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Import Status of Ornamental Atyidae in the Republic of Korea

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ABSTRACT

The family Atyidae includes over 500 freshwater shrimp species, with ornamental genera *Caridina* and *Neocaridina* widely traded for aquariums. From 2008-2024, 26 million individuals of 37 species were imported into Korea, mainly from Taiwan, Indonesia, and Thailand. Imports rose steadily after 2016, dominated by *Neocaridina heteropoda*, *Neocaridina denticulata*, *Caridina multidentata*, *Neocaridina davidi*, and *Caridina cantonensis*, comprising 94% of individuals. Although none were CITES-listed, eight *Caridina* species are threatened (CR/EN) under IUCN. *N. davidi* is invasive in the U.S. and Japan due to its tolerance and adaptability, and has been found in Germany. Risks include hybridization, disease transmission, and potential ecological disruption if released into the wild. While no ecological damage has yet been reported in Korea, preventive management is needed to avoid escapes and ensure biosecurity in light of increasing imports and ecological risks.

Keywords: Biosecurity, Ecological risk, Import status, International Union for Conservation of Nature and Natural Resources, Ornamental Atyidae

Introduction

The family Atyidae comprises 46 genera and over 500 species distributed worldwide, with an average of 8 new species proposed annually over the past 11 years (Bernardes, 2024). While some species inhabit estuarine and coastal habitats, the majority are strictly freshwater species (De Grave *et al.*, 2008; De Grave & Fransen, 2011), inhabiting bodies of water, including lakes, rivers, and aquatic habitats within caves on all continents except for Antarctica. However, they are predominantly distributed in tropical regions (De Grave *et al.*, 2008; 2015). They also play an important role as consumers in the food web of ecosystems by reducing sediment, increasing algae production, and decomposing leaves (Crowl *et al.*, 2001).

Ornamental Atyidae, comprising the genera *Caridina* and *Neocaridina*, has gained popularity among aquarium enthusiasts due to its vibrant coloration and relatively easy breeding characteristics. They are utilized for ornamental purposes and as a means of maintaining aquatic plant health (Englund & Cai, 1999; Patoka *et al.*, 2016). *Neocaridina davidi* (Bouvier, 1904), more commonly referred to as the cherry shrimp, and *Neocaridina denticulate* (De Haan, 1844) are available for purchase in Korea through both online and offline channels, primarily through aquarium stores. These shrimp exhibit a broad spectrum of color variations, including red, yellow, orange, and blue (Greenfis, 2025). Additionally, continuous crossbreeding is conducted to obtain varieties of different colors (Levitt-Barmats *et al.*, 2019).

The international import and distribution of these

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organisms is not merely a matter of economic activity. Such activities can cause various biological and ecological problems, including ecosystem disruption, introduction of pathogens, competition with native species, and genetic disruption (hybridization) (Šidagytė *et al.*, 2017; Twardochleb *et al.*, 2013; Zhang *et al.*, 2019). Animals that are traded for ornamental purposes are kept in indoor aquariums and released into gardens and urban ponds (Hassall, 2014; Patoka *et al.*, 2017). *N. davidi*, indigenous to Korea, China, and Vietnam (Cai, 1996; Wowor *et al.*, 2004), is considered an invasive species in the United States and Japan due to its tolerance to a wide range of water quality and temperature conditions (Englund & Cai, 1999; Klotz *et al.*, 2013; Niwa, 2010). Only three invasive Atyidae species are listed in South Korea (NIE, 2021), and there is a lack of basic data on import status and other related information. This poses challenges for the effective assessment of their potential risks and the establishment of management policies due to issues such as errors in species identification of imported individuals, inadequacies in field guides and databases, and information asymmetry between distributors and consumers (Keller *et al.*, 2008).

Accordingly, the aims of this study were to investigate the current status of ornamental Atyidae imported into Korea and, based on this, update the list of invasive Atyidae that are likely to be introduced into the domestic ecosystem. This will provide basic data for future ecological risk assessment and biological security management strategies.

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The import/export quarantine statistics of the National Fishery Products Quality Management Service (NFQS) were used to determine the import status of ornamental Atyidae into South Korea from 2008 to 2024 (National Fishery Products Quality Management Service, 2025). The species information on aquatic mollusks whose import has been verified was obtained from the Global Biodiversity Information Facility (GBIF), the International Union for Conservation of Nature and Natural Resources (IUCN), and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (CITES, 2025; Global Biodiversity Information Facility, 2025; IUCN, 2025).

Discussion

Status of Atyidae imports into the Republic of Korea

A total of 26,141,659 Atyidae individuals belonging to 6 genera and 37 species were imported into South Korea for ornamental purposes from 2008 to 2024. The genus *Caridina* accounted for the majority in terms of the number of species (28 species; 75.7%), and the genus *Neocaridina* accounted for the majority in terms of the number of individuals (18,503,495 individuals; 70.8%) (Appendix 1). Among these, *Caridina multidentata* and *Paratya compressa* were identified as species documented in the National Species List (NIBR, 2025).

The annual fluctuations in imports have fluctuated between a low of 2 and a high of 24, rising steadily since 2008, dipping modestly from 2014, and rebounding after 2022 (Fig. 1A). The number of imported individuals was less than 1,000,000 prior to 2015 but has continued to increase, exceeding 1,000,000 since 2016 (Fig. 1B). These findings may be attributed to the fact that, in the context of pet imports, initial interest is spread across a broad spectrum of species. However, as the importation process progresses, interest gravitates toward a select few species that are more amenable to captivity and less demanding in terms of maintenance (Hausmann *et al.*, 2023; Valdez, 2021).

Ornamental Atyidae is imported into South Korea from a total of 13 countries, i.e., Indonesia, the Philippines, the United States, Singapore, Vietnam, Sri Lanka, Taiwan,

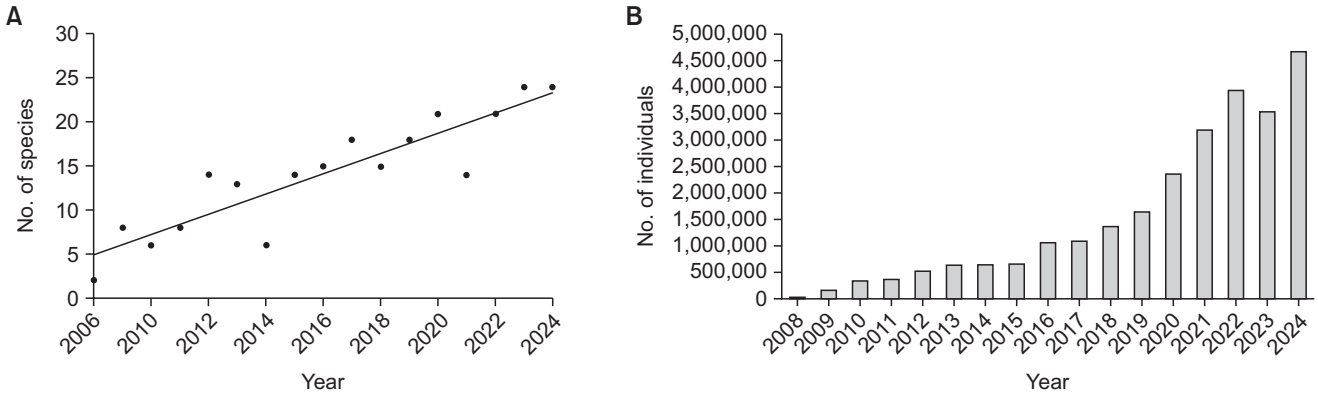

Fig. 1. Annual import status of ornamental Atyidae. (A) Number of species, (B) number of individuals.

Nigeria, Germany, Malaysia, India, China, and Thailand. Of these, Indonesia exported the most species (30), followed by Taiwan (13), Singapore (10), and China (7), with species imported from these four countries accounting for about 91.9% (34 species) of the total. In terms of the number of individuals, Taiwan exported the highest number at 16,415,461 individuals, followed by Indonesia (5,148,325 individuals) and Thailand (4,250,035 individuals). The number of individuals imported from these three countries accounted for approximately 98.7% of the total (Fig. 2B).

Major species

Among the imported species of Atyidae, *Neocaridina heteropoda* was the most prevalent, with a total of 9,879,643 individuals. This was followed by *Neocaridina demticulata*, which accounted for 4,968,114 individuals, *C. multidentata* (4,326,826 individuals), *N. davidi* (3,376,543 individuals), and *Caridina cantonensis* (2,093,899 individuals). These five species collectively constituted 94.3% of the total imported individuals (Fig. 3, Appendix 1) (Cheng, 2025; MSOne, 2025; Watanabe, 2025; Whispers of Aqua, 2025). Atyidae species are commonly farmed for the aquarium trade and have gained popularity as ornamental species due to their diverse coloration, which includes yellow, blue, red, white, and transparent (Kusmintarsih *et al.*, 2025). These species hold economic value in both the aquaculture and aquarium sectors (Hung *et al.*, 1993).

None of the imported Atyidae species was classified as endangered under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). However, six species were identified as critically endangered (CR) and two as endangered (EN) in the IUCN Red List assessment, indicating an extremely high likelihood of

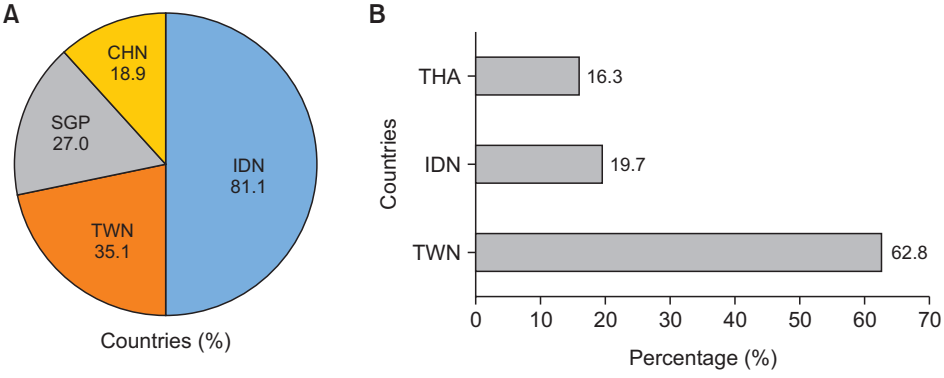

Fig. 2. Major importing countries of ornamental Atyidae. (A) Percentage of species, (B) percentage of individuals. IDN, Indonesia; TWN, Taiwan; SGP, Singapore; CHN, China; THA, Thailand.

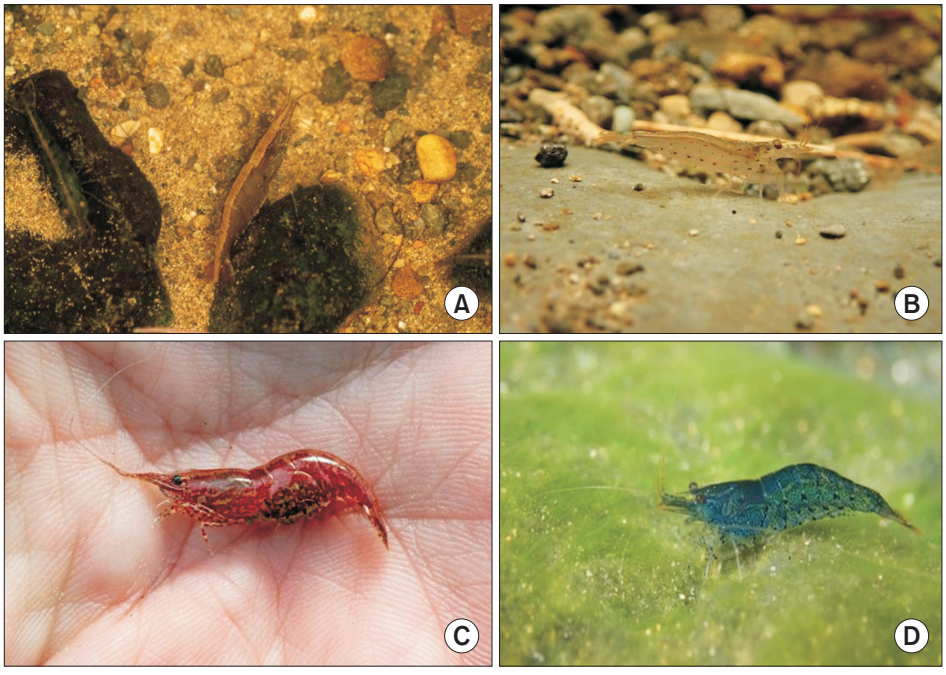

Fig. 3. Major imported species of ornamental Atyidae photos licensed under CC BY-NC 4.0 via Global Biodiversity Information Facility (Source: Cheng, 2025; MSOne, 2025; Watanabe, 2025; Whispers of Aqua, 2025). (A) *Neocaridina denticulata*, (B) *Caridina multidentata*, (C) *Neocaridina davidi*, (D) *Caridina cantonensis*.

extinction in the wild (IUCN, 2025). All eight species classified as CR and EN belong to the genus *Caridina* (Appendix 1).

Ecological risk

Among the ornamental Atyidae, *N. davidi* is regarded as an invasive species in the United States and Japan due to its capacity to tolerate a broad spectrum of water qualities and temperatures (Englund & Cai, 1999; Klotz *et al.*, 2013; Niwa, 2010). Recent findings have also documented its presence in the Rhine River drainage system in Germany (Klotz *et al.*, 2013). Ornamental Atyidae exhibit a high degree of susceptibility to external parasites that can lead to disease and mortality (Klotz *et al.*, 2013). Ciliates are the most well-known pathogenic protozoan ectoparasites, which can rapidly spread among ornamental shrimp hosts and cause significant losses in shrimp under aquaculture conditions (Patoka *et al.*, 2016). Furthermore, slight variations within populations resulting from the hybridization of the Atyidae species have led to the classification of *Neocaridina denticulata sinensis* and *Neocaridina denticulata denticulata* as native species (Cai, 1996; Hung *et al.*, 1993; Oh *et al.*, 2003; Shih & Cai, 2007), making it difficult to determine whether they are native or introduced species.

There have been no reported cases of ecological harm, such as competition with native species, disruption of food webs, habitat destruction, or disease transmission, caused by their introduction into ecosystems to date. However, implementing preventive measures against intentional and unintentional escape from aquariums, which are in the early stages of introduction, is essential given the potential for alien crustaceans to increase predation on native species or introduce new diseases or pathogens, thereby posing a threat to native species (Kusmintarsih *et al.*, 2025). In addition, given that the major exporting countries of Atyidae are located in Southeast Asia, including Taiwan, Indonesia, and Thailand, the species' ability to survive in artificially modified aquatic environments with heated effluent inflows, such as Jukdang Stream in the Republic of Korea, highlights the need for comprehensive surveys of rivers affected by heated discharges to assess its current distribution and potential spread (Park *et al.*, 2025).

Author Contributions

Conceptualization: YP. Data curation: YP, DC, MJ. Formal analysis: YP. Funding acquisition: YP. Writing – original draft: YP. Writing-review & editing: YP.

Conflict of Interest

The authors declare that they have no competing interests.

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Appendix 1. Import status of ornamental Atyidae list in the Republic of Korea (2008-2024)

Scientific name	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Country	IUCN
Atya gabonensis								10	20						440	640	2,110	DEU, NGA	LC
Atyopsis moluccensis		510	170		183					47	1,075	988	165	1235	424	816	9,501	SGP, THA, TWN, IDN	LC
Caridina aristocratensis						185		100										IDN	-
Caridina babaulti					5	1,360			3,600	300			1,000			12,750	13,800	SGP, IND, TWN	LC
Caridina breviata					5													SGP	VU
Caridina caerulea												549	400		100	3389	1513	IDN	VU
Caridina cantonensis				4,630	60,777	94,924	118,255	213,716	379,451	277,658	296,933	237,170	98,401	38,760	124,276	64,850	84,098	TWN, IDN, SGP, CHN, IND, DEU, VNM	LC
Caridina dennerli			400	460	3,220	1,620		530	1,710	2,350	1,930	10,311	63,444	28,572	10,243	15,628	13,857	IDN, CHN, TWN	CR
Caridina glaubrechti							125			700	710	955	1,444		250	5,098	4,363	IDN	CR
Caridina gracilirostris		2,355	29,396	22,396	29,746	27,290	30,090	31,440	25,686	25,900	22,458	35,277	28,020	29,854	23,725	24,540	19,540	SGP, IDN, THA, IND, VNM, LKA	LC
Caridina hodgarti									400							2,000	2,800	IND, IDN	DD
Caridina holthuisi										500			510		300	1,203	2,042	IDN	EN
Caridina loehae											350	805	410		200	703	610	IDN	CR
Caridina longidigita										100						462		IDN	VU
Caridina longirostris												2,400	17,000	6,700			310	TWN, IDN	LC
Caridina maculata								3,700	7,166	2,400					5,000			VNM, TWN	EN
Caridina mariae										200								IDN	-
Caridina multidentata	3,500	39,470	240,797	234,007	310,775	278,512	248,926	220,480	283,260	314,320	325,805	354,125	386,937	342,030	382,502	197,190	164,190	TWM, SGP, IDN	LC
Caridina profundicola													153		400	910	200	IDN	CR
Caridina propinqua		155	3,420	4,460	3,675	500		960										SGP, IDN	LC
Caridina rubropunctata								750	2,500									VNM	DD
Caridina serratirostris		30														710	15	DEU, IDN	LC
Caridina spinata				460	1,220	1,310		200	600	300	965	5,353	4,325	210	1,640	12,922	11,346	IDN	CR
Caridina spongicola				460	3,200	510		100	480	20	1,655	4,211	2,781	210	830	5,048	1,130	IDN, CHN	CR
Caridina striata					1,600	10					500	3,409	2,549		780	4,717	2,495	IDN	CR
Caridina sumatrensis																	10	IDN	LC
Caridina tigri					600					2,400	600	1,407	554					IDN	-
Caridina trimaculatus												600	700	420	300	860		IDN	-
Caridina typus																177,200	229,000	TWN, IDN	LC
Caridina woltereckae										1,500								IDN	CR

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Appendix 1. Continued

Scientific name	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Country	IUCN
Halocaridina rubra														1,000	10,000			USA	-
Neocaridina davidi											360	6,660	1,200	99,030	790,625	710,750	1,767,918	TWN, IDN, PHL	-
Neocaridina denticulata	1,225	94,359	63,286	100,864	113,053	219,833	248,204	147,940	352,272	418,730	489,556	595,266	934,986	489,022	274,198	239,550	185,770	IDN, TWN, MYS, SGP, THA, VNM, CHN	LC
Neocaridina heteropoda		22,960							500	28,650	206,705	339,594	777,370	2,101,838	2,240,036	2,008,950	2,153,040	TWN, IDN, CHN, THA, SGP	DD
Neocaridina serrata		9,535				1,365		19,752										MYS, SGP, IDN, CHN, DEU, TWN	-
Neocaridina zhangjiajiensis					1,638	5,495	1,210	11,620	10,150	4,350	9,666	27,882	32,832	47,600	55,800	35,200	5,100	TWN, IDN, THA	DD
Paratya compressa									2,610									CHN	LC

IUCN, International Union for Conservation of Nature and Natural Resources; IDN, Indonesia; PHL, Philippines; USA, The United States; SGP, Singapore; VNM, Vietnam; LKA, Sir Lanka; TWN, Taiwan; NGA, Nigeria; DEU, Germany; MYS, Malaysia; IND, India; CHN, China; THA, Thailand; LC, least concern; VU, vulnerable; CR, critically endangered; DD, data deficient; EN, endangered.