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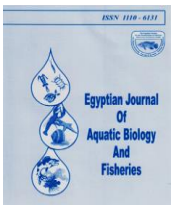

Species Diversity and Distribution of Freshwater Fish in The Mekong River, Northeast of Thailand

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ABSTRACT

The Mekong River holds global significance as a vital source of diverse aquatic resources, essential for sustaining livelihoods in the Mekong basin. This study focused on the fish species diversity at 16 sampling sites in the northeastern part of the Mekong River in Thailand, with data collected monthly from October 2013 to September 2014. A total of 164 fish species, belonging to 11 orders, 32 families, and 97 genera, were identified. The dominant family, Cyprinidae, included 74 species (45.1%). Notably, 153 species were found across all surveyed areas, while 6.7% (11 species) were exclusive to specific locations. Four species—*Parambassis wolffii* (Bleeker, 1850), *Urogymnus polylepis* (Bleeker, 1852), *Scaphognathops stejnegeri* (Smith, 1931), and *Pangasius sanitwongsei* (Smith, 1931)—displayed limited distribution, observed in less than 30% of the surveyed area. This limited distribution is likely due to various alterations to the Mekong River, highlighting the urgent need for conservation efforts to address the potential extinction risk facing these species.

INTRODUCTION

The Mekong River, one of the largest rivers globally, spans a distance of 4,763km since it originates from the Tibetan Plateau and flows toward South China **(Lu & Siew, 2006; Nuon *et al*., 2020)**. The Mekong River Basin comprises the Upper and Lower Mekong Basins, with the Upper Basin passing through China and Myanmar, accounting for 24% of the total basin area **(Lu & Siew, 2006; Mekong River Commission, 2019)**. The Lower Mekong River Basin, which encompasses Cambodia, Lao PDR, Thailand, and Viet Nam, represents about 76% of the entire Mekong River Basin **(Nuon *et al*., 2020)**. Notably, the Lower Mekong River Basin is globally recognized for its exceptional freshwater species diversity **(Mekong River Commission, 2019; Nuon *et al*., 2020)**. Moreover, it plays a critical role in supporting local livelihoods and national economies in the region **(WWF, 2016)**. The fish caught in the Lower Mekong River serve as primary food resources for the basin's inhabitants and are an important source of protein for rural livelihoods **(Baran *et al*., 2003; Na Mahasarakarm, 2007)**.

In recent decades, the Mekong River has experienced a series of transformations that have directly influenced its freshwater species. These transformations encompass various factors, including environmental changes **(Belay *et al*., 2010; Arias *et al*., 2019)**, coupled with anthropogenic activities such as overfishing **(Brown *et al*., 2009; Belay *et al*., 2010)** and dam construction **(Jinpeng *et al*., 2013; Yoshida *et al*., 2020)**. As a result, these alterations affect the livelihoods of communities dependent on the river **(Baran *et al*., 2003; Belay *et al*., 2010; Jinpeng *et al*., 2013; Nuon *et al*., 2020; Yoshida *et al*., 2020; Soukhaphon *et al*., 2021)**, as well as crucial aspects of aquatic life, such as reproduction, spawning, and the distribution of species **(Baran *et al*., 2003; Jinpeng *et al*., 2013; Yoshida *et al*., 2020; Soukhaphon *et al*., 2021)**. Consequently, there is a growing concern that numerous species of aquatic animals in the Mekong River may experience population decline, and even face the risk of extinction. Therefore, species diversity of freshwater fish should be studied in the lower Mekong River, northeast of Thailand.

The research aimed to document the species composition of freshwater fish, shedding light on the diversity and ecological significance of these populations. This study provides a valuable baseline for assessing the status of freshwater fish communities in the Mekong River. The findings will contribute to the development of effective conservation strategies and sustainable management practices aimed at protecting the diverse freshwater fish resources in the Mekong River and promoting the long-term resilience of both the ecosystem and the local communities reliant on these valuable aquatic resources.

MATERIALS AND METHODS

Study area

Daily fish catch samples were collected from the Mekong River between October 2013 and September 2014 at 16 monitoring sites. These sites included:

- Ban Wen Buk, Khong Chiam Subdistrict, Khong Chiam District (S1)
- Ban Pha Chan, Samrong Subdistrict, Pho Sai District (S2)
- Ban Na Muang, Khemarat Subdistrict, Khemarat District, Ubon Ratchathani Province (S3)
- Ban Chanuman, Chanuman Subdistrict, Chanuman District, Amnat Charoen Province (S4)
- Ban Bang Sai Yai, Bang Sai Yai Subdistrict, Mueang District, Mukdahan Province (S5)
- Ban Na Thon, Na Thon Subdistrict, That Phanom District (S6)
- Ban At Samart, At Samart Subdistrict, Mueang District (S7)
- Ban Chai Buri, Chai Buri Subdistrict, Tha Uthen District, Nakhon Phanom Province (S8)

- Ban Lao Luang, Dong Bang Subdistrict, Bueng Khong Long District (S9)
- Ban Bung Khla, Bung Khla Subdistrict, Bung Khla District (S10)
- Ban Kai Si, Kai Si Subdistrict, Mueang Bueng Kan District, Bueng Kan Province (S11)
- Ban Phon Phaeng, Phon Phaeng Subdistrict, Rattanawapi District (S12)
- Ban Dua, Ban Dua Subdistrict, Mueang District (S13)
- Ban Pha Tang, Pha Tang Subdistrict, Sangkhom District, Nongkhai Province (S14)
- Ban Huai Khob, Had Cumpee Subdistrict, Pak Chom District (S15)
- Ban Khong Ngew, Pak Tom Subdistrict, Chiang Khan District, Loei Province (S16) (Fig. 1).

Fish sampling procedures

Fish specimens were obtained from each station using the local fishing gear, including a net, fishnet, hand net, seine, bamboo fish trap, and fishhook, by local fishermen who documented their daily catches in a logbook. The duration of fishing operations varied according to the seasons and gear employed, with typical efforts spanning from 1 to 24 hours. However, the average duration of fishing activity during the study period amounted to approximately 6 to 7 hours per day **(Chea *et al.*, 2016)**. The samples were cleaned and preserved in 10% formalin solution. They were deposited at the Science and Applied Science Center, Buriram Rajabhat University. Fish samples were classified and identified in the laboratory according to **Smith (1945)**, **Vidthayanon (1993)**, **Rainboth (1996)**, and **Froese and Pauly (2024)**.

Water quality measurement

Water quality parameters, including pH (pH meter, INDEX ID1000(, dissolved oxygen (DO(, water temperature (DO meter, HANNA HI9146(, and turbidity (Secchi disk(, were measured every month. These measurements were conducted at a distance of at least 1 meter from the shoreline, ensuring that the sampling locations were representative of the flowing water and devoid of blind spots.

Data analysis

Species richness (SR) was determined using Margalef's formula **(Ludwig & Reynolds, 1988; Clark & Warwick, 1994)**:

$$SR = (S - 1)/\ln N \quad (1)$$

Where:

S = total number of species in each sample;

N = total number of all species.

To assess the similarity of fish communities across study sites, the Bray–Curtis similarity index was employed base on the presence or absence of all species at each site **(Ludwig & Reynolds, 1988)**.

RESULTS

Composition of fish

The fish of the Mekong River in the Northeast of Thailand exhibit considerable taxonomic diversity. A comprehensive survey revealed the presence of 164 species belonging to 11 orders, 32 families, and 97 genera)Table 1(. Cypriniformes was the dominant fish order, accounting for 50.0% of the total number of species (82 species), followed by Siluriformes (22.6%))Fig. 2(. Similarly, the family Cyprinidae constituted the most abundant group within the catch, which comprised 74 species)45.1%(, followed by Siluridae)6.1%(and Pangasiidae)6.1%( )Fig. 3(.

In our study, S1, S2, S6, S8, S10, and S12 exhibited the highest number of fish orders, each containing 11 orders. The greatest number was observed at S1, S2, S10, and S13, with a total of 32 families recorded. Furthermore, S1, S2, S10, and S13 had the highest number of fish genera, with 97 genera observed, followed closely by site S2 with 96 genera. In contrast, S4, S5, and S7 contained the lowest number of orders, families, and genera, with 9 orders, 28 families, and 91 genera, respectively (Table 1).

Among the 16 monitoring sites, S1 exhibited the highest species richness, followed by S2 and S12, respectively. On the other hand, S4, S5, and S7 reported the lowest species richness (Table 1).

The cluster analysis based on species abundance identified four distinct groups representing fish assemblage patterns across the surveyed sites. Group 1 included samples from Amnat Charoen, Mukdahan, Nakhon Phanom, and some sites in Ubon Ratchathani Province. This group was further divided into two subgroups comprised of subgroup 1a (S3, S7, S4, and S5) and subgroup 1b (S6 and S8). Group 2 encompassed the fish community from all samples in Loei Province, as well as some sites from Bueng Kan and Nongkhai Province, consisted of two subgroups. Subgroup 2a consisted of S14 and S16, and subgroup 2b contained S9, S11, S13, and S15. Group 3 comprised the fish community in Ban Wen Buk, Ubon Ratchathani Province, while group 4 included S2, S10, and S12. The smallest of the four primary groups, group 3, comprised all of the survey samples (Fig. 4).

During the survey, 153 species were found at all the sites, with the exception of 11 fish species discovered at certain stations. The least frequently encountered species was *Parambassis wolffii* (Bleeker, 1850), which was only found at S1, indicating that the species was endangered. Similarly, *Urogymnus polylepis* (Bleeker, 1852), *Scaphognathops stejnegeri* (Smith, 1931), *Pangasius sanitwongsei* (Smith, 1931), *Pangasius krempfi* (Fang & Chaux, 1949), *Macrochirichthys macrochirus* (Valenciennes, 1844), *Anguilla marmorata* (Quoy & Gaimard, 1824), *Wallago leerii* (Bleeker, 1851),

Boesemania microlepis (Bleeker, 1858), *Datnioides undecimradiatus* (Roberts & Kottelat, 1994), and *Hemitrygon laoensis* (Roberts & Karnasuta, 1987) were also observed at specific stations (Table 1).

Water quality parameter

Water quality parameters exhibited variations influenced by seasons and sampling sites. During the rainy season, the water in the Mekong River exhibited higher turbidity due to its deeper water level and faster flow. In contrast, during the summer, the water level was shallower, and the flow was slower, resulting in clearer water. The water quality parameters exhibited a range of values: dissolved oxygen ranged from 5.2 to 8.0mg/ L, pH from 6.3 to 8.7, water temperature from 22.6 to 33.8°C, and turbidity from 19 to 153cm.

DISCUSSION

Fish diversity

The Mekong River, renowned as a major global river, exhibits remarkable fish biodiversity **(Valbo-Jorgensen *et al*., 2009)**. Previous studies indicate that the fish population in the Mekong River comprises around 1,200 species, with the possibility of reaching up to 1,700 species **(Coates *et al*., 2003)**.

In the present study, 164 fish species across 97 genera were found in the Mekong River, Northeast Thailand, between October 2013 and September 2014. This number is higher than the 124 fish species recorded from four watersheds in the Eastern, Chao Phraya, Peninsular, and Maeklong regions of central Thailand during 2000-2004 in the studies of **Choi *et al.* (2005)** and **Panchan *et al*. (2013)** who recorded 54 fish species in the Chi River, Mahasarakham province, Thailand, during June-August 2011. On the other hand, the number of fish species in our study was lower than the 204 species in 114 genera reported by **Ngor *et al*. (2018a)**, found in the Tonle Sap River and Lake between 2012 and 2015, and the 182 species in 110 genera recorded by **Chea *et al.* (2016)** at 38 sites along the Lower Mekong River from December 2000 to November 2001. The variation in fish species between these studies may be attributed to differences in habitat characteristics among the study sites **(Ngor *et al*., 2018b)**. Additionally, fish distribution may be influenced by factors such as temperature, water quality, and precipitation **(Sunardi *et al*., 2012; Guo *et al*., 2015; Chea *et al*., 2016; Manjarrés-Hernández *et al*., 2018; Chemagin *et al*., 2020; Ama-Abasi *et al*., 2022)**. In addition, only 79 species of fish matched those recorded in Thailand in 1945 **(Smith, 1945)**. These changes in the composition of freshwater fish species are likely attributed to various alterations to the Mekong River, including pollution **(Coates *et al*., 2003; Chea *et al*., 2016)**, habitat destruction **(Brown *et al*., 2009)**, the construction of dams **(Kang *et al*., 2009; Jinpeng *et al*., 2013; Ngor *et al*., 2018b; Soukhaphon *et al*., 2021)**, environmental degradation **(Belay *et al*., 2010)**, exotic species **(Belay *et al*., 2010; Allen *et al*., 2012)**, climate

change **(Zhao *et al*., 2015; Soukhaphon *et al*., 2021)**, and the water quality **(Chea *et al*., 2016; Sor *et al*., 2021; Soukhaphon *et al*., 2021)**, which have contributed to the decline of aquatic organisms in the Mekong River over time.

From the results presented, Cypriniformes was the dominant fish order)50.0%), which is consistent with the findings of **Kang *et al*. (2009)** and **Chea *et al*. (2016)**, who found Cypriniformes as the dominant fish order in the Upper Mekong River (72.2%) and the Lower Mekong River (29.7%), respectively. Correspondingly, **Ngor *et al*. (2018a)** mentioned that the dominant fish order in the Tonle Sap River and Lake was Cypriniformes (49.0%).

According to the results of the current study, the family Cyprinidae dominated the captured fish, comprising 74 species (45.1%). This finding is consistent with that of **Panchan *et al.* (2013)**, who reported that Cyprinidae was the dominant fish group in the Chi River, Mahasarakham Province, Thailand, accounting for 44.4% of the species. Similarly, Cyprinidae was the dominant family in the the Tonle Sap River and Lake (39.2%) **(Ngor *et al*., 2018a)** and the Lower Mekong Basin (31%) **(Nuon *et al*., 2020)**. These consistent results across various studies confirm that Cyprinidae is the most prevalent family across multiple water bodies **(Valbo-Jorgensen *et al*., 2009; Rodmongkoldee *et al*., 2011; Jinpeng *et al*., 2013; Chea *et al*., 2016; Esmaeili *et al*., 2017; Ngor *et al*., 2018a; Ngor *et al*., 2018b; Bahouar *et al*., 2024)**. This is likely due to their tolerance of a wide range of conditions and adaptability to changing environments **(Kim & Kim, 2009; Goo *et al*., 2018)**.

The 16 monitoring sites exhibited diverse habitat characteristics, which influenced the distribution of fish species. The highest abundance of fish was observed at S1 (Ban Wen Buk, Khong Chiam District, Ubon Ratchathani Province), where the Mun River merges with the Mekong River. This site is characterized by deep and wide waters, with surface area and water depth being key factors influencing the abundance of aquatic animals **(Feiner *et al*., 2016; Ngor *et al*., 2018a)**. Higher species diversity was found in regions with deeper water and larger surface areas **(Ngor *et al*., 2018a)**. Extensive flooding and increased water depths create larger living areas and a more stable ecological environment by enhancing habitat connectivity and accessibility **(Ngor *et al*., 2018a)**. This favorable situation enables fish species to colonize new environments effectively, leading to an increased biodiversity **(Henriques-Silva *et al*., 2013)**.

Water quality

In this study, the sampled areas within the same region exhibited relatively similar climatic conditions, indicating a minimal variation. Consequently, the climate did not influence the composition of freshwater fish species across the sampling site. However, distinct variations in water quality parameters, water depth, and water surface area were observed between seasons, leading to noticeable effects on the species caught. During the rainy season, the water had high turbidity and rapid flow, accompanied by greater water

depth and extensive surface coverage. Conversely, the water was clear, shallow, and had a slower flow rate during the dry season.

From this survey, higher fish diversity was observed during the dry season, consistent with the findings of **Chea *et al*. (2016)** in their study of the Lower Mekong River. During this period, fish tend to aggregate in deep pools, microhabitats, or the main river course. In contrast, during the wet season, fish are expected to spread out more widely when the river expands, resulting in greater inundation of floodplains and increased habitat diversity **(Silvano *et al*., 2000; Chea *et al*., 2016)**.

Fish diversity management and conservation

The Mekong River ecosystem, known for its diverse ecosystems and abundant natural resources, has provided the local community with essential aquatic resources for sustenance and distribution. However, the community has observed a decline in these resources over the past few years, with changes in water quantity and flow patterns. The community attributes these changes to the construction of a dam, which they believe is causing the decline and extinction of aquatic animals. Previous research has demonstrated the negative impact of regulated rivers, hydrological alterations, flow disruptions, and unstable seasonal flow patterns on fish species diversity **(Phomikong *et al*., 2014; Röpke *et al*., 2017; Ngor *et al*., 2018b)**.

Based on the survey, certain fish species exhibit restricted distributions in specific areas. Notably, *Parambassis wolffii* (Bleeker, 1850), *Urogymnus polylepis* (Bleeker, 1852), *Scaphognathops stejnegeri* (Smith, 1931), and *Pangasius sanitwongsei* (Smith, 1931) were observed in less than 30% of the surveyed area, indicating their limited distribution. This restricted distribution may be due to specific habitat requirements, ecological factors, or anthropogenic impacts. Without immediate action, these fish species in the Mekong River are at risk of extinction.

CONCLUSION

The Mekong River is one of the most diverse fish populations in the world. However, the relentless pursuit of economic expansion and human activity has led to alterations in habitats and environments, thereby impacting species composition and biological diversity. Conservation of biodiversity in the Mekong River is therefore urgently needed. This study provides important baseline data on the current state of fish diversity and serves as a valuable resource for decision-making regarding the long-term preservation and management of freshwater biodiversity in the Mekong River, particularly in the northeastern region of Thailand.

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