Stanford

Mark Denny

John B. and Jean De Nault Professor of Marine Science at the Hopkins Marine Station, Emeritus

Bio

BIO

The field of biomechanics uses the principles of engineering and physics to understand how plants and animals function. I was raised as a biomechanic, beginning as an undergraduate at Duke University where I was recruited by two of the influential leaders of the field, Steve Wainwright and Steve Vogel. After my doctoral work at the University of British Columbia (where I explored the mechanics of gastropod locomotion with John Gosline), I began to wonder how biomechanics could be used in an ecological context, and I have been exploring this question ever since. Two years as a postdoc with Bob Paine at the University of Washington introduced me to the ecology of wave-swept shores, and it is in that uniquely stressful environment that my current research strives to advance our understanding of ecological mechanics.

ACADEMIC APPOINTMENTS

- Emeritus Faculty, Acad Council, Hopkins Marine Station

ADMINISTRATIVE APPOINTMENTS

- Director, Hopkins Marine Station, (2017-2020)

LINKS

- My Lab Site: http://web.stanford.edu/group/denny/cgi-bin/wordpress/

Research & Scholarship

CURRENT RESEARCH AND SCHOLARLY INTERESTS

Biomechanics, ecology, and ecological physiology

Teaching

COURSES

2022-23

- Environmental Change and Marine Biodiversity: BIO 125, BIOHOPK 125H, BIOHOPK 225H, OCEANS 125, OCEANS 225 (Spr)

2020-21

- Introduction to Research in Ecology and Ecological Physiology: BIOHOPK 47 (Sum)
- Using Physics to Explain Biology: Mechanistic Approaches to Plankton Ecology: BIO 10N (Aut)

STANFORD ADVISEES

Doctoral Dissertation Reader (AC)

James Fahlbusch

Publications

PUBLICATIONS

- **Rip Currents Off Rocky-Shore Surge Channels** *JOURNAL OF GEOPHYSICAL RESEARCH-OCEANS*
  MacMahan, J., Thornton, E., Patria, N., Gon, C., Denny, M.
  2023; 128 (8)

- **Wave damping by giant kelp, Macrocystis pyrifera.** *Annals of botany*
  Elsmore, K., Nickols, K. J., Miller, L. P., Ford, T., Denny, M. W., Gaylord, B.
  2023

- **A bendable biological ceramic.** *Science (New York, N.Y.)*
  Crane, R. L., Denny, M. W.
  2023; 380 (6651): 1216-1218

- **Elevated Salinity Rapidly Confers Cross-Tolerance to High Temperature in a Splash-Pool Copepod** *INTEGRATIVE ORGANISMAL BIOLOGY*
  Denny, M. W., Dowd, W.
  2022; 4 (1): obac037

- **Bivalves maintain repair when faced with chronically repeated mechanical stress** *JOURNAL OF EXPERIMENTAL BIOLOGY*
  Crane, R. L., Denny, M. W.
  2022; 225 (10)

- **Effects of heat acclimation on cardiac function in the intertidal mussel Mytilus californianus: can laboratory-based indices predict survival in the field?** *The Journal of experimental biology*
  Moyen, N. E., Somero, G. N., Denny, M. W.
  2022

- **Rapid Range Expansion of a Marine Ectotherm Reveals the Demographic and Ecological Consequences of Short-Term Variability in Seawater Temperature and Dissolved Oxygen** *AMERICAN NATURALIST*
  Burford, B. P., Wild, L. A., Schwarz, R., Chenoweth, E. M., Sreenivasan, A., Elahi, R., Carey, N., Hoving, H. T., Straley, J. M., Denny, M. W.
  2022

- **The limits of convergence in the collective behavior of competing marine taxa.** *Ecology and evolution*
  Burford, B. P., Williams, R. R., Demetras, N. J., Carey, N., Goldbogen, J., Gilly, W. F., Harding, J., Denny, M. W.
  2022; 12 (3): e8747

- **Physiological Consequences of Oceanic Environmental Variation: Life from a Pelagic Organism's Perspective.** *Annual review of marine science*
  Denny, M. W., Dowd, W. W.
  2021

- **Wave-Energy Dissipation: Seaweeds and Marine Plants Are Ecosystem Engineers** *FLUIDS*
  Denny, M.
  2021; 6 (4)

- **Wave Dissipation by Bottom Friction on the Inner Shelf of a Rocky Shore** *JOURNAL OF GEOPHYSICAL RESEARCH-OCEANS*
  Gon, C. J., MacMahan, J. H., Thornton, E. B., Denny, M.
  2020; 125 (10)

- **Long-term mechanistic hindcasts predict the structure of experimentally-warmed intertidal communities** *OIKOS*
  LaScala-Gruenewald, D. E., Denny, M. W.
  2020

- **Mussels' acclimatization to high, variable temperatures is lost slowly upon transfer to benign conditions.** *The Journal of experimental biology*
  Moyen, N. E., Somero, G. N., Denny, M. W.
  2020

- **Establishing typical values for hemocyte mortality in individual mussels (<it>Mytilus</it> <it>californianus</it>) using fluorescence-activated cell sorting**
  Moyen, N., Bump, P., Somero, G., Denny, M.
  WILEY.2020

- **A series of unfortunate events: characterizing the contingent nature of physiological extremes using long-term environmental records.** *Proceedings. Biological sciences*
  Dowd, W. W., Denny, M. W.
  2020; 287 (1918): 20192333

- **A single heat-stress bout induces rapid and prolonged heat acclimation in the California mussel, Mytilus californianus.** *Proceedings. Biological sciences*
  Moyen, N. E., Crane, R. L., Somero, G. N., Denny, M. W.
  2020; 287 (1940): 20202561

- **Mussels' acclimatization to high, variable temperatures is lost slowly upon transfer to benign conditions.** *The Journal of experimental biology*
  Moyen, N. E., Somero, G. N., Denny, M. W.
  2020

- **Establishing typical values for hemocyte mortality in individual California mussels, Mytilus californianus.** *Fish & shellfish immunology*
  Moyen, N. E., Bump, P. A., Somero, G. N., Denny, M. W.
  2020

- **Performance in a variable world: using Jensen's inequality to scale up from individuals to populations** *CONSERVATION PHYSIOLOGY*
  Denny, M.
  2019; 7: coz053

- **PISCO ADVANCES MADE THROUGH THE FORMATION OF A LARGE-SCALE, LONG-TERM CONSORTIUM FOR INTEGRATED UNDERSTANDING OF COASTAL ECOSYSTEM DYNAMICS** *OCEANOGRAPHY*
  Menge, B. A., Milligan, K., Caselle, J. E., Barth, J. A., Blanchette, C. A., Carr, M. H., Chan, F., Cowen, R. K., Denny, M., Gaines, S. D., Hofmann, G. E., Kroeker, K. J., Lubchenco, et al
  2019; 32 (3): 16–25

- **Impact of heating rate on cardiac thermal tolerance in the California mussel, Mytilus californianus.** *The Journal of experimental biology*
  Moyen, N. E., Somero, G. N., Denny, M. W.
  2019

- **Sensory perception plays a larger role in foraging efficiency than heavy-tailed movement strategies** *ECOLOGICAL MODELLING*
  LaScala-Gruenewald, D. E., Mehta, R. S., Liu, Y., Denny, M. W.
  2019; 404: 69–82

- **Survival in spatially variable thermal environments: Consequences of induced thermal defense** *INTEGRATIVE ZOOLOGY*
  Denny, M. W.
  2018; 13 (4): 392–410

- **The importance of wave exposure on the structural integrity of rhodoliths** *JOURNAL OF EXPERIMENTAL MARINE BIOLOGY AND ECOLOGY*
  Melbourne, L. A., Denny, M. W., Harniman, R. L., Rayfield, E. J., Schmidt, D. N.
  2018; 503: 109–19

- **Survival in Spatially Variable Thermal Environments: Consequences of Induced Thermal Defense.** *Integrative zoology*
  Denny, M.
  2018

- **"Internal tide pools" prolong kelp forest hypoxic events** *LIMNOLOGY AND OCEANOGRAPHY*
  Leary, P. R., Woodson, C., Squibb, M. E., Denny, M. W., Monismith, S. G., Micheli, F.
  2017; 62 (6): 2864–78

- **Coral larvae are poor swimmers and require fine-scale reef structure to settle.** *Scientific reports*
  Hata, T., Madin, J. S., Cumbo, V. R., Denny, M., Figueiredo, J., Harii, S., Thomas, C. J., Baird, A. H.
  2017; 7 (1): 2249-?

- **John Moffit Gosline, BA, PhD, FRSC (1943-2016).** *journal of experimental biology*

Shadwick, R. E., Denny, M. W.
2017; 220: 334-335

- **The fallacy of the average: on the ubiquity, utility and continuing novelty of Jensen's inequality** *JOURNAL OF EXPERIMENTAL BIOLOGY*
  Denny, M.
  2017; 220 (2): 139-146

- **Long-term, high frequency in situ measurements of intertidal mussel bed temperatures using biomimetic sensors.** *Scientific data*
  Helmuth, B., Choi, F., Matzelle, A., Torossian, J. L., Morello, S. L., Mislan, K. A., Yamane, L., Strickland, D., Szathmary, P. L., Gilman, S. E., Tockstein, A., Hilbish, T. J., Burrows, et al
  2016; 3: 160087-?

- **Life in an extreme environment: Characterizing wave-imposed forces in the rocky intertidal zone using high temporal resolution hydrodynamic measurements** *LIMNOLOGY AND OCEANOGRAPHY*
  Jensen, M. M., Denny, M. W.
  2016; 61 (5): 1750-1761

- **Quantifying the top-down effects of grazers on a rocky shore: selective grazing and the potential for competition** *MARINE ECOLOGY PROGRESS SERIES*
  LaScala-Gruenewald, D. E., Miller, L. P., Bracken, M. E., Allen, B. J., Denny, M. W.
  2016; 553: 49-66

- **The extraordinary joint material of an articulated coralline alga. II. Modeling the structural basis of its mechanical properties** *JOURNAL OF EXPERIMENTAL BIOLOGY*
  Denny, M. W., King, F. A.
  2016; 219 (12): 1843-1850

- **The extraordinary joint material of an articulated coralline alga. I. Mechanical characterization of a key adaptation** *JOURNAL OF EXPERIMENTAL BIOLOGY*
  Denny, M. W., King, F. A.
  2016; 219 (12): 1833-1842

- **Ecological Mechanics: Principles of Life's Physical Interactions**
  Denny, M. W.
  Princeton University Press.2016

- **Intertidal** *ECOSYSTEMS OF CALIFORNIA*
  Blanchette, C. A., Denny, M. W., Engle, J. M., Helmuth, B., Miller, L. P., Nielsen, K. J., Smith, J., Mooney, H., Zavaleta, E.
  2016: 337–57

- **Experimental determination of the hydrodynamic forces responsible for wave impact events** *JOURNAL OF EXPERIMENTAL MARINE BIOLOGY AND ECOLOGY*
  Jensen, M. M., Denny, M. W.
  2015; 469: 123-130

- **Thermal variation, thermal extremes and the physiological performance of individuals** *JOURNAL OF EXPERIMENTAL BIOLOGY*
  Dowd, W. W., King, F. A., Denny, M. W.
  2015; 218 (12): 1956-1967

- **Thermal variation, thermal extremes and the physiological performance of individuals.** *journal of experimental biology*
  Dowd, W. W., King, F. A., Denny, M. W.
  2015; 218: 1956-1967

- **Warm microhabitats drive both increased respiration and growth rates of intertidal consumers** *MARINE ECOLOGY PROGRESS SERIES*
  Miller, L. P., Allen, B. J., King, F. A., Chilin, D. R., Reynoso, V. M., Denny, M. W.
  2015; 522: 127-143

- **United We Fail: Group versus Individual Strength in the California Sea Mussel, Mytilus californianus** *BIOLOGICAL BULLETIN*
  Cole, A., Denny, M.
  2014; 227 (1): 61-67

- **United we fail: Group versus individual strength in the California sea mussel, Mytilus californianus.** *Biological bulletin*

Cole, A., Denny, M.
2014; 227 (1): 61-67

- **Aperture effects in squid jet propulsion** *JOURNAL OF EXPERIMENTAL BIOLOGY*
  Staaf, D. J., Gilly, W. F., Denny, M. W.
  2014; 217 (9): 1588-1600
- **Indefatigable: an erect coralline alga is highly resistant to fatigue.** *journal of experimental biology*
  Denny, M., Mach, K., Tepler, S., Martone, P.
  2013; 216: 3772-3780
- **Interaction of waves and currents with kelp forests (Macrocystis pyrifera): Insights from a dynamically scaled laboratory model** *LIMNOLOGY AND OCEANOGRAPHY*
  Rosman, J. H., Denny, M. W., Zeller, R. B., Monismith, S. G., Koseff, J. R.
  2013; 58 (3): 790-802
- **Natural intrusions of hypoxic, low pH water into nearshore marine environments on the California coast** *CONTINENTAL SHELF RESEARCH*
  Booth, J. A., McPhee-Shaw, E. E., Chua, P., Kingsley, E., Denny, M., Phillips, R., Bograd, S. J., Zeidberg, L. D., Gilly, W. F.
  2012; 45: 108-115
- **Biophysics, environmental stochasticity, and the evolution of thermal safety margins in intertidal limpets** *JOURNAL OF EXPERIMENTAL BIOLOGY*
  Denny, M. W., DOWD, W. W.
  2012; 215 (6): 934-947
- **Biophysics, bioenergetics and mechanistic approaches to ecology** *JOURNAL OF EXPERIMENTAL BIOLOGY*
  Denny, M.
  2012; 215 (6): 871
- **The fine art of surfacing: Its efficacy in broadcast spawning** *JOURNAL OF THEORETICAL BIOLOGY*
  Molacek, J., Denny, M., Bush, J. W.
  2012; 294: 40-47
- **Scaling Up in Ecology: Mechanistic Approaches** *ANNUAL REVIEW OF ECOLOGY, EVOLUTION, AND SYSTEMATICS, VOL 43*
  Denny, M., Benedetti-Cecchi, L.
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- **Anchor Ice and Benthic Disturbance in Shallow Antarctic Waters: Interspecific Variation in Initiation and Propagation of Ice Crystals** *BIOLOGICAL BULLETIN*
  Denny, M., Dorgan, K. M., Evangelista, D., Hettinger, A., Leichter, J., Ruder, W. C., Tuval, I.
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- **Grand Opportunities: Strategies for Addressing Grand Challenges in Organismal Animal Biology** *INTEGRATIVE AND COMPARATIVE BIOLOGY*
  Stillman, J. H., Denny, M., Padilla, D. K., Wake, M. H., Patek, S., Tsukimura, B.
  2011; 51 (1): 7-13
- **Importance of Behavior and Morphological Traits for Controlling Body Temperature in Littorinid Snails** *BIOLOGICAL BULLETIN*
  Miller, L. P., Denny, M. W.
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- **Failure by fatigue in the field: a model of fatigue breakage for the macroalga Mazzaella, with validation** *JOURNAL OF EXPERIMENTAL BIOLOGY*
  Mach, K. J., Tepler, S. K., Staaf, A. V., Bohnhoff, J. C., Denny, M. W.
  2011; 214 (9): 1571-1585
- **An inexpensive instrument for measuring wave exposure and water velocity** *LIMNOLOGY AND OCEANOGRAPHY-METHODS*
  Figurski, J. D., Malone, D., Lacy, J. R., Denny, M.
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- **Spreading the risk: Small-scale body temperature variation among intertidal organisms and its implications for species persistence** *JOURNAL OF EXPERIMENTAL MARINE BIOLOGY AND ECOLOGY*
  Denny, M. W., Dowd, W. W., Bilir, L., Mach, K. J.
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- **Preference Versus Performance: Body Temperature of the Intertidal Snail Chlorostoma funebralis** *BIOLOGICAL BULLETIN*
  Tepler, S., Mach, K., Denny, M.
  2011; 220 (2): 107-117
- **Anchor Ice and Antarctic Benthis Ecology: The Role of Interspecific Variation in Ice Nucleation**
  Denny, M., Dorgan, K., Evangelista, D., Hettinger, A., Leichter, J., Ruder, W., Tuval, I.
  OXFORD UNIV PRESS INC.2011: E33
- **Diatom sinking speeds: Improved predictions and insight from a modified Stokes' law** *LIMNOLOGY AND OCEANOGRAPHY*
  Miklasz, K. A., Denny, M. W.
  2010; 55 (6): 2513-2525
- **Aperture size effects in paralarval squid swimming**
  Staaf, D. J., Denny, M. W., Gilly, W. F.
  OXFORD UNIV PRESS INC.2010: E168
- **Currents and turbulence within a kelp forest (Macrocystis pyrifera): Insights from a dynamically scaled laboratory model** *LIMNOLOGY AND OCEANOGRAPHY*
  Rosman, J. H., Monismith, S. G., Denny, M. W., Koseff, J. R.
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- **Organismal climatology: analyzing environmental variability at scales relevant to physiological stress** *JOURNAL OF EXPERIMENTAL BIOLOGY*
  Helmuth, B., Broitman, B. R., Yamane, L., Gilman, S. E., Mach, K., Mislan, K. A., Denny, M. W.
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- **Marine Ecomechanics** *ANNUAL REVIEW OF MARINE SCIENCE*
  Denny, M. W., Gaylord, B.
  2010; 2: 89-114
- **Confronting the physiological bottleneck: A challenge from ecomechanics** *INTEGRATIVE AND COMPARATIVE BIOLOGY*
  Denny, M., Helmuth, B.
  2009; 49 (3): 197-201
- **On the prediction of extreme ecological events** *ECOLOGICAL MONOGRAPHS*
  Denny, M. W., Hunt, L. J., Miller, L. P., Harley, C. D.
  2009; 79 (3): 397-421
- **The role of temperature and desiccation stress in limiting the local-scale distribution of the owl limpet, Lottia gigantea** *FUNCTIONAL ECOLOGY*
  Miller, L. P., Harley, C. D., Denny, M. W.
  2009; 23 (4): 756-767
- **Can the giant snake predict palaeoclimate?** *NATURE*
  Denny, M. W., Lockwood, B. L., Somero, G. N.
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- **Thermal stress and morphological adaptations in limpets** *FUNCTIONAL ECOLOGY*
  Harley, C. D., Denny, M. W., Mach, K. J., Miller, L. P.
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- **Discovery of Lignin in Seaweed Reveals Convergent Evolution of Cell-Wall Architecture** *CURRENT BIOLOGY*
  Martone, P. T., Estevez, J. M., Lu, F., Ruel, K., Denny, M. W., Somerville, C., Ralph, J.
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- **Limits to running speed in dogs, horses and humans** *JOURNAL OF EXPERIMENTAL BIOLOGY*
  Denny, M. W.
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- **Flow Forces on Seaweeds: Field Evidence for Roles of Wave Impingement and Organism Inertia** *BIOLOGICAL BULLETIN*
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- **To bend a coralline: effect of joint morphology on flexibility and stress amplification in an articulated calcified seaweed** *JOURNAL OF EXPERIMENTAL BIOLOGY*
  Martone, P. T., Denny, M. W.
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- **To break a coralline: mechanical constraints on the size and survival of a wave-swept seaweed** *JOURNAL OF EXPERIMENTAL BIOLOGY*
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- **Desiccation protection and disruption: A trade-off for an intertidal marine alga** *JOURNAL OF PHYCOLOGY*
  Hunt, L. J., Denny, M. W.
  2008; 44 (5): 1164-1170
- **DESICCATION PROTECTION AND DISRUPTION: A TRADE-OFF FOR AN INTERTIDAL MARINE ALGA(1).** *Journal of phycology*
  Hunt, L. J., Denny, M. W.
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- **Biophysics - The intrigue of the interface** *SCIENCE*
  Denny, M. W.
  2008; 320 (5878): 886-886
- **Hydrodynamic forces and surface topography: Centimeter-scale spatial variation in wave forces** *LIMNOLOGY AND OCEANOGRAPHY*
  O'Donnell, M. J., Denny, M. W.
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- **Discovery of secondary cell walls and lignin precursors in the joints of the articulated coralline alga calliarthron**
  Martone, P. T., Estevez, J., Ralph, J., Lu, F., Ruel, K., Denny, M., Somerville, C.
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- **Techniques for predicting the lifetimes of wave-swept macroalgae: a primer on fracture mechanics and crack growth** *JOURNAL OF EXPERIMENTAL BIOLOGY*
  Mach, K. J., Nelson, D. V., Denny, M. W.
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- **Death by small forces: a fracture and fatigue analysis of wave-swept macroalgae** *JOURNAL OF EXPERIMENTAL BIOLOGY*
  Mach, K. J., Hale, B. B., Denny, M. W., Nelson, D. V.
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- **Ocean waves, nearshore ecology, and natural selection** *AQUATIC ECOLOGY*
  Denny, M. W.
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- **Jet propulsion in the cold: mechanics of swimming in the Antarctic scallop Adamussium colbecki** *JOURNAL OF EXPERIMENTAL BIOLOGY*
  Denny, M., Miller, L.
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- **Hot limpets: predicting body temperature in a conductance-mediated thermal system** *JOURNAL OF EXPERIMENTAL BIOLOGY*
  Denny, M. W., Harley, C. D.
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- **Thermal stress on intertidal limpets: long-term hindcasts and lethal limits** *JOURNAL OF EXPERIMENTAL BIOLOGY*
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- **Limits to phenotypic plasticity: Flow effects on barnacle feeding appendages** *BIOLOGICAL BULLETIN*
  Li, N. K., Denny, M. W.
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- **Paradox lost: answers and questions about walking on water** *JOURNAL OF EXPERIMENTAL BIOLOGY*
  Denny, M. W.
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- **Cyberkelp: an integrative approach to the modelling of flexible organisms** *PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B-BIOLOGICAL SCIENCES*
  Denny, M. W., Hale, B. B.
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- **Predicting wave exposure in the rocky intertidal zone: Do bigger waves always lead to larger forces-9** *LIMNOLOGY AND OCEANOGRAPHY*
  Helmuth, B., Denny, M. W.
  2003; 48 (3): 1338-1345
- **Modulation of wave forces on kelp canopies by alongshore currents** *LIMNOLOGY AND OCEANOGRAPHY*
  Gaylord, B., Denny, M. W., Koehl, M. A.
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- **Extreme water velocities: Topographical amplification of wave-induced flow in the surf zone of rocky shores** *LIMNOLOGY AND OCEANOGRAPHY*
  Denny, M. W., Miller, L. P., Stokes, M. D., Hunt, L. J., Helmuth, B. S.
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- **Revised estimates of the effects of turbulence on fertilization in the purple sea urchin, Strongylocentrotus purpuratus** *BIOLOGICAL BULLETIN*
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- **Blade motion and nutrient flux to the Kelp, Eisenia arborea** *BIOLOGICAL BULLETIN*
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- **The rewards of chance** *NATURAL HISTORY*
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- **Limits to optimization: Fluid dynamics, adhesive strength and the evolution of shape in limpet shells** *JOURNAL OF EXPERIMENTAL BIOLOGY*
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- **A biomechanical hypothesis explaining upstream movements by the freshwater snail Elimia** *FUNCTIONAL ECOLOGY*
  Huryn, A. D., Denny, M. W.
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- **A conjecture on the relationship of bacterial shape to motility in rod-shaped bacteria** *FEMS MICROBIOLOGY LETTERS*
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