

with the support of



湛江红树林 海上森林

ZHANJIANG'S MANGROVE, THE FOREST OF THE SEA

Professor LIAO BAOWEN
CCI FRANCE CHINE - FABIEN PACORY
SGD Pharma - FREDERIC BARBIER



FOREWORDS

Laurent Legodec, Consul General of France in Guangzhou

Sylvain Fourriere, Former French Consul General in Guangzhou

Prof. Liao Baowen, Chair, Zhanjiang Mangrove Wetland Conservation Foundation

Caroline Penard, General Manager, French Chamber of Commerce and Industry in China (CCI France Chine)

Fabien Pacory, Vice President, French Chamber of Commerce and Industry in China (CCI France Chine)

Dr. Ma Chaode, Assistant Resident Representative, United Nations Development Programme (UNDP) in China

Richard Bourne, SVP Asia-Pacific Japan, EcoVadis

Shi Hua, Program Head, Southern China, One Planet Foundation (WWF)

Kevin Baker, Director, American International School of Guangzhou

Peter Helis, Chief Advisor, Guangzhou Development District

Ada Liao, Member of Supervisory Board and Head of Strategic Development, Kingfa

Alice Guilhon and Frédérique Vidal, SKEMA Business School

Pauline Wirth du Verger, Director of the France Parliamentary Press Office

Olivier Rousseau, CEO, SGD Pharma



**Foreword By
Laurent Legodec
Consul General of France in Guangzhou**

Les mangroves comptent parmi les écosystèmes les plus remarquables de notre planète. Situées à la frontière entre la terre et la mer, elles se dressent comme des forteresses vivantes, protégeant nos côtes, abritant une biodiversité foisonnante et stockant d’immenses quantités de carbone. Jouant le rôle de boucliers pour les villes côtières face à la montée des eaux, elles enchevêtrent dans leurs racines à demi immergées les sols et abritent des millions de communautés animales - poissons, insectes et oiseaux - dont la vie dépend de leur préservation.

Au cours de ma carrière en Chine et en Asie du Sud-est, j’ai pu mesurer de près toute la beauté et la fragilité de ces « forêts rouges ». La question de la préservation ou de la restauration des mangroves occupent aujourd’hui, compte-tenu de leur importance, une place centrale dans les discussions environnementales internationales, qu’il s’agisse d’atténuation du changement climatique ou de développement durable des moyens de subsistance. Ces préoccupations trouvent un écho profond en Chine, pays qui a accompli au cours des dernières années des progrès remarquables dans la conservation et la restauration de ses écosystèmes de mangroves.

Aujourd’hui, en tant que Consul général de France à Canton, j’ai le privilège d’exercer dans une circonscription côtière qui englobe quatre provinces — le Guangdong, le Guangxi, le Fujian et Hainan — toutes riches d’un patrimoine exceptionnel de mangroves. Parmi elles, Zhanjiang se distingue comme le berceau de la plus vaste et de la plus concentrée des réserves de mangroves de Chine. Couvrant plus de 20 000 hectares et abritant plus de 300 espèces d’oiseaux, la Réserve nationale naturelle des mangroves de Zhanjiang est un joyau de biodiversité et un modèle exemplaire de gouvernance écologique. La visite du Président Xi Jinping à

Zhanjiang a d’ailleurs souligné l’importance nationale de ces écosystèmes.

L’effort mondial entrepris pour préserver ou restaurer les mangroves mobilise non seulement les gouvernements et la communauté scientifique internationale, mais aussi les entreprises qui repensent leur rôle dans la protection de la nature. Je suis fier de constater que de nombreuses entreprises françaises participent à cette dynamique ici en Chine — avec parmi elles SGD Pharma, dont la branche de Zhanjiang illustre une présence industrielle responsable, rejoignant d’autre entreprises françaises ayant une activité en Chine comme EDF, CMA CGM, Pernod Ricard et bien d’autres. Leurs initiatives, qu’il s’agisse de réduction des émissions, de restauration des écosystèmes ou de partenariats locaux, démontrent que le développement économique et la préservation de l’environnement peuvent — et doivent — avancer de concert.

Par sa résilience et sa capacité à prospérer dans l’adversité, la mangrove est un symbole tout trouvé du partenariat franco-chinois : enraciné dans des valeurs communes, renforcé par la coopération, et tourné vers la protection de ce que nous avons de plus précieux — notre planète. Le Cadre mondial pour la biodiversité de Kunming-Montréal et la récente Conférence des Nations unies sur les océans (UNOC 3) tenue à Nice ont tous deux réaffirmé le rôle essentiel des mangroves dans la réalisation de nos objectifs mondiaux en matière de biodiversité, de climat et de développement durable.

Puisse ces pages servir à la fois d’hommage et d’appel à l’action — pour préserver, restaurer et célébrer ces forêts extraordinaires qui nous relient toutes et tous, des rivages de Zhanjiang à ceux de la Méditerranée et bien au-delà.

Mangroves are among the most remarkable ecosystems on Earth. They stand at the crossroads between land and sea, serving as living fortresses that protect our coasts, sustain biodiversity, and store vast quantities of carbon. Acting as shields for coastal cities against rising sea levels, their semi-submerged roots entwine the soil and shelter millions of animal communities—fish, insects and birds—whose lives depend on their preservation.

During my career in China and South-East Asia, I witnessed at first-hand both the beauty and the fragility of these “red forests.” Because of their importance, the preservation and restoration of mangroves is now central to international environmental discussions, from climate mitigation to sustainable livelihoods. These concerns resonate deeply in China, a country that has made extraordinary progress in conserving and restoring its mangrove ecosystems.

Today, as Consul General of France in Guangzhou, I have the privilege of serving in a coastal jurisdiction that includes four provinces — Guangdong, Guangxi, Fujian, and Hainan — all rich in mangrove heritage. Among them, Zhanjiang stands out as the cradle of China’s largest and most concentrated mangrove reserve. Covering more than 20,000 hectares and hosting over 300 species of birds, the Zhanjiang Mangrove National Nature Reserve is a jewel of biodiversity and a powerful example of ecological governance. President Xi Jinping’s visit to Zhanjiang in April 2023 underscores the importance of these ecosystems to the nation.

The global effort to preserve or restore mangroves is mobilizing not only governments and the international scientific community, but also businesses who are rethinking their role in protecting nature. I am proud that a number of French companies are contributing to this movement—among them SGD Pharma, whose Zhanjiang branch exemplifies a responsible industrial presence, alongside other French companies present in China like EDF, CMA CGM, Pernod Ricard, and many others. Their initiatives, whether in reducing emissions, restoring ecosystems, or fostering local partnerships, show that economic development and environmental stewardship can and must advance together.

For its resilience and capacity to thrive in adversity, the mangrove is a fitting symbol of the Sino-French partnership—rooted deeply in shared values, growing stronger through cooperation, and protecting what is most vital: our planet. The Kunming-Montreal Global Biodiversity Framework and the recent United Nations Ocean Conference (UNOC 3) in Nice have both reaffirmed the critical role of mangroves in achieving our global goals for biodiversity, climate, and sustainable development.

May this book serve as both a tribute and a call to action—to preserve, restore, and celebrate these extraordinary forests that bind us all, from the shores of Zhanjiang to those of the Mediterranean, and far beyond.



**Foreword by
Sylvain Fourriere
Former French Consul General in Guangzhou**

La parution de ce beau livre vient tout à la fois illustrer l'engagement de Français et de Chinois déterminés à agir contre le dérèglement climatique et en faveur de la préservation de la flore et de la faune, la coopération exemplaire entre les secteurs privé, associatif et public, et finalement la capacité profonde des hommes à s'unir en une communauté de destin.

Comme bien souvent dans les aventures humaines, cela a commencé par la convergence de volontés : celle du représentant d'une grande entreprise française (SGD Pharma), Frédéric Barbier, de pleinement inscrire son activité industrielle dans la lutte contre le dérèglement climatique et la protection de l'environnement, épaulé et encouragé par un entrepreneur de talent, passionné constructeur de ponts entre la France et la Chine, Fabien Pacory, celle des autorités du Gouvernement de la ville de Zhanjiang, fermement engagées dans la protection de leur précieux patrimoine environnemental et enfin celle d'infatigables acteurs associatifs locaux qui œuvrent en faveur de la protection et de la restauration de la mangrove et de son riche écosystème.

Je suis heureux et fier d'avoir apporté mon soutien à cette grande aventure humaine, durant les quatre années pendant lesquelles j'ai assuré les fonctions de consul général de France à Canton. D'une part, la préservation de cet écosystème exceptionnel qu'est la mangrove, si précieux et si fragile à la fois, est un enjeu majeur et, d'autre part, j'ai été très sensible à la résolution de Frédéric Barbier et de Fabien Pacory de participer aux efforts des habitants de la ville de Zhanjiang en faveur de l'environnement de cette si belle ville. Les autorités du gouvernement de la ville de Zhanjiang y ont été également sensibles et leur soutien a été déterminant. A cet égard, je tiens en particulier à remercier Mme Wang, Directrice du Bureau des Affaires étrangères de Zhanjiang.

Sans nul doute, cette aventure est aussi une pierre solide de la coopération franco-chinoise, au sens large, en faveur de la lutte contre le dérèglement climatique, la préservation de la biodiversité et la sauvegarde de l'environnement.

En conclusion, je veux remercier tous les acteurs de cette forte mobilisation en faveur de la mangrove de Zhanjiang et aussi souhaiter qu'elle se poursuive longtemps !

The publication of this splendid book is an illustration of the shared commitment among French and Chinese citizens, determined to act against climate change in favor of preserving flora and fauna. It is also a testament to an exemplary cooperation between the private sector, non-profit organizations, and public bodies, and to the ability of people to unite as one community with a shared future.

This initiative emerged, as is often the case, from a convergence of diverse thinking: Frederic Barbier, representing SGD Pharma, a major French company, was seeking to embed environmental protection and the fight against climate change into the heart of his company's industrial mission. He was supported and encouraged by Fabien Pacory, a talented entrepreneur, and a passionate Franco-Chinese bridge builder. Their efforts echoed with Zhanjiang City Government's firm commitment to the protection of their precious environmental heritage, and, finally, with that of tireless members of the local community working to protect and restore the mangrove and its rich ecosystem.

I am happy and proud to have supported this great collective endeavor over the four years I served as Consul General of France in Guangzhou. Preserving the exceptional mangrove ecosystem, so precious and yet so fragile, is a major issue, and the resolve of Frederic Barbier and Fabien Pacory to join the citizens of Zhanjiang in preserving the beautiful environment of this beautiful city deeply impressed me. The Zhanjiang City Government authorities were receptive to this, and their support, and especially that of Ms. Wang, Director of the Zhanjiang Foreign Affairs Office, was crucial—my thanks go out to her.

Without a doubt, this venture is also a solid building block for Franco-Chinese cooperation in the broader sense, working together to fight against climate change, for the preservation of biodiversity, and for the protection of the environment.

In conclusion, I want to thank all those involved in this strong mobilization for the mangroves in Zhanjiang and I hope this will continue for a long time to come.



**Foreword by
Professor Liao Baowen
Chair, Zhanjiang Mangrove Wetland Conservation Foundation**

At present, our country's government has attached unprecedented importance to the protection and restoration of mangroves. In April 2017, while inspecting mangroves in Beihai, Guangxi, General Secretary Xi Jinping emphasized that: "We must respect science, implement responsibilities, and protect the mangroves." In April 2023, during a survey on Jinniu Island in Zhanjiang City, the general secretary once again pointed out that: "This mangrove forest is a 'national treasure' and should be protected like we protect our eyes." In November 2022, at the 14th Conference of the Parties to the Convention on Wetlands, General Secretary Xi Jinping proposed that "China will promote international exchanges and cooperation and establish an international mangrove center in Shenzhen." In September 2023, the 62nd meeting of the Standing Committee of the Convention on Wetlands approved the regional motion submitted by China on the establishment of an international mangrove center. By 2024, the International Mangrove Center officially launched its substantive operations and completed its establishment agreements, with the first batch of 18 member countries and the interim secretariat becoming stationed in Shenzhen at the same time.

In order to thoroughly implement the spirit of General Secretary Xi Jinping's important instructions on mangrove protection and comprehensively strengthen mangrove protection and restoration, the Ministry of Natural Resources and the State Forestry and Grassland

Administration jointly issued the "Special Action Plan for Mangrove Protection and Restoration (2020-2025)" in 2020. The plan clearly states that the creation and restoration of mangroves should be promoted under scientific

guidance, and ecological restoration should be prioritized on the basis of completing the clearance of breeding ponds in nature reserves. The goal is to achieve a total area of mangrove creation and restoration of 18,800 hectares, of which 9,050 hectares of mangroves will be created (Zhanjiang City has the heaviest task, at 2,813 hectares), and 9,750 hectares of existing mangrove forests are to be restored (Zhanjiang City faces the task of restoring 1,370 hectares).

This series of mangrove protection measures has aroused widespread concern from all walks of life, and the public's need for understanding of mangrove-related knowledge is becoming increasingly urgent. The French Chamber of Commerce and Industry in China is highly concerned about the progress of mangrove protection and restoration in Zhanjiang City, and has offered to cooperate with the Zhanjiang Mangrove Wetland Conservation Foundation (established in April 2022) to jointly compile a book on international mangrove science, aimed at helping more businesses, including French companies in China, understand mangroves better, pay greater attention to them, and support mangrove protection and restoration work. It is in this context that this book came into being.

This book is the fruit of a two-year collaboration between the scientific community specialized in mangrove preservation, the French Chamber of Commerce and Industry, and SGD Pharma.

I would sincerely like to thank all my friends and colleagues who provided me with precious material to enable the smooth publication of this book.

Acknowledgements

We are grateful for the picture support provided by the following units and individuals:

Units:

- Hainan Dongzhai Port National Nature Reserve Administration
- Guangdong Zhanjiang Mangrove National Nature Reserve Administration
- Guangxi Beilun Estuary National Nature Reserve Administration
- Guangxi Shankou National Nature Reserve Administration
- Guangdong Shenzhen Neilingding-Futian National Nature Reserve Administration
- Fujian Zhangjiangkou National Nature Reserve Administration
- Propaganda Department of Zhanjiang Municipal Party Committee
- Zhanjiang Bird Watching Association
- Zhanjiang Photography Association

Individuals:

Wang Wenqing, Chen Yuyun, Zhong Cairong, Feng Erhui, Lin Guangxuan, Yang Feng, Jia Chao, Chen Luzhen, Xin Kun, Su Bo.

Thanks to SGD Pharma for compiling and editing this book and for their support to plant so many mangrove trees.

Thanks to Professor Wang Wenqing of Xiamen University for helping write the popular science content of "Large Benthic Animals and Fish."

Thanks to Guangzhou Damei Natural Culture Technology Company for illustrating this book.



**Foreword by
Caroline Penard
General Manager, French Chamber of Commerce and Industry in China (CCI France China)**

C'est avec une grande fierté que je signe la préface de cet ouvrage consacré à l'un des trésors écologiques les plus précieux de notre planète : la mangrove. Ce livre, né de la collaboration entre la Fondation de Zhanjiang pour la Préservation de la Mangrove, les autorités consulaires françaises en Chine, le gouvernement de Zhanjiang, la Chambre de Commerce et d'Industrie France Chine, et SGD Pharma, témoigne d'une conviction partagée : le développement économique et la protection de la biodiversité doivent avancer de concert.

La CCI France Chine a pour mission d'accompagner les entreprises françaises à chaque étape de leurs projets en Chine, d'aider leurs ambitions à devenir des réalités, et d'informer et guider les entreprises chinoises désireuses de s'implanter en France. Nous avons également la responsabilité de promouvoir les intérêts de nos membres auprès des décideurs économiques et politiques français comme chinois. En soutenant des initiatives environnementales reconnues et pertinentes, telles que *Mangrove Together*, nous renforçons les ponts de dialogue et de confiance qui sont essentiels à toute coopération durable. Enfin, à travers nos nombreux événements, nous animons une communauté d'affaires dynamique, un espace d'échanges qui contribue chaque jour à rapprocher nos deux pays.

C'est dans cet esprit que je me suis rendue moi-même à

Zhanjiang pour planter des arbres mangroves. Ce geste symbolique était aussi une manière d'exprimer notre engagement concret aux côtés de nos partenaires locaux et de souligner l'importance de cet écosystème unique, à la fois rempart naturel contre l'érosion côtière, refuge pour la biodiversité et formidable puits de carbone.

Je tiens à saluer particulièrement SGD Pharma, dont l'engagement exemplaire a été reconnu dès 2024 par un prix distinguant cette initiative. Leur détermination à agir pour la planète, là où leurs activités les ancrent, illustre parfaitement l'esprit de responsabilité et d'innovation qui anime les entreprises françaises en Chine.

Je souhaite aussi exprimer ma profonde reconnaissance à Fabien Pacory, Vice-Président de la CCI France Chine. Son énergie, son sens du collectif et son soutien constant ont été déterminants pour faire émerger et grandir ce projet. Il incarne pleinement le rôle moteur que notre Chambre entend jouer dans les initiatives qui rapprochent nos communautés d'affaires autour de valeurs communes.

Puisse cet ouvrage inspirer d'autres actions, d'autres partenariats et d'autres engagements. La préservation des mangroves n'est pas seulement une cause environnementale ; c'est une aventure humaine et économique qui nous rappelle que notre avenir dépend de ce que nous choisissons de protéger aujourd'hui.

I am very proud to be writing the foreword for this book devoted to one of our planet's most precious ecological treasures: the mangrove. The book, which was born out of a collaboration between the Zhanjiang Mangrove Wetland Conservation Foundation, the French consular authorities in China, the Zhanjiang government, the French Chamber of Commerce and Industry in China (CCI France China), and SGD Pharma, bears witness to a shared conviction: economic development and biodiversity protection must move forward hand in hand.

The mission of CCI France China is to support French businesses at every stage of their projects in China, to help their ambitions become reality, and to support Chinese companies looking to set up in France with information and guidance. We also have the responsibility of promoting the interests of our members to economic and political decision-makers in both France and China. By supporting recognized and relevant environmental initiatives, such as *Mangrove Together*, we strengthen those bridges supporting dialogue and trust that are essential for any lasting cooperation. Finally, through our numerous events, we are hosts to a dynamic business community, a space for exchange that brings our two countries closer together daily.

It is in this spirit I went to Zhanjiang to plant mangrove trees. This symbolic gesture was also a way to express our concrete commitment alongside our local partners and to underscore the importance of this unique ecosystem, a natural protection against coastal erosion, a refuge for biodiversity, and a formidable carbon sink.

I would particularly like to commend SGD Pharma, whose exemplary commitment was recognized in 2024 with an award honoring this initiative. Their determination to act for the planet in those places where their activities are rooted is a perfect illustration of the spirit of responsibility and innovation that drives French companies in China.

I also wish to express my deep gratitude to Fabien Pacory, Vice-President of CCI France China. His energy, team spirit, and constant support were decisive in bringing this project into being and helping it grow. He fully embodies the driving role that our Chamber intends to play in initiatives based around shared values that bring our business communities together.

May this work inspire other actions, other partnerships, and other commitments. Mangrove preservation is not just an environmental cause; it is a human and economic endeavor, reminding us that our future depends on what we choose to protect today.



**Foreword by
Fabien Pacory**
Entrepreneur, Vice President of the French Chamber of Commerce and Industry in China, Advisor to the City of Zhanjiang

When we began this book two years ago, with Professor Liao Bowen, Chair of the Zhanjiang Mangrove Wetland Preservation Foundation, and Frederic Barbier, General Manager of SGD Pharma Asia-Pacific, we shared a simple conviction: the mangrove is more than a tree; it is a meeting point, an intersection between land and sea, between biodiversity and protection, and, perhaps most importantly for us, between China and France, two nations committed to building a sustainable future.

As an entrepreneur with a deep passion for sustainability, this project has been more than just a scientific or environmental endeavor. It has been a personal journey. For three years, I devoted myself to earning a Doctorate in Business Administration in Sustainability at SKEMA Business School, driven by the belief that companies, institutions, and individuals all share a responsibility to accelerate the transition toward a greener world. This book is one concrete outcome of that belief.

Its completion required the energy, expertise, and goodwill of many people. I would like to express my heartfelt gratitude to the French Embassy in China, the Consulate General of France in Guangzhou, and Caroline Penard, Director of the French Chamber of Commerce and Industry in China, whose support, encouragement, and trust made this initiative possible.

My vision for *Mangrove Together* is not only to raise awareness about the ecological importance of mangroves, on how they protect coastlines, preserve biodiversity, and absorb significant amounts of carbon, but also to create a bridge supporting cooperation between our two countries. Sustainability is a universal language, and few themes demonstrate this better than the restoration of mangrove forests.

Throughout this journey, I have been fortunate to work alongside inspirational partners whose commitment has strengthened my own enthusiasm. I am, by nature, a person who thrives on connections, who believes in the strength of positive energy, optimism, and collective effort. This book is a reflection of that spirit: dynamic, collaborative, and forward-looking.

If these pages can inspire even a few readers, entrepreneurs, students, policymakers or citizens to join us in the preservation of mangroves, or to pursue their own paths towards sustainability, then we will have succeeded.

Together, let us continue to plant, restore, and grow.

Together, let us keep building this bridge.



**Foreword by
Dr. Ma Chaode**
Assistant Resident Representative, United Nations Development Programme (UNDP) in China

The total global area of mangroves in 2020 is 14.8 million hectares. Mangroves are salt-tolerant evergreen forests found in intertidal environments at the land-sea interface, and mangrove species are distinguished by morphological and physiological adaptations that enable them to grow in saline environments.

Mangrove forests are vibrant havens for biodiversity. They serve as critical nurseries for fish, shelters for crustaceans, and feeding grounds for migratory birds. They form a complex web of life that supports both marine and terrestrial species, and their intricate root system is a cradle of life.

Mangroves also provide regulating services, such as coastal stabilization, nutrient absorption and carbon sequestration. Mangroves make crucial contributions to many parts of the UN 2030 Agenda for Sustainable Development Goals.

Mangroves are among the world's most productive ecosystems and are important carbon sinks. The high primary production of mangroves sustains a rich food web—from detritus decomposers to fish, mammals and birds—supporting provisioning services for food (especially fish), fiber and fuel alongside cultural services.

Protecting our existing mangrove forests and rehabilitating the ones that have been degraded or destroyed is one of the most worthy causes for us all. It is an investment in coastal resilience, climate mitigation, biodiversity conservation and sustainable utilization all at once.

In this global effort, China has emerged at the forefront of large-scale mangrove reforestation, demonstrating a profound commitment to ecological civilization. A shining example of this commitment can be found in Zhanjiang, Guangdong Province. The drive of the Zhanjiang local government, amplified by the dedicated work of the Zhanjiang Mangrove Foundation, has created a blueprint for successful conservation and restoration that inspires the world.

The United Nations Development Programme (UNDP), the largest global network for sustainable development, is celebrating its 60th anniversary globally. Contributing to the living planet is a priority of our mandate and we are glad to participate in the *Mangrove Together* Initiative. Launched by the French Chamber of Commerce and Industry in China, and strongly supported by partners like SGD Pharma, this ambitious initiative aims to plant 100,000 trees by 2030. This public-private partnership exemplifies the kind of collective effort needed to scale up effective solutions.

I was privileged to participate personally with all the related participants in this initiative in Zhanjiang in December 2024, to feel the mud between my fingers and contribute to the restoration of this magnificent ecosystem. It is a humbling and hopeful experience. My sincere wish is that more companies will recognize both their responsibility and the unique opportunity to contribute to this cause. By joining hands—governments, international organizations, the private sectors, and local communities—we can ensure that these lush, life-sustaining forests continue to thrive for generations to come. This book is a testament to their importance and a call to action for all of us to contribute to a sustainable planet.



Foreword by
Richard Bourne
SVP Asia-Pacific Japan, EcoVadis

ecovadis

It is a true honor to introduce this beautiful and vital book, which turns its gaze upon the remarkable mangrove ecosystems of Zhanjiang. Zhanjiang is not just a place on a map; it is a globally significant haven where land and sea converge, creating essential coastal forests that sustain countless forms of life and provide critical protection to our shores.

This volume is the result of dedicated collaboration. It weaves together the deep scientific understanding of experts like Professor Liao with truly breathtaking imagery, offering a comprehensive and captivating look at this unique environment. It reveals the complex biology of the mangroves while celebrating their unparalleled natural beauty.

Within these pages, you will find a picture that perfectly encapsulates the spirit of our shared commitment: a moment of tree planting. This act symbolizes the direct, impactful work being done every day.

This book serves as a powerful reminder of the irreplaceable value of these coastal jewels. The resilience of the Zhanjiang mangroves is something we must actively protect. It is crucial that we all, whether as individuals, institutions, or companies, recognize this responsibility and work together to ensure the longevity of this precious legacy.

This publication is therefore a special token of appreciation for those who stand with the mangrove foundation and the *Mangrove Together* initiative. Your commitment makes the difference between decline and a thriving success.

May this book inspire every reader to champion the ongoing preservation of the glorious green heart of Zhanjiang's coast.

Foreword by
Shi Hua
Program Head, Southern China,
One Planet Foundation

Mangroves are among the most valuable yet threatened ecosystems on our planet. They protect coastlines from storms, nurture rich biodiversity, store up to four times more carbon than terrestrial forests, and sustain the livelihoods of millions of people. At a time when climate change is accelerating and coastal communities face increasing risks, restoring mangrove ecosystems is not only an environmental necessity—it is a social and economic imperative.

This is why this project unites us. The collaboration between One Planet foundation (OPF), Zhanjiang City, the Zhanjiang Mangrove Foundation, the French Chamber of Commerce and Industry in China and SGD Pharma demonstrates how cross-sector partnerships can amplify both ecological and community benefits. Each actor plays a unique role: local authorities provide stewardship and long-term planning; NGOs ensure science-based restoration and transparent monitoring; and forward-looking enterprises bring resources, innovation, and global visibility to the efforts.

As the strategic partner of World Wide Fund for Nature (WWF), OPF has been working on biodiversity protection, ecological footprint reduction, and the assurance of sustainable use of natural resources in China for decades. For OPF, serving as one of the key participants in

this project, we have ensured that every contribution is used effectively, accurately assessed, and aligned with international best practice for nature-based solutions. Transparent governance is essential, not only to safeguard donors' trust, but also to ensure that mangrove restoration delivers measurable, verifiable, and lasting outcomes for ecosystems and communities alike.

The Zhanjiang mangrove initiative represents exactly the type of collaborative model needed for meaningful ecological restoration. By connecting expertise, networks, and financial support, the project demonstrates how collective action can accelerate large-scale mangrove planting and rehabilitation. It sets a precedent for how cities, civil society, and industries can work together to advance climate resilience, biodiversity conservation, and sustainable development.

Mangroves take time to grow, but the partnerships built today will determine the resilience of our coasts tomorrow. Through this joint effort, we take an important step toward safeguarding blue carbon ecosystems for future generations.



**Foreword by
Kevin Baker
Director, American International
School of Guangzhou**

In the heart of Zhanjiang, China, on a shimmering summer day, a landmark moment unfolded. Members of the American International School of Guangzhou (AISG) Board, including our Board Chairman Frederic Barbier, school leadership, parents, students, and alumni gathered to witness the signing of a Memorandum of Understanding between the American International School of Guangzhou and the Mangrove Wetlands Foundation. With this agreement, AISG became the first international school to join the Foundation's mission: an alliance grounded in hope, responsibility, and a shared vision for a carbon-zero future.

But the celebration of partnership didn't end with the signing. As the ink dried, everyone traded pens for shovels and boots. Under the warm, relentless sun, they pressed mangrove seedlings into the tidal flats, "coastal guardians," as one participant called them, tiny sentinels destined to protect shorelines, shelter wildlife, and capture carbon for centuries to come.

"Wow, I can really do this!" said Sunny, an elementary student, grinning beside the eight saplings he had just planted. "I hope they can grow into a big mangrove forest." His enthusiasm echoed across the flats, mingling with the quiet satisfaction of others who saw their efforts as part of something greater. Rachel, a secondary student, reflected, "Collective social effort can start from a small step... it's important to bring attention to how people can contribute to a greener future."

Some participants connected the experience to legacy. "Plant a tree, write a book, have a child," shared Maria, an AISG teacher, quoting a Venezuelan saying about our human need to leave something lasting. "Today we planted much more than seedlings; we sowed the commitment to multiply this experience." Others were struck

by the location itself: "rare plants coexisting harmoniously with humans and wild animals," noted Max, AISG's Director of Finance and Operations, who saw first-hand the delicate balance between urban life and nature.

For Lucy, an AISG Alum, the act of planting became a lesson in biology and climate science: mangroves, she learned, are natural wave-breakers, sediment fixers, and powerful carbon absorbers, pulling CO₂ out of the air three to five times faster than terrestrial forests. "Every small action counts," she said. "Those saplings will form a dense forest, protecting the coast, nurturing life, making our planet a little greener."

Even AISG parents felt transformed. "It's a joy to know we're contributing to a cause greater than ourselves," said Kate. "I hope experiences like this inspire a lifelong passion for environmental stewardship in our children." And from Soren, AISG Board member and Royal Danish Consulate General of Guangzhou, came a reminder of the magnitude of the setting: "The Zhanjiang Mangrove is China's largest mangrove and a wonderful place to visit... an excellent carbon sink, a haven for biodiversity, and a shield against rising seas."

This book captures those voices alongside striking images of moments of muddy hands, determined smiles, and young roots settling into new homes. The reflections that follow are diverse, some playful, some deeply contemplative, but all share the same heartbeat: a belief that sustainability is made possible by those who care enough to act.

May these mangroves grow tall and strong, sheltering life and standing against the tides, just as the seeds of awareness planted in our community grow into a forest of change.



**Foreword by
Peter Helis
Chief Advisor, Guangzhou Development District,
Birdwatcher and Conservation Photographer**

In the hush of dawn, when the world narrows to a single luminous point, a spoon-billed sandpiper probing the tide, a black-faced spoonbill rising like a pale ghost, a kingfisher exploding from the water in a streak of electric blue. Time itself seems to pause. These are the moments that have called me, again and again, into the wild heart of Guangdong, camera in hand.

More than ten years ago, I first came to Zhanjiang. I was then with the German Chamber, shepherding the early days of the BASF project. I arrived apprehensive. Would this vast industrial ambition scar the coast, silence its birds, choke its mangroves? The opposite has unfolded. What I feared lost has been fiercely protected, even reborn.

When my friends at the French Chamber in China shared their vision for these mangroves, I felt not just admiration, but recognition. They pledged 10,000 trees. On December 6, 2024, at Jinsha Bay Mangrove Science Base, that vow was surpassed: the 11,533rd tree for France (33 is the phone indicative for France), the 11,586th for China (86 is the one for China). Joined by the UN Development Programme, EcoVadis, local enterprises, and city leaders, they planted with purpose, turning mudflat into sanctuary.

Zhanjiang's renewal is a quiet revolution, echoing across Guangdong. I have walked its deltas and bays for years, chronicling its returning citizens. Skies once eerily still now pulse with wings; waters once barren teem with life. Zhanjiang is China's Mangrove Capital, guardian of over 6,687 hectares. Rare wanderers are settling in, drawn to restored green labyrinths like the one this book celebrates.

Mangroves are nature's patient architects: storm breakers, fish nurseries, vital waystations for millions along the East Asian-Australasia Flyway. To see 34 species now thriving here, from red sea olive to sea mulberry, is to witness resilience made visible, a promise kept to avocets, egrets, terns, and the brown-winged kingfishers that stitch sky to sea.

Through my lens, often shared in Chinese media, I seek to build bridges between people and the wild lives they overlook; between cultures united in stewardship. This book is no mere gallery. It is testament, chronicle, invitation. It bids you enter Zhanjiang's tangled emerald world, to feel the fragile pulse of its tides, to rejoice in the riot of wings above.

I am humbled to lend my voice. The French Chamber now looks ahead: 100,000 trees by 2030. May these pages stir in you what a cloud of birds rising from restored mangroves has stirred in me, a deep, abiding faith in a wilder, greener, more harmonious tomorrow.



**Foreword by
Ada Liao
Member of Supervisory Board and Head
of Strategic Development, Kingfa**

Protecting our planet while supporting human development is one of the greatest challenges of our time. At Kingfa, this conviction guides everything we do. Our mission is to create value through high-quality materials and services, fostering a better and more sustainable life. It takes on its full meaning when we engage in initiatives that restore the world's most precious ecosystems.

Among these ecosystems, mangroves hold a vital place. They protect coastlines, sustain biodiversity, and absorb carbon with remarkable efficiency. At a moment when climate change is putting coastal regions at risk, understanding, preserving, and restoring these blue forests is a collective responsibility.

It is with great pride that Kingfa supports this scientific popularization book dedicated to mangroves, produced by the Zhanjiang Mangrove Conservation Foundation, the French Chamber of Commerce and Industry in China (CCI France Chine), and SGD Pharma. Beyond the knowledge it shares, this book embodies the spirit of collaboration and shared responsibility that drives us.

Our core values, innovation, integrity, collaboration, sharing achievements, safety, and the highest environmental, health, and safety (HSE) standards, find a natural echo in this work. As a leader in advanced polymer materials, we place technology at the service of green, low-carbon, and circular development. We develop environmentally friendly products, strengthen clean production, and promote circularity through plastic waste recycling. Our carbon strategy and action plan reflect a clear ambition: to reduce our footprint and actively support our industry's journey toward carbon neutrality.

But sustainability is not something we can achieve alone. Meaningful action requires partnership. By embedding environmental, social, and economic considerations into our daily operations, Kingfa works to build lasting harmony between business and society. The *Mangrove Together* initiative embodies this belief: by bringing together industry, institutions, and communities, it enables deeper and more enduring impact.

May this book inform, inspire, and encourage more people to join this collective effort. Protecting mangroves means protecting our shared future.



**Foreword by
Alice Guilhon
Dean & Executive President SKEMA Business
School**



**Frédérique Vidal
EVP - Chief Strategy & Scientific Impact Officer
SKEMA Business School, Permanent Representa-
tive of the Principality of Monaco to the
United Nations Environment Programme and
the Whaling Commission, former French Minis-
ter of Higher Education, Research and Innovation**

À l'heure où les défis environnementaux deviennent pressants et où la préservation de la biodiversité s'impose comme un impératif collectif, SKEMA Business School est fière de s'associer à cette initiative remarquable portée conjointement par la Fondation de Zhanjiang pour la préservation de la mangrove, la Chambre de Commerce et d'Industrie France Chine, et SGD Pharma. Ce livre de vulgarisation scientifique sur la mangrove constitue une contribution essentielle à la compréhension d'un écosystème aussi discret qu'indispensable.

La mangrove est un trésor. Elle protège nos côtes des tempêtes et de l'érosion, elle abrite une biodiversité exceptionnelle, et elle figure parmi les puits de carbone les plus efficaces de la planète. Dans un monde traversé par l'urgence climatique, comprendre la mangrove, c'est déjà commencer à la protéger. C'est aussi reconnaître le rôle des savoirs, de l'éducation et de la coopération internationale pour bâtir un avenir soutenable.

C'est pourquoi SKEMA s'engage pleinement dans l'initiative "Mangrove Together", qui vise à mobiliser les entreprises afin de planter 100 000 arbres d'ici 2030. En tant que donateur, notre école s'inscrit dans une démarche cohérente avec ses valeurs : agir pour le monde, oser, vivre la diversité, viser l'excellence, et s'engager durablement. Ce sujet est aussi au cœur des préoccupations et actions menées par le programme de l'environnement des Nations Unies dont la Principauté de Monaco est un soutien indéfectible. La mangrove incarne chacune de ces valeurs. Elle agit silencieusement pour le monde ; elle est la preuve qu'un écosystème complexe peut prospérer grâce à la diversité ; elle

nous rappelle que toute restauration écologique est un acte de courage face à l'incertitude ; et elle exige de nous un engagement durable et structuré.

Cette initiative s'inscrit également dans les quatre piliers de notre plan stratégique UNVEIL 2030, conçu pour préparer nos étudiants, nos partenaires et nos communautés à un monde en profonde transformation. SEEK pour comprendre scientifiquement ; COMMIT pour s'engager durablement ; BUILD pour créer des solutions avec les acteurs locaux ; GROW pour faire grandir l'impact positif. La replantation de mangroves à Zhanjiang est l'illustration concrète de ces quatre piliers.

En soutenant ce projet, nous souhaitons non seulement contribuer à la restauration d'un écosystème vital, mais aussi inspirer nos étudiants - les leaders de demain - à développer une conscience environnementale éclairée et active. La mangrove n'est pas seulement un ensemble d'arbres : c'est un modèle de résilience, d'équilibre, et de coopération naturelle. C'est aussi une pédagogie vivante, un appel à repenser notre relation au vivant.

Nous souhaitons que ce livre permette à chacun d'entre nous - étudiants, citoyens, dirigeants, enseignants - de découvrir, comprendre et admirer cet écosystème essentiel, et qu'il encourage un nombre croissant d'entreprises et d'institutions à rejoindre l'initiative Mangrove Together.

C'est collectivement que nous pourrons protéger ce patrimoine naturel et transmettre aux générations futures un monde plus équilibré, plus vivant, et plus durable.

At a time when environmental challenges are becoming increasingly urgent and biodiversity preservation stands as a collective imperative, SKEMA Business School is proud to partner in this remarkable initiative jointly led by the Zhanjiang Mangrove Conservation Foundation, the France-China Chamber of Commerce and Industry, and SGD Pharma. This popular science book on mangroves makes an essential contribution to understanding an ecosystem that is as discreet as it is indispensable.

The mangrove is a treasure. It protects our coasts from storms and erosion, harbors exceptional biodiversity, and ranks among the planet's most effective carbon sinks. In a world marked by climate urgency, understanding mangroves is the first step toward protecting them. It also means recognizing the role of knowledge, education, and international cooperation in building a sustainable future.

That is why SKEMA is fully committed to the "Mangrove Together" initiative, which aims to mobilize businesses to plant 100,000 trees by 2030. As a donor, our school aligns this action with its core values: acting for the world, daring, living diversity, aiming for excellence, and committing sustainably. This topic is also at the heart of the concerns and actions undertaken by the United Nations Environment Programme, which the Principality of Monaco steadfastly supports. The mangrove embodies each of these values. It acts silently for the world; it proves that a complex ecosystem can thrive through diversity; it reminds us that every ecological res-

oration is an act of courage in the face of uncertainty; and it demands from us a sustained and structured commitment.

This initiative also aligns with the four pillars of our strategic plan, UNVEIL 2030, designed to prepare our students, partners, and communities for a profoundly transforming world. SEEK to understand scientifically; COMMIT to engage sustainably; BUILD to create solutions with local stakeholders; GROW to amplify positive impact. The mangrove replanting in Zhanjiang is a concrete illustration of these four pillars.

By supporting this project, we hope not only to contribute to restoring a vital ecosystem but also to inspire our students, the leaders of tomorrow, to develop an informed and active environmental awareness. The mangrove is not merely a collection of trees: it is a model of resilience, balance, and natural cooperation. It is also a living pedagogy, a call to rethink our relationship with the living world.

We hope this book enables each of us - students, citizens, leaders, teachers - to discover, understand, and admire this essential ecosystem, and that it encourages a growing number of businesses and institutions to join the *Mangrove Together* initiative.

Only collectively can we protect this natural heritage and bequeath to future generations a more balanced, more vibrant, and more sustainable world.



**Foreword by
Pauline Wirth du Verger
Journalist, Director of the France Parliamentary
Press Office
Rapporteur to the Comité de France
Mission Officer for the Malraux Commission on
Cultural Europe**

« The best time to plant a tree was twenty years ago. The second-best time is... now! »

Chinese Proverb

It was already more than three decades ago...

The People's Republic of China, wishing to open up to tourism, had intended, as part of its international exchanges, to submit an application file to the Comité de France for the launch of Hainan Island, which some today compared to a "Saint Tropez of the Middle Kingdom." As the historical partner of Le Journal du Parlement, the Comité thus sought to emphasize our friendship ties with China and highlight the profound evolution that had begun.

I would also recall that as early as 1965, it was André Malraux, himself a Member of the Comité de France, who was tasked by General de Gaulle to discuss the major issues of the time with Chinese leaders, and that a few years later, Roland Nungesser, another of his Ministers, served as President of the France-China Friendship

Group of the National Assembly before becoming Honorary President of the Comité.

These long-standing relations with China now find renewed momentum and a particularly unique resonance...

Having recently traveled to Zhanjiang myself to represent Le Journal du Parlement and Les Nouvelles Diplomatiques, and within the framework of the Malraux Commission, to support and relay the efforts underway for environmental heritage preservation, symbolically planting Mangrove there, I can only rejoice that a company such as SGD Pharma, a leader in this field with the "Mangrove Together" project led by Chairman and CEO Olivier Rousseau and orchestrated by Asia Pacific General Manager Frédéric Barbier, could be awarded by that same Comité, for whose application file I served as Rapporteur.

Furthermore, the preservation of such an ecosystem must appear to all as a bridge between East and West. And I salute all those, like Fabien Pacory, Vice-President of the Franco-Chinese Chamber of Commerce, whose involvement has concretely enabled the realization of a project

of this scale, especially knowing that mangrove preservation currently remains a central concern for the Chinese government.

The country, a champion of "Smart cities," is now embracing "Smart nature," with the protection of wetlands and their biodiversity having become a true matter of national pride.

It must be said that this tree shelters an invaluable biotope, hosting no fewer than 3,000 species, 25% of which are endangered, living above and below the water in the mangrove; a tree that protects coastlines from typhoons and costs 5 times less than traditional concrete protections; a tree that helps filter water and aquaculture effluents, and also absorbs carbon.

The Secretary-General of the Convention on Wetlands, Ms. Musonda Mumba, an environmental specialist, has moreover noted that mangroves are increasingly recognized as important carbon sinks: "It is estimated that the storage capacity of these ecosystems is around 23 gigatons of CO₂," she specified, before adding: "A loss of just 1% of the remaining mangroves is equivalent to burning 520 million barrels of oil!"

Thus, over the past two decades, China has created no fewer than 903 national wetland parks, which collectively protect 2.4 million hectares and are mostly open to the public free of charge.

In this spirit, I can only hope that this book invites donors, who are offered a turnkey solution to defend biodiversity, to fully invest in this adventure and ultimately reach the hoped-for target.

I will add that Franco-Chinese cooperation must advance step by step in an eminently tangible manner to ensure the preservation of an environment that is common to us all—an environment that we must, regardless of daily difficulties, conserve and nurture to the best of our ability, through initiatives such as the one we are celebrating together today.

This is not an easy task, but as the Chinese proverb says, "The best time to plant a tree was twenty years ago. The second-best time is... now!"



**Foreword by
Olivier Rousseau
CEO, SGD Pharma**

SGD Pharma has an unwavering commitment to sustainability. It is at the core of everything we do. Our vision for sustainability is embedded within both our Industrial and Commercial strategies.

We have taken major steps forward in our decarbonization efforts. Our targets, approved by the Science Based Targets Initiative (SBTi), aim for a 42% reduction in Scope 1 & 2 emissions and a 25% reduction in Scope 3 emissions by 2030, based on 2022 levels. These commitments are aligned with the trajectory to limit global warming to 1.5°C.

While we strive to reduce our carbon emissions, we also focus on preserving biodiversity in the communities where we operate.

SGD Pharma has been present in Zhanjiang for more than 20 years and we are honored to be able to give back and to contribute to the city's strong commitment to green production and biodiversity protection.

We have already planted 16,968 mangrove trees, in partnership with the Zhanjiang Mangrove Protection Association, contributing to the restoration of coastal ecosystems. We do so in collaboration with the French Chamber of Commerce and Industry and with an ever-growing number of suppliers and clients.

This book aims to incite more people to join us, and together, to reach 100,000 trees by 2030.

This achievement and many others in our plants in France, Germany, Italy, India and China illustrate our vision of a responsible, innovative company focused on the future.

SGD Pharma has been awarded the Palme d'Or Internationale du Comité de France.

This honor recognizes our Group's contribution to health and sustainable development, our international influence, and our long-standing commitment to environmental protection.

SGD Pharma's performance has also been recognized with an outstanding EcoVadis score of 90/100, earning us the Platinum medal and placing us among the top 1% of companies worldwide in terms of sustainability practices.

To you who are reading this preface, joining the Mangrove Together initiative is easy. You can scan the QR code on the last page and donate today to the Zhanjiang mangrove foundation and, by doing so, you will be joining an effort to reach 100,000 trees restored or planted by 2030. Together, we can do it.



Hélène Conway-Mouret, Former Minister and Vice-President of the French Senate, presents the Palme d'Or Internationale du Comité de France together with a Diplôme d'Honneur to SGD Pharma, at the Luxembourg Palace in Paris on January 21, 2026.



Olivier Rousseau, CEO of SGD Pharma, delivers an acceptance speech after receiving the Palme d'Or Internationale at the Luxembourg Palace, celebrating the Group's commitment to health and sustainability.



Olivier de Tilière, President of Comité de France and Parliamentary Press Office, browses through the Mangrove Book at the French Senate, expressing his appreciation for SGD Pharma's Mangrove Together initiative in Zhanjiang.

As of end of 2025, CCI France Chine, SGD Pharma and 26 other partners have planted 16,968 mangrove trees in Zhanjiang. The target of Mangrove Together is to plant 100,000 trees by 2030.



CONTENTS

UNDERSTANDING MANGROVES AND THEIR WETLAND ECOSYSTEMS

What is a mangrove forest? _____ 001

Why is mangrove called
the red tree forest in China? _____ 007

Categories of mangrove plants _____ 007

True mangrove plants _____ 007

Semi-mangrove plants _____ 010

Associated plants _____ 010

What are the characteristics of
mangrove plants? _____ 011

1. Viviparity or fetal germination _____ 011

2. Peculiar root system _____ 012

3. Band-like distribution phenomenon _____ 015

4. Salt secretion _____ 017

5. High cell osmolality _____ 017

6. The roots, stems and leaves of mangrove
plants are rich in tannins _____ 017

Distribution of mangrove
forests in the world _____ 019

Area and distribution of
mangrove forests in China _____ 021

CHARACTERISTICS OF MANGROVE WETLAND ECOSYSTEM

What are the functions of
mangrove ecosystems? _____ 025

1. The effect of wave elimination and
revetment is obvious _____ 025

2. The effect of purifying environmental
pollution is remarkable _____ 028

3. Mangrove forests are rich in biological resources _____ 029

4. Mangrove forests are a natural treasure trove for mankind _____ 030

5. Mangrove forests are ideal for ecotourism
and popular science education _____ 033

6. Mangroves are the main contributors to coastal blue carbon _____ 034

MANGROVE RESOURCES AND CHARACTERISTIC LANDSCAPE IN ZHANJIANG'S LEIZHOU PENINSULA

Characteristic landscape of
ancient mangrove plants on
Techeng Island _____ 037

Characteristic landscape of
Barringtonia racemosa, a rare
semi-mangrove plant in Suixi _____ 039

Characteristic landscape of the
precious population of Olive Forest
in Gaoqiao _____ 041

UNDERSTANDING THE ANIMAL AND PLANT SPECIES OF MANGROVE WETLANDS

True mangrove plants _____ 042

Autumn eggplant _____	042
Bone soil _____	044
Tung Blossom Tree _____	045
Red Sea Olive _____	046
Wood olive _____	047
Olive plum _____	048
Petalless mulberry _____	049
Laguanmu _____	050
Sea paint _____	051
Ras _____	052
Small-flowered mouse _____	053
Halogen fern _____	054
Water coconut _____	055

Semi-mangrove plants _____ 056

Water yellow skin _____	056
Wild Jasmine _____	057
Hostile _____	058
Blunt leaves stinky yellow wattle _____	059
Broadbud chrysanthemum _____	060

Principal Bird Species of Mangrove Wetlands _____ 061

Introduction to the Black-faced Spoonbill, a National Class I Protected Bird _____	063
White-throated Kingfisher _____	064
Bar-tailed Godwit _____	064
Western Osprey _____	065
Eurasian Curlew _____	065
Greater Crested Tern _____	066
Pied Avocet _____	066
Black-winged Stilt _____	067
Black-tailed Godwit _____	067
Caspian Tern _____	068
Dunlin _____	068
Red-necked Stint _____	069
Yellow Bittern _____	069
Chinese Egret _____	070
Blue-tailed Bee-eater _____	070
Nordmann's Greenshank _____	071
Blue-throated Bee-eater _____	071
Spoon-billed Sandpiper _____	072
Chinese Crested Tern _____	072

Macrobenthic fauna in mangrove wetlands _____ 073

Major fish species in mangrove wetlands _____ 075

BRIEF INTRODUCTION OF 6 MAJOR MANGROVE NATURE RESERVES IN CHINA

Zhanjiang Mangrove National Nature Reserve, Guangdong _____ 077

Dongzhaigang National Nature Reserve, Hainan _____ 081

Beilun Estuary National Nature Reserve, Guangxi _____ 088

Guangxi Shankou National Nature Reserve _____ 094

Shenzhen-Neilingding National Nature Reserve, Guangdong _____ 099

Zhangjiangkou National Nature Reserve, Fujian _____ 107

MAIN REFERENCES _____ 113

UNDERSTANDING MANGROVES AND THEIR WETLAND ECOSYSTEMS

What is a mangrove forest?

Mangroves are the woody plant communities that grow in the intertidal zones of both tropical and subtropical coasts, at the junction of land and sea.

Mangrove forests grow slightly above the mean sea level of tropical and subtropical low-energy coasts and the average high tide level of the returning tide (or the mean high tide level) and are subject to periodic inundation and exposure to seawater. The exposure usually lasts longer than the inundation.

The term mangrove was first used by biologist Bowman in 1878 (derived from the Portuguese *mangue* and the Spanish *mangle*, both of which come from the Amerindian Taino name for mangrove plant dye).



View of mangrove in Zhanjiang, home of 25% of the mangrove in China.

Mangroves in the narrow or strict sense refer specifically to mangrove plant species. There are still varying degrees of disagreement on the definition of mangrove plants. American scholar Davis (1940) saw mangrove plants as a general term for all plants that grow in the muddy and soft soil of the intertidal zone of tropical coasts, including true mangroves that grow in the intertidal zone and semi-mangroves that can grow both in the intertidal zone and on the shore. Indian and Pacific mangrove researchers Macnae (1968) and Walsh (1970) identified mangrove plants as trees and shrubs that grow only on tropical coasts, between the highest and average tide lines, and excluded "semi-mangroves" that can grow in both the intertidal zone and the shore. The apparent disagreement is that the former considers mangrove plants to be "the general term for all plants", while the latter considers them "trees and shrubs". The former also includes "semi-mangroves" while the latter does not.

Chinese scholars generally agree that mangrove plants only refer to woody plants in mangrove forests, and do not include herbaceous, vines and epiphytes (i.e. do not include associated plants). They distinguish mangrove plants into true mangrove and semi-mangrove.

Academician Lin Peng, a pioneer of mangrove forests in China, saw mangrove forests as a general term for woody plant communities growing in the intertidal flats zone of tropical and subtropical coasts.

This author defines mangrove as an endemic green plant community growing in the intertidal flats above the average sea level in the tropics and subtropics, which is a unique forest ecosystem at the transition between land and sea, and includes mangrove plants and semi-mangrove plants.



Mangrove is a unique forest ecosystem at the transition between land and sea.



Why is mangrove called the red tree forest in China?



The main plants that make up mangrove forests are mangrove plants, and the bark of mangrove plants is rich in tannins, which are colorless and transparent. The bark oxidizes easily and turns red when exposed to air, hence their name of red mangroves in Chinese.

Seaside dwellers in Southeast-Asian Island countries often refine the bark of mangrove trees to make red dye.

When the bark is removed, the tannins oxidize and turn red.

Categories of mangrove plants

True mangrove plants

True mangrove plants are woody plants that grow exclusively in the intertidal zone of tropical and subtropical low-energy oceans. The salt concentration of seawater required by true mangrove plants is generally 1–35 parts per thousand. True mangrove plants have the following characteristics: fetal germination or viviparity, special surface root systems (such as respiratory roots, pillar roots), salt resistance, and high cell osmotic pressure. Table 1-1 (Page 009) shows the list of true mangrove plants in China.



Table 1-1 Species and distribution of true mangrove plants in China (Liao Baowen and Zhang Qiaomin, 2014).

Family name	Species name	Hainan	Guangdong	Guangxi	Taiwan	Hong Kong	Macao	Fujian	Zhejiang
Acrostichaceae	Acrostichum aureum	🌳	🌳	🌳	🌳	🌳	🌳		
	A. acuminata speciosum	🌳							
Meliaceae of the Neem family	Neem Xylocarpus granatum	🌳							
Euphorbiaceae of the Euphorbiaceae family	Sea lacquer Excoecaria agallocha	🌳	🌳	🌳	🌳	🌳			
Hymulaceae Sonneratiaceae	Cup calyx Mulberry Sonneratia alba	🌳							
	Haysan S caseolares	🌳	✓						
	Hainan Haisang Sx hainanensis	🌳							
	Mulberry ovalis S ovata	🌳							
	Pseudo-Mulberry Sx gulingai	🌳							
Mulberry without valve * S apetala	✓	✓	✓				✓		
Mangroveaceae Rhizophoraceae	Bruguiera gymnorrhiza	🌳	🌳	🌳	🌳			✓	
	Helen B sexangula	🌳	✓					✓	
	Acumina B s. var. rhymchopetala	🌳	✓					✓	
	Ceriops tagal	🌳	🌳						
	Autumn eggplant Kandelia obovata	🌳	🌳	🌳	🌳	🌳	🌳	🌳	✓
	Mangrove Rhizophora apiculata	🌳							
	Red Sea Olive R stylosa	🌳	🌳	🌳	🌳			✓	
Make the gentleman family Combretaceae	Red Olive Plum Lumitzera littorea	🌳							
	Olive Lee, L racemosa	🌳	🌳	🌳	🌳	🌳		✓	
	laguncularia racemosa	✓	✓	✓				✓	
Myrsinaceae	Aegiceras corniculatum	🌳	🌳	🌳	🌳	🌳	🌳	🌳	
Verbenaceae of the Verbenaceae family	Avicennia marina	🌳	🌳	🌳	🌳	🌳	🌳	🌳	
Acanthaceae	Acanthus ebracteatus	🌳	🌳	🌳					
	Rats A ilicifolius	🌳	🌳	🌳		🌳	🌳	🌳	
Rubiaceae in the Rubiaceae family	Vase of flowers and wood Scyphiphora hydrophyllacea	🌳							
Palmae of the family Palmae	Water coconut Nypa fruticans	🌳							
	Total Species**	24	11	10	7	7	5	4	0

Note: * refers to the addition of 2 species of true mangrove plants that have been successfully domesticated and introduced, ** refers to the natural distribution only, 🌳 refers to the natural distribution, ✓ the successful introduction of the species, and the following Table 1-2 (Page 010) is the same

Semi-mangrove plants

Semi-mangrove plants are amphibious woody plants that can grow at the mean high tide or mid-tide level of tropical and subtropical low-energy coastal tides, as well as on the coast. Table 1-2 shows the list of semi-mangrove plants in China.

Table 1-2 Species and distribution of semi-mangrove plants in China (Liao Baowen and Zhang Qiaomin, 2014).

Family name	Species name	Hainan	Guangdong	Guangxi	Taiwan	Hong Kong	Macao	Fujian	Zhejiang
Hernandiaceae	Hernandia nymphiifolia	🌳							
leguminosae in the legume family	Water yellow skin Pongamia pinnata	🌳	🌳	🌳	🌳	🌳			
Malvaceae	Hibiscus tiliaceus	🌳	🌳	🌳	🌳	🌳		🌳	
	Thespesia populnea	🌳	🌳	🌳	🌳	🌳		✓	
Sycamoreaceae Sterculiaceae	Silver-leaved tree Heritiera littoralis	🌳	🌳	🌳	🌳	🌳		✓	
Celandaceae Lythraceae	Pemphis acidula	🌳			🌳				
Barose Barringtoniaceae	Barringtonia racemose	🌳			🌳			✓	
Oleanderaceae Apocynaceae	Sea Mango Cerbera manghas	🌳	🌳	🌳	🌳	🌳	🌳	✓	
	Clerodendrum inerme	🌳	🌳	🌳	🌳	🌳	🌳	🌳	
Verbenaceae of the Verbenaceae family	Blunt leaves Stinky Vitex Premna obtusifolia	🌳	🌳	🌳	🌳				
	Seaside cattail wood Dolichandrone spathacea	🌳	🌳						
Bignoniaceae of the Aster family	Pluchea indica	🌳	🌳	🌳	🌳	🌳	🌳	🌳	
Asteraceae Compositae	Total Species**	12	9	8	10	7	3	3	0

Associated plants

There is also an important category of coastal plant known as associated plants (or concomitant plants). Associated plants refer to woody plants that can only occasionally grow at the mean high tide of the regression tide and along the coast with semi-mangrove plants, as well as herbaceous, liana, epiphytic and parasitic plants that grow in the intertidal zone.

What are the characteristics of mangrove plants?

1. Viviparity or fetal germination

Mangrove plants have survived in harsh ecological environments and have demonstrated amazing adaptability due to their unique biological characteristics: viviparity, salting, well-developed (morphological) root systems, and rich tannins.

The most wonderful feature of mangrove plants is their viviparity. The seeds of many plants in mangrove forests begin to germinate in the fruit, growing into rod-shaped hypocotyls (i.e. small seedlings that have not taken root). After a certain degree of development, the hypocotyl breaks away from the mother tree and falls into the silt of the beach, where it usually takes a few hours to a few days to take root, quickly settle, and naturally form a new plant.

The hypocotyls that fail to take root in the mud in time can drift on the ocean for months with the current, taking root and growing thousands of miles away on the coast. The most typical of these are autumn eggplant, wood olive, and red sea olive. Viviparous phenomena are divided into explicit viviparous phenomena and cryptoviviparous phenomena.



Viviparous phenomenon (hypocotyl of Olive)



Viviparous phenomenon (cryptoviviparous hypocotyl of paulownia tree)

2. Peculiar root system

The sediment beneath the mangrove forest is an unstable substrate in which mangrove plants develop special root systems. Some (e.g. mangrove tree, red sea olive, etc.) grow roots from the main stem, which are called pillar roots, and some (e.g. silver-leaved tree, autumn eggplant, etc.) have roots that extend horizontally on the surface of the silt and are called tabular roots. Tung trees and sea lacquer have surface roots, which are reticulated roots that spread across the ground.

The low oxygen supply in the sediment is not suitable for root growth, so some mangrove plants develop special root systems to provide oxygen to the roots. Some plants (e.g. Gloma, Mulberry) grow upright roots that extend upwards from the surface of the silt, called respiratory roots, while others (e.g. Lotus) have curved joints at their roots that extend from the surface of the silt, called knee-like roots.

Pillar and tabular roots are good for resisting wind and waves, while respiratory and geniculate roots contain skin holes and aeration tissues that facilitate gas exchange and air storage. These special roots also play a role in accumulating sediment and raising tidal flats.



Pillar roots



Creeping roots



Fingerlike respiratory roots



Plate-shaped roots

3. Band-like distribution phenomenon

Due to the shape of the different mangrove plants themselves, there is a wide range of adaptability to tidal water, salinity, soil, and the intertidal flats topography within the mangrove realm.

Different mangrove communities occupy different positions on the intertidal flats, forming a strip distribution phenomenon (ecological sequence) that is roughly parallel to the coast.

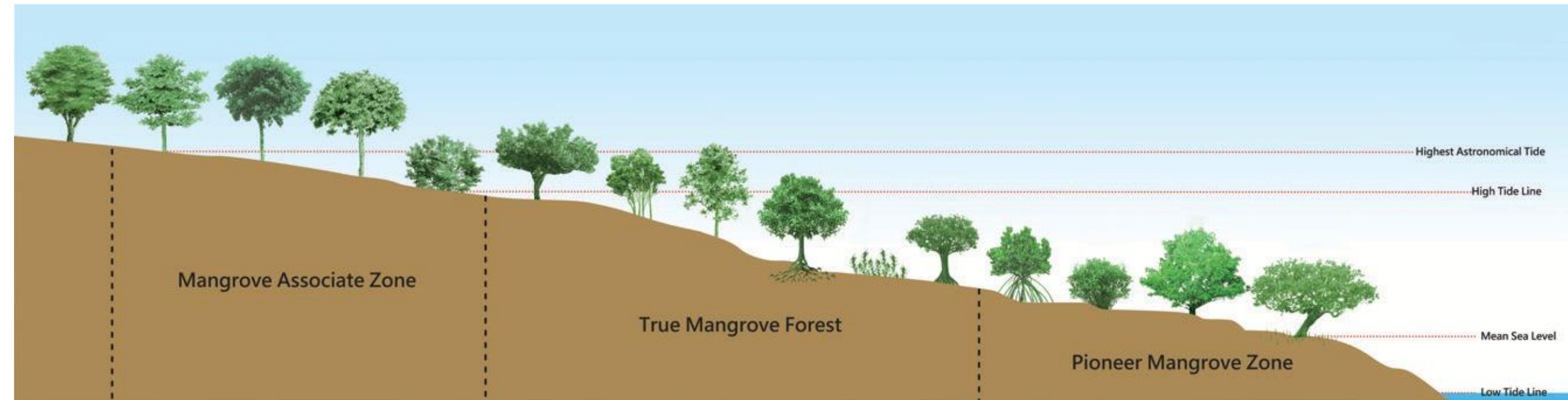


Diagram of the main ecological sequences of mangrove forests in China



Techeng island, Zhanjiang

4. Salt secretion

Tropical and subtropical beaches have strong sunlight and a soil rich in salt. Mangrove plants mostly have a halophytic and physiological drought adaptation morphological structure, such as white bone soil and paulownia tree, and other salt glands located on the back of the leaves, which can discharge the salt in the tissues; some mangrove plants, such as wood olive and sea lacquer, store salt in the vacuole in the cell, or form crystals in the leaves. When the leaves fall, the salt is discharged along with the leaf.

5. High cell osmolality

Mangrove plants can adapt to high salinity environments, mainly due to their high cell osmotic pressure. Mangrove plants can produce a suction force higher than the osmotic pressure of the soil solution, usually up to between 30×10^5 and 38×10^5 Pascals. The high cell osmotic pressure of mangrove plants ensures that the plants can absorb sufficient water and nutrients from the swampy saline soil, which is an important condition for mangrove plants' growth in the saline soils of tidal flats.



Leaf salt (budding white bone soil)

6. The roots, stems and leaves of mangrove plants are rich in tannins

If the tree is attacked and loses a part of its bark, the trunk comes into contact with air, and an oxidation reaction will occur, turning the trunk red. Tannic acid is a natural preservative that gives the wood in mangrove plants its preservative properties. It has an astringent taste and toxicity that effectively hinders the destruction of trees by rodents and termites, among others. It can also denature and inactivate proteins, which can effectively alleviate the phenomenon of microbial decay and prolong the life of trees.



Distribution of mangrove forests in the world

Mangrove forests around the world are found on tropical and subtropical coasts generally between the Tropic of Cancer and the Tropic of Capricorn. In the Northern Hemisphere, mangroves can be found as far north as Kagoshima (31°22' N) in Japan and Bermuda (32°20' N) in the Atlantic Ocean. In the Southern Hemisphere, mangroves can be distributed as far south as New Zealand (38°59' N) and the east coast of South Africa (32°59' S).

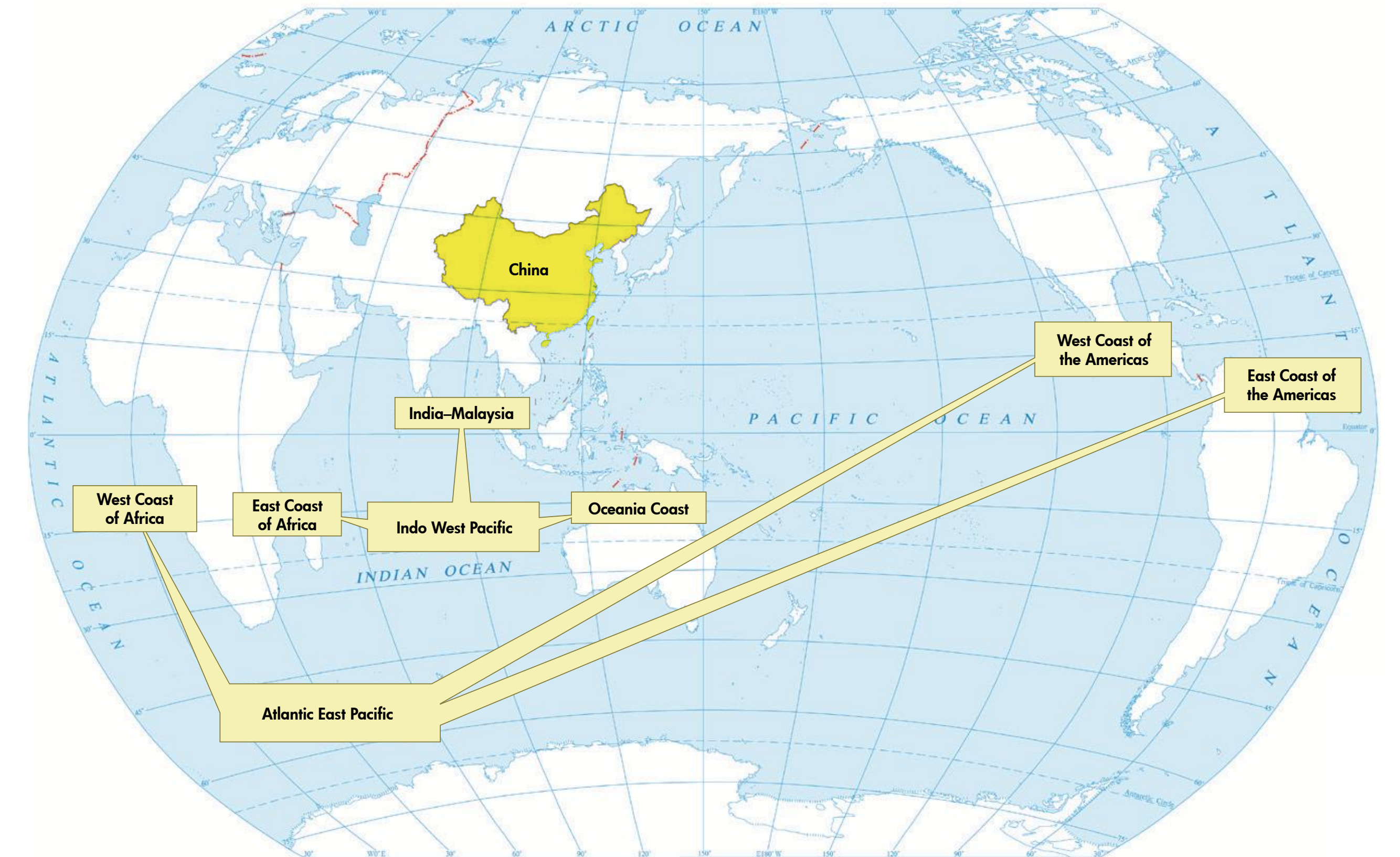
The world's mangrove forests are mainly distributed along the coasts of 118 countries and regions around the Indian Ocean and the western Pacific coast. Due to different statistical methods and mangrove standards, the total area of mangrove forests in the world differs in calculations but is roughly between 10 million and 18 million hectares.

Historically, 75% of the coast in the tropics was occupied by mangrove forests. The country with the largest mangrove area in the world is Indonesia (3.1 million hectares), followed by Australia (980,000), Brazil (960,000), Mexico (740,000), Nigeria (650,000) and Malaysia (510,000).

The world's largest mangrove forests are located in the Bay of Bengal (1 million hectares) and the Nile Delta in Africa (700,000 hectares). Indonesia is the country with the largest mangrove area in the world, containing 20% of the world's mangrove forests.

There are two distribution centers of global mangrove forests: an eastern taxon dominated by East Asia and Oceania (the Indo West Pacific or IWP region) and a western taxon dominated by both sides of the Atlantic (the Atlantic East Pacific or AEP region). There are around 69 species of mangrove plants in the world and 11 hybrid species. Among them, the eastern taxon has a rich number of mangrove plant species, with as many as 54 species and 9 hybrids, while the western taxon has a smaller number of mangrove plant species, with only 17 species and 2 hybrids. (Duke, 2017).

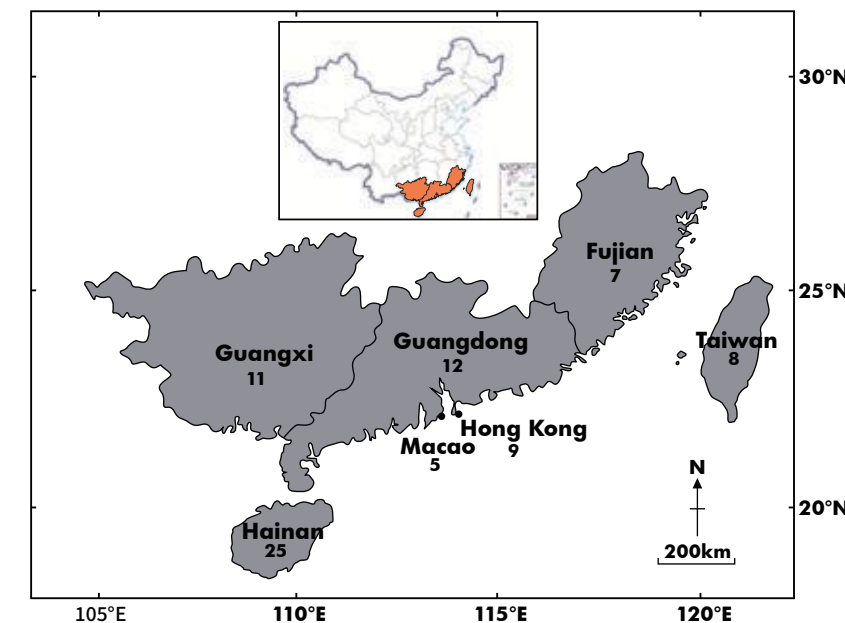
The Indo-Malay Peninsula is home to the highest diversity of mangrove plant species in the world. Southeast-Asian countries not only have a large area of mangrove forests, but also the regions with the most abundant mangrove plant species in the world. From the equator to the south or north, the higher the latitude, the fewer mangrove plant species and the lower the mangrove height.



Global mangrove distribution map

Area and distribution of mangrove forests in China

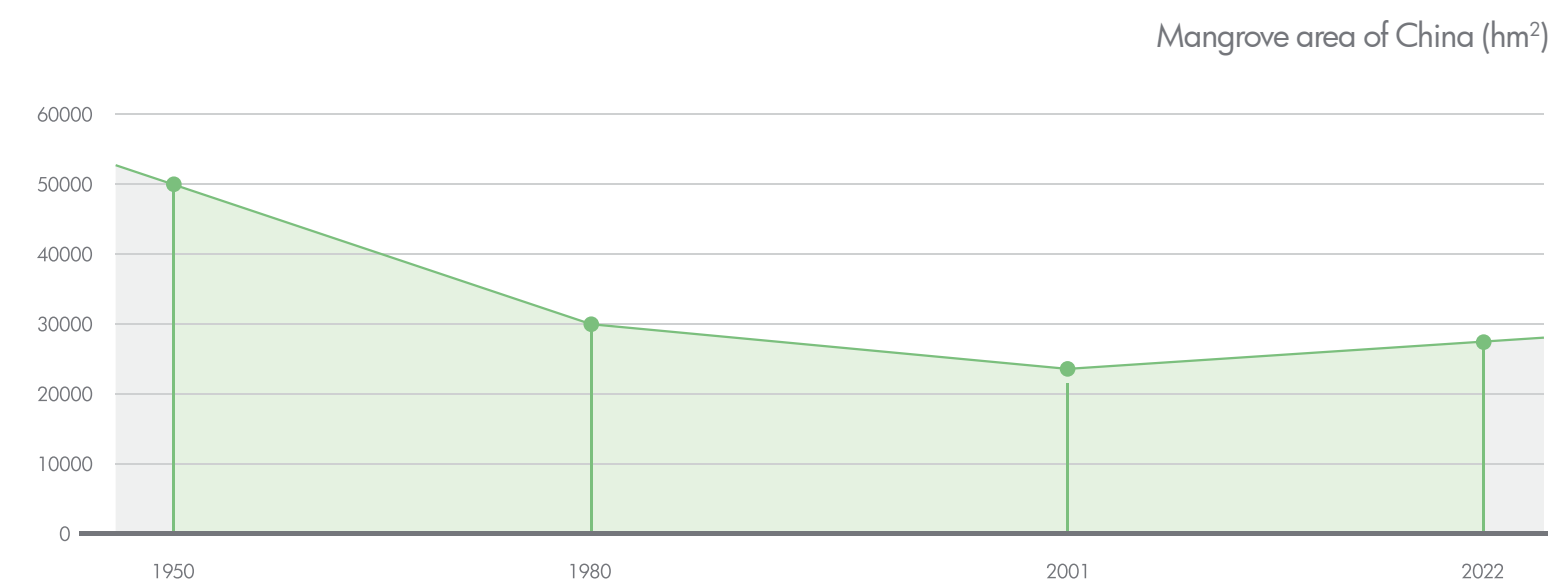
Mangrove forests are naturally distributed in eight provinces and regions, including Hainan, Guangdong, Guangxi, Fujian, Zhejiang, Hong Kong, Macao and Taiwan, between Yulin Port in Hainan Province and Shacheng Bay in Fuding, Fujian Province, and the northern boundary of artificial introduction is Zhoushan, Zhejiang. The northernmost mangrove plant in China is the autumn eggplant.



Schematic map of mangrove distribution in China with the number of real mangrove plant species.

In the early middle of the 20th century, there were still nearly 50,000 hectares of mangrove forests in China. After the reclamation of land from the sea from the early 60s to the 70s, the expansion of pond aquaculture since the 80s, and the urbanization and port construction since the 90s, the area of mangrove forests in China has decreased dramatically. In 2001, the former State Forestry Administration organized a national wetland survey, calculating the area of mangrove forests at 22,024.9 hectares, plus 659 hectares in Hong Kong, Macao and Taiwan, giving a total area across China of 22,683.9 hectares. This is only 45% of what existed in the middle of the 20th century.

Since 2001, the Chinese government has attached great importance to the protection and restoration of mangrove forests, and through strict protection of existing mangrove forests and large-scale afforestation China has successfully curbed the sharp decline in mangrove coverage, and the area of mangrove forests has gradually rebounded, from 22,000 hectares in 2001 to the 27,200 hectares (excluding Hong Kong, Macao and Taiwan) announced in 2022, an average annual increase of 2.5%. China is one of the few countries in the world with a net increase in mangrove area, while the total area of mangrove forests worldwide is decreasing at a rate of between 0.16 and 0.39% per year.



Map of mangrove area change in China

CHARACTERISTICS OF MANGROVE WETLAND ECOSYSTEM

The term "mangrove ecosystem" refers to the woody plant communities and their environment in the intertidal zone of tropical and subtropical coasts. It is an organic synthesis of mangrove and semi-mangrove plants and a small number of associated plants with intertidal muddy beaches (and some rare sandy or rocky beaches).

As producers, mangrove plants are the backbone of the ecosystem, working with algae to produce organic matter and energy and release oxygen to meet the needs of most organisms. Microorganisms such as bacteria are decomposers, breaking down plant detritus and other biological organisms into nutrients that are absorbed by algae and zooplankton.

These plankton feed benthic animals such as fish, shrimp, crabs, shellfish, etc. Waterfowl and large fish, which feed on fish, shrimp, crab and shellfish, are the third level of consumers in this system, and are in the highest nutritional position, which plays an important role in regulating the material cycle and energy conversion of the system. Birds and large fish are used by humans (for edible, medicinal, aesthetic, educational, scientific and other purposes).

Mangrove ecosystems are characterized by high productivity, a high return rate and a high decomposition rate. The primary productivity of mangrove forests is much higher than that of terrestrial forests at the same latitude, and even higher than that of tropical rainforests. The survey found that the primary productivity of the estuarine bay was 20 times that of the open sea, 10 times that of the ordinary coast, and 3.3 times that of the upwelling area, and the primary productivity of the mangrove forest was the highest in the estuarine bay.

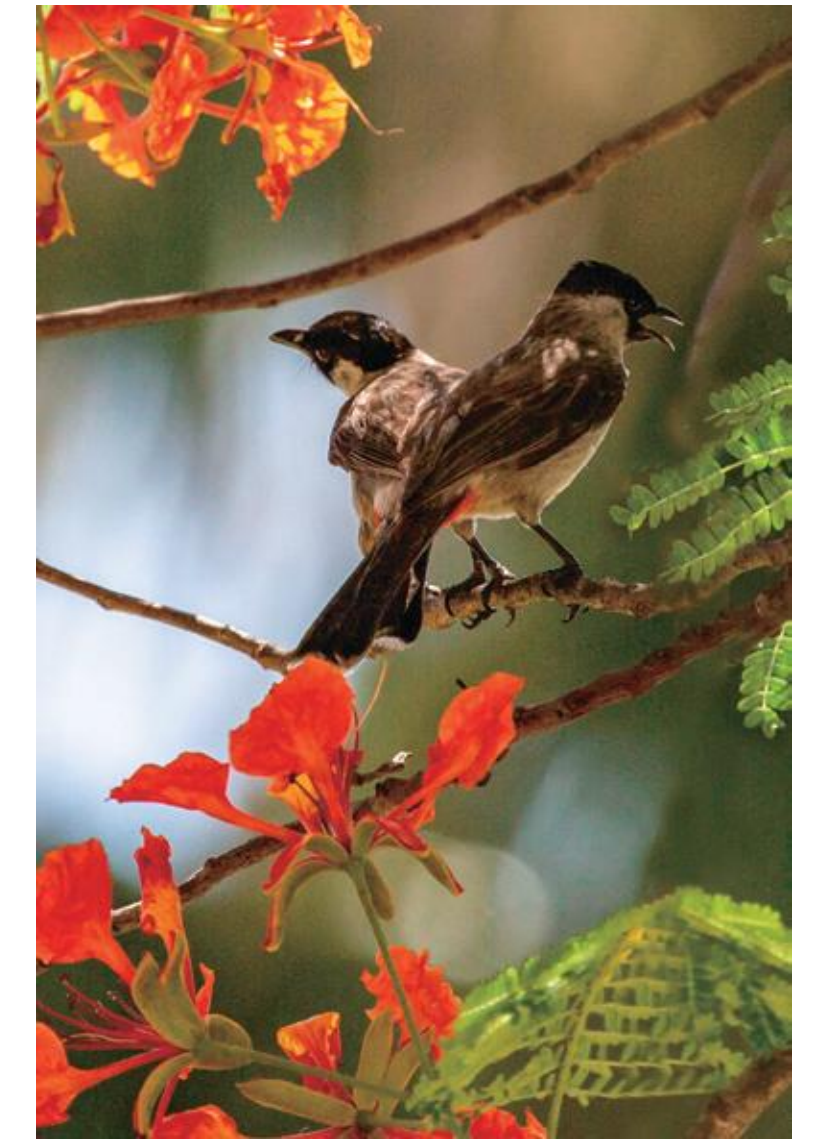


Schematic diagram of the food chain in a mangrove ecosystem

For example, the annual litter of the 25-year-old Lotus forest in Dongzhaigang in China was 12.55 t/hm², which was greater than that of the Xishuangbanna natural tropical rainforest (11.55 t/hm²). A large proportion (about 40 per cent) of the primary productivity of mangrove communities is returned to forest land through litter, while litter in general does not account for more than 25 percent of net primary productivity.

The alternating environmental conditions of high temperature, high humidity, dry and wet in mangrove areas and the repeated impact of tides create the best conditions for litter decomposition, and litter quickly decomposes into organic detritus and soluble organic matter, providing bait for plankton and benthic organisms.

The semi-decomposition period of litter is even shorter than that of tropical rainforests, so that mangroves can provide a steady stream of abundant food and nutrition for consumers in forest areas.



What are the functions of mangrove ecosystems?

1. The effect of wave elimination and revetment is obvious

Mangrove forests are recognized as the "green guardians of the coast" and are the first barrier of coastal ecological shelterbelts, which play a huge role in fixing embankments and eliminating waves, resisting natural disasters such as storm surges and tsunamis. It is estimated that the benefits of mangrove wave removal and revetment in China reach 1 billion yuan per year. Its wave elimination and revetment functions are realized through the functions of wave elimination, slow flow, siltation promotion, and wind speed reduction. Waves (mainly storm waves) are the main dynamic factor that damages coasts and embankments.

Mangrove forests are more than 100 m wide with a coverage of over 0.4 m, and their height is above 2.5 m (small tidal range sea areas such as eastern Guangdong and Hainan) or 4.5 m (large tidal range sea areas such as western Guangdong and Beibu Gulf), producing a wave dissipation effect that can be higher than 80%.

Water flow is another important factor in damaging coasts and embankments. Long-term studies on the hydrodynamics of mangrove tidal gully systems show that the hindrance effect of mangroves on water flow makes the flow velocity in the forest area only 1/10 of the tidal channel flow velocity. In addition, mangrove forests have the function of promoting siltation and land formation, and beach siltation can achieve the effect of consolidating embankments. According to field experiments, the siltation rate of mangrove beach is 2–3 times that of bare beach. Mangrove forests can accelerate siltation and the seaward extension of the shoal, promote the increase of sediment content with a particle size of less than 0.01 mm, and participate in the sedimentation with its litter.

The effect of mangrove revetment has been confirmed in domestic and foreign examples. For example, on July 24th, 2003, Typhoon Ibulu swept through the city of Taishan in Guangdong Province, causing the sea to break through the embankments and dams, inundating villages, and causing losses of more than 70 billion yuan. After the typhoon, it was found that mangrove forests have a strong function of resisting wind and waves and protecting dikes. Most of the dikes which did not get washed away were protected by the presence of mangroves outside the dikes, while most of the dikes without mangrove protection were washed away. Mangrove forests effectively protect the farmland, villages and people's lives and property. During the tsunami disaster in the Indian Ocean at the end of 2004, the large mangrove area of the Mangrove Nature Reserve in Ranong, Thailand, protected the inhabitants while 70 percent of the residents of the adjacent shore without mangrove protection were killed.

It has been proved that the protective function of a simple artificial seawall is far lower than that of a seawall-mangrove composite system. Moreover, according to expert calculations, the investment in the construction of mangrove green seawalls is only 1/20 of the investment in wood and stone construction. In the process of seawall construction and maintenance, restoring and protecting mangroves, and building a protective system that combines biological and engineering measures will achieve twice the result with half the effort.



Mangrove (Mulberry) wave dissipation shelter forest



Fishing boats that take shelter in mangrove areas during typhoons

2. The effect of purifying environmental pollution is remarkable

The mangrove ecosystem is a multi-stage purification system with anaerobic and aerobic demand composed of mangroves, bacteria, algae, zooplankton, fish, shrimp, crabs, shellfish and other biological communities. According to the study, the annual CO_2 absorption of mangrove forests is $4,085 \text{ g/m}^2$ (calculated according to the mangrove forest in Fugong Town, Longhai District, which is less than 10 km away from Xiamen Island), which is 4-5 times higher than that of general urban green space. Mangrove forests can fix nitrogen [$150\text{-}250 \text{ kg}/(\text{hm}^2 \cdot \text{a})$] and phosphorus [$15\text{-}20 \text{ kg}/(\text{hm}^2 \cdot \text{a})$] in wetland systems to alleviate the eutrophication of the water body. Mangroves can also absorb and accumulate a large number of heavy metal pollutants in the wetland system in a variety of ways, thereby purifying the heavy metal pollution in the bay estuary ecosystem. In addition, the heavy metals absorbed by plants are mainly distributed in roots, stems and other parts that are not easy for animals to eat, preventing them being transmitted to humans through seafood which could affect human health. Mangrove wetlands can also mitigate the occurrence of red tides by "trapping" the typical algae in the sewage.



Clean water

3. Mangrove forests are rich in biological resources

Mangroves are one of the most biodiverse ecosystems. At present, a total of 2,854 species have been recorded in mangrove wetlands in China, and the species richness per unit area is 1,766 times higher than the marine average (Lai Tinghe and He Binyuan, 2007). The special habitat of mangrove forests contains unique biodiversity, and many biological species are unique to mangroves, such as true mangrove plants, sea frogs, etc. The mangrove area also maintains a high diversity of bird species. The vast tidal flats, abundant food and sheltered environment in the mangrove area provide a place for various seabirds to feed, inhabit and breed, and also become a wintering place and migration transit point for international migratory birds. With an area of just over 300 hectares, more than 100,000 migratory birds overwinter here every year, especially in recent years, where it has become the main wintering habitat for black-faced spoonbills. There are many rare and endangered species in China's mangrove plants, such as water coconut, red olive plum and Hainan mulberry among others.



Monk crab



Horseshoe crab



Redshank

4. Mangrove forests are a natural treasure trove for mankind

In addition to ecological and social benefits, mangroves also provide direct economic benefits. Its traditional use includes the provision of fuelwood, food (seafood), medicines, feed, fertilizers, chemical raw materials (such as tannin), etc. Most mangrove plants have special economic utilization value, for example, mulberry and tung flower trees are raw materials in papermaking, sea lotus, horn fruit tree, autumn eggplant and so on are rich in tannins which can extract chemical raw materials, and rat grass, white bone soil, silver leaf tree and many others have medicinal value.

Mangrove ecosystems provide feeding grounds, habitats and hatcheries for a wide range of marine animals, including many commercial fish and shrimp. In Malaysia, for example, an estimated 31% of fisheries (about 200,000 tonnes) are associated with mangrove ecosystems. The mangrove area is rich in fish, shrimp, crab and shellfish resources, which plays a role in promoting the construction of the blue ocean "vegetable basket" project and improving the living standards of coastal residents



Fiddler Crab



Mudskipper



Local fishermen in Zhanjiang



Local fishermen in Zhanjiang

5. Mangrove forests are ideal for ecotourism and popular science education

The mangrove forest area is a superior geographical location where land and sea meet, with strange roots, exotic fruits, green leaves, and where blue sea and blue sky complement each other, forming a unique natural landscape. Mangrove forests are integrated with the birds, reptiles, benthic organisms and plankton that inhabit them, and their biodiversity is comparable to tropical rainforests, making them a good place for people to relax and for recreation. It is also a good place to carry out popular science activities such as learning about coastal landforms, marine biology, wetland botany and the life culture of coastal residents. Combining tourism development with popular science education is an effective form of protecting and utilizing mangroves. Guangzhou Nansha Mangrove Wetland Park is a well-known mangrove tourist attraction in China, covering an area of about 200 hm², since its opening in 2005, it has received more than 200,000 tourists and scientific expeditions from more than 30 countries every year, bringing significant economic benefits to the local area.

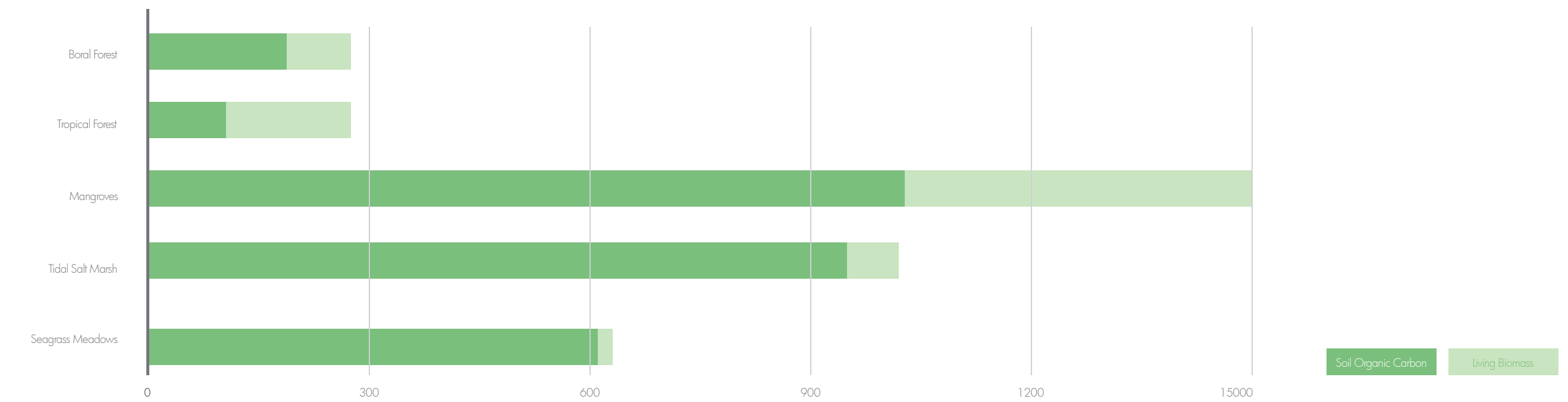


6. Mangroves are the main contributors to coastal blue carbon

Coastal ecosystems such as mangroves, coastal salt marshes and seagrass beds capture and store large amounts of carbon that are permanently buried in marine sediments, making them one of the densest carbon sinks on the planet, known as coastal "blue carbon".

Bouillon et al. (2008) argue that mangroves cover only 0.1% of the world's land area, but count for 5% of the world's total carbon sequestration, and their net primary productivity is comparable to tropical rainforests. Due to their high carbon density and carbon sink potential, mangroves will play an important role in reducing atmospheric CO₂ concentrations and mitigating global climate change, and are major contributors to coastal blue carbon sinks.

Donato et al. (2012) estimate that the global average carbon density of mangroves was 1023 ± 88 Mg C/ha, of which the vegetation carbon density was 159 Mg C/ha based on the study of 25 representative types of mangroves in the Indo-Pacific region, while the carbon density of the underground is more than five times that of vegetation. Howard et al. (2014) comprehensively compared existing studies around the world to compare carbon stocks and distribution patterns of different types of ecosystems, among which mangrove forests have significantly higher carbon counts than other ecosystems, and soil carbon storage accounts for the largest proportion (see figure below).



Comparison of carbon stock allocation patterns in different types of ecosystems (Howard, 2014).

MANGROVE RESOURCES AND CHARACTERISTIC LANDSCAPE IN ZHANJIANG'S LEIZHOU PENINSULA

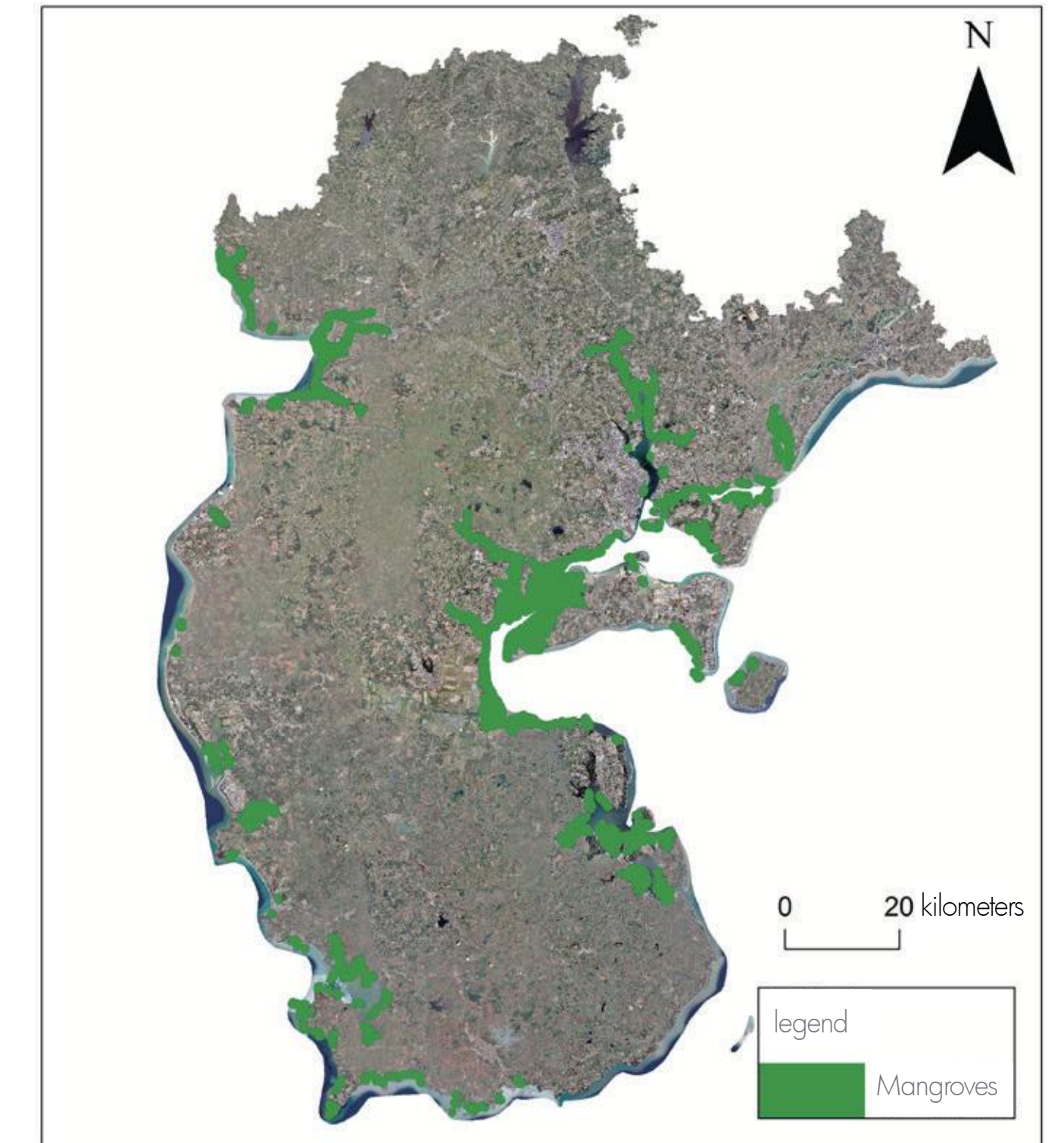
According to the latest survey results of the mangrove team of the Institute of Tropical Forestry of the Chinese Academy of Forestry in 2022, Zhanjiang City has an area of 7196.87 hm² of mangrove forests, of which the largest mangrove distribution area is Leizhou City, accounting for 24% of the total area of mangrove forests in Zhanjiang City, followed by Lianjiang City, accounting for 20%, and the smallest mangrove area is Chikan District, with only one mangrove patch, with an area of 3.22 hm², accounting for 0.04% of the total area of mangrove forests in Zhanjiang.

There are 13 species of true mangrove plants in Zhanjiang City, including white bone soil, paulownia tree, red sea olive, autumn eggplant, wood olive, petal less mulberry, Laguan wood, olive plum, horn fruit tree, brine fern, rat and small flower, among which Mulberry and Laguan wood are imported from abroad, and the rest are native tree species in China.

There are 10 species of semi-mangrove plants, including sea lacquer, silver-leaved tree, hostile, sea mango, water yellow bark, hibiscus, bitter lang tree, poplar-leaved hibiscus, broad-bracted chrysanthemum, and blunt-leaved stinky yellow wattle.

According to the Implementation Plan of the Special Action Plan for the Protection and Restoration of Mangrove Forests in Guangdong Province, rare and endangered mangrove plants in Guangdong Province include olive plum, hornnut tree, jade stamen, and silver leaf tree. In addition, according to the literature, there was a large area of distribution in Zhanjiang City, but there are only a few small populations of mangrove plant species left in a few places, and the endangered mangrove plants are also included in this survey, including *B. acuminata*, *R. microflora*, and *Vitex obtuse-leaved*.

Therefore, there are seven rare and endangered mangrove plants in Zhanjiang City: Horn Fruit Tree, Olive Plum, Mouse Small-flowered Fern, Sharp-leaved Halogen Fern, Silver-leaved Tree, Hostile Stamen and Blunt-leaved Stinky Vitex.



Schematic map of the distribution of mangrove forests on the Leizhou Peninsula

Characteristic landscape of ancient mangrove plants on
Techeng Island



The trunk of an ancient tree of white bone soil



Bone loam breathes roots and its canopy



Landscape of ancient trees in white bone soil

Characteristic landscape of *Barringtonia racemosa*, a rare semi-mangrove plant in Suixi



Fruitful



Flower



Jade forest

Characteristic landscape of the precious population of Olive Forest in Gaoqiao



Precious patches of olive



The propagules of the wood olive (hypocotyl)



A trail in a wooded forest

UNDERSTANDING THE ANIMAL AND PLANT SPECIES OF MANGROVE WETLANDS

True mangrove plants

Autumn eggplant

Kandelia obovata Sheue, Liu et Yong

Mangroveaceae *Lymphaeaceae*. Evergreen shrub or small tree, 3–5 m high.

Distribution: It is distributed in the coastal flats of Hainan, Guangdong, Guangxi, Fujian, Taiwan and Hong Kong in China, and has been artificially introduced in Zhejiang.

Characteristics: Light-loving plant, with a certain shade tolerance. It can grow in coastal muddy or sedimentary high, medium and low tidal flats. It is a non-thermophilic tree species, and it is the plant with the strongest cold resistance among mangrove plants in China, and the salt resistance is medium. Mode of reproduction: viviparous hypocotyl reproduction.



Autumn eggplant



Floral cotyl



White bone soil flower



Fruit



Bone soil

Bone soil

Avicennia marina (Forsk) Vierh.

Verbenaceae is a plant of the genus Whitebone Soil. Small evergreen trees or shrubs, 2–3 m high, up to 6 m, the bark is grayish-white, the branches are square, and there are raised knots.

Distribution: It is naturally distributed in Hainan, Guangdong, Guangxi, Fujian, Hong Kong, Macao and Taiwan in China, along the tidal flats.

Characteristics: Light-loving plant. It is mostly distributed in sandy tidal flats and can grow in high, medium and low tidal zones. Strong cold resistance. It is highly resistant to salinity and can be naturally renewed on beaches with a salinity of 30‰ seawater. Mode of propagation: seed propagation.

Tung Blossom Tree

Aegiceras corniculatum (Linn.) Blanco

Purple Bullscardae plant. evergreen thicket. The height is generally less than 2–3 m (up to 5 m in Sanya).

Distribution: Mainly naturally distributed in Hainan, Guangdong, Guangxi, Fujian, Taiwan, Hong Kong and Macao in China. There are artificial introductions in Zhejiang.

Characteristics: Light-loving plant. It has a certain ability to tolerate yin. It grows on silty tidal flats in the high, medium and low tidal zones along the coast. It can be naturally regenerated in around 30‰ seawater salinity, and the reproduction method is viviparous hypocotyl reproduction.



Tung Blossom Tree



Inflorescence Hypocotyls

Red Sea Olive

Rhizophora stylosa Griff

Mangrove family, small evergreen trees or shrubs, 2–4 m high, up to 5 m in Sanya, Lingshui and other places. The bark is grayish-brown and smooth, with multi-pillar roots sticking out of the trunk or branches into the mudflats.

Distribution: It is naturally distributed in Guangdong, Guangxi, Hainan, Hong Kong and the southern coast of Taiwan in China, and there are artificial introductions in Fujian.

Characteristics: Light-loving tree species, strong salt resistance, can naturally regenerate and reproduce on sandy or silty tidal flats with salinity of 30‰, can be naturally distributed in high, middle and low tidal zones, and is the main afforestation pioneer tree species among the naturally distributed mangrove plant species in China. Mode of reproduction: viviparous hypocotyl reproduction.



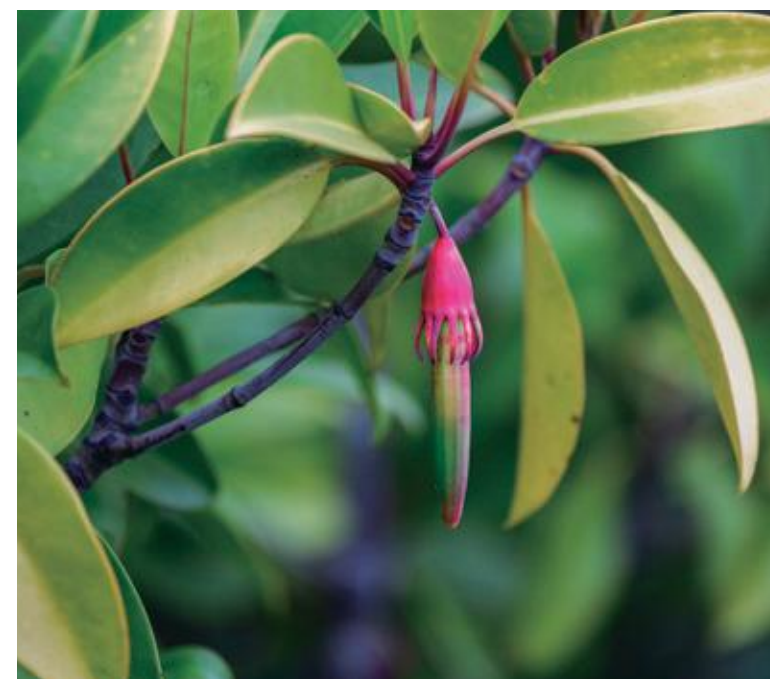
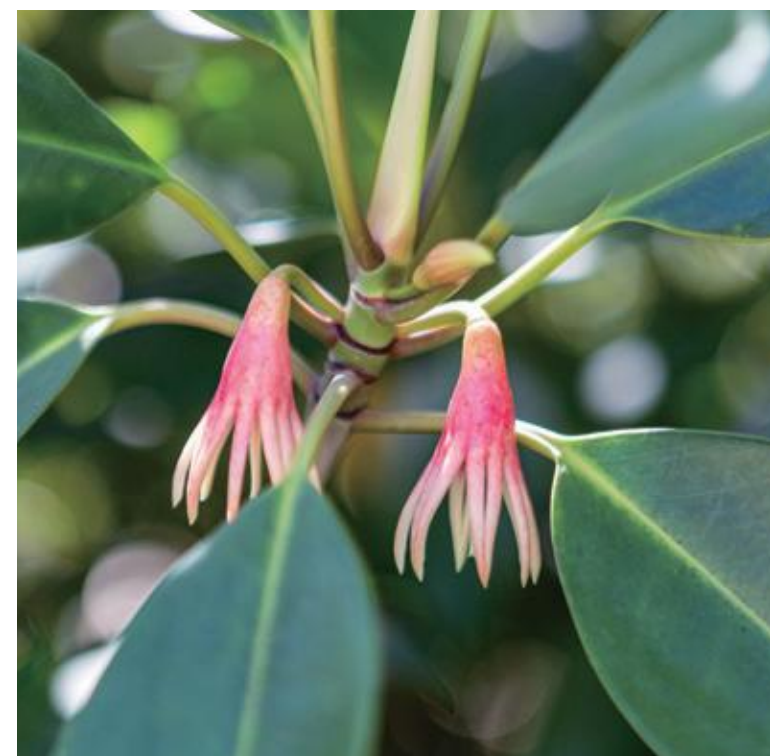
Wood olive

Bruguiera gymnorhiza (Linn.) Savigny

Mangroveaceae *Sylvestiaceae*. Evergreen trees or small trees, 4–7 m. It has a knee-like respiratory root. The bark is gray to black, with obvious longitudinal cracks, and the old trees are lumpy and cracked. The pores are few and large, and they are mostly concentrated at the base of the tree. The tannic acid oxidation of the inner bark of the tree is purplish-red.

Distribution: Mainly distributed in Hainan, Guangdong, Guangxi, Fujian, Hong Kong and Taiwan in China.

Characteristics: Light-loving tree species, often distributed in the high tide zone silt, silty or sandy mudflats, often with Lotus and Lotus sharp-petaled in Hainan to form mixed forests. It is one of the main afforestation tree species in the high tide zone. Mode of reproduction: viviparous hypocotyl reproduction.



Peduncle hypocotyls



Red Sea Olive

Olive plum

Lumnitzera racemosa Willd

Aceae Olive Plum plant. Small evergreen trees or shrubs, 3–5 m high, up to 7 m, dark gray bark, with long striplike cracks.

Distribution: Mainly naturally distributed in Guangdong, Guangxi and Hainan in China.

Characteristics: Light-loving plant. It is mainly distributed in the sandy or silty tidal flats in the high tide zone with a short period of seawater inundation. It has medium cold resistance, strong salt resistance, and the seeds can regenerate naturally on the moist tidal flats with a salinity of 30‰. Mode of propagation: seed propagation.



Olive plum

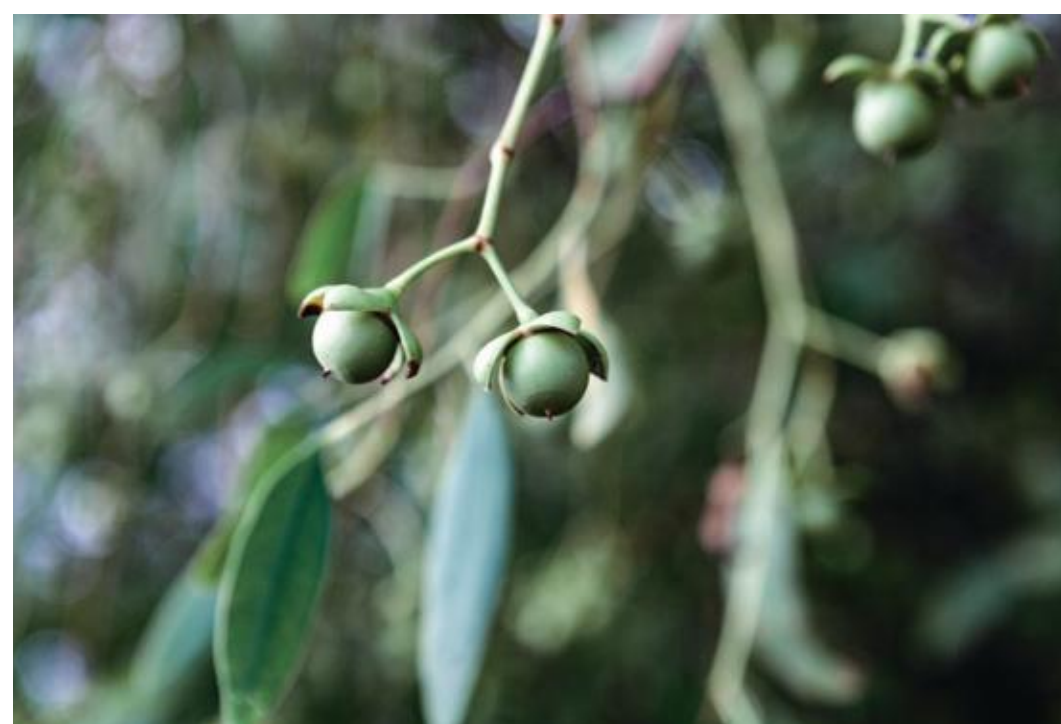
Petalless mulberry

Sonneratia apetala Buch.-Ham.

Mulberry of the family Mulberry. Evergreen tree, 15–20 m high. The twigs are slender and drooping, with raised knots. It has well-developed shoot-like respiratory roots.

Distribution: Native to Bangladesh and India. In 1986, it was introduced to Dongzhai Port for planting, and later promoted in Guangdong, Guangxi, Fujian and Zhejiang in China.

Characteristics: Light-loving plant. This tree species is a pioneer tree species in afforestation of tidal flats in medium and low salinity and low tidal zones. At present, many people are worried about the risk of ecological invasion, and long-term monitoring and control should be strengthened. Mode of propagation: seed propagation.



Flowers, fruits

Laguanmu

Laguncularia racemosa Gaertn. F.

Kolaguan wood plant. Evergreen tree, 10–14 m high, stems gray-green. Linnai multi-fingered respiratory roots.

Distribution: This species was introduced from Mexico in 1999 to Dongzhai Port, Hainan Province for planting experiments, and 127 trees were introduced in the first generation. It bloomed and fruited in 2002 and was harvested and raised in 2003 and then spread to Guangdong, Fujian and other places the following year.

Characteristics: Light loving and not shade tolerant. This species is native to La Paz, Mexico, and has a salinity of up to 45‰ in the seawater, and the seeds can regenerate normally under natural conditions. It has strong cold resistance, which is comparable to that of white bone soil and paulownia trees, and worse than that of autumn eggplant. It can grow in muddy and sandy tidal flats in the middle and high tide zones. The fruit of this species is a cryptophytic fruit, and the seed has strong fecundity, which has a strong competitive advantage over local species.



Fruit



Laguanmu

Sea paint

Excoecaria agallocha Linn.

Euphorbiaceae sea lacquer plant. Semi-deciduous small trees or shrubs, 3–5 m high, up to 7 m. The trunk of the tree bears white milk.

Distribution: It is naturally distributed in Hainan, Guangxi, Guangdong and Taiwan in China.



Inflorescence

Characteristics: Light-loving plant. It does not have high requirements for soil quality, and mostly grows in areas with less or no submerged seawater in the high tide zone. Strong salt resistance. Propagation method: seed propagation, cuttings propagation.



Sea paint

Ras

Acanthus ilicifolius Linn.

Rats of the family *Rataceae*. Evergreen erect shrub, 0.5–1.5 m high, up to 2 m, thick stem, cylindrical, semi-lignified, branched in the upper part, adventitious roots in the lower part.

Distribution: Naturally distributed in Hainan, Guangxi, Guangdong, Fujian, Taiwan, Hong Kong and Macao in China.

Characteristics: Light-loving plant. It has a certain ability to tolerate yin. The leaves have the function of salt secretion, and the ability to resist cold and salt is strong. It mostly grows in the forest edge or sparse forest land in the middle and high tide zones, and the leaves of the rats naturally distributed in Hainan Island have hard spines. Propagation method: propagation by seed or cuttings.



Sea paint



Inflorescence fruit

Small-flowered mouse

Acanthus ebracteatus Vahl

Rats of the family *Rataceae*. Evergreen erect subshrub, 1–2 m high, adventitious roots, mostly.

Distribution: It is mainly naturally distributed in Hainan and Guangdong in China, and has a small amount of distribution in Guangxi.



Small-flowered mouse



Flowers, fruits

Characteristics: Semi-shade-tolerant plant. Grows in high tide levels, river channels or sparse forests. Propagation method: seed propagation, cuttings propagation.

Halogen fern

Acrostichum aureum Linn.

Halofern is a perennial herbaceous plant with a height of 60–120 cm and a height of 200 cm. The rhizome is erect, together with the base of the petiole, and the apex is densely covered with brownish-brown broad-lanceolate scales.

Distribution: Mainly distributed in Guangdong, Guangxi, Hainan, Hong Kong, Taiwan and Macao in China.

Characteristics: Light-loving, with a certain ability to tolerate shade, medium salt tolerance. It mostly grows in the high tide zone of the coastal zone, low-lying grasslands and ponds with perennial waterlogging. Reproduction mode: spore reproduction.



Halogen fern

Water coconut

Nypa fruticans Wumb.

Palm family, water coconut. Evergreen shrub, clumped, 3–7 m high, underground stems.

Distribution: It is mainly naturally distributed in the coasts of Haikou, Wenchang and Wanning on the east coast of Hainan Island in China.

Characteristics: Light-loving plant. Its salt requirements are not strict, and it can grow on sandy and muddy tidal flats in the high, middle and low tide zones of the coast. Poor cold resistance. The tree shape, flowers and fruits are all beautiful and can be used for planting in wetland parks. The tree species has a viviparous phenomenon, and the mode of reproduction: seed propagation.



Halogen fern

Semi-mangrove plants

Water yellow skin

Pongamia pinnata (Linn.) Pierre

Fabaceae water yellow bark plants. Semi-deciduous tree, up to 7 m high.

Distribution: Mainly naturally distributed in Hainan, Guangdong, Guangxi, Hong Kong and Taiwan in China.

Characteristics: Light-loving plants. It is mainly distributed in areas with little or no tidal water above the high tide zone, and the soil requirements are not strict. Mode of propagation: seed propagation.



Water yellow skin

Wild Jasmine

Clerodendrum inerme (Linn.) Gaertn.

Verbenaceae is a plant of the genus Tung. Evergreen climbing shrub, 1–2 m high, gray-green bark.

Distribution: It is naturally distributed in the coastal areas south of Fujian Province in China.

Characteristics: Light-loving plant, with a certain shade tolerance. In coastal tidal flats it is distributed in areas with little tidal water or no inundation. Mode of propagation: seed propagation.



Flower Fruit

Hostile

Barringtonia racemosa (Linn.) Spreng.

Plants of the family *Jadeaceae*. Evergreen tree or small tree, sparse shrub, 2–4 m high, thick branchlets, obvious defoliation marks.

Distribution: It is naturally distributed in Hainan, Guangdong and Taiwan in China, and there are artificial introductions in Guangxi.

Characteristics: Light-loving plant, growing on tidal flats with little seawater or land without seawater flooding in the coastal high tide zone. It can be grown in either sandy or muddy substrates. The tree shape is beautiful, and it can be cultivated as an ornamental plant. It is mostly used for coastal landscaping. Propagation mode: seed propagation is the mainstay.



Inflorescence fruit

Blunt leaves stinky yellow wattle

Premna obtusifolia R. Br.

Verbenaceae is a plant of the genus *Vitex*. Climbing shrubs or small trees, 1–3 m high, up to 5 m in the Paracel Islands. The old branches have round to oval yellowish-white skin holes, and the young branches have short pubescence.

Distribution: Mainly naturally distributed in Hainan (including Xisha Islands), Guangdong, Guangxi, Fujian, Taiwan and Hong Kong in China.

Characteristics: Light-loving plant. It grows in muddy and sandy coastal mud, gravel or seaside rock crevices with little or no seawater inundation. It has high vitality. Mode of propagation: seed propagation.



Water yellow skin

Broadbud chrysanthemum

Pluchea indica (Linn.) Less.

Asteraceae broad-bract chrysanthemum. Evergreen shrub, 1–1.5 m high. Young branches are pubescent.

Distribution: Mainly naturally distributed in the coastal provinces south of Fujian in China.

Characteristics: Light-loving plant, it has a certain tolerance to shade. It grows on muddy or sandy substrates, has strong survivability. It can be used for low hedges in landscaping. Propagation method: seed propagation, cuttings or rametre propagation.



Broadbud chrysanthemum

Principal Bird Species of Mangrove Wetlands

According to the IOC World Bird List compiled by the International Ornithologists' Union, there are 11,093 bird species worldwide.

According to the China Bird Report, 1,493 bird species have been recorded in China to date.

According to relevant literature (Zhang Min et al., 2022), 584 bird species have currently been recorded in Guangdong Province.

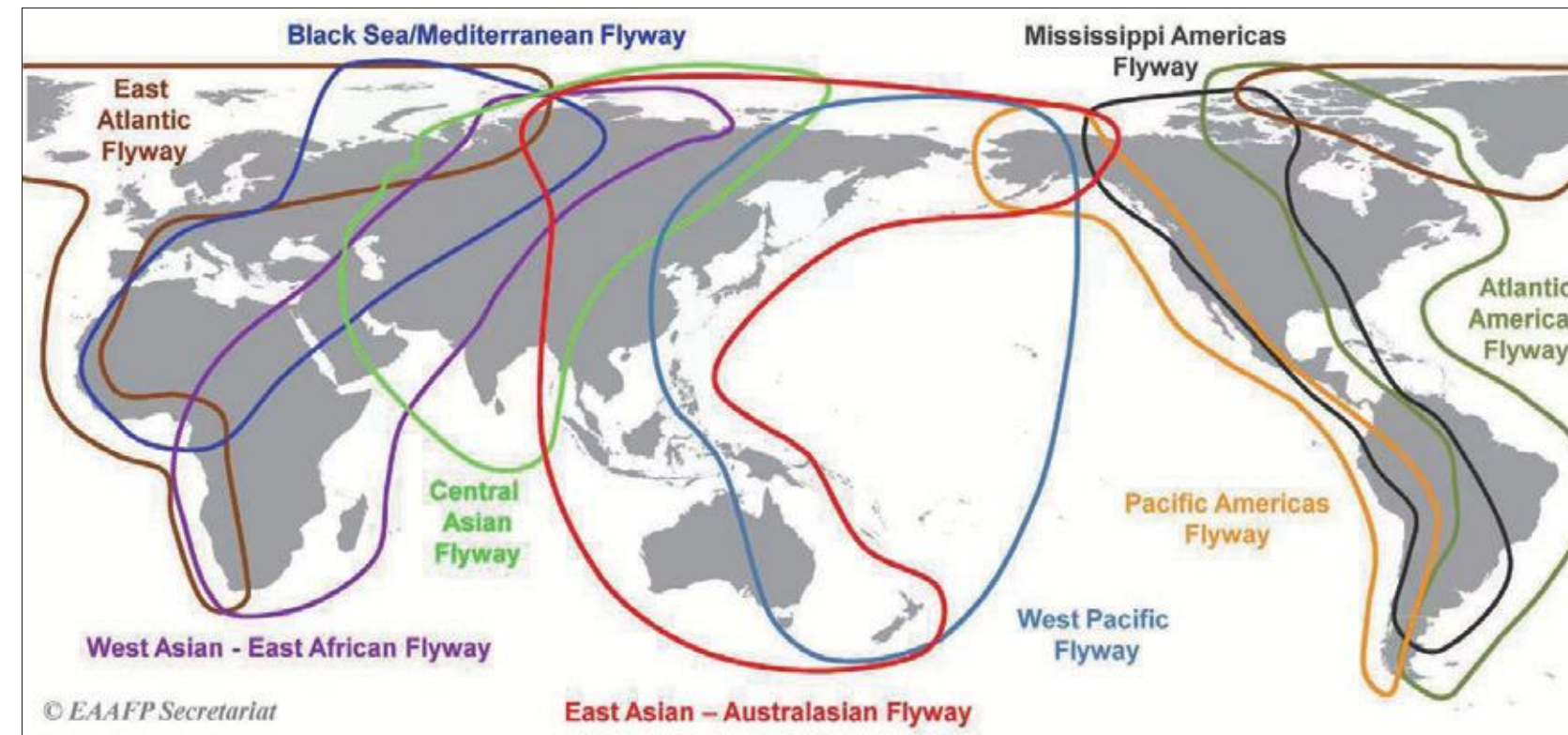
Based on historical literature and existing bird data, the Zhanjiang Birdwatching Society has compiled a checklist of birds for Zhanjiang City, documenting 341 species. These belong to 20 orders, 68 families, and 191 genera. Among them, there are 122 species of coastal wetland birds, primarily waterfowl and waders, belonging to 6 orders and 17 families.

Large numbers of birds spend their winter in Zhanjiang.

During the spring and autumn migration seasons, large numbers of migratory birds also pass through the coastal areas of Zhanjiang. They rest and forage here to replenish their energy before continuing their long journey.

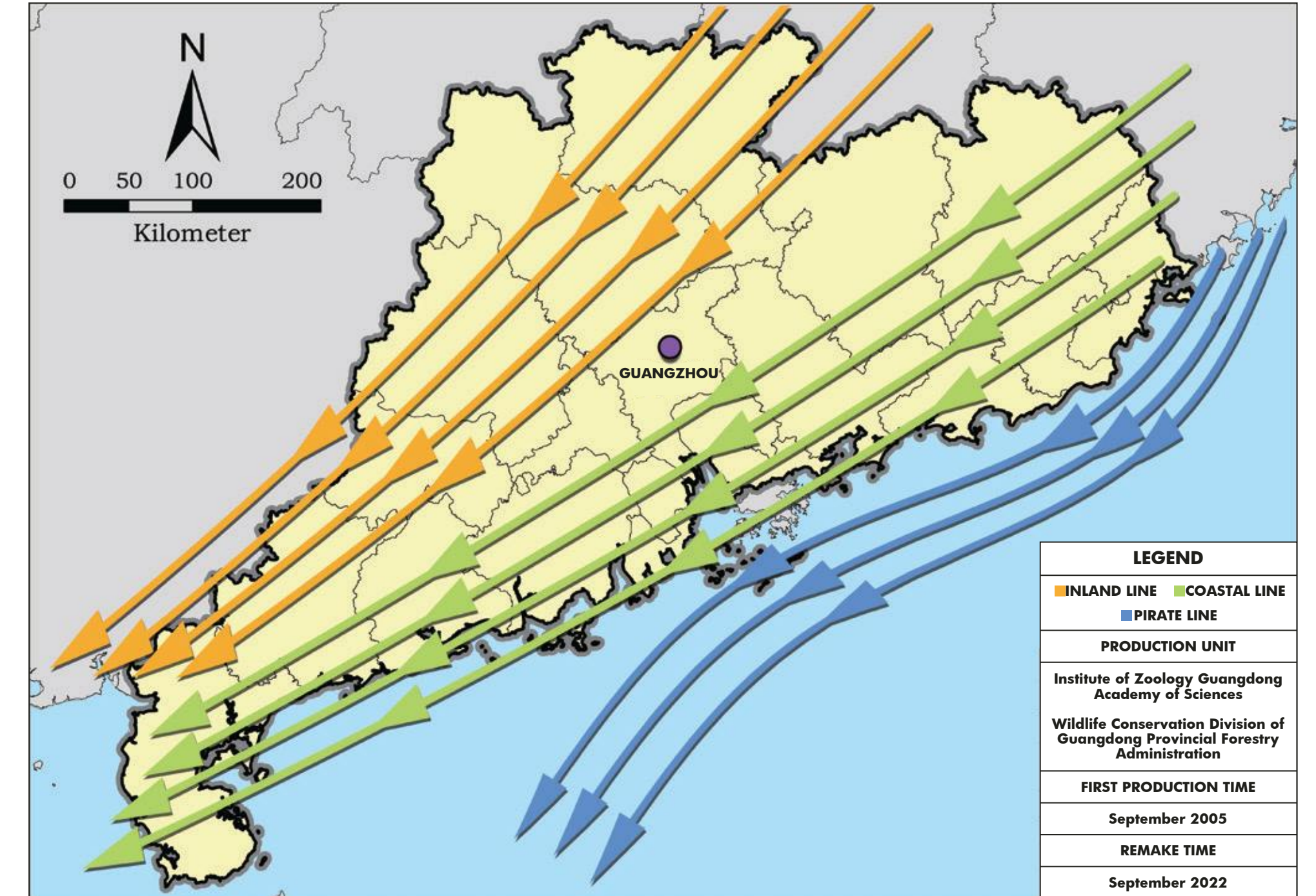
Relatively fewer birds are present in summer, but many resident birds and summer visitors remain, along with some non-breeding immature birds that linger in the wintering grounds through the summer.

The global bird migration routes are shown in the map below. The migration route for mangrove birds in China falls within the East Asian-Australasian Flyway.



Schematic Diagram of Global Bird Migration

The bird migration routes in Guangdong Province can be further subdivided into three routes, as shown in the map below. The mangrove bird migration route is the coastal line.



Schematic Diagram of Bird Migration in Guangdong Province

**Introduction to the Black-faced Spoonbill,
a National Class I Protected Bird**

Black-faced Spoonbill *Platalea minor*; Order: Pelecaniformes, Family: Threskiornithidae, Genus: Platalea.

It gets its name because its flat, long bill resembles the Chinese traditional musical instrument, the pipa.

Distribution: It breeds in the northern part of the Korean Peninsula and migrates south for winter. In China, it is generally a winter visitor. The Black-faced Spoonbill inhabits lakes, ponds, marshes, and reed swamps from estuaries to coastal mudflats. It is often solitary or found in small groups and is wary, avoiding humans. Its diet consists mainly of small fish, shrimp, crabs, mollusks, aquatic insects, etc. In the 1930s, the Black-faced Spoonbill was a common species in the eastern coastal regions of China. Due to rapid human population growth and economic development, its suitable habitat has dwindled. Many individuals now become confined to the few remaining suitable habitats in winter, making these sites their last refuges.

The Black-faced Spoonbill is listed as Endangered on the IUCN Red List of Threatened Species and is also a National Class I Protected Animal in China.



White-throated Kingfisher

Scientific Name:

Halcyon smyrnensis.

Suborder: Alcedines,

Family: Alcedinidae,

Genus: Halcyon.

National Class II Protected Wildlife.



Bar-tailed Godwit

Scientific Name:

Limosa lapponica.

Order: Charadriiformes,

Family: Scolopacidae (Wader).

National "Three Haves" Protected Wildlife

(Note: "Three Haves" means special ecological, scientific, or social significance).



Western Osprey

Scientific Name:
Pandion haliaetus.

Order: Accipitriformes,
Family: Pandionidae (Bird of Prey).

National Class II Protected Wildlife.



Greater Crested Tern

Scientific Name:
Thalasseus bergii.

Order: Charadriiformes,
Family: Laridae (Waterbird).

National Class II Protected Wildlife.



Eurasian Curlew

Scientific Name:
Numenius Arquata.

Order: Charadriiformes,
Family: Scolopacidae (Wader).

National Class II Protected Wildlife.



Pied Avocet

Scientific Name:
Recurvirostra avosetta.

Order: Charadriiformes,
Family: Recurvirostridae (Wader).

National "Three Haves" Protected Wildlife.



Black-winged Stilt

Scientific Name:
Himantopus Himantopus.

Order: Charadriiformes,
Family: Recurvirostridae (Wader).

National "Three Haves" Protected Wildlife.



Caspian Tern

Scientific Name:
Hydroprogne caspia.

Order: Charadriiformes,
Family: Laridae (Waterbird).

A winter visitor in Zhanjiang City, migrating to the mangrove coastal wetlands of the Leizhou Peninsula every autumn to overwinter.

National Class II Protected Wildlife.



Black-tailed Godwit

Scientific Name:
Limosa limosa.

Order: Charadriiformes,
Family: Scolopacidae (Wader).

National "Three Haves" Protected Wildlife.



Dunlin

Scientific Name:
Calidris alpina.

Order: Charadriiformes,
Family: Scolopacidae (Wader).

National "Three Haves" Protected Wildlife.



Red-necked Stint

Scientific Name:
Calidris ruficollis.

Order: Charadriiformes,
Family: Scolopacidae (Wader).

National "Three Haves" Protected Wildlife.



Chinese Egret

Scientific Name:
Egretta eulophotes.

Order: Pelecaniformes,
Family: Ardeidae (Wader).

National Class I Protected Wildlife.



Yellow Bittern

Scientific Name:
Ixobrychus sinensis.

Order: Pelecaniformes,
Family: Ardeidae (Wader).

National "Three Haves" Protected Wildlife.



Blue-tailed Bee-eater

Scientific Name:
Merops philippinus.

Order: Coraciiformes,
Family: Meropidae (Climbing Bird / Near-Passerine).

National Class II Protected Wildlife.



Nordmann's Greenshank

Scientific Name:
Tringa guttifer.

Order: Charadriiformes,
Family: Scolopacidae (Wader).

National Class I Protected Wildlife.



Blue-throated Bee-eater

Scientific Name:
Merops viridis.

Order: Coraciiformes,
Family: Meropidae (Climbing Bird / Near-Passerine).

National Class II Protected Wildlife.



Spoon-billed Sandpiper

Scientific Name:
Calidris pygmaea.

Order: Charadriiformes,
Family: Scolopacidae (Wader).

A winter visitor in Zhanjiang City, migrating to the mangrove coastal wetlands of the Leizhou Peninsula every autumn to overwinter. Numbers are very scarce.

National Class I Protected Wildlife.



Chinese Crested Tern

Scientific Name:
Thalasseus bernsteini.

Order: Charadriiformes,
Family: Laridae (Waterbird).

National Class I Protected Wildlife.



Macrobenthic fauna in mangrove wetlands

Macrobenthic fauna are common in mangrove wetlands.



Rough snail



Spotted ribbed snail



Black-mouthed snail



Cockles and razor clams



Mangrove clam



Pseudoburrow blue crab



Ole color snail



Northern calling fiddler crab



Cockles



Blunt-toothed paddle crab



Clam

Major fish species in mangrove wetlands

Fish are common in mangrove wetlands.



Tarpon / *Elops saurus*



Omnivorous beantooth eel / *Pisodonophis boro*



Chinese catfish / *Arius sinensis*



Gerres filamentosus



Therapon jarbua



Lutianus russelli



Allanetta bleekeri



Spotted grouper / *Epinephelus malabaricus*



Leiognathus brevirostris



Sparus latus



Shortfin rudder / *Kyphosus lembus*



Synaptura orientalis

BRIEF INTRODUCTION OF 6 MAJOR MANGROVE NATURE RESERVES IN CHINA

Since 2000, with the gradual understanding of the value of mangroves, the improvement of environmental protection awareness and the improvement of the rule of law, direct and large-scale damage to mangroves has rarely occurred, and most mangroves have been included in the scope of protected areas. So far, China has established 38 protected areas with mangroves as the main protection object (excluding Taiwan's Tamsui Estuary, Guandu and Hong Kong's Mai Po), including 6 national nature reserves (1 in Hainan, 2 in Guangxi, 2 in Guangdong and 1 in Fujian). The total area of the reserve is about 65,000 hectares, of which about 16,500 hectares are mangroves, accounting for 60% of the total area of mangrove forests in China, well above the world average of 25%. It can be said that mangroves are the most protected natural ecosystems in China.

Zhanjiang Mangrove National Nature Reserve, Guangdong

Guangdong Zhanjiang Mangrove National Nature Reserve is located in Zhanjiang City, in the southwest of Guangdong Province, with a total area of 20,278.8 hectares along the 1,556-kilometer coastline of the Leizhou Peninsula. The reserve is rich in biodiversity, with 25 species of true mangrove and semi-mangrove plants in 15 families, including white bone soil, red sea olive, wood olive, autumn eggplant, paulownia tree, etc. 312 species of birds have been recorded, including spoon-billed sandpiper, oriental white stork, Chinese limelight tern, relict gull, black-faced spoonbill, black-billed gull and other waterfowl that are rare in the world, making it an important bird area in Guangdong Province.



Aerial view of the Gaoqiao mangrove forest in Zhanjiang

The reserve was established in January 1990 and was limited to 2,000 hectares of mangrove wetlands along the coast of Gaoqiao and Cheban towns in Lianjiang City. In December 1997, it was promoted to a national nature reserve, and the scope of protection was extended to the main mangrove wetlands along the entire coast of the Leizhou Peninsula.

Zhanjiang mangrove wetland is the essence of wetland resources in southern China, an important habitat and resting place for migratory birds migrating from north to south, and an important area of China's coastal shelterbelt construction system and wetland protection project, which plays a very important role in purifying seawater, regulating climate, protecting coasts, preventing and reducing disasters, protecting biodiversity, and maintaining ecological security. At present, the reserve is classed as "Wetland of International Importance", "National Model Nature Reserve" and "Chinese and Biosphere Reserve".

In 2016, the management of nature reserves was commended by seven national ministries and commissions, and won the title of "National Advanced Collective of Nature Reserves".

In 2021, the Zhanjiang Mangrove Afforestation Project implemented by the Protected Area Administration was listed by the Ministry of Natural Resources as a typical case of national ecological restoration.

In 2022, CCTV News Network's "Great Beauty China" column will show the "spring and vibrant" scenery of Zhanjiang Mangrove Reserve in 23 seconds.

In April 2023, General Secretary Xi Jinping visited the Jinniu Island area of the reserve for investigation and research, and gave instructions to protect this "national treasure" like protecting the eyes.

In recent years, the reserve has also been rated in "the top ten most beautiful forests in Guangdong", "the top ten most beautiful wetlands in Guangdong" and "the most beautiful forest tourist destination in Guangdong".



Mangrove landscape of Techeng Island in Zhanjiang



Mangrove sunset, Zhanjiang



Ancient trees of white bone soil

Dongzhaigang National Nature Reserve, Hainan

Founded on January 3, 1980 and promoted to a national nature reserve by the State Council in July 1986, Dongzhaigang National Nature Reserve in Hainan Province is the first wetland nature reserve based on mangroves in China. The reserve covers an area of 3,337.6 hectares, with abundant animal and plant resources, including 36 species of mangrove plants from 20 families, accounting for 97% of the country, 4 species of seagrass in 2 families, 13 species of reptiles in 6 families, 9 species of mammals in 7 families, 151 species of mollusks in 58 families, 208 species of insects in 66 families, 7 species of amphibians in 5 families, and 229 species of birds in 57 families. There are 177 species of fish in 63 families and 126 species of shrimp and crabs in 26 families, which is a treasure trove of species genes and resources. At the same time, it is also the nature reserve with the largest contiguous area, the most tree species, the best stand quality and the richest biodiversity in China's mangrove forests so far. In 1992, it was included in the list of wetlands of international importance, in 2006 it was rated as a national demonstration reserve by the State Forestry Administration, in 2012 it was rated as one of the 20 most beautiful forests in China by the magazine "Forests and Humans", and in September 2019, it was awarded the national greening model unit by the National Greening Committee.

Due to its biological diversity and species rarity, Dongzhaigang mangrove forest and its ecosystem have great ecological and research value. They enjoy a certain popularity and influence at home and abroad, and have received extensive attention from all walks of life.









Red Sea Olive at high tide

Beilun Estuary National Nature Reserve, Guangxi

Guangxi Beilun Estuary National Nature Reserve is located at the southwestern most tip of China's mainland coast, in Fangchenggang City, Guangxi Zhuang Autonomous Region, bordering Beibu Gulf in the southeast and Vietnam in the southwest. Beilun Estuary Nature Reserve is a nature reserve that focuses on the protection of mangrove ecosystems, marine biological resources and their habitats, and mangrove wetland birds. In April 2000, it was approved by the State Council to be promoted to a national nature reserve. In February 2008, it was included in the List of Wetlands of International Importance, and in 2013, it was jointly rated by the Ministry of Environmental Protection and the Ministry of Education as the first batch of "National Primary and Secondary School Environmental Education Social Practice Bases".

The total area of the reserve is 3,000 hectares, with a total of 18 species of mangrove plants, accounting for about half of the mangrove plants in the country, including 11 species of true mangrove plants and 7 species of semi-mangrove plants. Within the jurisdiction of Pearl Bay, the reserve has the largest bay mangrove forest and the largest contiguous area of pure olive forest in the country. The Beilun estuary area is home to the largest contiguous rat community in the country, and the mangrove forest in this area is also the only border mangrove forest in China.

As of 2022, a total of 155 species of macrobenthic animals, 58 species of fish, and 302 species of birds have been recorded in the reserve, including 15 globally threatened bird species (3 globally critically endangered (CR) species, 4 globally endangered (EN) species, and 8 vulnerable (VU) species), and 69 species of birds under national key protection (11 species under first-class protection and 58 species under second-class protection). The reserve has become a safe passage and an important habitat for migratory birds, where various ecological resources have been effectively protected, and a solid green ecological barrier has been built for China's southwest maritime border.





Mangrove landscape at high tide



Landscape of wood olive at high tide, Zhanjiang



Sea forest - mangrove forest

Guangxi Shankou National Nature Reserve

Guangxi Shankou Mangrove Ecological National Nature Reserve is located in the southern part of China's mainland coast, located in Beihai City, Guangxi Zhuang Autonomous Region, composed of Yingluo Port and Dandou Sea on the east and west sides of Shatian Peninsula in Hepu County, Guangxi, adjacent to Zhanjiang Mangrove Reserve in Guangdong Province in the east, and spanning the three towns of Shankou, Shatian and Baisha in Hepu County. It was established with the approval of the State Council in 1990, joined the UNESCO Network of Man and Biosphere Reserves in 2000, was listed as a wetland of international importance in 2002, was rated as one of the "Top Ten Charming Wetlands in China" by CCTV in 2013, became one of the first batch of "Two Mountains" theoretical theme practice bases in Guangxi in 2021, and was awarded the National Nature Education School (Base) in 2023.

The total area of the reserve is 8,003 hectares. The reserve is rich in biodiversity, with 10 species of true mangrove plants and 7 species of semi-mangrove plants, among which the Yingluo Port area of the reserve preserves the largest and oldest natural red sea olive forest in China, which is an important mangrove provenance base and gene bank in China.

As of 2022, a total of 96 species of phytoplankton, 378 species of macrobenthic animals, 456 species of insects, 31 species of spiders, and 242 species of birds (including 5 species of national first-class key protected birds and 39 species of national second-class protected birds) have been recorded in the reserve. The abundant species resources make Shankou Nature Reserve an important research base and science popularization base for mangrove ecosystem in China.



Mangrove landscape





Shenzhen-Neilingding National Nature Reserve, Guangdong

Futian mangrove forest is an important part of the Futian National Nature Reserve in Neilingding, Guangdong, which was founded in October 1984 and promoted to a national nature reserve in May 1988.

Futian Mangrove Forest is located in the northeast of Shenzhen Bay, from the Xinzhou estuary in the east, to Shenzhen Bay Park in the west, to the sea area outside the tidal flat and the Shenzhen estuary in the south, and to the Guangzhou-Shenzhen Expressway in the north, with a coastline of about 6 kilometers and a total area of 367.64 hectares. In 2020, Futian mangrove forest was included in the list of wetlands of national importance, and in 2022, it was included in the list of wetlands of international importance.

Futian Mangrove Forest and Hong Kong's Mai Po Reserve, a Ramsar Wetland of International Importance, face each other across the water, forming the internationally renowned Deep Bay Mangrove Wetland Ecosystem, which is one of the important wetlands in southern China. The confluence of rivers and seas, the mixture of brackish and fresh water, accompanied by tidal phenomena, abundant organic matter and fertile water quality, provide a good geomorphological and physical environment for the development of mangrove wetlands. The mangrove forests in the area are distributed in a strip and the community is simple, with the widest part of the forest exceeding 500 meters, which is mainly composed of three native communities (*Lycodium officinalis*, Tung Blossom Tree and White Bone Soil) and one introduced artificial community (Mulberry and Mulberry without petals). The mangrove forest covers an area of about 100 hectares, with 20 species of mangrove plants in 9 families and 7 species of mangrove plants that grow naturally in the local area.



Aerial view of the mangroves in Shenzhen Bay

The coastal wetland ecosystem composed of mangroves, Jiwei fish ponds and peripheral tidal flats provides a necessary foraging and habitat environment for wintering or transiting migratory birds, and is an important wintering ground and transit station on the East Asian-Australasian migratory bird flyway, where nearly 100,000 long-distance migratory birds stop every year, and is an important wintering ground for the black-faced spoonbill, a globally endangered and rare bird, according to the "Black-faced Spoonbill Global Synchronous Census 2023 Report". According to the show, there are 6,633 black-faced spoonbills in the world in 2023, and 299 in Shenzhen Bay, accounting for about 4.51% of the global total.

As of 2023, more than 270 species of birds have been recorded in the reserve, including 13 species of national Class I protected birds, including black-faced spoonbill, yellow-billed egret, little greenshank, black stork and white-shouldered eagle, 47 species of national Class II protected birds, including Great Knot, White-rumped Curlew, Brown-winged Jay, White-breasted Emerald, Pheasant and Black Kite, and 353 species of vascular plants, more than 340 species of insects, 162 species of macrobenthic animals, 63 species of fish and 330 species of phytoplankton, 243 species of zooplankton, 9 species of reptiles, 8 species of amphibians, and 6 species of mammals.

Futian Mangrove Ecosystem is an oasis between the two megacities of Shenzhen and Hong Kong, which plays an important role in maintaining the ecological balance of the region, and is known as the Great Green Wall next to Shenzhen Bay. The natural beauty of "the sunset and a thousand birds fly together, and the still water grows together in the sky" highlights the harmonious coexistence of the city and the wetland, man and nature, and is a window and business card to show the achievements of the city's ecological civilization construction.







Zhangjiangkou National Nature Reserve, Fujian

Fujian Zhangjiangkou Mangrove National Nature Reserve is located in Yunxiao County, Fujian Province, on the vast tidal flat west of Shilu Pagoda at the mouth of the Zhangjiang River, facing the sea from Taiwan's Tamsui Estuary Mangrove Reserve. With five species of mangrove plants such as rats, and a total area of 2,360 hectares, the reserve was established in 1992, approved by the Fujian Provincial People's Government in 1997 to establish a provincial nature reserve. In June 2003 it was approved by the State Council to be promoted to a national protected area, and in February 2008 it was included in the List of Wetlands of International Importance, the first wetland of international importance in Fujian Province.

Zhangjiangkou Mangrove Forest Reserve is an important station for migratory birds, especially as it is the only way for migratory waterbirds in East Asia. There are a large number of international, domestic and regional protected animals, and 154 species of birds of 15 orders, 38 families. 154 species of birds are monitored and recorded, and in the migratory bird migration season, migratory birds include herons, plovers, geese and ducks, gulls and other waterbirds up to more than 10,000.

Zhangjiang Estuary is the southeast coastal high-quality aquatic germplasm resource bank, where the mud cockles, saw-edge blue crabs, razor clams and other aquatic products. They are delicious, nutritious and widely-known, not only as products of national geographical indication, but also as an important source of economic income for people in the surrounding area.

Taking advantage of its unique ecological advantages, the Zhangjiangkou Mangrove Reserve continues to promote ties with Xiamen University and other universities, realizes local school cooperation, highlights its unique advantages, and continuously innovates in the ways and means of publicity and education for the mangrove reserve, with the goal of "mechanism activity, industrial prosperity, people's prosperity, and ecological beauty", striving to build a "green cradle" on the west coast of the Taiwan Strait. It has been successively recognized as the first batch of ecological civilization practice sites in Zhangzhou City, the first batch of ecological science popularization education bases of the Ecological Society of China, the "Fujian Provincial Environmental Education Base", "Fujian Provincial Science Education Base", "Fujian Provincial Science Education Base", "The First Batch of Pilot Projects of Sino-Japanese Cooperation Environmental Education Base" and other honorary titles.







MAIN REFERENCES

WANG Wenqing, SHI Jianbin, CHEN Luzhen, et al, 2021. Development strategy of mangrove wetland conservation and restoration in China[M]. Beijing: China Environment Publishing Group

WANG Wenqing, CHEN Qiong, 2013. Southern coastal salt-tolerant plant resources (1)[M].Xiamen: Xiamen University Press

LIAO Baowen, ZHANG Qiaomin, 2014. Distribution area and tree species composition of mangrove wetlands in China. Wetland Science, 12(4):435-439.

LIAO Baowen, XIN Kun, HUANG Bo, et al., 2021. Hazards and prevention and control techniques of mangrove water lice[M]. Beijing: Science Press

WANG Wenqing, ZHANG, Linting, ZHONG Cairong. Atlas of mangrove plants in Hainan (internal booklet).

Special thanks to HE Ling for providing the photographs used in this book.



**Scan to learn about Zhanjiang Mangrove
Wetland Conservation Foundation
and to donate to help reach 100,000 trees by 2030.**

With your support, we can do it.