

УДК 574.9

A FIRST APPROACH TO MAP THE SPATIOTEMPORAL FEATURES
OF SPREAD FOR TWO INVASIVE FISH SPECIES IN ARMENIA

K. S. HAMBARDZUMYAN^{1*}, V. L. ASATRYAN^{1**}, S. Kh. PIPOYAN^{2***}

¹ *Scientific Center of Zoology and Hydroecology of NAS RA, Armenia*

² *Armenian State Pedagogical University after Kh. Abovyan, Armenia*

Fish farming in Armenia leads to the introduction of alien fish species such as Prussian carp (*Carassius gibelio*) and Stone moroko (*Pseudorasbora parva*). Given their rapid spread throughout Armenia, it became necessary to investigate their spatio-temporal distribution patterns to develop some monitoring tools and conservation strategies for the stocks of native species. Thus, we created a comprehensive database through literature reviews, structured interviews with scientists, and open-source data. Our analysis revealed an increasing frequency of records as ichthyological studies intensified. These invasive species are now encountered in nearly all regions of Armenia, with altitude being the only limiting factor, probably due to water temperature.

<https://doi.org/10.46991/PYSU:C/2023.57.3.170>

Keywords: invasive species, Prussian carp, *Carassius gibelio*, Stone moroko, *Pseudorasbora parva*, monitoring, mapping.

Introduction. The Republic of Armenia is a landlocked country within the territory of the Caucasus biodiversity hotspot [1]. The country's surface flow is primarily formed by the two major river basins of the South Caucasus, namely the Kura and Aras rivers. Throughout the 20th century, the impact of the economy on the native fish diversity of the rivers in Armenia became evident, leading to numerous changes that continue to this day. In the early 1920's only 22 fish species were documented in Armenia [2], while the recent studies show that partially due to the development of fish farms since the 1960's the number of fish species increased to more than 40 [3–5]. However, there are no evidences on natural reproduction of some of them in the wild thus, some records of new species in the rivers are just the matter of occasion. The development of aquaculture in Armenia lead to an introduction of variety of fish species from Europe, Central Asia, and the Far East [5]. As a result, water bodies in Armenia were invaded by non-native and low-valued fish species too, such as Prussian carp *Carassius gibelio* (Bloch, 1782) and Stone moroko *Pseudorasbora parva* (Temminck & Schlegel, 1846) [5]. These species are

* E-mail: hambardzumyanknarik2000@gmail.com

** E-mail: asatryanvardan@gmail.com

*** E-mail: s.pipoyan@gmail.com

recognized as invasive in many countries [6–10]. Considering biological invasion harms both the ecosystems and local economy [11], it is crucial to investigate the geographic and temporal diffusion of them.

The natural range of distribution of *C. gibelio* encompasses territory from Central Europe to Siberia and Eastern Asia [12]. Due to its high adaptive capacity this species has been spreading through water bodies across Eurasia and Southern America. In Armenia, *C. gibelio* was first introduced at the end of the 1960s. It was inadvertently imported from the Odesa region, along with fingerlings of other carp species (*Cyprinus carpio* Linnaeus, 1758), for rearing in Masis fish farm, from where it spreads throughout Armenia [5].

Pseudorasbora parva is native for East Asia [13]. However, over the past 60 years its distribution has expanded from Central Asia to Northern Africa [14], including also the territory of Armenia. Although *P. parva* was first documented in Armenia in the 1990s, it was probably introduced during the 1960's with the fingerlings of Grass carp *Ctenopharyngodon idella* (Valenciennes, 1844) imported for the purpose of purifying water of Yerevan and Ararat ponds [15].

Despite the fact that *C. gibelio* and *P. parva* are widely spread alien species in the territory of Armenia, there is a lack of a comprehensive study on their spatial expansion through time. This study represents the first attempt to compile a temporal data on their distribution and map the results. The research is of utmost importance for developing monitoring strategies to assess the impact of these species on the biodiversity of surface waters in Armenia.

Materials and Methods.

Data Collection and Coordination. We have developed a database containing information on the record locations of *P. parva* and *C. gibelio* in Armenia. This database includes the following key aspects: name of species, location of record, surface water type (river, reservoir, lake or fish pond), name of the river, coordinates, elevation above sea level, date of registration, and author or source. Due to the scarcity of literature on the topic, the structure of the database was designed considering available data. However, in order to enhance the database for monitoring purposes, we recognized the need to supplement it with additional data. To accomplish this, we studied the distribution data of *P. parva* and *C. gibelio* based on the mentions in the scholar literature [2–5, 15–33]. However, the literature often lacks specific dates of fish species documentation with only stating the decade rather than the exact date. To address this issue and ensure consistency in our mapping efforts, we prefer to use the median year within the decade as a representative value. Furthermore, we incorporated available data of fish species locations from international open-source platforms such as iNaturalist [34] and GBIF [35] to expand the scope and coverage of the database. In this paper, we have also utilized the unpublished data from fieldworks conducted by S. Pipoyan from 1987 to 2022. Additionally, the results of the project “Environmental Value, Landscape, and Biological Diversity of the Lori Plateau Lakes and Watershed”, funded by Rufford, were incorporated. In cases where the scientific literature lacked coordinates, we used the open-source Google Maps to obtain the necessary coordinates based on the site description.

As a result, a total of 182 records were made in the database with 117 referring to *C. gibelio* and 65 to *P. parva*. At this stage, the records do not allow to recognize other important metrics like the abundance or dominance of the species. However,

it is highly advantageous to further develop the database by incorporating the individual records of specimens. This will enable a range of ichthyological analyses to be conducted, providing valuable insights into the dynamics and characteristics of alien species.

Data Analysis. The distribution data of *C. gibelio* and *P. parva* were imported into ArcGIS Pro for spatiotemporal analysis. The data was initially divided by species and then further categorized into five time periods: until 1980, 1981–1990, 1991–2000, 2001–2010, and 2011–2022. Then the summary of records per decade was derived and classified through the river basins and lakes/ponds. To analyze the spatio-temporal spread of the species, we conducted an analysis of the areas, where the ichthyological investigation were carried out in the past and where particularly those two species were recorded. Such approach allows to have more holistic imagination of the change in the spatial range for each of the species through decades.

Results and Discussion. The literature review (Tab. 1), shows that the documented presence of both *P. parva* and *C. gibelio* in Armenia was very scarce until the 1980s [15]. It was during this decade that *C. gibelio* was first recorded in the basin of Lake Sevan. Although sporadic records were made in the 1990s and 2000s, the most significant surge in research efforts took place between 2010 and 2021, revealing widespread distribution of *C. gibelio* across nearly all surveyed sites, with the exceptions of the Debed River and the middle and lower courses of the Aghstev River. Although the first official record of *P. parva* in Armenia was in the 1990s, considering the high probability of its introduction in the 1960s, we have made a single record in the database for the Vardavar Lake for the period before the 1980s based on work of Dadikyan [16]. The number of records for *P. parva* has also increased between 2010 and 2021, albeit with a more limited presence in comparison to *C. gibelio*. Spatial analysis reveals that since the appearance of *P. parva* in Armenia five official records were made in the 1980s from the Ararat Valley and Akhuryan River basin.

Subsequently, in the 1990s, *P. parva* was observed in 11 additional sites, including water bodies in the Ararat Valley and Azat reservoir. In the 2000s, *P. parva* was first documented in the Kura River drainage basin (Dilijan district). Notably, intensified research efforts from 2011 to 2022 resulted in the identification of *P. parva* in 38 more locations, indicating its widespread distribution throughout all regions of Armenia (Tab. 2).

Carassius gibelio was first introduced into Armenia in the 1960s and was recorded in Masis fish farm. In the wild its first record was made in the 1980s in Lake Sevan [19], followed by several records along the basin involving tributaries. In parallel, several records were made in Ararat Valley, the Akhuryan River and the Arpa River basins (Tab. 2). Notably, during the 1980's, the number of *C. gibelio* records was six times higher compared to *P. parva*, despite their introduction occurring around the same time. This leads to two hypotheses: firstly, *C. gibelio* may have adapted more effectively to the new climate, enabling faster spread, and secondly, *P. parva*, resembling fingerlings of *C. idella*, may have remained unnoticed. The number of records and its geography remains almost the same in the 1990s with the following decline during the 2000s. In the 2010s, the intensity of records increased again and in overall 46% of all records were made during the last decade including the first scholar record of *C. gibelio* within the Kura River basin.

Table 1

Number of records per fish species within different time periods and their geography

<i>Carassius gibelio</i>		
Decade	Record number	Locations
Till 1980	1	<i>Fish Farm:</i> 1 – Masis
1981–1990	32	<i>Rivers:</i> 2 – Aras; 1 – Arpa; 1 – Azat; 1 – Karchaghbyur; 1 – Kasakh; 1 – Martuni; 1 – Masrik; 4 – Mecamor. <i>Lakes:</i> 1 – Arinj; 1 – Ayghrlich; 1 – Mecamor; 4 – Sevan; 1 – Vardavar. <i>Ponds:</i> 5 – in Armavir Region. <i>Reservoirs:</i> 1 – Azat; 1 – Karnut; 1 – Meghri. <i>Fish Farms:</i> 3 – Masis; 1 – Armash.
1991–2000	22	<i>Rivers:</i> 1 – Aras; 4 – Akhuryan; 1 – Gavaraget; 4 – Hrazdan. <i>Lakes:</i> 1 – Arpi; 1 – Qarhanq; 1 – Sevan. <i>Canal:</i> 1 – Shirak. <i>Reservoirs:</i> 1 – Aparan; 1 – Arajadzor; 1 – Azat; 1 – Hrazdan; 1 – Herher; 1 – Kechut; 1 – Yervan. <i>Pond:</i> 1 – in village Apnagyugh.
2001–2010	8	<i>Lakes:</i> 1 – in city Dilijan; 1 – Karalich; 1 – Parz; 1 – in Victory park (Yerevan). <i>Reservoirs:</i> 1 – Kanaker; 1 – Spandaryan; 1 – Vardaqaq. <i>Pond:</i> 1 – little pond near Arpa Lake (village Areni).
2011–2022	54	<i>Rivers:</i> 1 – Aghstev; 3 – Dzoraget; 1 – Gargar; 3 – Hrazdan; 1 – Kasagh; 1 – Lichq; 1 – Pambak; 1 – Tsakkar; 3 – Tashir; 4 – Vorotan. <i>Lakes:</i> 1 – in city Artashat; 1 – Gosh; 2 – Khor Virap Sanctuary; 7 – Lori plateau; 1 – Sevan; 1 – three lakes in Vanadzor). <i>Reservoirs:</i> 1 – Angeghakot; 1 – Joghaz; 1 – Hakhum; 1 – Ijevan; 1 – Marmarik; 1 – Mecavan; 1 – Sarnaghbyur; 1 – Shamb; 1 – Tavush; 1 – Tsili-Tsov; 1 – Vedi. <i>Ponds:</i> 5 – in Lori Plateau; 1 – near Tashir city; 1 – near village Katnaghbyur; 1 – near village Jrabi; 2 – near village Hovk; 1 – in Jrvezh Forest Park.
<i>Pseudorasbora parva</i>		
Decade	Record number	Locations
Till 1980	1	<i>Lake:</i> 1 – Vardavar (artificial lake in Yerevan).
1981–1990	5	<i>River:</i> 2 – Akhuryan. <i>Lake:</i> 1 – near village Arinj. <i>Reservoir:</i> 1 – Karnut. <i>Fish Farm:</i> 1 – Yeghegnut.
1991–2000	11	<i>Rivers:</i> 1 – Aras; 1 – Azat; 1 – Hrazdan; 1 – Kasagh; 1 – Mecamor. <i>Ponds:</i> 1 – in village Jrabi; 1 – in village Sis. <i>Reservoir:</i> 1 – Azat. <i>Fish Farm:</i> 1 – Armash, 1 – Masis. <i>Canal:</i> 1 – near village Hovtashat.
2001–2010	10	<i>Rivers:</i> 1 – Agstev; 1 – Akhuryan; 1 – Arpa; 1 – Kasagh; 1 – Vedi. <i>Reservoirs:</i> 1 – Aparan; 1 – Jajur; 1 – Sarnaghbyur; 1 – Vardakar, 1 – Yerevan.
2011–2022	38	<i>Rivers:</i> 1 – Ayri; 1 – Dzknaget; 2 – Dzoraget; 3 – Hrazdan; 2 – Tashir; 4 – Vorotan. <i>Canal:</i> 1 – Kakhanov. <i>Lakes:</i> 1 – Arpi; 9 – in Lori Plateau; 1 – in city Stepanavan; 1 – three lakes (Vanadzor); 1 – in Victory park (Yerevan). <i>Reservoirs:</i> 1 – Akhuryan; 1 – Akhpara; 1 – Arajadzor; 1 – Joghaz; 1 – Marmarik; 1 – Mecavan; 1 – Shamb; 1 – Spandaryan; 1 – Tavush; 1 – Tolors; 1 – Vorotan.

Table 2

The relation between the investigated area and areas where *C. gibelio* and *P. parva* were recorded

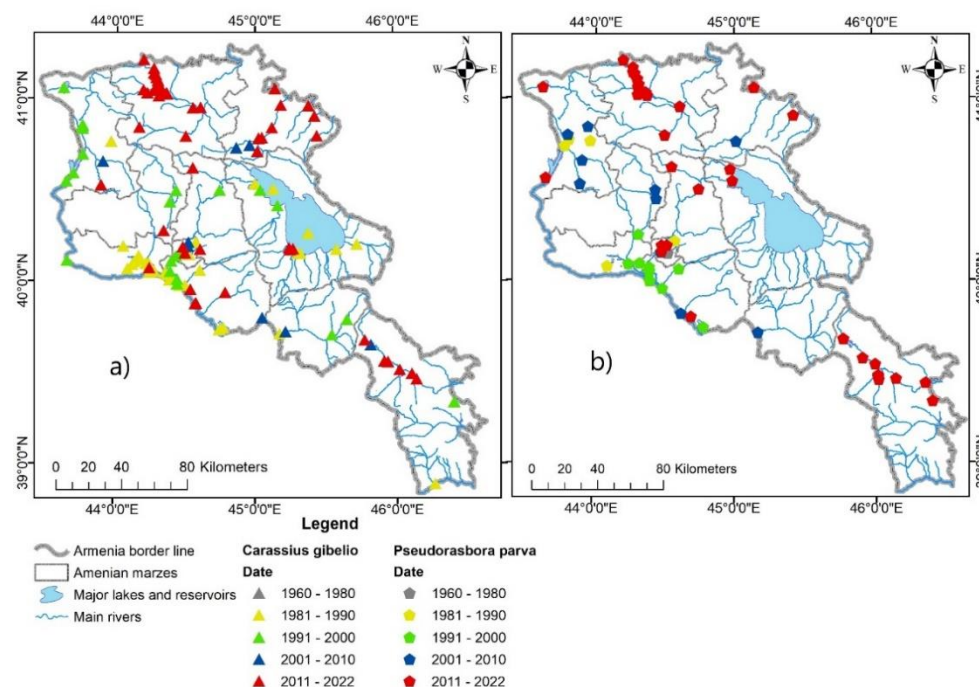
Source	<i>Carassius gibelio</i>		<i>Pseudorasbora parva</i>	
	investigated area	species found	investigated area	species found
Barach, 1940	Armenian surface waters	–	Armenian surface waters	–
Dadikyan, 1971	Armenian surface waters	–	Armenian surface waters	–
Hovhannesian, Smoley, 1985	Sevan Lake	Sevan Lake	–	–
Dadikyan, 1986	Armenian surface waters	–	Armenian surface waters	–
Smoley et al., 1987	Sevan Lake	Sevan Lake	–	–
Mailyan et al., 1987	Azat Reservoir, 1984	–	Azat Reservoir, 1984	–
Mailyan et al., 1989	the Masrik River, 1987	the Masrik River	–	–
Pipoyan, 1993	fish ponds in Ararat plateau. <i>Lakes:</i> Sevan; Parz; Arinj; Meghri	fish ponds in Ararat plateau. <i>Lakes:</i> Sevan; Parz, Arinj; Meghri	–	–
Pipoyan, 1996			<i>River:</i> Aras; Metsamor; lower course of Azat; fish farms of Masis; Armash; Eghegnut	<i>River:</i> Aras; Metsamor; lower course of Azat; fish farms of Masis; Armash; Eghegnut
Barseghyan, Vardanyan, 2011	small Sevan	small Sevan		
Pipoyan, 2012	<i>Rivers:</i> Aras; Aghstev; Arpa; Akhuryan; Azat; Debed; Dzoraget; Hakhum; Metsamor 1998–1999; lower and upper course of Hrazdan; confluence point of Hrazdan with Marmarik; Meghri; Pambak; Tavush; Vedi; Voghji; Vorotan. <i>Lake:</i> Arpi. <i>Reservoirs:</i> Akhuryan; Tavush	<i>Rivers:</i> Aras; Aghstev; Arpa; Akhuryan; Azat; Debed; Dzoraget; Hakhum; Metsamor; lower and upper course of Hrazdan; confluence point of Hrazdan with Marmarik; Meghri; Pambak; Tavush; Vedi; Voghji; Vorotan. <i>Lake:</i> Arpi. <i>Reservoirs:</i> Akhuryan; Tavush	<i>Rivers:</i> Aras; Aghstev; Arpa; Akhuryan; Azat; Debed; Dzoraget; Hakhum; Metsamor 1998–1999, lower and upper course of Hrazdan; confluence point of Hrazdan with Marmarik; Meghri; Pambak; Tavush; Vedi; Voghji; Vorotan. <i>Lake:</i> Arpi. <i>Reservoirs:</i> Akhuryan, Tavush.	<i>Rivers:</i> Arpa; Aghstev; Akhuryan; Azat; lower course of Hrazdan; Vedi. <i>Lake:</i> Arpi. <i>Reservoir:</i> Akhuryan.
Pipoyan and Tigranyan, 2012	Arpi Lake, 2000s	Arpi Lake		
Vardanyan et al., 2011			mouth of the Hrazdan River	mouth of the Hrazdan River
Vardanyan, 2013			lower course of the Dzknaget River	lower course of the Dzknaget River

Pipoyan, Arakelyan, 2015			Rivers: lower course of Azat; Debet; lower and middle course of Kasakh. Reservoir: Azat, 1998. Lake near Novoseltsevo. Ponds near Hovk,	Rivers: lower course of Azat; Debet; lower and middle course of Kasakh. Reservoir: Azat. Lake near Novoseltsevo. Ponds near Hovk,
Vardanyan et al., 2019	the River Vorotan, 2017	the River Vorotan	the River Vorotan, 2017	the River Vorotan
Arakelyan, 2018	confluence point of the Tashir River with the Dzoraget River; Lakes of Lori Plateau	confluence point of the Tashir River with the Dzoraget River; Lakes of Lori Plateau		
Pipoyan et al., 2020			the River Vorotan. Reservoirs: Tolors 2018; Shamb 2018; Spandaryan; Angeghakot; Arajadzor	the River Vorotan. Reservoir: Tolors, Shamb, Spandaryan, Angeghakot, Arajadzor
Arakelyan, Pipoyan, 2021	Rivers: middle and lower course of the Aghstev; Debet 2015–2018; Dzoraget; Pambak; Tashir. Reservoirs: Tavush; Aygedzor; Joghaz	River: Dzoraget; Pambak; Tashir; Khndzorut. Lakes: Tsover, Gosh; Reservoirs: Tavush; Joghaz	Rivers: middle and lower course of the Aghstev; Debet 2015–2018; Dzoraget; Pambak; Tashir. Reservoirs: Tavush; Aygedzor; Joghaz	River: middle and lower course of the Aghstev; Tashir. Reservoirs: Tavush; Joghaz

Based on the spatial distribution depicted in the Fig. 1, it is evident that both *C. gibelio* and *P. parva* exhibit a pervasive presence across all the regions of Armenia. These species display a wide-ranging distribution along the major tributaries of the rivers Aras and Kura, encompassing not only the river systems, but also the main tributaries of Lake Sevan itself. Nonetheless, in different periods the distribution range of *C. gibelio* surpasses that of *P. parva*, notably extending to include all major tributaries of Lake Sevan. However, it could be also noticed the decline in the number of locations, where *C. gibelio* encountered during the last few years in the basin of Lake Sevan, which proves the reports on the decline of this species there. Furthermore, an examination of the temporal trends, as outlined in the Tab. 1 reveals more pronounced increase in the frequency of *C. gibelio* encounters over time compared to *P. parva*.

Elevation review further revealed that neither *P. parva* nor *C. gibelio* has been documented above an elevation of 2100 m in Armenia. Among the recorded locations, the highest point, where *P. parva* has been observed, is Lake Arpi, which sits at an elevation of 2025 m. Likewise, *C. gibelio* has been found in Lake Arpi and the Spandaryan Reservoir, which reach an elevation of 2031 m.

These observations suggest that higher elevations, accompanied by the lower temperatures, may serve as limiting factors for these species. The inability of their fingerlings to develop under such lower temperature conditions could explain their absence in higher elevation habitats.



Spatio-temporal features of *C. gibelio* (a) and *P. parva* (b).

Conclusion. Since the introduction of *P. parva* and *C. gibelio* into Armenia, *C. gibelio* spread more rapidly and widely, showing a higher number of records compared to *P. parva* in each described period. However, a lack of published data on the occurrence of these species didn't allow to estimate their spatio-temporal spread during the Soviet period precisely. Increased research efforts and the introduction of open source databases since 2010s have increased the relevance of data for such analyses but still not guaranteeing a full picture of distribution in Armenia given the citizen science tools are not developed enough. Recently both species are already recorded in almost all regions of Armenia but neither *P. parva* nor *C. gibelio* were documented above an elevation of 2100 m. This suggests that higher elevations and lower temperatures may serve as limiting factors for these species, with their fingerlings unable to develop under such conditions.

Received 18.10.2023

Reviewed 11.11.2023

Accepted 15.12.2023

REFERENCES

1. Myers N., Mittermeier R., et al. Biodiversity Hotspots for Conservation Priorities. *Nature* **403** (2000), 853–858.
<https://doi.org/10.1038/35002501>
2. Barach G.P. Fishes of Armenia. *Tr. Sevan. Hidrobiol. Stn.* **6** (1940), 5–70 (in Russian).

3. Kuljanishvili T., Epitashvili G., et al. Checklist of the Freshwater Fishes of Armenia, Azerbaijan and Georgia. *J Appl. Ichthyol.* (2020), 1–14.
<https://doi.org/10.1111/jai.14038>
4. Pipoyan S.Kh. *Fish Identification Guide for Armenia*. Yerevan, Antares (2021), 168 (in Armenian).
5. Pipoyan S.Kh. *Ichthyofauna of Armenia: Development Stages and Modern Status*. Palmarium Academic Pub. (2012), 538 (in Russian).
6. Fuad H., Vetešník L., Šimková A. Is Gynogenetic Reproduction in Gibel carp (*Carassius gibelio*) a Major Trait Responsible for Invasiveness? Institute of Vertebrate Biology. Czech Academy of Sciences. *J. Vertebrate Biol.* **70** (2021), 21049.
<https://doi.org/10.25225/jvb.21049>
7. Perdikaris C., Ergolavou A., et al. *Carassius gibelio* in Greece: the Dominant Naturalised Invader of Freshwaters. *Rev. Fish Biol. Fish.* **22** (2012), 17–27.
<https://doi.org/10.1007/s11160-011-9216-8>
8. Ribeiro F., Rylková K., et al. Prussian Carp *Carassius gibelio*: a Silent Invader Arriving to the Iberian Peninsula. *Aquat. Ecol.* (2015), 99–104.
<https://doi.org/10.1007/s10452-015-9508-5>
9. Declerck S., Louette G., et al. Patterns of Diet Overlap Between Populations of Non-indigenous and Native Fishes in Shallow Ponds. *J. Fish Biol.* **61** (2002), 1182–1197.
<https://doi.org/10.1111/j.1095-8649.2002.tb02464.x>
10. Gozlan R., Andreou D., et al. Pan-continental Invasion of *Pseudorasbora parva*: Towards a Better Understanding of Freshwater Fish Invasions. *Fish & Fisheries* **11** (2010), 315–340.
<https://doi.org/10.1111/j.1467-2979.2010.00361.x>
11. Diagne C., Leroy B., et al. High and Rising Economic Costs of Biological Invasions Worldwide. *Nature* **592** (2021), 571–576.
<https://doi.org/10.1038/s41586-021-03405-6>
12. Kalous L., Bohlen J., et al. Hidden Diversity Within the Prussian Carp and Designation of a Neotype for *Carassius gibelio* (Teleostei: Cyprinidae). *Ichthyol. Explor. Freshw.* **23** (2012), 11.
13. Rosecchi E., Crivelli A., Catsadorakis G. The Establishment and Impact of *Pseudorasbora Parva*, an Exotic Fish Species Introduced into Lake Mikri Prespa (North-Western Greece). *Aquatic Conservation: Marine and Freshwater Ecosystems* **3** (1993), 223–231.
14. Gozlan R., Pinder, A., Shelley J. Occurrence of the Asiatic Cyprinid *Pseudorasbora parva* in England. *J. Fish Biology* **61** (2002), 298–300.
<https://doi.org/10.1111/j.1095-8649.2002.tb01755.x>
15. Pipoyan S. Stone Moroco *Pseudorasbora parva* (Cyprinidae) in Reservoirs of Ararat Plain (Armenia). *Issues of Ichthyology* **36** (1996), 549–551 (in Russian).
16. Dadikyan M. *Fishes of Armenia*. Yerevan: Armenian SSR Publishing (1971), 215 (in Armenian).
17. Dadikyan M. *Fishes of Armenia*. Yerevan: Armenian SSR Publishing (1986), 246 (in Russian).
18. Hovhannesian P., Smoley A. Prussian carp in Lake Sevan. *Bio. J. Arm.* **8** (1985), 725–726.
19. Smoley A., Pivazyan S., et al. The Introduction of Prussian carp into Lake Sevan and Its Potential Influence on the Fish Community. Workshop “Nature, City, People”. Yerevan (1987), 149–151.
20. Mailyan R., Egizaryan E., Vartanyan L. Investigation of Azat Reservoir for Fishery Purpose. *Uch. Zap. Yerevan. Gos. Univ.* **1** (1987), 124–128 (in Russian).
21. Mailyan R., Pipoyan S., Barsamyan N. *Research on Fecundity of Prussian carp Introduced in Lake Sevan*. YSU Press (1989), 88–93 (in Russian).
22. Pipoyan S. *Morphological and Biological Features of Prussian carp Carassius auratus gibelio (Bloch., 1783) in Different Water Basin of Armenia*. Thesis for an Academic Degree. Yerevan (1993), 22 (in Russian).
23. Pipoyan S., Tigranyan E. *Changes in Ichthyofauna of the Arpi Lake (Armenia) after its Transformation to Reservoir*. Conf. “Mountainous Ecosystems and Their Components” (2012), 116–117 (in Russian).
24. Pipoyan S., Arakelyan A. The Distribution of Tapmouth gudgeon *Pseudorasbora parva* (Temminck et Shlegel, 1846) (Actinopterygii, Cyprinidae) in Water Bodies of Armenia. *Rus. J. Biol. Invas.* **6** (2015), 179–183.
<https://doi.org/10.1134/S2075111715030030>
25. Pipoyan S., Arakelyan A. The Ichthyofauna of Aghstev and Debed River Basins (North Armenia) and the Impact of Separate Factors on its Transformation. *Int. J. Oceanography and Aquaculture (IJOAC)* **2** (2018), 1–9.

26. Pipoyan S., Arakelyan A., Babayan A. Tapmout Gudgeon *Pseudorasbora parva* (Temminck et Shlegel, 1846) (Actinopterygii, Cyprinidae) in the Vorotan River Basin. *Bio. J. Armenia* **1–2** (2020), 137–141 (in Russian).
27. Arakelyan A. Some Biological Features of *Carassius gibelio* (Bloch, 1773) (Actinopterygii, Cypriniformes) in the River Tashir. *Biol. J. Armenia* **3** (2018), 77–83 (in Armenian).
28. Arakelyan A., Pipoyan S. *Fish Fauna of Water Ecosystem of Lori and Tavush Regions of the Republic of Armenia*. Yerevan, Antares (2021), 7–45 (in Armenian).
29. Vardanyan T.V. *Growth of Stone moroco Pseudorasbora parva (Temminck et Shlegel, 1846) in the Sevan Lake Basin*. Proc. Int. Sci. Conf. of Young Scientists “Biodiversity and Environmental Problems of Preservation of Wild Nature”. Armenia, Tsakhkadzor (2013), 237–241 (in Russian).
30. Vardanyan T.V., Barseghyan N.E., Gabrielyan B.K. *Invasion of Stone moroco Pseudorasbora parva (Temminck et Shlegel, 1846) in the Sevan Lake Basin*. Proc. Int. Sci. Conf. “Biological Diversity and Protection of Caucasian Fauna”. Yerevan (2011), 92–95 (in Russian).
31. Vardanyan T.V., Barseghyan N.E., et al. Species Composition of Ichthyofauna of Vorotan River (Armenia). *Electronic J. Nat. Sci.* **32** (2019), 12–16.
32. Barseghyan N., Vardanyan T. Feeding of the Prussian carp in Lake Sevan. *Biol. J. Armenia* **3** (2011), 15–19 (in Armenian).
33. Kuljanishvili T., Mumladze L., et al. The First Unified Inventory of Non-Native Fishes of the South Caucasian Countries, Armenia, Azerbaijan, and Georgia. *Knowl. Manag. Aquat. Ecosyst.* **422** (2021), 32.
<https://doi.org/10.1051/kmae/2021028>
34. *iNaturalist*
https://www.inaturalist.org/observations?place_id=8433&taxon_id=424997 (26.05.2023)
https://www.inaturalist.org/observations?place_id=8433&taxon_id=118880 (26.05.2023)
35. *GBIF*
https://www.gbif.org/occurrence/search?q=carassius%20gibelio&occurrence_status=present&adm_gid=ARM (26.05.2023)
<https://www.gbif.org/occurrence/4137771474> (26.05.2023)

Ք. Ս. ՀԱՄԲԱՐՁՈՒՄՅԱՆ, Վ. Լ. ԱՍԱՏՐՅԱՆ, Ս. Խ. ՊԻՊՈՅԱՆ

ՀՀ ՏԱՐԱԾՔՈՒՄ ԵՐԿՈՒ ԻՆՎԱԶԻՎ ՁԿՆԱՏԵՍԱԿՆԵՐԻ ՏԱՐԱԾՄԱՆ
ՏԱՐԱԾԱԺԱՄԱՆԱԿԱՅԻՆ ԱՌԱՆՁՆԱՀԱՏԿՈՒԹՅՈՒՆՆԵՐԸ
ՔԱՐՏԵԶԱԳՐԵԼՈՒ ԱՌԱՋԻՆ ՓՈՐՁԸ

Ա մ փ ո փ ու մ

Հայաստանում ձկնաբուծության զարգացումը նպաստել է ոչ տեղաբնակ ձկնատեսակների ներմուծմանը, որոցից են արծաթափայլ կարասը (*Carassius gibelio*) և ամուրյան նրբաձուկը (*Pseudorasbora parva*): Հաշվի առնելով ՀՀ տարածքում վերջիններիս արագ բազմացումը՝ մշտադիտարկման գործիքներ մշակելու և տեղական ձկնատեսակների պաշարները պահպանելու նպատակով անհրաժեշտություն է առաջանում ուսումնասիրելու արեալի կտրուկ ընդարձակման տարածաժամանակային առանձնահատկությունները: Նպատակին հասնելու համար մշակել ենք համապարփակ տվյալների բազա՝ հիմք ընդունելով գիտական գրականությունը, գիտնականների հետ հարցազրույցները և բաց հասանելիության տվյալների վերլուծությունը: Արդյունքում պարզվել է, որ ձկնաբանական հետազոտությունների ինտենսիվության աճին զուգահեռ այս ձկնատեսակների գրանցումների հաճախականությունը ևս աճել է: Այժմ այս ինվազիվ ձկնատեսակները հանդիպում են ՀՀ բոլոր

մարզերում, և վերջիններիս տարածման միակ սահմանափակող գործոնը նրանց ապրելավայրերի ծովի մակարդակից բարձրությունն է, ինչը հավանաբար պայմանավորված է ջրի ջերմաստիճանի ցուցանիշներով:

К. С. АМБАРЦУМЯН, В. Л. АСАТРЯН, С. Х. ПИПОЯН

ПЕРВАЯ ПОПЫТКА КАРТИРОВАНИЯ ПРОСТРАНСТВЕННО-
ВРЕМЕННЫХ ОСОБЕННОСТЕЙ РАСПРОСТРАНЕНИЯ ДВУХ
ИНВАЗИВНЫХ ВИДОВ РЫБ В АРМЕНИИ

Резюме

Рыбоводство в Армении привело к интродуцированию чужеродных видов рыб, каковыми являются серебряный карась (*Carassius gibelio*) и амурский чебачок (*Pseudorasbora parva*). Учитывая скорость распространения данных видов на территории Армении, возникла необходимость изучить пространственно-временные особенности этого процесса для разработки методов мониторинга и стратегий сохранения запасов местных видов. Для решения поставленных задач мы создали базу данных на основе обзора литературы, интервью с учеными и анализом открытых источников данных. Результаты показали увеличение частоты регистраций инвазивных видов по мере роста интенсивности ихтиологических исследований. В настоящее время данные виды распространены почти во всех регионах Армении. При этом высота над уровнем моря является единственным очевидно ограничивающим фактором, что, вероятно, связано с температурой воды.