian coasts of the Caspian Sea and its rivers, including the Atrak, Gorganroud, Gharasu, Tajan, Babolroud, Haraz, Sardabroud, Aras, Tonekabon, Polroud and Sefidroud rivers, the Anzali lagoon, and the Gorgan bay (Kozhin, 1957; Svetovidov, 1945; Holčík and Oláh, 1992; Shamsi et al., 1997; Kiabi et al., 1999; Abdoli, 2000; Bagherian and Rahmani, 2007; 2009; Abdoli and Naderi, 2009; Patimar et al., 2010).

**Habitat and ecology:** The Caspian Shemaya lives in both brackish and freshwater, downstream, coastal lakes, estuaries, and adjoining areas of seas where salinity is lower than 14 ppt (Kottelat and Freyhof, 2007b). Commonly, this fish lives near to surface, but Knipovich (1921) reported this species from depths of 23.8-25.6 m in the Iranian shore of the Caspian Sea. This semi-anadromous species migrates to the rivers and moves to upstream for spawning. In southern part of the Caspian Sea, its spawning grounds have been reported from the Atrak River in southeast to the Aras River in southwest of the Caspian Sea, but it also found predominantly in rivers of the central parts of the southern Caspian Sea basin (Patimar et al., 2010).

Holčík and Oláh (1992) reported a feeding migration in July to September in the Anzali lagoon. *Alburnus chalcoides* feeds on phytoplankton e.g. Crysophyta, Chlorophyta and Cyanophyta and zooplankton e.g. Copepoda and Cladocera (Abdurakhmanov, 1962). Furthermore, it feeds on macrophytes (Coad, 2015) and some larger organisms such as Chironomidae

larvae, Gomphonema, crustaceans, terrestrial insects, and small fish (Rajabi Nezhad and Azari Takami, 2001).

**Age and growth:** It is reported that the Caspian Shemaya's longevity is over 5 years in the southern Caspian Sea basin (Holčík and Oláh, 1992; Patimar et al., 2010). The growth of *A. chalcoides* in the southern Caspian Sea basin is related to the age and geographical location where it lives (Patimar et al., 2010). It spawns in spring in the Anzali lagoon at 10-29.0 cm with a mean weight of 64.7 g (Holčík and Oláh, 1992; Karimpour et al., 1993) in March and peaks in May and at the beginning of June (Karimpour et al., 1993). All the spawning fish were 2-5 year-old but most of them (63%) were 3-year-old. The males will reach maturity one year earlier than females in 2-4 year-old i.e. the females mature in 3-5 year-old (Holčík and Oláh, 1992; Karimpour et al., 1993).

The fish growth rate at first three years of life is more than that of the second three years (Holčík and Oláh, 1992). In Haraz and Shiroud rivers, the age groups of 2<sup>+</sup> years for males and 3<sup>+</sup> years for females are the most abundant age groups (Rahmani, 2008). Rahmani et al. (2009) found that the growth rate is better in the Shiroud River compared to the other populations in the southern Caspian Sea basin, because this river has proper biological parameters. Patimar et al. (2010) compared the growth rate of *A. chalcoides* populations from the Shiroud and Gorganroud rivers and found a five-year life cycle, with a negative allometric growth pattern for males and a positive one for females in Siahroud River. Also, they found a positive allometric growth pattern for both sexes in the Gorganroud River (Patimar et al., 2010). Mousavi-Sabet et al. (2014) presented the length-weight relationship of the genus *Alburnus* in Iran and reported a negative allometric growth for *A. chalcoides* from the southern Caspian Sea basin.

**Reproduction:** *Alburnus chalcoides* spawns intermittently while has three batches of eggs. It lays two of them only within a period of 18-19 days (Svetovidov, 1945; Coad, 2015). The Caspian Shemaya is a semi-anadromous species. Female

Table 1. Absolute fecundity of *Alburnus chalcooides* found by different authors in the southern of the Caspian Sea, Iran.

Study area	Mean (min.-max.)	Reference
Anzali Lagoon	6630 (2951-11855)	Karimpour et al. (1993)
Sefidroud River	9960 (2929-18860)	Azari Takami and Rajabi Nezhad (2003)
Shiroud River	3906 (1370-10387)	Rahmani (2006 and 2009)
Haraz River	3568 (1647-6932)	Rahmani (2006)
Siahroud River	8426 (1674-38340)	Patimar et al. (2010)
Gorganroud River	4215 (623-17263)	Patimar et al. (2010)

matures and spawns one year later than male, while they are larger than males (Bagherian and Rahmani, 2007). In addition, females form the majority (57%) of the migrated fish (Coad, 2015). Sometimes larger fish mature and spawn earlier (Karimpour et al., 1993; Rahmani et al., 2009). During spawning period, the Caspian Shemaya enters the rivers (for long distances upstream) in autumn and move upstream. Then, it spawns in heavy current rivers on gravel bottom (Svetovidov, 1945; Sattari et al., 2004). Males are marked with small tubercles scattered on top of the head and fine tubercles on the anterior flank scales during spawning periods (Bagherian and Rahmani, 2007). Sexual proportion is unbalanced in females' favor (1:1.54) in Siahroud and Gorganroud rivers (Patimar et al., 2012) and Shiroud River (1:2.36) (Rahmani et al., 2009). Males are somewhat territorial. They gather at spawning grounds together and stay for females, which arrive later (Freyhof and Kottelat, 2007a, b). *Alburnus chalcooides* spawns from April to July in Siahroud River, and from March to June in the Gorganroud River, and its peak is in May in both rivers (Patimar et al., 2010). Nikoo et al. (2010) measured serum sex steroids of *A. chalcooides* during spawning in the Valiabad River and concluded that this fish may be a multiple spawner. Spawning occurs in 0.2-0.7 m depth, water flow rate about 1 m/s, and 18-26°C, often with a lot of splashing (Kottelat and Freyhof, 2007b). Since adults were caught in July and February and young fish were found in the southern Caspian Sea throughout the year, it concluded that Iranian populations spawn throughout the year (Svetovidov, 1945). Eggs stick and adhere on pebbles or stones. Embryo developed for 2-3 days,

larvae migrates to shallows and backwaters after the remaining among the gravels about 8-11 days (Kottelat and Freyhof, 2007b). The juveniles migrate to downstream in autumn of the same year or spring of the next year. Parents go back to the sea, lakes, and/or estuaries soon after the spawning.

Rahmani et al. (2009) reported a peak gonadosomatic index for males in May and for females in early June in the Shiroud River. *Alburnus chalcooides* has 1.5 mm eggs in diameter as early as 13 March (with a standard length of 213.2 mm) and 1.7 mm on 4 June (with a total length of 154.6 mm) (Karimpour et al., 1993). Mean absolute fecundity of the Caspian Shemaya from the southern Caspian Sea basin has been reported 3568 eggs in Haraz River (Rahmani, 2006), 6630 eggs in the Anzali lagoon with a mean relative fecundity is 140 eggs/g of body weight (Karimpour et al., 1993), 3900 eggs with diameter reaching 1.17 mm in the Shiroud River (Rahmani et al., 2009), 8426 eggs (average 212 eggs/g) with mean diameters of 1.40 mm in the Siahroud River (Patimar et al., 2010) and 4215 eggs (average 112 eggs/g) with mean diameters of 1.40 mm in Gorganroud River (Patimar et al., 2010) (Table 1).

**Conservation status:** This species has been reported as near threatened species in the southern Caspian Sea basin due to damming, over and illegal fishing during spawning season and destruction of the spawning grounds (Kiabi et al., 1999; Naderi and Abdoli, 2004). Mostafavi (2007) reported that *A. chalcooides* is a near threatened species in the Talar River in Mazandaran Province (north of Iran). In addition, this species is listed as a vulnerable to endangered species in Europe (Lelek, 1987) and an

endangered species in Turkey (Fricke et al., 2007). However, *A. chalcoides* is ranked in Red List Category and Criteria of IUCN (Gesner et al., 2010) as least concern. Unfortunately, there is no information and ranking available about *A. chalcoides* in the Caspian Sea basin in IUCN.

**Threats:** The main threat are water pollution especially in spawning grounds, damming the rivers which are the migration routes of this fish, over and illegal fishing during spawning and deterioration of the spawning grounds (Kiabi et al., 1999; Naderi and Abdoli, 2004; Abdoli and Naderi, 2009). In addition, there are some reports about excessive levels of cadmium, lead and other heavy metals in this fish (Shirvani and Jamili, 2009).

Based on our study, further researches including habitat requirements, population genetics, migrations (number, duration, and reason), natural behavior during migration, ionic balance and osmoregulation, spawning and artificial breeding can help to better understanding of this species.

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## چکیده فارسی

### مروری بر شاه‌کولی خزری، (*Alburnus chalcoides* (Güldenstädt, 1772))

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<sup>۳</sup>گروه شیلات، دانشکده علوم دریایی، دانشگاه تربیت مدرس، نور، ایران.  
<sup>۴</sup>گروه شیلات، دانشکده منابع طبیعی، پردیس کشاورزی و منابع طبیعی دانشگاه تهران، کرج، صندوق پستی ۴۳۱۴، ایران.

#### چکیده:

شاه‌کولی خزری، *Alburnus chalcoides* در سیستم‌های رودخانه‌ای حوضه‌های آبریز دریا‌های آرال، سیاه و خزر یافت می‌شود و یک گونه با ارزش اقتصادی از کپورماهیان در حوضه جنوبی دریای خزر می‌باشد. این گونه به‌عنوان یک گونه در معرض تهدید به‌واسطه سدسازی، صید بی‌رویه و غیرقانونی، تخریب جایگاه‌های تخم‌ریزی و آلودگی آب گزارش شده است. شاه‌کولی خزری یک گونه مهم از نظر بوم‌شناختی و اقتصادی می‌باشد، اما اطلاعات در مورد زیست‌شناسی و بوم‌شناسی آن بسیار پراکنده است. از این‌رو در این مطالعه مروری، آرایه‌شناسی، ویژگی‌های عمومی و ریخت‌شناسی، پراکنش، زیستگاه و بوم‌شناسی، سن و رشد، تولیدمثل، وضعیت حفاظتی و تهدیدات آن به‌طور خلاصه بیان شده و یک فهرست منابع در مورد این ماهی ارائه می‌گردد.

کلمات کلیدی: *Alburnus chalcoides* کپورماهیان، شاه‌کولی، حفاظت.