BioInvasions Records (2020) Volume 9, Issue 3: 580–587

Rapid Communication

First record of non-native sailfin molly *Poecilia latipinna* (Lesueur, 1821) (Cyprinodontiformes: Poeciliidae) in Africa (Lake Manzala, Egypt)

Mohamed A. Abu El-Regal[1,2,*] and Lafi S. Al-Solami[1]

[1]*Marine Biology Department, Faculty of marine Science, King Abdulaziz University, Jeddah, Kingdom of Saudi Arabia*
[2]*Marine Science Department, Faculty of Science, Port Said University, Egypt*

**Corresponding author*
E-mail: *m_abuelregal@yahoo.com*

Citation: Abu El-Regal MA, Al-Solami LS (2020) First record of non-native sailfin molly *Poecilia latipinna* (Lesueur, 1821) (Cyprinodontiformes: Poeciliidae) in Africa (Lake Manzala, Egypt). *BioInvasions Records* 9(3): 580–587, https://doi.org/10.3391/bir.2020.9.3.14

Received: 10 March 2020
Accepted: 30 April 2020
Published: 24 June 2020

Thematic editor: Michal Janáč

Abstract

The sailfin molly, *Poecilia latipinna* (Lesueur, 1821), is a popular aquarium fish, native to the eastern coastline of North America. It has been introduced to many countries worldwide as biological control agent and through releases from aquarium hobbyists. The aim of this paper is to report the presence of sailfin molly in a brackish lake in northern Egypt (Lake Manzala). Twenty-five individuals (8 males and 17 females) of sailfin molly were incidentally collected while fishing for tilapia fish in the lake. All individuals were identified as *P. latipinna* based on morphological features and this is possibly the first documented record of sailfin molly in Africa.

Key words: alien fish, introduction, aquarium trade, northern lake, Mediterranean Sea

Introduction

Sailfin molly, *Poecilia latipinna* (Lesueur, 1821) are small, live bearing fish that are native to the north-eastern coasts of the United States and South America (Page and Burr 1991). In its native range, sailfin molly are common in ponds, marshes, roadside ditches, and thrive under poor quality water conditions (Coad 2017). The sailfin molly is a small species, seldom exceeding 12.5 cm in length (Robins and Ray 1986); however it can attain lengths of 15 cm (Rohde et al. 1994). The body of the species is oblong with a dorsally flattened head and superior mouth. The anal fin is modified into gonopodium, which is used as copulatory organ. Males are characterized by the presence of a large sail-like dorsal fin and distinctive coloration. The body is generally green, grey to jet black and some rows of brown spots on the sides may blend together creating the appearance of stripes on the dorsal side. The popularity of sailfin mollies in aquarium trade is attributed to their attractive coloration, short generation time and the ability to breed in captivity (Moyle 2002). Consequently, they have been widely introduced around the world for aquarium trade (Grossman and Cudmore 1999) and biological control of insects (Fuller et al 1999). It has been initially introduced to Hawaii (Seale 1905; Brock 1960; Yamamoto and Tagawa 2000) and Philippines (Juliano et al. 1989) for biological control of mosquitoes.

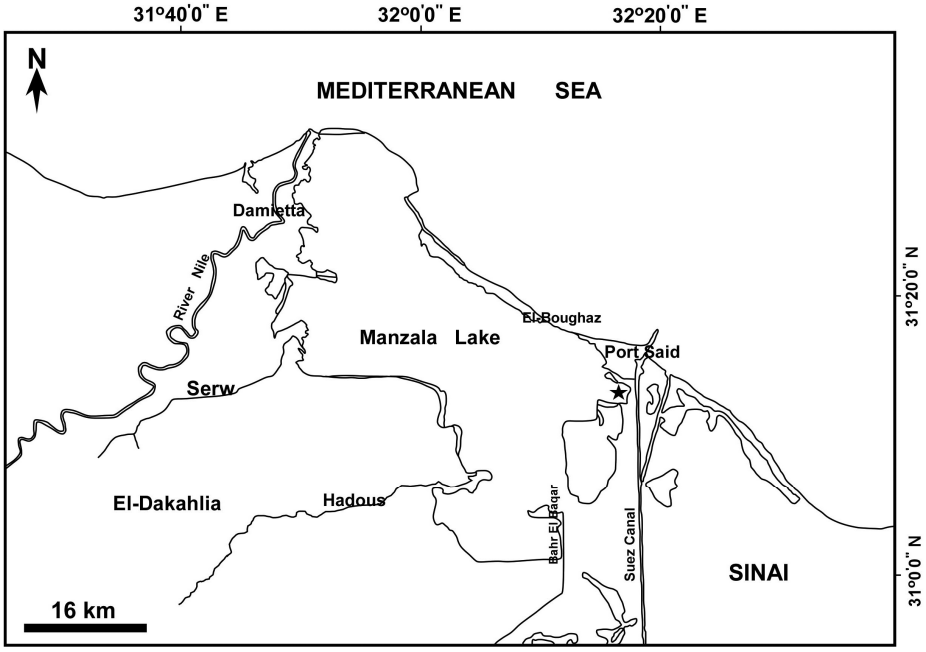

Figure 1. Area of the occurrence of the sailfin molly in Lake Manzala.

Up to date, the sailfin molly has been introduced in 29 countries located mainly in Asia, Oceania, central and South America (Koutsikos et al. 2018). In Asia, the species has been introduced to some countries in the Middle East. It has been reported in Al-Hammar Marsh in Iraq (Hussain et al. 2009), in estuaries in the Gulf of Oman (Randall 1995), in Iran (Sabet 2018) and Wadi Haneefah stream, Riyadh, Saudi Arabia (Al-Kahem et al. 2007). In Europe, the only known population of the sailfin molly has been reported in Lake Vouliagmeni, Greece (Koutsikos et al. 2017). So far, there are no confirmed records of established populations of the species in Africa (Koutsikos et al. 2018). Consequently, the aim of this paper is to report for the first time the presence of sailfin molly in Africa, and specifically to Lake Manzala (Egypt) which is located on the south-east coast of the Mediterranean Sea.

Materials and methods

Study site

This study was conducted in Lake Manzala which is a brackish and shallow lake (average depth; 1.25 m) located on the northeastern edge of the Egyptian Nile Delta between latitudes 31°07′N and 31°30′N and longitudes 31°48′E and 32°17′E (Figure 1). The lake is bordered by the Mediterranean Sea to the North, Suez Canal to the East, and Damietta Branch of the River Nile to the West (Abdel-Rasheed 2011). The lake is connected to the Mediterranean Sea by means of El-Gamil Straits and also receives freshwater inflows from the Nile River and drainage water (El-Wakeel and Wahby 1970). The most important species in the lake includes tilapias, mullets and catfish. Moreover, it is considered as one of the most important wintering and nesting sites for many species of migratory birds (El-Bokhty 1996; El-Enani 2004).

Water temperature in the lake varies from 12.5 °C in winter and increases gradually through spring reaching its maximum value of 30 °C in summer (Elmorsi et al. 2017). Salinity also varies seasonally, with maximum values (20 PSU) recorded in winter season and minimum values in summer (1.0 to 4.6 PSU) (Elmorsi et al. 2017).

Sampling and sample processing

Sailfin molly was captured as a by-catch by local fishermen while fishing Nile tilapia *Oreochromis niloticus* (Linnaeus, 1758) in October 2017 from the northeastern section of the lake. Fish were collected by hand net from a shallow muddy area very close to El-Gamil Straits, the source of saltwater to the lake. Hence, it is the most saline part of the lake where salinity reaches 20 PSU (Abdel-Rasheed 2011; Elmorsi et al. 2017).

Fish were taken to the laboratories of the Marine Science Department, Faculty of Science, Port Said University (Egypt) for examination. All fish were sexed, measured (total length, TL and standard length, SL, cm), and morphometric and meristic characters were determined.

Results

All individuals were identified as *Poecilia latipinna* based on the distinctive coloration, the number of dorsal fin rays, broad caudal peduncle, and the position of dorsal fin to anal fin as well as enlarged dorsal fin. Coloration of the body was light gray/olive, with rows of brown spots along the body sides. Dorsal and caudal fins were characterized by distinctive orange spots which combine in some areas notably on the upper edge of the dorsal fin to give the appearance of long stripes. The head was small and flattened with an upturned mouth (Figure 2).

In males, the dorsal fin was enlarged and had a sail-like profile. It is composed of 13–15 rays whereas, in females the dorsal fin had only 12 rays. The anal fin of females was composed of 6–7 rays and modified into a gonopodium in males. There were 25–27 scales on the lateral line and 14–16 scales on the caudal peduncle (Table 1). The origin of the dorsal fin was located anterior to the origin of both anal and pelvic fins. There were 12–13 rays in pectoral fin, and 6–7 rays in pelvic rays.

The size of males ranged from 5.7 cm to 8.1 cm TL with an average of 7 cm, whereas that of females ranged from 4.9 cm to 8.5 cm TL with an average length of 6.9 cm (Table 2). The pre-dorsal fin formed about 25% of the total length in males and females but only 10% in larger females. The female body depth increased from 35% to 55% of the total length as the female grew from 4.9 to 8.1 cm. All females were mature and reproductively active and released larvae as soon as they were taken out of the water.

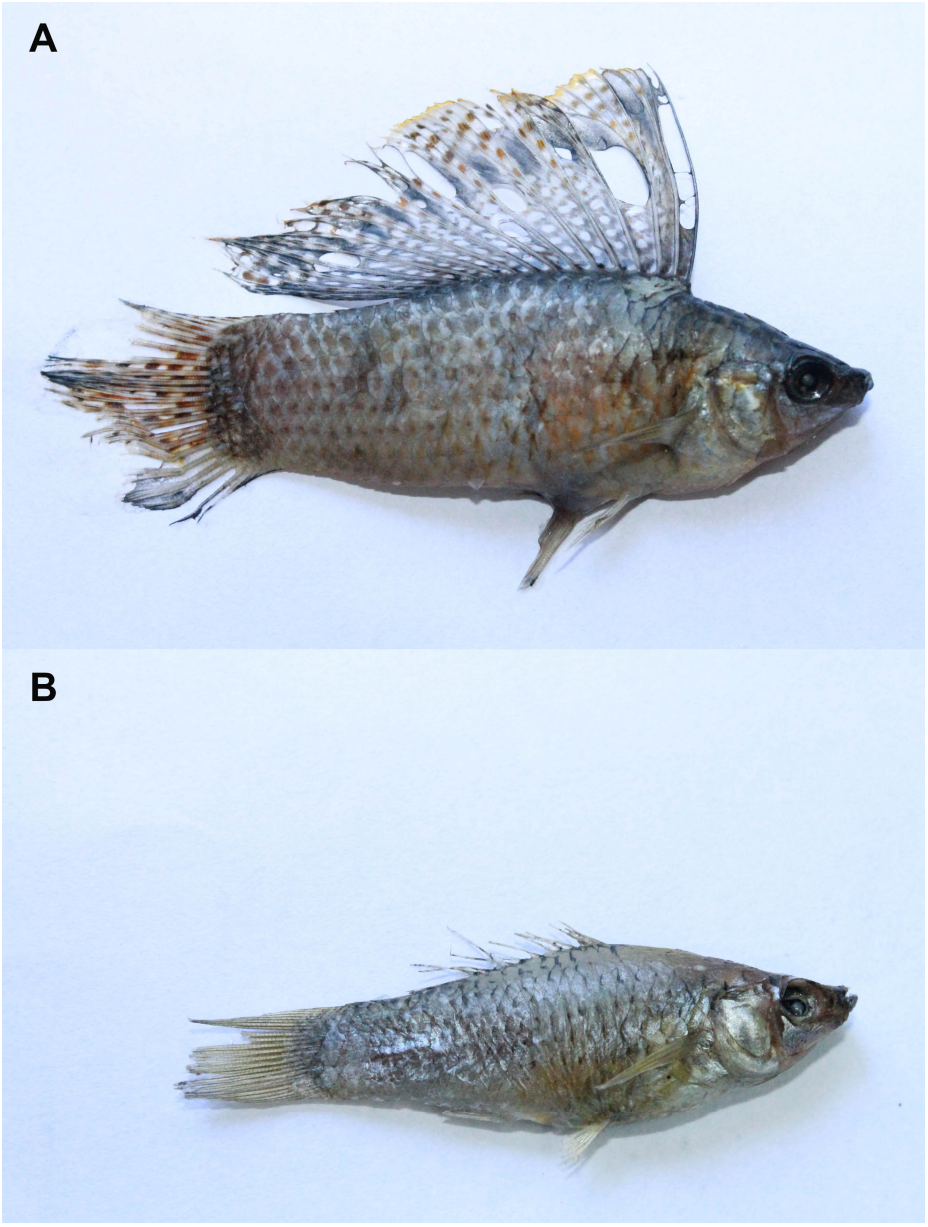

Figure 2. Sailfin molly (A – male, B – female) collected from Lake Manzala, Egypt.

Table 1. Comparison between the characteristic features of sailfin molly collected from Lake Manzala and other studies.

Feature	Hubbs et al. 2008 Texas	Coad 2017 Iran	Koutsikos et al. 2017 Greece	The present collection
Maximum TL (cm)	–	15	–	8.5
Dorsal-fin rays	12–14	12–18	13–16	13–15
Anal-fin rays	–	7–9		6–7
Pelvic-fin rays	–	6–7		7
Number of scales on lateral line		23–30	26–28	25–29
Number of scales on caudal peduncle		–	16	14–16
Position of D to A	anterior		anterior	anterior
Position of D to P2	anterior		anterior	anterior
Number of young	–	6–160		100–120

Table 2. Morphometrics and sex of sailfin molly collected from Lake Manzala.

Serial #	TL (cm)	SL/TL%	HL/TL%	PDL/TL%	BD/TL%	ED/HL%	Sex
1	4.9	3.8	22.4	24.5	36.7	27.3	Female
2	5.2	4.1	23.1	36.5	40.4	16.7	Female
3	5.3	4.3	22.6	34.0	45.3	25.0	Female
4	5.7	4.3	21.1	26.3	35.1	25.0	Male
5	5.9	4.7	15.3	35.6	55.9	33.3	Female
6	6.1	4.8	21.3	36.1	55.7	23.1	Female
7	6.5	5	21.5	24.6	32.3	21.4	Male
8	6.8	5.5	19.1	36.8	52.9	23.1	Female
9	6.8	5.4	20.6	26.5	32.4	21.4	Male
10	6.9	5.3	21.7	22.9	33.3	20.0	Male
11	7	5.5	22.9	27.1	34.3	25.0	Male
12	7.1	5.5	21.1	23.9	57.7	20.0	Female
13	7.2	6.5	20.8	36.1	63.9	20.0	Female
14	7.2	6.4	22.2	30.6	56.9	18.8	Female
15	7.3	5.4	23.3	31.5	54.8	17.6	Female
16	7.3	5.8	20.5	34.2	54.8	20.0	Female
17	7.3	5.9	21.9	35.6	52.1	18.8	Female
18	7.3	5.8	16.4	27.4	35.6	25.0	Male
19	7.5	6	22.7	37.3	56.0	17.6	Female
20	7.5	5.9	20.0	28.0	33.3	20.0	Male
21	7.6	5.1	21.1	34.2	55.3	25.0	Female
22	7.7	6.2	20.8	36.4	54.5	25.0	Female
23	8.1	6.5	21.0	33.3	56.8	17.6	Female
24	8.1	6.1	14.8	23.5	34.6	25.0	Male
25	8.5	6.9	21.2	10.6	54.1	16.7	Female

TL Total length, HL head length, SL Standard length, BD Body depth, PDL predorsal length, ED Eye diameter

Discussion

The distinctive features of sailfin molly include the oblong body with a small dorsally flattened head, enlarged colored dorsal fin and a broad caudal peduncle. Due to the overlapping morphological characters of molly species (Ptacek and Breden 2005), taxonomic identification of molly populations is difficult. Indeed, several records of mollies may be derived from misidentified specimens, such as the Vouliagmeni sailfin molly, which was initially identified as *Poecilia sphenops* Valenciennes, 1846 (Chintiroglou et al. 1996), and *Poecilia* species in Kenya which has been misidentified as *P. latipinna* (Seegers et al. 2003). The misidentification of *Poecilia* species reflects the importance of taxonomic studies when examining the spread and the impact of non-indigenous species. Sailfin molly species is outwardly similar and can be confused with the Yucatan molly, *P. velifera* Regan, 1914. However, Yucatan molly is generally larger (may reach 20 cm) in size, compared to sailfin moly (max length 15 cm). Furthermore, the dorsal fin is higher and longer with more fin rays (18–19) in Yucatan molly compared to less than 15 rays in the sailfin molly. Number of scales on the caudal peduncle is higher in the Yucatan molly (20 scales) than sailfin molly (16) (Parzefall 1989). The Guppy, *Poecilia reticulata* Peters, 1859 is smaller than the sailfin molly and attains a maximum size of 6 cm (Gomon and Bray 2017).

Aquarium trade has been considered as one of the important pathways for introduction of non-indigenous species (Nunes et al. 2015; Sabet 2018). There are no public aquaria of freshwater fishes in Egypt in general or in the area around the Lake Manzala in particular. The lake receives water from different sources including the River Nile, which runs along the whole country. The sailfin molly may have been released to any of these sources by ornamental fish hobbyist. Although the sailfin molly has not been recorded in the southern Mediterranean, Koutsikos et al. (2018) indicated that climatic conditions in the Mediterranean basin are suitable for the establishment of the species without barriers. The closest area where the species is recorded is the Lake Vouliagmeni in Greece (Koutsikos et al. 2017). There are no validated introductions in Africa since the previous reports in Kenya were proved to be misidentifications (Seegers et al. 2003).

The species is a euryhaline and may tolerate salinity gradients from freshwater to hypersaline conditions (95 PSU) (Gonzalez et al. 2005; Hussain et al. 2009). The success of the species to establish after introduction is likely to be affected by salinity as salinity affects the life and reproductive traits of poeciliids in general (Meffe and Snelson 1989; Martin et al. 2009). Despite the ability of the species to spawn in all salinity gradients, production and growth of fry vary significantly among different salinity levels with the maximum fry production in 25 and growth in 10 PSU (Kumaraguru et al. 2005). Moreover, the species can also tolerate and acclimate to hypoxic conditions with concentration of oxygen as low as 1 mg/L (Timmerman and Chapman 2004).

Sailfin molly inhabits only the slow-moving waters and the rapidly flowing water may hinder the establishment and the growth of the population (Pen and Potter 1991). Conditions in Lake Manzala are favorable for the establishment of the sailfin molly due to relatively high salinity, lentic condition and muddy vegetated bottom. The area where the fish were caught had dense vegetation cover and high salinity (20 PSU) due to the proximity with the Mediterranean Sea (Elmorsi et al. 2017).

Sailfin molly is presumed to be responsible for the decline of some fish species in the regions of introduction (Sigler and Sigler 1987; Englund 1999). Juliano et al. (1989) stated that this species competes with the native milkfish, *Chanos chanos* (Forsskål, 1775) for food in the Philippines. It was also responsible for the decline of the native damselfish, *Megalagerion* sp. on Oahu, Hawaii (Englund (1999) and the desert pupfish *Cyprinodon macularius* Baird & Girard, 1853 in California (Robins 2014).

The report of the sailfin molly from Lake Manzala is the first in the southern Mediterranean Sea and possibly in Africa. This extends the known introduction range of sailfin molly to a new geographic and climatic area. The reproduction of the species may indicate the establishment of the species as a new population. However, yet there are no estimates of size or trend of the population in Lake Manzala. Thus, further research is necessary to assess the population size.

While possible impact of sailfin molly on aquatic life in Lake Manzala is unclear, introduction of the species may exhibit adverse impacts on the fish fauna in the lake through predation, competition, habitat changes, genetic changes, and introduction of parasites and diseases. Direct surveys are needed to obtain basic information about the population of the sailfin molly and its distribution range in the lake. Furthermore, studies on causes of introduction of the species and the impacts of introduction on the local fish communities in the lake are required.

Acknowledgements

This project was funded by the Deanship of Scientific Research (DSR), King Abdulaziz University, Jeddah, under grant No. (D-612-150-1441). The authors, therefore, gratefully acknowledge DSR technical and financial support. Authors would like also to thank S. Carbonara (CIHEAM, Italy) S. Bogorodeski, (Station of Naturalists, Omsk, Russia) Ronald Frick (Lauda-Königshofen, Germany), and María Eugenia (Centro de Investigación y de Estudios Avanzados del IPN, Unidad, Mérida, Mexico) for the confirmation of the species identity. We would like to thank the reviewers for the peer review of the manuscript that greatly improved it.

References

Abdel-Rasheed ME (2011) Ecological studies on Lake Manzala with special reference to their water quality and sediment productivity. MSc Thesis, Faculty of Science, Al-Azhar University, 200 pp

Al-Kahem HF, Al-Ghanim A, Ahmad Z (2007) Studies on feeding ecology of sailfin molly (*Poecilia latipinna*) dwelling in Wadi Haneefah Stream, Riyadh. *Pakistan Journal of Biological Sciences* 10: 335–341, https://doi.org/10.3923/pjbs.2007.335.341

Brock VE (1960) The introduction of aquatic animals into Hawaiian waters. *Internationale Revue der gesamten Hydrobiologie* 45(4): 463–480

Chintiroglou C-C, Valkouma T, Culley M (1996) Allometry of feeding and body size in a population of the sea anemone *Paranemonia vouliagmeniensis*. *Journal of the Marine Biological Association of the United Kingdom* 76: 603–616, https://doi.org/10.1017/S0025315400031313

Coad WB (2017) Review of the livebearer fishes of Iran (Family: Poeciliidae). *Iranian Journal of Ichthyology* 4: 305–330

El-Bokhty EB (1996) Distribution of bottom fauna in Lake Manzala in relation to prevailing environmental conditions. MSc Thesis, Fac. Sci., Tanta University, 160 pp

El-Enani HR (2004) Ecological and biological studies on Lake El-Manzala with special reference to their water quality and sediment productivity. MSc Thesis, Faculty of Science, Al Azhar University, 180 pp

Elmorsi R, Hamed MA, Abou-El-Sherbini KS (2017) Properties of Manzala Lake, Egypt. *Egyptian Journal of Chemistry* 60: 519–535, https://doi.org/10.1016/j.heliyon.2019.e02276

El-Wakeel S, Wahby SD (1970) Hydrography and chemistry of Lake Manzala, Egypt. *Hydrobiology* 67(2): 173–200

Englund RA (1999) The impacts of introduced poeciliid fish and Odonata on the endemic *Megalagrion* (Odonata) damselflies of Oahu Island, Hawaii. *Journal of Insect Conservation* 3: 225–243, https://doi.org/10.1023/A:1009651922486

Fuller PL, Nico LG, Williams JD (1999) Nonindigenous fishes introduced into inland waters of the United States. American Fisheries Society, Bethesda. Maryland, USA, 22 pp

Gomon MF, Bray DJ (2017) *Poecilia reticulata* in Fishes of Australia. http://136.154.202.208/home/species/3637 (accessed 10 March 2020)

Gonzalez RJ, Cooper J, Head D (2005) Physiological responses to hyper-saline waters in sailfin mollies (*Poecilia latipinna*). *Comparative Biochemistry and Physiology. Part A, Molecular & Integrative Physiology* 142: 397–403, https://doi.org/10.1016/j.cbpa.2005.08.008

Grossman EJ, Cudmore BC (1999) Summary of North America fish introductions through the aquarium/horticulture trade. In: Claudi R, Leach JH (eds) Nonindigenous freshwater organisms: vectors, biology and impacts. Lewis Publishers, Boca Raton, pp 129–134

Hubbs C, Edwards RJ, Garrett GP (2008) An Annotated Checklist of the Freshwater Fishes of Texas, with Keys to Identification of Species, 2nd Edition, Texas Academy of Science, 45 pp

Hussain NA, Mohamed ARM, Al-Noo SS, Mutlak FM, Abed IM, Coad BW (2009) Structure and ecological indices of the fish assemblages in the recently restored Al-Hammar Marsh, southern Iraq. *BIORISK - Biodiversity and Ecosystem Risk Assessment* 3: 173–186, https://doi.org/10.3897/biorisk.3.11

Juliano RO, Guerrero R III, Ronquillo I (1989) The introduction of exotic aquatic species in the Philippines. In: De Silva SS (ed), Proceedings of the Workshop on Introduction of Exotic Aquatic Organisms in Asia: The Asian Fisheries Society, pp 83–90

Koutsikos N, Economou AN, Vardakas L, Kommatas D, Zogaris S (2017) First confirmed record of an established population of sailfin molly, *Poecilia latipinna* (Actinopterygii: Cyprinodontiformes: Poeciliidae), in Europe. *Acta Ichthyologica Et Piscatoria* 47: 311–315, https://doi.org/10.3750/AIEP/02234

Koutsikos N, Vardakas L, Kalogianni E, Economou AN (2018) Global distribution and climatic match of a highly traded ornamental freshwater fish, the sailfin molly *Poecilia latipinna* (Lesueur, 1821). *Knowledge and Management of Aquatic Ecosystems* 419: 1–11 https://doi.org/10.1051/kmae/2018014

Kumaraguru KP, Rajagopal S, Balasubramanian T (2005) Effect of salinity on gestation period, fry production, and growth performance of the sailfin molly (*Poecilia latipinna* Lesueur) in captivity. *Israeli Journal of Aquaculture - Bamidgeh* 57(3): 191–196

Martin SB, Hitchi AT, Purcell KM, Klerks PL, Leberg PL (2009) Life history variation along a salinity gradient in coastal marshes. *Aquatic Biology* 8: 15–28, https://doi.org/10.3354/ab00203

Meffe G, Snelson FFJ (1989) An ecological overview of Poeciliid fishes. In: Meffe G, Snelson FFJ (eds), Ecology and Evolution of Livebearing Fishes (Poeciliidae). Engelwood Cliffs, New Jersey, USA, Prentice Hall, pp 13–31

Moyle PB (2002) Inland fishes of California. University of California Press, Berkeley, USA, 517 pp

Nunes AL, Tricarico E, Panov VE, Cardoso AC, Katsanevakis S (2015) Pathways and gateways of freshwater invasions in Europe. *Aquatic Invasions* 10: 359–370, https://doi.org/10.3391/ai.2015.10.4.01

Page LM, Burr BM (1991) A field guide to freshwater fishes of North America north of Mexico. The Peterson Field Guide Series, volume 42. Houghton Mifflin Company, Boston, MA, 663 pp

Parzefall J (1989) Sexual and aggressive behaviour in species hybrids of *Poecilia mexicana* and *Poecilia velifera* (Pisces, Poeciliidae). *Ethology* 82: 101–115, https://doi.org/10.1111/j.1439-0310.1989.tb00491.x

Pen LJ, Potter IC (1991) Reproduction, growth and diet of *Gambusia holbrooki* (Girard) in a temperate Australian river. *Aquatic Conservation: Marine and Freshwater Ecosystems* 1: 159–172, https://doi.org/10.1002/aqc.3270010205

Ptacek M, Breden F (2005) Phylogenetic relationships among the mollies (Poeciliidae: *Poecilia*: *Mollienesia* group) based on mitochondrial DNA sequences. *Journal of Fish Biology* 53: 64–81, https://doi.org/10.1111/j.1095-8649.1998.tb01018.x

Randall JE (1995) Coastal fishes of Oman. Honolulu, Hawai'i, USA, University of Hawaii Press, 439 pp

Robins CR, Ray GC (1986) A field guide to the Atlantic Coast fishes of North America. Houghton Mifflin Harcourt, 354 pp

Robins RH (2014) Sailfin molly. Florida Museum of Ichthyology, Gainesville, Florida, http://www.flmnh.ufl.edu/fish/Gallery/Descript/SailfinMolly/SailfinMolly.html

Rohde FC, Arndt RG, Lindquist DG, Parnell JF (1994) Freshwater fishes of the Carolinas, Virginia, Maryland and Delaware. Univ. North Carolina Press. Chapel Hill, North Carolina and London, England, 222 pp

Sabet HM (2018) Range extension of an exotic sailfin molly *Poecilia latipinna* (Lesueur, 1821) in Iran. *Poeciliid Research* 8: 18–23

Seale A (1905) Report of Mr. Alvin Seale of the United States Fish Commission, on the introduction of top-minnows to Hawaii from Galveston, Texas. *The Hawaiian Forester and Agriculturist* 2: 364–367

Seegers LL, De Vos L, Okeyo DO (2003) Annotated checklist of the freshwater fishes of Kenya (excluding the lacustrine haplochromines from Lake Victoria). *Journal of East African Natural History* 92: 11–47, https://doi.org/10.2982/0012-8317(2003)92[11:ACOTFF]2.0.CO;2

Sigler WF, Sigler JW (1987) Fishes of the Great Basin: a natural history. University of Nevada Press, Reno, NV, 335 pp

Timmerman CM, Chapman LJ (2004) Hypoxia and interdemic variation in *Poecilia latipinna*. *Journal of Fish Biology* 65: 635–650, https://doi.org/10.1111/j.0022-1112.2004.00474.x

Yamamoto MN, Tagawa AW (2000) Hawai'I's native and exotic freshwater animals. Mutual Publishing, Honolulu, Hawaii, 200 pp