Int. J. Aquat. Biol. (2016) 4(4): 256-268
ISSN: 2322-5270; P-ISSN: 2383-0956
Journal homepage: www.ij-aquaticbiology.com

Review Article

Review of the Lampreys of Iran (Family Petromyzontidae)

Brian W. Coad

Canadian Museum of Nature, Ottawa, Ontario, K1P 6P4 Canada.

Abstract: The systematics, morphology, distribution, biology, economic importance and conservation of the lamprey of Iran are described, the species is illustrated, and a bibliography on this fish in Iran is provided. There is one native and endemic species in the Caspian Sea basin, *Caspiomyzon wagneri*. The genus *Caspiomyzon* is characterised by having 2 dorsal fins, an oral disc narrower than the body, teeth are generally low and blunt, the supraoral lamina is small, oval and sometimes has 2 tubercles and rarely 2 teeth, the infraoral lamina has 4-6, usually 5, teeth which may be bicuspid at their tips, there are about 8 small teeth of equal size in the transverse lingual lamina, the exolaterals, anterials and posterials are strong and close together, anterior and endolateral circumorals 9-11, usually 11, and 3 long, papillose velar tentacles are present. Characters of the species are the same as the genus. Trunk myomeres number of *C. wagneri* are 53-68 in ammocoetes.

Article history:
Received 11 May 2016
Accepted 14 July 2016
Available online 25 August 2016

Keywords: Caspian Sea, Biology, *Caspiomyzon*, Morphology.

Introduction

The freshwater ichthyofauna of Iran comprises a diverse set of families and species. These form important elements of the aquatic ecosystem and a number of species are of commercial or other significance. The literature on these fishes is widely scattered, both in time and place. Summaries of the morphology and biology of these species were given in a website (www.briancoad.com) which is updated here for one family, while the relevant section of that website is now closed down.

Family Petromyzontidae

Lampreys in the family Petromyzontidae are found in cooler waters of the northern hemisphere, with a few related species in other families in the southern hemisphere. Their origins lie at least 300 million years in the past. There are about 44 lamprey species in 9 genera (Eschmeyer and Fong 2011; Renaud, 2011; Maitland et al., 2015) with only one recorded from Iran. Coad (1987, 1998) and Coad and Abdoli (1996) place this species in context with the Iranian ichthyofauna.

Lampreys are jawless fishes, lacking bone in the skeleton and having 7 pairs of pore-like gill openings. The eel-like body has no pectoral or pelvic fins. There are one or two dorsal fins and a caudal fin. An anal fin-like fold develops in spawning females. The mouth is a suctorial disc armed with rows of horny teeth. There are also teeth on the tongue. The median nostril, or nasohypophyseal opening, is not connected to the mouth. There is a light-sensitive pineal organ or "third eye" behind the nostril. The skin is covered in mucus which is poisonous to fishes and humans. Lampreys are edible if the mucus is cleaned off.

Their tooth arrangement is used in classification and identification along with the number of myomeres (muscle blocks along the body). Both tooth counts and the number of cusps are used, in particular those on the supraoral lamina (bar above the "mouth", the oesophageal opening), the infraoral

* Corresponding author: Brian W. Coad
E-mail address: bcoad@mus-nature.ca

lamina (bar below the "mouth") and the row of teeth on both sides of the "mouth". There are various series of smaller teeth and of course teeth on the tongue. Larval lampreys lack teeth and are particularly difficult to identify and their determination often requires specialist knowledge. Characters for the larvae include counts of myomeres and pigmentation patterns.

Lampreys have an unusual life cycle. Adults die after spawning and the eggs develop into a larva, known as an ammocoete, which lacks teeth, has an oral hood, eyes covered by skin, a light-sensitive area near the tail, and is a filter-feeder while buried in mud and silt. Fleshy tentacles in the oral hood are used to extract minute organisms from the water, such as algae (desmids and diatoms) and protozoans. After several years (up to 19 but usually 7 or less), the ammocoete transforms into an adult with enlarged eyes, teeth, a different colour and pronounced dorsal fins. The body shrinks during this metamorphosis and adults are only larger than ammocoetes if they feed. The adult may be a parasite on other fishes and marine mammals, or non-feeding. Individuals of a species may or may not be parasitic and different species may be parasitic or non-parasitic. The non-parasitic species are believed to have evolved from a parasitic species so there tends to be closely related parasitic/non-parasitic species pairs.

Parasitic adults feed mostly on other fishes, attaching to their bodies by suction and using their toothed tongue to rasp through the skin and scales to take blood and tissue fragments. Prey is detected by sight but some lampreys attach to hosts during the night. Perhaps this reduces their own predation risks and enables them to approach their quiescent hosts more easily. Lampreys tend to select larger fish as these survive longer and ensure a good food supply. The flow of blood is aided by an anti-coagulant in lamprey saliva called lamphedrin which also serves to break down muscle tissue. The attack may weaken or even kill the host. Weakened fishes are more prone to diseases and the wound provides an easy path of entry for them. The fish (and marine mammal) species parasitised are varied and reflect availability in the habitat.

Marine lampreys enter fresh water to spawn and freshwater species may move into or up streams. The scientific name of the family means "stone sucker" and the adult mouth is used to hold or suck onto stones as well as on prey. This suction enables the lamprey to maintain position in fast-flowing streams when spawning and even to climb over rapids and small waterfalls. Usually spawning occurs in shallow water with a moderate current, a bottom of gravel and nearby sand and silt for the ammocoetes to live in. Either or both sexes build a nest by moving gravel around with their sucking mouths and by thrashing their bodies. A shallow depression is formed, about 0.5-1.0 metre long. Spawning often occurs in groups and several males may attach to a female with the sucking disc. The process takes several days as only a few white to yellow eggs are laid at a time. The eggs are adhesive.

Adult lampreys are usually caught when attached to a host or when spawning. Electro-shocking will force ammocoetes out of their u-shaped burrows to the surface and immobilize adults. They sometimes attach to boats and occasionally to human swimmers when their skin is cool but are easily removed, perhaps because nobody has left a lamprey on their skin long enough to see if the tongue starts rasping flesh!

Genus *Caspiomyzon* Berg, 1906

This genus is characterised by having 2 dorsal fins, an oral disc narrower than the body, teeth are generally low and blunt, the supraoral lamina is small, oval and sometimes has 2 tubercles and rarely 2 teeth, the infraoral lamina has 4-6, usually 5, teeth which may be bicuspid at their tips, there are about 8 small teeth of equal size in the transverse lingual lamina, the exolaterals, anterials and posterials are strong and close together, anterior and endolateral circumorals 9-11, usually 11, and 3 long, papillose velar tentacles are present.

There is a single species in the genus found only in the Caspian Sea basin. *Agnathomyzon*

Figure 1. Lateral view of adult *Caspiomyzon wagneri*, Shirud River, courtesy H. Nazari.

Gratzianow, 1906 and its subgenus *Haploglossa* Gratzianow, 1906 are synonyms of *Caspiomyzon* (Eschmeyer et al. 1996).

Caspiomyzon wagneri (Kessler, 1870)
(Figs. 1-6)

Common names: mar mahi (= snake fish), marmahi-ye dehangerd (= round mouth snake fish), mahi dehangerd, mahi dehangerd daryacheh-ye khazar or dahangerd-e-Daryaye Khazar (= Caspian Sea round mouth fish). [ilanbaligi or xazar ilanbaligi, djilan-balux or morma in Azerbaijan; kaspiiskaya minoga or Caspian lamprey in Russian; Volga lamprey].

Systematics: The type locality of *P. Wagneri* is from the mouth of the Tvertsa to Astrakhan; Oka and Kama rivers, and the 3 syntypes (29.0-33.0 cm) are in the Zoological Institute, St. Petersburg (ZISP 31) (Holčík, 1986). The Zoological Museum of Moscow University (ZMMU) has one syntype from the Kura River near Evlakh (P-1393) and one from the Moskva River (P-555) with P-569 from the Volga River near Kazan being lost (Pavlinov and Borissenko, 2001). The Naturhistorisches Museum Wien in 1997 had one specimen listed as "? syntype, ?paratype" (sic) under NMW 61053. *Agnathomyzon* (*Haploglossa*) *caspicus* Gratzianow, 1907 is a synonym.

Key characters: This is the only lamprey species in Iran, easily recognised by the absence of pectoral and pelvic fins, a round, suctorial mouth containing blunt teeth, and 7 branchial openings.

Morphology: Characters of the species are the same as the genus. Trunk myomeres number 53-68 in ammocoetes, and 68(2) or 69(1) in adults from Iran. Ginzburg (1936) describes ammocoetes from Iran.

Figure 2. Dorsal view of Adult *Caspiomyzon wagneri*, courtesy of Afshin Afzali.

Renaud et al. (2009) give details of the feeding apparatus and Renaud (2011) of morphology. Nazari et al. (2009) found significant differences for morphometric, but not meristic, characters, between fish from the Shirud and Talar River, although a principal components analysis showed relatively high overlap. Vatandoust et al. (2015) examined fish from the Babol and Khey rivers and found morphological differences in such characters as predorsal length, interdorsal length, interorbital distance, tail length and first dorsal fin length, with high and moderate overlap between the two localities in males and females, respectively.

Sexual dimorphism: Females reach larger sizes than males and have a smaller urogenital papilla. During the spawning migration, the lamprey undergoes certain morphological changes some of which have been linked to sex of the fish. The teeth become blunt, fin size increases, the dorsal fins become almost united at the base in males, and there is a change in colour. The urogenital papilla length in males increases from a mean of 1.1 mm to 4.9 mm and in females from a mean of 0.6 to 1.7 mm.

Figure 3. Adult *Caspiomyzon wagneri*, Shirud River, courtesy H. Nazari.

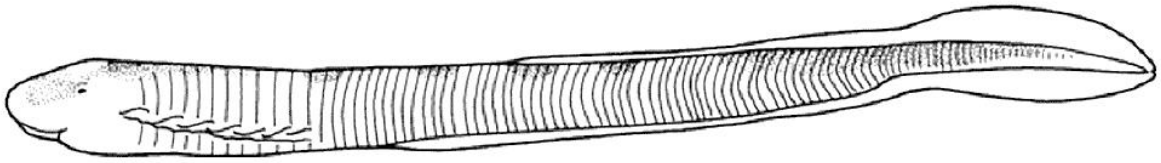

Figure 4. Line drawing of an ammocoete of *Caspiomyzon wagneri* by S. Laurie-Bourque.

Colour: Adults are dark grey with a silvery-white belly. Spawning adults become black on the back and flanks with a grey belly covered with dark oval spots, or are an overall golden colour (Hassan Nazari, pers. comm. 28 July 2011, see photo above). Ammocoetes are a pale grey to yellowish with a white belly.

Size: Attains 57.5 cm total length and 205.5 g as the adult and 13.0 cm total length as the ammocoete. After metamorphosis of the ammocoete there is shrinkage in length, the difference between prespawning and spawning adults being on average 22.3% in Iranian samples (Renaud, 1982). There is also a small variety which measures 19-31 cm and can attain sexual maturity at 19.1 cm (forma *praecox*).

Distribution: Found only in the Caspian Sea and rivers draining to it, in particular the Volga where it had its largest distribution but is now known only as far as the Volgograd Reservoir; also in the Ural, Terek, and Kura rivers. It is recorded in Iran from the upper reaches of the Aras River, and from the Astara to the Gorgan River along the whole Caspian coast.

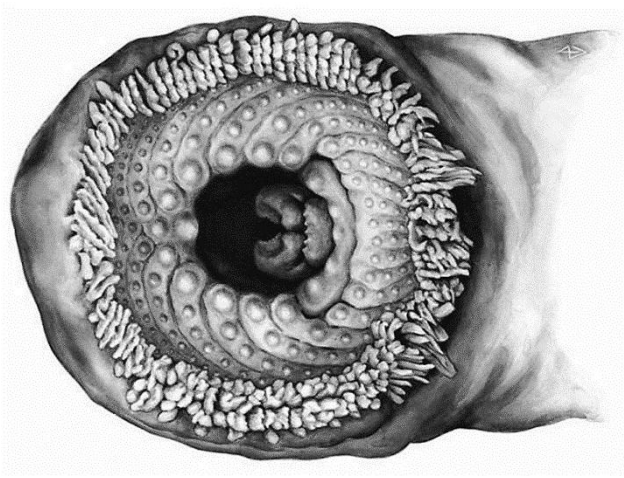

Figure 5. Line drawing of disc of *Caspiomyzon wagneri* by P. I. Voevodine (41.8 cm total length, Russia, Volga River, CMNFI 1980-0926).

Specific localities include the Aras River, Anzali Mordab and the Gelroudkhan, Nahang Roga, Pir Bazar Roga, Pasikhan River and Siah Darvishan River in the Anzali region, to Kisom on the Safid River (but see under Conservation), and in the Babol, Chalus, Cheshmkelya, Golshan, Gorgan, Haraz, Hevigh, Kargan, Kheyrod, Pol-e Rud, Sardab, Shafa, Shirud, Siardarvishan, Tajan, Talar and Tonekabon

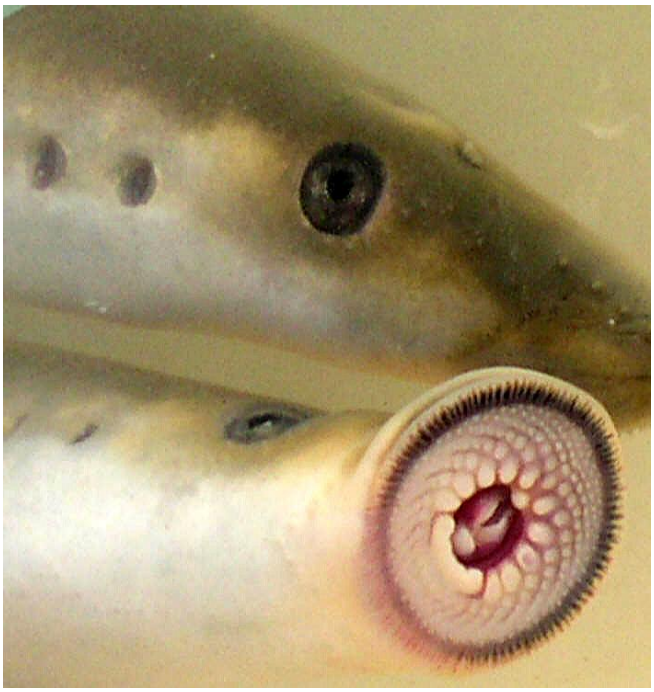

Figure 6. Live adult *Caspiomyzon wagneri* disc, courtesy H. Nazari.

rivers, and in most large streams (Derzhavin, 1934; Holčík and Oláh, 1992; Hosseinpour, 1995; Ramin, 1997; Karimpour, 1998; Abbasi et al., 1999, 2007; Kiabi et al., 1999; Abdoli, 2000; Nazari, 2002; Abbasi, 2006; Banagar et al., 2008; Abdoli and Naderi, 2009; Piri et al., 2009; Esmaeili et al., 2014). Migrations into the Babol, Gorgan and Sardab rivers are reported by Ghasempouri (1993), the Chalus and Sardab rivers by the Annual Report, 1994-1995, Iranian Fisheries Research and Training Organization, Tehran (1996), and the Shirud (Nazari and Abdoli, 2010), for example.

Zoogeography: Known only from the Caspian Sea, its relationships with other lamprey genera have been reviewed by Potter et al. (2015).

Habitat: The habitat of this species in the southern Caspian Sea proper is unknown although some specimens have been caught in the Caspian at 600-700 m (Jolodar and Abdoli, 2004). Larvae burrow 1-2 cm into the river bottom and favour areas where current is moderate at river bends. They can also be found in the centre of rivers or in backwaters. Fine-grained sand with some ooze and detritus is preferred at all stages of larval growth but larger larvae can also be found in a silt-sand bottom with much plant debris and macrophytes. The ammocoetes select and change habitat according to sediment size as they grow. They prefer depths greater than 3 m as protection against drying out, are mostly shallower than 11 m but as deep as 22 m (Ginzburg, 1970), yet in different rivers or at different times will be concentrated in water of markedly different depths, e.g., 30-85 cm versus 6-8 m. Metamorphosing lampreys are found in areas of faster current in deeper water and without macrophytes.

Spawning migrations up the Volga River used to exceed 1500 km but construction of dams now prevents this. The lamprey migrates in schools with the smaller fish arriving in estuaries first. Larger lampreys migrate more quickly and travel further. The speed varies from 1.9 to 15.9 km/day. The migration is triggered by decreasing water temperature and increasing water level. The strongest migration is reported at 6-11°C. Movement upriver only occurs at night, near the surface when dark and on the bottom when the moon is out. During the day, the lampreys hide among stones. Body fat in the Volga delta was 34% but by the time the fish reached the spawning grounds upriver it had declined to 1-2%. In the Kura River of Azerbaijan, the lamprey migrates at the same time as the Caspian salmon (*Salmo caspius*) and often attaches to the opercular region of this species. The peak of this run is in December and January. The migration in the Volga takes place from the middle of September to the end of December. Migrating lampreys prefer a current velocity of 0.4-0.6 m/sec and stay close to banks and the bottom. Prespawning adults overwinter among stones or in the substrate of rivers. During winter-spring several individuals may be found coiled in a ball under stones (Askerov et al., 2001). They hardly respond to external stimuli such as noise or being handled. Transformed lampreys migrate to the Caspian Sea. Before breeding, males change colour, increase slightly in size, develop their fins, and become much more active (Askerov et al., 2001).

Nazari and Abdoli (2010) note a short fall migration in late September to October with the main

migration being in spring (see below). Movement was mostly at night and involved swimming and resting attached to the concrete of a bridge used as the observation post. Farrokhnejad et al. (2014) examined migrating lampreys in the Shirud from 20 March to 26 April 2012. During this period 833 lampreys started to migrate in the dark and 332 in the light. The dark migration started at 10.5°C and the sex ratio was 0.87:1 in favour of females. The most intensive migration (77%) was from 1800 hours (twilight) to 0200 hours. Daylight migration occurred when temperature was more than 15°C and higher temperatures near the end of the migration altered the normal nocturnal activity and extended it into daylight hours.

Age and growth: The growth rates of metamorphosing lampreys and adults are almost unknown. Length and weight decrease but coefficient of condition increases in spawning as opposed to pre-spawning adults. The shrinkage in mean total length is 18-26%. Females are heavier than males up to about 43 cm but past this point, males weigh more. There are 3 age groups of larvae in the Volga (Ginzburg, 1970), with average lengths of 3.1 cm, 6.2 cm and 10.1 cm and 2-4 age groups in the Kura. In their fourth year of life, they metamorphose to adults after a downstream migration into the Caspian Sea. Adult life span is at least 1 year and 5 months. Maximum age is 6 years. Maturity is attained in May and the beginning of June in the Volga, and from May to the end of July in the Kura River. Mature lampreys are mostly 35-41 cm in the Volga and 41-46 cm in the Kura River. The female lamprey dies after spawning but the male may live longer until sperm production ceases.

Nazari et al. (2010) investigated growth parameters in fish from the Shirud and Talar River. Most fish were in the 367-369 mm length group, length-weight relationship was positive, high and significant, growth was negatively allometric, the coefficient of condition was higher in females, sex ratio was nearly equal, and growth parameters were similar in the two rivers. Rasta et al. (2015) found Shirud fish had a total length range of 330.4-465.4 mm, mean 393.24 mm, weight range 82.34-179.94 g, mean 118.62 g, and female to male ratio was 1.2:1. Farrokhnejad et al. (2014a) and Nazari et al. (2015) found the migrating Shirud lampreys lost body length (6.8 and 18.8%) and weight (13.6 and 26.16%) in males and females, respectively.

Food: Abakumov (1959) maintains that this lamprey attacks Caspian salmon (*Salmo caspius*) based on nineteenth century observations by Kessler (1870) and Kavraiskii (1896-1897). Lelek (1987) also considers it to be parasitic. The lampreys may only have been using Caspian salmon for transport. Certainly the teeth in this lamprey are blunt, unlike those in lamprey species known to parasitise fishes. In contrast, Holčík (1986) states that it is non-parasitic and Ghasempouri (1993) agrees. Renaud (1982) supposes that adults feed on amphipods since juvenile acanthocephalans (*Corynosoma* sp.) are found in prespawners. This worm has amphipods as the intermediate host. However, Holčík (1986) thinks that the acanthocephalans are swallowed while the adult lampreys are feeding on the internal organs of dead fish they scavenge. Certainly larvae of *Corynosoma strumosum* (perhaps correctly *C. caspicum*: B. Kiabi, in litt. 1994) are found only in the body cavity of fishes. Renaud et al. (2009) list it as a carrion feeder but note the well-developed buccal glands which may compensate for the blunt teeth and it may well feed on fishes. The feeding habits of the adult of this species remain to be confirmed by direct observation. Gut contents include aquatic vegetation in Iran and in the Volga delta. Migratory, transforming and spawning lampreys do not feed. The gut diameter decreases from 2.7 mm in prespawners to 1.4 mm in spawners in Iran (Renaud, 1982). Ammocoetes feed on detritus and diatoms. Joorabian Shooshtari et al. (2011) compared mercury concentrations in Iranian Caspian lampreys with ammocoetes of other jawless fishes and found a concentration 10 times less. This difference was attributed to the non-parasitic diet of a detritivore. Benam et al. (2016) compared the gastrointestinal tract of mature and maturing male and female lampreys in the Shirud and confirmed

non-feeding on the migration by absence of significant gut contents and by liver degeneration (greater in females which produce eggs).

Reproduction: Ginzburg (1969, 1970) examined the reproduction of this species below the Volgograd Dam on the Volga River and similar conditions may obtain in Iran. The dam has probably increased fecundity by reducing the length of the spawning migration so that the fish have more energy reserves for egg production. A spawning migration exists from December to May with a peak concentration in the second 10 days of February although the catches declined in April at least in part because of the opening of the spillway of the dam. Before the dam was built the migration from the Caspian Sea passed through the delta from mid-October to mid-December, with a peak in December. The fish migrated when water temperatures reached 10-11°C and moved through channels where the current was strongest. Spawning begins at 15-16°C, usually in early June but sometimes at the end of March through to the beginning of July, and temperatures during spawning are usually 15-23°C. Each female produces up to 60,000 turquoise, or blue-green, eggs and spawns once in her lifetime. Eggs are ovate and diameter reaches 1.5 mm. The eggs are laid on coarse- to fine-grained, turquoise sand at a water depth of 3.5-19.0 m, sometimes shallower. The egg colour is cryptic against the sand substrate. Many eggs are carried downstream by the current. A redd is excavated in sand or gravel by the male or by the female (authors differ on this point) and the lamprey attaches to stones by their suctorial disc. The male attaches to the female's head with his disc and wraps his body around hers. The tails of both fish quiver and eggs and sperm are released at the same time. Females release all their eggs and die but males may spawn again with other females. Ammocoetes hatch after 8-10 days at 17-23°C at lengths of 0.33-0.42 cm. Metamorphosis of ammocoetes occurs at 8.0-11.0 cm in October in Iran.

Nazari and Abdoli (2010) examined migration and reproduction in lampreys from the Shirud in the southern Caspian Sea from 16 March to 2 May at

Figure 7. Shirud migration, courtesy H. Nazari.

11.0-21.25°C. The most intensive migration was at night (peaking at 2100 and declining to 0300 hours) at 16°C (34.4% of the run) (Fig. 7). About 75% of the run had passed by the time water temperature reached 16-17°C. Migration stopped when temperature reached 21°C. Numbers observed each night varied from 1 to 60, average 17, with peak migrations at 26 March to 10 April and 15 April to 25 April. Sex ratio was 1.07:1 in favour of males but not significantly different. Absolute fecundity was 31,758-51,198 eggs (mean 41,924 eggs) relative fecundity was 80.3-148.1 eggs/mm length (mean 107.2 eggs/mm length) and 260.8-677.4 eggs/g (mean 397.6 eggs/g). Egg diameter was 0.78-1.15 mm (mean 0.92 mm). The gonadosomatic index of females was 5.83-31.44 (mean 11.22), the peak being in mid-April. Downstream migrating lampreys were spent but no dead ones were noted so some may survive to spawn a second time. Two ammocoetes, 20 and 22 mm long, were found near the mouth of the Shirud River on 18 April 2006 (river bank in a substrate of the sand-mud, water depth <30 cm). They probably belong to the autumn migratory group (Hassan Nazari, pers. comm. 28 July 2011).

Ahmady et al. (2010a, 2010b), Ahmadi et al. (2011, 2011), Mojazi Amiri et al. (2012) and Ahmadi (2016) also examined fish from the Shirud and found both fall and spring migrants ready for spawning with no differences in numbers of males and females, weight, length, absolute fecundity (17,778 eggs in

spring, 20,247 in fall - see above study), egg diameter (800 μm in spring, 710 μm in fall) and sex ratio (close to 1:1). The gonadosomatic and hepatosomatic indices were higher in fall females. Fall migratory fish had a lower condition factor. Sexual steroids and gonad histology also confirmed spring and fall spawning.

Farrokhnejad et al. (2014) determined Shirud fish had 208-470 maturing degree days from the start of the upstream migration to maturation, and males matured earlier than females. Farrokhnejad et al. (2014a) found the migrating Shirud lampreys had a maximum gonadosomatic index of 9.51 and 35.12 for maturing and mature females respectively and 4.84 and 13.23 for males. The hepatosomatic index of males and females in the maturing stage was 0.85 and 1.02 and in the mature stage 1.31 and 0.975. This suggests a starvation period and rapid production of gametes.

Parasites and predators: See above under Food. Nazari et al. (2010) also record *Corynosoma* in their fish. Caspian lampreys are eaten by *Silurus glanis* (Coad, 2015), *Lota lota*, *Sander lucioperca*, and *Huso huso*.

Economic importance: This species was consumed and used for oil extraction in the former U.S.S.R. (Thomas, 1961; Ginzburg, 1969). Their fat content is so high that they were once dried and used as candles (Kottelat and Freyhof, 2007) and the high fat level makes them tasty (Askerov et al., 2001). The caloric value for the Caspian lamprey is 3.4 kcal/g wet weight. The catch in the Volga-Caspian region was 3,420,000 kg or 33.4 million fish in 1913 but fishing by state organizations ceased after the Volgograd Reservoir was constructed. The mean annual catch in Azerbaijan for 1930-1963 ranged from 10 to 269 tonnes. Local fisheries continue but are of little significance. It is not commercially important in Iran for religious reasons but catches of several hundred kilograms can be made in an hour in such rivers as the Gorgan, Babol and Sardab (Ghasempouri, 1993).

This lamprey is ingested medicinally for treatment of haemorrhoids and besmi (sic, ?) by Turkmen of the southeastern Caspian (Hassan Nazari, pers. comm. 29 July 2011).

Robins et al. (1991) list this species as important to North Americans. Importance is based on its use as food, in textbooks and because it is reputedly ichthyosarcotoxic. Intoxication results from eating the flesh, skin or surface mucus of raw or cooked Caspian lamprey, the location of the toxin being uncertain. A biogenic amine is believed to be responsible. Mucus may cause skin irritations. Poisoning can be avoided by soaking the lamprey in brine as cooking alone is insufficient. Symptoms develop in a few hours and include nausea, vomiting, dysenteric diarrhoea, urge to urinate or defecate without ability to do so, abdominal pain and weakness. Recovery takes several days and treatment is symptomatic (Coad, 1979). However, lampreys lack scales and are not eaten in Iran.

Conservation: The Caspian lamprey has been proposed for inclusion in the "Red Book of the U.S.S.R." which forms the basis for measures to protect species (Pavlov et al., 1985) and is listed as "vulnerable" in Europe by Lelek (1987) and Maitland (1991). It is vulnerable because it migrates into rivers which are polluted and dammed and because of its restricted and declining distribution. These conditions apply particularly in Iran, although there is some evidence for spawning based on captures in the 1990s (Holčík and Oláh, 1992). Joorabian Shooshtari et al. (2011) note that it is extirpated in the Safid River. Çiçek and Sungur Birekcikligil (2016) state that it is extinct in the Turkish Aras River basin.

Kiabi et al. (1999) consider this species to be near threatened in the south Caspian Sea basin according to IUCN criteria. Criteria include medium numbers, habitat destruction, widespread range (75% of water bodies), absent in other water bodies in Iran, and absent outside the Caspian Sea basin. Mostafavi (2007) lists it as near threatened in the Talar River, as do Banagar et al. (2008) for the Haraz River, both in Mazandaran. The IUCN (2015) lists it as Near Threatened.

Abdollahi and Imanpoor (2011), Imanpoor and

Abdollahi (2011) and Abdollahi et al. (2013) determined blood serum biochemical parameters and their relationship with gonadal parameters for Shirud fish, useful in management of reproduction and culture of this species. Relationships were attributed to the lack of feeding on migration and the use of reserved protein and fat in muscles. Joorabian Shooshtari et al. (2011) found Iranian lampreys had relative mercury concentration in their tissues as follows: muscle > ovaries > liver > skin > testes. The mean values of mercury in muscle and testes were 192.25±7.10 and 21.42±1.48 Hg ng/g dry weight, respectively. There were no significant differences between the sexes in the Hg level of most tissues except for gonads. They concluded that this species could be used as an indicator of aquatic pollution as it is a scavenger on the sea floor. Nasrolah Pourmoghadam et al. (2015) showed that manganese could seriously affect reproductive success as spermatozoid motility decreased with an increase in concentration of this heavy metal pollutant.

Sources: The main source of information on this species are the summaries by Holčík (1986) and Renaud (2011) which should be consulted for further details on morphology and biology. Further details on collections examined can be found in the museum catalogues.

Iranian material: CMNFI 1970-0511, 7 ammocoetes, 30-82 mm total length, Gilan, Shafa River estuary (37º35'N, 49º09'E); CMNFI 1970-0514, 33 ammocoetes, 24-92 mm total length, Gilan, Shafa River estuary (37º35'N, 49º09'E); CMNFI 1970-0515, 23 ammocoetes, 25-98 mm total length, Gilan, Shafa River estuary (37º35'N, 49º09'E); CMNFI 1970-0534, 30 ammocoetes, 47-91 mm total length, Gilan, Shafa River estuary (37º35'N, 49º09'E); CMNFI 1970-0535, 14 ammocoetes, 78-102 mm total length, Gilan, Shafa River estuary (37º35'N, 49º09'E); CMNFI 1970-0546, 2 adults, 352-355 mm total length, Gilan, Safid River (no other locality data); CMNFI 1970-0585, 3 adults, 406-455 mm total length, Gilan, Nahang Roga River (37º28'N, 49º28'E); CMNFI 1971-0327A, 1 adult (part of trunk), Gilan, Shafa River estuary (37º35'N, 49º09'E); CMNFI 1979-0787, 9 adults, 353-428 mm total length, Gilan, Nahang Roga River (37º28'N, 49º28'E); CMNFI 1980-0118, 8 adults, 270-317 mm total length, Gilan, Gelroudkhan River, tributary of the Anzali Mordab (no other locality data); CMNFI 1980-0119, 10 adults, 290-348 mm total length, Gilan, Gelroudkhan River, tributary of the Anzali Mordab (no other locality data); CMNFI 1980-0139, 44 ammocoetes, 36-95 mm total length, Gilan, Golshan River estuary (37º26'N, 49º40'E); CMNFI 2001-0011, 4, 356-365 mm total length, Mazandaran, Shirud (36º51'N, 50º49'E).

Acknowledgements

I am indebted to the Department of Biology, Shiraz University and the Canadian Museum of Nature, Ottawa for funding of research. Numerous colleagues and co-authors assisted in developing the website on Iranian fishes, providing specimens, data and photographs and are listed at www.briancoad.com

References

Abakumov V.A. (1960). The damage done by lampreys to fish stocks. Fisheries Research Board of Canada Translation Series, 274: 1-2.

Abbasi K. (2006). Identification and distribution of fish fauna in Hevigh River (Guilan Province). Iranian Journal of Biology, 18(4): 370-382. (In Farsi)

Abbasi K., Moradkhah S., Sarpanah A.N. (2007). Identification and distribution of fish fauna in Siahdarvishan River (Anzali Wetland basin). Pajouhesh va Sazandegi, 19(1)(74): 27-39. (In Farsi)

Abbasi K., Valipour A., Talebi Haghighi D., Sarpanah A., Nezami S. (1999). Atlas of Iranian Fishes. Gilan Inland Waters. Gilan Fisheries Research Centre, Rasht. 113 p. (In Farsi)

Abdoli A. (2000). The Inland Water Fishes of Iran. Iranian Museum of Nature and Wildlife, Tehran. 378 p. (In Farsi)

Abdoli A., Naderi M. (2009). Biodiversity of Fishes of the Southern Basin of the Caspian Sea. Abzian Scientific Publications, Tehran. 243 p. (In Farsi)

Abdoli A., Naderi M., Foroughifrad H., Kiabi B.H. (2014). Fish diversity and distribution in two protected rivers, Sardabrud and Chalus, southern Caspian Sea

basin, Iran. Iranian Journal of Ichthyology, 1(2): 91-95.

Abdollahi M., Farokhnejad M.R., Monajjemi M., Raoufi P., Imanpoor M.R. (2013). The relationship between gonadal and blood serum biochemical parameters in broodstocks of the Caspian lamprey, *Caspiomyson wagneri* Kessler 1870. Journal of Natural Environment, Iranian Journal of Natural Resources, 65(4): 409-420.

Abdollahi M., Imanpoor M.R. (2011). Blood serum biochemical parameters of *Caspiomyzon wagneri* (Kessler, 1870). Iranian Journal of Biology, 24(6): 915-924.

Ahmadi M. (2016). Study of sexual steroids and gonad histology between fall and spring migrants of Caspian lamprey (*Caspiomyzon wagneri*), to Shirood River (South of Caspian Sea). Journal of Khorramshahr Marine Science and Technology. (In Press)

Ahmadi M., Amiri B.M., Abdoli A., Fakharzade S.M.E., Hoseinfar S.H. (2011). Sex steroids, gonadal histology and biological indices of fall and spring Caspian lamprey (*Caspiomyzon wagneri*) spawning migrants in the Shirud River, southern Iran. Environmental Biology of Fishes, 92(2): 229-235.

Ahmadi M., Mojazi Amiri B., Abdoli A., Nematolahi M.A., Fakharzadeh S.M.E. (2011). A study on some biological indices of migratory Caspian lamprey, *Caspiomyson wagneri*, in the Shirood River in the fall and spring. Journal of Fisheries, 64(3): 269-279. (In Farsi)

Ahmady M., Mojazi Amiri B., Abdoli A., Fakharzadeh S. M.E., Hosseinifar S.H. (2010a). The study of some biological indices of migratory Caspian lamprey, Caspiomyzon wagneri, spawners in Shirood River in fall and spring. 9th International Congress on the Biology of Fish, Barcelona, 5-9 July 2010. (Abstract)

Ahmady M., Mojazi Amiri B., Abdoli A., Fakharzadeh S. M.E., Nematollahi M.A. (2010b). Some biological indexes of Caspian lamprey (*Caspiomyzon wagneri*), immigrant to Shirood River in fall and spring. 9th International Congress on the Biology of Fish, Barcelona, 5-9 July 2010. (Abstract)

Askerov F.S., Zaytsev Y.Y., Kasumov R.Y., Kuliyev Z. (2001). Bioraznoobrazie: Chudesnye Ryby Kaspiya/ Biodiversity: Amazing Caspian Fishes. Print Studio, Baku. 164 p. (In Russian and English)

Banagar G.R., Karami M., Hassanzadeh Kiabi B., Ghasempoori M. (2008). Fish diversity in Haraz River. Journal of Marine Sciences and Technology, 7(1-2): 39-49.

Banagar G.R., Kiabi B.H., Homayoonnezhad I., Piri I., Amirian P. (2008). Biodiversity of fish species in Haraz River (an ecological approach). World Applied Sciences Journal, 5(1): 5-11.

Benam S., Mojazi Amiri B., Rafiee G.R., Abedi M., Namdariyan A. (2016). Comparative study on the gastrointestinal tract of mature and maturing female and male of Caspian lamprey, *Caspiomyzon wagneri* (Kessler, 1870) in the southern Caspian Sea (Cephalaspidomorphi: Petromyzontidae). Iranian Journal of Ichthyology, 3(2): 140-149.

Çiçek E., Sungur Birekcikligil S. (2016). Ichthyofauna of the Turkish parts of Kura-Aras River Basin. FishTaxa, 1: 14-26.

Coad B.W. (1979). Poisonous and venomous freshwater fishes of Iran. Pahlavi Medical Journal, 9(4): 388-407.

Coad B.W. (1987). Zoogeography of the Freshwater Fishes of Iran, pp. 213-228. In: F. Krupp, W. Schneider, R. Kinzelbach (Eds.). Proceedings of the Symposium on the Fauna and Zoogeography of the Middle East, Mainz, 1985. Beihefte zum Tübinger Atlas des Vorderen Orients, Reihe A (Naturwissenschaften), 28, Dr. Ludwig Reichert Verlag, Wiesbaden, 338 p.

Coad B.W. (1998). Systematic biodiversity in the freshwater fishes of Iran. Italian Journal of Zoology, 65 (Supplement): 101-108. (Proceedings of the Ninth Congress of European Ichthyologists (CEI-9) "Fish Biodiversity" organised in Naples at the University Federico II and held in Trieste - Italy, 24-30 August 1997).

Coad B.W. (2015). Review of the freshwater catfishes of Iran (Order Siluriformes). Iranian Journal of Ichthyology, 1(4): (In Press)

Coad B.W., Abdoli A. (1996). Biodiversity of Iranian freshwater fishes. Abzeeyan, 7(1): 4-10. (In Farsi, English Abstract)

Derzhavin A.N. (1934). Presnovodnye ryby yuzhnogo poberezh'ya Kaspiya. Vstuplenie [Freshwater fishes of the southern shore of the Caspian Sea. Introduction]. Trudy Azerbaidzhanskogo Otdeleniya Zakavkazskogo Filiala Akademii Nauk SSSR, Sektor Zoologii, Baku 7: 91-126.

Eschmeyer W.N., Ferraris C.J., Hoang M.D., Long D.J. (1996). A Catalog of the Species of Fishes. Preliminary version (Sept. 1996). http://www.

calacademy.org /research/ichthyology/species.

Eschmeyer W.N., Fong J.D. (2011). Pisces. In: Z.-Q. Zhang (Ed.). Animal biodiversity: An outline of higher level classification and survey of taxonomic richness. Zootaxa, 3148: 26-38.

Esmaeili H.R., Coad B.W., Mehraban H.R., Masoudi M., Khaefi R., Abbasi K., Mostafavi H., Vatandoust S. (2014). An updated checklist of fishes of the Caspian Sea basin of Iran with a note on their zoogeography. Iranian Journal of Ichthyology, 1(3): 152-184.

Farrokhnejad M.R., Abdoli A., Hassanzadeh Kiabi B., Nazari H. (2014). A study on correlation between temperature and light during the Caspian lamprey (*Caspiomyzon wagneri*) spawning migration in the Shirud River, southern Caspian Sea, Iran. Institute of Fisheries Management Lamprey Conference, National Science Learning Centre, York, England, 6-8 May 2014.

Farrokhnejad M.R., Mojazi Naziri B., Abdoli A., Nazari H. (2014a). Some reproductive characteristics in maturing and mature spring migrants of Caspian lamprey *Caspiomyzon wagneri* in the Shirud River, southern Caspian Sea, Iran. Institute of Fisheries Management Lamprey Conference, National Science Learning Centre, York, England, 6-8 May 2014.

Farrokhnejad M.R., Mojazi Naziri B., Abdoli A., Nazari H. (2014b). Gonadal histology and plasma sex steroid concentrations in maturing and mature spring migrants of Caspian lamprey *Caspiomyzon wagneri* in the Shirud River, southern Caspian Sea, Iran. Ichthyological Research, 61(1): 42-48.

Ghasempouri S.M. (1993). The Caspian Sea lamprey. Abzeeyan 4(7): 18-21. (In Farsi)

Ghasempouri S.M. (1999). Systematics, distribution and ecology of Caspian sea lamprey (*Caspiomyzon wagneri*) in south region. Scientific and Research Quarterly of Jihad-e Sazandegi 44. (In Farsi)

Ginzburg Y. I. (1936). Opisaniye lichinok kaspiiskoi minogi *Caspiomyzon wagneri* (Kessler) iz rechki Cheshmkelya (Iran) [Description of larvae of the Caspian lamprey (*Caspiomyzon wagneri* (Kessler)) from the Cheshmkelya stream (Iran)]. Izvestiya Azerbaidzhanskogo Filiala Akademii Nauk SSSR, 1936(1): 47-50.

Ginzburg Y.I. (1969). The spawning population of the Caspian lamprey [*Caspiomyzon wagneri* (Kessler)] after regulation of the Volga River by the dam of the Volgograd Power Station. Problems of Ichthyology, 9(6): 821-828.

Ginzburg Y.I. (1970.) Reproduction of the lamprey [*Caspiomyzon wagneri* (Kessler)] below the Volgograd Dam and the development of its larvae. Journal of Ichthyology, 10(4): 485-493.

Holčík J. (1986). The Freshwater fishes of europe. Volume 1, Part I. Petromyzontiformes. AULA-Verlag, Wiesbaden. 313 p.

Holčík J., Oláh J. (1992). Fish, fisheries and water quality in Anzali Lagoon and its watershed. Report prepared for the project - Anzali Lagoon productivity and fish stock investigations. Food and Agriculture Organization, Rome, FI:UNDP/IRA/88/001 Field Document 2: 109 p.

Hosseinpour N. (1995). Survey on macro-zoobenthic resources in Siahdarvishan and Pasikhan Rivers, Potamon Zone (Quantitative). Iranian Fisheries Scientific Journal, 4(3): 8-21. (In Farsi)

Imanpoor M.R., Abdollahi M. (2011). Serum biochemical parameters of Caspian lamprey, *Caspiomyson wagneri* during final spawning migration. World Applied Sciences Journal, 12(5): 600-606.

IUCN. (2015). The IUCN Red List of Threatened Species. International Union for the Conservation of Nature, Gland, Switzerland (http://www.iucnredlist.org/).

Jolodar M.N., Abdoli A. (2004). Fish Species Atlas of South Caspian Sea Basin (Iranian Waters). Iranian Fisheries Research Organization, Teheran.110 p. (In Farsi and English)

Joorabian Shooshtari S., Shirood Najafi M., Khosravi N., Ghasempouri S.M., Esmaili Sari A. (2011). Concentration of mercury in selected tissues of the Caspian lamprey (*Caspiomyzon wagneri*) migrants in spawning season. Iranian Journal of Toxicology, 5(1-2): 460-467.

Karimpour M. (1998). The ichthyofauna of Anzali Lagoon. Iranian Journal of Fisheries Sciences, 7(2): 83-94. (In Farsi)

Kavraiskii F.F. (1896-1897). Lososevye (Salmonidae) Kavkaza i Zakavkaz'ya [Die Lachse der Kaukasusländer und ihrer angrenzenden Meere]. Tiflis. 1: 89 p., 2: 79 p. (In Russian and German)

Kessler K. (1870). Volzhskaya minoga (*Petromyzon wagneri* n. sp.) [Volga lamprey (*Petromyzon wagneri* n. sp.)]. Trudy Sankt-Peterburgskogo Obshchestva Estestvoispytatelei, 1: 207-214.

Kiabi B.H., Abdoli A., Naderi M. (1999). Status of the fish fauna in the South Caspian Basin of Iran. Zoology in the Middle East, 18: 57-65.

Kottelat M., Freyhof J. (2007). Handbook of European freshwater fishes. Kottelat, Cornol, Switzerland and Freyhof, Berlin, Germany. 646 p.

Lelek A. (1987). The Freshwater Fishes of Europe. Volume 9. Threatened Fishes of Europe. AULA-Verlag, Wiesbaden. 343 p.

Maitland P.S. (1991). Conservation of threatened freshwater fish in Europe. Convention on the Conservation of European Wildlife and Natural Habitats, Nature and Environment Series, Council of Europe Press, Strasbourg, 46: 1-76.

Maitland P.S., Renaud C.B., Quintella B.R., Close D.A., Docker M.F. (2015). Conservation of native lampreys. Fish and Fisheries Series, 37: 375-428.

Mojazi Amiri B., Ahmadi M., Abdoli A., Nematoolahi M.A. (2012). Comparative study on the physiological indices in spring and fall spawning migrant of Caspian lamprey (*Caspiomyzon wagneri*) in the Shirud River, southern Caspian Sea, Iran. The 7th AOSCE Congress, 3-7 March 2012, Kuala Lumpur, Malaysia. (Abstract)

Mostafavi H. (2007). Fish biodiversity in Talar River, Mazandaran Province. Journal of Environmental Studies, 32(40): 127-135. (In Farsi)

Nasrolah Pourmoghadam M., Eagderi S., Mojazi Amiri B., Poorbagher H., Nemati Mobin N. (2015). Effect of sub-lethal concentrations of manganese on sperm motility of the Caspian lamprey (*Caspiomyzon wagneri*). Ecoperisa, 3(2): 1023-1029.

Nazari H. (2007). Evaluation of some population parameters of Caspian lamprey (*Caspiomyzon wagneri*) during the migratory season in the Shirud and Talar rivers southern Caspian Sea. Dissertation, Islamic Azad University, Tehran. (In Farsi)

Nazari H., Abdoli A. (2008). Biology of the Caspian lamprey (*Caspiomyzon wagneri* Kessler, 1870). Abzeeyan, 2008: 57-63. (In Farsi)

Naazari H., Abdoli A. (2010). Some reproductive characteristics of endangered Caspian lamprey (*Caspiomyzon wagneri* Kessler, 1870) in the Shirud River southern Caspian Sea, Iran. Environmental Biology of Fishes, 88(1): 87-96.

Nazari H., Abdoli A., Vosoughi G.H., Keymaram F. (2009). Investigation of morphometric and meristic characters of the Caspian lamprey (*Caspiomyzon wagneri*) during migration season in Shirud and Talar rivers. Iranian Scientific Fisheries Journal, 17(4):147-162. (In Farsi)

Nazari H., Abdoli A., Vossoughi G.H., Kaymaram F. (2010). Evaluation of some growth parameters of Caspian lamprey (*Caspiomyzon wagneri*) during the migratory season in the Shirud and Talar rivers (Mazandaran Province). Journal of Marine Science and Technology, 9(2): 55-67. (In Farsi)

Nazari H., Nazari H., Farrokhnejad M.R., Abdoli A., Hassanzadeh Kiabi B. (2015). Reproductive physiology of upstream-migrant Caspian lampreys *Caspiomyzon wagneri* in the Shirud River, southern Caspian Sea, Iran. Conference for Young Scientists, 21-25 September 2015, Kyiv, Ukraine. (Abstract)

Nazar K. (2002). Identification of different fish species in Kargan-Rood River on Guilan Province, 1994. Iranian Scientific Fisheries Journal, 11(1): 73-84. (In Farsi)

Noori M. (1990). Caspian lamprey (*Caspiomyzon wagneri*). In: National Conference on Suitable Beneficiary Resources of the Caspian Sea Fisheries, pp: 100-115. (In Farsi)

Pavlinov I.Y., Borissenko A.V. (2001). Types of vertebrates in the zoological museum of Moscow University. Sbornik Trudov Zoologicheskogo Muzeya MGU (Archives of the Zoological Museum of Moscow State University) 41: 1-250. (In Russian and English).

Pavlov D.S., Reshetnikov Y.S., Shatunovskiy M.I., Shilin N.I. (1985). Rare and disappearing fishes in the USSR and the principles of their inclusion in the "Red Book". Journal of Ichthyology, 25(1): 88-99.

Piri I., Nezhad I.M., Amirian P. (2009). Investigation of fish species diversity in Haraz River. Proceedings of the 2009 International Conference on Chemical, Biological and Environmental Engineering (CBEE 2009), World Scientific Publishing, Singapore, pp: 323-328.

Potter I.C., Gill H.S., Reenaud C.B., Haoucher D. (2015). The taxonomy, phylogeny, and distribution of lampreys. Fish and Fisheries Series, 37: 35-73.

Ramin M. (1997). Indentification (sic) of Babolrud River's fish fauna. Iranian Fisheries Scientific Journal, 6(3): 59-72. (In Farsi)

Rasta M., Ghorbani R., Hajimoradloo A.M., Shiroud Mirzaei F. (2015). Length and weight relationship of Caspian lamprey (*Caspiomyzon wagneri* Kessler, 1870) in the Shiroud River, Mazandaran Province.

The Third Iranian Conference of Ichthyology, Shiraz University, Shiraz, 6-7 May 2015. (Abstract)

Renaud C.B. (1982). Food and feeding habits of the Caspian lamprey after metamorphosis. Fourth Congress of European Ichthyologists, 20.-24.9.1982, Hamburg. (Abstract number 252)

Renaud C.B. (2011). Lampreys of the World. An annotated and illustrated catalogue of the lamprey species known to date. Food and Agriculture Organization, Rome, Species Catalogue for Fishery Purposes 5: 109 p.

Renaud C.B., Gill H.S., Potter I.C. (2009). Relationships between the diets and characteristics of the dentition, buccal glands and velar tentacles of the adults of the parasitic species of lampreys. Journal of Zoology, 278(3): 231-242.

Robins C.R., Bailey R.M., Bond C.E., Brooker J.R., Lachner E.A., Lea R.N., Scott, W.B. (1991). World fishes important to North Americans exclusive of species from the continental waters of the United States and Canada. American Fisheries Society Special Publication, 21: 243 p.

Shirazinejad A.R., Saremi A. (2000). Biology of Caspian lamprey (*Caspiomyson wagneri*). Dissertation, Esfahan University of Technology. (In Farsi)

Thomas M.L.H. (1961). Lamprey fisheries, past and present, of North America and Europe. Fisheries Research Board of Canada, Biological Station and Technical Unit, London, Ontario, Circular 3: 4-7.

Vatandoust S., Mousavi-Sabet H., Razeghi-Mansour M., AnvariFar H., Heidari A. (2015). Morphometric variation of the endangered Caspian lamprey, *Caspiomyzon wagneri* (Pisces: Petromyzontidae), from migrating stocks of two rivers along the southern Caspian Sea. Zoological Studies, 54(1): 1-9.