
SEL Research 深度学习技术实现跳虫快速鉴定，推动土壤生物多样性研究革新

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SEL Research 深度学习技术实现跳虫快速鉴定，推动土壤生物多样性研究革新。论文标题：Deep learning method for collembola identification using single species and community combinations images

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Deep learning method for collembola identification using single species and community combinations images

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ABSTRACT

• YOLOv8 was better than Faster R-CNN in Collembola detection, attaining 97% precision.

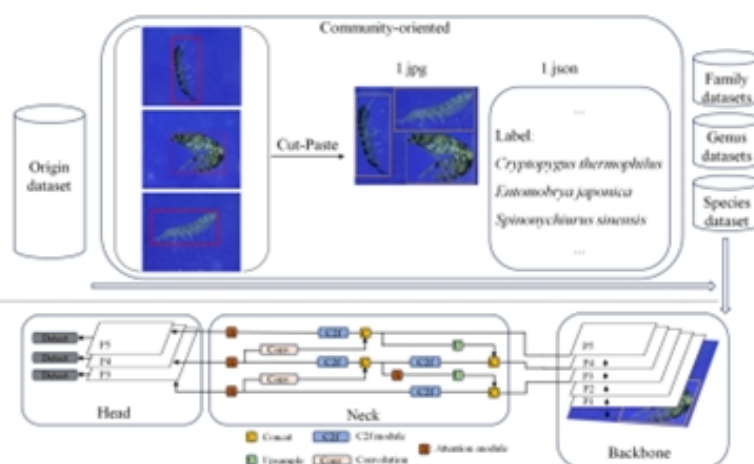
• Precision varied widely (18.51%–99.17%) with Collembola diversity at genus-level.

• Our study shows deep learning's potential for rapid and precise ecology evaluation.

Deep learning methods are increasingly vital for species classification across animal species. However, the arthropod classification and detection of deep learning remain underexplored, especially soil arthropods. In this study, we collected 5020 images of collembolan individual as the origin dataset, spanning 6 families, 10 genera, and 51 species in China. By employing the cut-paste method, we created community image datasets of collembolan with diversity gradient to train and evaluate YOLOv8 and Faster R-CNN models for collembolan identification using deep learning methods.

Our classification model achieved 83.05% precision and detection models exceeded 97%. YOLOv8 models were the most effective, with a higher top-1 precision all over 80% at the family level, compared to the Faster R-CNN model, which had a minimum precision of 60%. Using community datasets of genera belonging to Isotomidae or Entomobryidae family to train YOLOv8 models, we observed precision ranging from 18.51% to 99.17%, reflecting the changes of detection performance based on Collembola diversity. The YOLOv8 models excelled in identifying genera within Isotomidae family compared to Entomobryidae family. Our study pioneers the application of the YOLOv8 deep learning model for rapid detection and classification of Collembola, while proposing an adaptive training strategy specifically designed for diversity gradient samples. Our research demonstrates the potential of deep learning for rapid, accurate Collembola identification and extends to broader ecological assessments.

Keywords Collembola diversity, Collembola identification, deep learning, image identification, object detection



由中山大学和中国科学院城市环境研究所领衔的国际团队，开发了一种基于深度学习（YOLOv8模型）的跳虫（Collembola）快速鉴定新方法。该研究通过分析5020张涵盖中国6科51种跳虫的高清图像，首次实现：

1. 个体识别精度达97%，物种分类准确率83.05%；

2. 复杂群落场景适应性：针对不同多样性梯度（2~9属）的跳虫群落，模型精度稳定维持在80%以上；

3. 技术突破性：相较传统Faster R-CNN模型，YOLOv8在微小体型（1~2 mm）和形态相似物种的鉴别中表现更优。

科学价值

跳虫作为土壤健康的指示生物，在养分循环和生态系统功能中起关键作用。传统分类依赖专家显微镜观察，效率低下。本研究通过：

- 创新数据增强：采用剪切-粘贴算法构建多样性梯度合成图像库；
- 跨学科技术融合：结合计算机视觉与生态学，解决土壤动物鉴定的尺度敏感性和形态相似性难题。

应用前景

- 生态监测：支持土壤污染评估和生物多样性保护
- 农业实践：为精准农业提供土壤健康快速诊断工具

方法学拓展：技术框架可推广至螨类、线虫等土壤微型动物研究

作者及团队介绍

庄晓濠（第一作者），中山大学2023级硕士研究生，研究方向为AI识别土壤动物。

孙新（通讯作者），理学博士，中国科学院城市环境研究所，研究员，博士生导师。德国洪堡学者。近年围绕城市土壤生物多样性，系统揭示了城市土壤生物群落空间分布格局及驱动机制，并阐明了动物宿主与其寄生虫和病原菌的互作机制及其对人类健康的风险。目前在Nature Cities、PNAS、Glob Change Biol、Soil Biol Biochem等期刊发表论文120余篇、专著1部。主持国家自然科学基金国际(地区)合作与交流项目、科技部重点研发计划课题等十余项。担任多个国内外土壤学领域期刊编委。获第八届中国土壤学会优秀青年学者奖等。

刘胜杰（通讯作者），中山大学生态学院副教授，主要从事土壤生物学与生态学方面的研究，研究领域可分为：1) 土壤节肢动物的多样性和生态功能；2) 土壤食物网的结构和功能；3) 土壤生态系统对全球气候变化的响应与调节。先后主持了3项国家自然科学基金，5项省部级项目。目前以一作或通讯作者（含共同）在国内外生态学和土壤学期刊发表研究论文20篇。

专题征稿

城市土壤生态与同一健康

Call for papers: Urban Soil Ecology and One Health

Urban landscapes are complex incubators for emerging public health threats, including the persistence and spread of zoonotic pathogens that jeopardize the integrated health of humans, animals, plants, and environments—a nexus addressed by the One Health framework. Within these ecosystems, soil biodiversity is a keystone component that underpins critical ecosystem functions, yet it persists as one of the least understood elements of urban ecosystems.

Aligned with the World Soil Day 2025 theme, "Healthy soils for healthy cities," this special issue calls for research to address this knowledge gap. We seek submissions that illuminate the distribution patterns and functional contributions of urban soil biota, particularly under pressures from human activity and climate change. We are also interested in studies exploring how harnessing urban soil biodiversity can lead to nature-based solutions for mitigating biodiversity loss, adapting to climate change, and reducing the urban burden of disease. We particularly encourage studies proposing frameworks for embedding soil biodiversity into urban governance and policy to directly enhance One Health outcomes.

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期刊简介

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