POLICY BRIEF

THE POWER OF REFERENCE COLLECTIONS FOR BIODIVERSITY MONITORING

TETTRIs
Transforming European
Taxonomy through Training,
Research and Innovation

Summary

Global environmental changes have accelerated the speed of biodiversity decline at an unprecedented rate. In the context of the **EU Green Deal**, the **2030 Biodiversity Strategy** and the **Global Biodiversity Framework**, biodiversity monitoring is a crucial component for understanding biodiversity changes in our ecosystems and ultimately reversing negative trends. In turn, the success of any biodiversity monitoring scheme is dependent on accurate, reliable and timely available taxonomic data, tools and expertise. EU-funded project **TETTRIs** is tasked with developing and validating taxonomic knowledge and systems in support of the current biodiversity governance framework needs.

Taxonomy is the science of naming, describing and classifying organisms and applies to both biological and geological diversity of the world.

This policy brief highlights the importance of reference collections and provides recommendations in support of European monitoring efforts, with a special focus on pollinators. Under TETTRIs, a roadmap to build linked virtual and physical reference collections has been developed and is being tested for further refinement through the so-called **Third-Party Projects** (3PPs), carried out by local actors in biodiversity hotspots and protected areas across Europe.

In this framework, **reference collections** are a set of specimens with reliable identifications belonging to a defined group, used as a benchmark to identify additional specimens.

Policy context

The 2022 Kunming–Montréal Global Biodiversity Framework (GBF) **requires countries to implement biodiversity monitoring programs and guides** accomplishment of global Sustainable Development Goals by 20230. In Europe, the approved Nature Restoration Law (NRL), part of the European Green Deal, sets binding targets for monitoring species and ecosystems. In particular, the EU 2030 Biodiversity Strategy and the revised Pollinators Initiative aim to halt and reverse by 2030 the current pollinators decline that threatens wildlife and agriculture, and human welfare at large.

The EU Pollinator Monitoring Scheme (EUPoMS), proposed in 2021 by the European Commission, provides a **framework for systematic pollinator monitoring**, addressing knowledge gaps and guiding implementation criteria, requirements and mechanisms.

Nearly **90%** of the world's wild flowering plant species, essential for ecosystem functioning, depend, entirely or at least in part, on **animal pollination**.
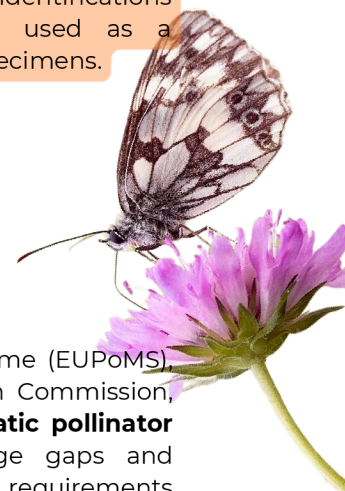
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Species identification for biodiversity monitoring

Under the joint framework of all these initiatives, several components are critical for effective and sustained (pollinator) monitoring anchored on species identification:

Taxonomic expertise

Taxonomists are experts in species identification as a reliable, globally accepted reference to manage biodiversity. Taxonomy guides decisions on what to preserve, remove (i.e. invasive alien species) and restore, to foster the healthy functioning of natural ecosystems.

Taxonomic expertise is mostly found in collection-holding institutions where professional taxonomists conduct research and use their knowledge and scientific collections to document biodiversity. Yet, this expertise is scarce, unequally spread, and insufficient for the herculean effort of describing all species.

As more than 1 million species are threatened with extinction in the World **taxonomists are also a species in sharp decline.**

Taxonomic tools

To contribute to expanding taxonomic knowledge pivotal for comprehensive monitoring, para-taxonomists, amateurs, and citizen scientists need adequate resources, including proper training and

tools such as AI apps, field guides, factsheets, and research papers to support identification in the field. These tools vary in accessibility, reliability, and required expertise. Moreover, many species may require detailed examination with scientific equipment in proper laboratories.

Many species cannot be identified from general images but require **specialised work**.

Scientific reference collections

Natural history collections serve as repositories for type specimens and benchmarks to avoid species misidentification. Those are pivotal for implementing biodiversity monitoring. As underlined by the EUPoMS, each country should develop a national reference collection managed by credited institutions (like natural history museums) and coordinated by central European hubs (such as CETAF). These collections support taxonomic training and foster innovative monitoring methods, including automatic image analysis and sound recognition.

Only ca. 15% of biodiversity worldwide is well described and documented. The rest remains **a mystery** for science.

Overcoming shortages in resources

Information on collections, species composition, genomic data, and identification keys needs to be accessible on open platforms. Digital indexes of reference collections help stakeholders locate benchmark specimens. These indexes are vital for raising awareness and increasing accessibility to collections.

Future virtual collections must include images of diagnostic traits for accurate identification. However, the field still faces a shortage of experts and resources, hindered by siloed knowledge and limited access to taxonomic infrastructure.

Transformative change is needed to optimize taxonomic research capacity. To address the shortage of tools and resources, **the CETAF community developed a roadmap under the EU-funded TETTRIs project** for building virtual and physical reference collections. TETTRIs emphasizes the importance of reference collections and species indexes for reliable species recognition, especially for difficult taxa. This effort aims to improve identification resources, expand capacity, and ensure quality species monitoring in three axes:

⬡ **Access**: natural history collections and the information extracted (e.g. a species index) must be easily findable and openly accessible to stand as benchmarks and optimally support the activities that encompass identifying individual organisms.

⬡ **Innovation**: collaborative efforts lead to further develop AI tools using image and sound recognition. The metadata obtained enrich reference collections and enlarge the set of features to record and track over time to avoid misidentification and facilitate aggregation of results.

⬡ **Education, training and capacity building:** this contributes to create more and better benchmark collections. Such measures raise interest in taxonomic disciplines (as entomology) among the youngest generation, reach out other stakeholders, including industry, and consolidate a coordinated and dynamic training ecosystem (e.g. DEST).

Recommendations

The realisation and use of reference collections as a pivotal element for biodiversity monitoring anchors on the availability of taxonomic knowledge and expertise together with the adequate tools and systems supporting species identification.

A. Expand dedicated human resources

A.1 Fostering taxonomic recognition through communication initiatives and raising awareness among different audiences of the need of taxonomic work in the species monitoring activities.

A.2 Facilitating training and capacity building through a coordinated catalogue of materials based on: a) a multilingual environment adapted to local needs; b) a multi-level system to address different competences requirements from advanced to beginners; and c) a "train the trainers" model to scale up and ensure sustainability of a comprehensive programme.

A.3 Promoting citizen scientist involvement and tooling them up with adequate resources and benchmark collections to complement professional taxonomists.

B. Provide varied and customised tools and mechanisms

B.1 Building accessible and open species indexes in European collection-holding facilities, to facilitate navigation across a-growing amount of biodiversity data.

B.2 Investing in the provision of detailed references of species, including images portraying specific characteristics needed for identification, keys and species factsheets with descriptions to make benchmark specimens (along with standardised nomenclature) easily available.

B.3 Creating interactive maps and online registries of natural history collections in Europe (such as the CETAF Registry of Collections), preferably also including private collections, with additional information at the species level.

C. Secure sustainable funding mechanisms

C.1 Integrating a long-term approach in support of reference collections to expand, curate and manage taxonomic information for interoperable data aggregation across borders, from local to global levels.

C.2 Increasing the visibility of taxonomy in the EU Framework Programmes and fostering strategic partnerships, to advance taxonomic resources and services and maximise impact for biodiversity monitoring.

C.3 Implementing stable and systemic schemes for taxonomy-related job positions, by opening revised education paths, allowing expanded professional careers, and fostering multidisciplinary integration of taxonomists.

D. Facilitate governance structures

D.1 Founding and developing focused working groups to build reference collections, with the involvement of taxonomic facilities, associations of interested parties (entomological societies) and Citizen Science initiatives.

D.2 Creating a European portal for reference collections (e.g through CETAF) to harmonise and multiply the added value from joint actions, such as streamlining of protocols, sharing expertise and generating best practices.

D.3 Providing training platforms for capacity building in the field of taxonomy beyond projects' timeframes, linked to reference collections and other supporting tools, for the engagement of new generations of experts, professionals and amateurs, in biodiversity monitoring.

Final statement

The development of reference collections is critical for the identification of species to ensure the **effective implementation of monitoring schemes** in Europe and to comprehensively achieve the major targets identified in the Global Biodiversity Framework. A **centralised European platform** of benchmark collections, along with other critical tools such as keys, factsheets and AI/ML tools, can provide harmonised protocols, support the use of common standards and facilitate cross-fertilisation across borders. Yet, this effort cannot be attained in isolation but needs to be aligned to the (sufficient) **taxonomic expertise** required for the provision of reliable, comprehensive and interoperable data, critical for **decision-making in biodiversity monitoring**.

TETTRIs

Transforming European Taxonomy through training, research and innovations

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Type

HORIZON IA - Innovation Action