The Potential of Gastropods Resources in the Kakek Bodo Waterfall Pasuruan, East Java

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Abstract
Gastropoda is the largest class in the phylum Mollusca, consisting of more than 25,000 genera that include snails, land snails, freshwater snails, and other marine animals. Kakek Bodo Waterfall is a tourist attraction located in Pecalukan Village, Prigen Subdistrict, Pasuruan Regency, East Java, and is classified as a freshwater site. Kakek Bodo Waterfall also features a rocky substrate and riverbed, making it a suitable habitat for gastropods. This study was conducted to determine the potential species richness of gastropods found at Kakek Bodo Waterfall. Data collection was carried out using a random sampling method without fixed intervals, employing two stations as sampling points: the first point was located in the stream flowing from Kakek Bodo Waterfall, and the second point was around Kakek Bodo Waterfall. The results of the study revealed the presence of five gastropod families: the Viviparidae family (species *Filopaludina javanica*), the Pachychilidae family (species *Sulcospira testudinaria*), the Buccinidae family (species *Anentome helena*), the Neritidae family (species *Clithon bicolor*), and the Ampullariidae family (species *Pomacea canaliculata*). The presence of gastropods in the area surrounding the waterfall plays a crucial role in the ecosystem, aligning with SDG Goal 15 (Life on Land) and contributing to the conservation and sustainability of terrestrial ecosystems.

Keywords: Gastropods, Identification, Morphology, Morphometry, Ecosystem
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INTRODUCTION

Tourism in Indonesia plays a vital role as a source of foreign exchange earnings for the country's development, given its diverse natural resources, culture, and traditions. One of Indonesia's tourist attractions is waterfalls (Dwi & Liana, 2018). A waterfall is a natural feature that offers a panoramic view of water falling from a height along a permanent river course (Bharata et al., 2022).

One of the natural waterfall tourist attractions in East Java is Kakek Bodo Waterfall. Kakek Bodo Waterfall is located at coordinates 7°41'51''S and 112°37'41''E in Pecalukan Village, Prigen Subdistrict, Pasuruan Regency, East Java. This waterfall is approximately 40 meters high, situated at an elevation of 850 meters above sea level (masl), and features a 40-meter-high cascade (Andini & Kusufa, 2024). Kakek Bodo Waterfall is surrounded by forest, providing dense shade and cool air, and is flanked by rocks that add to its exotic charm. The waterfall's presence significantly influences the diversity of flora and fauna in the surrounding area. This is due to the high humidity and relatively low temperatures in areas near the waterfall (Candrika et al., 2023). The waterfall and its surroundings provide an ideal habitat for several gastropod species, such as snails and land snails. These species benefit from the high humidity, the presence of water, and the abundance of food available around the waterfall.

Gastropods are the largest class in the phylum Mollusca, comprising more than 25,000 genera that include snails, land snails, and other marine animals (Dennis et al., 2021). Gastropods typically have shells, though some species lack them. Some gastropods live on land, while others inhabit marine or freshwater environments (Lestari et al., 2021). Freshwater gastropods can live on the bottom or at the water's surface. The majority of freshwater gastropods prefer to live on the bottom of bodies of water and lay their eggs on the water's surface. Based on their diet, gastropods are classified as algivores,

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detritivores, or filter feeders. Currently, there are approximately 4,000 species of gastropods, particularly freshwater gastropods (Putra et al., 2023).

Gastropods play a very important role in aquatic ecosystems as indicators of water quality. Gastropod diversity can provide insights into the condition of aquatic environments, including water quality and the presence of pollutants. Aquatic environments are highly susceptible to human activities and natural changes, making it crucial to monitor their quality (Safitri et al., 2020). As aquatic organisms, gastropods can reflect various aquatic environmental conditions, including temperature, pH, dissolved oxygen, and the presence of pollutants. Therefore, the environmental conditions of a body of water can be assessed through gastropod diversity (Al-Aqsha et al., 2023).

Gastropods play an important role in ecosystems. Tourist areas experience frequent interaction with humans, which naturally creates the potential for ecosystem changes in those areas. Therefore, it is important to analyze the potential diversity of gastropods in this area. The objective of this study is to explore and analyze the potential gastropod diversity inhabiting the aquatic ecosystem around Kakek Bodo Waterfall. Additionally, this research aligns with SDG Goal 13 ("Life Below Water"), which aims to help preserve gastropod diversity in the terrestrial areas surrounding the waterfall, a key component of the ecosystem cycle. This study is expected to provide new insights into the potential gastropod diversity, as well as the importance of protecting and preserving biodiversity particularly the gastropod group in the Kakek Bodo Waterfall.

MATERIALS AND METHODS

Collection and Sampling Locations. This study was conducted on October 18, 2024, from 7:00 a.m. to 12:00 p.m. WIB at the Kakek Bodo Waterfall area, Pecalukan Village, Prigen Subdistrict, Pasuruan Regency, East Java.

Data collection was conducted using a survey method at several points located at Kakek Bodo Waterfall. Sampling Point 1: The stream flowing from Kakek Bodo Waterfall; the stream has high light intensity, resulting in a temperature of approximately 25°C. Sampling Point 2: The area surrounding Kakek Bodo Waterfall; the waterfall has low light intensity, resulting in a temperature of approximately 18°C.



Figure 1. Map of the sampling locations, Kakek Bodo Waterfall, Pasuruan, East Java.

Sampling Techniques. The sampling method used in this study was the free-collection method. The gastropods collected were those found at each sampling site and were collected at random without adhering to any specific distance. The gastropods that were found were documented using a camera and then placed in collection bottles.

Sample Preservation. The gastropods were rinsed under running water to ensure their shells were clean and easy to identify. The cleaned specimens were placed in collection bottles filled with 70% alcohol. Next, the specimens are labeled on paper labels or tracing paper. After preservation, the

gastropod species are identified and taken to the Animal Taxonomy Laboratory in the Department of Biology, Faculty of Mathematics and Natural Sciences, Surabaya State University.

Morphometric Measurements and Identification. Each gastropod species will be identified by observing morphological characteristics, such as shell shape, shell aperture shape, color, pattern, and number of shell whorls (Rupmana et al., 2022). Data on morphological characteristics will be identified based on references from Brown (2005) and Marwoto (2012), as well as journals on freshwater gastropods. Validation will also be conducted through official websites such as Mollusca Base (https://www.molluscabase.org).

Data Analysis. The analysis used was descriptive analysis, which clearly describes the morphological and morphometric characteristics of the gastropods that were found.

RESULTS

The study identified 5 species from 5 families. The gastropod species found in the Kakek Bodo Waterfall area are *Sulcospira testudinaria*, *Filopaludina javanica*, *Anentome helena*, *Clithon bicolor*, and *Pomacea canaliculata*. The gastropods found in these species belong to five different families: Viviparidae, Buccinidae, Pachychilidae, Neritidae, and Ampullariidae. Each of these species was found at Site 1 the river flowing from Kakek Bodo Waterfall and Site 2 the area surrounding Kakek Bodo Waterfall in Pasuruan and will be identified based on the visible morphological characteristics of the three species.

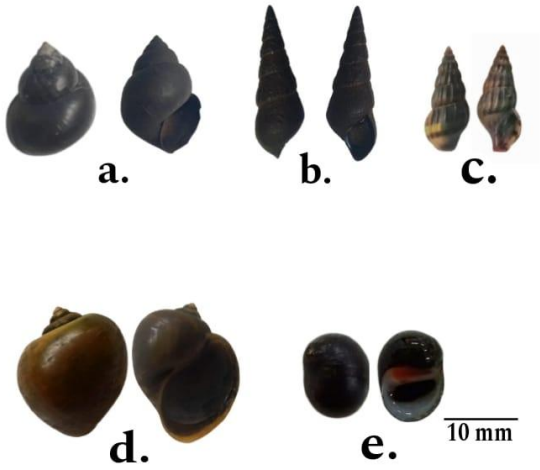


Figure 2. (a) *Filopaludina javanica*, dorsal and ventral views; (b) *Sulcospira testudinata*, dorsal and ventral views; (c) *Anentome helena*, dorsal and ventral views; (d) *Clithon bicolor,* dorsal and ventral views; (e) *Pomacea canaliculata*, dorsal and ventral views.

Morphometric measurements, such as shell length and width, shell shape, and operculum diameter, were taken for these five species, yielding the results shown in **Table 1.**

Table 1. Types of gastropods found in the Kakek Bodo Waterfall, Pasuruan, East Java.

Family	Species	Length (mm)	Width(mm)	Operculum Diameter (mm)
Viviparidae	*Filopaludina javanica*	20	15	10
Pachychilidae	*Sulcospira testudinaria*	30	10	5
Buccinidae	*Anentome helena*	18	8	4
Neritidae	*Clithon bicolor*	20	9	3
Ampullariidae	*Pomacea canaliculata*	30	26	20

DISCUSSION

Table 1, a gastropod belonging to the Viviparidae family was found. Members of the Viviparidae family are characterized by a spiral-shaped (turriform or globular) shell with several whorls; their shells are relatively large for freshwater snails; and their colors vary from black to olive green and brown, sometimes with faint patterns. The species identified from the Viviparidae family is *Filopaludina javanica*; this species is commonly found in various freshwater habitats such as rivers, lakes, rice paddies, and ponds with both calm and fast-flowing currents (Mahruf et al., 2020). This type of gastropod is characterized by a black shell, a rounded shell shape, a right-coiled (dextral) shell, a smooth shell surface without spines or protrusions, a rounded shell opening (aperture), a shell height from the base to the apex reaching 20 mm, a shell width at its widest point reaching 15 mm, an operculum diameter ranging from 10 mm, and 5 whorls on the shell. *Filopaludina javanica* reproduces viviparously, this snail gives birth to live young, but the developing embryos are retained within the mother's body, specifically in the anterior region. This species exhibits high tolerance for its habitat, *Filopaludina javanica* is capable of surviving in polluted waters and reducing organic waste in those waters (Lailiyah et al., 2021).

Another type of gastropod was found at both sampling sites, namely gastropods belonging to the family Pachychilidae. The species found in the Pachychilidae family is *Sulcospira testudinaria*, this species inhabits rivers or lakes with both calm and fast-moving currents. *Sulcospira testudinaria* is also a type of gastropod that lives on the bottom of water bodies with a small amount of sand, mud, or a layer of organic material such as leaf litter (Umam & Wahyuningsih, 2022). Members of this family generally have thick, heavy shells that serve as protection against predators and harsh environments. The shells are tower-shaped (turriform), with spirals that are relatively long compared to those of other families. The shell surface is generally smooth or has minimal ornamentation, such as spiral or axial lines, and shell color varies from dark to pale (Hamli et al., 2020). Within this family, the species *Sulcospira testudinaria* is characterized by a black shell, large shell size, right-handed (dextral) whorl, a thread-like shell shape, a rough-textured shell surface with spiral grooves (sulci) and often axial lines; the shell height from the base to the apex reaches 30 mm; the shell width at its widest point reaches 10 mm; the operculum diameter ranges from 5 mm; the aperture is oval-shaped; the operculum is round; and the number of whorls is 5. *Sulcospira testudinaria*, commonly known as "susuh kura" by local communities, is a freshwater snail belonging to the family Pachychilidae that thrives in various clean water bodies. The shell of *Sulcospira testudinaria* can be used as an adsorbent in community water sources to remove metals, such as from dug wells (Ivontianti et al., 2022).

Another type of gastropod was also found at sampling site 2, specifically from the Buccinidae family. Members of the Buccinidae family inhabit marine, river, lake, swamp, and pond environments, primarily in cold to temperate waters (Suryani & Harahap, 2023). The shells are spiral-shaped and often have a rough or ridged surface. They are typically thick and sturdy, with sizes varying depending on the species (Strong et al., 2021). A species found in this family is *Anentome helena*, this species is characterized by a bright yellow base shell color with alternating black transverse stripes, a large shell size, a right-handed (dextral) whorl, a thread-like shell shape, a rough-textured shell surface with a distinct number of (whorls), and the shell has spiral grooves or ridges along its surface. The shell measures up to 18 mm in height from the base to the apex, up to 8 mm at its widest point, and the operculum diameter ranges from 4 mm; the aperture is narrow and oval-shaped with a slightly pointed tip at the top; the operculum is round and has 6 coils. *Anentome helena* is known as the "killer snail", This species is an obligate carnivore that preys on other small snails. As a result, it helps control excessive snail populations, thereby maintaining the balance of aquatic ecosystems. By preying on invasive species or other competing snails, *Anentome helena* supports the sustainability of natural habitats (Marwoto et al., 2020). In addition to preying on live snails, *Anentome helena* also feeds on dead organisms and food scraps. This aids in the decomposition of organic matter, preventing the buildup of waste that can degrade water quality (Oktafitria et al., 2024).

Gastropods of the family Neritidae were also found at sampling site 1. Members of this family are predators of bivalves and other gastropods; they feed by drilling holes in the shell using their secretory glands. Neritidae can be identified by their shell shape, which features a large body whorl and short, coiled whorls. This family inhabits marine, coastal, and muddy waters, as well as freshwater and terrestrial environments (Anggraini et al., 2021). The species *Clithon bicolor* is characterized by a black shell color on both the dorsal and ventral surfaces, a thick shell, a right-handed (dextral) whorl, a rounded shell shape, a smooth shell surface, a shell height from the base to the apex of up to 20 mm, a shell width at its widest point of up to 9 mm, an operculum diameter ranging from 3 mm, and an aperture shaped like an elongated oval. This species inhabits flowing freshwater bodies.

The gastropods at sampling point 1 belong to the family Ampullariidae. This family inhabits freshwater environments, primarily in tropical and subtropical regions; they are found in swamps, rivers, ponds, and irrigation canals and are able to survive in oxygen-deprived water conditions thanks to their dual respiratory organs (Akbar, 2021). The shells are round to oval in shape with varying colors (green, brown, yellowish, or striped). Sizes can range from small to quite large (reaching diameters of up to 15 cm). They possess an operculum (shell flap) to protect their bodies while hiding (Jatmiko et al., 2021). Within this family, the species *Pomacea canaliculata* is characterized by a yellowish-brown shell color, a large shell size, a right-handed (dextral) shell whorl, a round shell shape, a smooth shell surface, a shell height from the base to the apex reaching 30 mm, a shell width at its widest point reaching 26 mm, an operculum diameter ranging from 20 mm, an oblong aperture, an oblong operculum, and a total of 4 whorls. *Pomacea canaliculata,* commonly known as the golden apple snail, is a freshwater snail native to South America that was introduced to Indonesia around 1980. The golden apple snail is a major agricultural problem, serving as a pest of rice crops in Southeast Asia, particularly in Indonesia (Saputra et al., 2018). This variation can occur because the golden apple snail adapts to humid or waterlogged environments with shallow, flowing water, clear environmental conditions, and water temperatures ranging from 10–35 °C; it can survive in water with a pH of 5–8. Abiotic factors such as high water transparency and the abundance of aquatic plants further support the survival of golden apple snail populations (Chirsto et al., 2024).

The Kakek Bodo Waterfall area boasts extraordinary biodiversity, including a gastropod population that plays a crucial role in maintaining the balance of terrestrial ecosystems, which aligns with Sustainable Development Goal (SDG) 15. Sustainable Development Goal (SDG) 15 emphasizes the protection, restoration, and sustainable use of terrestrial ecosystems. This goal aims to preserve biodiversity, combat land degradation, and prevent the loss of species diversity (Hadi et al., 2024). Gastropods, which include various species of snails and land snails, play a crucial role in terrestrial ecosystems and can contribute to the achievement of SDG 15, particularly regarding biodiversity conservation and ecosystem stability. The species identified *Filopaludina javanica*, *Sulcospira testudinaria*, *Anentome helena*, *Clithon bicolor*, and *Pomacea canaliculata* all serve as bioindicators of environmental quality. If an area experiences degradation—for example, due to heavy metal pollution or climate change the populations of some gastropod species will decline or disappear from that habitat (Ariyanti et al., 2023).

The relatively pristine environmental conditions around the waterfall area provide sufficient nutrients for the growth of macroinvertebrates, thereby optimizing the potential abundance of gastropods (Retnaningdyah et al., 2023). Therefore, protecting gastropods in terrestrial habitats can contribute to monitoring the health of the broader ecosystem, which is linked to efforts to protect terrestrial ecosystems. As part of biodiversity, the conservation of habitats and gastropod-friendly environmental management can help preserve biodiversity and ensure the sustainability of the broader terrestrial ecosystem (Ardyati et al., 2022).

CONCLUSION

Based on the research findings, it can be concluded that five species from five families were found in the Kakek Bodo Waterfall. The species identified were *Sulcospira testudinaria* (family

Pachychilidae), *Filopaludina javanica* (family Viviparidae), *Anentome helena* (family Buccinidae), *Clithon bicolor* (family Neritidae), and *Pomacea canaliculata* (family Ampullariidae). Each species possesses distinctive morphological and morphometric characteristics, adapted to the conditions of its aquatic habitat. The presence of gastropods in the area surrounding the waterfall plays a crucial role in the ecosystem, such as regulating algae populations, recycling nutrients, and supporting soil and vegetation stability due to their role as environmental bioindicators. This aligns with SDG 13 (Life Below Water). By preserving this gastropod diversity, we contribute to the conservation of biodiversity, which is essential for the sustainability of terrestrial and aquatic ecosystems in the region.

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CONFLICT OF INTEREST

The author has no conflict of interest.

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