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Diversity, Composition, and Bioindicator Potential of Aquatic Macroinvertebrates in Asin Hot Spring, Tublay, Benguet

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Abstract

This study assesses the physical, chemical, and macroinvertebrate composition in Asin Hot Spring. Sampling was conducted in 150 meters. The rapid assessment of the integration of the hot spring in the river reveals favorable water parameters; pH, temperature, and TSS are within the quality criteria, and the substratum is characterized by a sandy, rocky substratum. Macroinvertebrates' Shannon-Weiner diversity index is considered moderate diversity. EPT abundance revealed a value of 56 population counts belonging to EPT. The EPT abundance revealed that the river has good population of pollution sensitive insects, revealing a good water quality.

INTRODUCTION

River ecosystems are of immense importance due to their contribution to the overall health of our planet. Rivers play a vital role in maintaining the water cycle, acting as natural channels for the transportation of water from the land to the oceans. They serve as a lifeline for countless species, providing them with essential resources for survival (Unveiling the Ecological Importance of River Ecosystems, 2023). However, human activities like urbanization, agricultural runoff, and industrial discharge are posing a growing threat to these systems, which is causing water quality to worsen (Lapong & Fujihara, 2008). The ecosystem services they provide span comparable scale varying both spatially and temporally in terms of the goods and services they provide human societies, including drinking water, fisheries, regulating services such a flood mitigating and water filtration, supporting services such as maintaining wildlife habitat and biodiversity, and cultural values such as recreation and aesthetics (Alan et al., 2016). Over the years, aquatic ecosystems have been subjected to various human stressors, impacting the hydromorphology, organic compound build-up, sediment characteristics, and physiochemical qualities of water bodies (Elosegi et al., 2010).

Water quality plays a central role in all aspects of living organisms on the earth. Water quality is defined as a measure of water use for different purposes, drinking, industrial, agricultural, recreational, and habitat, suing various parameter as physical, chemical, and biological (Giri and Qiu 2016). Water quality refers to the condition and characteristics of water that determine its suitability for various uses and the health of aquatic ecosystems. It encompasses the chemical, physical, and biological properties of water and the presence of contaminants and pollutants. Monitoring and maintaining good water quality is crucial for human health, ecosystem sustainability, and the overall well-being of communities (SINAY, 2023).

Macroinvertebrate metrics are helpful tools for the assessment of water quality and over all aquatic ecosystem health (Tampo, 2021). Benthic macroinvertebrates are commonly used as indicators of the

biological conditions of waterbodies. They are reliable indicators because they spend all or most of their lives in water, are easy to collect and differ in their tolerance to pollution (US EPA, 2019). It is often used as indicators of aquatic ecosystem health because many species are sensitive to pollution and sudden changes in their environment, community characteristics such as abundance, richness, diversity, evenness, and community composition can be monitors to determine whether the community is changing over time due to natural or human-caused impacts (Regional Aquatics Monitoring Program, n.d). The freshwater macroinvertebrate taxa are varied in response to organic pollution and thus their diversity and composition have been used to make difference about pollution loads (Tampo et al., 2021). Gov.uk. (2006) emphasize that the presence or absence of macroinvertebrates families and their relative proportions may be indicative of the state of the water body. Some benthic macroinvertebrates are tolerant of pollution (such as aquatic worms). Other taxa are sensitive to pollution. The presence or absence of both tolerant and sensitive taxa is important information. Benthic macroinvertebrates experience a variety of other stressors besides pollution. The amount of fine sediment on the stream bottom can impact the stream community (King County, n.d). Benthic macroinvertebrates are valuable bioindicators in freshwater streams and rivers. These organisms live most, if not lives in the water. Macroinvertebrates are relatively easy to collect using dip nets and kick net, and they are “canary in a coalmine” for water pollution (Luell, 2020). Some of the macroinvertebrate-based indices of river health have been proven to be particularly useful and effective, such as the EPT (Ephemeroptera, Plecoptera, Trichoptera) index. The Ephemeroptera, Plecoptera, and Trichoptera (EPT) index is a widely used metric in stream bioassessment.

MATERIALS AND METHODS

Study site

Asin Hot Spring is considered recreational and a spot for relaxation as hot spring water merges with the river. This natural geothermal attraction attracts locals and tourists to experience the natural hot spring. Barangay Tuel in Tublay is an upland farming community near the capital of La Trinidad. It is situated approximately at 16.520°N, 120.5910°E with an elevation of 779.5 msl (Tuel, Tublay, Benguet Profile—PhilAtlas, 1990). The local economy is primarily supported by upland agriculture, including vegetables and root crops (brgy.to, 2020). Asin Hot Spring is also the lower portion of the Bayokbok Falls, the lotic section of the river was opened to the public for ecotourism in 2019. The Sayangan River joined the Balili River at points 16.508194 and 120.568728. The Balili River flows through Bagong, Baguling, and Naguilian before emptying into the Lingayen Gulf.

The study site focus to measure the upper, middle and lower section of the river which the hot springs is situated. A stretch of 150m has been carefully delineated and establish as a primary study area for this research. The three stations allow a spatial analysis of the river’s characteristics. The inclusion of the hot spring location adds a unique geothermal component to the study, potentially influencing water temperature and macroinvertebrate within the designated 150-meter study reach.

Figure 1: Map showing the three sampling stations, Station 1 (upper) Station 2 (middle) and Station 3 (lower) portion of Payay-Asin River Tublay.

Water quality assessment

An onsite water quality assessment was conducted throughout the delineated area. It characterized the substrate of the river. Further, water parameter such as discharge, temperature, total suspended solid and pH were measured during month of April, 20026. The assessment employed a replicate sampling approach, wherein multiple measurements were taken at sampling stations to ensure the accuracy of the results. Discharge is typically calculated as the product of velocity and cross-sectional area. Surface water velocity is the direction and speed with which the water is moving, measured in feet per second (ft/s) or meters per second (m/s). It was calculated with the formula:

$$Q = V * A$$

where:

Q=discharge

V=velocity of moving water in m/s

A= the cross-sectional area of water in the channel

Water temperature were recorded to assess the thermal condition of the river which is important since it influence the availability of dissolved oxygen and reflects the thermal condition of hot spring in the study area. The pH, which measures the acidity and alkalinity of the water via pH paper, and temperature, which determines the thermal conditions of the river. Total suspended solids were measured through gravimetric methods and will reflect the concentration of suspended particles from the surrounding agricultural and residential areas

Macroinvertebrates sampling and identification

A 3 mins kick sampling will be conducted each sampling station to collects the number of macroinvertebrates. Benthic macroinvertebrates will be sample through a D-net. These techniques involve agitating the stones or sediment of a river by foot and catching the sample with net with a mesh is 2mm

(Clayton, 2019). Collection of macroinvertebrates on 10m of chosen habitats using nets while holding the nets facing upstream, disturbing the substratum with the feet so that the macroinvertebrates are washed into the net. this process will continue covering the slow and fast flowing section until 10 meter is sampled (Environmental Protection (Water) Policy 2009 -Monitoring and Sampling Manual Biological Assessment Aquatic Macroinvertebrate Sampling, Processing and Index Calculation, n.d.).

The collected specimens will be identified using photographic guides and taxonomic references. After identification, organism will be counted, and diversity indices will be computed for analysis.

Shannon-Weiner Diversity Index (H')

$$H = \sum_{i=l}^{s} pi(lnpi)$$

where:

Pi=number of individuals of species/total number of samples

S=number od species or species

Relative Abundance

$$RA: \frac{ai}{A} X\ 100$$

where:

ai=number of individuals of species i

A=total number if individuals collected in sampling areas

RESULTS AND DISCUSSION

Water Quality Assessment

The descriptive analysis gives an overview on the variation of water quality parameter in Asin Hot Spring during the sampling period. The results derived from replicated measurements revealed the range of water quality parameter such pH, temperature, TSS and discharge across the sampling points. The results provide a baseline condition of the hot spring river system.

Substratum. The substratum within the 150 meter study area is characterized by gravel and sandy bottom materials. The different sizes of gravel and pebbles pose significant purposes to the survival of aquatic fauna. Substrate is a critical component of river ecosystems and serves as a vital habitat for macroinvertebrates, including the different spatial requirements of macroinvertebrates. Its diverse types play a crucial role in maintaining the ecological structure and functional health of the entire watershed (Wipfli et al., 2007). Coarse-grained substrates can form relatively suitable living spaces, providing an ideal habitat for benthic organisms (Mikuś et al., 2021). The spaces formed by holes and cracks not only serve as ideal refuges for macroinvertebrates to escape threats from predators like fish but also facilitate the growth of algae and the accumulation of organic debris such as dead branches and leaves on the substrate, providing essential food sources for macroinvertebrates' survival (Gao et al., 202). In the study of Hall et al. (2018) in a study conducted in Runswick Bay, northern England, added holes and grooves to large areas of substrate and found that there were 13 species of organisms settling in the grooves, which was five more species than in the holes, including three types of algae and two macroinvertebrates.

Figure 2: Gravel–sandy substratum of the 150-m study reach in Asin Hot Spring, Tublay, Benguet, showing heterogeneous particle sizes that provide habitat and refuge for benthic macroinvertebrates.

Discharge. The river discharge was measured with a flow rate of 56. 995 m^3/s (2,012.83 cfs). Discharge is the most critical flow-related variable when assessing habitat conditions for fish and benthic organisms in streams with flows of up to 5 cfs (cubic feet per seconds) while velocity is more important in streams and rivers with greater flows (Plafkin et al., 1989 Meals & Dressing 2008). The values measure is considered as substantial discharge this feature allows the transport of pollutants. The amount of water discharge influences the dilution capacity of pollutants and other materials. This also influence the sedimentation. Furthermore, the water discharge influences the macroinvertebrate faunal composition by disrupting assemblages' structure and affecting recovery time (Silva-Filho and Maltchik, 2000). The findings of Rocha et al. (2012) on the influence of flow variability, the results showed that macroinvertebrates were more abundant in the late wet phase and in the drying phase. A higher richness was also observed during this period, when new taxa where registered.

Temperature. The water temperature recorded ranges from 24^0C to 25 ^{0}C, with the average value falling from this range, despite the presence of the hot spring it has a narrow temperature range of 1 ^{0}C. The finding does not deviate from the findings of Sitsit et al. (2024) from the water temperature in Balili River ranging from 17 to 24 ^{0}C. The measured value is accepted set by the DENR ranges from 26-30 ^{0}C Class B intended for recreational purposes (Department of Environment and Natural Resources – Environmental Management Bureau, 2016).

TSS. The Total Suspended Solids of the river was recorded the Station 1 and 2 and station 3 does not exceed the 65-ppm water quality standard set by DENR. High measures of total suspended solids indirectly harm aquatic species when solids settle out and clog gills, destroy habitat, and reduce the availability of food. Furthermore, suspended materials in streams promote solar heating, which can increase water temperatures, and reduce light penetration, which reduces photosynthesis, both of which contribute to lower dissolved oxygen. Sediment also can carry chemicals attached to the particles, which can have harmful environmental effects (Nimrod, 2019).

pH. Results of sampling on the different stations exceeded the quality criterion set by DAO (1990), it was recorded that the pH ranges from 8-8.5, similarly to the study conducted by the Bestre et al. (2018) the river measured pH ranges from 8-8.9. This value is attributed to the presence of hot spring which releases sulphuric compounds. Berezina (2001) found that a pH range of 4.09-8.65 resulted in the greatest species diversity among macroinvertebrates. Another study, conducted by Robertson-Brian, Inc (2004) on the topic of optimal conditions for freshwater organisms, stated that freshwater macroinvertebrates would thrive with a water pH ranging from 6.5-8.5.

Macroinvertebrate diversity

A total of 11 species were identified along the 150-meter stretch of the study area. The recorded taxa included *Eurylophella* sp., *Potamanthidae*, *Leptophlebiidae*, *Stone Fly larvae*, *Epeorus* sp., dragonfly nymphs (Order Odonata), caddisfly larvae (Order Trichoptera), as well as the presence of snails (Class Gastropoda), riffle beetles (Family Elmidae), and freshwater crabs.

The species composition provides insight into the structure of the aquatic community inhabiting the area, indicating the presence of both pollution-sensitive and moderately tolerant taxa.

The computed Shannon–Wiener diversity index (H′) was 2.3628, which indicates moderate diversity. This suggests that the study area supports a relatively balanced macroinvertebrate community, although environmental conditions may still impose some limitations on species distribution and abundance.

Figure 3: Aquatic macroinvertebrates collected using kick sampling and D-net methods.

Relative Abundance. The table shows the relative abundance of macroinvertebrate taxa in the study area. *Leptophlebiidae* sp. recorded a relative abundance of 12.36%, indicating its notable presence in the aquatic community. This family belongs to the order Ephemeroptera and is commonly known as prong-gilled mayflies, which are generally considered sensitive to environmental disturbances.

In addition, *Eurylophella* sp. and caddisfly larvae (Order Trichoptera) were among the most abundant taxa observed during sampling. The presence and abundance of these taxa suggest that the study area still supports pollution-sensitive organisms, although varying environmental conditions may influence their distribution.

Land cover is also an important factor influencing macroinvertebrate abundance. According to Sadykova et al. (2025), seminatural areas generally support higher macroinvertebrate abundance, while urbanized land cover is associated with reduced abundance due to habitat degradation and increased environmental stressors.

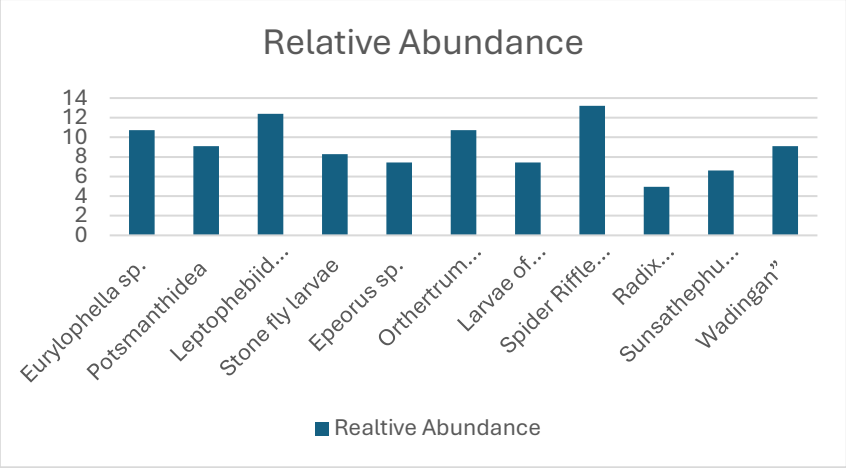

Figure 4: Relative abundance (%) of aquatic macroinvertebrate taxa collected

EPT index as bioindicators

The presence of the EPT (Ephemeroptera, Plecoptera, and Trichoptera) is used as bioindicator of good ecosystem due to the sensitivity of to the pollution and environmental stress. The result showed that EPT abundance of 56 individual. This suggest that the river supports a good population of pollution sensitive taxa. Computed EPT abundance representing 46.28%, this indicates moderate good quality conditions. However, the presence of non-EPT and tolerant taxa such as snails (*Radix rubiginosa*) indicates that some level of environmental stress or habitat alteration may still be present in the ecosystem.

Table 1. EPT counts and abundance

EPT	Count
Eurylophella sp	13
Leptophlebiidae	15
Isonychiidae	10
Speorus sp	9
Stone fly larvae	9
EPT Abundance	56

CONCLUSION

The water quality of Asin Hot Spring was sampled, the river has sandy rocky substratum and discharge flow of 56. 995 m^3/s. Physical and chemical parameters are limited to TSS, pH and temperature, the values are within the water quality criteria set in DAO 34 series (1990). Temperature in the area ranges from 24 to 25 ^0C. pH ranges from 8-8.5.

The macroinvertebrate community recorded a total of 11 species, including pollution-sensitive groups such as Ephemeroptera, Plecoptera, and Trichoptera (EPT). The computed Shannon–Wiener diversity index ($H' = 2.3628$) indicates a moderate level of diversity, suggesting that the ecosystem still supports a relatively balanced aquatic community despite environmental influences.

A total of 56 EPT individuals, suggesting that the river support a good population o-sensitive taxa. The computed abundance of 46.28% indicates moderates good water quality conditions within the river ecosystem.

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