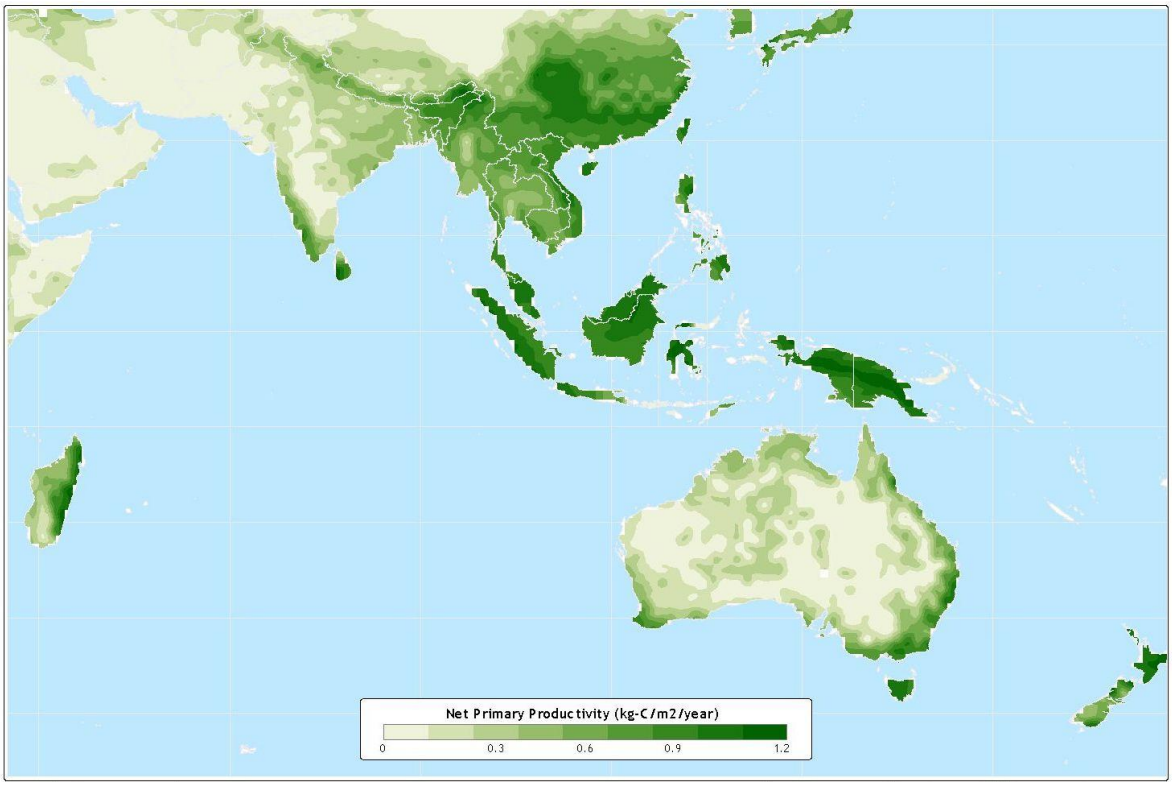
中国科协海智计划海南(海南大学)工作基地

海南大学环南海陆域生物多样性研究中心

2021 年报

Annual Report 2021



海南大学

HAINAN UNIVERSITY

环境污染综合防治高端论坛在海南陵水召开

2021 年 11 月 26-28 日，由海南大学主办，海南大学生态与环境学院、中国科学院生态环境研究中心、海南省生态环境监测中心以及工作基地承办的“环境污染综合防治高端论坛”在海南陵水举行。

本次高端论坛一共邀请了中国工程院的贺泓、郝吉明、曲久辉、任洪强、徐祖信 5 位院士以及清华大学、同济大学、天津大学、中国科学院生态环境研究中心、海南大学、海南师范大学等 40 余位环境生态学领域的专家学者。海南省生态环境厅伍晓红副厅长、海南省科技厅李海璇处长、海南大学副校长傅国华教授等相关领导，以及海南大学生态与环境学院王旭执行院长、任明迅教授(挂职副院长)、黄青教授、杨飞教授、马斌教授等参加了论坛。

工作基地/研究中心负责人任明迅教授主持了本次高端论坛开幕式，傅国华副校长、贺泓院士、李海璇处长、伍晓红副厅长先后做了热情洋溢的欢迎词，对本次高端论坛促进院士专家助力海南大学“世界一流学科”建设和海南省“科技翻身仗”的殷切期望。

贺泓院士主持了高端论坛的学术报告环节。南京大学吴兵、同济大学韩梦琪、中科院生态环境研究中心马金珠、中科院生态环境研究中心楚碧武、海南省环科院徐文帅、海南大学柔性引进人才金放鸣（上海交通大学）、海南大学马斌、海南大学马文超、海南大学黄青等先后介绍了自己团队的研究成果，涉及大气污染、水污染、固废污染防治与处理等多个方面。院士专家们提出了诸多意见和开展合作研究的意向。

会后，王旭执行院长、任明迅教授、黄青教授等陪同院士专家考察了五指山热带雨林。

目录

封面图片：环南海区域及周边地区的净初级生产力(制图：美国威斯康辛大学麦迪逊分校可持续与全球环境研究中心)。

《2021 年海南省生态环境系统领导干部政治能力提升暨党的十九届五中全会精神专题培训班》在海口顺利举办

2021 年 7 月 7 日至 7 月 9 日，由海南省生态与环境厅和海南大学共同举办、海南大学生态与环境学院承办的《2021 年海南省生态环境系统领导干部政治能力提升暨党的十九届五中全会精神专题培训班》在海口召开。参与培训的学员均为省生态与环境厅各处室的领导干部及各市县区生态环境局的局长，共 48 人。工作基地/研究中心主任任明迅教授主持了开班仪式和闭幕式。海南大学副校长傅国华教授、生态与环境学院黄海民书记和王旭执行院长、省生态环境厅人事处处长苏俊等领导出席了开班仪式。

该培训班邀请了庞京城教授、宋增伟教授、傅国华教授、杨小波教授、李百炼院士、任明迅教授等讲授了专题培训课程。培训内容包括十九届五中全会精神解读、习近平生态文明思想解读、国家生态文明试验区建设、海南传统生态文化等六大专题。

工作基地/研究中心首席海智专家李百炼教授(俄罗斯科学院外籍院士、世界生态高峰会主席、中国科协海智专家)做了《以生态技术的创新打造未来绿色发展的城市》的培训课程，受到与会学员的热烈欢迎，纷纷邀请李百炼院士到地方指导环境治理与城市可持续发展工作。

工作基地/研究中心主任任明迅教授应邀做了《国家生态文明试验区背景下的海南传统生态文化及其现代传承》培训课程，介绍了海南丰富的自然禀赋及典型的传统生态文化，并探讨了利用现代科技手段发掘海南本土优良农耕文化的生态学基础，提出应结合环境美化、生态文化两个维度来打造国家生态文明试验区和国家公园的“海南样板”。

一、中心概况

海南大学环南海陆域生物多样性研究中心于 2017 年 7 月正式成立，同年 11 月受海南省科学技术协会资助，成为海南大学首家“海外智力为国服务行动计划”工作站。2020 年 6 月，在整合海南大学相关学科引进的海智专家与骨干教师的基础上，获批成立中国科学技术协会海智计划海南(海南大学)工作基地。现任学术委员会主任李百炼教授(美国加利福尼亚大学河滨分校)、工作基地/研究中心负责人任明迅教授(海南大学生态与环境学院)。

中国科学技术协会海智计划海南(海南大学)工作基地和海南大学环南海陆域生物多样性研究中心实行“两位一体”的建设模式，聚焦海南岛、粤港澳大湾区、台湾地区以及环南海区域，集中开展海外智力引进、科技合作与交流、人才培养等，积极担当起海南大学在践行“一带一路”国家战略和国家生态文明试验区(海南)建设中的作用，力争成为环南海生物多样性与生态文化研究中心、区域合作与交流中心。

目前设置三个研究方向：（1）生物多样性与生态保育；（2）环南海区域生态安全；（3）传统生态文化与当代生态文明建设。

已与美国加州大学河滨分校、美国佛罗里达国际大学、日本东京大学、荷兰瓦赫宁根大学、美国夏威夷大学、德国莱布尼兹热带海洋研究中心、德国亚琛工业大学以及环南海地区的新加坡南洋理工大学、新加坡国立大学、新加坡植物园、柬埔寨皇家农业大学、菲律宾大学内湖省分校、越南 Ton Duc Thang 大学、中国台湾与香港地区多家机构签订了合作协议或开展过实质合作。

5 年以来，积累了大量的野外调查、科学实验和理论研究数据，从环南海区

域收集了战略植物资源(热带作物野生近缘种、药用植物、油料植物、观赏植物等)近 3000 份(含植物活体、腊叶标本、DNA、种子等)。

在中国科协、海南省科协和海南大学的指导与支持下，工作基地/研究中心大力开展海外智力为国服务行动计划，积极引进美国、日本、新加坡等地知名华裔学者与当地专家，开展聚焦海南省和环南海区域生态环境、生物多样性领域的合作研究与人才培养。目前，已引进海外智力专家有：

专家	国籍(是否华裔)	工作单位	研究领域
李百炼 Larry Bai-Lian Li	美国(华裔)	加利福尼亚大学河滨分校	人类生态学、生态规划
刘虹 Hong Liu	美国(华裔)	佛罗里达国际大学	生物多样性保护
任添荣 Yam Wing Tim	新加坡(华裔)	新加坡植物园	兰花保育与新品种选育
练春兰 Chunlan Lian	日本(华裔)	日本东京大学	森林资源与生态学
邹乐明 Chou Loke Ming	新加坡(华裔)	新加坡国立大学	珊瑚礁生态
张金龙 Jinlong Zhang	中国(华裔)	中国香港嘉道理农场暨植物园	植物分类与资源收集
谢宗宇	中国台湾(华裔)	中国台湾民享生态调查公司	生物多样性、自然教育
张浩	中国香港(华裔)	中国香港高等教育研究院	生态规划
Pastor L. Malabrigo	菲律宾(非华裔)	菲律宾大学内湖省分校	植物多样性与生态文化
Sandra Yap	菲律宾(非华裔)	菲律宾远东大学	热带植物多样性
Van The Pham	越南(非华裔)	越南 Ton Duc Thang 大学	植物多样性
Vu Van Lien	越南(非华裔)	越南国家自然博物馆	生态环境
Wattana Tanming	泰国(非华裔)	泰国清迈诗丽皇后植物园	热带植物多样性护
Erizal Sodikin	印尼(非华裔)	印尼 Sriwijaya 大学	热带农业资源

二、定位与研究方向

中国科学技术协会海智计划海南(海南大学)工作基地和海南大学环南海陆域生物多样性研究中心，以海南大学近五年引进的生态学与生物学专业青年人才为骨干，联合和引进海内外高端智力，聚焦海南省与环南海区域的生物多样性与生物资源、区域生态安全与生态服务功能优化与提升、传统生态文化与当代生态文明建设研究，主要服务国家“一带一路”战略、国家生态文明试验区(海南)、海南热带雨林国家公园以及中国特色自由贸易港建设。

（一）生物多样性与生态保育

主要针对海南省和环南海区域(海南岛、台湾岛、菲律宾群岛、婆罗洲、马来半岛、中南半岛等)，开展重要战略植物资源如重要作物野生近缘种、特色林木花卉等的发掘、引种与基础生物学研究。针对海南岛热带雨林、淡水湿地、珊瑚礁、红树林与城市关键海岸带等，揭示生物多样性形成与维持机制、解析关键生态过程、开展退化生态系统恢复研究，优化与提升重要生态系统的生态服务功能等，保障和提升海南省生态安全。

（二）环南海区域生态安全

针对海南省地处中国大陆与东南亚的中间地带、位于中国南方生态屏障前沿及“一带一路”关键节点等特点，利用集中引进环南海区域海智专家的基础，从海南岛、南海岛礁、粤港澳大湾区、环南海区域等不同尺度开展海南岛生态安全及关键生态系统生态服务功能优化与提升、区域环境安全与生态文明建设等合作研究与交流，为海南热带雨林国家公园、国家生态文明试验区等“三区一中心”建设保驾护航。

（三）传统生态文化与当代生态文明建设

发掘海南省及环南海区域的优秀生态文化，特别是入选国家级文化遗产与非物质文化遗产如洋浦千年古盐田晒盐技艺、琼中山兰稻作文化系统，以及有望申报农业文化遗产的木棉-梯田耕作体系、五指山牙胡梯田耕作体系等，从现代科学理论与技术角度，揭示其生物学基础与生态学原理，实现“把论文写在海南大地上”。同时，探索传统生态文化的现存价值及其在当代社会中的传承与利用途径，提升海南地方民族及中华民族的文化自信、民族自信，通过生态文化和环境美化两个维度丰富生态文明建设内涵，打造国家生态文明试验区的“海南样板”。

三、大事记

➢ 中国科协王守东书记一行访问工作基地

2021 年 9 月 15 日，中国科协党组成员、机关党委书记王守东、中国科协国际合作部副部长王庆林在海南省科协和海南大学符宣国书记、曹宪忠副校长、科发院邹勇华院长等有关领导的陪同下，对工作基地进行了现场调研。工作基地负责人任明迅教授汇报了工作基地的概况、成果及规划，并介绍了实验室相关情况。王守东书记对工作基地作为首家设立在高校的海智计划工作基地给予了高度评价，鼓励工作基地汇聚海外智力、服务海南地方社会经济，继续在积累较好的生态环境与生命健康领域做出更大的贡献。

➢ 海南省“海智计划”海南大学工作站获择优扶持类资助

2021 年 9 月 30 日，海南省科协评审了海南省“海智计划”海南大学(环南海陆域生物多样性研究中心)工作站 2021 年度的工作成效，考核结果为优秀，给以 2022 年择优扶持资助。工作基地/研究中心将继续围绕环南海地区进行植物资源收集与研究、生态环境保护，在已有的合作基础上，高效推进并完成我工作站与海外高端智力合作项目；进一步深化环南海周边国家与地区的科技合作与交流；拓展国际学术交流与科研合作，为服务国家生态文明试验区(海南)和海南热带雨林国家公园、深化“一带一路”沿线国家科技合作等做出积极的贡献。

2021 年 6 月 18 日，海南省科协党组成员、副主席林明才以及省科协国际部部长朱玲一行四人对我工作基地/研究中心进行考察、调研。林明才副主席在充分肯定了工作基地/研究中心在环南海区域、“一带一路”沿线取得的阶段性进展，

并期望我中心不忘初心，切实利用好已有的海外人才智慧发展海南。尤其是海南红树林的修复工作依然十分严峻，希望我中心充分利用好东南亚人才资源解决目前海南生态环境领域的卡脖子问题。

➢ 任明迅主持的海南省创新研究团队项目完成研究任务

2021 年 12 月，工作基地/研究中心负责人任明迅教授主持的海南省自然科学基金创新研究团队项目《环南海区域植物长距离扩散与演化动态研究》（30 万元）完成了研究任务，通过了结题答辩。该项目以苦苣苔科、风筝果属等典型热带植物类群为例，研究了海南岛与南海周边地区植物区系的历史联系，并利用分子生物学与生物地理学技术方法探讨了这些植物的长距离扩散机制、迁移路线及未来的演变趋势，对认识海南岛植物多样性的形成历史和指导海南热带雨林国家公园生物多样性保护具有积极意义。

➢ 中国工程科技发展战略海南研究院咨询研究项目完成主要内容

工作基地/研究中心首席海智专家李百炼和负责人任明迅联合主持的中国工程科技发展战略海南研究院咨询研究项目《国家生态文明试验区(海南)背景下热带雨林国家公园体制机制创新研究》完成主要研究内容。该项目用 2000、2010、2019 年的遥感数据和实地调查数据，图表量化并验证了热带雨林国家公园主要生态服务功能是水源涵养和固碳释氧功能，鹦哥岭、黎母山、五指山和、吊罗山和毛瑞林场的固碳释氧功能最高，而五指山、吊罗山、霸王岭和毛瑞的生物多样性最高；并指出应优先保护五指山、吊罗山、霸王岭、毛瑞。这一结果精准揭示了海南热带雨林国家公园七个区域的主要生态服务功能和保护优先区域，为制定有效的管理政策提供了依据。

➢ 工作基地获三项海南省自然科学资金项目资助

陈权博士获海南省自然科学基金高层次人才项目《海南东寨港红树林植物群落功能多样性研究》(8 万元)。该项目主要研究红树林群落和主要红树植物功能性状，并为探索全球变暖下生物群落功能过程提供参考，同时为预测海岸带红树林如何应对未来气候变化提供科学依据。

谭珂博士获海南省青年基金资助《翅果对植物长距离扩散的作用机制——以环南海区域分布的风筝果(*H. benghalensis*)为例》(5 万)。该项目将对海南省植物多样性与东南亚植物迁移提供新的视角，有望显著提升“金虎尾路线”在生物地理学领域的指导价值。

张哲博士获得获海南省青年基金资助《海南三种同域分布蝴蝶兰属植物的生殖隔离与适应性进化》(5 万元)。该项目为保护三种蝴蝶兰的种质资源提供本底资料和理论依据，也为海南热带雨林国家公园内兰科物种的保护提供新的思路。

➢ 《海南热带雨林国家公园高速公路穿越段的环境监测与生态恢复技术》项目进展顺利

李百炼和任明迅联合主持的海南省院士创新平台科研专项《海南热带雨林国家公园高速公路穿越段的环境监测与生态恢复技术》进展顺利。

该项目执行期 2020-2023 年，经费 50 万元。项目组基于对海南热带雨林国家公园高速公路穿越段为期 2 年的实地考察和长期的环境监测，以及 2000、2010、2019 年遥感数据解析发现，道路目前对国家公园景观的影响较小，但由于道路存在较明显的环境影响累加效应如多年的道路径流、汽车尾气等可能改变道路两侧的微生境，影响到生物迁移和生态过程，建议加强大型道路如高速公路道路径流

的汇流与净化、道路两侧生态廊道、长期环境监测等方面的研究。

➢ 积极参与海南大学“一院一校”国际化办学计划

依托工作基地/研究中心的国际合作研究基础，海南大学生态与环境学院成功获批 2 项海南大学“一院一校”国际化办学计划，分别是：战略合作伙伴项目(新加坡国立大学)、高端外专引智项目(新加坡南洋理工大学)。这使得我院和生态学科成为我校唯一同时获批两项“一院一校”项目的学院和学科。

2021 年 12 月邀请了新加坡科学院邹乐明院士向海南大学生态与环境学院研究生讲授了《海洋生态学》课程。签订了合作协议。

此外，工作基地/研究中心和菲律宾大学筹建的环南海陆域生物多样性研究中心也进入了学校的国际联合科研平台培养项目库，将经过 2 年的合作研究与联合培养学生，积极申报中国科协“一带一路”国际科技组织合作平台建设项目。

➢ 海南热带雨林国家公园综合科考与迎评报告顺利完成

骨干成员杨小波教授主持、任明迅教授等多位成员参与的海南省林业局专项《海南热带雨林国家公园综合科考(植物部分)》项目(总经费 298 万元)，通过近 1 年的数据整理、野外补充调查及系统研究，于 2020 年 12 月 21 日顺利通过结题。该项目对国家公园内的主要生态系统类型、珍稀保护植物、古树名木、特有植物、海南长臂猿食源植物、野生观赏植物、有害及入侵植物和农业生物多样性等重要植物类群开展了分类调查与综合研究。这项工作摸清了海南热带雨林国家公园生态系统、植被类型及各类植物资源本底，对进一步开展该热带雨林国家公园生物多样性保护与生态功能优化与提升具有积极的促进作用。

参与了海南热带雨林国家公园自然禀赋及试点成效评估的调研工作，承担了

成效评估及生态系统代表性与面积适宜性子项目(HD-KYH-2020125-2)、结构完整性和功能完整性子项目(HD-KYH-2020125-8)的编写工作，在短短 1 个月的时间，收集了近 100 多篇文献、整理了大量第一手资料，撰写了近 10 万字的文字材料，保障了海南热带雨林国家公园迎评工作的顺利通过。

➢ 《热带生物学报》“中国国家公园”专辑进展顺利

工作基地/研究中心负责人任明迅教授担任专辑召集人，在海南大学主办的《热带生物学报》上组织了“中国国家公园”专辑。目前已召集 6 篇稿件，覆盖 5 个国家公园中的 4 个，内容包括了国家公园体制机制与社区共管、生物多样性与生态修复等领域，具有很好的代表性，有望显著提升海南热带雨林国家公园和《热带生物学报》的影响力。专辑预计在 2022 年 3 月正式刊出。


《热带生物学报》编辑部

《热带生物学报》"中国国家公园"专辑征稿启事

尊敬的各位专家：

《热带生物学报》是海南大学主办的中国科技核心期刊，主要刊登热带生物学及相关领域原创性研究、综述、数据与资料等论文。

建设国家公园、建立以国家公园为主体的自然保护地体系，是贯彻习近平生态文明思想的重大举措，对深化生物学与生态学研究及推进生物多样性与生物资源保护实践具有积极的意义。2018 年至今，我国已开展了三江源等 10 个国家公园试点，各地国家公园相关政策、体制机制、生物资源与生态价值、保护实践等取得了长足的进展。鉴于此，《热带生物学报》特组织“中国国家公园”专辑，报道和交流国家公园相关研究成果，促进中国国家公园的建设及生物多样性保育实践，欢迎大家赐稿！

投稿网址：https://rdswxb.hainanu.edu.cn

投稿截止日期：2021 年 11 月 30 日

审稿方式：快速评审绿色通道（终审意见在投稿日期后 2 个月内）

稿件主题：中国国家公园管理体制机制、生物多样性及生态服务功能等

稿件类型：实验研究论文、研究型综述

专辑联系人：任明迅

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主编：罗

《热带生物学报》编辑部

2021 年 月 日

中国核心期刊《热带生物学报》
征稿启事

尊敬的各位专家：

2018年至今，我国各地国家公园相关政策、体制机制、生物资源与生态价值、保护实践等取得了长足的进展。《热带生物学报》特组织“中国国家公园”专辑，报道和交流国家公园相关研究成果，促进中国国家公园的建设及生物多样性保育实践。

欢迎大家赐稿！

稿件主题：中国国家公园管理体制机制、生物多样性及生态服务功能等
稿件类型：实验研究论文、研究型综述
审稿方式：快速评审绿色通道（终审意见在投稿日期后2个月内）

投稿网址：https://rdswxb.hainanu.edu.cn
投稿截止日期：2021年11月30日
专辑联系人：任明迅
邮箱：renmx@hainanu.edu.cn　　联系电话：8976552618

《热带生物学报》“中国国家公园”专辑征稿启事

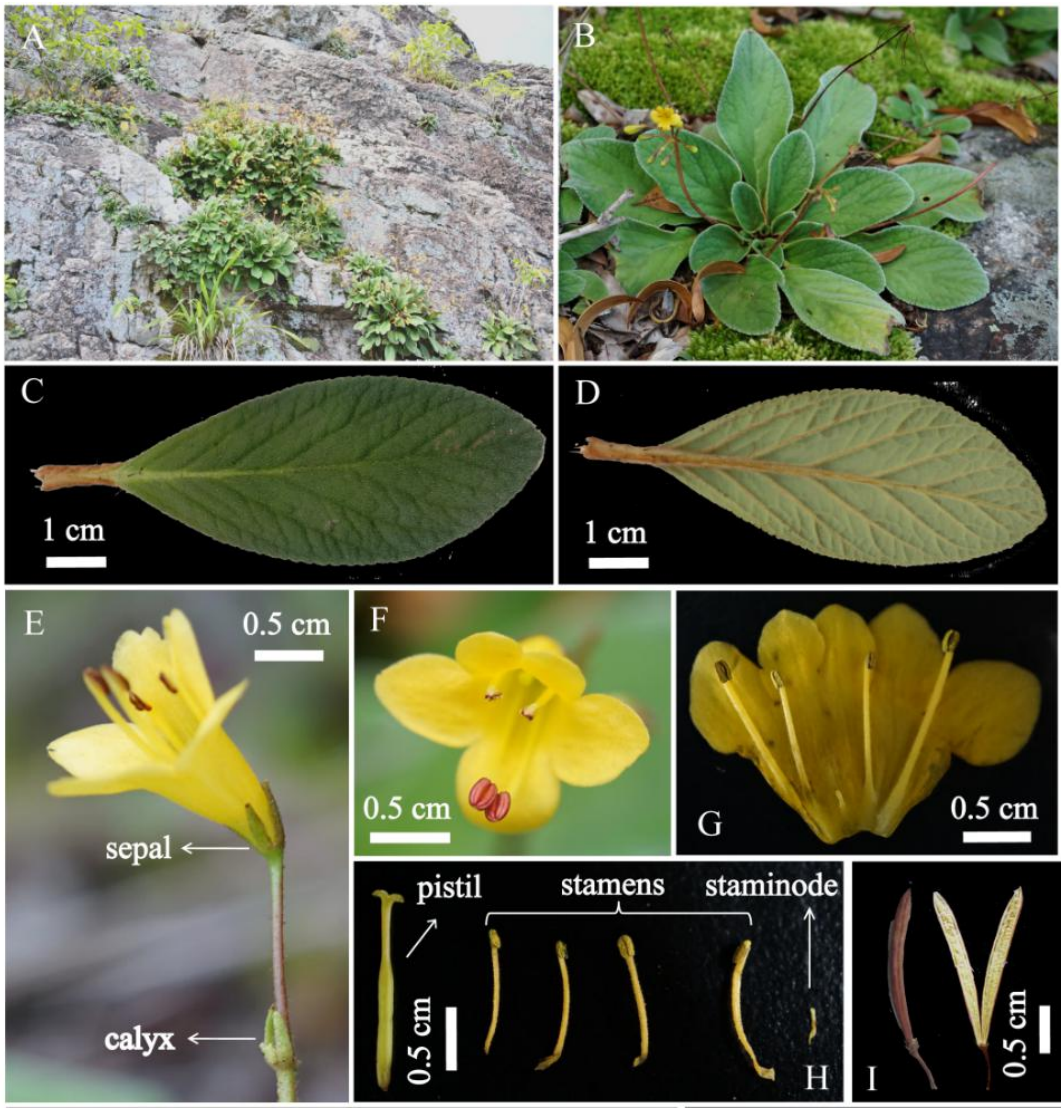
四、代表性成果

➢ 研究方向一：生物多样性与生态保育

工作基地/研究中心骨干成员任明迅教授、毛伟教授、陈权博士等参与了海南省重大科技计划《红树林资源保育与生态恢复关键技术研究与应用示范》项目(2020-2023 年，总经费 1000 万；工作基地可支配经费 70 万元)。目前开展了东寨港红树林的群落结构与主要植物功能性状研究，探究了半红树植物黄槿的遗传多样性及根系微生物，弄清了滨海盐场的濒危红树植物与耐盐微生物的来源，对进一步开展濒危红树植物评估和红树林退化机理研究等具有积极作用。

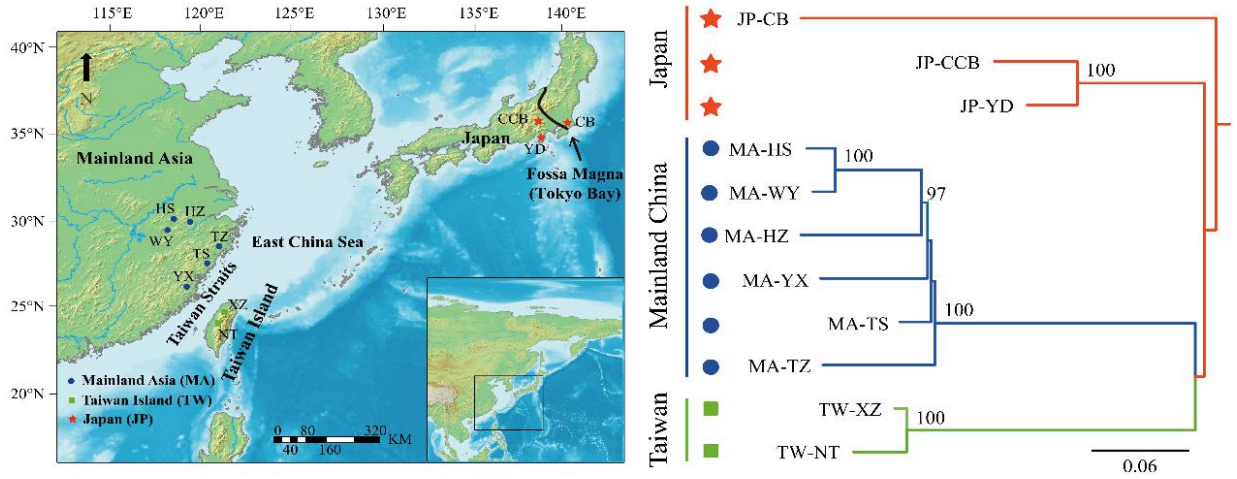
在对环南海区域苦苣苔科线柱苣苔属、马铃苣苔属的野外调查研究基础上，结合形态学与分子生物学证据，发现海南岛一个特有的马铃苣苔属(*Oreocharis*)新种：海南马铃苣苔(*Oreocharis hainanensis* S.J.Ling & M.X.Ren)。该种生长在海南岛低海拔裸露石灰岩、耐旱耐贫瘠，是苦苣苔科马铃苣苔属在此类生境生长的唯一物种；花冠亮黄色，花冠筒钟状，具有较高的园艺引种价值，是海南岛热带雨林原真性和完整性的一个有力证据(Phytotaxa，已接受发表)。

利用核基因 ITS1、ITS2 和叶绿体基因 trnL-trnF 重建了广义马铃苣苔属主要物种的分子系统关系，将其分为两个支系，一个支系主要分布于中国西南地区，以黄色花冠、雄蕊 4 枚为主；另一个支系则集中分布于中国南部与东南部区域，以紫色花冠为主，并出现了雄蕊 2 枚的特化类群。通过花部特征和地理分布特点证实了广义马铃苣苔属花冠发生了两侧对称向辐射对称的演化(植物科学学报，2021, 39(4): 379-388)。



海南热带雨林国家公园特有的海南马铃苣苔（新种）

通过对间断分布在中国大陆、台湾岛和日本的孑遗植物苦苣苔进行简化基因组测序(ddRAD)研究发现，中国大陆、台湾岛和日本三个区域种群遗传分化极大，基因流有限，隔离作用占主导；中国大陆和日本支系起源于共同祖先，分化于 11.85 Ma，台湾支系于 4.05 Ma 从中国大陆分化而来，三个支系都经历了不同时间短的种群收缩与扩张。通过构建苦苣苔整个分布区域 SDM 模型发现，台湾岛和日本区域在末次盛冰期经历了明显的扩张，中国大陆和台湾岛区域在当前时期经历了明显的收缩，台湾岛适宜分布区域在未来时期会扩张。



中国大陆、台湾岛和日本三个区域的苦苣苔遗传关系

迄今为止，从环南海区域采集的战略植物资源(热带作物野生近缘种、药用植物、油料植物、观赏植物、亚洲热带植被建群种等)共有苦苣苔科、金虎尾科、木棉科、梅花草属、秋海棠科、兰科、唇形科、旋花科、风毛菊属以及苔藓植物腊叶标本约近 2000 份、DNA 种质资源近 3000 份。

➢ 研究方向二：环南海区域生态安全

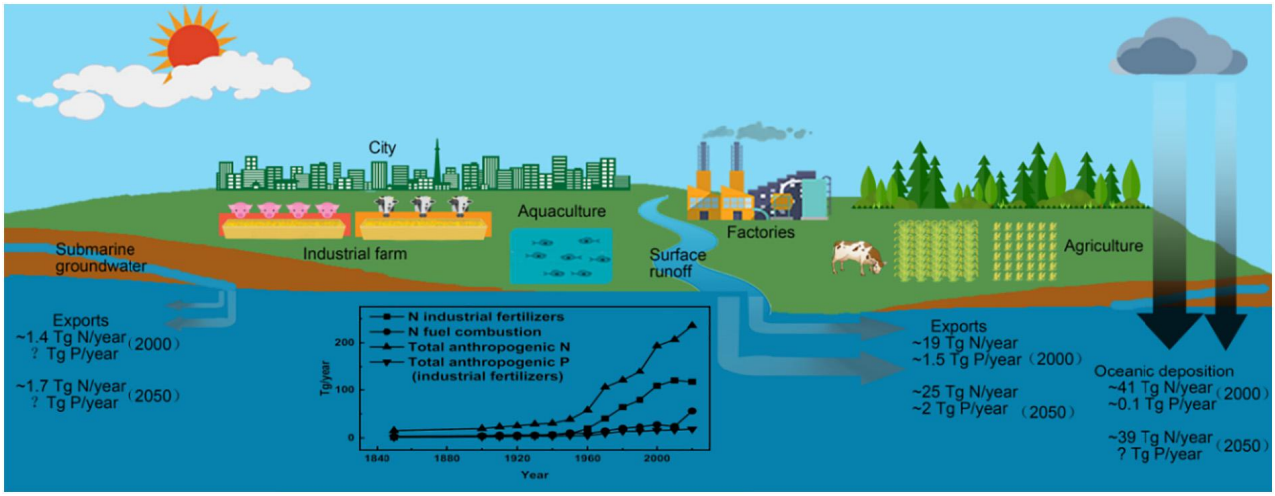
参与承办了 2021 年 7 月 7-9 日举行的海南省生态环境系统领导干部政治能力提升暨党的十九届五中全会精神专题培训班，并参加了 2021 年 12 月五指山市环境保护和生态核心功能区建设培训班的授课等。

开展了与中国科学院水生生物研究所的联合实验室筹建工作，加强海南大学生态与环境学院、中国科学院水生生物所在海南省水域生物资源调查与保护、水域生态修复、生态系统服务功能优化与提升等领域方面的合作，积极服务海南生态文明和自由贸易港建设，保证海南水域生态安全。

工作基地/研究中心首席海外智力李百炼多次带队，考察了海南昌化江、文昌河、罗带河、大广坝水库、高坡岭水库等重要水系，与当地政府商讨了水污染治

理与环境整治方案，提出从农村产业转型、美丽乡村建设等方面思考，结合现代生态学工程技术与手段，合理规划海南各大水系及其周边水域，真正贯彻落实“绿水青山就是金山银山”发展理念。

引进了新加坡科学院邹乐明院士建立了院士工作站，与赵洪伟教授一起开展从海陆统筹污染防控与生态修复方向开展珊瑚礁与海草床的保护与修复研究。发现适量的铵供应对珊瑚发育最有利，并确认了通过减少近海硝酸盐输入和适当管理鱼类种群来维持珊瑚礁生态系统的健康。研究成果发表在环境科学与生态学领域 Top 期刊《Science of the Total Environment》(影响因子 7.96)。



全球海洋养分污染的过去和未来状况

➢ 研究方向三：传统生态文化与当代生态文明建设

为贯彻落实习近平总书记“希望广大科技工作者以提高全民科学素质为己任，把普及科学知识、弘扬科学精神、传播科学思想、倡导科学方法作为义不容辞的责任”的指示，工作基地/研究中心任明迅教授主动带队，带领谭珂博士、向文倩博士研究生、杨鑫硕士研究生等积极参与海南岛各项科普活动及社区志愿者活动，深入浅出地向大众科普海南传承千年的洋浦盐田晒盐技艺、木棉-稻田耕作体系，

以及滨海红树林生态与保护，提高海南大众的科学知识和民族自信。将科研成果用通俗易懂的方式走进大众，积极推动形成讲科学、爱科学、学科学、用科学的良好氛围。

任明迅教授带队联合无字教育公司在海口白沙门公园举办木棉文化科普

1. 制作海南热带雨林国家公园科普系列视频

工作基地/研究中心张哲博士后(合作导师：任明迅教授)在海南省林业厅智慧雨林中心的资助下，牵头组织了海南热带雨林国家公园的科普系列视频。任明迅教授与凌少军博士陪同摄制组跋山涉水，深入俄贤岭实地拍摄了刚发现的海南岛新种——海南马铃苣苔。

谭珂博士参与录制了被子植物翅果的类型与演化历史的科普视频、向文倩博士研究生参与录制了木棉生态价值和木棉文化的科普视频。

这些科普系列视频是在海南省林业局（海南热带雨林国家公园管理局）、智慧雨林中心资助和指导下完成的宣传海南热带雨林国家公园的官方素材，具有较高的学术价值和人文价值。这些视频雅俗共赏、寓教于乐、文理兼容，通过网络传播，快速高效地宣传了海南热带雨林国家公园的建设成效以及海南本土优秀生态文化，提升了海南国家公园和生态文明建设形象。

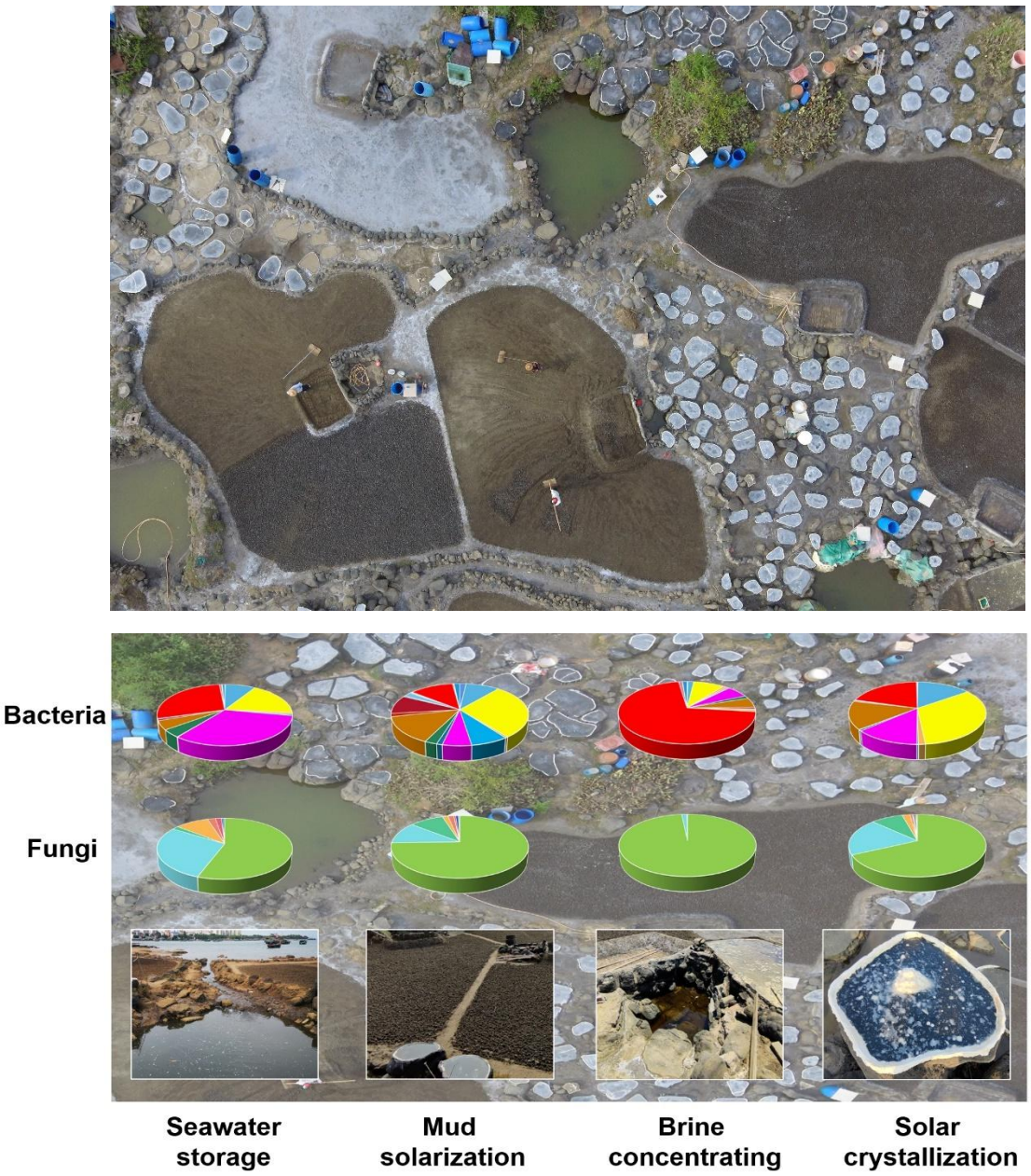
海南热带雨林国家公园科普视频拍摄

2. 揭示洋浦古盐田的生态学基础和耐盐微生物种质资源

工作基地/研究中心聚焦儋州洋浦千年古盐田（2008 年入选国家级非物质文化遗产），开展微生物宏基因组学、特异微生物类群及生态过程等方面的研究，发现古盐田长期的高盐环境和火山岩石槽的暴晒过程选择并保留了特殊的耐盐微生物，决定了这里所产食盐具有极高的纯度和特别风味。

这一研究从现代科技角度，初步解析了洋浦盐田晒盐技艺的生物多样性基础与生态学原理，确定了关键微生物类群及其功能，对筛选耐盐微生物种质资源、

增强海南民族自信与文化自信等具有积极意义。这一成果已在线发表在环境科学与生态学领域 Top 期刊《Science of the Total Environment》(影响因子 7.96)。



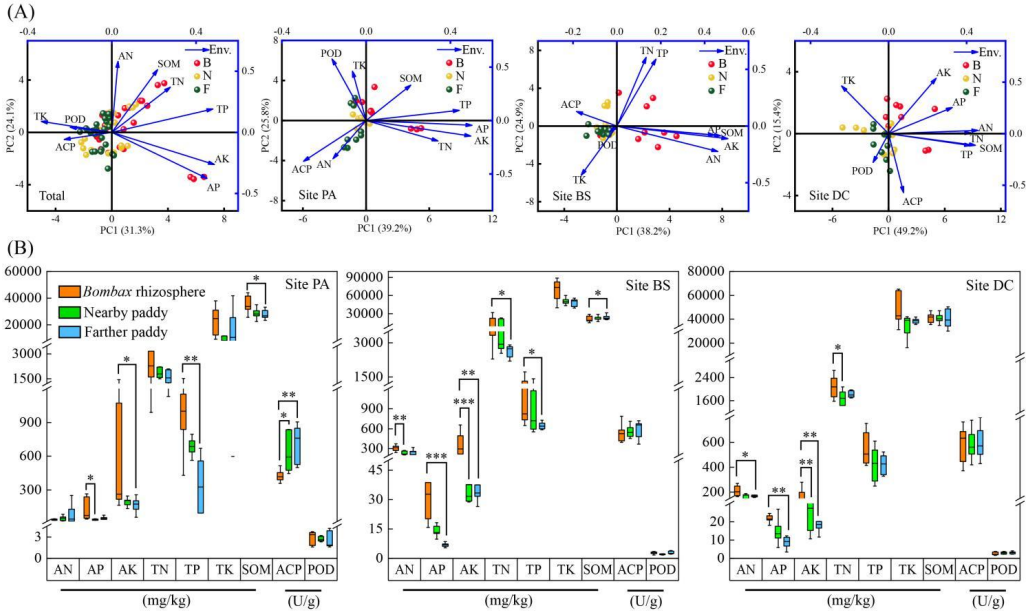
海南儋州千年古盐田的微生物群落动态变化

3. 木棉-稻田耕作体系的资源循环过程与生态学基础

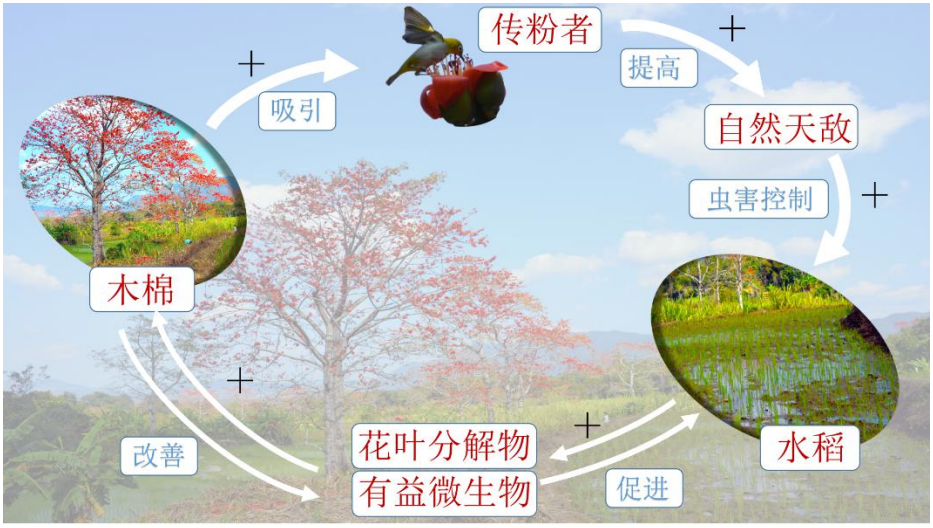
工作基地还初步研究了亚洲热带地区特有的木棉-稻田耕作体系的生物学基础与生态学原理，首次系统提出了木棉-稻田耕作体系的循环方式：海南传统耕

作方式在稻田间保留和栽种大量木棉，可能利用了木棉春季开花吸引鸟和天敌昆虫，降低了春季插秧期的田间害虫；凋谢的木棉花及花蜜大量掉落在尚处于秧苗期的稻田中，在热带高温条件下快速分解，形成的养分以及木棉花蜜带来的消化链球菌属、硝酸盐还原细菌等有益微生物，提高了稻田养分和资源循环利用程度。

木棉根系还可以分泌或聚集有益微生物，进而改善田间土壤微生物环境，从而提高水稻产量等。这些研究结果可为后续建议海南省昌江县木棉-稻田耕作体系申报中国农业文化遗产奠定基础。相关结果正在陆续发表中。



木棉通过花的分解和根系分泌物提高了稻田的土壤营养水平

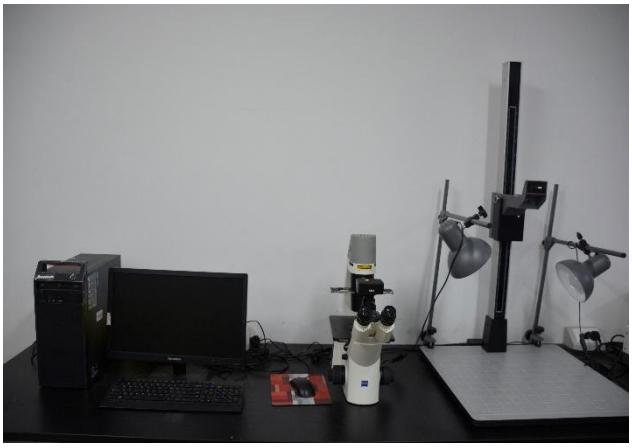


木棉-稻田耕作体系的资源循环过程与生态学关系

五、平台建设

1. 分子生态学实验室


2. 植物形态分析实验室

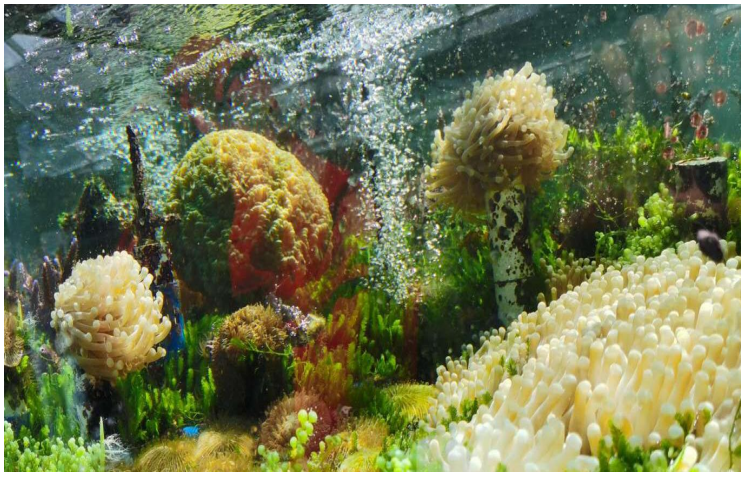



3. 植物化学分析室


4. 陆基珊瑚养殖基地

万宁市山根镇的繁育区与养殖区(30 亩)

珊瑚幼体生长情况



珊瑚排卵与受精生长

5. 资源收集与保存

- 植物昆虫标本库


- 真菌标本库

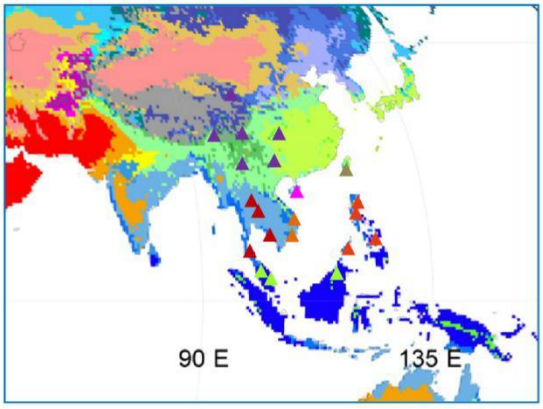

- 引种资源圃


➢ 野外重点采集与研究区域

▲ 广西和云南(横断山区)

▲ 台湾(恒春半岛、兰屿)

▲ 海南(霸王岭、尖峰岭)



▲ 菲律宾(吕宋岛、巴拉旺岛)

▲ 泰国(清迈、清莱)

▲ 越南(芽庄、巴拿山)

▲ 泰国(巴蜀、芭提雅)

▲ 马来西亚(沙巴、森美兰)

马来西亚(Kaki Bukit Tabur)

肯尼亚(Kilifi)

菲律宾(Arayat)

六、合作与交流

➢ 2021 年 9 月 15 日，中国科协王守东书记一行来访海南大学，调研我工作基地。海南大学符宣国书记、曹宪忠副校长、科发院邹勇华院长、国际合作与交流处杨志昕处长等参加调研。

➢ 2021 年 3 月 15 日，世界自然保护联盟（IUCN）主席、原教育部副部长章新胜先生在海南国家公园研究院汤炎非执行院长陪同下来访，肯定了我工作基地/研究中心在珊瑚礁与海洋生态保护方面的研究进展。

➢ 2021 年 5 月 21-22 日，中国工程院院士、国际宇航科学院院士、生态环境部卫星环境应用中心王桥院士等人应邀来访，对海南省与海南大学生态环境遥感技术的创新与发展提出了宝贵建议。

➢ 2021 年 12 月，参加了中国林学会热带雨林分会成立大会暨海南热带雨林保护发展研讨会，杨小波、任明迅、张莉娜等当选为热带雨林分会常务委员。

➢ 2021 年 10 月 15-17 日，任明迅等参加了在华东师范大学举办的第二届植物生态学前沿论坛暨 Journal of Plant Ecology 2021 编委会，开展了学术交流与人才引进。

➢ 2021 年 12 月，参加了 2021 年中国(海南)国际热带农产品冬季交易会，海南大学展区展出了我工作基地/研究中心的情况介绍和研究成果。

➢ 2021 年 5 月 18 日，华东师范大学生态与环境科学学院陈小勇院长、中国科学院华南植物园罗世孝研究员来访，就生态学专业与学科建设经验交流展开座谈。

➢ 2021 年 12 月 30 日，任明迅作为子课题负责人参加海南省重大科技计划“红树林资源保育与生态恢复关键技术研究与应用示范”项目中期工作会议，主要承担东寨港红树林群落结构、濒危红树遗传多样性及根系微生物研究。

➢ 2022 年 1 月 4 日，徐诗涛、任明迅、王文娟等参加了海南省重大科技计划项目《木棉新优品种选育及产业化关键技术研究与示范》工作启动会，将主要承担木棉栽培生态与木棉文化旅游资源研究。

➢ 2021 年 11 月 10-12 日，华东师范大学生态与环境科学学院院长陈小勇教授应邀为 2019 级生态学本科生上了《分子生态学》课程部分课程，取得了良好的效果。

➢ 2021 年 11 月 11 日，华东师范大学生态与环境学院院长陈小勇教授应邀在儋州校区作了“薛荔-传粉小蜂互惠关系分子机制”学术报告。任明迅、唐亮、张莉娜等老师及 100 余名学生参加。

➢ 2021 年 1 月 25 日，主办了海南省自然教育与生态文明建设线上研讨会，北京大学刘华杰、首都师范大学顾有容、江西婺源林奈实验室刘芝龙等参会做了报告。与会专家针对海南自然教育、生态文明建设等提出了诸多宝贵意见。

➢ 2021 年 7 月 9 日，李百炼、任明迅应邀为《2021 年海南省生态环境系统领导干部政治能力提升暨党的十九届五中全会精神专题培训班》授课。

➢ 2021 年 11 月 2-5 日，2021 年全国热带作物学术年会在海南澄迈召开。任明迅教授受邀做了《木棉-稻田耕作体系的生态学基础》报告，并担任分会主持人，与中国热带农业科学院等专家讨论了合作研究意向。

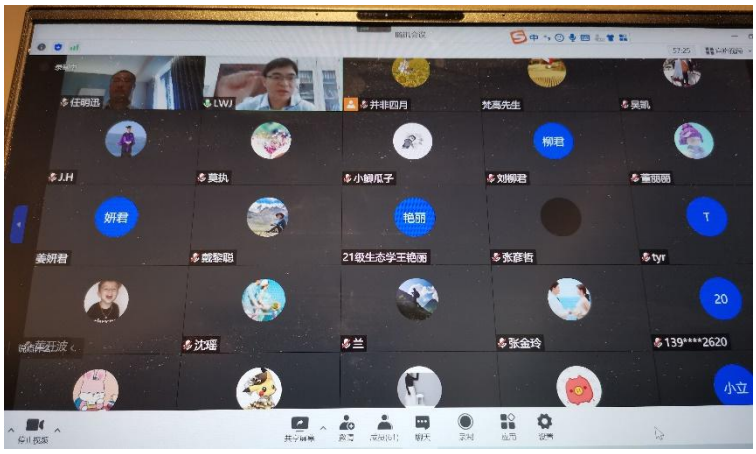
➢ 2021 年 4 月 29 日，举办了传统生态文化及其现代传承系列讲座的第一讲《中国的木棉文化及其现代传承》，介绍了中国木棉文化的概况和演变，特别是工作基地在木棉-稻田耕作体系方面的研究成果。线上参会人员近 200 人。

➢ 2021 年 6 月 18 日，海南省科协党组成员、副主席林明才，省科协国际部朱玲部长一行四人对我工作基地/研究中心进行考察调研。

➢ 2021 年 5 月 24 日，联合国教科文组织地下水主席、南非西开普敦大学地球科学系的徐永新教授受叶长青副教授的邀请来访，作了《中非视角下的中国水资源与生态环境的保护》的专题讲座。

➢ 2021 年 5 月 20 日，中国科学院水生生物所徐军研究员、唐辉远研究员来访。双方讨论了共建海南生态联合实验室合作协议，双方合作撰写并提交了关于加强海南岛水资源保护与利用的政协提案。

➢ 2021 年 5 月 6 日，天津大学环境科学与学院邱顺添院长、马文超教授来访交流，并落实了马文超教授依托我校申报青年长江学者的事宜。2021 年底成功获批。



➢ 2021 年 10 月 17 日，北京师范大学生命科学学院廖万金教授在线为我校青年教师讲解了国家自然科学基金的申报经验以及申报书撰写技巧。我校 60 多位教师参加。

➢ 2021 年 12 月 7 日，任明迅参加了由中国教育国际交流研修学院主办，海南大学、中国教育在线联合承办的“中外合作办学专题研修班”。

➢ 2021 年 9 月 1 日，任明迅和中国科学院水生生物研究所专家调研了万宁小海生态修复工程，与万宁市人大主任吴明阳、万宁生态环境局吴毓波局长等座谈，对小海流域治理提出了合作意向。

➢ 2021 年 9 月 6 日，任明迅应邀参加了 2021 年可持续发展大数据国际论坛。该论坛同时成立了全球首个服务联合国 2030 年可持续发展议程的国际科研机构“可持续发展大数据国际研究中心”。

➢ 2021 年 11 月 28 日，王旭、任明迅、黄青等陪同中国工程院贺泓院士、郝吉明院士、曲久辉院士、任洪强院士以及海南省环境监测中心谢东海高级工程师等考察了五指山热带雨林。

➢ 2021 年 5 月 15 日，中国农业科学院深圳农业基因组研究所的王丽研究员应邀在《两院学坛》作了《当梦想照进现实——一个非典型科学家的斜杠人生》的讲座。

➢ 2021 年 6 月 5 日，海南师范大学生命科学学院王旭初教授应邀参加海南大学《两院学坛》，任明迅、唐亮、张莉娜等老师以及儋州校区近200名学生参加了整个活动。

➢ 2021 年 6 月 28 日，任明迅和赵洪伟主持了我校与荷兰瓦赫宁根大学联合召开的“生态环境类研究与研究生培养”线上研讨会，商讨了两校在生态环境类研究生联合培养等方面的合作方式。

➢ 2021 年 7 月 8 -10 日，李百炼主持了中国工程科技发展战略海南研究院咨询研究项目的进展汇报会，任明迅汇报了项目进展情况，研究院李丽主任和骆凯老师参加了项目汇报会。

➢ 2021 年 7 月 11 日，受文昌市水务局邀请，李百炼、叶长青、谭珂等考察了文昌河及其流域污染治理与环境整治展开考察、调研。并与文昌水务局、中国科学院重庆生态修复与生态工程中心专家们研讨。

➢ 2021 年 7 月 12 日，李百炼、任明迅参加了海南大学“生态文明”优秀大学生夏令营。李百炼向全体营员介绍了生态与环学科世界前沿研究进展情况，鼓励营员们致力于生态与环境学科研究学习。

➢ 2021 年 7 月 13 日，李百炼在任明迅等人的陪同下，考察了海南热带雨林国家公园的鹦哥岭地区、海南中线高速公路跨越昌化江路段的环境现状、俄贤岭-大广坝水库水质与水源涵养能力等。

➢ 2021 年 7 月 15 日，李百炼应邀为生态与环境学院、南海海洋资源利用国家重点实验室师生们作了《以生态技术的创新引领水环境系统治理》的学术报告。

➢ 2021 年 7 月 16-17 日，受东方市生态环境局王兴壮局长和水务局王斌局长的邀请，李百炼、任明迅等调研指导了东方市罗带河、高坡岭水库等地的水系污染防控及流域综合整治工作。

➢ 2021 年 8 月 10 日，任明迅教授应邀访问了重庆市药用植物研究所，并开展了金佛山野生植物资源调查，讨论并落实合作开展梅花草属植物生态与保育研究相关事宜。

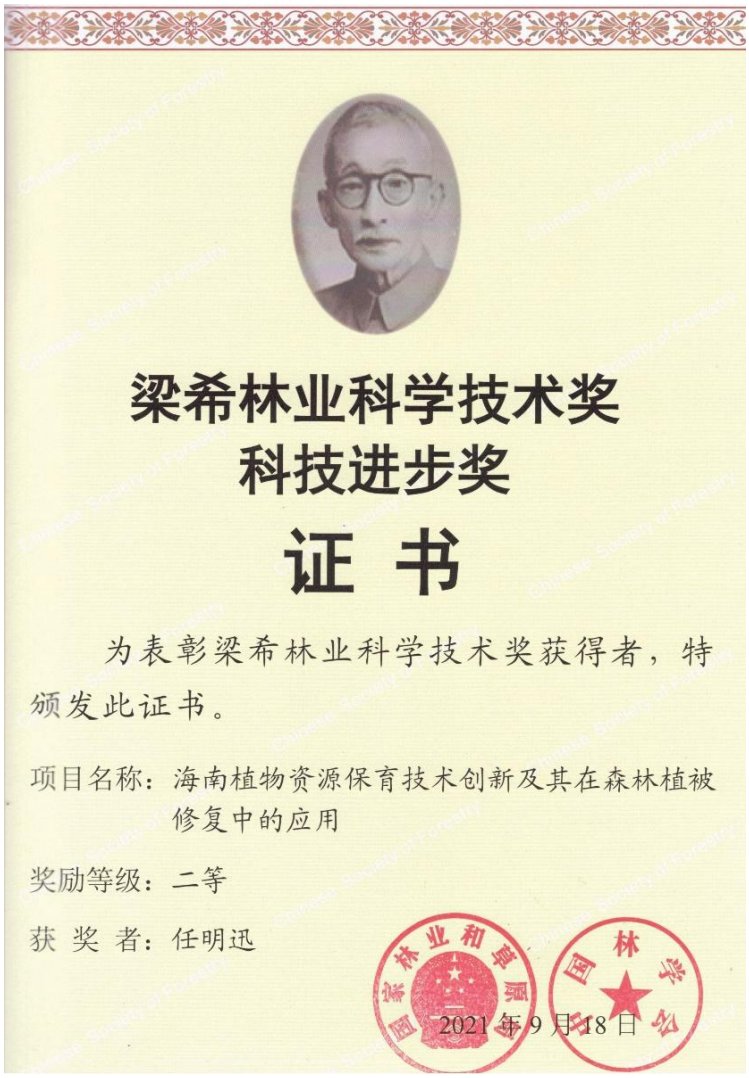
➢ 2021 年 8 月 31 日，中国科学院水生生物所唐辉远研究员、徐军研究员、方涛研究员以及海南乾都公司李峻峰总经理来访，双方达成了就淡水生态及陆海统筹环境治理方面开展合作的意向。

➢ 2021 年 9 月 1 日，任明迅教授陪同中国科学院水生生物研究所唐辉远研究员、方涛研究员、海南乾都公司李峻峰总经理考察万宁小海生态修复工程。并与万宁市人大常委会吴明阳主任、生态环境局吴毓波局长和林斯健副局长等人座谈。

➢ 2021 年 9 月 16 日，江苏省中科院植物研究所植物染研究团队、文化旅游部全国公共文化发展中心、北京乡村文化保护与发展志愿者协会等专家来访，双方讨论了联合开展生态文化和自然教育合作意向。

➢ 2021 年 9 月 25 日，任明迅、王文娟、向文倩等应邀考察了位于海南澄迈的中国东方文化研究会自然与户外教育文化专业基地，落实了后续联合开展自然教育、大学生实习基地等事宜。

➢ 2021 年 10 月底，海南大学生态学科在海南大学儋州校区举行学科建设研讨会。研讨会邀请了中国热科院黄乔乔研究员、海南师范大学王旭初教授、海大林学院周淑荣教授等专家参加指导了生态学学科发展规划等。



➢ 2021 年 9 月 18 日，杨小波、任明迅等作为“海南植物资源保育技术创新及其在森林植被修复中的应用”的主要完成人，获得了国家林草局和中国林学会颁发的第十二届梁希林业科学技术奖科技进步二等奖。这一奖项充分肯定了我中心科研工作者在海南植物资源发掘、保育基础理论研究，以及植被生态修复与珍稀濒危物种人工繁育及野外种群恢复等实践工作方面做出的成绩。

➢ 2021 年 12 月 9 日，任明迅受邀参加了五指山市环境保护和生态核心功能区建设培训班的授课。市政府党组成员高亮、市生态环境局陈仲平局长、市党校郑媚月校长等参加了培训班。

➢ 主办或参与主办的学术会议

会议名称	会议类别	会议时间	参加人数
海南省自然教育与生态文明建设研讨会	全国会议(线上)	2021 年 1 月	120
环南海区域生物多样性与生态文化学术交流会	国际会议(线上)	2021 年 4 月	80
环境污染综合防治高端论坛	全国会议(海南陵水)	2021 年 11 月	40
中国林学会热带雨林分会成立大会暨海南热带雨林保护发展研讨会	全国会议(海南海口)	2021 年 12 月	200(线上+线下)

➢ 学术报告情况

报告名称	报告人	会议名称	地点	时间
The impact of management policies on the carbon sequestration potential of forests and coastal ecosystems in Hainan Province	毛伟	海岸带生态系统与全球变化国际研讨会	厦门	2021.04
中国的木棉文化及现代传承	向文倩	环南海区域生物多样性与生态文化学术交流会	线上	2021.04
Ecological risk assessment of roads in Hainan Tropical Rainforest National Park	吴挺勋	世界著名科学家武汉论坛之生物多样性保护与国家公园建设国际研讨会	武汉	2021.10
海南省濒危红树植物濒危机制及野外种群恢复应用示范	任明迅	海南省重大科技计划项目中期汇报暨2022年工作计划会议	儋州	2021.12
国家自然科学基金申报的战略与战术	任明迅	青海民族大学昆仑英才千人计划学术会	线上	2021.11
可降解地膜对农田生态系统的影响	刘毓海	全国热带作物学术年	澄迈	2021.11

		会		
木棉-稻田耕作体系的生态学基础	任明迅	全国热带作物学术年会	澄迈	2021.11

➢ 参加学术会议情况

会议名称	会议类别	会议时间	参会人员
第二届植物生态学前沿论坛暨 JPE2021 编委会议	全国会议 (上海)	2021.10	任明迅、胡中民、刘文杰
“融合创新、加快一流课程与教材建设”研讨会	全国会议 (广州)	2021.05	张莉娜
2021 年可持续发展大数据国际论坛	全国会议 (线上)	2021.09	任明迅、章杰、张翔
北京生物多样性科学研究会 2020 年学术年会	全国会议 (线上)	2021.01	姚小兰、凌少军
CForBio 讲坛第九讲	国际会议 (线上)	2021.02	谭珂、文静
第十七届公众科学日“以自然之道保护生物多样性——带你玩转国家公园	全国会议 (线上)	2021.05	姚小兰
第四届全国生物多样性监测研讨会	全国会议 (线上)	2021.09	张莉娜
第七届全国生物多样性信息学研讨会	全国会议 (线上)	2021.09	张莉娜
第二十届中国生态学大会—热带雨林生物多样性及国家公园分会	全国会议 (线上)	2021.10	张莉娜
第二十届中国生态学大会	全国会议 (线上)	2021.10	姚小兰、向文倩

深圳市南亚热带植物多样性重点实验室暨深圳市中国科学院仙湖植物园第七届学术交流活动	全国会议(线上)	2021.11	张莉娜
自然与文化遗产保护论坛	全国会议(线上)	2021.11	向文倩、魏雅丽
第三届生物多样性前沿论坛暨《生物多样性》第六届编委会议	全国会议(线上)	2021.12	姚小兰

七、社会兼职

姓名	学术组织或科研机构	职务	任职时间
杨小波	国际生物多样性计划中国委员会	委员	2012-
	海南省生态学学会	理事长	2010-
	中国生态学会	常务理事	2012-
	海南省植物学会	副理事长	2011-
	海南省环境学会	副理事长	2008-
	海南省环境教育协会	常务副会长	2008-
	中国林学会热带雨林分会	常务委员	2021-
任明迅	《Collectanea Botanica》	编委	2014-
	《热带生物学报》	编委	2020-
	中国科协海智计划海南(海南大学)工作基地	负责人	2020-
	热带特色林木花卉遗传与种质创新教育部重点实验室	副主任	2019-
	海南省热带生态环境修复工程研究中心	主任	2019-
	海南省李百炼院士工作站	负责人	2018-
	海南省林学会	副秘书长	2018-
	海南省植物学会	理事	2016-
	中国林学会热带雨林分会	常务委员	2021-
张莉娜	中国植物学会苔藓专业委员会	委员	2010-
	中国野生植物保护协会苔藓植物专业委员会	委员	2020-2025

赵洪伟	中国太平洋学会珊瑚礁分会	会员	2018-
	海南省蓝丝带海洋环境保护协会	共同发起人	2018-
	中国未来海洋联盟	成员	2014-
	海南省碳达峰碳中和研究会	理事	2021-
	海南省邹乐明院士创新团队	平台负责人	2020-
	海南省热带生态环境修复工程研究中心	副主任	2019-
黄青	巴塞尔公约亚太区域中心	化学品和废物环境管理智库专家	2021-2026
	《亚热带植物科学》	编委	2020-
	海南省贺泓院士工作站	负责人	2020-
毛伟	《中国沙漠》	青年编委	2021-
	《热带生物学报》	编委	2020-
刘毓海	《中国化学快报》	编委	2019-

八、在研项目

国家自然科学基金：面上项目

- 环南海区域线柱苣苔属物种分化历史与长距离扩散格局(负责人：任明迅，执行期：2019.01－2022.12，总经费：60 万)

国家自然科学基金：地区科学基金

- 海南热带山地雨林苔藓植物群落多样性及其维持机制(负责人：张莉娜，执行期：2022.1－2025.12，35 万)
- 龙脑香科青梅属不同果实类型传播与适应的生态遗传学研究(负责人：唐亮，执行期：2021.1－2024.12，35 万)。
- 尖峰岭热带山地雨林叶内生与附生真菌-细菌的多层互作网络及其驱动因子研究(负责人：丁琼，执行期：2020.01－2023.12，40 万)
- 造礁珊瑚-虫黄藻共生体响应扑草净胁迫的分子机制(负责人：赵洪伟，执行期：2019.01－2022.12，40 万)
- 海南东岸热带滨海森林群落植物多样性恢复与维持对台风的响应(负责人：杨小波，执行期：2018.01－2021.12，总经费：35 万)
- 海南热带山地云雾林苔藓植物多样性与谱系结构(负责人：张莉娜，执行期：2018.01－2021.12，总经费：38 万)

省部级项目

- 军委科技委国防科技创新特区项目保密项目(珊瑚相关研究)(负责人：赵洪伟，执行期：2018.11-2021.03，125 万)
- 海南省林业局专项：海南热带雨林国家公园综合科考(植物部分) (负责人：杨小波，执行期：2020-2021，经费：298 万)
- 海南省林业局专项：海南热带雨林国家公园人工生态系统未来演变方向研究与规划建议(负责人：杨小波，执行期：2021-2024，经费：180 万)
- 海南省林业局专项：海南热带雨林国家公园海南粗榧等林木种质资源调查(负责人：杨小波，执行期：2021-2022，经费：50 万)
- 海南省重大科技专项课题：农业农村面源氮磷对近海生态系统的影响及防控技术研究与示范(负责人：赵洪伟，执行期：2021-2024，经费：180 万)
- 海南省重点研发项目：琼东陆源氮素排放与近海珊瑚礁退化关系历史反演及其调控策略(负

责人：赵洪伟，执行期：2021.09-2023.09，经费：50 万)

- 海南省院士创新平台科研专项：海南热带雨林国家公园告诉公路穿越段的环境监测与生态恢复技术(负责人：李百炼、任明迅，执行期：2020-2023，经费：50 万)
- 海南省院士创新平台科研专项：城市化建设对海南岛珊瑚礁的影响及其可恢复性评价(负责人：赵洪伟，执行期：2021.10-2024.10，经费：50 万)
- 中国工程科技发展战略海南研究院咨询研究专题项目：国家生态文明试验区(海南)背景下热带雨林国家公园体制机制创新研究(负责人：李百炼、任明迅，执行期：2020-2021，经费：58 万)
- 海南省重大科技计划项目子课题：我国热带红树及滨海盐生植物资源保育与应用示范(负责人：任明迅，执行期 2020-2023，可支配经费：70 万)
- 海南省林业局专项：海南热带雨林国家公园自然禀赋及试点成效评估相关报告(结构完整性、功能完整性)(负责人：任明迅，执行期 2020-2021，经费：5 万)
- 海南省贺泓院士工作站专项：(负责人：黄青，执行期：2020.1-2023.12，60 万 (海南省科技厅 30 万、海南大学 30 万)
- 清华大学环境模拟与污染控制国家重点联合实验室开放基金：(负责人：赵洪伟，执行期：2020.06-2022.06，8 万)
- 海南省自然科学基金项目：海南岛低地雨林建群种青梅的种群基因组研究(负责人：唐亮，执行期：2020.01-2022.12，10 万)
- 海南省自然科学基金项目：基于养分回收的种苗基质开发(负责人：黄青，执行期：2019.03-2021.12，10 万)。
- 海南大学校企合作项目：餐厨垃圾的安全处理与利用(负责人：黄青，执行期：2020.08-2023.08，36 万)
- 海南省自然科学基金高层次人才项目：海南东寨港红树林植物群落功能多样性研究(负责人：陈权，执行期：2021.09-2024.06，8 万)
- 海南省自然科学基金项目：基于养分回收的种苗基质开发(负责人：黄青，执行期：2019.03-2021.12，经费 10 万)
- 海南省自然科学基金项目：环境要素时空变异下的海南岛城市园林树种 BVOCs 释放潜力及效应 (负责人：何禾，执行期：2019.03- 2021.12，经费 5 万)
- 海南省自然科学基金项目：海南三种同域分布蝴蝶兰属植物的生殖隔离与适应性进化(负责人：张哲，执行期：2021.09-2024.06，经费 5 万)
- 海南省自然科学基金项目：翅果对植物长距离扩散的作用机制——以环南海区域分布的风筝果(*H. benghalensis*)为例(负责人：谭珂，执行期：2021.09-2024.06，经费 5 万)

- 海南省科学技术协会择优支持类项目：海南省“海智计划”海南大学工作站的建设与运行(负责人：任明迅，执行期：2021.10-2022.10，经费 5 万)
- 海口市秀英区园林管理局:海口市秀英区主城区黄土裸露及生态修复方案专项调研(负责人：任明迅，执行期：2021.06-2021.08，经费：7.8 万)
- 三亚中科遥感研究所：东寨港及五指山保护区历史野外资料及更新(负责人：任明迅，执行期：2020.10-2021.12，经费 5 万)
- 海南大学研究生精品课程建设：生物多样性与保护生物学(负责人：任明迅，执行期：2021.07-2023.06，经费 3 万)

九、主要论著目录

➢ 论文

1. Can intercropping with native trees enhance structural stability in young rubber (*Hevea brasiliensis*) agroforestry system? **European Journal of Agronomy**, 2021,130:126353(责任作者：杨小波、李东海)
2. Microbial community and functional prediction during the processing of salt production in a 1000-year-old marine solar saltern of South China. **Science of The Total Environment**, 2021: 152014. (责任作者：任明迅)
3. Impacts of nitrogen pollution on corals in the context of global climate change and potential strategies to restore coral reefs. **Science of the Total Environment**, 2021, 774: 145017. (责任作者：赵洪伟)
4. Chiral enantiomers of the plant growth regulator paclobutrazol selectively affect community structure and diversity of soil microorganisms. **Science of the Total Environment**, 2021, 797: 148942. (第一作者：赵洪伟)
5. Comparison of three palm peroxidases expressed by Escherichia coli: Uniqueness of African oil palm peroxidase. **Protein Expression and Purification**, 2021, 179: 105806. (责任作者：赵洪伟)
6. Melatonin alleviates salt damage in tomato seedling: A root architecture system, photosynthetic capacity, ion homeostasis, and antioxidant enzymes analysis. **Scientia Horticulturae**, 2021, 285: 110145. (责任作者：任明迅)
7. Protective mechanisms of melatonin against vanadium phytotoxicity in tomato seedlings:

insights into nutritional status, photosynthesis, root architecture system, and antioxidant machinery. **Journal of Plant Growth Regulation**, 2021: 1-17. (责任作者：任明迅)

8. Melatonin Mitigates Nickel Toxicity by Improving Nutrient Uptake Fluxes, Root Architecture System, Photosynthesis, and Antioxidant Potential in Tomato Seedling. **Journal of Soil Science and Plant Nutrition**, 2021: 1-14. (责任作者：任明迅)
9. Annual population dynamics and their influencing factors for an endangered submerged macrophyte (*Ottelia cordata*). **Frontiers in Ecology and Evolution**, 2021: 763. (责任作者：宋希强、任明迅)
10. Spatial factors and plant attributes influence soil fungal community distribution patterns in the lower reaches of the Heihe River Basin, Northwest China. **Environmental Microbiology**, 2021, 23(5): 2499-2508. (第一作者：王文娟)
11. Dissolved organic carbon drives nutrient cycling via microbial community in paddy soil. **Chemosphere**, 2021, 285: 131472. (责任作者：黄青)
12. Microbial-induced concrete corrosion under high-salt conditions: Microbial community composition and environmental multivariate association analysis. **International Biodeterioration & Biodegradation**, 2021, 164: 105287(责任作者：黄青)
13. A comprehensive study of phosphorus removal and recovery with a Fe-loaded sulfoaluminate cement (FSC) adsorbent. **Journal of Water Process Engineering**, 2021, 39: 101744. (责任作者：黄青、胡珊)
14. Recovery of Phosphate and Ammonium from Biogas Slurry as Value-Added Fertilizer by Biochar and Struvite Co-Precipitation. **Sustainability**, 2021, 13(7): 3827. (责任作者：黄青)
15. Effect of pyrolysis temperature on characterisation of dissolved organic matter from pyroligneous acid. **Molecules**, 2021, 26: 3416. (责任作者：黄青)
16. Seasonal variation in chemical compositions of essential oils extracted from Lavandin flowers in the Yun-Gui plateau of China. **Molecules**, 2021, 26: 5639. (责任作者：黄青)
17. Characterization of biochars produced by co-pyrolysis of Hami melon (cantaloupes) straw mixed with polypropylene and their adsorption properties of cadmium. **Int. J. Environ. Res. Public Health**, 2021, 18: 11413(责任作者：黄青)
18. The effects of waste cement on the bioavailability, mobility, and leaching of cadmium in soil.

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19. *Radula subacuminata*, a new epiphyllous species of *Radula* (Marchantiophyta) from China and Vietnam. **The Bryologist**, 2021, 124(2): 257-270. (第一作者：张莉娜)
20. Seasonal Dynamics of Photochemical Performance of PS II of Terrestrial Mosses from Different Elevations. **Plants**, 2021, 10(12): 2613. (责任作者：郝杰威、张莉娜)
21. Genetic Divergence between Two Sympatric Ecotypes of *Phalaenopsis pulcherrima* on Hainan Island. **Diversity**, 2021, 13(9): 446. (责任作者：宋希强、任明迅)
22. Seasonal Differences in Water-Use Sources of *Impatiens hainanensis* (Balsaminaceae), a Limestone-Endemic Plant Based on “Fissure-Soil” Habitat Function. **Sustainability**, 2021, 13(16): 8721. (责任作者：宋希强、任明迅)
23. Isolation and characterization of twelve polymorphic microsatellite markers in the endangered *Hopea hainanensis* (Dipterocarpaceae). **Ecology and Evolution**, 2021, 11(1): 4-10. (责任作者：唐亮)
24. Annual population dynamics and their influencing factors for an endangered submerged macrophyte (*Ottelia cordata*). **Frontiers in Ecology and Evolution**, 2021: 763. (责任作者：宋希强、任明迅)
25. Seasonal Dynamics of Photochemical Performance of PS II of Terrestrial Mosses from Different Elevations. **Plants**, 2021, 10(12): 2613. (责任作者：郝杰威、张莉娜)
26. 海南苏铁种群结构与森林群落郁闭度的关系. **生物多样性**, 2021,29(11): 1461-1469 (责任作者：杨小波、李东海)
27. 海南苏铁野生种群分布特点及种群动态研究. **林业资源管理**, 2021,(04)：130-137 (责任作者：杨小波、李东海)
28. 环境因子对海南岛野生兰科植物物种组成与分布格局的影响. **植物生态学报**, 网络首发时间：2021-12-05 (责任作者：杨小波等)
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30. 铅锌矿区周边土壤重金属污染及植物富集特征. **热带生物学报**, 网络首发时间：2021-10-18 (责任作者：杨小波、李东海)
31. 广义马铃苣苔属的生物地理格局与花部演化. **植物科学学报**, 2021, 39(4): 379–388. (责

任作者：任明迅)

32. 东南亚兰科植物的物种多样性、生活习性及其传粉系统. **广西植物**, 2021, 41(10): 1638–1698. (责任作者：宋希强)
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35. 海南 中国典型热带雨林. **森林与人类**, 2021, (10) (责任作者：杨小波)
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37. .海南坡垒 海南热带雨林代表树种. **森林与人类**, 2021, (10) (责任作者：杨小波)
38. 海南黄花梨 5 年开花, 10 年成材. **森林与人类**, 2021, (10) (责任作者：杨小波、李东海)
39. 国内外垃圾分类对海南省生活垃圾分类的启示. **环境保护与循环经济**, 2021. 41(8): 14–17, +36(责任作者：黄青)
40. 基于 Citespace 的国内城市水体修复研究综述. **绿色科技**, 2021, 23(12): 50–53. (责任作者：杨小波)
41. 海南植被分类体系与植被分布图. **中国科学：生命科学**, 2021, 51(03): 321–333. (责任作者：杨小波)
42. 谈“十四五”生态保护与绿色发展的生态关系. **科技导报**, 2021, 39(3):87–101. (作者：李百炼、伍业钢)

➢ 专著

1. 申益春，任明迅。2021。羊山湿地植被与景观。中国建材工业出版社(ISBN：978-7-5160-3127-8)

十、代表性论著首页

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Microbial community and functional prediction during the processing of salt production in a 1000-year-old marine solar saltern of South China

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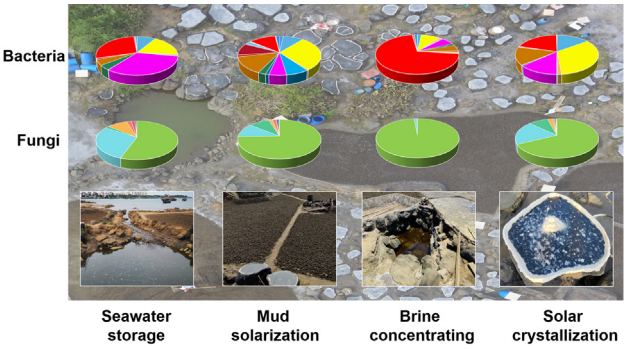
HIGHLIGHTS

- Mud solarization and brine crystallization on basalt platforms are two key steps of traditional techniques.
- The richness and diversity of bacterial and fungal communities changed dramatically during salt-making processes.
- The traditional salt-making techniques selected and maintained highly specialized microorganisms.

GRAPHICAL ABSTRACT



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ABSTRACT

In Hainan Island, South China, a 1000-year-old marine saltern has been identified as an intangible cultural heritage due to its historical complicated salt-making techniques, whereas the knowledge about this saltern is extremely limited. Herein, DNA sequencing and biochemical technologies were applied to determine bacterial and fungal communities of this saltern and their possible functions during four stages of salt-making, i.e. seawater storage, mud solarization, brine concentrating, and solar crystallization. The results showed that both of bacterial and fungal communities were suffered from significant changes during processing of salt-making in Danzhou Ancient Saltern, whereas the richness and diversity of bacterial community dominated by Proteobacteria, Bacteroidota and Cyanobacteria was considerably greater than that of fungal community dominated by Ascomycota, Basidiomycota and Mortierellomycota. Additionally, the succession of bacterial community was closely associated with both of salt physicochemical properties (Na^+, Cl^-, total phosphorus, total nitrogen, Ca^{2+} and Mg^{2+}) and bacteria themselves, whereas fungal community was more closely associated with physicochemical properties than fungi themselves. Importantly, *Cyanobium*_PCC-6307, *Synechococcus*_CC9902, *Marinobacter*, *Prevotella* and *Halomonas* as dominant bacterial genera respectively related to the metabolisms of amino acid, carbohydrate, terpenoids/polyketides, lipid and nucleotide were correlated with salt flavors. Saprophytic and saprotroph-symbiotroph fungi dominated by *Aspergillus*, *Mortierella*, *Amanita*, *Neocucurbitaria* and *Tausonia* also played core roles in the formation of salt flavors including umami and sweet smells. These findings revealed the highly specified microbiome community in this 1000-year-old saltern that mainly selected by brine solarization on basalt platforms, which is helpful to explore the underlying mechanisms of traditional salt-making techniques and to explore the useful microbes for nowadays food, medicine and chemical industries.

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Review

Impacts of nitrogen pollution on corals in the context of global climate change and potential strategies to conserve coral reefs

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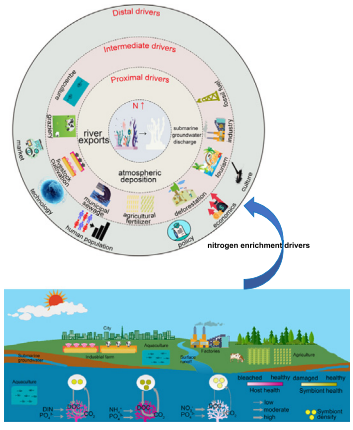
HIGHLIGHTS

- Anthropogenic nitrogen and phosphorus increase in the oceans and seas.
- Nitrogen can directly affect corals, or indirectly through algae and viruses.
- Nitrate enrichment and ammonium enrichment have different effects on corals.
- The tolerance thresholds for nitrogen can greatly differ among corals.
- Reducing nitrate input and CO_2 emissions are promising conservation strategies.

GRAPHICAL ABSTRACT

NOTE: Correlation between coral and symbiodiniaceans is partially referenced to the literature (Morris et al. 2019).



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ABSTRACT

Ocean warming has severe impacts on coral reef ecosystems with frequent incidences of coral bleaching. In addition, eutrophication poses an increasing threat to coral reef environments and has been found to increase the vulnerability of corals to thermal bleaching. Eutrophication has accelerated in recent years with coastal nutrient loads expected to continue to increase under global change. However, the mechanisms by which nutrient pollution affects corals and coral reefs are still under debate, in particular with regard to nitrogen. The main objective of this paper is to review mechanisms by which nitrogen pollution affects coral health and corresponding strategies to reduce the impact of nitrogen pollution. Different coral species possess varying tolerance thresholds for nitrogen enrichment and corals show differential responses to enrichment with nitrate and ammonium. Nitrate assimilation increases oxidative stress in corals, promotes growth of the phototrophic symbionts in corals, and induces phosphate starvation in these symbionts, which further impairs the symbiosis. In contrast, a moderate supply of ammonium is mostly beneficial for coral development. In addition, combined nitrogen and

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Chiral enantiomers of the plant growth regulator paclobutrazol selectively affect community structure and diversity of soil microorganisms

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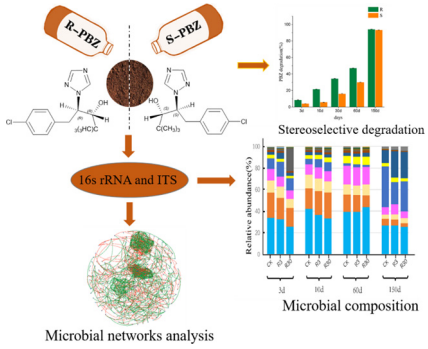
HIGHLIGHTS

- Selective degradation of paclobutrazol enantiomers was probably due to *Pseudomonas* and *Mycobacterium*.
- Paclobutrazol enantiomers showed significant enantiomeric effects on soil microbial community.
- Paclobutrazol enantiomers affected soil fungal community greater than bacterial.

GRAPHICAL ABSTRACT



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ABSTRACT

Paclobutrazol is a triazole plant growth regulator with a wide range of applications in crop and fruit tree production. Paclobutrazol is used as a racemic mixture in agriculture. However, the effects of paclobutrazol enantiomers on soil microbial community structure and diversity are unclear. In the present study, Illumina high-throughput sequencing was used to study the enantioselective effects of two paclobutrazol enantiomers on soil microbial community. S-paclobutrazol was more persistent than R-paclobutrazol. The half-lives of the S- and R-isomers were 80 d and 50 d, respectively. No interconversion between the two isomers occurred in soils. In addition, the enantiomers had significant enantiomeric effects on soil microbial community and the paclobutrazol degradation was probably attributed to the presence of *Pseudomonas* and *Mycobacterium*. Notably, the relative abundance of *Fusarium*, a genus of filamentous fungi producing gibberellins, could be enantioselectively affected by the chiral enantiomers. Paclobutrazol enantiomers exhibited greater effects on the fungal community structure than bacterial community structure due to the fungicidal activity of paclobutrazol. Finally, R-paclobutrazol had a significant effect on the microbial networks. The findings of the present study suggest that the use of S-paclobutrazol may accomplish both plant growth regulation and the minimization of effects of paclobutrazol on soil microbial communities.

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Melatonin alleviates salt damage in tomato seedling: A root architecture system, photosynthetic capacity, ion homeostasis, and antioxidant enzymes analysis

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ABSTRACT

Tomato is considered an important vegetable crop for studying the response to abiotic stresses, which deteriorate the growth and development of plants, particularly salt stress. Melatonin is a crucial pleiotropic nontoxic signaling molecule that has a various role in modulating of plant responses to environmental stresses. The purpose of the study was to reckon the alleviating effects of melatonin on tomato plant growth and development in salinity condition. The results exhibited that the pretreatment of tomato seedlings with 100 μM melatonin for 3 days effectively improved the root architecture, photosynthetic pigments, photosynthetic assimilation and growth status of plants under subsequent salt stress (150 mM). The pretreatment slashed sodium ions concentration in leaf and stem by checking sodium ions transport from roots to shoot. Furthermore, melatonin notably surged potassium contents. Melatonin pretreatment (3 days) followed by salinity exposure (7 days) efficiently lowered the oxidative stress by checking the over accumulation of superoxide ($O_2^{\bullet-}$) and hydrogen peroxide (H_2O_2), reducing the malondialdehyde (MDA) content and electrolyte leakage (EL). This was associated with increased activities of enzymatic antioxidants [superoxide dismutase (SOD), catalase (CAT), glutathione reductase (GR) and ascorbate peroxidase (APX)] and non-enzymatic antioxidants [ascorbic acid (AsA) and glutathione (GSH)]. In conclusion, melatonin pretreatment significantly escalates the salinity tolerance of tomato seedlings by scavenging the excessive ROS and improving cellular membrane stability of, thus mitigating salinity-induced oxidative damage.

1. Introduction

Global agricultural production gets limited by salinity in the soil. The potassium ion (K^+) absorption gets inhibited due to the excessive presence of sodium ion (Na^+) in the soil, which ultimately abates the growth and yield of a particular crop (Zhu, 2003). Reactive oxygen species (ROS) are formed in considerable amounts in plants under Salt stress (SS). An excessive amount of ROS damages cells of plants and imparts oxidative stress when plants' scavenging capacity is reached beyond a certain limit. Plants form an intricate antioxidant system in response to environmental stresses to regulate redox homeostasis, including SOD, CAT, APX and POD (Peroxidase), as well as other free radical scavengers (Liang et al., 2017). The physiology of plants gets disturbed by SS through various mechanisms, including the damage of cellular organelles in response to higher concentrations of Na^+ ions which results in the inhibition of enzymatic activities and proteins formation and distorting the process of respiration and photosynthesis. It also causes an imbalance in nutrients which ultimately causes a decline in transport and uptake of nutrients from root to shoot. Besides, plants suffer from physiological drought as SS limits the water uptake and minimizes the

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Annual Population Dynamics and Their Influencing Factors for an Endangered Submerged Macrophyte (*Ottelia cordata*)

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Due to wetland loss, *Ottelia cordata* (*O. cordata,* Wallich) Dandy has been categorized as an endangered species on the List of Key Protected Wild Plants in China. Quantifying the relative importance of demographic (i.e., growth, survival, and reproduction) and habitat preference traits on the population dynamics (abundance) of *O. cordata* could guide how to develop the best recovery strategies of *O. cordata*, yet currently, there are no studies that investigate this. By monitoring monthly changes in *O. cordata* abundance and demographic traits (plant height, leaf area, flower sex ratio, and seed number) that were highly correlated with growth rate, photosynthetic rate, and water depth, we identified several relationships. Linear mixed-effect models and variance partition quantified the specific effects of four demographic traits and water depth on *O. cordata* abundance in three habitat types (paddyfield, stream, and spring). The linear mixed-effect models indicate that among the four demographic traits, height could be significantly positively correlated to abundance in all three habitat types. In contrast, other three traits (leaf area, sex ratio, and seed numbers) were non-significantly associated with abundance across each habitat. Height was determined by water depth, so water depth rather than photosynthetic rate and reproduction rate may promote the development and recovery of *O. cordata* populations. Variance partition results showed that water depth mediated the positive influence of growth rate on the abundance of *O. cordata* in the living habitats (paddyfield and spring). In contrast, water depth but not growth rate determined the abundance of *O. cordata* in the living habitat (stream). However, water depth had a significantly negative impact on the abundance of *O. cordata* in stream habitats, likely because all of the streams were shallow. Altogether, in the short term for avoiding the potential harm or even extinction of *O. cordata*, keeping appropriate water depth or transplanting *O. cordata* to spring should be an effective strategy because the water

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Spatial factors and plant attributes influence soil fungal community distribution patterns in the lower reaches of the Heihe River Basin, Northwest China

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Summary

Inland river basins include critical habitats and provide various ecosystem services in extremely arid lands. However, we know little about the distribution patterns of soil fungal communities in these river basins. We investigated the distribution patterns of soil fungal communities from the riparian oasis zone (ROZ) to the circumjacent desert zone (CDZ) at the lower reaches of the Heihe River. The results indicated that soil fungal communities were mainly dominated by the phyla Ascomycota and Basidiomycota across all samples. The dominant soil fungi taxa were significantly different between ROZ and CDZ habitats at both the phylum and genus levels. Fungal alpha diversity was mainly affected by spatial factors and plant functional traits, and Pearson correlation analysis revealed that fungal alpha diversity was more closely related to plant functional traits than soil properties. Furthermore, fungal community structure was best explained by spatial factors and plant attributes (including plant diversity and plant functional traits). Together, our findings provide new insights into the significance of spatial factors and plant attributes for predicting distributions of fungal communities in arid inland river basins, which will help us better understand the functions and services of these ecosystems.

Introduction

Soil fungal community is regarded as one of the most important components in multiple ecosystems, given that it plays a critical role in regulating biodiversity and processes of ecosystems as major plant litter decomposers and mutualists or pathogens of specific plants (Bardgett and van der Putten, 2014; Li *et al*., 2019). Furthermore, the soil fungal community is sensitive and responds rapidly to environmental changes, making it a more reliable indicator of environmental health (Astudillo-García *et al*., 2019). Therefore, exploring distribution patterns and key ecological drivers of soil fungal communities is crucial to enhancing our understanding of the ecosystem responses to widespread environmental changes.

In recent decades, there have been considerable debates on the distribution patterns of soil fungal diversity and its main drivers in various ecosystems (Tedersoo *et al*., 2014; Větrovský *et al*., 2019; Guo *et al*., 2020). However, no consensus has been reached on the relationship between soil fungal communities and environmental factors due to different geographic scales and environmental gradients among studies (Hendershot *et al*., 2017). Generally, changes in soil properties may directly affect the composition and diversity of soil microorganisms because of their important roles as complex habitats for the life on earth (Lauber *et al*., 2008; Thakur *et al*., 2020). Compared with bacteria, soil fungi are more likely to be affected by plants due to their closer associations with plants (Bonfante and Anca, 2009). Previous studies have indicated that plant characteristics are important factors in determining the distribution patterns of soil fungal communities (Canini *et al*., 2019; Koyama *et al*., 2019). In addition, there is growing evidence that soil fungi are the initial consumers of belowground inputs from plants (Hannula *et al*., 2012; Ballhausen and de Boer, 2016) and the primary decomposers of recalcitrant organic matter (Treseder and Lennon, 2015), such as cellulose and lignin. Thus, plant variation may substantially influence soil fungal communities by providing distinct plant litter sources, creating more heterogeneous niches for fungi (Nguyen *et al*., 2016). For instance, a recent study on forest ecosystem has demonstrated that soil fungal beta diversity is highly positively correlated with plant beta diversity, and woody plants exert greater impacts on soil fungal communities than herbaceous

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Protective Mechanisms of Melatonin Against Vanadium Phytotoxicity in Tomato Seedlings: Insights into Nutritional Status, Photosynthesis, Root Architecture System, and Antioxidant Machinery

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Abstract

In recent decades, global crop production is being threatened by contamination of arable lands with vanadium (V). Among many stress-relief substances, melatonin (ME) is a widely studied biomolecule acting as an antioxidant under stress conditions. The current study was aimed to investigate the response of tomato seedlings towards vanadium stress, along with the circumventing role of ME by promoting V stress tolerance in tomato seedlings. Our results revealed that accentuated inhibition of growth and biomass were caused by V (40 mg/L) stress, mainly due to impairments of photosynthetic systems, root traits, and mineral homeostasis. Conversely, notable reinforcement of plant growth parameters was seen with ME (100 μM) application, with improved chlorophyll content, root morphology, mineral nutrient homeostasis, and gas exchange parameters, along with reduced V accumulation. Further, ME efficiently triggered the antioxidant enzymes activities, by restoring cellular integrity [reduced electrolyte leakage (EL) and malondialdehyde] and restricted production of superoxide ($O_2^{\bullet-}$) and hydrogen peroxide (H_2O_2) radicals, mainly through regulation of antioxidant enzymes. The present study highlighted the potential role of ME in tomato, for circumventing V-induced phytotoxicity, mainly by boosting photosynthesis, biomass production, redox balance, nutrient uptake, and root traits. In conclusion, ME application restricted the V availability in plant, improved plant growth and, thus, provided an improved V stress tolerance.

Keywords Abiotic stress · Root growth · Heavy metal · Plant growth · Food security · Nutrient fluxes

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ORIGINAL PAPER

Melatonin Mitigates Nickel Toxicity by Improving Nutrient Uptake Fluxes, Root Architecture System, Photosynthesis, and Antioxidant Potential in Tomato Seedling

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Abstract
Globally, crop production has been widely threatened by contamination of arable lands with heavy metals including Nickel (Ni). Stress-relief molecule melatonin (ME) has been widely used to mitigate the phytotoxicity induced by heavy metals. The current study aimed to explore the response to Ni stress and the alleviating role of ME in boosting Ni-stress tolerance in tomato seedlings. The roots of tomato seedlings pretreated with ME (100 μM) for 3 days, followed by applied Ni (50 μM) for 7 days. The treatments were composed of (1) control (CK); (2) melatonin (ME, 100 μM); (3) nickel (Ni, 50 μM); and (4) melatonin and nickel treatment (ME+Ni, 100 μM + 50 μM). Nickel toxicity noticeably inhibited plant growth and biomass production by impairing the root architecture, photosynthesis process, nutrient uptake, and antioxidant enzymes. Conversely, ME-supplementation inhibited Ni-induced growth damage, improved root architecture, nutrient uptake, pigment contents, and leaf gas exchange parameters, and decreased Ni-accumulation. Furthermore, the electrolyte leakage (EL), malondialdehyde (MDA) content, and reactive oxygen species (ROS) accumulation were significantly reduced in ME-treated seedlings via improving antioxidant enzyme activity as well as upregulation of their encoding gene expression. In conclusion, our findings provide a shred of substantial evidence that ME improved Ni-induced phytotoxicity in tomato seedlings, mainly by improving the root architecture, biomass production, mineral homeostasis (reducing nickel accumulation in plants), and photosynthetic efficiency.

Keywords Environment · Melatonin · Nickel · Tomato · Nutrient uptake · Plant growth · Photosynthesis

1 Introduction

Amidst major threats to living organisms and the environment, the most dramatic one is the heavy metal pollution (Wo-Niak and Basiak 2003). In plants, heavy metal presence can interfere physiological changes, such as free radical formation, water status disturbance, enzyme activity variations, and photosynthesis inhibition (Pál et al. 2006). Heavy metal application adversely affected physiological attributes (Shafeeq-ur-Rahman et al. 2020; Viciedo et al. 2019). Alloway (1995) described that Ni lies amidst ubiquitous trace metals emitted through both anthropogenic and natural activities, causing environmental pollution. Hussain et al. (2013) marked this element as an important trace metal, as it is the 22nd most abundant element found in the earth's crust. In plant growth, developmental and biological functions, Ni plays a vital role in trace amounts (~ 0.01 to 5.0 μg g^{-1} of dry weight) (Rizwan et al. 2017). Contrarily, Ni has adverse effects on plant growth and leads to phytotoxicity at elevated levels, mainly due to decreased root activity, unbalanced osmosis, hindered mineral homeostasis, impaired photosynthesis and destroyed photosystem, and membrane integrity (Jahan et al. 2020). As narrated by Valivand et al. (2019),

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Radula subacuminata, a new epiphyllous species of *Radula* (Marchantiophyta) from China and Vietnam

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Abstract. *Radula* sect. *Epiphyllae* is a pantropical section of subg. *Metaradula*, often growing on the surface of living leaves and with occurrence of gemmae on leaf lobes. Its taxonomic status was once in controversy centered on which subgenus it belonged to and whether it was monophyletic. We describe *Radula subacuminata*, a new epiphyllous species from China and Vietnam based on morphological and molecular evidence. Phylogenetic analyses of combined molecular datasets (*trn*G, *trn*L-F, *rps4* and *atp*B-*rbc*L) with maximum parsimony, maximum likelihood and Bayesian methods reveal that *R. subacuminata* belongs to sect. *Epiphyllae* and has close relationships with *R. acuminata*, *R. grandilobula* and *R. protensa*, three other epiphyllous species all bearing gemmae on the surface of leaf lobes. A PCA analysis of morphological traits indicates these four taxa are distinctive groups. The results also confirm that sect. *Epiphyllae* is monophyletic and should be retained. A preliminary key to 18 species in sect. *Epiphyllae* is provided.

Keywords. Molecular phylogeny, new taxon, Radulaceae, *Radula* subg. *Metaradula*.

◆ ◆ ◆

Radula Dumort. is one of the largest genera of liverworts and the only genus of the family Radulaceae Müll.Frib., belonging to the order Porellales Schljakov. (Söderström et al. 2016). It is almost world-wide in distribution and has the center of species diversity in tropical regions (Devos et al. 2011). *Radula*, with 250 currently accepted species (Pócs 2017; Promma et al. 2018; Promma & Chantanaorrapint 2015; Söderström et al. 2016; Zhang & Zhu 2016) often occurs on soil, rocks, decayed logs, and more often, on tree trunks and leaves of vascular plants. On the basis of previous molecular and morphological investigations (Devos et al. 2011; Patiño et al. 2017), the infrageneric classification for *Radula* was defined as seven subgenera (namely subg. *Amentuloradula* Devos, M.A.M.Renner, Gradst., A.J.Shaw et Vanderp., subg. *Cladoradula* Spruce, subg. *Dactyloradula* Devos, M.A.M.Renner, Gradst., A.J.Shaw et Vanderp., subg. *Metaradula* R.M.Schust., subg. *Odontoradula* K.Yamada, subg. *Radula*, and subg. *Volutoradula* Devos, M.A.M.Renner, Gradst., A.J.Shaw et Vanderp.). Among them, subg. *Metaradula* (Schuster 1984) was established for those taxa whose perianths bear a

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Article

Seasonal Dynamics of Photochemical Performance of PS II of Terrestrial Mosses from Different Elevations

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Abstract: Mosses are critical components of tropical forest ecosystems and have multiple essential ecological functions. The drying and rehydrating and often hot environments in tropical regions present some of the greatest challenges for their photosynthetic activities. There is limited knowledge available on the physiological responses to the changing environments such as temperature and water pattern changes for terrestrial mosses. We examined the seasonal dynamics of photochemical performance of PS II through the measuring of chlorophyll fluorescence of 12 terrestrial mosses in situ from five different elevations by Photosynthesis Yield Analyzer MINI-PAM-II, along with the seasonal changes of climatic factors (air temperature, dew point, relative humidity and rainfall), which were collected by local weather stations and self-deployed mini weather stations. The results showed a great seasonality during observing periods, which, mainly the changes of rainfall and relative humidity pattern, presented significant impacts on the photochemical performance of PS II of terrestrial mosses. All these tested moss species developed a suitable regulated and non-regulated strategy to avoid the detrimental effect of abiotic stresses. We found that only *Hypnum plumaeforme*, *Pterobryopsis crassicaulis* and *Pogonatum inflexum* were well adapted to the changes of habitat temperature and water patterns, even though they still experienced a lower CO_2 assimilation efficiency in the drier months. The other nine species were susceptible to seasonality, especially during the months of lower rainfall and relative humidity when moss species were under physiologically reduced PS II efficiency. *Anomobryum julaceum*, *Pogonatum neesii*, *Sematophyllum subhumile*, *Pseudotaxiphyllum pohliaecarpum* and *Leucobryum boninense*, and especially *Brachythecium buchananii*, were sensitive to the changes of water patterns, which enable them as ideal ecological indicators of photosynthetic acclimation to stressed environments as a result of climate change.

Keywords: chlorophyll fluorescence; ecophysiology; environmental stress; photosystem II; terrestrial mosses

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1. Introduction

Photosynthesis is particularly sensitive to adverse environmental factors, such as high air temperature and vapor pressure deficits [1], making photosynthetic measurements an important component in environmental and ecological studies. To avoid the abiotic stresses, land plants have developed photoprotective mechanisms that enable them to dissipate excess excitation energy as heat via the so-called non-photochemical quenching (NPQ) mechanism [2–4]. Even though bryophytes (liverworts, hornworts and mosses) are the earliest diverging lineages of the extant land plants [5–7], they still face great challenges of the cycle of drying and rehydrating and often high temperatures in tropical regions. Given the poikilohydric nature of their water relations, bryophyte carbon dynamics are affected by the respiratory demands of desiccation and rehydration as well as by the photosynthetic

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Genetic Divergence between Two Sympatric Ecotypes of *Phalaenopsis pulcherrima* on Hainan Island

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Abstract: Ecotypes are the result of ecological differentiation at the early stages of speciation. Adaptation to soil conditions offers arguably the best examples of local adaptation in plants. Two sympatric ecotypes, with either a red or green abaxial leaf surface, were found without clear geographical isolation in *Phalaenopsis pulcherrima*, a Southeast Asia endemic and endangered orchid. The soil of the red leaf ecotype has a higher water content and nutrient content than the green ecotype. What is the genetic structure of the two ecotypes? Is there complete or partial reproductive isolation between the two ecotypes? In this work, leaf reflection of the two ecotypes in *P. pulcherrima* were compared, to illustrate their difference in leaf color. The genetic differentiation between two ecotypes was examined, using ISSR and SRAP markers to determine the genetic structure of the populations. Our results showed that the green ecotype had reflectance spectrum peaks at 530 nm and 620 nm, while in the red ecotype, the peak at 530 nm was absent. A total of 165 ISSR and SRAP loci showed a high level of genetic diversity within the green ecotype, and analyses of the population structure revealed two genetic clusters that corresponded to the red and green ecotypes. The percentage of variation between the two ecotypes (24.55%) was greater than the percentage of variation among the populations (16.54%)—indicating partial reproductive isolation, high genetic differentiation, and that ecological differentiation has been more important than geographical barriers among populations within ecotypes. Most pairwise F_{ST} values between the populations within either ecotype on Hainan Island were less than 0.15; however, the F_{ST} between both the Thai and Malaysian populations and the Hainan Island population was greater than 0.25, due to South China sea isolation. Ecotypic differentiation is an important part of speciation; therefore, we must take into account the axes along which lineages sort, when formulating protection strategies.

Keywords: adaptation; differentiation; metapopulation; natural selection; conservation strategy

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1. Introduction

Ecotypes refer to groups of individuals within a species, with distinct phenotypic and genetic variations [1,2]. Typically, ecotypes are geographically well separated, but sometimes ecotypes co-exist at the local scale [3,4]. It is widely recognized that ecotypes are the result of ecological differentiation at the early stages of speciation [5,6]. This early stage is often characterized by the formation of partial reproductive isolation [7–11].

Adaptation to soil conditions (edaphic adaptation) offers a classic example of local adaptation in plants [12,13]. Soil attributes, including water content, nutrient status, and toxicity, provide especially rich conditions for divergent natural selection, resulting in divergent morphology, phenology, and, more generally, life history [2,14,15]. Among them, divergence in flowering time is a common cause of reproductive isolation. Inland and coastal ecotypes of the yellow monkeyflower *Mimulus guttatus* represent an excellent model

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Seasonal Differences in Water-Use Sources of *Impatiens hainanensis* (Balsaminaceae), a Limestone-Endemic Plant Based on "Fissure-Soil" Habitat Function

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Abstract: The southwestern mountains of Hainan Island are the southernmost region with tropical karst landform in China. The frequent alternation of dry and wet seasons leads to the loss of the mineral nutrients of limestone, creating karst fissure habitats. Plants living in karst fissure habitats for long periods of time have developed local adaptation mechanisms correspondingly. In the paper, hydrogen–oxygen stable isotope technology was applied to determine the water-use sources of *Impatiens hainanensis* in the dry and wet seasons, hoping to expound the adaptation mechanism of *I. hainanensis* in karst fissure habitats to the moisture dynamics in the wet and dry seasons. In the wet season (May to October, 2018), the air humidity is relatively high in the *I. hainanensis* habitat; in the dry season (November 2018 to April 2019), there is a degree of evaporation. In the wet season, fine-root biomass increases with soil depths, while coarse-root biomass decreases with soil depths; in the dry season, fine-root biomass is lower and coarse-root biomass is higher compared with the wet season. It was found that the average rainfall reached 1523 mm and the main water-use sources were shallow (0–5 cm) and middle (5–10 cm) soil water, epikarst water, and shallow karst fissure water during the wet season; the average rainfall reached 528 mm, and the deep (10–15 cm) soil water and shallow karst fissure water were the main water-use sources during the dry season. Fog water has a partial complementary effect in the dry season. The differences in the distribution of root biomass and each source of water in the wet and dry seasons of *I. hainanensis* also reflect the different water-use strategies of *I. hainanensis* in the wet and dry seasons. In both dry and wet seasons, *I. hainanensis* formed a water-use pattern dominated by soil water and shallow fissure water (0–15 cm) under the influence of the "fissure-soil-plant" system in the karst region.

Keywords: *Impatiens hainanensis*; karst; shallow fissures; hydrogen–oxygen stabilized isotopes; water utilization

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1. Introduction

The environment governs the geographical distribution, growth, and developmental status of plants, but the environment is influenced by plants at all times [1]. In the soil–plant–atmosphere continuum, plant water is influenced by environmental physical factors such as soil, air moisture limitation, and the regulation of organisms themselves [2]. Water is the most important limiting factor for ecosystem processes and functions in deserts and ecologically fragile areas [3], and it plays a critical role in plant growth and development, survival, and distribution [4]. The intensity and frequency of precipitation determine the survival, composition, structure, and functional assemblage of plant species in ecosystems [5]. In the context of global climate change, changes in precipitation patterns, in

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NATURE NOTES

Isolation and characterization of twelve polymorphic microsatellite markers in the endangered *Hopea hainanensis* (Dipterocarpaceae)

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Abstract

Microsatellite markers were isolated and characterized for *Hopea hainanensis* Merrill & Chun, an endangered tree species with scattered distribution in Hainan Island and northern Vietnam. Twenty-six microsatellite markers were developed based on next-generation sequencing data and were genotyped by capillary electrophoresis on an ABI 3730xl DNA Analyzer. Twelve markers were found to be polymorphic in *H. hainanensis*. GENODIVE analyses indicated that the number of alleles ranged from 2 to 6 per locus, and the observed and expected heterozygosity varied from 0 to 0.755 and from 0.259 to 0.779, respectively. Primer transferability was tested with *Hopea chinensis* Hand.-Mazz. and *Hopea reticulata* Tardieu, in which 3 and 7 microsatellite markers were found to be polymorphic, separately. The results showed that *H. reticulata* and *H. hainanensis* had similar levels of genetic diversity. A neighbor joining dendrogram clustered all individuals into two major groups, one of which was exclusively constituted by *H. hainanensis*, while the other consisted of two subgroups, corresponding to *H. reticulata* and *H. chinensis*, respectively. The 12 polymorphic microsatellite markers could be applied to study genetic diversity, population differentiation, mating system, and fine-scale spatial genetic structures of *H. hainanensis* as well as its close relatives, facilitating the conservation and restoration of these endangered but valuable *Hopea* species.

KEYWORDS

Dipterocarpaceae, endangered species, *H. hainanensis*, microsatellite markers, next-generation sequencing

1 | INTRODUCTION

Hopea hainanensis Merrill & Chun is a large evergreen tree that can grow up to 20 m. It is found in tropical lowland forest of Hainan Island and northern Vietnam (Li et al., 2007). *Hopea hainanensis* is known for its highly valued timber which is extremely durable and suitable for making boats and building bridges and houses (Li et al., 2007). As a result, adult trees of this species had been overly logged, leading to a reduction of 50%–70% population in the last three hundred years (Ly et al., 2018). The remaining population of *H. hainanensis* is severely fragmented and isolated in a few reserves in Hainan Island. This species is scarce in its natural habitat and is assessed as

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Comparison of three palm tree peroxidases expressed by *Escherichia coli*: Uniqueness of African oil palm peroxidase

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ABSTRACT

Palm tree peroxidase has greater catalytic activity, stability and broad application prospects in comparison with horseradish peroxidase. However, slow growth, ecological destruction and high costs prohibit isolation of native peroxidases directly from palm trees. Bioreactor production of palm tree peroxidases would therefore be preferred to overcome such production limitations. Comparison of different recombinant glycan-free palm tree peroxidases would allow understanding the criticality of total glycans to the functions and characteristics. In the present study, African oil palm tree peroxidase expressed by *Escherichia coli* showed similar stability and 30-100-fold greater activity than that of recombinant royal palm tree peroxidases, but both of their comprehensive indexes were superior to the commercial, native horseradish peroxidase. Recombinant *Chamaerops excelsa* peroxidase showed no activity possibly due to incorrect protein folding. The results confirmed that recombinant expression by *E. coli* is potentially an effective means to obtain a mass of palm peroxidases with high activity and stability.

1. Introduction

Peroxidases are an important class of antioxidant enzymes, are widely distributed in nature and can catalyze the oxidation of various electron donor substrates accompanied by decomposing H_2O_2 [1–3]. Due to its ability to catalyze the oxidation-reduction reaction of multiple substrates, peroxidases are considered to be one of the important enzymes in biocatalytic conversion [4–6], enzyme-linked immunosorbent assay [7,8], wastewater treatment [9], electrochemistry [10,11]. Horseradish peroxidase (HRP) has become one of the most studied plant peroxidases because of its advantages (e.g., wide applications) and disadvantages (e.g., low stability and inability to achieve catalytic efficiency required by biotechnology) [12]. Therefore, chemical modification, genetic manipulation and other methods had been used to improve its stability and catalytic efficiency [13,14]. Another option is to search for peroxidases with better properties than HRP.

Sakharov et al. first isolated highly stable peroxidases from African oil palm tree leaves, indicating that the palm leaves may be a promising source of commercial peroxidase [15]. Subsequently, palm peroxidases with high activity and stability were found in leaves of other palm species, such as royal palm tree (*Roystonea regia*) [16], date palm tree (*Phoenix dactylifera*) [17], windmill palm tree (*Trachycarpus fortunei*) [18], and *Chamaerops excelsa* tree [19]. Isolation and purification of native peroxidases from palm trees can obtain peroxidases with high stability and activity. However, this production method faces a practical problem of slow growth of most palm tree species and thus shortage of palm tissue supplies. High cost is a major hurdle for use of native palm peroxidases. Heterologous expression might be a potentially effective way to achieve high-yield with a low cost. *Pichia pastoris* is a common heterologous eukaryotic expression system that can be used to produce engineered enzymes with glycosylation. *P. pastoris* had been used to produce windmill palm tree peroxidase (WPP), but the output was only 0.14 mg/L [20]. *Escherichia coli* expression system is a common heterologous prokaryotic expression system, which has been used in the production of various enzymes due to its high yield and short production cycle [21–24], such as production of active manganese peroxidase [25],

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The Recovery of Phosphate and Ammonium from Biogas Slurry as Value-Added Fertilizer by Biochar and Struvite Co-Precipitation

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Abstract: Biowaste materials could be considered a renewable source of fertilizer if methods for recovering P from waste can be developed. Over the last few decades, there has been a high level of interest in using biochar to remove contaminants from aqueous solutions. This study was conducted using a range of salts that are commonly found in biogas slurry ($ZnCl_2$, $FeCl_3$, $FeCl_2$, $CuCl_2$, Na_2CO_3, and $NaHCO_3$). Experiments with a biogas digester and aqueous solution were conducted at pH nine integration with NH_4^+, Mg^{2+}, and PO_4^{3-} molar ratios of 1.0, 1.2, and 1.8, respectively. The chemical analysis was measured to find out the composition of the precipitate, and struvite was employed to remove the aqueous solutions. The study found that the most efficient removal of phosphate and ammonium occurred at pH nine in Tongan sludge urban biochar and rice biochar, respectively. Increasing the concentration of phosphate and ammonium increased the phosphate and ammonium content. Moreover, increasing the biochar temperature and increasing the concentration of phosphate and ammonium increased the efficiency of the removal of ammonium and phosphate. The removal efficiency of ammonium and phosphate increased from 15.0% to 71.0% and 18.0% to 99.0%, respectively, by increasing the dose of respective ions K^+, Zn^{2+}, Fe^{3+}, Fe^{2+}, Cu^{2+}, and $CO_3{}^2$.The elements were increased from 58.0 to 71.0 for HCO_3^- with the increasing concentration from 30 mg L^{-1} to 240 mg L^{-1}.This study concluded that phosphate and ammonium can be recovered from mushroom soil biochar and rice biochar, and phosphate can be effectively recovered via the struvite precipitation method.

Keywords: co-precipitation; removal efficiency; phosphates; ammonium; biochar; struvite

1. Introduction

Phosphorus and ammonium recovery are significant from an environmental management perspective as they contribute to eutrophication [1–6] and can be found in numerous wastewaters at variable concentrations [3,7–12]. Struvite ($MgNH_4PO_4.6H_2O$) is approximately12% nitrogen (N) and 51.8% phosphorus (P). A P_2O_5 content greater than 30% is considered phosphate-rich. Therefore, a large amount of P recovery in struvite is particularly value added [4,13,14]. Additionally, struvite is also a comprehensive nutrient fertilizer

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Microbial-induced concrete corrosion under high-salt conditions: Microbial community composition and environmental multivariate association analysis

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ABSTRACT

The corrosion of concrete materials in urban sewage pipes by microorganisms is a serious issue in wastewater networks around the world. There has been no systematic study conducted on material corrosion by microorganisms, particularly for high-salt environments in coastal cities. This study compared and analysed reactors under different salinities, and the 16S ribosomal ribonucleic acid gene sequence method was used to analyze the bacterial communities associated with concrete corrosion. Redundancy analysis demonstrated that chemical oxygen demand, volatile fatty acids, and sulphate altered the structure and distribution of the microbial community. The predominant bacteria, Proteobacteria, accounted for 41.85% of the seawater group. Among them, the sulphur functional microorganism, *Desulfomicrobium*, accounted for 4.14%. These bacteria can decompose macromolecular organic matter to provide energy for reproduction. Furthermore, they continue to provide sulphur for the eosinophilic sulphur-oxidising bacteria attached to the surface of the high alkaline concrete sample. The aggregated sulphur-oxidising bacteria produce biological sulphuric acid, leading to corrosion and damage to the concrete structure. Salinity promoted the aggregation of corrosion-inducing bacteria, accelerating the growth of corroding microorganisms on the concrete material of coastal urban sewage pipes.

1. Introduction

Concrete structures in sewer systems are one of the most critical components in drainage networks (Anbari et al., 2017); these structures suffer from serious corrosion during long-term service (Wang et al., 2016; Li et al., 2020). The annual costs associated with structural failure from microbial corrosion have caused huge economic losses (Fytianos et al., 2020; Li et al., 2020). A sewer system is a vast and complex microbial ecosystem, and the corrosion of concrete is often impacted by microbial activities from multiple environmental factors (Li et al., 2019). Previous studies have reported that approximately 40% of concrete failure in sewer systems may be directly attributed to microbial-induced corrosion (Moreno et al., 2015). However, there is a lack of knowledge on this process for coastal city sewer systems. A high-salinity environment creates a resilient microbial community inside the micro-ecosystem, exacerbating microbial corrosion of marine concrete structures. Concrete structures in coastal city sewer systems experience distinct sewage conditions, including elevated temperatures and high salinity. These conditions alter the kinetics of sulphur oxidation and reduction, providing a suitable environment for microbial colonisation (Li et al., 2020). Specific microbes easily corrode concrete by secreting biogenic acids, resulting in increased porosity of concrete (Jiang et al., 2016; El Gamal et al., 2017).

Some studies have shown that different environmental changes significantly impact bacterial abundance (Zhao et al., 2017). At present, there are many studies on freshwater areas, analyses of freshwater areas have indicated that *Proteobacteria*, *Cyanobacteria*, and *Campylobacter* were the dominant bacterial groups. They are microbial communities with a great risk of corrosion (Li et al., 2019).*Proteobacteria* and *Actinomyces* were considered the dominant bacteria in biofilms formed on concrete in freshwater environments (Kong et al., 2018). The pH of the concrete surface was the key factor influencing bacterial composition (Maresca et al., 2016). Bacteria related to the metabolism of nitrogen and sulphur accounted for 70% of metabolising bacteria, which were

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A comprehensive study of phosphorus removal and recovery with a Fe-loaded sulfoaluminate cement (FSC) adsorbent

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Sulfoaluminate cement
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ABSTRACT

The present study was designed to produce a new adsorption efficiency, cost-efficient, and recoverable cementitous adsorbent (FSC) and study the removal and recovery of phosphorus (P). The result of Langmuir isotherm revealed the maximum capacity is 46.8 mg/g. Interference by competitive ions (Cl^-, NO_3^-, SO_4^{2-}, and HCO_3^-) was weak, and P adsorption reached 95% of the optimum value in a wide pH of 3.0–7.0. The results of batch experiments, SEM-EDS, XRD, and FTIR suggested that the adsorption of phosphate obviously facilitated the release of SO_4^{2-} from the FSC hydration products via SO_4^{2-} exchange, and formation of metal-P precipitates was the predominant P removal mechanism. The column filtration results showed the number of bed volume before P breakthrough was 1564–2112, and the effluent pH stabilized at 8.0. The P-loaded FSC was used to cultivate *Ipomoea aquatica Forsk* in the hydroponic boxes, the sample plant dry weight using adsorbed FSC as P-source was (0.40~0.41) ± 0.05 g, which was dramatically increased comparing with the non-P source samples (0.19 g ± 0.07 g). Our present study firstly employed the sulfoaluminate cement-based material for eutrophic water remediation and presents a comprehensive study combining P removal mechanisms, influencing factors, and application. Insights gained from adsorption mechanisms and P recovery approach can further our understanding on the practical application of FSC.

1. Introduction

Excessive phosphorus (P) leads to the rampant growth of bacteria and algae, which deplete oxygen levels and deteriorate the quality of the aquatic ecosystems, resulting in environmental as well as economic damage [1,2]. On the other hand, as a non-renewable natural resource that cannot be substituted with other sources, the natural source of P is dwindling and geopolitically imbalanced [3,4].

Up to present, a variety of materials have been evaluated for phosphate removal, including natural minerals (e.g., mineral, zeolite, rock, and crab shell) [5–7], industrial byproducts (e.g., steel slag, fly ash, and waterworks sludge residuals) and artificially synthesized products (e.g., organic polymer adsorbents, biochar, and ceramsite) [8,9]. However, the direct use of raw materials will have shortcomings such as small adsorption capacity, poor mechanical strength, and low chemical stability. On the other hand, the high costly of specifically synthesized adsorption materials makes its implement challenging. Several adsorbents mentioned above, for example, the powdered materials (carbon-based composites and natural mineral, etc.) and the materials with poor swelling property, may cause secondary pollution due to the difficulty of solid-liquid separation.

Sulfoaluminate cement (SC) has been widely used in architecture due to its early strength, low alkali and less CO_2 release characteristics in recent years [10,11]. It contains elements including Ca oxides (36%–43%), Al oxides (28~40%) and Fe oxides (1~3%) [11], which opens up the possibility of adsorption and precipitation of P. In the process of SC hydration, the amorphous calcium silicate hydrate and aluminum hydroxide are generated, which have been used to remove heavy metal ions such as Cr(III), Pb^{2+}, and Cd^{2+} [12,13]. Concrete (fabricated with SC and bottom ash aggregates) was testified can remove 70% of the dissolved P, however, the implementation of the SC cement was inhibited by the clogging effect [14]. The cement and concrete waste were also employed for phosphate removal, and the mechanism involved was formation of the $Ca_3(PO_4)_2$ precipitate according to ion

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molecules

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Seasonal Variation in Chemical Compositions of Essential Oils Extracted from Lavandin Flowers in the Yun-Gui Plateau of China

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Abstract: Lavandin, as an important cash crop, is cultivated in Kunming, Yun-Gui Plateau of China. For the special growing environment, Lavandin was grown here and used to investigate the changes in the yield and chemical compositions of essential oils extracted from the flowers in different seasons. The essential oils were extracted by hydro-distillation and analysis by gas chromatography-mass spectrometry (GC-MS). Results indicated great changes in chemical composition depending on the season of harvesting. The yields of essential oils ranged from 2.0% to 3.8% among the seasons, and the highest yield was in the summer. Chemical composition data showed that the extracted oils were rich in oxygenated monoterpenes (55.4–81.4%), eucalyptol (38.7–49.8%), camphor (8.41–14.26%), α-bisabolol (6.6–25.5%), and linalool (4.6–12.5%). The contents of eucalyptol and α-bisabolol changed in a contrary trend with seasonal variations. The results provided new insight for Chinese Lavandin germplasm to be used in application and development, and reference to the researcher, the farmer, and investor for sustainable industrialization of the plant grown in the Yun-Gui Plateau of China, but also the similar plateau area of the sustainable developments.

Keywords: Lavandin; essential oil; Yun-Gui Plateau; monoterpenes; eucalyptol; camphor

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1. Introduction

Lavandula species are outstanding members of the family Lamiaceae, which are native to the Mediterranean region and south to tropical Africa, with a disjunction to India, and are currently widely cultivated in many regions of the world [1]. The genus is an ornamental and aromatic shrub, which is valuable for the production of essential oils of commercial value as a fragrance, pharmaceutical preparations, and cosmetic products, and is also used in the food industry and ecological agriculture [2–7].

These essential oils have been obtained from the flowers, stems, and leaves of the species *L. angustifolia*, *L. hybridia*, and *L. latifolia*, and are classified into three groups on the basis of their content of linalool, linalool acetate, and camphor [8]. Due to their wide economic exploitation, there are many reports on the fragrances of essential oils and identification of constituents from the *Lavandula* species. These studies demonstrate a high degree of intraspecific differences of chemical constituents in the oil, as influenced by genotype, age, development periods, organ, climate, geography, season, and even extraction method, etc. [9–17].

Yun-Gui Plateau is a subtropical monsoon climate region with favorable environmental and edaphic conditions for ornamental, aromatic, and medicinal plants. Since

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Characterization of Biochars Produced by Co-Pyrolysis of Hami Melon (Cantaloupes) Straw Mixed with Polypropylene and Their Adsorption Properties of Cadmium

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Abstract: Reuse of waste from Hami melon (cantaloupes) straws (HS) mingled with polypropylene (PP) ropes is necessary and beneficial to mitigate environmental pollution. The objective of this study was to investigate the characteristics and mechanisms of Cd^{2+} adsorption on biochars produced by co-pyrolysis of HS-PP with various mixing ratios. N_2-sorption, scanning electron microscopy (SEM), energy dispersive X-ray spectrometer (EDS), elemental analysis, Fourier-transform infrared spectroscopy (FTIR), X-ray diffraction (XRD), thermal gravity, and differential thermal gravity (TG/DTG) were applied to evaluate the physicochemical properties of materials. Batch adsorption experiments were carried out for investigating the effects of initial pH, Cd^{2+} concentration, and adsorption time. It was found that the Langmuir and pseudo-second-order models fitted best for the experimental data, indicating the dominant adsorption of co-pyrolysis biochars is via monolayer adsorption. Biochar derived at 4/1 mixing ratio of HS/PP by weight percentage had the highest adsorption capacity of 108.91 $mg \cdot g^{-1}$. Based on adsorption isotherm and kinetic analysis in combined with EDS, FTIR, and XRD analysis, it was concluded that the main adsorption mechanism of co-pyrolysis biochar involved the surface adsorption, cation exchange, complexation of Cd^{2+} with surface functional groups, and chemical precipitation. This study also demonstrates that agricultural wastes to biochar is a sustainable way to circular economy.

Keywords: Hami melon straw; polypropylene; co-pyrolysis; biochar; Cd^{2+}

1. Introduction

China is a large agricultural country; accompanied with agricultural production, the generation of solid waste continues to grow rapidly. The agricultural waste production increased with the human demand for food and other agricultural products. According to the China Statistical Yearbook, the yields of crop straw are over 750 million tons every year in China. Extensive studies have been conducted on agricultural waste management worldwide, but the total utilization rate of agricultural waste in most villages of the world is less than 30% due to poor economic returns and low environmental awareness, which is a waste of these resources [1].

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Effects of plastic mulch film residues on soil-microbe-plant systems under different soil pH conditions

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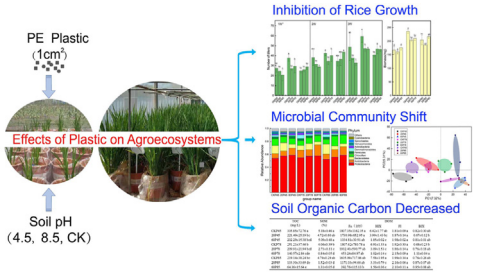
HIGHLIGHTS

- Plastic mulch film residues (PMFR) affect the rhizophere bacterial communities.
- Microbe significant correlations with SOM and SOC when response to PMFR.
- Negative effects of PMFR on rice growth were stronger under acidic conditions.
- SOC declined significantly more in alkaline soils with PMFR concentrations.

GRAPHICAL ABSTRACT



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Rice growth

ABSTRACT

Plastic mulch film residues (PMFR) accumulated throughout mulching years can result in serious environmental problems, especially in hotter areas with frequent farming (e.g. the tropics). The effects of long-term mulching on the soil-microbe-plant system, however, are largely unknown. As mulching years is positively correlated with PMFR concentrations, we used a controlled pot experiment to investigate the effects of mulching years (20a: The concentration of PMFR is about 2 g kg^{-1}, 60a: About 6 g kg^{-1}) on rice growth, rhizosphere bacterial communities, and soil organic carbon (SOC) under different soil pH conditions. Mulching years reduced rice growth; 20a showed more negative effects than 60a on rice tillers number and biomass. PMFR changed the composition, diversity, and metabolic function of the rhizosphere bacterial communities. The content of SOC decreased as mulching residues increased; total organic carbon (TOC), soil organic matter (SOM), Fn (355), and humification index (HIX) declined by 30.24%, 55.97%, 59.74%, and 70.24%, respectively. Furthermore, significant correlations between bacterial communities and SOC were observed in the soil-microbe-plant system. PMFR showed stronger negative effects on rice growth in acidic soil (pH 4.5); however, in basic soil (pH 8.5), there were stronger

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Plastic mulch debris in rhizosphere: Interactions with soil-microbe-plant systems

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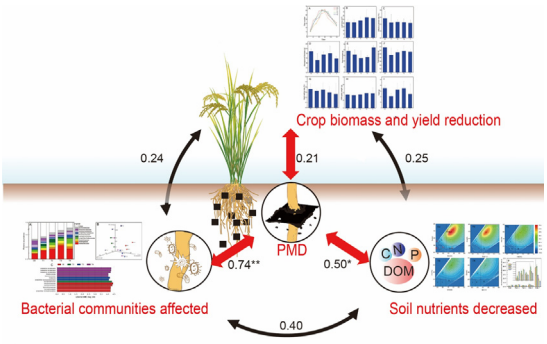
HIGHLIGHTS

- The proportion of P was increased by plastic mulch debris (PMD) up to 110.34%.
- PMD increased the total OTUs of bacteria by 0.03–17.05%.
- PMD reduced the diversity and evenness of bacterial (Shannon) by 0.69–7.55%.
- The rank of impact degree of PMD on factors were, "soil > microbe > plant".
- Specific influence mechanism of PMD on agroecosystem is indicated to be complex.

GRAPHICAL ABSTRACT



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ABSTRACT

Large amounts of plastic mulch debris (PMD) accumulated in the soil can endanger agroecosystems. However, little is known about the interactions between PMD and soil-microbe-plant systems. In this study, a pot experiment (four replicates) in tropical greenhouse was conducted to investigate the effects of PMD (polyethylene) at different concentrations (0, 0.4, 0.8, 4.0, 6.0 g kg^{-1}) on soil nutrients, rhizosphere bacterial communities and rice growth. This study further explored the interactive mechanisms between PMD and environmental factors based on correlation analysis and previous studies. The results showed that PMD continuously reduced the soil capabilities to store nutrients (C, N, P, humic-like substances) and increased the proportion of P and biodegradable dissolved organic matter (DOM). At the full ripening stage of rice growth, total organic carbon (TOC), total nitrogen (TN) and total phosphorus (TP) in all PMD treatments significantly decreased by 60.86, 52.51 and 34.83% respectively as compared to CK ($p < 0.05$). Furthermore, PMD increased the total abundance of bacteria but reduced the diversity and evenness of bacterial communities, which further affected microbial metabolic functions. Total OTUs and Shannon decreased 0.02–17.05% and 0.69–7.55% in treatments. At harvest-time, PMD reduced the biomass and yield of rice with 11.34 and 19.24% (all treatments on average) lower than CK. Under the influence of PMD, the order of correlation size between PMD and one environmental factor was PMD-soil > PMD-microbe > PMD-plant, and the order of correlation between two environmental factors was soil-microbe > microbe-plant > soil-

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Dissolved organic carbon drives nutrient cycling via microbial community in paddy soil

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ABSTRACT

Microbial mediated iron cycling drives the biogeochemical cycling of carbon, nitrogen, sulfur, and phosphorus. However, the fate of the microbial community and the relative metabolic pathways in paddy soil after the addition of biogas slurry are poorly understood. In this study, the response of functional genes was investigated by growing one-season rice in paddy soils in a pot experiment. Seven treatments were prepared: 1) control (CK); 2) organic carbon (OC); 3) fertilizer (F); 4) 5% of biogas slurry (B05); 5) 10% of biogas slurry (B10); 6) 15% of biogas slurry (B15); 7) 20% of biogas slurry (B20). In the biogas slurry treatments, *Geobacter* increased more than in the other treatments during rice growth, which were structured by TOC. Particularly, in the B10 treatment, the relative abundance of *Geobacter* was 1.6 and 14.8 times higher than that of CK at the heading and mature stages, respectively. At the heading stage, the addition of biogas slurry and OC shifted the microbial phosphorus-transformation communities differently. There were no significant differences in the carbon, nitrogen, and sulfur metabolic pathways between the two treatments. At the mature stage, the carbon: nitrogen: phosphorus balance was significantly influenced by the regulation of functional gene expression and metabolic activities. These findings provide insight into the key factors affecting carbon, nitrogen, sulfur, phosphorus, and iron during rice growth after carbon inputs.

1. Introduction

Paddy soils are characterised by fluctuating redox conditions caused by waterlogging and drainage regimes (Itoh et al., 2013), which provide suitable habitats for a wide range of microbes (Sun et al., 2018). Fluctuating redox reactions shift the microbial community and the sequential reduction of terminal electron acceptors, such as NO_3^-, Fe^{3+} and SO_4^{2-}. Many studies have focused on studying microbes to understand the biogeochemical cycling of paddy soils (Wei et al., 2019; Li and Zhou, 2020). However, there is a knowledge gap among the microbial community, metabolic pathways, and identification of functional genes in the paddy soil.

Phosphorous is an essential element for all biota (Rodríguez and Fraga, 1999), and microbes play an important role in soil phosphorus cycling (Richardson and Simpson, 2011). Forty genes involved in phosphorus transformation have thus far been identified, including those involved in phosphorus-starvation response regulation (group 1), inorganic phosphorus solubilisation and organic phosphorus mineralisation (group 2), and phosphorus uptake and transport (group 3) (Bergkemper et al., 2016).

Iron fluctuation (Fe^{III}–Fe^{II} redox wheel) with carbon, nitrogen, sulfur, and phosphorus drives global biogeochemical cycles (Li et al., 2012; Kappler et al., 2021). Microbes play an important role in the formation and transformation of iron minerals (Luu and Ramsay, 2003). Iron acts

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Article

The Effects of Waste Cement on the Bioavailability, Mobility, and Leaching of Cadmium in Soil

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Abstract: Waste cement is a construction and demolition waste produced from old buildings' demolition and transformation. In recent years, the recycling of recycled concrete is limited to the use of recycled aggregate, and the research on the utilization of waste cement in waste concrete is scarce. This study explored the effective application of waste cement for the adsorption of cadmium (Cd^{2+}) from an aqueous solution and the bioavailability and immobility of Cd^{2+} in soil. Results showed that the maximum adsorption capacities of ordinary Portland cement(OPC) paste, fly ash cement (FAC) paste, and zeolite cement (ZEC) paste for Cd^{2+} were calculated to be 10.97, 9.47, 4.63 $mg \cdot g^{-1}$, respectively. The possible mechanisms for Cd^{2+} adsorption in the solution by waste cement mainly involve precipitation by forming insoluble Cd^{2+} compounds in alkaline conditions, and ion exchange for Cd^{2+} with the exchangeable calcium ions in waste cement, which were confirmed by XRD and SEM. Results from diethylene triaminepentaacetic acid (DTPA) extraction and toxicity characteristic leaching procedure (TCLP) implied reduction of the Cd^{2+} mobility. DTPA-extractable Cd^{2+} decreased by 52, 48 and 46%, respectively, by adding 1% OPC, FAC and ZEC. TCLP-extractable Cd^{2+} decreased by 89.0, 80.3, and 56.0% after 1% OPC, FAC, and ZEC treatment, respectively. BCR analyses indicate that OPC, FAC, and ZEC applications increased the percentage of Cd^{2+} in residual fraction and induced a high reduction in the acid-soluble Cd^{2+} proportion. The leaching column test further confirmed a reduction in Cd^{2+} mobility by waste cement treated under continuous leaching of simulated acid rain (SAR). Therefore, waste cement exhibited a significant enhancement in the immobilization of Cd^{2+} under simulated acid rain (SAR) leaching. In summary, the application of alkaline waste cement could substantially remove Cd^{2+} from wastewater and reduce Cd^{2+} mobility and bioavailability in contaminated soil.

Keywords: waste cement; cadmium; adsorption; immobilization; bioavailability; leaching

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1. Introduction

Cd^{2+} is widely distributed throughout the world due to its high toxicity and long biological half-life [1]. Cd^{2+} cause harmful effects on human and plants due to its high mobility and toxicity [2–4]. Soil Cd^{2+} contamination has become a serious environmental problem with the development of mining exploration, metallurgy industry, solid waste disposal, paints pigments, and wastewater irrigation [5,6]. Acid rain in southern China makes the Cd^{2+} in the soil unstable and spreads to the surrounding environment through surface runoff or leaching to groundwater [7]. The restoration of Cd^{2+} contaminated soil to minimize the risks to human and ecological health needs attention.

Soil remediation by in situ immobilization is a promising technique that stabilizes potentially toxic elements in the soil by adding natural or artificial materials. It is a rapid, cost-effective, and environmentally friendly remediation technology [8,9]. In recent years,

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Effect of Pyrolysis Temperature on the Characterisation of Dissolved Organic Matter from Pyroligneous Acid

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Abstract: Dissolved organic matter (DOM) greatly influences the transformation of nutrients and pollutants in the environment. To investigate the effects of pyrolysis temperatures on the composition and evolution of pyroligneous acid (PA)-derived DOM, DOM solutions extracted from a series of PA derived from eucalyptus at five pyrolysis temperature ranges (240–420 °C) were analysed with Fourier transform infrared spectroscopy, gas chromatography–mass spectroscopy, and fluorescence spectroscopy. Results showed that the dissolved organic carbon content sharply increased ($p < 0.05$) with an increase in pyrolysis temperature. Analysis of the dissolved organic matter composition showed that humic-acid-like substances (71.34–100%) dominated and other fluorescent components (i.e., fulvic-acid-like, soluble microbial by-products, and proteinlike substances) disappeared at high temperatures (>370 °C). The results of two-dimensional correlation spectroscopic analysis suggested that with increasing pyrolysis temperatures, the humic-acid-like substances became more sensitive than other fluorescent components. This study provides valuable information on the characteristic evolution of PA-derived DOM.

Keywords: pyroligneous acid; dissolved organic matter; two-dimensional correlation spectroscopy; pyrolysis temperature

1. Introduction

Pyrolysis is increasingly becoming the most attractive technology for converting biomass waste into bio-oil or biochar [1]. Pyroligneous acid (PA), a by-product of biomass biochar, contains organic substances such as phenolics, aldehydes, ketones, esters, and acids [2,3]. PA has been widely applied as a bacteriostatic agent, plant growth promoter, antioxidant agent, and feed additive because of its complex composition [4,5].

PA and biochar, which are carbon-rich substances with abundant functional groups, have been produced through the pyrolysis of biomass including agricultural and forestry residues in the absence of oxygen [6,7]. Previous studies indicated that biochar-derived dissolved organic matter (DOM) shows significantly different environmental behaviours and recalcitrance because of its abundant reactive functional groups, including phenolic,

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•研究报告•

海南苏铁种群结构与森林群落郁闭度的关系

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摘要: 海南苏铁(*Cycas hainanensis*)是古老的苏铁属植物, 为国家Ⅰ级重点保护植物, 也是IUCN红色名录的濒危物种。为研究海南苏铁在海南昌江保梅岭省级自然保护区的种群结构与森林郁闭度的关系, 本文通过样方法对海南苏铁种群及其所在群落进行调查, 分析了其群落结构和物种多样性, 以及其种群密度、年龄结构、存活曲线、空间分布格局与森林郁闭度的关系。结果表明: 海南苏铁所在群落垂直结构分为乔木上下2层、灌木层和草本层。海南苏铁所在群落物种多样性指数偏高, 群落内物种组成丰富; 各样方内海南苏铁数量分布不均, 经常群生于海拔500 m左右的林下、林缘间。海南苏铁种群结构属于增长型, 种群更新力强, 种群存活曲线趋近于Deevey-II型, 死亡率随着龄级增加而增加, 说明海南苏铁种群处于相对稳定的状态, 随着种群个体的生长发育, 其生存力逐渐下降; 海南苏铁种群空间分布格局呈聚集型, 聚集程度指标随着林分郁闭度变大而增加。曲线估计结果显示, 海南苏铁幼苗幼树在透光率36.11%–58.33%显著增加。综上所述, 昌江保梅岭地区的海南苏铁种群处于较为稳定的增长状态, 喜生长于海拔500 m左右、郁闭度为35%–60%的森林环境中。

关键词: 海南苏铁; 群落结构; 种群结构; 存活曲线; 分布格局

吴二焕, 李东海, 杨小波, 左永令, 李龙, 张培春, 陈琳, 田路嘉, 李晨笛 (2021) 海南苏铁种群结构与森林群落郁闭度的关系. 生物多样性, 29, 1461–1469. doi: 10.17520/biods.2021150.
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研究报告

Population structure of *Cycas hainanensis* and its relationship with forest canopy density

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ABSTRACT

Aim: *Cycas hainanensis*, an ancient species of *Cycas*, is a top priority plant species in China and is also classified as endangered by the International Union for Conservation of Nature (IUCN) Red List. We aim to study the relationship between population structure and forest canopy density of *C. hainanensis* in the Baomeiling Provincial Nature Reserve of Changjiang County, Hainan Province.

Methods: After an investigation of the *C. hainanensis* population and its community by utilizing the sample survey, we analyzed community characteristics including structure and species diversity, and population characteristics such as age structure, survival curve, spatial patterns, and population density. We also studied the relationship between *C. hainanensis* and forest canopy density.

Results: The vertical structure of the community of *C. hainanensis* was divided into two tree layers, shrub layer and herb layer. The species diversity index of the community was high and the community species composition was rich. The distribution of *C. hainanensis* was uneven in all quadrats and formed clusters in the undergrowth as well as the forest edge at an elevation of 500 m. The population dynamics belonged to growth type, and the population renewal ability is strong. The population survival curve of *C. hainanensis* tended to the Deevey-II type. The population mortality increased with age, which indicated that the population of *C. hainanensis* was in a state of stable growth. The

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Jin X，Ling SJ，Wen F，Ren MX. Biogeographical patterns and floral evolution of *Oreocharis* (Gesneriaceae)[J]. *Plant Science Journal*，2021，39(4)：379-388

广义马铃苣苔属的生物地理格局与花部演化

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摘 要：本文系统总结了广义马铃苣苔属(*Oreocharis*)的地理分布范围和花部特征，利用核基因ITS1、ITS2和叶绿体基因*trnL-trnF*重建广义马铃苣苔属主要物种的分子系统关系，并结合花部特征和地理分布特点分析花部特征的适应性与演化规率。结果显示：广义马铃苣苔属可分为两个支系，一个支系主要分布于中国西南地区，以黄色花冠、雄蕊4为主；另一个支系则集中分布于中国南部与东南部区域，以紫色花冠为主，并出现了雄蕊2的特化类群。广义马铃苣苔属花冠发生了两侧对称向辐射对称的演化。海南岛分布的所有4个物种都是该岛的特有种，来源于一个共同祖先(可能是花冠亮黄色、花辐射对称)，后期逐渐出现花冠橙红色、两侧对称等性状。高山深谷的地理隔离作用、不同生境的隔离作用以及以不同蜂类传粉者类群的趋异选择是马铃苣苔属物种花部特征多样性演化的主要原因。

关键词：长蒴苣苔亚科；马铃苣苔属；物种多样性；花部综合特征；传粉；适应演化
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Biogeographical patterns and floral evolution of *Oreocharis* (Gesneriaceae)

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Abstract: We examined the geographical distribution ranges and floral traits of *Oreocharis* and used nuclear ITS1，ITS2 and chloroplast *trnL-trnF* sequences of 58 *Oreocharis* species to construct a phylogenetic tree. We then analyzed the adaptation and evolution of floral traits based on the above data. Results showed the *Oreocharis* could be separated into two clades. Clade A was mainly distributed in Southwest China and predominantly showed yellow corollas with four stamens; Clade B was mainly distributed in South and Southeast China and predominantly showed purple corollas，with several species evolving two stamens. Corolla evolution from zygomorphy to actinomorphy was also detected. All four Hainan-endemic

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ZHANG Z, REN MX, XIANG WQ, et al. Species diversity, habits and pollination system of Orchidaceae in Southeast Asia [J]. Guihaia, 2021, 41(10): 1683-1698.

东南亚兰科植物的物种多样性、生活习性及其传粉系统

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摘 要: 兰科(Orchidaceae)植物广布于除两极和极端沙漠地区外的各种陆地生态系统,包括 5 个亚科 800 多属 28 000 多种。东南亚地区兰科植物种数约占世界的 1/3,是兰科植物生物多样性热点区域之一。通过查阅文献及书籍等资料,该文系统整理了东南亚兰科植物物种种类及其扩散演化历史,并对其生活习性和传粉系统进行了归类。结果表明:(1)东南亚兰科植物 8 855 种,分属 5 亚科 17 族 26 亚族 240 属;(2)主要生活型为附生的有 127 属 6 000 种以上,地生 97 属 2 000 种以上,腐生 13 属约 100 种,藤本 4 属 40 余种;(3)根据整理出的东南亚 79 个属的兰科植物传粉系统发现,有 44 个属含有自动自交的物种,具报酬物的传粉系统有花粉(仅见于拟兰亚科)、芳香类物质(仅见于香荚兰亚科)和花蜜(5 个亚科均有)等报酬物类型。欺骗性传粉系统广泛存在于各个亚科,包括食源性欺骗、性拟态、繁殖地拟态和信息素拟态等类型。东南亚兰科植物在物种、生活习性及传粉系统都展现出极高的多样性,对这些生物学特点的总结将为兰科植物的保育提供一定的理论基础和本底资料。

关键词: 东南亚, 兰科植物, 物种多样性, 传粉生物学, 保育

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Species diversity, habits and pollination system of Orchidaceae in Southeast Asia

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Abstract: Orchidaceae, widely distributed in various terrestrial ecosystems except for Antarctica, Arctic and extreme desert areas, comprises more than 28 000 species in more than 800 genera of 5 subfamilies. As one of the hotspots of orchid biodiversity in the world, Southeast Asia accounted for about 1/3 of all orchid species. In this paper, we reviewed the species diversity, evolution and dispersal history, as well as classified the habits and pollination systems of orchid species in Southeast Asia. The results are as follows: (1) A total of 8 855 orchid species, which belongs to 5 subfamilies, 17 tribes, 26 subtribes and 240 genera in Southeast Asia, were enumerated and evaluated. (2) The main habits of orchids in Southeast Asia include more than 6 000 epiphytic species of 127 genera, more than 2 000 terrestrial species of 97 genera, about 100 saprophytic species of 13 genera and more than 40 vine species of 4 genera. (3) According to the pollination system of 79 genera of Orchidaceae in Southeast Asia, 44 genera contained automatic self-pollination species. Rewarding pollination systems involve the forms of pollen (only found in subfamily Apostasioideae),

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海南苏铁野生种群分布特点及种群动态研究

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摘要：为摸清掌握海南苏铁（*Cycas hainanensis* C. J. Chen）植物资源在海南的分布规律及种群发展动态，通过 56 个实测点与 62 个样方对海南岛野生海南苏铁开展全面调查，对该省天然海南苏铁的自然种群地理分布、种群特征和种群分布格局及影响种群环境因子开展研究。结果表明：1）海南苏铁主要分布在五指山市、保亭县和琼中县等中南部山区市县和昌江县的东南部山区；2）集中分布于 400～800m 的中低海拔半阳坡、半阴坡和 40%～60% 中等偏高郁闭度的热带雨林中，地势平坦，常生于林下或林缘灌丛中及沟谷旁；3）海南苏铁种群内幼树、中树居多，但大树少，幼苗最少，更新力不强，种群结构表现为稳定型；4）静态生命表结果显示，种群死亡率整体上表现出随着龄级的增加而递增的趋势，存活曲线整体上看接近于 Deevey-Ⅰ型；5）种群分布有向均匀分布转变的趋势。

关键词：海南岛，海南苏铁，种群特征，地理分布，分布特征
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Study on Distribution Characteristics and Population Dynamics of Wild *Cycas Hainanensis* in Hainan Island

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Abstract: In order to recognize the distribution characteristics and population dynamics of *Cycas Hainanensis* resources in Hainan, a general investigation of wild *Cycas Hainanensis* was conducted in 56 sites and 62 quadrats in Hainan Island. The geographical distribution, population characteristics, population distribution pattern and the influence environmental factors of wild *Cycas Hainanensis* population were studied. The results showed that: 1) the investigated regional distribution of *Cycas hainanensis* mainly included Wuzhishan city, Baoting county and Qiongzhong county etc in central and southern mountain cities and counties, and the southeast mountain areas of Changjiang county; 2) *Cycas Hainanensis* was mainly distributed in tropical rainforests with a medium and high elevation range of 400～

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基于 Citespace 的国内城市水体修复研究综述

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摘要：为详细了解国内近 20 年城市水体污染修复的发展趋势与研究前沿，利用 CNKI 数据库以“城市＋水体＋修复”为主题进行检索，以 2000～2020 年间的相关文献为对象，采用文献计量学方法，利用 Citespace 可视化分析软件对城市水体修复分析发现：在 20 年间，我国学术界对于城市水体污染修复的研究关注度呈现总体上升趋势；该领域研究中高频关键词前三位为“生态修复”“黑臭水体”“城市河道”；对于城市水体污染修复的研究主要由各个机构独自进行，机构与机构间的合作呈现小聚集的模式，研究作者间除个别团体合作较紧密，人数较多外，大部分研究作者跨单位并无明显合作关系。基于以上分析，预测了在城市水体修复领域未来的研究热点为：修复理念的综合应用研究和多种水体修复联合技术的研发，以及多学科多专业联合攻关。

关键词：城市；水体；修复；污染；Citespace
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1 引言

随着经济的飞速发展，城市人口不断增长，造成城市水体受到不同程度的污染，这不仅会破坏城市人居环境的和谐，损坏水体生态系统，还会直接影响区域内居民身心健康和经济社会的可持续发展[1～3]。所以，城市水体污染问题已经成为当前我国亟待解决的环境问题之一，而进行水体修复是这一问题的主要应对策略。水体修复是指通过人工干预的方式，采用物理、化学和生物修复技术，令城市水体恢复到原有的生态功能的过程，而不是依赖于水生生态系统自身的适应能力和调节能力来调节和净化水体[4]。20 世纪 60 年代，生态工程的理念开始在欧美出现，1965 年德国的 Ernst Bittmann 在莱茵河用芦苇和柳树进行生态护岸试验[5]，可以看作是最早的河流生态修复实践[6]。

近年来，我国学者在城市河流或湖泊等水体修复领域也做了大量研究，如苏媛[7]等对美人蕉、水菖蒲、西伯利亚鸢尾等浮床植物进行水体净化率对比实验，认为前两者净化效率因不同水体而异，而西伯利亚鸢尾不适宜作为浮床植物。杜聪[8]等采用复合微生物菌剂对城市黑臭河道进行不同浓度梯度实验，得出在一定浓度范围内，投放菌剂明显改善河道水质，同时也有助于恢复生物多样性。王熙[9]等通过对污染水体中投放过氧化钙的实验，认为在一定范围内向水体中投放过氧化钙可以有效抑制嗅味物质和氮磷的释放，但基本都是对于某一特定方向的研究总结，没有进行过整体性的分析。周飞祥[10]通过人工浮岛，复氧技术，水生动植物的净化作用，有效治理了河南省鹤壁市的严重黑臭水体现象。黄伯平[11]等通过曝气造流、设置生物膜自净设备等技术，有效修复了南京市江心洲河道的水质污染与生态破坏问题。上述提出的技术手段均在不同领域充实了水体修复方面的理论，也提高了相关实践的工作效率。为了更好地了解我国近 20 年在这方面的工作取得成绩和存在的问题，本文利用 Citespace 可视化分析软件对 2000～2020 年间的相关文献进行分析，分析城市水体修复的研究现状和未来热点，明确这一领域的演化路径和发展趋势。

2 数据来源与研究方法

2.1 数据来源

以“城市＋水体＋修复”3 个词汇为主题词，将检索时间设置 2000～2020 年，在 CNKI 数据库得到 988 篇期刊论文，经过整理，剔除无效数据后，得到有效文献 944 篇。

2.2 研究方法

自 2003 年陈超美教授开发 Citespace 后，此软件已经成为近年来最具有代表性的信息可视化软件之一，通过展现知识领域的交叉关系，突出某一研究领域的研究热点及研究趋势，在以总结现有文献材料的基础上，强化相关领域的文献数据的可视化，从而预见该领域未来趋势[12]。本文通过 Excel 软件和 Citespace 文献计量工具，绘制城市水体修复主题相关文献中发文量分析图、高频关键词共现图、高频关键词聚类图、机构合作网络图谱、作者合作网络图谱、高频关键词时区分布图，梳理出近 20 年来该领域的研究现状，展望未来的研究热点方向，以期为后续相关研究提供一定参考。

3 研究现状分析

3.1 发文量时间分析

图 1 显示，基于 2000～2020 年城市水体污染修复

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论 文 中国植被生态学专辑

海南植被分类体系与植被分布图

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摘要 本文结合历史资料和本团队30多年的野外样方调查数据, 分析了海南植被的组成与结构特点, 修订和完善了海南植被分类体系; 通过遥感解译、样方数据和野外实地核实, 完成了海南植被分布图的绘制. 在水平地带性上, 海南植被可区划为热带雨林区和季雨林区. 在热带雨林区, 垂直地带上可区划为低地雨林、山地雨林、高山云雾林和山顶灌丛; 在季雨林区, 植被类型垂直地带性差异不明显. 非地带性植被类型有海草床(草丛)、红树林、滨海丛林, 包括潟湖、岛屿和河口等海岸丛林(含三沙市的岛屿丛林)、滨江(河)丛林、次生草丛、次生灌丛和藤蔓丛等. 海南植被可划分为自然植被和人工植被两大类, 自然植被可分为森林、灌丛、草丛和藤蔓丛4个植被型纲, 5个植被型组, 14个植被型, 196个群系("群系"="海南植被志"中的"类群"); 人工植被主要有3个植被型组: 生态保护植被型组、生态景观植被型组和农业生产植被型组, 共9个植被型. 本研究同时完成了海南省尺度(不含三沙市)、市县尺度和乡镇尺度等三个级别的分布图(1:5万比例尺).

关键词 植被分类, 热带植被, 海南, 中国, 植被制图

亚洲的热带雨林, 多以龙脑香科(Dipterocarpaceae)、肉豆蔻科(Myristacaceae)、玉蕊科(Barringtoniaceae)等种类为优势[1,2]. 中国的雨林由于分布于热带北缘, 典型的热带种已较少, 如龙脑香科植物在东南亚约有25属400余种, 在中国只有5属和12种[3], 其中海南只有2属3种, 云南和广西南部有4属6种[3]. 但是, 龙脑香科、肉豆蔻科、玉蕊科等科植物的出现, 也说明中国雨林与东南亚赤道雨林有密切关系, 属亚洲热带雨林范畴[3~12].

热带季雨林一直以来都是颇具争议的植被类型, 国内外不同的学者使用的名称并不一致. Beard[13]在研究南美洲的特里尼达岛热带森林时, 将其划分为低山雨林、常绿季雨林、半常绿季节雨林和落叶季节林四个顶极类型. 而Richards[1]认为, 这个方案中的常绿季节林和低山雨林在群落结构和外貌上差异很小, 应该把常绿季节林归并到热带雨林的范畴. 热带季雨林的物种丰富度由于不同地区不同学者所选取的样地面积不同而无法比较, 但是其相对热带雨林来说是较低的, 且优势种和主要伴生种在干旱季节落叶是热带季雨林的典型特征[14~17]. 在海南的落叶季雨林中, 其优势种

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十四五规划

科学规划“十四五”，擘画发展新蓝图

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谈“十四五”生态保护与绿色发展的生态关系

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摘要 从“十四五”保护与发展的生态关系角度,探讨了生态保护与绿色发展的十大生态关系,阐述了生态保护和绿色发展中的一系列有关生态关系的生态智慧及生态技术,并对长江、黄河等流域的生态保护和修复提出了相关建议。

关键词 生态;生态经济;生态智慧;生态技术;生态城市

“十四五”时期的生态与环境保护,提出以2035年基本建成美丽中国的目标为指引,做长长板、补足短板、以点带面,全面开展目标设定、措施部署工作。具体来说,一是要将各行政区域生态保护和绿色发展融入流域、区域的生态环保和绿色发展大格局,即基于长江、黄河流域生态大保护和绿色发展的基础上,增加对淮河、海河、松花江、辽河等大流域、渤海湾等大海域的流域生态系统修复。二是以武汉、成都、长沙、西安等为中心城市的大都市群,在长三角、珠三角、汾渭平原等区域,全面开展流域和区域生态保护与绿色发展工作,将各行政区域与流域和区域的大格局的生态保护和绿色发展结合起来,整体提升中国生态保护和绿色发展质量。要实现这两大目标,处理好各种生态关系至关

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