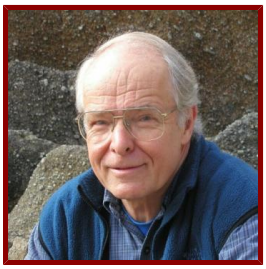
Stanford



George Somero

David and Lucile Packard Professor in Marine Science, Emeritus

Hopkins Marine Station

Curriculum Vitae available Online

Bio

BIO

EDUCATION

B.A. 1962 Carleton College - Biology

Ph.D. 1967 Stanford University - Biology

PROFESSIONAL EXPERIENCE

2008-current Associate Director—Hopkins Marine Station

2005-current Senior Fellow—Woods Institute for the Environment, Stanford University

2000-2008 Director—Hopkins Marine Station, Stanford University

1995-current David and Lucile Packard Professor of Marine Science, Stanford University

1991-1995 Wayne and Gladys Valley Professor of Marine Biology, Oregon State University

1980-1991 Professor, Scripps Institution of Oceanography, University of California, San Diego

1984-1989 John Dove Isaacs Chair in Natural Philosophy, Scripps Institution of Oceanography

1983-1989 Chair, Marine Biology Research Division, Scripps Institution of Oceanography

1976-1980 Associate Professor, Scripps Institution of Oceanography

1970-1976 Assistant Professor, Scripps Institution of Oceanography

1967-1970 Postdoctoral Fellow, University of British Columbia

1963-1966 Member-U.S. Antarctic Research Program

AWARDS

National Science Foundation Predoctoral Fellowship

National Science Foundation Postdoctoral Fellowship

Isaac Walton Killam Postdoctoral Fellowship

John Simon Guggenheim Memorial Fellowship

Member of U.S. National Academy of Sciences

Fellow of the American Association for the Advancement of Science

Honorary Doctor of Science Degree-Carleton College

Helsinki Medal-University of Helsinki

Member of California Academy of Sciences

EDITORIAL BOARDS

American Journal of Physiology, Journal of Comparative Physiology, Journal of Experimental Biology, Comparative Biochemistry and Physiology

GOVERNMENT PANELS

National Science Foundation—Panel on Ecological and Evolutionary Physiology (1992-1995)

National Research Council—Ocean Studies Board (1997-1999)

National Research Council—Committee on Evaluation, Design, and Monitoring of Marine

Reserves and Protected Areas (1998-2000)

National Research Council—Frontiers in Polar Biology (2002)

National Research Council—International Polar Year committee (2003)

National Research Council—Committee on Ocean Acidification (chair: 2012)

ACADEMIC APPOINTMENTS

- Emeritus Faculty, Acad Council, Hopkins Marine Station
- Member, Bio-X
- Affiliate, Stanford Woods Institute for the Environment

Research & Scholarship

CURRENT RESEARCH AND SCHOLARLY INTERESTS

RESEARCH INTERESTS: The unifying theme in our research is adaptation of organisms to the environment. We seek to determine how different environmental factors, notably temperature and the threat of desiccation, affect organisms, and how organisms respond adaptively to these perturbations. Proteins are a primary study system in most of our work. We are documenting how adaptive change in protein sequence (primary structure) achieves the conservation of critical functional and structural characteristics of enzymatic and structural proteins. These studies exploit homologous (orthologous) proteins from differently adapted species, frequently congeneric species adapted to only slightly different temperatures.

We are using these comparative studies not only to examine adaptation to environment, but also to deduce basic structure-function relationships in proteins. For example, we are delineating the sites in the primary and higher orders of protein structure where adaptive change is permissible. Mapping of adaptively important changes in orthologs of closely related congeners supports the hypothesis that much of the protein molecule contributes to the energy changes that accompany catalysis.

Our studies of proteins are performed in solution conditions that mimic the intracellular conditions encountered by the proteins. The use of in vitro media that simulate in vivo conditions has enabled us to demonstrate that the “micromolecules” of the cell, that is, the small solutes that bathe macromolecules, contribute importantly to the establishment of the functional and structural properties of proteins. Macromolecular and micromolecular evolution play complementary roles in adaptation to environment.

Our field studies focus on “real world” effects of temperature on protein systems. A primary focus of these studies is to determine how changes in environmental temperature affect the latitudinal and depth distribution patterns of marine organisms. These studies demonstrate that many organisms live close to the upper thermal limits of protein structure and function, and suggest that global warming may have pronounced effects on ectothermic (“cold-blooded”) animals.

Studies of thermal effects at the molecular level are complemented by physiological investigations, for example, of heart function. The results of the physiological studies also indicate that only slight increases in maximal habitat temperature are likely to have profound negative effects on many marine animals. Paradoxically, the most warm-adapted species appear in many cases to be the most threatened by further increases in temperature, such as those that may result from continued global climate change. Our physiological studies also focus on an invasive species of mussel which has replaced a native mussel along much of the California coast. We have identified differences in cardiac function and enzymatic activity that may account for the competitive advantage of the invader and allow predictions to be made of how effectively it will colonize habitats to the north of its present distribution range.

We are using DNA microarray (“gene chip”) technology to monitor shifts in gene expression in response to environmental change (alterations in oxygen availability, salinity, and temperature). Among our goals in using these new approaches is the elucidation of the molecular bases of the different capacities of species to respond adaptively to environmental changes.

Teaching

GRADUATE AND FELLOWSHIP PROGRAM AFFILIATIONS

- Biology (School of Humanities and Sciences) (PhD Program)

Publications

PUBLICATIONS

- **Temperature adaptation in structure and function in lactate dehydrogenase-A reflects convergent evolution in a few key protein regions.** *Proceedings of the National Academy of Sciences of the United States of America*
  Zhu, X. L., Liao, M. L., Ma, L. X., Somero, G. N., Dong, Y. W.
  2025; 122 (42): e2517759122
- **RNA editing generates mRNA isoforms with distinct stabilities that may expand the thermal tolerance of mRNA and proteins inMytilusspecies.** *Zoological research*
  Liao, M., Zhu, Y., Zhu, X., Somero, G. N., Dong, Y.
  2025; 46 (3): 527-537
- **From molecules to morphology: How food supply influences the larvae of sea urchins across all levels of biological organization.** *Molecular ecology*
  Somero, G. N.
  2024: e17384
- **Tissue-specific temperature dependence of RNA editing levels in zebrafish.** *BMC biology*
  Li, W., Bu, M., Hu, R., Jiang, S., Chen, L., Somero, G. N.
  2023; 21 (1): 262
- **Oxidative stress effects are not correlated with differences in heat tolerance among congeners of Mytilus.** *The Journal of experimental biology*
  Dowd, W. W., Somero, G. N.
  2023
- **Turning a page: remaining a top competitor in an evolving publication ecosystem.** *The Journal of experimental biology*
  Somero, G. N.
  2023; 226 (2)
- **Solutions: how adaptive changes in cellular fluids enable marine life to cope with abiotic stressors** *MARINE LIFE SCIENCE & TECHNOLOGY*
  Somero, G. N.
  2022
- **Solutions: how adaptive changes in cellular fluids enable marine life to cope with abiotic stressors.** *Marine life science & technology*
  Somero, G. N.
  2022; 4 (3): 389-413
- **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
- **Thermal adaptation of mRNA secondary structure: stability versus lability.** *Proceedings of the National Academy of Sciences of the United States of America*
  Liao, M., Dong, Y., Somero, G. N.
  2021; 118 (45)

- **An integrated, multi-level analysis of thermal effects on intertidal molluscs for understanding species distribution patterns.** *Biological reviews of the Cambridge Philosophical Society*
  Dong, Y., Liao, M., Han, G., Somero, G. N.
  2021

- **A tribute to Dr. Serge N. Timasheff, our mentor.** *Biophysical reviews*
  Aune, K., Lee, J., Prakash, V., Bhat, R., Andreu, J., Monasterio, O., Perez-Ramirez, B., Shearwin, K., Arakawa, T., Carpenter, J., Crowe, J., Crowe, L., Somero, et al
  2021; 13 (4): 459-484

- **The Goldilocks Principle: A Unifying Perspective on Biochemical Adaptation to Abiotic Stressors in the Sea.** *Annual review of marine science*
  Somero, G. N.
  2021

- **Introduction to the special issue: Comparative biology of cellular stress responses in animals.** *Journal of experimental zoology. Part A, Ecological and integrative physiology*
  Kultz, D., Somero, G. N.
  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 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

- **The cellular stress response and temperature: Function, regulation, and evolution.** *Journal of experimental zoology. Part A, Ecological and integrative physiology*
  Somero, G. N.
  2020

- **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
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- **PRESENT AND FUTURE ADAPTATION OF MARINE SPECIES ASSEMBLAGES DNA-Based Insights into Climate Change from Studies of Physiology, Genomics, and Evolution** *OCEANOGRAPHY*
  Palumbi, S. R., Evans, T. G., Pespeni, M. H., Somero, G. N.
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- **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.
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- **Comparing mutagenesis and simulations as tools for identifying functionally important sequence changes for protein thermal adaptation** *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA*
  Liao, M., Somero, G. N., Dong, Y.
  2019; 116 (2): 679–88

- **Comparing mutagenesis and simulations as tools for identifying functionally important sequence changes for protein thermal adaptation.** *Proceedings of the National Academy of Sciences of the United States of America*
  Liao, M., Somero, G. N., Dong, Y.
  2018

- **RNA thermosensors: how might animals exploit their regulatory potential?** *The Journal of experimental biology*
  Somero, G. N.
  2018; 221 (Pt 4)

- **Structural flexibility and protein adaptation to temperature: Molecular dynamics analysis of malate dehydrogenases of marine molluscs** *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA*
  Dong, Y., Liao, M., Meng, X., Somero, G. N.
  2018; 115 (6): 1274–79

- **Thermal history and gape of individual Mytilus californianus correlate with oxidative damage and thermoprotective osmolytes** *JOURNAL OF EXPERIMENTAL BIOLOGY*
  Gleason, L. U., Miller, L. P., Winnikoff, J. R., Somero, G. N., Yancey, P. H., Bratz, D., Dowd, W.
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  Liao, M., Zhang, S., Zhang, G., Chu, Y., Somero, G. N., Dong, Y.
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  Dong, Y., Li, X., Choi, F. M., Williams, G. A., Somero, G. N., Helmuth, B.
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- **What Changes in the Carbonate System, Oxygen, and Temperature Portend for the Northeastern Pacific Ocean: A Physiological Perspective** *BIOSCIENCE*
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- **Adaptations of protein structure and function to temperature: there is more than one way to 'skin a cat'** *JOURNAL OF EXPERIMENTAL BIOLOGY*
  Fields, P. A., Dong, Y., Meng, X., Somero, G. N.
  2015; 218 (12): 1801-1811

- **Adaptations of protein structure and function to temperature: there is more than one way to 'skin a cat'.** *journal of experimental biology*
  Fields, P. A., Dong, Y., Meng, X., Somero, G. N.
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- **Proteomic analysis of cardiac response to thermal acclimation in the eurythermal goby fish Gillichthys mirabilis** *JOURNAL OF EXPERIMENTAL BIOLOGY*
  Jayasundara, N., Tomanek, L., Dowd, W. W., Somero, G. N.
  2015; 218 (9): 1359-1372

- **Temporal patterning of thermal acclimation: from behavior to membrane biophysics.** *journal of experimental biology*
  Somero, G.
  2015; 218: 167-169

- **Master of all trades: thermal acclimation and adaptation of cardiac function in a broadly distributed marine invasive species, the European green crab, Carcinus maenas.** *journal of experimental biology*

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- **The impact of ocean warming on marine organisms** *CHINESE SCIENCE BULLETIN*
  Yao, C., Somero, G. N.
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- **Food availability, more than body temperature, drives correlated shifts in ATP-generating and antioxidant enzyme capacities in a population of intertidal mussels (Mytilus californianus)** *JOURNAL OF EXPERIMENTAL MARINE BIOLOGY AND ECOLOGY*
  Dowd, W. W., Felton, C. A., Heymann, H. M., Kost, L. E., Somero, G. N.
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- **Effects of temperature acclimation on cardiorespiratory performance of the Antarctic notothenioid Trematomus bernacchii** *POLAR BIOLOGY*
  Jayasundara, N., Healy, T. M., Somero, G. N.
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- **Physiological plasticity of cardiorespiratory function in a eurythermal marine teleost, the longjaw mudsucker, Gillichthys mirabilis.** *journal of experimental biology*
  Jayasundara, N., Somero, G. N.
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- **Thermal stress and cellular signaling processes in hemocytes of native (Mytilus californianus) and invasive (M. galloprovincialis) mussels: Cell cycle regulation and DNA repair.** *Comparative biochemistry and physiology. Part A, Molecular & integrative physiology*
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  Somero, G. N.
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- **Lessons from cold-adapted enzymes: Can protein adaptation to temperature be simple and quick?**
  Somero, G.
  OXFORD UNIV PRESS INC.2013: E204
- **Behavior and survival of Mytilus congeners following episodes of elevated body temperature in air and seawater** *JOURNAL OF EXPERIMENTAL BIOLOGY*
  Dowd, W. W., Somero, G. N.
  2013; 216 (3): 502-514
- **The impact of acute temperature stress on hemocytes of invasive and native mussels (Mytilus galloprovincialis and Mytilus californianus): DNA damage, membrane integrity, apoptosis and signaling pathways** *JOURNAL OF EXPERIMENTAL BIOLOGY*
  Yao, C., Somero, G. N.
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- **Functional Determinants of Temperature Adaptation in Enzymes of Cold- versus Warm-Adapted Mussels (Genus Mytilus)** *MOLECULAR BIOLOGY AND EVOLUTION*
  Lockwood, B. L., Somero, G. N.
  2012; 29 (10): 3061-3070
- **The Physiology of Global Change: Linking Patterns to Mechanisms** *ANNUAL REVIEW OF MARINE SCIENCE, VOL 4*
  Somero, G. N.
  2012; 4: 39-61
- **Latitudinal differences in Mytilus californianus thermal physiology** *MARINE ECOLOGY PROGRESS SERIES*
  Logan, C. A., Kost, L. E., Somero, G. N.

2012; 450: 93-105

- **Bruce D. Sidell (20 March 1948-8 February 2011) Obituary** *COMPARATIVE BIOCHEMISTRY AND PHYSIOLOGY A-MOLECULAR & INTEGRATIVE PHYSIOLOGY*
  Driedzic, W. R., Shick, J., Somero, G. N.
  2011; 160 (3): 440–42
- **Bruce D. Sidell (20 March 1948-8 February 2011) Obituary** *COMPARATIVE BIOCHEMISTRY AND PHYSIOLOGY C-TOXICOLOGY & PHARMACOLOGY*
  Driedzic, W. R., Shick, J., Somero, G. N.
  2011; 154 (4): 437–39
- **Bruce D. Sidell (20 March 1948-8 February 2011) Obituary** *COMPARATIVE BIOCHEMISTRY AND PHYSIOLOGY B-BIOCHEMISTRY & MOLECULAR BIOLOGY*
  Driedzic, W. R., Shick, J., Somero, G. N.
  2011; 160 (2-3): 119–21
- **Bruce D. Sidell (20 March 1948-8 February 2011) Obituary** *COMPARATIVE BIOCHEMISTRY AND PHYSIOLOGY D-GENOMICS & PROTEOMICS*
  Driedzic, W. R., Shick, J., Somero, G. N.
  2011; 6 (3): 335–36
- **Bruce D. Sidell 20 March 1948-8 February 2011 OBITUARY** *JOURNAL OF EXPERIMENTAL BIOLOGY*
  Driedzic, W., Shick, J., Somero, G. N.
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  Somero, G. N.
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- **Effects of thermal acclimation on transcriptional responses to acute heat stress in the eurythermal fish Gillichthys mirabilis (Cooper)** *AMERICAN JOURNAL OF PHYSIOLOGY-REGULATORY INTEGRATIVE AND COMPARATIVE PHYSIOLOGY*
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  Lockwood, B. L., Somero, G. N.
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- **Transcriptomic responses to salinity stress in invasive and native blue mussels (genus Mytilus)** *MOLECULAR ECOLOGY*
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- **Phosphorylation Events Catalyzed by Major Cell Signaling Proteins Differ in Response to Thermal and Osmotic Stress among Native (Mytilus californianus and Mytilus trossulus) and Invasive (Mytilus galloprovincialis) Species of Mussels** *PHYSIOLOGICAL AND BIOCHEMICAL ZOOLOGY*
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  Lockwood, B. L., Sanders, J. G., Somero, G. N.
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- **Transcriptional responses to thermal acclimation in the eurythermal fish Gillichthys mirabilis (Cooper 1864)** *AMERICAN JOURNAL OF PHYSIOLOGY-REGULATORY INTEGRATIVE AND COMPARATIVE PHYSIOLOGY*
  Logan, C. A., Somero, G. N.
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  Lockwood, B. L., Sanders, J. G., Somero, G. N.
  OXFORD UNIV PRESS INC.2010: E103–E103
- **The physiology of climate change: how potentials for acclimatization and genetic adaptation will determine 'winners' and 'losers'** *JOURNAL OF EXPERIMENTAL BIOLOGY*
  Somero, G. N.
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- **Can the giant snake predict palaeoclimate?** *NATURE*
  Denny, M. W., Lockwood, B. L., Somero, G. N.
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- **Heterologous hybridization to a complementary DNA microarray reveals the effect of thermal acclimation in the endothermic bluefin tuna (Thunnus orientalis)** *MOLECULAR ECOLOGY*
  Castilho, P. C., Buckley, B. A., Somero, G., Block, B. A.
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- **cDNA microarray analysis reveals the capacity of the cold-adapted Antarctic fish Trematomus bernacchii to alter gene expression in response to heat stress** *POLAR BIOLOGY*
  Buckley, B. A., Somero, G. N.
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- **Temperature adaptation of cytosolic malate dehydrogenases of limpets (genus Lottia): differences in stability and function due to minor changes in sequence correlate with biogeographic and vertical distributions** *JOURNAL OF EXPERIMENTAL BIOLOGY*
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- **Heat-Shock Protein 70 (Hsp70) Expression in Four Limpets of the Genus Lottia: Interspecific Variation in Constitutive and Inducible Synthesis Correlates With in situ Exposure to Heat Stress** *BIOLOGICAL BULLETIN*
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- **Following the heart: temperature and salinity effects on heart rate in native and invasive species of blue mussels (genus Mytilus)** *JOURNAL OF EXPERIMENTAL BIOLOGY*
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- **Have your say: welcome to the JEB Forum** *JOURNAL OF EXPERIMENTAL BIOLOGY*
  Phillips, K., Hoppeler, H., Somero, G.
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