



Cyprus
University of
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Faculty of Engineering
and Technology

Doctoral Dissertation

**Mechanistic Modeling of Overwater Dispersal for Terrestrial
Vertebrates with Applications in Palaeobiogeography and
Ecology**

Alexandros Pantelides

Limassol, September 2026

CYPRUS UNIVERSITY OF TECHNOLOGY
FACULTY OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF CIVIL ENGINEERING AND GEOMATICS

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Approval Form

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Presented by

Alexandros Pantelides

Supervisor: Dr. Phaedon Kyriakidis, Professor of Geoinformatics, Department of Civil
Engineering and Geomatics, Cyprus University of Technology

Supervisor: Dr. Paul Upchurch, Professor of Palaeobiology, Department of Earth
Sciences, University College London

Advisory Committee Member: Dr. Philip D. Mannion, Professor of Palaeobiology,
Department of Earth Sciences, University College London

Cyprus University of Technology

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The approval of the dissertation by the Department of Civil Engineering and Geomatics does not necessarily imply the approval by the Department of the writer's views.

Acknowledgements

Καὶ πᾶν ὃ τι ἐὰν ποιῇτε ἐν λόγῳ ἢ ἐν ἔργῳ, πάντα ἐν ὀνόματι Κυρίου Ἰησοῦ, εὐχαριστοῦντες τῷ Θεῷ καὶ Πατρὶ δι’ αὐτοῦ.

“And whatever you do, in word or deed, do everything in the name of the Lord Jesus, giving thanks to God the Father through Him.”

— Colossians 3:17

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“But let the one who boasts, boast in the Lord.”

— 2 Corinthians 10:17

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And with that, let us turn to the thesis—and may God help us all get through it.

ABSTRACT

Overwater dispersal has played an important role in shaping the distributions of terrestrial vertebrates, yet the physical feasibility of such movements is rarely evaluated mechanistically. This thesis develops a bottom-up framework for estimating energetic, hydrodynamic and environmental constraints on movement across aquatic barriers. First, a mechanistic model combining bioenergetics and hydrodynamics is developed to estimate optimal swimming speed, minimum cost of transport, and maximum swimming distance and duration. The framework is then extended to examine how ocean currents and continuous versus intermittent locomotion alter energetic expenditure and theoretical dispersal limits. Finally, a spatial framework projects specified distance- or duration-based constraints onto modern and palaeogeographic reconstructions for cases of continuous active swimming or passive drifting. Applications to extant terrestrial and semi-aquatic vertebrates and extinct non-avian dinosaurs show that feasibility is contingent on physiology, locomotor behaviour, environmental transport and parameter uncertainty, while simple shortest-distance estimates provide only a first-order representation of accessibility across complex marine landscapes. Together, these approaches provide conditional estimates of dispersal feasibility and complement traditional top-down biogeographic inference of overwater dispersal by adding a mechanistic test of whether such hypothetical events were physically achievable.

Keywords: Overwater dispersal; terrestrial vertebrates; mechanistic modelling; historical biogeography; movement ecology.