The 4th Thailand International Symposium on Natural History Museums:
Era of Ecosystem Restoration, 95–111.

The preliminary observation field survey on diversity and ecology of fishes in Ma Basin, Laos PDR

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Article History
Received: 15 February 2024
Accepted: 3 July 2024
Published Online: 8 August 2024

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Abstract

The field survey conducted two time per year with wet season from 28–31 May 2023 and dry season from 6–14 December 2023, in the Ma river basin, Et district, Houaphanh Province northern of Laos PDR. There were six sampling sites for the fishing gear surveys including market surveys. The sampling method used mainly experimental gillnet surveys (GNS) as well as biological parameters associated with participation from local fishermen. The results of fish species based on 1,359 specimens collected in total revealed eight orders 17 families and 46 species. We found that Cyprinidae was the most dominant family with 24 species in total (52.17%), 38 species shared with the northern Vietnam fish fauna included the southern China, while five species shared with the Mekong fish fauna and three species are exotic species. There are 483 specimens with 34 species and 876 specimens with 37 species in the wet and dry seasons, respectively. The water temperature in the wet season was high ranging 30.83–35.4 ºC the dry season was low ranging 22.76–24.98 ºC.

Keywords
diversity, ecology, fishes, Ma Basin, Lao PDR

Introduction

The Mekong basin is a large part of the Indochinese region covering 810,000 km^2 (Rainboth *et al*., 2012). The lower Mekong basin (LMB) comprises 183,000 km^2 from 62 sub-basin as 90% of the watershed area of the country (Phanthamala, 2015). Two rivers of Ma and Nam Neun/Ca river basin outside of the Mekong river basin in Lao PDR, occupies the other 10% of watershed (Phongpachith, 2005). The Ma river from the mountainous area with an elevation of 2,178 m a.s.l. in the northern part of Vietnam and flows to the Houaphanh Province in Laos PDR westward and then Vietnam again eastward with length 512 km covering area 28,400 km^2 (37.6% in Laos PDR, 62.4% in Vietnam) (Doan *et al*., 2015) The largest tributaries of the Ma River include the Nam Et and Nam Xam (Chu as it is called in Vientnam) (Global

Citation. Philavong, S., J. Grudpan. and C. Grudpan. 2024. The preliminary observation field survey on diversity and ecology of fishes in Ma Basin, Laos PDR. In *The 4th Thailand International Symposium on Natural History Museums: Era of Ecosystem Restoration* on 21–22 December 2023 at Rama 9 Museum Thailand: 95–111 pp.

Environment Facility 2019).

The mainstream of the Ma river flows through Houaphan and Xieng Khouang Provincein Laos 80 km, having water volume 20.2 km3 annually to serve area 1,751.33 km^2 under irrigation (Zuklin *et al*., 2021). The Government planned expansion of irrigation up to 2,159.52 km^2, supporting plantation with 1,973.08 km^2 rice crop, 8.56 km^2 perennial crop, 59.22 km^2 sugar cane, 52.99 km^2 arable land, and 65.67 km^2 aquacultural farm (Global Environment Facility, 2019). To accomplish this plan requires the flow 49–61 m^3/s (Chung *et al*., 2017). According to recent climate change, the Ma river is regarded as an concerned issue (Doan *et al*., 2015). The Et river is a main tributary of the Ma river system in Laos, having width having width 131.81–189.28 m one space, depth 0.89–2.51 m and temperature 20.90–23.00 ^{0}C (Global Environment Facility, 2019). This river originates from Nam Et Phou Louey National Park of Laos (NEPL NPA) where is the largest protected area 5,959 km^2 with the elevation 400–2,280 m m.s.l. and location at 20.136°E 103.649°N (Johnson, 2012).

Most previous studies have been focused on fish fauna of the Mekong River basin, western of Lao PDR. Rainboth *et al*. (2012) reported more than 1,200 species from the Mekong basin including estuary and marine ecosystem. Nagao Natural Environment Foundation (2021) recorded 568 species found in fresh and brackish-water area of the Indochinese Mekong. However, the fish fauna of the eastern Lao RDP bordering to Vietnam were little known and most associated research were conducted. A 68 native species were recorded from the freshwaters of Vietnam (from the Ca River basin northwards) and immediately adjacent waters in China and Laos. Farraris (2002) recorded 268 species from the freshwaters of the northern Vietnam. Nguyen *et al*. (2023) recorded 150 species from the river basins in the northern part of central Vietnam. Huu Duc *et al*. (2015) reported 110 species belonging to 69 genera and 20 families from the red river. The objective of this study is to document the preliminary observation on the diversity and ecology of fishes from the Mar River in the eastern Lao PDR.

Materials and Methods

Study areas

The six sampling sites were conducted including the Ma river (MR) for three sites and the Et river (ER) for three sites and other Makets. These sites were in Et district, Houaphanh province, northern Lao PDR (latitude 20°46’47.86’’N and longitude 103°58’01.98’’ E) with the average elevation 298 m a.s.l. The sites are also located nearby Lao–Vietnam border, about 12 km far from Chieng Khoung District, Son La Province, Vietnam. The samplings were conducted in two seasons including. The wet season from 28–31 May 2023 and the dry season from 6–14 December 2023. GPS and overview map of sampling sites were shown in Table 1 and Figure 1, respectively.

Table 1. GPS and locality information of sample sites (WGS 84).

Cods	Locality name	Wet season, date	Dry season, date	Elevation, m a.s.l.	Location, WGS 84
MR-S1	Vang Thana	28 May 2023	08 December 2023	321	104°06’80.75’’E 20°49’00.83’’N
MR-S2	Pak Nam Et	29 May 2023	10 December 2023	339	104°01’33.67’’E -20°49’19.90’’N
MR-S3	Ban Luu Villager	29 May 2023	10 December 2023	295	103°59’14.52’’E 20°50’10.03’’N
ER-S4	Fish Conservation Zone	30 May 2023	11 December 2023	296	103°58’01.98’’E 20°46’47.86’’N
ER-S5	Na Man Villager	30 May 2023	09 December 2023	346	103°56’23.37’’E 20°41’44.73’’N
ER-S6	Na Khouang Villager	31 May 2023	09 December 2023	316	103°56’20.75’’E 20°41’53.77’’N

Ma river (MR-S1, MR-S2, MR-S3) mainstream and Et river (ER-S4, ER-S5, ER-S6) tributary.

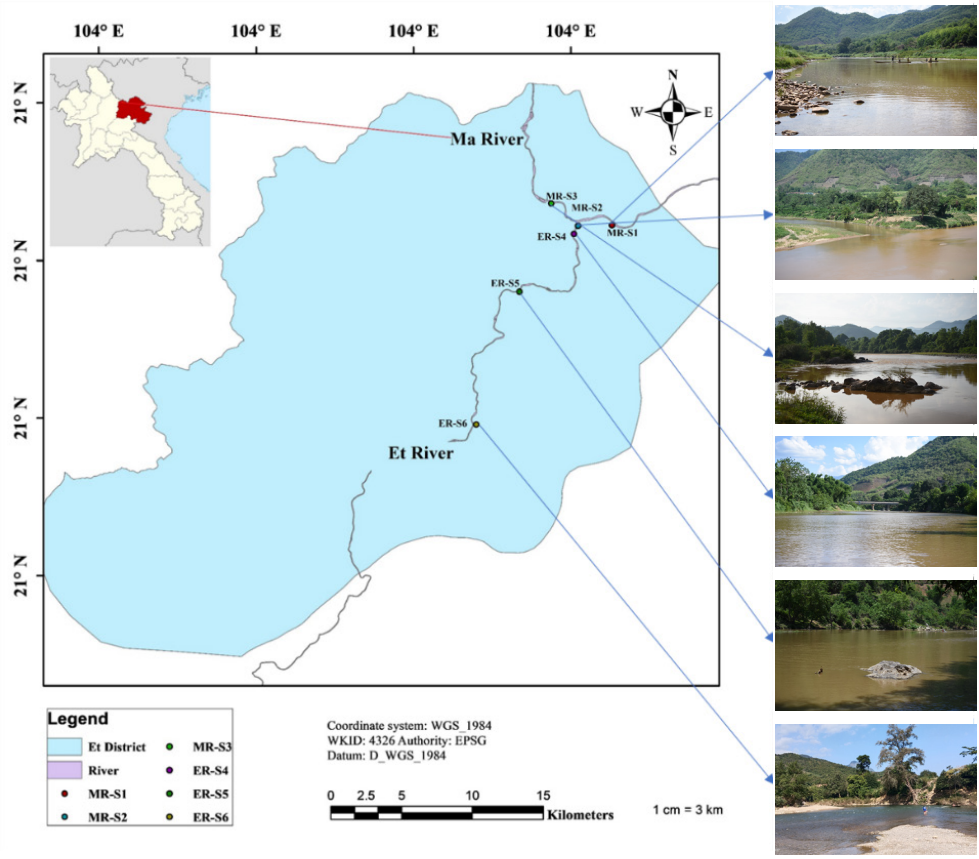

Figure 1. Map locality of sample sites in the Ma and Et rivers in Et District, Houaphanh Province norther of Lao PDR: A, site 1 in Vang Thana, Ma river (MR-S1); B, sites 2 in Pak Nam Et, Ma river (MR-S2); C, site 3 in Ban Luu, Ma river (MR-S3); D, site 4 in Fish Conservation Zone, Et river (ER-S4); E, site 5 in Na Man, Et river (ER-S5); and F, site 6 in Na khouang, Et river (ER-S6), and market.

Fish samples

There were three types of fish sampling methods: gillnet surveys (GNS) having net size as 50 m long and 3.5 m depth with 5 different mesh sizes such as 2 cm, 3 cm, 4 cm, 5 cm and 6 cm; 2) cast net with net size as 3.5 m high, mesh size 5 cm catching area 3 m^2; and 3) seine net with net size a 10 m long, 2 m high and mesh size 5 mm The operation of fishing conducted 100 m along river line for 1 hour. The fish specimens obtained were fixed 10% formalin in the field and after two weeks changed to 70% ethanol, they were identified to species by using recent publications (Clarke and Warwick, 2001; Chen and Kottelat, 2003). The systematic arrangement followed. Fricke *et al*. (2024). Location abbreviations indicated as sampling sites at Ma river 1, 2 and 3 (MR-S1, MR-S2 and MR-S3); sampling sites at Et river 4,5 and 6 (ER-S4, ER-S5 and ER-S6); Et market (ET-MK); Sam Neua market (SN-MK); Nam Neun market (NN-MK); Na Por market (NP-MK); Tha Si Nam-market (TS-MK); Nam Ngum market (NNG-MK); and Nam Neung market (NNE-MK).

Water environmental variables

The water samples collected from sample sites were detected by various parameters including temperature (Te ^{0}C), Dissolved oxygen (DO, mg/l), pH measured by Hanna HI-98194 multiparameter water quality Meter; Ammonium (NH4, g/l), Nitrate (NO3, mg/l), Nitrate (NO3, mg/l), Phosphate (PO4, mg/l), Sulphide (SiO3, mg/l), Total hardness (CaCO3, mg/l), Magnesium (Mg, mg/l) and Potassium (Pr, mg/l) measured by electronic equipment PF-12 Plus of machine-made (MN); Water depth (m) tested by HONDEX depth meter portable ultrasonic sounding device PS-7 and Formatter (m/s) taken by electric current meter a DENTEN-Measurement range of CMT-10 CM: 0.03–3.00 m/s electronic equipment and elevation tested by GPS (OREGOM-750) (Zare-Shahraki *et al*., 2022; Levin *et al.,* 2021).

Statistical analysis

The specimen groups and water environmental variables were analyzed by Past statistical software, version 4.06b. The specimen groups were constructed by using Upson multivariate in ordination with canonical correspondence (CCA). The species diversity was evaluated by clustering classical in two-way analysis and clustering neighbor joining with species following Zhang *et al*. (2020); Chen *et al* (2023).

Results

Fish diversity

In wet season, the number of specimens was 483 specimens belonging 34 species in 17 families and eight orders based on number of specimens, the major groups included data on dry season are Cyprinidae (61.10%), Danionidae (14.29%), Cichlidae (5.80%), and Nemacheilidae (3.93%) and in the dry season, the field surveys in sampling and market sites obtained 876 specimens belonging to 37 species in 13 families and eight orders based on number of specimens, the main groups comprised of Gobiidae (31.73%), Balitoridae (25.46%), Cyprinidae (20.32%) and Cichlidae (5.71%).

Checklist of fish species

Order Cypriniformes

Family Xenocyprinidae (Wet season 1.24%; dry season 1.71%)

1. *Chanodichthys recurviceps* Richardson, 1846 (Figure 2A)

Wet season, 3 specimens (0.62%): ER-S5, 2 specimens (29 May 2023); ER-S5, 1 specimen, 29 May 2023.

2. *Xenocypris macrolepis* Bleeker, 1871 (Figure 2)

Wet season, 3 specimens (0.62%): ER-S4, 2 specimens, 29 May 2023; MR-S1, 1 specimen, 30 May 2023. Dry season, 15 specimens (1.71%): MR-S1, 12 specimens, 08 December 2023; SN-MK, 1 specimen, 13 December 2023; NN-MK, 2 specimens, 13 December 2023.

Family Danionidae (Wet season 14.29%; dry season 1.37%)

3. *Opsariichthys dienbienensis* Nguyen & Nguyen, 2000 (Figure 2C)

Wet season, 69 specimens (14.29%): NN-MK, 54 specimens, 27 May 2023; MR-S3, 4 specimens, 29 May 2023; ER-S5, 7 specimens, 29 May 2023; MR-S1, 3 specimens, 30 May 2023; MR-S2, 1 specimen, 30 May 2023. Dry season, 12 specimens (1.37%): MR-S1, 1 specimen, 8 December 2023; ET-MK, 1 specimen, 9 December 2023; MR-S2, 8 specimens, 10 December 2023; MR-S3, 1 specimen, 10 December 2023; NN-MK, 1 specimen, 13 December 2023.

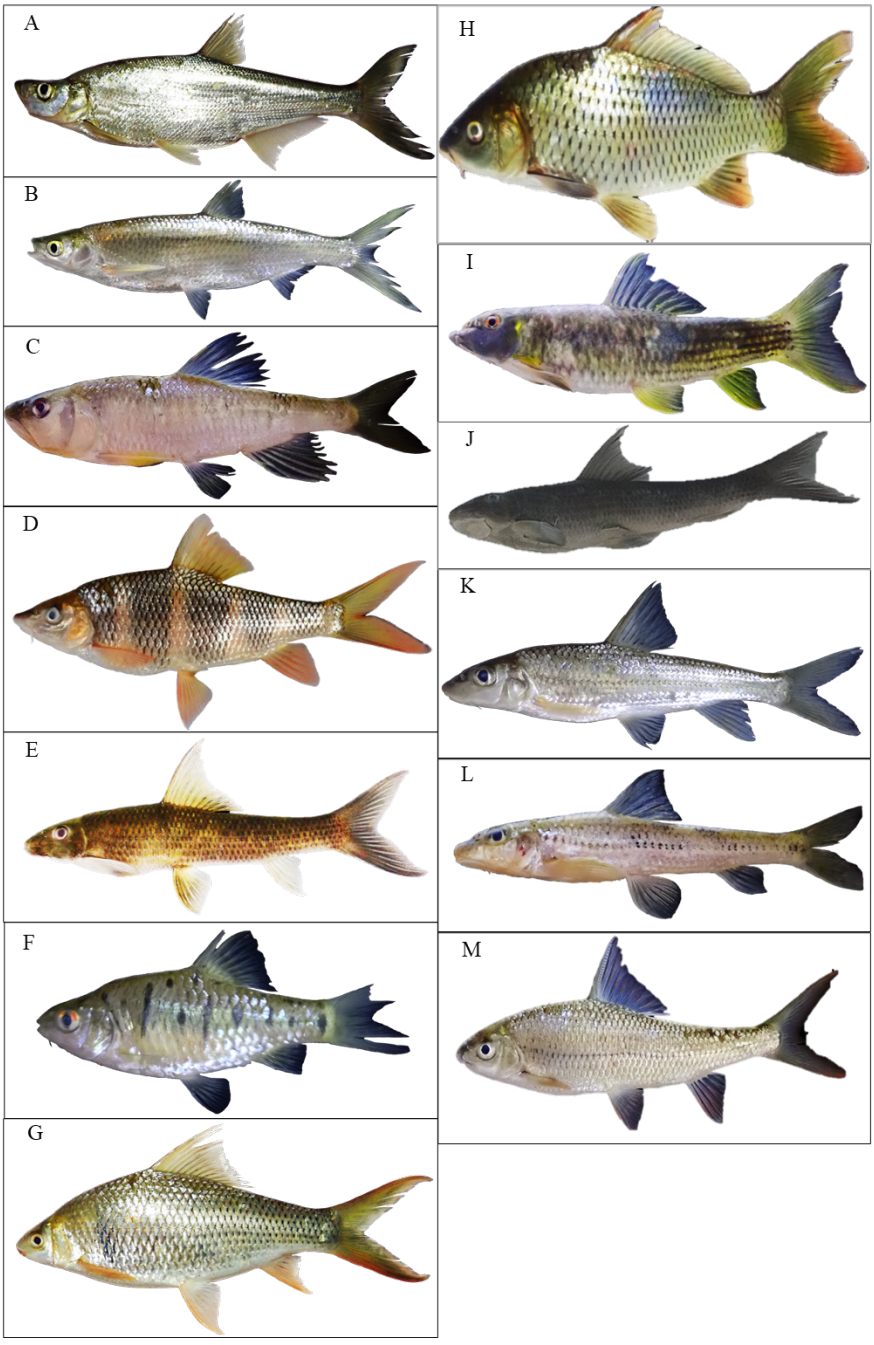

Figure 2. A, *Chanodichthys recurviceps,* B, *Xenocypris macrolepis*; C, *Opsariichthys dienbienensis*; D, *Acrossocheilus xamensis*; E, *Ageneiogarra theunensis*; F, *Barbodes semifasciolatus*; G, *Cirrhinus molitorella*; H, *Cyprinus sp*; I, *Garra bourreti*; J, *Garra poilanei*; K*, Hemibarbus labeo*; L, *Hemibarbus maculatus*; M, *Onychostoma lepturus.*

Family Cyprinidae (Wet season 61.10%; dry season 20.32%)

4. *Acrossocheilus xamensis* Kottelat 2000 (Figure 2D)
Wet season, 17 specimens (3.52%): ER-S6, 6 specimens, 28 May 2023; ET-MK, 1 specimen, 29 May 2023; SN-MK, 10 specimens, 1 June 2023.

5. *Ageneiogarra theunensis* Kottelat, 1998 (Figure 2E)
Dry season, 2 specimens (0.23%): TS-MK, 2 specimens (6 December 2023).

6. *Barbodes semifasciolatus* Günther, 1868 (Figure 2F)
Wet season, 8 specimens (1.66%): MR-S3, 8 specimens (31 May 2023). Dry season, 1 specimen (0.13%): MR-S3, 1 specimen (10 December 2023).

7. *Cirrhinus molitorella* Valenciennes, 1844 (Figure 2G)
Wet season, 3 specimens (0.62%): ER-S6, 1 specimen (28 May 2023); ER-S4, 2 specimens (29 May 2023).

8. *Cyprinus* sp. (Figure 2H)
Dry season, 1 specimen (0.13%): ET-MK, 1 specimen (8 December 2023).

9. *Garra bourreti* Pellegrin, 1928 (Figure 2I)
Wet season, 3 specimens (0.62%): NN-MK, 3 specimens, 27 May 2023. Dry season, 1 specimen (0.11%): NN-MK 1 specimen,13 December 2023.

10. *Garra poilanei* Petit & Tchang, 1933 (Figure 2J)
Wet season, 3 specimens (0.62%): SN-MK, 3 specimens, 1 June 2023. Dry season, 3 specimens (0.34%): SN-MK, 3 specimens, 13 December 2023.

11. *Hemibarbus labeo* Pallas, 1776 (Figure 2K)
Wet season, 13 specimens (2.69%): NN-MK, 13 specimens, 27 May 2023. Dry season, 1 specimen (0.13%): SN-MK, 1 specimen, 13 December 2023.

12. *Hemibarbus maculatus* Bleeker, 1871 (Figure 2L)
Wet season, 29 specimens (6.00%): NN-MK, 9 specimens, 27 May 2023; ER-S6, 2 specimens, 28 May 2023; ER-S5, 16 specimens, 29 May 2023; ET-MK, 2 specimens, 29 May 2023. Dry season, 21 specimens (2.40%): ER-S5, 3 specimens, 9 December 2023; ET-MK, 17 specimens, 11 December 2023; SN-MK, 1 specimen, 13 December 2023.

13. *Onychostoma lepturus* Boulenger, 1900 (Figure 2M)
Wet season 28 specimens (5.80%): NN-MK, 9 specimens, 27 May 2023; ER-S6, 3 specimens, 28 May 2023; ER-S5, 16 specimens, 29 May 2023. Dry season, 13 specimens (1.48%): TSNNG-MK, 1 specimen, 6 December 2023; NP-MK, 2 specimens, 6 December 2023; ER-S5, 1 specimen, 9 December 2023; ER-S6, 5 specimens, 9 December 2023; ET-MK, 1 specimen, 9 December 2023; ET-MK, 3 specimens, 11 December 2023.

14. *Onychostoma ovale* Pellegrin & Chevey, 1936 (Figure 3A)
Wet season, 4 specimens (0.83%): NN-MK, 2 specimens, 27 May 2023; ET-MK, 2 specimens, 29 May 2023.

15. *Osteochilus salsburyi* Nichols & Pope, 1927 (Figure 3B)
Dry season, 2 specimens (0.23%): SN-MK, 2 specimens, 13 December 2023.

16. *Paraspinibarbus macracanthus* Pellegrin & Chevey, 1936 (Figure 3C)
Wet season 5 specimens (1.02%): ER-S6, 1 specimen, 28 May 2023; ER-S4, 3 specimens, 29 May 2023. Dry season, 15 specimens (1.71%): MR-S1, 12 specimens, 8 December 2023; MR-S3, 3 specimens, 10 December 2023.

17. *Poropuntius krempfi* Pellegrin & Chevey 1934 (Figure 3D)
Wet season, 11 specimens (2.28%): NN-MK, 9 specimens, 27 May 2023; ER-S6, 2 specimens, 28 May 2023. Dry season, 11 specimens (1.26%): ER-S5, 2 specimens, 9 December 2023; ER-S6, 1 specimen, 9 December 2023; ET-MK, 2 specimens, 11 December 2023; SN-MK, 6 specimens, 13 December 2023.

18. *Sarcocheilichthys hainanensis* Nichols & Pope, 1927 (Figure 3E)
Wet season, 4 specimens (0.83%): NN-MK, 4 specimens, 27 May 2023. Dry season, 4 specimens (0.46%): NN-MK, 4 specimens, 13 December 2023.

19. *Scaphiodonichthys macracanthus* Pellegrin & Chevey, 1936 (Figure 3F)
Wet season, 3 specimens (0.62%): NN-MK, 2 specimens, 27 May 2023; ET-MK, 1 specimen, 29 May 2023. Dry season, 5 specimens (0.57%): NP-MK, 1 specimen, 6 December 2023; TSNNG-MK, 1 specimen, 6 December 2023; ET-MK, 3 specimens, 9 December 2023.

20. *Spinibarbus caldwelli* Nichols, 1925 (Figure 3G)
Wet season, 8 specimens (1.66%): NN-MK, 5 specimens, 27 May 2023; ET-MK, 1 specimen, 29 May 2023; SN-MK, 2 specimens, 1 June 2023. Dry season, 2 specimens (0.23%): SN-MK, 2 specimens, 8 December 2023.

21. *Spinibarbus maensis* Nguyen, Duong & Tran 2007 (Figure 3H)
Wet season 139 specimens (28.78%): NN-MK, 21 specimens, 27 May 2023; ER-S6, 4 specimens, 28 May 2023; ER-S4, 6 specimens, 29 May 2023; ET-MK, 24 specimens, 29 May 2023; MR-S1, 4 specimens, 30 May 2023; ER-S2, 80 specimens, 30 May 2023. Dry season, 96 specimens (10.9%): MR-S1, 3 specimens, 8 December 2023; ER-S5, 21 specimens, 9 December 2023; ER-S6, 26 specimens, 9 December 2023; ER-S2, 1 specimen, 10 December 2023; MR-S3, 2 specimens, 10 December 2023; ER-S4, 14 specimens, 11 December 2023; SN-MK, 28 specimens, 13 December 2023; NN-MK, 1 specimen, 13 December 2023.

22. *Squalidus atromaculatus* Nichols & Pope, 1927 (Figure 3I)
Wet season, 22 specimens (4.50%): NN-MK, 13 specimens, 27 May 2023; ER-S5, 3 specimens, 29 May 2023; ET-MK, 6 specimen, 29 May 2023.

23. *Squaliobarbus curriculus* Richardson, 1846 (Figure 3J)
Wet season, 2 specimens (0.41%): MR-S1, 2 specimens, 30 May 2023.

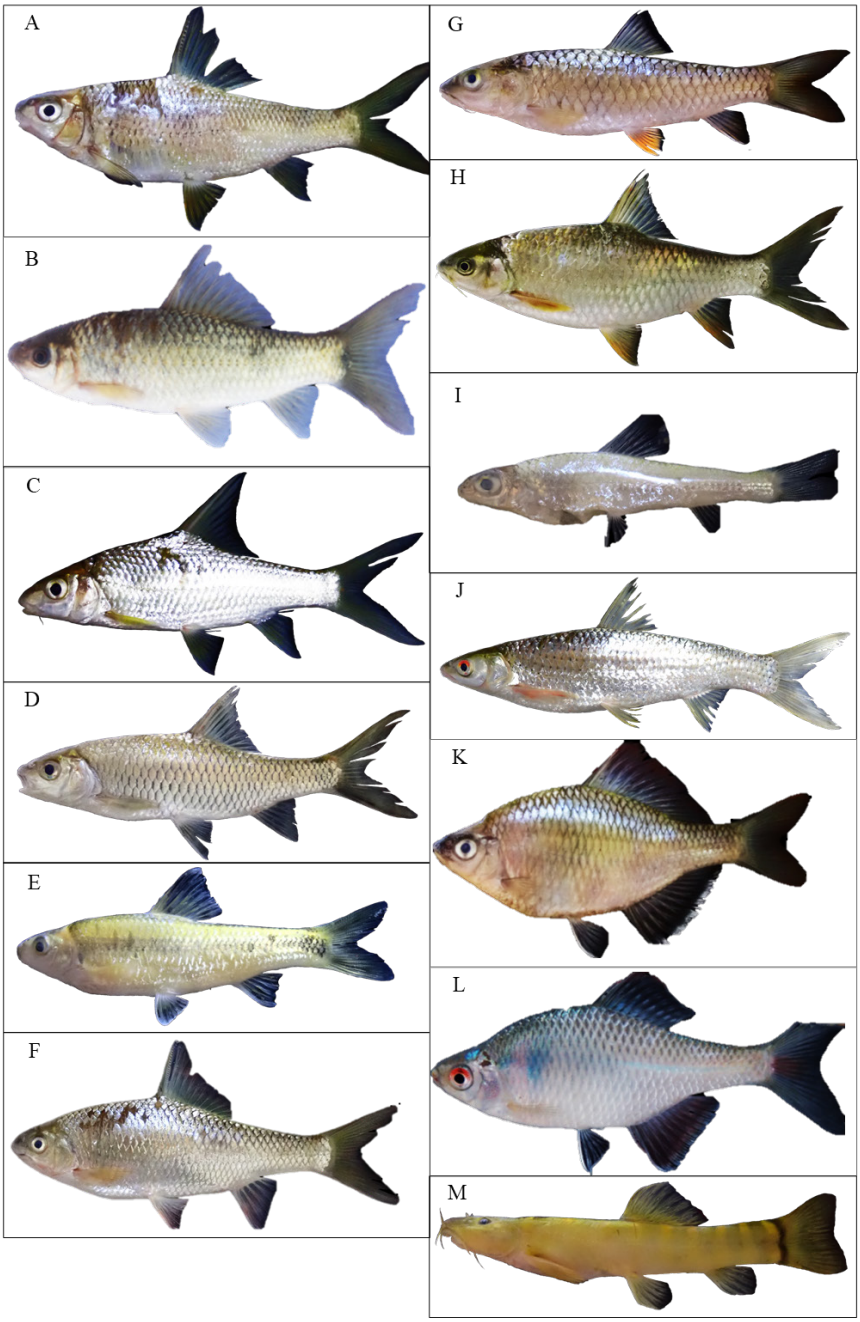

Figure 3. A, *Onychostoma ovale*; B, *Osteochilus salsburyi*; C, *Paraspinibarbus macracanthus;* D, *Poropuntius krempfi;* E, *Sarcocheilichthys hainanensis*; F, *Scaphiodonichthys macracanthus*; G, *Spinibarbus caldwelli;* H, *Spinibarbus maensis*; I, *Squalidus atromaculatus;* J, *Squaliobarbus curriculus*; K, *Acheilognathus longibarbatus*; L, *Rhodeus ocellatus*; M, *Schistura fasciolata.*

Family Acheilognathidae (Wet season 2.90%; dry season 1.50%)

24. *Acheilognathus longibarbatus* Mai, 1978 (Figure 3K)
Wet season, 14 specimens (2.9%): NN-MK, 9 specimens, 27 May 2023; ER-S6, 1 specimen, 28 May 2023; ER-S5, 1 specimen, 29 May 2023; ET-MK, 2 specimens, 29 May 2023; MR-S2, 1 specimen, 30 May 2023. Dry season, 12 specimens (1.37%): NN-MK, 12 specimens, 13 December 2023.

25. *Rhodeus ocellatus* Kner, 1866 (Figure 3L)
Dry season, 1 specimen (0.13%): MR-S3, 1 specimen, 10 December 2023.

Family Nemacheilidae (Wet season 3.93%; dry season 2.74%)

26. *Schistura fasciolata* Nichols & Pope, 1927 (Figure 3M)
Wet season, 19 specimens (3.93%): NN-MK, 19 specimens, 27 May 2023. Dry season, 21 specimens (2.40%): ET-MK, 5 specimens, 8 December 2023; ER-S5, 3 specimens, 9 December 2023; ET-MK, 1 specimen, 9 December 2023; MR-S3, 5 specimens, 10 December 2023; ET-MK, 1 specimen, 10 December 2023; NNE-MK, 6 specimens, 13 December 2023.

27. *Schistura* sp. (Figure 4A)
Wet season, 3 specimens (0.34%): ER-S5, 2 specimens, 9 December 2023; MR-S2, 1 specimen, 10 December 2023.

Family Balitoridae (Wet season 0.83%; dry season 25.46%)

28. *Balitora* sp. 1 (Figure 4B)
Dry season, 7 specimens (0.80%): ET-MK, 6 specimens, 8 December 2023; MR-S3, 1 specimen, 10 December 2023.

29. *Balitora* sp. 2 (Figure 4C)
Dry season, 7 specimens (0.80%): ET-MK, 3 specimens, 8 December 2023; ER-S5, 1 specimen, 9 December 2023; and ET-MK, 3 specimens, 10 December 2023.

30. *Gastromyzon leveretti* (Nichols & Pope, 1927) (Figure 4D)
Dry season, 2 specimens (0.23%): ET-MK, 2 specimens, 8 December 2023.

31. *Sinogastromyzon rugocaudus* Mai, 1978 (Figure 4E)
Wet season, 4 specimens (0.83%): ET-MK, 4 specimens, 29 May 2023. Dry season, 207 specimens (23.63%): ET-MK, 197 specimens, 8 December 2023; ET-MK, 10 specimens, 10 December 2023.

Family Cobitidae (Wet season 0.21%)

32. *Misgurnus anguillicaudatus* Cantor, 1823 (Figure 4F)
Wet season, 13 specimen (2.69%): SN-MK, 13 specimens, 1 June 2023.

Order Characiformes

Family Prochilodontidae (Wet season 0.41%)

33. *Prochilodus nigricans* Spix & Agassiz, 1829 (Figure 4G)
Wet season, 2 specimens (0.41%): ER-S4, 2 specimens, 29 May 2023.

Order Siluriformes

Family Siluridae (Wet season 1.86%)

34. *Pterocryptis cucphuogensis* Mai, 1978 (Figure 4H)
Wet season, 1 specimens (0.20%): NN-MK, 1 specimen, 27 May 2023.

Family Bagridae (Wet season 1.24%; dry season 0.68%)

35. *Hemibagrus vietnamicus* Mai, 1978 (Figure 4I)
Wet season, 6 specimens (1.24%): ER-S6, 2 specimens, 28 May 2023; ER-S4, 2 specimens, 29 May 2023; SN-MK, 2 specimens, 1 June 2023. Dry season 6 specimens (0.68%): NN-MK, 6 specimens, 13 December 2023.

Family Clariidae (Wet season 0.68%)

36. *Clarias fuscus* (Lacepède, 1803) (Figure 4J)
Dry season, 6 specimens (0.68%): NNG-MK, 6 specimens, 14 December 2023.

Family Sisoridae (Wet season 1.66%; dry season 5.25%)

37. *Glyptothorax honghensis* Li, 1984 (Figure 4K)
Wet season, 4 specimens (0.83%): NN-MK, 4 specimens, 27 May 2023. Dry season, 1 specimen (0.57%): ET-MK, 1 specimen, 9 December 2023; NN-MK, 4 specimens, 13 December 2023.

38. *Glyptothorax interspinalum* Mai, 1978 (Figure 4L)
Wet season, 4 specimens (0.83%): NN-MK, 4 specimens, 27 May 2023. Dry season, 41 specimens (4.68%): ET-MK, 1 specimen, 8 December 2023; ET-MK, 40 specimens, 10 December 2023.

Order Synbranchiformes

Family Mastacembelidae (Wet season 0.41%; dry season 0.23%)

39. *Mastacembelus armatus* Lacepède, 1800 (Figure 4M)
Wet season, 1 specimen (0.41%): ER-S5, 1 specimen. Dry season, 2 specimens (0.23%): ER-S5, 1 specimen, 9 December 2023; SN-MK, 1 specimen, 13 December 2023.

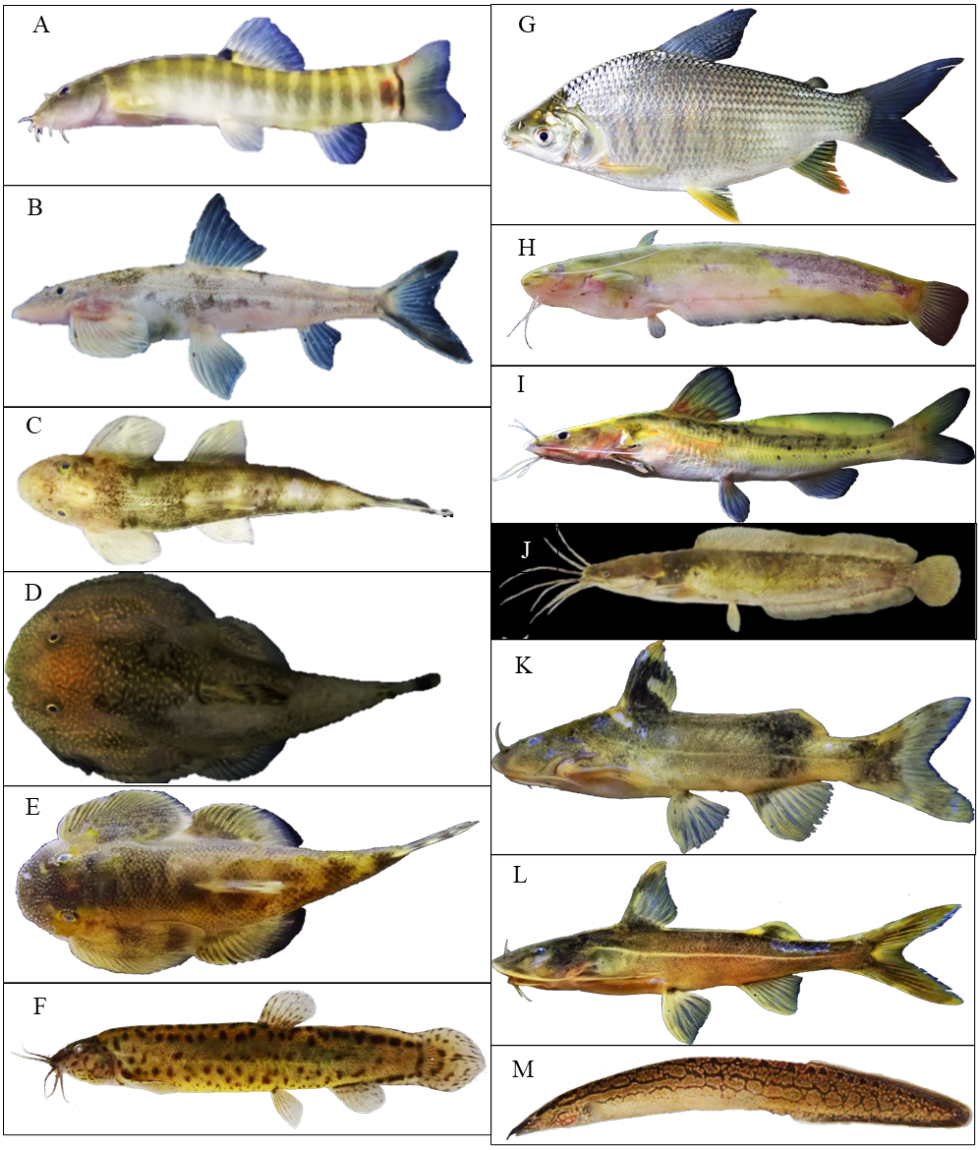

Figure 4. A, *Schistura* sp.; B, *Balitora* sp. 1; C, *Balitora* sp. 2; D, *Gastromyzon leveretti*; E, *Sinogastromyzon rugocaudus*; F, *Misgurnus anguillicaudatus*; G, *Prochilodus nigricans*; H, *Pterocryptis cucphuogensis;* I, *Hemibagrus vietnamicus;* J, *Clarias fuscus;* K, *Glyptothorax honghensis*; L*, Glyptothorax interspinalum*; M, *Mastacembelus armatus.*

Order Cichliformes

Family Cichlidae (Wet season 5.80%; dry season 5.71%)

40. *Coptodon zillii* Gervais, 1848 (Figure 5A)
Wet season, 28 specimens (5.80%): NN-MK, 6 specimens, 27 May 2023; ER-S5, 1 specimen, 29 May 2023; MR-S1, 4 specimens, 30 May 2023; MR-S2, 3 specimens, 30 May 2023; MR-S3, 14 specimens, 31 May 2023. Dry season, 50 specimens (5.71%): MR-S1, 4 specimens, 8 December 2023; ER-S5, 13 specimens, 9 December 2023; MR-S2, 31 specimens, 10 December 2023; MR-S3, 2 specimens, 10 December 2023.

Order Anabantiformes

Family Channidae (Wet season 1.45%; dry season 2.51%)

41. *Channa limbata* Cuvier, 1831 (Figure 5B)
Wet season, 7 specimens (1.45%): NN-MK, 2 specimens, 27 May 2023; ET-MK, 2 specimens, 29 May 2023; MR-S3, 3 specimens, 31 May 2023. Dry season, 20 specimens (2.28%): MR-S1, 1 specimen, 8 December 2023; MR-S2, 2 specimens, 10 December 2023; MR-S3, 5 specimens, 10 December 2023; NNG-MK, 12 specimens, 14 December 2023.

42. *Channa striata* Bloch, 1793 (Figure 5C)
Dry season, 2 specimens (0.23%): NNG-MK, 2 specimens, 14 December 2023.

Order Gobiiformes

Familly Gobiidae (Wet season 2.69%; dry season (31.73%)

43. *Rhinogobius honghensis* Chen, Yang & Chen, 1999 (Figure 5D)
Wet season, 2 specimens (0.41%): MR-S3, 2 specimens, 31 May 2023. Dry season, 219 specimens (25.00%): NNE-MK, 219 specimens, 13 December 2023.

44. *Rhinogobius nammaensis* Chen & Kottelat, 2001 (Figure 5E)
Dry season, 42 specimens (4.79%): ER-S5, 13 specimens, 9 December 2023; ET-MK, 23 specimens, 9 December 2023; ET-MK, 6 specimens, 10 December 2023.

45. *Rhinogobius similis* Gill, 1859 (Figure 5F)
Wet season, 11 specimens (2.28%): MR-S1, 3 specimens, 30 May 2023; MR-S2, 2 specimens, 30 May 2023; MR-S3, 6 specimens, 31 May 2023. Dry season, 17 specimens (1.94%): MR-S1, 5 specimens, 8 December 2023; MR-S2, 6 specimen, 10 December 2023, MR-S3, 6 specimens, 10 December 2023.

Order Perciformes

Family Sinipercanidae (Dry season 0.13%)

46. *Siniperca vietnamensis* Mai, 1978 (Figure 5G)
Dry season, 1 specimen (0.13%): SN-MK, 1 specimen, 13 December 2023.

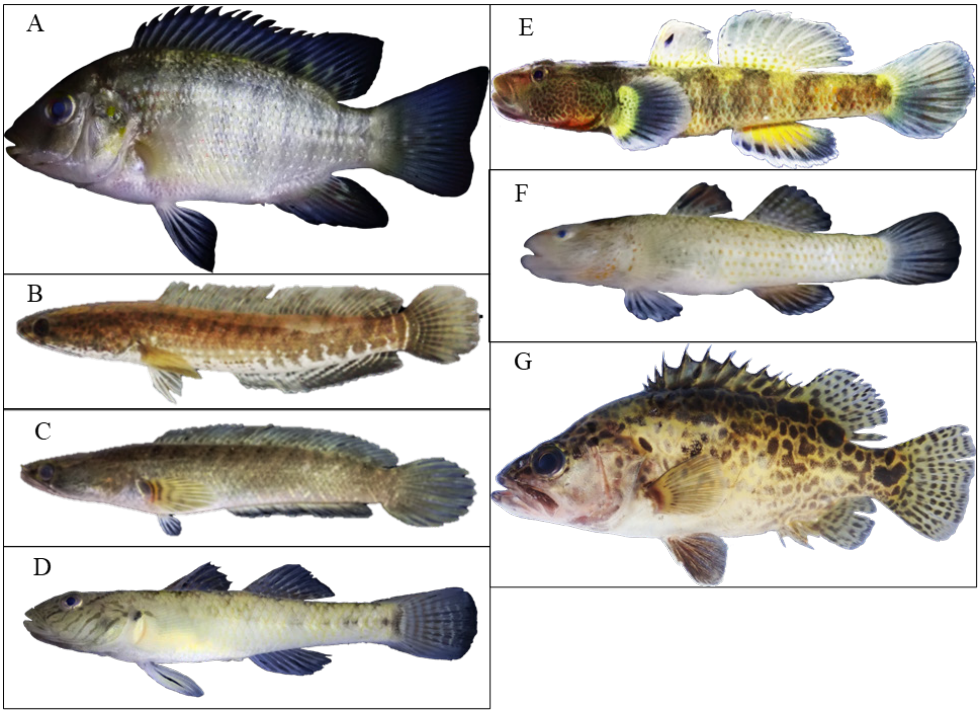

Figure 5. A, *Coptodon zillii*; B, *Channa limbata*; C, *Channa striata*; D, *Rhinogobius honghensis*; E, *Rhinogobius nammaensis*; F, *Rhinogobius similis*; G, *Siniperca vietnamensis*.

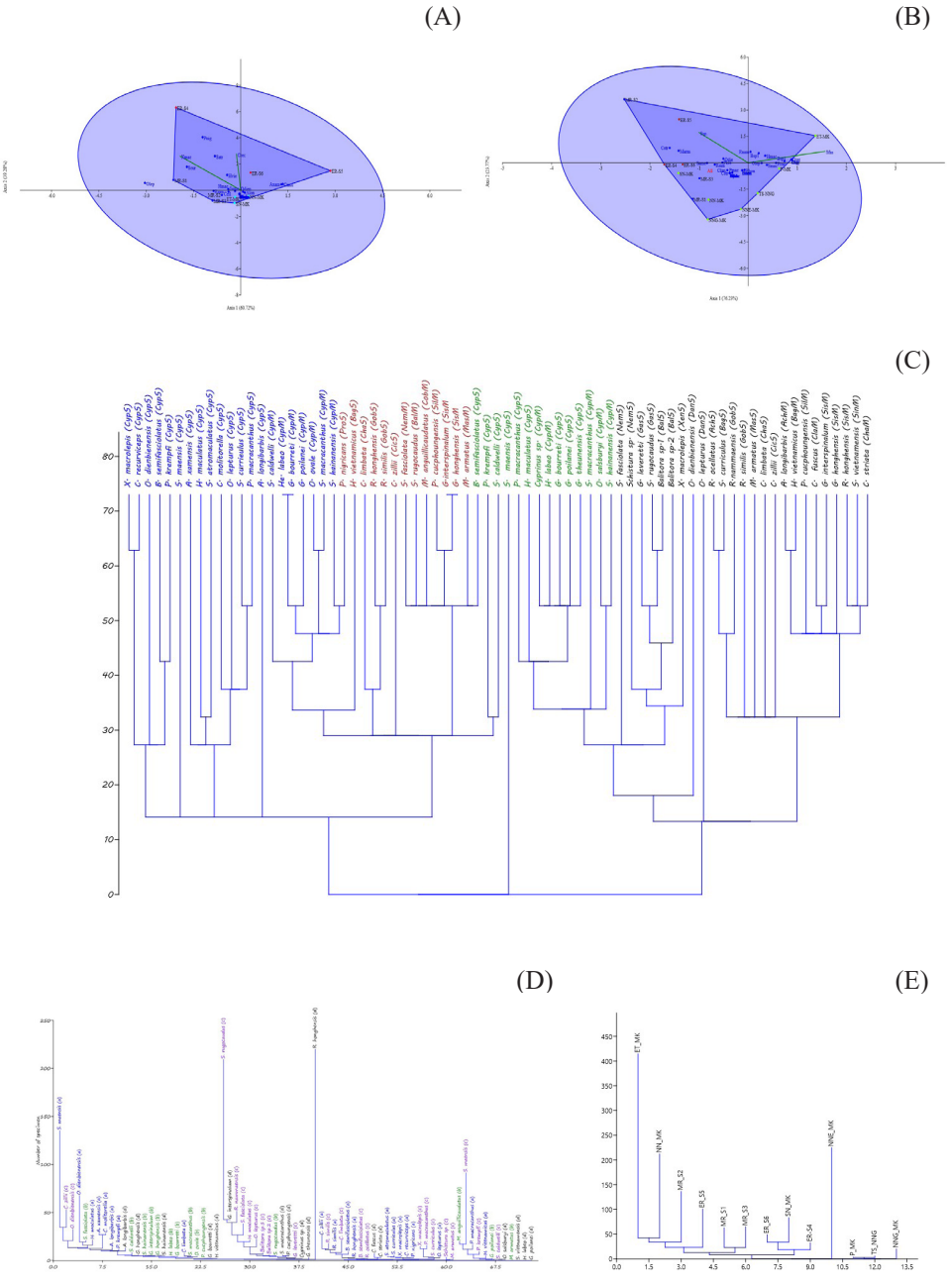

Figure 6. Status of richness and diversity metrics in specimen from field survey in wet and dry seasons by variables were analyzed by CCA axis: (A). Specimens from dry season in sample and other market sites found 483 specimens Belonging to 34 species (Axis1, 60.72% and Axis2, 39.28%): (B). Specimens from dry season in sampling and market sites included 876 specimens belonging to 39 species (Axis1 76.23% and Axis2, 23.77%) no significant (p>0.05);

(C). Comply with specimen group of two season with 1,359 specimens in total (483+876) The group of wet season; (W) indicated 34.36% sampling sites 28.74%[(a)] and maket sites 5.62%[(b)]) and group of dry season; (D) represented 65.64% sampling sites 43.99%[(c)] and market sites 21.64%[(d)]) by using two-way stratigraphic analysis in Past statistical software (Hoang *et al*. 2021); (E). The group clusters were constructed based on the number of specimens.

Water environmental variables in sample sites

The water parameters showed difference between Ma river (MR) and Et river (ER) in the wet season from 28–31st May 2023, and dry season from 8–13th December 2023 in the Et district see in Figure 7).

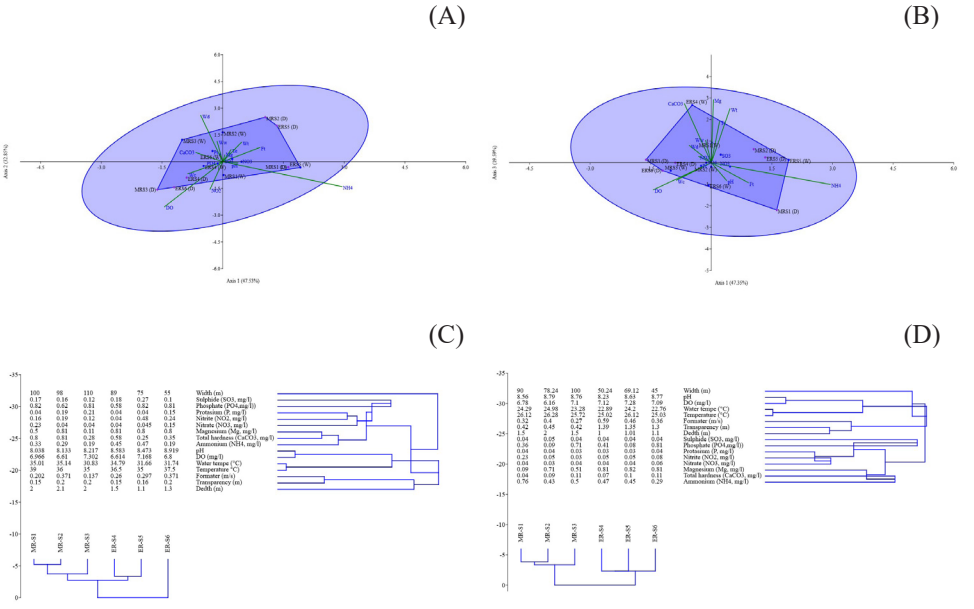

Figure 7. Status of richness and diversity metrics in relation to environmental stressors at Ma river and Et river in the dry and wet seasons: Eigenvalue of wet (A) and dry (B) seasons were constructed by the environmental variables loading to CCA and water parameters showed no significant relationships (P>0.05) (Nguyen *et al*., 2023); Groups of sample sites in wet (C) and dry (D) seasons were generated by two-way stratigraphic analysis. This paragraph should move to part of discussion.

Discussion

The results reveal differences in composition of species based on number of specimens collected between wet and dry seasons at Ma and Et Rivers. The wet season is dominant with Cyprinidae (61.10%), Danionidae (14.29%), CicFighlidae (5.80%) and Nemacheilidae (3.93%), whereas the dry season is conspicuous with Gobiidae (31.73%), Balitoridae (25.46%), Cyprinidae (20.32%), and Cichlidae (5.71%). This difference is probably caused by environmental alternation in the wet and dry seasons and seasonal migration in some species *Spinibarbus maensis* is abundant whole time a year. This scientific evidence supports that the fish species should be Iconic Symbol for Et river, because they relate with local economic livelihood and tradition in the region to do sustainable development in many points of view

for the government. Balance-managing in natural resources can be sustainable in the case of renewable resources and as sources of revenue for investment in future growth for long-term development and poverty alleviation in the region. We're willing to study morphology and feeding biology for our next scientific issue.

The Ma river is higher in water temperature and more turbid than the Et river (Figure 7). This may be affected by the water flow rate of Ma river that is absolutely controlled by regulation of Song Ma Hydropower Dam, 32 km upstream from sampling sites, but there is no a hydropower dam in the Et river.

Acknowledgments

We would like to thank the grantor; Hungarian Tied Aid Loan for Laos Development of the food chain safety system in the Lao PDR (HAKI-LAO) supported budget to research. And Thank term work Livestock and fishery selection in the Houaphanh Province (PAFO) and District of Agriculture forestry (DAFO) Et District and chief of village in the sampled sites to helped concerted sampled. Special thanks to academic staff member of department of fisheries, Faculty of Agriculture, Ubon Ratchathani University (UBU) for their collaboration.

References

Anderson, J.T. and C.A. Davis. 2013. Wetland techniques volume 2: Organisms. In **Wetland Techniques: Volume 2: Organisms** (Issue October). https://doi.org/10.1007/978-94-007-6931-1.

Bloom, N., and J.V. Reenen. 2013. No Title'. **NBER Working Papers** 89.

Chung, L. N., N.T.K. Cuc, T.A. Ngoc, N.T. Nam, L.V. Son and T.V. On. 2017. 'Required Flows for Aquatic Ecosystems in Ma River, Vietnam'. **International Journal of Environment, Agriculture and Biotechnology** 2 (6): 3068–77. https://doi.org/10.22161/ijeab/2.6.37.

Chen, I.S. and M. Kottelat. 2003. Three new freshwater gobies of the genus Rhinogobius (Teleostei: Gobiidae) from northeastern Laos. **Raffles Bulletin of Zoology** 51(1): 87–95.

Chen, J., Y. Chen, W. Tang, H. Lei, J. Yang and X. Song 2023. Resolving phylogenetic relationships and taxonomic revision in the Pseudogastromyzon (Cypriniformes, Gastromyzonidae) genus: molecular and morphological evidence for a new genus, Labigastromyzon. **Integrative Zoology** 1–22. https://doi.org/10.1111/1749-4877.12761.

Clarke, K. R. and R. M. Warwick. 2001. Change in marine communities: an approach to statistical analysis and interpretation. 2nd edition. Primer-E, Plymouth. **Plymouth, United Kingsom: PRIMER-E**, 172. http://plymsea.ac.uk/7656/%250Ahttp://owasptop10.googlecode.com/files/OWASP Top 10 2013.pdf%0Ahttp://plymsea.ac.uk/7656/%0Ahttp://owasptop10.googlecode.com/files/OWASP Top 10 - 2013.pdf

Doan V.L., M.K. Nguyen and C.D. Bui. 2015. Study on Establishing a Monitoring System for Groundwater in the Condition of Climate Change and Sea Level Rise: Case Study of Ma River Basin in Vietnam. **Journal of Environmental Science and Engineering** B 4(9): 459–469. https://doi.org/10.17265/2162-5263/2015.09.001.

Ferraris, C.J. 2002. Freshwater Fishes of Northern Vietnam. a Preliminary Checklist of the Fishes Known or Expected To Occur in Northern Vietnam With Comments on Systematics and Nomenclature. **Copeia** 2002(4): 1168–1170. https://doi.org/10.1643/0045-8511(2002)002[1168:]2.0.co;2.

Fricke, R., W.N. Eschmeyer and R. Van der Laan (eds). 2024. **Eschmeyer' s catalog of fishes: genera, species, references. Electronic Version**. Available from: http://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp on accessed 20 May 2024

Global Environment Facility. 2019. Fostering Water and Environmental Security in the Ma and Neun / Ca Transboundary River Basins and Related Coastal Areas (CEO Endorsement). **Good (Full) Version**.

Hoang, D.H., H.P. Manh, T.N. Duy, N.T. Trong and P.V. Van. 2021. Geographic Distribution of Indigenous Inland Fishes in Central Coast Rivers, Northern Annam. **Technology Journal of Agriculture & Rural Development** 10/2021 (December): 14–30.

Huu Duc, N., T. Duc Hau and H Thi Thanh Hai. 2015. Fish Species Composition in the Red River and

Its Tributaries in the Yen Bai Province, Vietnam. Journal of Science, Natural Science 60(4): 97–103. https://doi.org/10.18173/2354-1075.2015-00084.

Johnson, A. 2012. A landscape summary for the Nam Et-Phou Louey National Protected Area, Lao PDR. **Evidence-Based Conservation: Lessons from the Lower Mekong, January 2012**: 73–90.

Levin, B.A., S.K. Aleksandra, L.R. Oksana and S.G. Alexander. 2021. Unexpected Diversity of Feeding Modes among Chisel-Mouthed Ethiopian Labeobarbus (Cyprinidae). **Water (Switzerland)** 13 (17): 1–16. https://doi.org/10.3390/w13172345.

Ngoc, D.Q., N.H., Duc and T.D. Hau. 2014. A new species of fish belonging to of subgenus Spinibarbichthys (Spinibarbus: Cyprinidae: Cypriniformes) in Vietnam. **Tap Chi Sinh Hoc** 29(2), 22–25. https://doi.org/10.15625/0866-7160/v29n2.5369.

Nguyen, H.H., T.N. Nguyen, T.T. Tran, T.H.T. Nguyen, X.H. Nguyen and T.D. Nguyen, T. D. 2023). Present status of inland fisheries and its linkage to ecosystem health and human wellbeing in North Central of Vietnam. **Ecosystem Services** 59 (May 2022): 101505. https://doi.org/10.1016/j.ecoser.2022.101505.

O'Higgins, T.G., M. Lago and T.H. DeWitt. 2020. Ecosystem-Based Management, Ecosystem Services and Aquatic Biodiversity: Theory, Tools and Applications. **Ecosystem-Based Management, Ecosystem Services and Aquatic Biodiversity: Theory, Tools and Applications, August:** 1–580. https://doi.org/10.1007/978-3-030-45843-0.

Phanthamala, S. 2015. Water Resources Management in Lao PDR Singthong PHANTHAMALA Department of Water Resources. **Department of Water Resources.** https://www.mrcmekong.org/assets/RSF7/presentations/Lao-PDR-Water-Resources-Management.pdf.

Rainboth, W.J., C. Vidthayanon and M.D. Yen. 2012. Fishes of the Greater Mekong Ecosystem with Species List and Photographic Atlas. **Museum of Zoology, University of Michigan** No. 201.

Zhang, Z., W. Zhang, X. Hu, K. Li, P. Luo, X. Li, W. Xu and S. Li. 2020. water Evaluating the E ffi cacy of Point-of-Use Water Treatment Systems Using the Water Quality Index in. **Water** 12(867): 1–15. https://www.researchgate.net/figure/Classification-of-drinking-water-quality-based-on-the-WQI-20-36-37_tbl1_340076156.

Zuklin, T., N. Maury, S. Sitthivong, T. Van Pham, O. Le Duc, C. Bordes, B. Leprince, C. Ducotterd, L. Van Oanh, P. Vilay, V.Q. Luu and L. Luiselli. 2021. The "empty forest syndrome" and the herpetofaunal communities in laos (south-eastern Asia). **Russian Journal of Herpetology** 28(6): 333–347. https://doi.org/10.30906/1026-2296-2021-28-6-333-347

Zare-Shahraki, M., E. Ebrahimi-Dorche, A. Bruder, J. Flotemersch, K. Blocksom and D. Bănăduc. 2022. 'Fish Species Composition, Distribution and Community Structure in Relation to Environmental Variation in a Semi-Arid Mountainous River Basin, Iran'. **Water** (Switzerland) 14(14). https://doi.org/10.3390/w14142226.