UNIVERSITY
OF SKÖVDE

School of Bioscience

WRITTEN EXAMINATION

Course Molecular Ecology in Conservation

Examination Written final examination

Course code BV715A

Credits for written examination 3.5 hp

Date 2026-01-15

Examination time 8.15-12.30h

Examination responsible Sonja Leidenberger

Teachers concerned Sonja Leidenberger, Tomas Jonsson, Niclas Norrström

Aid at the exam/appendices - No

Other - No

Instructions

- ☐ Take a new sheet of paper for each teacher.
- ☐ Take a new sheet of paper when starting a new question.
- ☒ Write only on one side of the paper.
- ☒ Write your name and personal ID No. on all pages you hand in.
- ☒ Use page numbering.
- ☒ Don´t use a red pen.
- ☒ Mark answered questions with a cross on the cover sheet.

Grade points **40 in total. The written exam will determine the grade of the course. You have to reach at least 50-59% = E, 60-69% = D, 70-79% = C, 80-89% = B, and more than 90% = A in the entire exam.**

Examination results should be made public within 18 working days

Good luck!

Total number of pages 3

Molecular Ecology in Conservation, BV715A, VT 2025

Final examination 15th of January 2025 **In total: 40 points**

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Goal 1: *In detail explain theories, applications and scientific methods within the field of molecular ecology.*

Goal 2: *Critically evaluate results from molecular ecological methods/analyses.*

Background - Ecology and 'Molecular' (6.5 points)

* How has Ernst Haeckel (1869) defined 'ecology'? (1 point)

* What is meant by '*Phenotypic plasticity*' (1 point)?

* Give an example for Haploid chromosomes (1 point) and explain why it is of interest in ecology to study these chromosomes (1.5 points).

* Give for each marker (mtDNA and nDNA) pme example where they are used in molecular ecology (1 point: 0.5 point for each example per marker).

* What are the two main differences between Sanger sequencing (1st generation) and Illumina sequencing (2rd generation)? (1p)

Species and phylogeography (6.5 points)

* Explain the differences between the Morphological Species Concept (MSC) and the genetic species concept (GSC) and name a problem for each of the concepts (1.5 points).

* Hybridization occured in history, but also now. Decribe hybridization effects by explaining

a) what 'sympatric' and 'allopatric' means? (1 point)

b) why it can lead to introgression and what happens genetically? (1 point)

c) what is the main difference when you looking at mtDNA or nDNA? (1 point)

You can use the example of the toads *Bufo bufo* and *Bufo spinosus* to explain hybridization, if you want.

* What is a haplotype network showing in contrast to a cladogram? (2 points)

Population genetics, dispersal and gene flow (10 points)

* Genetic diversity was studied in a population where 10 loci were examined in 100 individuals. The number of alternative alleles found among the examined individuals distributed over the 10 loci was 2, 3, 2, 1, 1, 1, 5, 1, 1, 2. The number of individuals who were heterozygous for the respective loci was 20, 40, 10, 0, 0, 0, 60, 0, 0, 10.

a) Calculate the proportion of *polymorphic loci* (P) (1 point)

b) Calculate the degree of (observed) *heterozygosity* (H_O) across all analysed loci (1 point)

c) Calculate the *allelic diversity* (A) (1 point)

* *Effective population size* (N_E) is an important concept in conservation biology.
(a) Explain what effective population size (N_E) is. (1 point)
(b) Name three factors that affect effective population size and cause it to be smaller than the observed population size. (1.5 points)

* F-statistics (based on heterozygosity) can be used to describe the distribution of genetic variation across populations within a species and estimate the gene flow among these populations. When studying several subpopulations of a species it was found that 'the average degree of inbreeding in individual subpopulations' ($F_{I,S}$) was close to zero, while both 'the degree of differentiation among subpopulations' ($F_{S,T}$) and 'the total departure from expected Hardy-Weinberg proportions in the entire population' ($F_{I,T}$) was close to unity (one).

Name which three of the following statements that are correct interpretations of this finding (maximum 1.5 points, but each wrong answer will give you -0.5 point).

a) There is almost no departure from expected Hardy-Weinberg proportions in the subpopulations!
b) There are significant departures from expected Hardy-Weinberg proportions in the subpopulations!
c) There is no sign of fixation of different alleles in different subpopulations!
d) There has been fixation of different alleles in different subpopulations!
e) Departures from expected Hardy-Weinberg proportions in the entire population was almost entirely due to inbreeding within subpopulations!
f) Departures from expected Hardy-Weinberg proportions in the entire population was almost entirely due to population differentiation!

* Explain the meanings of isolation of populations by distance (IBD), resistance (IBR) and environment (IBE) respectively. (3 points)

Behavioral ecology (8 points)

* Explain the distinction between a social mating system and a genetic mating system. Using molecular genetic data, describe how researchers can reveal discrepancies between the two, and briefly explain why such discrepancies are evolutionarily important. (3 points)

* Compare microsatellites and SNPs for use in parentage analysis. Discuss one advantage and one limitation of each marker type, and explain why modern parentage studies increasingly rely on SNP data. (3 points)

* Describe one population-level and one individual-level molecular genetic approach for detecting sex-biased dispersal. Explain how the results from each approach are interpreted. (2 points)

Conservation & Genetics (9 points)

* Biodiversity is important. Many threats lead can lead to small populations that have a higher risk for extinction. Explain in details what the extinction vortex is. (2 points)

* What stands IUCN for (0.5 point) and what are they doing (0.5 point) ?

* Explain DNA barcoding and its application in conservation (e.g., for evoluationary significant units). (3 points)

* Explain with a concrete example what biological invasion is and how environmental DNA (eDNA) can be used in this context. What is the advantage of this technique – what is curently the most challenging part? (3 points)