

“211 工程”重点项目:生物多样性与区域生态安全

上海九段沙湿地自然保护区 科学考察集

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内 容 简 介

上海九段沙湿地自然保护区位于长江入海口,是由长江挟带的泥沙在该区域不断淤积而形成的沙洲。保护区内生物资源丰富,人为活动的干扰少,是我国少有的基本保持河口原生湿地状态的区域,具有极高的保护价值。本书以科研人员多次科学考察所获得的第一手资料为依据,并参考历史资料,对上海九段沙湿地自然保护区的自然地理和动植物资源及其生态系统价值评价等方面进行了详细的介绍。自然地理方面涉及九段沙的形成、演变、气候特征、气象要素、海洋水文、地质地貌、土壤及环境状况等内容,动植物资源方面涉及了保护区的藻类植物、高等植物、浮游动物、底栖动物、鱼类、鸟类、水生哺乳动物等内容。本书为深入研究河口湾区域湿地生态系统的发生、发展、演变规律及其内在机制提供了重要的基础资料,也为该区域生物多样性的保护与合理利用提供了重要的科学依据。

本书可供环境保护、自然保护区管理、湿地科学、生物多样性研究等相关领域的专业人员使用,也可为大专院校相关专业的师生提供参考。

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序

《上海九段沙湿地自然保护区科学考察集》(以下简称《科考集》),在我国著名的湿地保护专家陈家宽教授的亲自主持下,经过复旦大学、华东师范大学、上海师范大学、上海水产大学、上海市环境科学研究院等有关方面专家、学者的共同努力正式完成了。《科考集》以大量的数据、翔实的资料,全面、系统地介绍了九段沙湿地的自然环境,丰富的动、植物资源,环境评价,以及在此基础上与国内外著名湿地的比较研究,是一部相关信息量大、科技含量高、具有很高的科研价值的科考报告。《科考集》的完成,不仅对九段沙湿地自然保护区的科学研究具有奠基作用,同时,也是上海九段沙湿地自然保护区创建国家级自然保护区取得阶段性成果的一个重要标志。

九段沙湿地位于长江河口和东海的交汇处,海洋、河流、陆地三大生态系统的相互作用,使九段沙湿地成为研究自然条件下的成陆过程、河口湿地生态系统自然演变过程及其生物多样性起源与维持的良好场所,也使九段沙湿地成为世界上最重要的生态敏感区之一。加之九段沙虽紧邻上海,但人为干扰极少,对生态学、河口学的研究极具科学价值。

自2000年3月上海九段沙湿地自然保护区成立三年来,上海市人民政府和浦东新区人民政府对九段沙湿地予以了高度关注,先后投入了大量人力、物力、财力用于九段沙湿地自然保护区的建设。2003年1月22日,在国家环境保护总局的关注下,“上海九段沙湿地自然保护区创建国家级自然保护区工作会议”举行。推进九段沙湿地的保护和建设,把九段沙建成国内一流、国际领先的自然保护区,已成为与会专家、学者和领导的一种共识。与此同时,九段沙湿地科考工作作为一项重要的基础工作进一步加快。在这一过程中,承担九段沙科考任务的同志们,先后多次登上九段沙,风餐露宿,忘我工作,采集了大量的标本和数据,倾注了大量的心血和汗水,付出了艰辛和智慧。《科考集》的如期完成,凝聚着集体的才智,体现了可贵的团队精神,是对所有参与科考工作的同志们辛勤劳动的一种回报。

胡锦涛总书记在日前召开的中央人口资源环境座谈会上指出,人口资源环境工作是强国富民安天下的大事,是全面建设小康社会的必然要求。九段沙湿地是上海市面积最大的自然保护区,《科考集》的完成和《上海九段沙湿地自然保护区总体规划》的实施,是一项功及当代、利在千

秋的前瞻性工作。九段沙湿地的保护和建设,对于上海未来生态环境的改善,促进人与自然的和谐,实现经济、社会的可持续发展和把上海建成国际经济、金融、贸易、航运中心之一,无疑将产生巨大而又深远的影响。

2003年,是我们深入贯彻党的十六大精神,全面建设小康社会的起步之年。初春时节,我欣喜地得到了这本《科考集》,它预示着九段沙湿地的春天即将来临。春华秋实,风光无限,我相信,九段沙湿地的未来更美好!

借此机会,我谨代表浦东新区环境保护和市容卫生管理局,向陈家宽教授及参与《科考集》撰写的其他同志表示崇高的敬意和衷心的感谢!

上海市浦东新区环境保护和市容卫生管理局局长

王贵岭

2003年3月18日

Overview of Shanghai Jiuduansha Wetland Nature Reserve*

Shanghai Jiuduansha Wetland Nature Reserve is located between the south and north troughs of Sand Bars in the Yangtze River estuary. It is composed of four shoals (i. e. South Jiangyasha, Upper Jiuduansha, Middle Jiuduansha and Lower Jiuduansha) and their surrounding water regions of elevation higher than -6 meter. It covers 423.2 square kilometers, stretching 46.3 kilometers from east to west and 25.9 kilometers from south to north.

The Reserve is located in an area where the flows of the Yangtze River and tides of the East China Sea interact strongly. The flows of the Yangtze River have two distinct seasons (dry and wet), while there are two types of tide in a month: spring and neap tides. The interactions of the two water systems resulted in the formation of Jiuduansha in the Yangtze River estuary. The physical conditions of Jiuduansha and the properties of its ecosystems comprehensively reflect the complex interactions of ecological processes in terrestrial, freshwater and marine ecosystems.

According to the charts of the Yangtze River estuary from 1842 till now, Jiuduansha was originally a part of the Waitongsha shoal in the Yangtze River estuary. Frequent floods of the Yangtze River in 1949 and 1954 resulted in the mergence of troughs of the ebb tide and the flood tide at the east of Waitongsha shoal, and thus Jiuduansha deviated from Tongsha shoal. After a half-century evolvement, Jiuduansha has become stable shoals. Analyses of hydrology and sediment physiognomy suggest that Jiuduansha might become 'the third generation of Chongming Island' in the Yangtze River estuary in the future.

Determined by its special position in the Yangtze River estuary, Jiuduansha has a great diversity of biological resources. Surveying the biological resources is the first step for their sustainable use and conservation. Universities and institutes based in Shanghai have investigated the natural resources including biological resources at Jiuduansha since 1990's. From October 2002 to January 2003, Fudan University and Jiuduansha Wetland Nature Reserve jointly conducted four surveys on the natural conditions and biological resources of Jiuduansha, which would be useful to conservation of biological diversity in the Yangtze River estuary. The major results are summarized as follows:

* Prepared by Bo Li, Zhijun Ma and Jiakuan Chen.

Zooplankton

Zooplanktons play an important role in food chains of the estuarine ecosystems. The interactions of various environmental factors shape the features of zooplanktons at Jiuduansha. In our surveys from December of 2002 to January of 2003, 118 species of zooplanktons were identified at Jiuduansha, including 96 species of crustacean, 8 species of Protozoa, 3 species of Chaetognatha, 6 species of Rotifer. At the same time, 10 species of planktonic copepods were recorded, i. e. *Schmackeria poplesia*, *Sinocalanus sinensis*, *Limnoithona sinensis*, *Tortanus vermiculus*, *Cetropages sinensis*, *Labidocera euchaeta*, *Sinocalanus dorrii*, *Mesocyclops leuckarti*, *Eodiaptomus sinensis* and *Cyclops vicinus*. Additionally, *Acanthomysis longirostris*, *Acetes chinensis* and *Asplanchna* sp. were also found at Jiuduansha.

A comparison of the zooplanktons was made between the Yangtze River estuary and the other estuaries in China. In the Yangtze River estuary, *Sinocalanus sinensis*, *Schmackeria poplesia*, *Brachionus calyciflorus* are common species, while *Sagitta crassa*, *Acartia bifilosa*, *Centropages mcmurrici*, *Tortanus spinicaudatus*, *Calanus sinicus*, *Penilia avirostris*, *Evadne tergestina* are dominant in the Yellow River estuary. In Zhujiang River estuary, zooplanktons consist of alongshore low-salt species, warm-current species and tropic outer-sea species.

Phytoplankton

According to our surveys, 118 species of algae belonging to 57 genera of 7 phyla were recorded, of which 85 species from 37 genera belong to Bacillariophyta, accounting for 70.2% of the total. Chlorophyta was the second largest phylum, containing 18 species from 9 genera. Other phyla included Cyanophyta (7 species from 7 genera), Pyrrophyta (3 species of 1 genus), Euglenophyta (3 species from 3 genera), Cryptophyta (1 species) and Chrysophyta (1 species).

In the shallow water around Jiuduansha shoals, 102 taxa of phytoplanktons were recorded, belonging to 47 genera of 5 phyla. Most of the species were Bacillariophyta, containing 76 taxa. Other phyla included Chlorophyta (17 taxa), Cyanophyta (5 taxa), Pyrrophyta (3 taxa) and Chrysophyta (1 taxon). Forty-five taxa of algae were also recorded in the shallow waters on the Jiuduansha shoals, belonging to 32 genera of 5 phyla. Among them, there were 32 taxa of Bacillariophyta, 6 taxa of Cyanophyta, 3 taxa of Chlorophyta, 3 taxa of Euglenophyta, and 1 taxon of Cryptophyta.

The mean density of phytoplanktons was 17.13×10^4 cells per liter. Similarly, Bacillariophyta was most abundant, whose density was 16.268×10^4 cells per liter, accounting for 94.7% of the total cells. Cyanophyta was the second most abundant, at a density of 0.556×10^4 cells per liter, accounting for 3.42% of the total. Other phytoplanktons included Chlorophyta (0.264×10^4 cells per liter) and Pyrrophyta ($0.264 \times$

10^4 cells per liter). Other phyla were not recorded during our surveys. The dominant species of the phytoplanktons were *Sielitonema costatum* Grev. , *Ditylum brightwellii* Grum. , *Melosira granulata* var. *angustissima* — Müller, *Coscinodiscus radiatus* Ehr. , *C. perforatus* Ehr. , *C. asteromphalus* Ehr. , *Chaetoceros lorenzianus* Grun. , *Nitzschia spectabilis* (Ehr.) Ralfs. and *Pediastrum simplex* Meyen.

Vegetation

Jiuduansha Wetland Nature Reserve consists of newly formed wetland ecosystems, which are experiencing a rapid succession. Its vegetation has four features: 1) the vegetation consists of few species; 2) the vegetation is on rapid primary succession as the sediments carried by the Yangtze River are deposited at Jiuduansha; 3) the vegetation is primary in nature due to little disturbance by human activities; and 4) the structure of plant community is simple.

A total of 17 tracheophyte species were identified at Jiuduansha, all of which are angiosperms, belonging to 7 family and 15 genera. As in similar wetland ecosystems, Jiuduansha wetland ecosystems are dominated by monocotyledons (4 families, 12 genera and 14 species). The other species are dicotyledons (3 families, 3 genera), all of which are all present at low abundance. In nature, the vegetation of Jiuduansha Wetland Nature Reserve belongs to subtropical evergreen and deciduous broad-leaved forest zone, eastern (humid) evergreen broad-leaved forest sub-zone, northern subtropical evergreen and deciduous mixed broad-leaved forest zone, the Yangtze River-Huaihe River plain, cultivation and aquatic plant zone. However, the vegetation of Jiuduansha does not reflect the features of zonal vegetation, which is determined by the properties of the wetland ecosystem.

It is estimated that the total area of vegetation of Jiuduansha covers an area of 3 239.06 hm^2 . The vegetation of Jiuduansha is dominated by 3 plant associations, of which *Scirpus mariqueter* association is the most common one, with the total area being 2 591.47 hm^2 . In fact, *Scirpus mariqueter* association at Jiuduansha is the largest one in China. The other two are *Phragmites australis* and *Spartina alterniflora* associations, which cover areas of 910.22 and 427.37 hm^2 , respectively. At present, the vegetation of Jiuduansha is developing rapidly, and the area covered by vegetation is growing at the speed of 210 hm^2 per year. It should be pointed out that *Spartina alterniflora* invasions in the Jiuduansha wetland are an important threat to its native flora, and have potential impact on wetland birds through reducing both habitats and foods (*Scirpus mariqueter*, zoobenthos). Therefore, it seems urgent to control *Spartina alterniflora* invasions in the Jiuduansha wetland so that the habitats for wetland birds can be protected.

Zoobenthos

A total of 130 zoobenthos taxa were identified in Jiuduansha Wetland Nature Re-

serve, accounting for 98% of the benthos reported in the Yangtze River estuary. Survey of intertidal habitats of Jiuduansha Wetland Nature Reserve yielded 18 species of macrofauna in Upper Jiuduansha, 23 species in Middle Jiuduansha and 22 species in Lower Jiuduansha, respectively. Abundance of macrofauna was highest in Lower Jiuduansha, reaching 6 291 individuals/m². Species diversity of macrofauna in Upper and Middle Jiuduansha was higher than that in Lower Jiuduansha, indicated by species abundance ranking curves, while there was no distinct difference in diversity of macrofauna species between Upper and Middle Jiuduansha. Molluscs were the predominant group in all intertidal habitats in terms of their abundance and species richness, followed by crustacean and annelida. Compared with adjacent marine and freshwater environments, estuarine marsh habitats of Jiuduansha support fewer species of meiofauna, but are of higher abundance. The composition of macrofauna at Jiuduansha is characteristic of macrobenthic diversity of the Yangtze River estuary.

Macrofauna in different habitats of Jiuduansha Wetland Nature Reserve was compared to examine the relationship between macrofauna diversity and primary producers. Ten macrofauna species were recorded in algae-dominated bare beach, 17 species in habitats covered with low density of *Scirpus mariqueter*, 22 species in habitats covered with high density of *S. mariqueter*, 21 species in habitats planted with *Spartina alterniflora*, and 11 species in habitats covered with *Scirpus mariqueter*. Diversity of macrofauna was the lowest in algae-dominated bared beach and in habitats covered with *Scirpus mariqueter*. *Glaucomya chinensis* and *Synidotea laevidorsalis* dominated in bare beach and in habitats covered with low density of *Scirpus mariqueter*. *Assiminea violacea*, *Corophium sinensis* and *Hyoplax deschampsii* were predominant species in all vegetated habitats. *Cingula* and Chironomidae had preferences for the habitats covered with *S. mariqueter* and *S. alterniflora*. *Stenothyra glabra* had the highest density in habitats covered with *S. mariqueter*. ANOVA analyses indicated that species richness, density, α diversity indices of macrofauna, and density of mollusc were significantly different among the habitats.

A comparison of benthic macrofaunas between Jiuduansha and Chongming Dongtan suggest that the diversity of macrofauna at Jiuduansha was higher (both more species and higher evenness) than that at Chongming Dongtan. Benthic macrofauna is the second producers at Jiuduansha Wetland Nature Reserve, and serves as food source for fish, birds and other invertebrates. In low tidal habitats dominated by algae, birds are the most important predators of benthic macrofauna. In mid- and high tidal habitats covered with marsh plants, zoobenthos serve as preys mainly for fish and other macro-invertebrates.

Jiuduansha Wetland Nature Reserve is the spawning area for the Yangtze River population of *Eriocheir sinensis*, one of the most economically important aquatic products in China. Moreover, Jiuduansha provides most important habitats for *Exopalaemon annandalei*, *E. Mondestus* and *Portunus trituberculatus*. Jiuduansha Wetland Nature

Reserve is considered to be the key area for the conservation of economic invertebrates of Yangtze River estuary as almost all economic invertebrates of Yangtze River estuary are present at high abundance at Jiuduansha. Our survey suggests that the conservation of Jiuduansha Wetland Nature Reserve is essential to the sustainable utilization of invertebrate resources of the Yangtze River estuary.

Fish

Fish identified at Jiuduansha wetland reflect the characteristics of estuarine fish fauna. A review reveals that 128 species of fish from 18 orders and 48 families were identified at Jiuduansha and surrounding water regions. The Perciformes were the dominant taxon, including 43 species, which accounted for 33.6% of the total species. Other taxa include 16 species of Cypriniformes (12.5% of the total), 11 species of Clupeiformes (8.6% of the total), 9 species of Tetraodontiformes (7% of the total), 5 species of the Chondrichthyes (3.9% of the total) and 49 species of fish from 13 other orders (38.3% of the total). If the fish are grouped in relation to habitats, 30% of the total fish are estuarine and sea fish; 20% fresh-water fish; 10% sea coastal fish; and 10% diadromous fish. Therefore, the fish fauna of Jiuduansha is considered to be transitional between the lower reaches of the Yangtze River and the East China Sea.

The majority of fish at Jiuduansha are benthivores and detritivores, e. g. Gobioidae, Cynoglossidae and *Leiocassis longirostris*, *Mugil cephalus*, *Mugil cephalus*, and certain taxa, such as Salangidae and Clupeidae are zooplanktivores. There are few species in the water area, which are typical phytoplanktivores. Similarly, only few species, such as *Harporodon nehereus*, *Saurida elongata*, *Lateolabrax japonicus* and *Eupleurogrammus muticus* are piscivores.

The environments of the estuary are strongly affected by the interactions of brine and freshwater movements, and changes in environmental factors here are quite seasonal. For this reason, the fish diversity, abundance and distribution all are of seasonality. In spring, coastal fish overwintering in the outer sea migrate to the water area of Jiuduansha for feeding and spawning. In summer and autumn, freshwater fish living in the middle and lower reaches of Yangtze River move to Jiuduansha for feeding. Additionally, as a consequence of ocean currents, certain marine fish may come to the water area of Jiuduansha for feeding. Consequently, the species diversity of fish is very high from spring to autumn at Jiuduansha. It is also worth mentioning that 5 species of national priority-protected fish were recorded at Jiuduansha.

Therefore, Jiuduansha not only has a very high diversity of fish native to the estuary but also provides the feeding and spawning habitats for the fish of different habitats. Jiuduansha is very important to biodiversity conservation of fish from several important ecoregions of China, the Yangtze River estuary, the valley of Yangtze River, the northern East China Sea and the southern Yellow Sea.

Birds

One of Jiuduansha's ecological values is the provision of habitats for waterbirds. In our recent surveys, 113 species of birds from 9 orders and 21 families were recorded at Jiuduansha, most of which could be grouped into shorebirds, geese and ducks, egrets, gulls and birds in Passeriformes. Two orders, Charadriiformes and Passeriformes, were dominant at Jiuduansha, which accounted for 31.9% and 31.0% of the total bird species, respectively. Eight species are listed as the second class of national priority-protected animals, and six species are listed in "China RDB of Endangered Animals". Of them, black-faced spoonbill (*Platalea minor*) is the endangered species recognized by IUCN and BirdLife International. At Jiuduansha, five types of habitat were identified to be important for birds that have different habitat preferences, i. e., reed communities, sea-bulrush communities, smooth cord-grass communities, bare tideland and shallow water region. Waterbirds were the most important functional group, which accounted for 61.9% of total bird species. Those birds require both bare tidelands and shallow water areas as their habitats.

From the viewpoint of biogeography, most of the bird species are travelers and winter migrants of palaearctic origin, which accounted for 60.2% of the total species. However, if only the breeding species (residents and summer migrants) at Jiuduansha are considered, species of oriental region are dominant at Jiuduansha, taking 53.4% of the breeding species. Therefore, Jiuduansha is the transitional zone between palaearctic and oriental regions in relation to birds' origin. It is not surprising that birds at Jiuduansha share some features of palaearctic and oriental birds.

The structure of its vegetation is simple as Jiuduansha consists of 3 newly formed islands. This is the major reason why relatively fewer bird species were recorded at Jiuduansha. Nevertheless, the abundances of existing birds are very high there. Jiuduansha is located at the middle site of migrant flyway in Eastern China, and is also the middle site of East Asian-Australasian Flyway. In migrating season, a large number of migrants stay at Jiuduansha. The wetlands at Jiuduansha supply foods and energy for the long distance flyway of birds. A field investigation conducted in 1996 revealed that, for 7 species of shorebirds, the number of individuals of each species exceeded 1% of the world's total number of that species, which is taken as the criterion of Wetland of International Importance. This means that Jiuduansha is important stopover site for the migrants. Meanwhile, Jiuduansha is also wintering grounds for birds. More importantly, Jiuduansha is little disturbed by human activities, and thus it can provide good habitats for the migrants.

Although water conservancy projects along the Yangtze River may have considerable impact on rate of sedimentation at Jiuduansha, Jiuduansha will still keep growing. This will bring a great diversity of habitats for the waterbirds. At the same time, the

various plant communities at different successional stages provide habitats for different types of bird species. Therefore, it is predicted that the bird species and their abundances may increase in the future.

Mammals

The water area of Jiuduansha wetland is important habitats for aquatic mammals, especially for resident species. Fourteen species of aquatic mammals were recorded in the water area of Jiuduansha and vicinal regions. These aquatic mammals are all national priority-protected animals.

Eight species, namely *Balaenoptera physalus*, *Balaenoptera brydei*, *Balaenoptera acutorostrata*, *Physeter macrocephalus*, *Mesoplodon densirostris*, *Orcinus orca*, *Pseudorca crassidens* and *Steno bredanensis* are ocean mammals. Four species, namely *Sousa chinensis*, *Lagenorhynchus obliquidens*, *Tursiops truncatus* and *Neophocaena phocaenoides* are coastal mammals. *Neophocaena phocaenoides* can live in the middle and lower reaches of the Yangtze River. *Lipotes vexillifer* is a freshwater species living only in the middle and lower reaches of the Yangtze River. In addition, *Tursiops truncatus* and *Phoca largha* are quite often recorded in the water region of Jiuduansha. Consequently, Jiuduansha Wetland Nature Reserve is believed to be important habitat for protecting *Neophocaena phocaenoides*, *Tursiops truncatus* and *Phoca largha*.

Conclusions

Our recent surveys show that Jiuduansha wetlands are of great conservation value, for which there are various reasons. First, the Jiuduansha wetlands are primary in nature, and have been subjected to little human disturbance, which reflects the nature of the Yangtze River estuarine wetlands. Second, Jiuduansha is still in the early stage of primary succession of the estuarine wetland ecosystems, and thus its vegetation and the structure of plant communities are simple. Nevertheless, the wetlands contain a great diversity of other taxa that are of great conservation, economic or scientific value, including phytoplanktons, zooplanktons, benthic fauna, fish and birds. Third, Jiuduansha provides important habitats for a large number of endangered animals, where 27 national priority-protected animals were identified; 5 species of fish, 8 species of birds and 14 species of aquatic mammals. Fourth, Jiuduansha provides feeding and/or spawning habitats for many economic (especially the aquacultural) animals or migrating routes for migratory birds. For this reason, protecting Jiuduansha wetlands is critical to the sustainable use of fishery resources in the Yangtze River estuaries. Fifth, Jiuduansha is an important stopover site for the migratory birds, which plays an important role in their life histories. Sixth, Jiuduansha contains plant communities that reflect different stages of succession of estuarine wetland ecosystems, which are of great scientific value. At the same time, it is good model ecosystem for studying physical geography, hydrology, and

origin and maintenance of biodiversity of estuarine ecosystems. Seventh, Jiuduansha is still growing very rapidly due to sedimentation, implying that it can potentially provide a great diversity of habitats for more species, especially wetland birds. Finally, estuarine wetland ecosystems are extremely sensitive to hydrological changes and other types of environmental changes, and hence conserving Jiuduansha and its ecosystems will offer unique opportunities to explore the potential impact that water conservancy projects along the Yangtze River may have on ecological processes in the watershed and the estuary.

Conclusions

Our recent surveys show that Jiuduansha wetlands are of great conservation value, for which there are various reasons. First, the Jiuduansha wetlands are primary in nature, and have been subjected to little human disturbance, which reflects the nature of the Yangtze River estuarine wetlands. Second, Jiuduansha is still in the early stage of primary succession of the estuarine wetland ecosystem, and thus its vegetation and the structure of plant communities are simple. Nevertheless, the wetlands contain a great diversity of other taxa that are of great conservation, economic or scientific value, including phyllophorans, zooplankton, benthic fauna, fish and birds. Third, Jiuduansha provides important habitats for a large number of endangered animals, where 37 national priority protected animals were identified; 5 species of fish, 8 species of birds and 14 species of aquatic mammals. Fourth, Jiuduansha provides feeding and/or spawning habitats for many economic (especially the aquatic bird) animals or migrating routes for migratory birds. For this reason, protecting Jiuduansha wetlands is critical to the sustainable use of fishery resources in the Yangtze River estuary. Fifth, Jiuduansha is an important stopover site for the migratory birds, which plays an important role in their life history. Sixth, Jiuduansha contains plant communities that reflect different stages of succession of estuarine wetland ecosystems, which are of great scientific value. At the same time, it is good model ecosystem for studying physical geography, hydrology, and

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第一篇 自然保护区概况

* 本篇由各章作者提供,马志军整理成文。

