Aquatic Vertebrates — Biology 382
Spring 2007, M 1:30 to 5:30 p.m., OH 314
Professor: John Long email: jolong@vassar.edu
office: Olmsted 317 office hours: T, 10:30 to 12 noon or by appointment

Date	Topic	Readings	Lab Exercise
29-Jan	Out & back again.	Zimmer (1998)	Fossils at Warthin Museum Character evolution.
5-Feb	The latest Devonian tetrapod-like fishes.	Liem et al. (2001) Ch. 1 Daeschler et al. (2006) Long et al. (2006) Shubin et al. (2006)	Discussion of primary literature. MacClade: character evolution. PAUP: phylogenetic reconstruction.
12-Feb	Modeling vertebrates.	McHenry et al. (1995) Long et al. (2004) Long et al. (2006)	Special guest: Charles Pell Discussion & workshop. Pell's seminar.
19-Feb	Vertebrates and their phylogeny.	Liem et al. (2001) Ch. 2 Liem et al. (2001) Ch. 3	Discussion of chapters. Introduction to live vertebrates. High-speed video and analysis. Term projects: intro to grant proposals.
26-Feb	Analysis of vertebrate aquatic locomotion.	Fish (1996a) Lauder & Jayne (1996)	Exam: vertebrate phylogeny Kinematic data collection. Data analysis.
5-Mar	Evolution of primary aquatic locomoiton.	Drucker et al. (2002) Lauder et al. (2002) Webb (1988)	Measuring drag and lift. "Blue Planet" Term projects: outlines due.
26-Mar	Evolution of secondary aquatic locomotion.	Fish (1996b) Fish (2001) Thewissen et al. (1997)	Special guest: Frank Fish Discussion. Fish's seminar.
2-Apr	Evolution of vertebrate organ systems.	Koob & Long (2000) Northcutt (2002) Ruben (1989)	Term projects: outlines due Term projects: brainstorm goals, approach
9-Apr	Development & evolution.	Coates & Cohn (1999) Burke & Nowicki (2001) Holland (1998)	Discussion. Grant writing. Experiments, modeling, analysis.
16-Apr	Development & evolution: tadpoles.	Liu et al. (1997). Rot-Nikcevic et al. (2004) Handrigan et al. (2007)	Special guest: Richard Wassersug Discussion/workshop. Wassersug's seminar.
23-Apr	Vertebrate genomes	Hoegg & Meyer (2005) Malaga-Trillo et al. (01) Stellwag (2004)	Discussion. Workshop projects.
30-Apr	The First Vertebrates	Chen et al. (1999) Holland & Chen (2001) Shu et al. (1999)	Discussion. Exchange project drafts.
7-May	Presentations of project (one slide)		

Assignments	Due	Points
1. Annotated phylogeny of Devonian tetrapodomorphs.	1:30 p.m., 12 February	10
2. Exam: vertebrate phylogeny.	1:30 p.m., 26 February	10
3. Kinematic analysis of aquatic locomotion.	1:30 p.m., 5 March	10
4. Review: evolution of cetacean locomotion.	1:30 p.m., 2 April	10
5. Outline of research proposal.	1:30 p.m., 2 April	5
6. Review: tadpole locomotion & evolution.	1:30 p.m., 16 April	10
7. Presentation of research project	1:30 p.m., 7 May	10
8. Research proposal.	1:30 p.m., 7 May	20
9. Preparedness for and participation in discussions.	every Monday	10
10. Attendance.	mandatory	5
	total	100

Late penalty of 2% per day without an excuse from your class advisor (Dean of Studies office).

Readings (all available at our Blackboard site unless otherwise noted)

Burke, A.C. and J.L. Nowicki (2001). Hox genes and axial specification in vertebrates. *Integr. Comp. Biol.*, 41, 687-697.

Chen, J.Y., Huang, D.Y. and C.W. Li. (1999). An early Cambrian craniate-like chordate. *Nature*, 402, 518-522.

Coates, M.I. and M.J. Cohn (1999). Vertebrate axial and appendicular patterning: the early development of paired appendages. *Integr. Comp. Biol.*, 39, 676-685.

Daeschler, E.B., Shubin, N.H. and F.A. Jenkins, Jr. (2006). A Devonian tetrapod-like fish and the evolution of the tetrapod body plan. *Nature* 440, 757-763.

Eliot G. Drucker and George V. Lauder (2002). Wake dynamics and locomotor function in fishes: Interpreting evolutionary patterns in pectoral fin design. *Integr. Comp. Biol.*, 42, 997 - 1008.

Fish, F. E. (1996a). Measurement of swimming kinematics in small terrestrial mammals. Pp. 171-188, IN *Measuring Movement and Locomotion: From Invertebrate to Humans,* Neuroscience Intelligence Unit Series (K.-P. Ossenkopp, M. Kavaliers, and P. R. Sanberg). Springer, New York.

Fish, F. E. (1996b). Transitions from drag-based to lift-based propulsion in mammalian aquatic swimming. *American Zoologist*, 36(5), 628-641

Fish, F. E. (1998). Biomechanical perspective on the origin of cetacean flukes. Pp. 303-324. IN *The Emergence of Whales: Evolutionary Patterns in the Origin of Cetacea*, (J. G. M. Thewissen), Plenum Press, New York.

Handrigan, G.R. and R.J. Wassersug (2007). The anuran Bauplan: A review of the adaptive, developmental, and genetic underpinnings of frog and tadpole morphology. *Biological Reviews* 82, 1-25.

Hoegg, S. and A. Meyer (2005). Hox clusters as models for vertebrate genome evolution. *Trends in Genetics* 21, 421-424.

Holland, N.D. and J. Chen (2001). Origin and early evolution of the vertebrates: new insights from advances in molecular biology, anatomy, and palaeontology. *BioEssays* 23, 142-151.

Holland, P.W. (1998). Major transitions in animal evolution: a developmental genetic perspective. *Integr. Comp. Biol.*, 38, 829 - 842.

Koob, T.J. and J. H. Long, Jr. (2000). The vertebrate body axis: evolution and mechanical function. *Integr. Comp. Biol.,* 40, 1-18.

Lauder, G.V. and B.C. Jayne (1996). Pectoral fin locomotion in fishes: testing drag-based models using three-dimensional kinematics. *Integr. Comp. Biol.,* 36, 567-581.

Lauder, G.V., Nauen, J.C. and E.G. Drucker (2002). Experimental hydrodynamics and evolution: function of median fins in ray-finned fishes. *Integr. Comp. Biol.*, 42, 1009-1017.

Liem, K.F., Bemis, W.F., Walker, W.F. Jr., and L. Grande (2001). *Functional Anatomy of the Vertebrate An Evolutionary Perspective, 3rd Ed.* Harcourt: Philadelphia. Chapters 1 to 3.

Liu, H., Wassersug, R. and K. Kawachi (1997). The three-dimensional hydrodynamics of tadpole locomotion. *J. Exp. Biol.* 200, 2807-2819.

Long, J.A., Young, G.C., Holland, T., Senden, T.J. and E.M.G. Fitzgerald (2006). An exceptional Devonian fish from Australia sheds light on tetrapod origins. *Nature* 444, 199-202.

Long, J.H. Jr., Lammert, A., Pell, C.A., Kemp, M., Strother, J., Crenshaw, H.C. and M.J. McHenry (20(A navigational primitive: biorobotic implementation of cycloptic helical klinotaxis in planar motion. *IEEE Journal of Oceanic Engineering* 29(3), 795-806.

Long, J.H. Jr., Schumacher, J., Livingston, N. and M. Kemp (2006). Four flippers or two? Tetrapodal swimming with an aquatic robot. *Bioinspiration & Biomimetics* (Institute of Physics) 1, 20-2

Malaga-Trillo, E. and A. Meyer (2001). Genome duplications and accelerated evolution of Hox gene and cluster architecture in teleost fishes. *Integr. Comp. Biol.*, 41, 676-686.

McHenry, M.J., Pell, C.A. and J.H. Long, Jr. (1995). Mechanical control of swimming speed: stiffness and axial wave form in an undulatory fish model. *J. Experimental Biology* 198, 2293-2305.

Northcutt, R.G. (2002). Understanding vertebrate brain evolution. *Integr. Comp. Biol.*, 42, 743-756.

Rot-Nikcevic, I. and R.J. Wassersug (2004). Arrested development in *Xenopus laevis* tadpoles: How size constrains metamorphosis. *J. Experimental Biology* 207, 2133-2145.

Ruben, J.A. (1989). Activity physiology and evolution of the vertebrate skeleton. *Integr. Comp. Biol.,* 29, 195-203.

Shu, D.G., Luo, H.L., Conway Morris, S., Zhang, X.L., Hu, S.X., Chen, L., Han, J., Zhu, M, Li, Y.

and L.Z. Chen (1999). Lower Cambrian vertebrates from south China. *Nature* 402, 42-46.

Shubin, N.H., Daeschler, E.B. and F.A. Jenkins, Jr. (2006). The pectoral fin of *Tiktaalik roseae* and the origin of the tetrapod limb. *Nature* 440, 764-775.

Stellwag, E.J. (2004). Are genome evolution, organism complexity and species diversity linked? *Integr. Comp. Biol.*, 44, 358-365.

Thewissen, J. G. M. and F. E. Fish. (1997). Locomotor evolution in the earliest cetaceans: Functional model, modern analogues, and paleontological evidence. *Paleobiology*, 23(4), 482-490.

Webb, P.W. (1988). Simple physical principles and vertebrate aquatic locomotion. *Integr. Comp. Biol.,* 28, 709-725.

Webb, P.W (1984). Body form, locomoition, and foraging in aquatic vertebrates. *Integr. Comp. Biol.*, 24, 107-120.