Natural history collections in the genomic era – an Australian perspective

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AUSTRALIAN MUSEUM

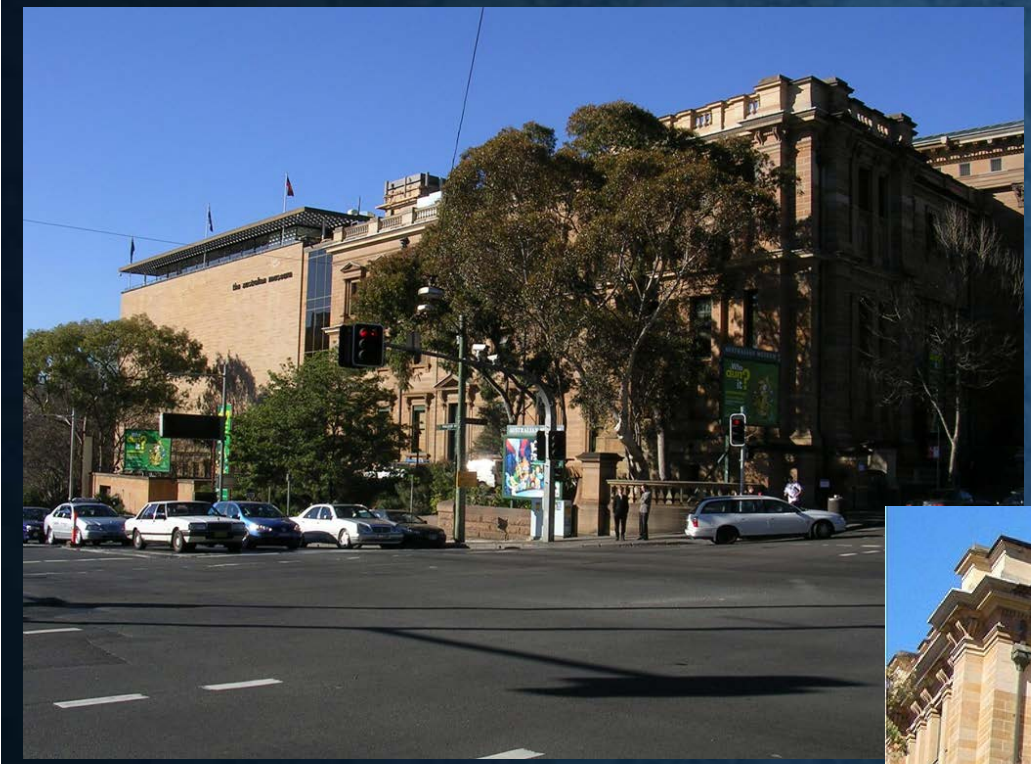
190 YEARS 1827 > 2017

AUSTRALIAN MUSEUM IN THE BEGINNING

The oldest museum in Australia established in 1827. The museum in the current site opened in 1857.

Originally named
Colonial Museum
Re-named AM in 1936

AUSTRALIAN MUSEUM NOW



18 million objects and specimens in the Natural Science and Cultural Collections

The Museum plays a leading role in collection-based research in Australia

NATURAL HISTORY COLLECTIONS

Arachnology
Entomology
Herpetology
Ichthyology
Malacology
Mammology
Marine Invertebrates
Mineralogy
Ornithology
Palaeontology

Dedicated collection managers

NATURAL HISTORY COLLECTION SIZE

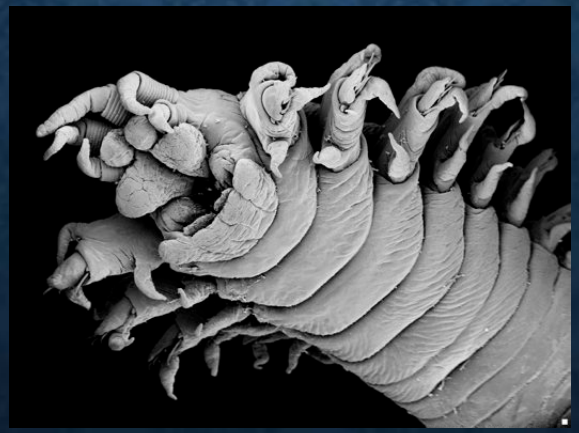
- 1.6 million lots (18 million specimens, including microscope slides, SEM stubs and photos)
- Over 2000 primary types

AUSTRALAIN MUSEUM COLLECTIONS

Spirit (wet) collection:

Frozen tissue collection:

Pinned collection:

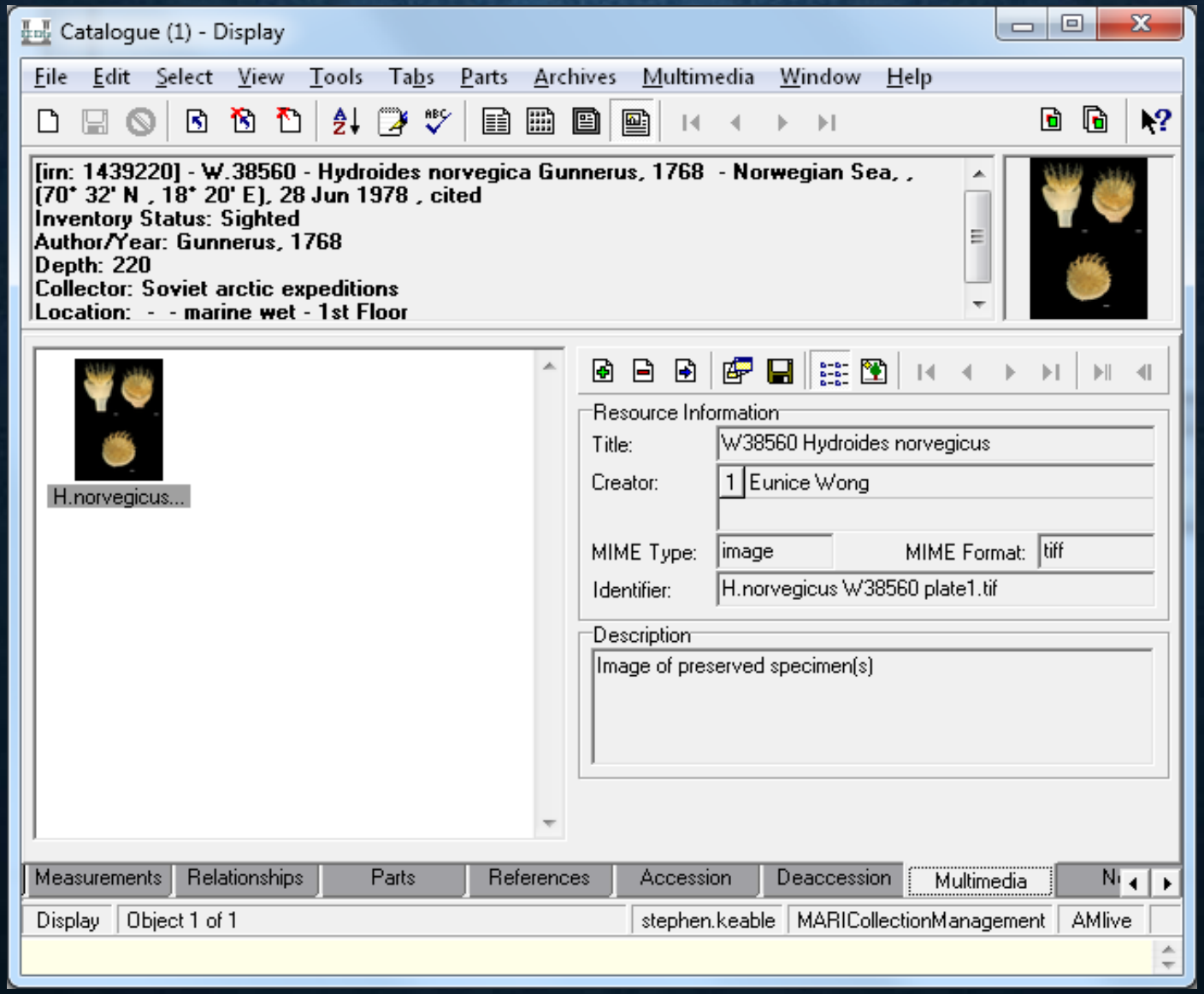


SEM stubs and images

Dry collection:

All registered in KE EMU – Electronic Museum database

AN EXAMPLE OF EMU SPECIMEN ENTRY



Australian Centre for Wildlife Genomics: Molecular Biology Facilities

- A DNA extraction laboratory with DNA preparation robots
- A pre-PCR laboratory with a liquid handling robot
- A main laboratory housing PCR machines, gel running equipment and imaging equipment.

FROZEN TISSUE COLLECTION

- The Australian Museum's Frozen Tissue Collection (FTC) constitutes an integral part of the AM Natural History collections
- FTC managed and curated by Australian Centre for Wildlife Genomics
- Ensures long term archival storage conditions for molecular taxonomy studies and commercial projects
- One of the oldest in Australia (since 1980's)

FROZEN TISSUE COLLECTION

- Currently includes ~85,000 samples of frozen tissue samples and DNA extractions
- Ever expanding collection (recent expeditions and field trips by AM researchers)
- Largest collections come from Australia, South-East Asia and the Pacific Ocean

FROZEN TISSUE COLLECTION

- Tissue samples in the form of actual tissue – e.g. muscle, liver, kidney, bone for large vertebrates, while whole bodies are retained for very small invertebrates
- Samples are used by:
  - AM Research Scientists
  - Loaned to researchers throughout the world (license agreement, approved by AM head of Natural Sciences)

FROZEN TISSUE COLLECTION FREEZERS

- FTC is housed in eight ultra-low temperature (ULT) freezers stored at -80°C, each freezer contains over 10 000 unique samples.
- Two additional freezers for active researcher's material
- Smaller -20°C freezers for ongoing projects
- When a research project is completed, the associated tissue and DNA is accessioned into the main frozen tissue collection

-80°C freezers

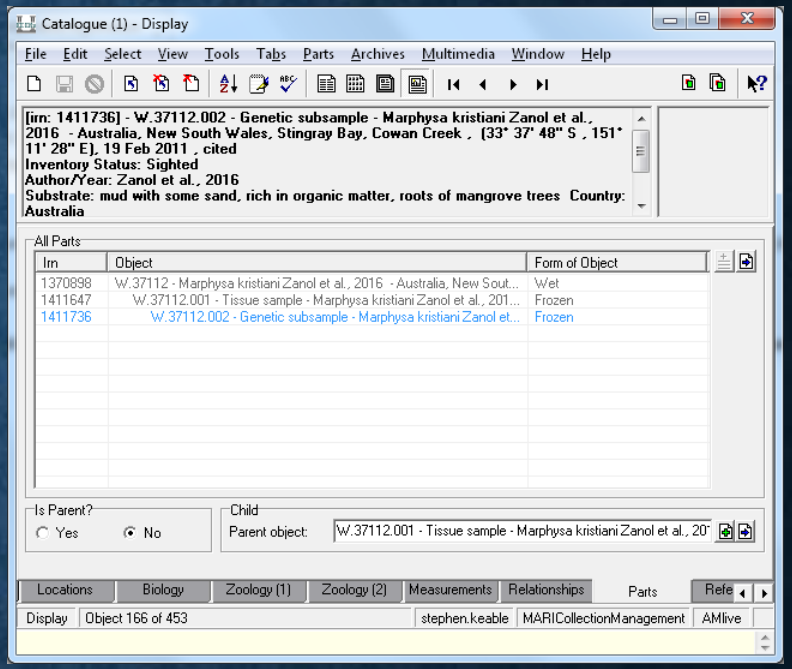
FROZEN TISSUE COLLECTION FREZER SECURITY

- Each freezer is equipped with a temperature sensor wired into a separate system that monitors the temperature status.
- DNA lab staff members are sent text messages that report any problems or temperature fluctuations.
- Power to the freezers is automatically backed up via a generator.
- One of the ULT freezers is kept vacant to act as a backup in the case of freezer failure

-80°C freezers

FROZEN TISSUE COLLECTION

- Data integrated into Electronic Museum (KE EMU) database
- Each sample uses a unique identifier – an EBU number assigned to each specimen
- Standardised pre-barcoded cryovials
- Association of the EBU number and the sample exact location (a freezer location, box number and well position) is crucial



FROZEN TISSUE COLLECTION MANAGEMENT

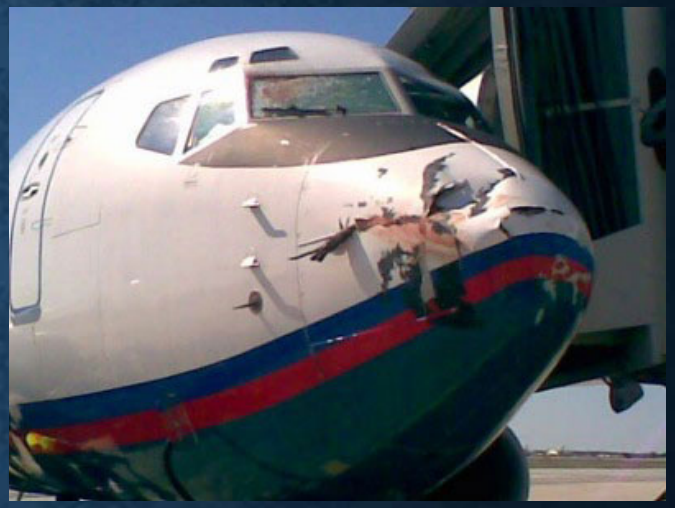
- Collection is unusual compared to other collections:
- it is responsible for the content management, the responsibility of managing the usage of the specimens is with each of the Natural Science Collection Managers.
- FTC is not physically sectioned off into different areas but everything is stored in the freezers together.

Frozen Tissue Collection Management

- Dedicated collection manager whose service role includes:
- Locating samples and providing subsamples for research activities
- Maintaining the integrity of the collection
- Acquisition for and curation of the collection
- Processing new accessions

AUSTRALIAN CENTRE FOR WILDLIFE GENOMICS COMMERCIAL SERVICES

- In addition to supporting taxonomic and evolutionary research
- Bird strikes - DNA-based species identification of the wildlife involved
- Wildlife forensic – DNA-based identifying wildlife involved in crimes such as the illegal poaching or trafficking of endangered species
- Quarantine Approved Premise - limited access by AM staff



Taxonomy, phylogeny and barcoding of the ecologically and economically important tubeworm genus *Hydroides*

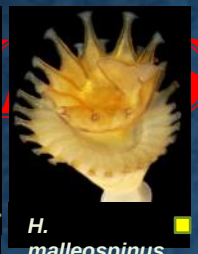
A project supported by Australian Biological Resource Study grant and based on AM collections

MORPHOLOGICAL REVISION:


H. adamaformis

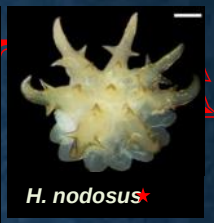

H. exaltatus


H. glasbyi n. sp.


H. malleospinus


H. qiui n. sp.


H. furcifer

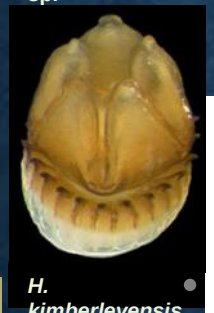

H. nodosus


H. operculatus


H. pseudexaltatus


H. albiceps

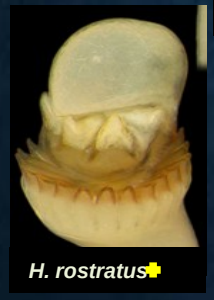

H. minax


H. kimberleyensis


H. rectus


H. externispina


H. tuberculatus

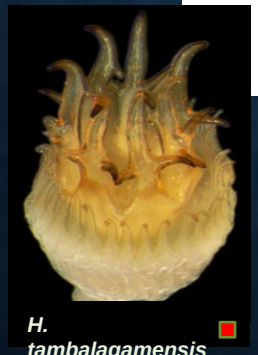

H. rostratus

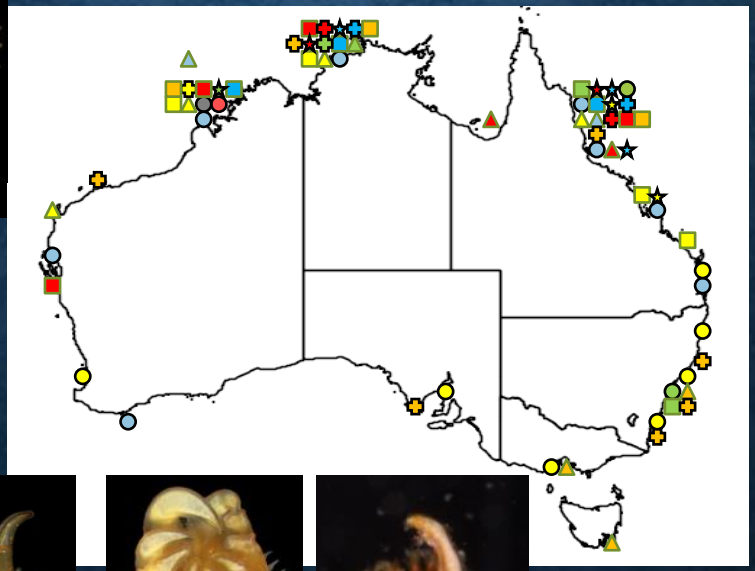

H. sanctaecrucis


H. elegans

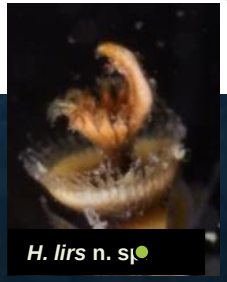

H. diramphus


H. longispinosus


H. tambalagamensis




H. amrii n. sp.

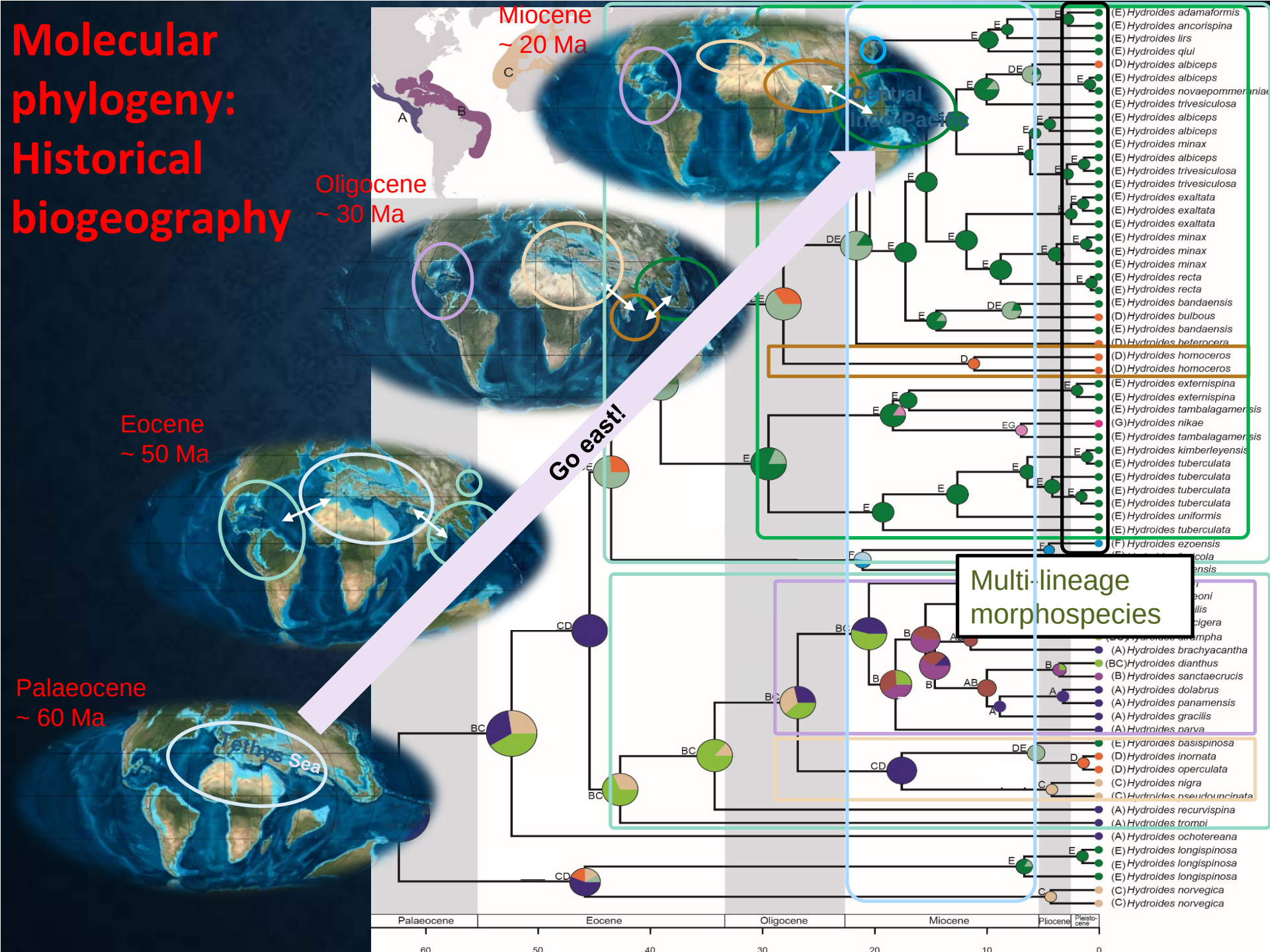

H. lirs n. sp.


H. ezoensis


H. triversiculosus

1435 specimens, 25 species

Morphological revision: *Hydroides* world-wide


Molecular phylogeny: Historical biogeography
Miocene ~ 20 Ma
Oligocene ~ 30 Ma
Eocene ~ 50 Ma
Palaeocene ~ 60 Ma
Tethys Sea
Central Indo-Pacific
Go east!
Multi-lineage morphospecies
(E) Hydroides adamaformis
(E) Hydroides ancorispina
(E) Hydroides lirs
(E) Hydroides qiui
(D) Hydroides albiceps
(E) Hydroides albiceps
(E) Hydroides novaepommeraniae
(E) Hydroides trivesiculosa
(E) Hydroides albiceps
(E) Hydroides albiceps
(E) Hydroides minax
(E) Hydroides albiceps
(E) Hydroides trivesiculosa
(E) Hydroides trivesiculosa
(E) Hydroides exaltata
(E) Hydroides exaltata
(E) Hydroides exaltata
(E) Hydroides minax
(E) Hydroides minax
(E) Hydroides minax
(E) Hydroides recta
(E) Hydroides recta
(E) Hydroides bandaensis
(D) Hydroides bulbous
(E) Hydroides bandaensis
(D) Hydroides homoceros
(D) Hydroides homoceros
(E) Hydroides externispina
(E) Hydroides externispina
(E) Hydroides tambalagamensis
(G) Hydroides nikae
(E) Hydroides tambalagamensis
(E) Hydroides kimberleyensis
(E) Hydroides tuberculata
(E) Hydroides tuberculata
(E) Hydroides tuberculata
(E) Hydroides tuberculata
(E) Hydroides uniformis
(E) Hydroides tuberculata
(F) Hydroides ezoensis
(A) Hydroides brachyacantha
(BC) Hydroides dianthus
(B) Hydroides sanctaecrucis
(A) Hydroides dolabrus
(A) Hydroides panamensis
(A) Hydroides gracilis
(E) Hydroides basispinosa
(D) Hydroides inornata
(D) Hydroides operculata
(C) Hydroides nigra
(A) Hydroides recurvispina
(A) Hydroides ochotereana
(E) Hydroides longispinosa
(E) Hydroides longispinosa
(E) Hydroides longispinosa
(C) Hydroides norvegica
(C) Hydroides norvegica
Palaeocene
Eocene
Oligocene
Miocene
Pliocene
Pleisto-cene
60
50
40
30
20
10
0

IDENTIFICATION AND CRYPTIC SPECIES DETECTION: COI BARCODING OF *HYDROIDES*

Whole genome sequencing of 8 species of *Hydroides*

Mitochondrial genome screening

New COI barcoding primer sets developed for *Hydroides*

A database with 278 sequences of 45 *Hydroides* world-wide


BIOLOGY