Introduction

Precise data for species distribution is crucial for efficient conservation of aquatic biodiversity.

Many aquatic species are notoriously hard to detect.

Recent research has enabled aquatic species detection through analysis of DNA taken from water samples.

References:
Introduction

- Precise data for species distribution is crucial for efficient conservation & management strategies
- Many aquatic species are notoriously hard to detect
- Recent research has enabled aquatic species detection through analysis of DNA taken from water samples


Hebert’s Proposal

Most efficient way to sustain species identification = utilizing DNA sequences as “taxon barcodes”

Few taxonomists  > 0.01% of estimated 10-15 million species

Taxonomic expertise is collapsing

Hebert et al. (2003)
Persistence in Aquatic Systems

DNA of 400 bp may persist in lake environments for ~1 week at 18°C (64.4°F) (Matsui et al. 2001)

What is eDNA?
- eDNA = cell-bound or dissolved DNA that persists in the environment
  - Shed cells, excretions (feces), decaying tissues, urine
  - Every species has a unique DNA sequence
  - Degrades naturally

Methodology
- Collecting water at sample sites
- Filter water to concentrate DNA
- Quantitative Polymerase Chain Reaction (qPCR)
- Screen PCR results for sequence of target species
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Proposed advantages

- Non-invasive alternative
- "Sight-unseen" detection
- Detection sensitivity
- Cost-effective, reduced physical labor
- Invasive and/or cryptic species

Problems & Limitations

Asian carp in Lake Michigan
(Jerde et al. 2011)
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(Jerde et al. 2011)

- Collected 1,000 2L surface samples
- Developed species-specific test for bighead & silver carp
- No false positives in rivers w/o Asian carp & when tested w/ other species
- eDNA surveillance = best approach for the vast scale of monitoring efforts needed in the Great Lakes region

Headwater amphibians, Idaho
(Goldberg et al. 2011)

- No false positives
- 4 co-occurring amphibians species
- Rocky Mtn Tailed frog more difficult to detect in Spring than Fall
- Potential due to metamorphosis timing?
- Species-specific PCR test
- Peristaltic pump used for water samples
- PCR tests and sequencing

American bullfrogs in France
(DeJean et al. 2012)

- Compared detection sensitivity of traditional field methods with new eDNA techniques
- 48 sites surveyed using both methods
American bullfrogs in France (DeJean et al. 2012)

- eDNA surpassed traditional field surveys in sensitivity & sampling effort
- Enables early detection of invasive species
- Suggests American bullfrog distributions have been strongly underestimated

Detection factors (Pilloid et al. 2014)

- Temperature and light conditions play key role in rapid DNA degradation
- eDNA persisted for roughly 8-18 days (longer in shaded treatment)
- Detectability decreased significantly ~50 m downstream

Future Research Directions

- Influences on eDNA detection:
  - Field methods
  - Lab protocols
  - Environmental conditions
- Factors influencing:
  - Lower limits of detection
  - Residence time of eDNA in varying aquatic environments
- Correlation between DNA concentration & species density

(Darling and Mohan 2011, Pilloid et al. 2013, Thomsen et al. 2012)
Conclusions

- Vast potential for monitoring aquatic systems
- Proven efficiency in multi-species detection
- Effective detection of cryptic species
- Early detection & monitoring of invasive species
- Cost effective / reduced physical labor
- Many uncertainties remain!

References


Photos

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