STUDY ON COMPOSITION AND FLORISTIC ELEMENTS OF AQUATIC PLANTS IN KARST WETLAND, SOUTH CHINA

HU, C.[1,2†] – WEI, F.[3†] – ZHANG, Z. H.[1,2] – XU, C. H.[1,2] – ZHONG, C. F.[1,2] – HU, G.[1,2*]

[1]*Key Laboratory of Wildlife Evolution and Conservation in Mountain Ecosystem of Guangxi, Nanning 530001, China*

[2]*School of Environment and Life Science, Nanning Normal University, Nanning 530001, China*

[3]*Guangxi Zhuang Autonomous Region Ecological Environment Monitoring Center, Nanning 530001, China*

[†]*The authors have contributed equally to this work*

[*]*Corresponding author*
e-mail: ahhugang@126.com; ORCID: 0000-0002-0662-811X

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Abstract. Wetland plant communities are important in maintaining wetland ecosystem functions and conserving biodiversity. However, current studies on the diversity of wetland plant communities are mainly focused on non-karst regions, while there are fewer studies on the diversity of karst wetland plant communities. To address this research gap, this study analyzes the composition and diversity of the flora of the Huixian karst wetland in south China. The results show that there are 133 species of wetland plants in 39 families and 78 genera in the Huixian Karst wetland, including 128 species of angiosperms in 34 families and 73 genera, and 4 genera and 4 species of ferns in 4 families. The dominant families are Gramineae and Cyperaceae, containing 15 and 7 genera respectively; the dominant genera are *Polygonum, Heleocharis* and *Cyperus*, each containing 6 species. By life type and ecological characteristics, emergent plants are the most dominant in the Huixian Karst wetland, with 77 species, accounting for 57.46% of the total. The flora of the Huixian Karst Wetland is divided into 10 types and shows obvious tropical subtropical characteristics.

Keywords: *macrophytes, algae, plant diversity, plant composition, karst, wetland*

Introduction

Wetlands, transitional zones between terrestrial and aquatic ecosystem, have the richest biodiversity, and they are important environments for human survival (Sui and Zhang, 2019; Oliveira-Filho et al., 2021). Wetland ecosystems are also known as the "kidneys of the earth” because they play a crucial ecological service role in flood storage, water purification, climate regulation, and biodiversity maintenance (Mao et al., 2023). It is one of the three major and most important ecosystems in the world, together with forests and oceans. Karst wetland ecosystems are influenced by karst fissures and geological formations, and hydrological processes are characterized by rapid recharge and discharge and dramatic seasonal changes in water level and flow (Zhao et al., 2021; Yan et al., 2021). Karst waters are calcium-rich, alkaline, and highly perishable, and surface contaminants are very likely to rapidly contaminate groundwater through water fall holes (Zhao et al., 2021). In fact, the dynamic variability of karst water in terms of water quantity and quality, as well as the rapid hydrological processes are also highly susceptible to changes in ecological processes, leading to extremely sensitive and fragile karst wetland ecosystems (Hartmann et al., 2015). As a result, wetland plants are

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characterized by ecological sensitivity to environmental changes and instability of community distributions.

Karst wetland plants are an important part of karst wetland ecosystems (Hu et al., 2021), but in recent decades, with the development of industrial production, considerable human activity disturbances have caused dramatic changes in the water cycle and the spatial and temporal distribution of water resources at the watershed scale. This affects and alters hydrological processes and water balance of the watershed, and it can lead to substantial shrinkage of karst wetland areas, serious degradation of ecological functions, and loss of biodiversity, which has led to concerns about the decline of ecological services in karst wetlands (Zhu et al., 2021; Lan et al., 2022). For example, the vegetation in the interlocking zone of the Li River is affected by seasonal flooding and the high frequency of human disturbance activities. Uneven intra-annual distribution of water resources is a problem that is becoming more serious, leading to the fragility of the interlocking zone ecosystem, shrinking wetlands, degraded vegetation, and exposed gravel (Li et al., 2015). Previous research has also shown that changes in hydrological processes in wetlands directly affect wetland plant cover, species composition, primary productivity, and material-energy cycles, which in turn lead to vegetation community succession (Findlay and Fischer, 2013; Yao et al., 2014).

In the past 40 years, the karst wetland area of Huixian in Guangxi, south China, has continued to shrink, and the water body is severely eutrophic. To better understand this phenomenon, this study comprehensively investigated plant diversity in the Huixian karst wetlands of Guangxi, south China. It aims to provide theoretical support for biodiversity conservation and ecosystem management in the Huixian karst wetland ecosystem of Guangxi, south China.

Materials and methods

Study area

The Huixian Marsh Wetland (110°08′15″-110°18′00″E, 25°01′30″-25°11′15″N) is located in the northern part of Guangxi, south China. It is one of the largest low-altitude karst swamp wetlands in China, with an altitude of 150-160 m and a total area of 120 km^2. It has a subtropical monsoon climate, with an annual average temperature of 16.5- 20.5℃ and an annual average rainfall of 1890.4 mm. There is frequent flooding from April to September, followed by a dry period from October to March (Xiao et al., 2019). The vegetation of the Huixian wetland is mainly water-holding and submerged, with many plant species and lush growth. The main establishment species are *Cladium chinense*, *Phragmites communis*, *Typha angustata*, *Isachne globosa*, *Ischaemum rugosum* and *Ischaemum rugosum*. *Ischaemum rugosum* var. segetum), *Vallisneria denseserrulata*, *Hydrilla verticillata*, and *Ceratophyllum demersum* var. Limnphila sessiliflora.

Field survey

In August 2022, this study investigated the species diversity of plant communities at the study sites in the Mudong, Dulong, Huangjaitang, Guntang, Doumen, Xiatingjaitang, and Mamianxu Huixian karst wetlands in Guangxi. This study set a total 37 sampling points, with 7 quadrats set at regular intervals of 5 meters for each sampling point among 34 sampling points. However, due to environmental factors, only 4 quadrats were set for 4 sampling points. Thus, a total of 250 sample squares were set up for the survey

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(*Figure 1*). Through field surveys, plant species names and community and habitat characteristics of the study area were recorded, and azonal composition analysis was conducted according to the plant list combination method presented in Wu (1991). The plants in the boxes were uprooted, and the number of plants was counted by species, and the cover, height biomass of each plant was recorded. The seasonal phase and total cover were also determined. In the October and April, 0.5 L water sample was collected for algae. The samples were fixed with a 4% formalin solution. Algae were identified and counted using optical microscope (Ziess Axio Vert.A1, Germany). The dominant species included species whose abundance was more than10% of the total abundance of algae (Zhang and Huang, 1991).

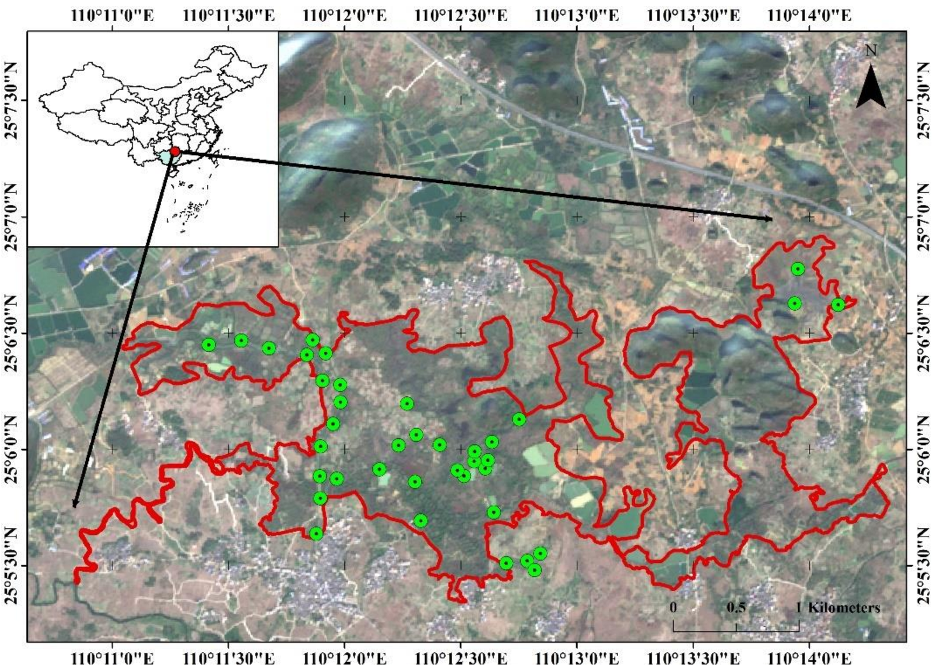

***Figure 1.** Map of soil samples collecting locations*

Statistical analysis

The species richness, Simpson dominance index, Shannon-Wiener diversity index, and Pielou evenness index were selected to determine the α-diversity index of plant communities and to characterize the species diversity of major wetland plant communities in the Huixian karst wetlands. The Shannon-Wiener species diversity index (H) was calculated using equation (1), the Pielow's evenness index (E) was calculated as shown in equation (2), and the Simpson's ecological dominance index (C) was calculated as shown in equation (3). All equations come from Ma and Liu (1994). The important value (IV) was calculated as in equation (4), based on the existing literature (Wu et al., 2018).

$$H = -\sum_{i=1}^{S} P_i \ln P_i \quad \text{(Eq.1)}$$

$$E = \frac{H}{\ln S} \quad \text{(Eq.2)}$$

$$C = 1 - \sum_{i=1}^{S} \frac{n_i}{N} \quad \text{(Eq.3)}$$

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$$S_i = \frac{(RA_i + RF_i + RD_i)}{3} \quad \text{(Eq.4)}$$

where S is the number of species, N is the total number of species, $P_i$is the importance value of the i species, and n_i is the number of individuals of the i species. S_i is the importance value for the i species, and RA_i, RF_i, RF_i represent the relative abundance, frequency, coverage, and dominance, respectively, of the i species.

Results

Plant species composition

There were 133 species of wetland plants in 39 families and 78 genera found in the survey (Appendix A., *Table 1*), among which one family, one genus and one species of moss accounted for 2.56%, 1.28% and 0.75% of the total wetland plants in the Huixian karst wetland. Four families, four genera and four species of ferns accounted for 10.26%, 5.13% and 3.01%, respectively, and 34 families, 73 genera and 128 species of angiosperms accounted for 87.18%, 93.59% and 96.99% respectively, which shows that angiosperms were dominant.

Table 1. *Statistics of wetland plants in the Huixian karst wetland*

Plant community	Family	The proportion of the total family (%)	Genera	The proportion of the total genera (%)	Species	The proportion of the total species (%)
Bryophytes	1	2.65	1	1.28	1	0.75
Pteridophyte	4	10.26	4	5.13	4	3.01
Angiosperm plant	34	87.18	73	93.59	128	96.99
Total	39	100.00	78	100.00	133	100.00

Among the 39 families of wetland plants in the Huixian karst wetland, the size of the family was determined by the number of genera, and the families containing more than four genera included Scrophulariaceae (4 genera), Umbelliferae (4 genera), Cyperaceae (6 genera), and Gramineae (15 genera). Ten families containing two to three genera, accounted for 25.64% of the total number of plant families and 26.03% of the total number of genera. The remaining 25 families were single genera and singular families, accounted for 64.1% of the total number of plant families, accounted for 34.25% of the total number of genera. This indicates the predominance of singular families.

Among the 39 families of wetland plants in the Huixian karst wetland, families containing more than six species included Scrophulariaceae (4 genera and 6 species), Polygonaceae (2 genera and 8 species), Cyperaceae (6 genera and 24 species), and Gramineae (15 genera and 31 species), which accounted for 36.98% of the total number of genera and 53.91% of the total number of species of wetland plants. Of those families containing two to five species, there were15 families, with a total of 29 genera and 42 species, accounting for 39.73% of the total number of genera and 32.81% of the total number of plant species. There were 17 families with only a single species, accounting for 23.29% of the total number of genera and 13.28% of the total number of species of wetland plants, indicating the predominance of families containing more than 6 species.

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Among the 73 genera of wetland plants in the Huixian karst wetland, those containing more than five species included five species of *Echinochloa*, five species of *Heleocharis*, five species of *Scirpus*, seven species of *Cyperus*, six species of *Polygonum*. A total of 28 species in five genera accounted for 6.85% of the total number of genera and 21.88% of the total species. The genera containing only one species are monogeneric species, and there was a total of 46 genera accounting for 63.01% of the total number of genera and 35.94% of the total number of species. There was a predominance of species in monospecific genera. In addition, a total of 133 species of wetland plant communities were recorded, with 35 dominant species identified by reference to plant species values (Appendix A).

Characteristics of the geographical composition of the flora

According to the range types of Chinese seed plants classified in Zhengyi (1991), the flora of the karst wetlands of Huixian was divided into 10 range types (*Table 2*).

Table 2. *Diversity of angiosperm in the karst wetland in Huixian*

Distribution type	Genera	Proportion of the total genera (%)	
		Excludes world distribution genera	Contains world distribution genera
World distribution (Cos)	21	——	30.88
Pantropical distribution (PalTr)	20	42.55	29.41
Intermittent distribution of tropical Asia and tropical America (TrAs-TrAm)	1	2.13	1.47
Tropical Asia to Tropical Oceania distribution (TrAs-TrAu)	6	12.77	8.82
Tropical Asian to tropical African distribution (TrAs-TrAf)	3	6.38	4.41
Tropical Asia distribution (TrAs)	4	8.51	5.88
Northern Temperate distribution (NTem)	8	17.02	11.76
Intermittent distribution in East Asia and North America (EAs-Nam)	3	6.38	4.41
Old World Temperate distribution (PalTem)	1	2.13	1.47
East Asia Distribution (EAs)	1	2.13	1.47

The world distribution of 21 genera accounts for 30.88% of the total number of genera and includes among others *Rumex, Polygonum, Ranunculus, Ceratophyllum, Hypericum, Ammania, Lobelia, Typha, Myriophyllum, Juncus, Panicum, Lemna, Spirodela, Jussisea,* and *Najas.*

The pantropical distribution of 20 genera accounts for 29.41% of the total number of genera, such as *Rotala, Ludwigia, Centella, Hydrocotyle, Hygrophila, Bergia, Vallisneria, Arundo, Isachne, Cladium, Fimbristylis, Kyllinga, Mariscus, Eriocaulon, Commelina, Alternanthera, Paspalum, Ischaemum, Leersia, Hemarthria.* The Intermittent distribution of tropical Asia and tropical America of 1 genus is *Eichhornia*. The tropical Asia to Tropical Oceania distribution of 6 genera, which are *Dysophylla, Mazus, Hydrilla, Murdannia, Eremochloa.* The tropical Asian to tropical African distribution of 3 genera, which are *Cyanotis, Adina, Lagarosiphon*. The Tropical Asia distribution of 4 genera, such as *Coix, Pogostemon, Colocasia, Alocasia*. The Northern Temperate distribution of 8 genera, such as *Nuphar, Salix, Cryptotaenia, Mentha, Veronica, Echinochloa, Beckmannia, Alopecurus*. The Intermittent distribution in East

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Asia and North America of 3 genera, such as *Saururaceae*, *Zizania*, *Acorus*. The Old World Temperate distribution of 1 genera is *Oenaanhe.* The East Asia Distribution of 1 genus is *Houttuynia.* Therefore, the large proportion of tropical genera indicates that the flora of the Huixian karst wetland has a tropical-subtropical characteristic and feature.

Diversity of plant life and growth forms

According to the life form and ecological characteristics of plants, the plants of the Huixian karst wetland can be divided into wet, water-holding, floating, and submerged types. Among them, there are 34 species of wetland plants, such as *Isachne globose* and *Alternanthera philoxeroides*, making up 25.37% of the total number of species. 77 species of emergent plants, such as *Nelumbo nucifera*, *Acorus calamus*, and *Sagittaria trifolia* var. sinensis, accounted for 57.46% of the total number of species. 13 species of submerged plant, such as *Potamogeton malaianus* and *Potamogeton crispus*, made up 9.7% of the total number of species. There were 10 species of floating plants, such as *Nuphar pumilum* and *Ricciocarpus natans*, comprising 7.4% of the total number of species. It shows that the number of emergent plants species is relatively large, and the Huixian karst wetland is dominated by emergent plants.

The growth types of plants in the Huixian karst wetlands are divided into two categories: herbaceous and woody plants. Among them, there were 46 species of annual herbs (35.34% of total species), 84 species of perennial herbs (63.16% of total species), and one species each of deciduous shrubs, small trees, and trees 0.75% of total species).

Species diversity in the plant communities

The plant community of the Huixian karst wetland mainly consisted of emergent and submerged plants (*Table 3*). The highest Shannon-Weiner index was for the *Potamogeton malaianus* community (1.3862), and the smallest was for the *Typha angustata* community (0.2031). Similarly,the highest Simpson index was for the *Potamogeton malaianus* community (2.4104), and the smallest was for the *Typha angustata* community (1.0657). The highest uniformity index was in the *Ceratophyllum demersum* var.oryzelorum community (0.9753) and the lowest was in the *Typha angustata* community (0.2031).

Table 3. *Density of species in wetland plants community*

Plant community	Simpson index	Shannon -Weiner index	Richness index
Form. Vallisneria denseserrulata	1.2542	0.6680	0.3340
Form. Potamogeton malaianus	2.4104	1.3862	0.8745
Form. Hydrilla verticillata	1.1604	0.3809	0.3809
Form. Ceratophyllum	1.9588	0.9754	0.9753
Form. Limnphila sessiliflora	1.3206	0.5870	0.5870
Form. Vallisneria denseserrulata Form. Hydrilla verticillata	1.0901	0.2563	0.2563
Form. Potamogeton malainus Form. Hydrilla verticillata	1.5520	0.7790	0.7790
Form. Myriophyllum spicatum Form. Vallisneria denseserrulata	2.0308	1.2532	0.7906
Form. Hygrophila salicifolia	1.3554	0.7304	0.4608
Form. Typha angustata	1.0657	0.2031	0.2031
Form. Zizania caduciflora	1.0666	0.2046	0.2046
Form. Phragmites communis	1.5631	1.0029	0.5014

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Diversity of freshwater algae

In October, a total of 5 phyla, 22 families and 32 genera of algae were collected. The dominant families are Oscillatoriadaceae, Naviculaceae, Fragilariaceae, Scenedesmaceae, Zygnemataceae, Desmidiaceae, and Tribonemataceae. The dominant genera are *Spirulina Turpinem.Gardner*, *Synedra Ehrenberg*, *Cymbella Agardh*, *Tabellaria Ehrenberg*, *Stauroneis Ehrenberg*, *Navicula Bory*, *Scenedesmus Meyen*, *Pediastrum Mey.*, *Cosmarium Gord*, *Mougeotia Agardh*, and *Tribonema Derbeset*. The dominant species are *Oscillatoria princes*, *Oscillatoria subcontorta*, *Synedra acus*, *Synedra amphicephala*, *Pediastrum duplex*, *Tabellaria fenestrate*, *Stauroneisanceps Ehrenberg*, and *Cymbella tumida*.

In April, a total of 6 phyla, 28 families and 44 genera of algae were collected. The dominant families are Chroococcaceae, Naviculaceae, Achnanthaceae, Fragilariaceae, Chlamydomonadaceae, Chlorellaceae, Zygnemataceae, and Volvox. The dominant genera are *Chroococcus Nag*, *Navicula Bory*, *Cocconeis Ehrenberg*, *Synedra Ehrenberg*, *VolvoxLinn*, *Chlamydomonas*, and *Mougeotia Agardh*. The dominant species are *Synedra acus*, *Synedra amphicephala*, *Navicula cryptocephala*, *Navicularhynchocephala*, *Navicula viridula*, *Cocconeis placentula*, *Mougeotia laetevirens, and Cymbella pusilla Grunow*.

In the October and April samplings, the largest proportion of Bacillariophyta composition were 39.13% and 38.55%, Chlorophyta at 30.43% and 30.12%, and Cyanophyta at 24.64% and 16.87% respectively for the two samplings. Other phyla account for a smaller proportion of the species composition (*Figure 2*).

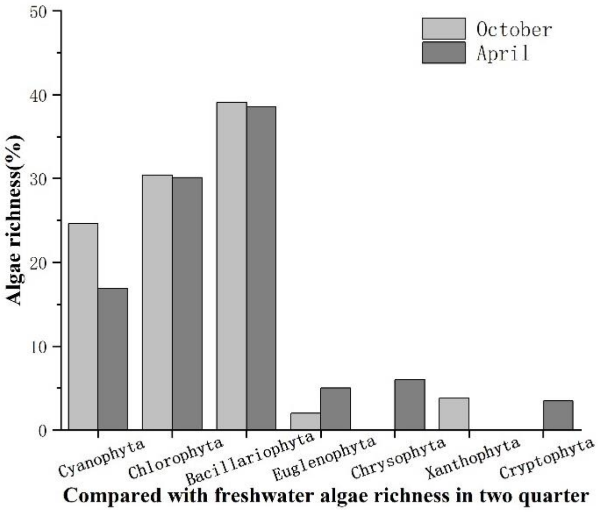

Figure 2. *Freshwater algae richness at two time periods*

Discussion

A total of 39 families, 78 genera and 133 species of wetland plants were identified in the Huixian karst wetland, including one family, one genus, and one species of mosses; four families, four genera, and four species of ferns; and 34 families, 73 genera, and 128 species of angiosperms. These accounted for 87.18%, 93.59%, and 96.99%, respectively, and show the absolute dominance of angiosperms. Among the angiosperms, there were 49 species of dicotyledons in 21 families and 33 genera and 79 species of

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monocotyledons in 13 families and 40 genera. The wetland plant genera containing higher number of species included Cyperaceae, Gramineae, and Polygonaceae. The families containing higher number of genera included Umbelliferae, Scrophulariaceae, Cyperaceae, and Gramineae, while the single genera families included 25 families and accounted for a larger share in the total number of families. There were 46 single genera species, accounting for 63.01% of the total number of genera and 35.94% of the total number of species. The genera with the largest number of species were *Cyperus*. Hygrophyte (34 species) and emergent plants (77 species) accounted for relatively large proportion, 57.46% and 25.37%, respectively. In the study area, some species need special attention, for example, *Oryza rufipogon*, a Grade II protected plant in China, is a wild relatives germplasm gene pool of cultivated rice. *Nuphar pumilum*, with its increasingly narrow habitat range and its declining numbers of individuals, thus should *Nuphar pumilum* be classified as vulnerable. We attempted to compare the species composition and diversity pattern of the Huixian karst wetland with other wetlands in the world. It was found that Asteraceae, Cyperaceae and Gramineae were families with higher species richness in the Qinghai-Tibet Plateau wetland and southern Brazilian plateau marsh (Li et al., 2022). In the Dongting Lake wetland, Cyperaceae, Gramineae, and Compositae were three typical families. These might be that different wetland ecosystems have unique species compositions due to their special geological history and modern environmental conditions (Xie et al., 2014).

There are 10 distribution zone types of plants in the Huixian karst wetland, mainly consisting of world-distributed (21) and tropical-distributed genera (34) and accounting for 30.88% and 49.99% of the total number of genera in the area. In general, the seed flora exhibited obvious tropical-subtropical characteristics.

Plant diversity is an important indicator in measuring the ecological functions of wetlands and their ecosystem stability (Sutton-Grier et al., 2011). Plant community diversity represents the level of species diversity in plant communities (Schlatter et al., 2015). The analysis of plant community diversity in the Huixian karst wetland showed that the *Potamogeton malaianus* community had the highest values for the Shannon-Weiner and Simpson indices, while the *Typha angustata* community had the lowest. The highest evenness index was for the *Ceratophyllum demersum*.var.quadrispinum community, and the smallest was for the *Typha angustata* community. In the study area, the *Potamogeton malaianus* community was mainly distributed in still or slow-flowing water at 0.8-1.8m, and the *Ceratophyllum demersum*.var.quadrispinum community was mainly distributed in the slow-flowing rivers or in ponds with live water at 0.6-1 m. In contrast, the *Typha angustata* community is mainly distributed in shallow lakes or shallow water areas along rivers, where anthropogenic activities are more frequent.

The richness of Bacillariophyta, Chlorophyta, and Cyanophyta were higher in October than in April, particularly for Cyanophyta. The main reason for this may be due to the reduced precipitation in the wetland in autumn. The water bodies in the Huixian karst wetland are nearly static bodies of water, and water supply is mainly determined by precipitation, which together with the high level of agricultural activity in autumn, contributes to greater pollution, eutrophication of water bodies, and cyanobacterial blooms. In the spring, precipitation is more frequent in this wetland, and water quality is better and less likely to experience eutrophication in the water column. As a result, there are fewer cyanobacteria and a higher diversity of algae.

In recent decades with population growth and social and economic development, people have increasingly reclaimed the Huixian karst wetland. Some of the natural

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swamps and lakes have been reclaimed for farmland, orchards, and drylands (Pan et al., 2020). The area of wetlands has gradually decreased, and the water level of the Huixian karst wetland has dropped while serious droughts have occurred, resulting in the regulating capacity of the wetland ecosystem being subsequently decreased (Li et al., 2017; Qin et al., 2020). At the same time, a large amount of domestic sewage, pesticides, fertilizers, and farm manure have been discharged into the wetland, leading to the intensification of eutrophication of the water body, further accelerating the trend of wetland ecosystem deterioration, and destroying the ecological balance of the Huixian karst wetland. In addition, in the Huixian wetland, the proliferation of invasive alien species, such as *Eichhornia crassipes* and *Alternanthera philoxeroides*, has led to the obstruction of river channels and the reduction of dissolved oxygen content in water, which affects the growth and reproduction of aquatic plants and animals.

Conclusions

This study found that there are 39 families, 78 genera, and 133 species of wetland plants in the Huixian karst wetland in south China. Angiosperms were dominant, and the main families were Gramineae and Cyperaceae. The dominant genera are *Polygonum*, *Cyperus*, and *Heleocharis*. Emergent plant species, accounting for 57.46% of the total, were the dominant plant type. The seed flora of the Huixian karst wetland showed obvious tropical-subtropical characteristics. The results of this study on the plants of the Huixian karst wetland provide empirical evidence of the overall ecological and environmental quality of the study area.

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Conflict of Interests. The authors declare that they have no competing interests.

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APPENDIX

Appendix A. *Plant directory of wetlands in a karst wetland in Huixian*

		Family	Genera	Species	Dominant species
1	Bryophyte	Ricciaceae	*Rcciocarpus Corda*	*Ricciocarpus natans*	
2	Pteridophyte	Equisetaceae	*Equisetum*	*Equisetum ramosissimum*	
3		Ceratopteridaceae	*Ceratopteris*	*Ceratopteris thalictroidel*	
4		Marsileaceae	*Marsilea*	*Marsilea quadrifolia*	
5		Azollaceae	*Azolla*	*Azolla imbricata*	
6	Dicotyledons	Saururaceae	*Saururus*	*Saururus chinensis*	
7			*Houttuynia*	*Houttuynia cordata*	
8		Ranunculaceae	*Ranunculus*	*Ranunculus ternatus*	
9				*Ranunculus sieboldii*	
10				*Ranunculus japonicus*	
11				*Ranunculus cantoniensis*	
12		Ceratophyllaceae	*Ceratophyllum*	*Ceratophyllum demersum.var.quadrispinum*	Yes
13		Nymphaeaceae	*Nymphaea*	*Nelumbo nucifera*	
14			*Nuphar*	*Nuphar pumilum*	
15		Umbelliferae	*Oenanthe*	*Oenanthe japonica*	
16			*Centella*	*Centella asiatica*	
17			*Cryptotaenia*	*Cryptotaenia japonica*	
18			*Hydrocotyle*	*Hydrocotyle sibthorpioides* var. batrachium	
19		Elatinaceae	*Bergia*	*Bergia ammanioides*	
20		Polygonaceae	*Rumex*	*Rumex crispus*	
21				*Rumex japonicus*	
22			*Polygonum*	*Polygonum chinense*	
23				*Polygonum aviculare*	
24				*Polygonum plebeium*	
25				*Polygonum hydropiper*	Yes
26				*Polygonum harbatum* var. gracile	
27				*Polygonum minus*	Yes
28		Amaranthaceae	*Alternanthera*	*Alternanthera sessilis*	
29				*Alternanthera philoxeroides*	Yes
30		Salicaceae	*Salix*	*Salix dunnii*	
31				*Salix babylonica*	
32		Cruciferae	*Nasturtium*	*Nasturtium officinale*	
33		Guttiferae	*Grangea*	*Hypericum japonicum*	Yes
34		Lytheraceae	*Rotala*	*Rotala rotundifolia*	Yes
35				*Rotala indica*	
36			*Ammannia*	*Ammannia baccifera*	
37		Onagraceae	*Ludwigia*	*Ludwigia prostrata*	Yes
38				*Jussiaea repens*	Yes
39		Haloragidaceae	*Myriophyllum*	*Myriophyllum spicatum*	Yes
40				*Myriophyllum verticillatum*	Yes
41		Convolvulaceae	*Ipomoea*	*Ipomoea aquatica*	
42		Rubiaceae	*Adina*	*Adina pilulifera*	
43		Campanulaceae	*Lobelia*	*Lobelia chinensis*	
44		Scrophulariaceae	*Limnophila*	*Limnophila sessiliflora*	Yes
45			*Lindernia*	*Lindernia crustacea*	
46				*Lindernia procumbens*	
47				*Lindernia antipoda*	
48			*Mazus*	*Mazus japonicus*	

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		Family	Genera	Species	Dominant species
49			*Veronica*	*Veronica undulata*	
50		Lentibulariaceae	*Utricularia*	*Utricularia aurea*	Yes
51		Acanthaceae	*Hygrophila*	*Hygrophila salicifolia*	
52		Labiatae	*Mentha*	*Mentha haplocalyx*	
53			*Dysophylla*	*Dysophylla sampsonii*	
54				*Pogostemon aurcularius*	
55	Monocotyledon	Hydrocharitaceae	*Hydrilla*	*Hydrilla verticillata*	Yes
56			*Vallisneria*	*Vallisneria spiralis*	
57				*Vallisneria denseserrulata*	Yes
58				*Vallisneria spinulosa*	
59				*Lagarosiphon alternifolia*	
60		Alismataceae	*Sagittaria*	*Sagittaria trifolia var. sinensis*	
61				*Sagittaria trifolia var. angustifolia*	
62		Potamogeronaceae	*Potamogeton*	*Potamogeton crispus*	
63				*Potamogeton malaianus*	Yes
64		Najadaceae	*Najas*	*Najas marina*	
65				*Najas japonica*	Yes
66		Commelinaceae	*Commelina*	*Commelina communis*	
67			*Cyanotis*	*Cyanotis vaga*	
68			*Murdannia*	*Murdannia triquetra*	
69		Eriocaulaceae	*Eriocaulon*	*Eriocaulon buergerianum*	Yes
70			*Eriocaulon*	*Eriocaulon sexangulare*	
71		Pontederiaceae	*Eichhornia*	*Eichhorina crassipes*	Yes
72		Araceae	*Acorus*	*Acorus calamus*	
73			*Colocasia*	*Colocasia antiquorum*	
74			*Alocasia*	*Alocasia odora*	
75		Lemnaceae	*Spirodela*	*Spirodela polyrrhiza*	
76			*Lemna*	*Lemna minor*	
77		Typhaceae	*Typha*	*Typha angustata*	Yes
78		Juncaceae	*Juncus*	*Juncus effusus*	
79		Cyperaceae	*Cladium*	*Cladium chinense*	Yes
80			*Cyperus*	*Cyperus rotundus*	
81				*Cyperus pilosus*	
82				*Cyperus difformis*	
83				*Cyperus compressus*	
84				*Cyperus haspan*	Yes
85				*Cyperus malaccensis* var. brevifolius	
86				*Mariscus umbellatus*	
87			*Kyllinga*	*Kyllinga brevifolia*	
88				*Kyllinga cororata*	
89			*Scirpus*	*Scirpus triqueter*	
90				*Scirpus juncoides*	
91				*Scirpus wallichii*	Yes
92				*Scirpus triangulatus*	Yes
93				*Eleocharis plantagineiformis*	Yes
94			*Heleocharis*	*Eleocharis tuberosa*	
95				*Eleocharis yokoscensis*	
96				*Eleocharis tetraquetra*	
97				*Eleocharis atropurpurea*	
98				*Eleocharis attenuata* var. erhizomatosa	
99			*Fimbristylis*	*Fimbristylis sericea*	
100				*Fimbristylis dichotoma*	
101				*Fimbristylis diphylloides*	Yes
102				*Fimbristylis compressa*	Yes
103		Gramineae	*Coix*	*Coix lacroyma-jobi* var. ma-yuen	
104			*Echinochloa*	*Echinochloa colonum*	
105				*Echinochloa crusgalli*	Yes

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		Family	Genera	Species	Dominant species
106				*Echinochloa crusgalli* var. mitis	
107				*Echinochloa crusgalli* var. zelayensis	
108				*Echinochloa crusgalli* var. hispidula	
109			*Beckmannia*	*Beckmannia syziachne*	
110			*Panicum*	*Panicum psilopodium*	
111				*Panicum repens*	Yes
112			*Isachne*	*Isachne globosa*	Yes
113				*Isachne kunthiana*	
114				*Isachne truncata*	
115			*Leersia*	*Leersia hexandrs* var. japonica	
116			*Oryza*	*Oryza sativa*	
117				*Oryza rufipogon*	
118			*Phragmites*	*Phragmites communis*	Yes
119				*Phragmites karka*	
120			*Paspalum*	*Paspalum thunbergii*	Yes
121				*Paspalum paspaeoides*	Yes
122				*Paspalum longifolium*	
123				*Paspalum orbiculare*	
124			*Ischaemum*	*Ischaemum rugosum* var. segetum	Yes
125				*Ischaemum ciliare*	
126				*Ischaemum aristatum*	
127			*Pteris*	*Eremochloa ciliaris*	
128				*Eremochloa ophiuroides*	
129			*Hemarthria*	*Hemarthria altissima*	Yes
130				*Hemarthria compressa*	
131			*Alopecurus*	*Alopecurus aequalis*	
132			*Arundo*	*Arundo donax*	
133			*Zizania*	*Zizania caduciflora*	

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