

RAUL KAMANTIGUE SUAREZ
CURRICULUM VITAE
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I. BIOGRAPHICAL DATA

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II. EDUCATION

B.Sc. Biology (1973) Ateneo de Manila University, Loyola Heights, Quezon City,
Philippines

M.Sc. Zoology (1976) University of the Philippines, Diliman, Quezon City, Philippines

Ph.D. Zoology (1981) University of British Columbia, Vancouver, B.C., Canada

III. PROFESSIONAL EMPLOYMENT

1973-74 Research Assistant, Department of Zoology, University of the Philippines, Diliman,
Quezon City, Philippines

1975-76 Instructor, Department of Zoology, University of the Philippines, Los Banos,
Laguna, Philippines

1976-80 Teaching Assistant, Department of Zoology, University of British Columbia,
Vancouver, B.C., Canada V6T 2A9

1981-82 Senior Lecturer, University of the Philippines-Southeast Asian Fisheries
Development Center (UP-SEAFDEC) Graduate Program, University of the
Philippines, Iloilo, Philippines

1981-82 Senior Researcher, Aquaculture Department, Southeast Asian Fisheries
Development Center, Tigbauan, Iloilo, Philippines

1982-83 Postdoctoral Research Scholar, Department of Pharmacology, Stanford University
School of Medicine, Stanford, California, U.S.A.

1984-90 Research Associate, Department of Zoology, University of British Columbia,
Vancouver, B.C., Canada V6T 2A9

1990-present Research Associate (honorary), Department of Zoology, University of British
Columbia, Vancouver, B.C., Canada V6T 2A9

1990-91 Assistant Professor (Limited-Term), Department of Biological Sciences, Simon
Fraser University, Burnaby, B.C., Canada V5A 1S6

1992 Lecturer, Department of Zoology, University of British Columbia, Vancouver, B.C.,
Canada V6T 1Z4

1993-94 Assistant Professor (Tenure-Track), Department of Biological Sciences, Florida International University, University Park, Miami, Florida 33199, U.S.A.

1994-98 Assistant Professor, Department of Ecology, Evolution, & Marine Biology, University of California, Santa Barbara, CA 93106-9610, U.S.A

1998-2006 Associate Professor, Department of Ecology, Evolution, & Marine Biology, University of California, Santa Barbara, CA 93106-9610, U.S.A

2006-present Professor, Department of Ecology, Evolution, & Marine Biology, University of California, Santa Barbara, CA 93106-9610, U.S.A

IV. OTHER CURRENT POSITIONS

1990-present, Research Associate (honorary), Department of Zoology, University of British Columbia, Vancouver, B.C., Canada V6T 2A9

2004-present, Associate Editor, Theoretical Biology and Medical Modeling

2005-present, Editor, Journal of Experimental Biology

V. AREAS OF RESEARCH INTEREST

Evolutionary Design of Functional Capacities: relation between flux capacities and physiological flux rates in metabolic pathways; integrative approaches to reconcile functional design at the biochemical level to structure and function at higher levels of organization; upper evolutionary limits to physiological and biochemical design, allometric scaling of metabolic rate

Energetics of Locomotion: control of energy metabolism and metabolic fuel selection; enzyme and mitochondrial function in working muscles; limits and constraints to the design and performance of locomotory muscles, relation between design and performance

Ecological consequences and evolutionary implications of metabolic biochemistry: evolution of bioenergetic pathways in the context of animal locomotion; relations between metabolic rates, metabolic fuel selection and foraging ecology

VI. AWARDS AND HONORS

1959 Bronze Medal in 2nd Grade Spelling, Lourdes School, Mandaluyong, Philippines

1995 Plenary Speaker, International Congress of Comparative Physiology and Biochemistry, Birmingham, U.K.

VII. GRANT SUPPORT

1990-91 Natural Sciences and Engineering Research Council of Canada (NSERC) Operating Grant (Can\$40,000)

1992-94 Natural Sciences and Engineering Research Council of Canada (NSERC) Operating Grant (Can\$72,000)

1995 UCSB University Senate (US\$4,600)

1995-99 National Science Foundation (US\$150,000) Design of Glycolytic Capacities in Hymenopteran Flight Muscles

2003 National Science Foundation (US\$2,500) 30 Years of Biochemical Adaptation: A Symposium in Memory of Peter W. Hochachka

2000-2005 National Science Foundation (US\$243,000) Design of Oxidative Capacities in Hymenopteran Flight Muscles

2005 UCSB University Senate (US\$4,500)

2005-2007 National Science Foundation (US\$230,265) Fueling Hummingbird Foraging: Mechanisms and Ecological Implications

2007-2008 UC-MEXUS Research Grant (US\$16,939) Fuel Use During Flight in Nectarivorous Bats

VIII. GRADUATE STUDENTS AND POSTDOCS SUPERVISED

James F. Staples (postdoc 1995-96), now Associate Professor, University of Western Ontario

Diane M. O'Brien (Ph.D. 1998 Princeton University, co-supervised with Carlos Martinez del Rio), now Assistant Professor, University of Alaska, Fairbanks

Charles-A. Darveau (Ph.D. 2004 University of British Columbia, co-supervised with Peter W. Hochachka), now Assistant Professor, University of Ottawa

IX. PUBLICATIONS

1. **Suarez, R.K.** and P.W. Hochachka. 1981. Preparation and properties of rainbow trout liver mitochondria. *J. Comp. Physiol.* 143: 269-273.
2. **Suarez, R.K.** and P.W. Hochachka. 1981. The pyruvate branch-point in fish liver mitochondria: effects of acylcarnitine oxidation on pyruvate dehydrogenase and pyruvate carboxylase activities. *J. Comp. Physiol.* 143: 275-279.
3. **Suarez, R.K.** and P.W. Hochachka. 1981. Pyruvate carboxylase from rainbow trout liver. *J. Comp. Physiol.* 143: 281-288.
4. Mommsen, T.P. and **R.K. Suarez.** 1984. Control of gluconeogenesis in hepatocytes from rainbow trout: role of pyruvate branch-point and phosphoenolpyruvate-pyruvate cycle. *Mol. Physiol.* 6: 9-18.

5. **Suarez, R.K.**, M.D. Mallet, C. Daxboeck and P.W. Hochachka. 1986. Enzymes of energy metabolism and gluconeogenesis in the Pacific blue marlin *Makaira nigricans*. *Can. J. Zool.* 64: 694-697.
6. **Suarez, R.K.**, G.S. Brown and P.W. Hochachka. 1986. Metabolic sources of energy for hummingbird flight. *Am. J. Physiol.* 251: R537-R542.
7. Petersen, T.D.P., P.W. Hochachka and **R.K. Suarez**. 1987. Hormonal control of gluconeogenesis in hepatocytes from rainbow trout: regulatory role of pyruvate kinase. *J. Exp. Zool.* 243: 173-180.
8. **Suarez, R.K.** and T.P. Mommsen. 1987. Gluconeogenesis in teleost fishes. *Can. J. Zool.* 65: 1869-1882.
9. **Suarez, R.K.** 1988. Thinking with and without oxygen: energy metabolism in vertebrate brains. *Can. J. Zool.* 66: 1041-1045.
10. Hochachka, P.W., B. Emmett and **R.K. Suarez**. 1988. Limits and constraints in the scaling of oxidative and glycolytic enzymes in homeotherms. *Can. J. Zool.* 66: 1128-1138.
11. **Suarez, R.K.**, R.W. Brownsey, W. Vogl, G.S. Brown and P.W. Hochachka. 1988. Biosynthetic capacity of hummingbird liver. *Am. J. Physiol.* 255: R699-R702.
12. Moyes, C.D., L.T. Buck, P.W. Hochachka and **R.K. Suarez**. 1989. Oxidative properties of carp red and white muscle. *J. Exp. Biol.* 143: 321-331.
13. **Suarez, R.K.**, C.J. Doll, A.E. Buie, T.G. West, G.D. Funk and P.W. Hochachka. 1989. Turtles and rats: a biochemical comparison of anoxia-tolerant and anoxia-sensitive brains. *Am. J. Physiol.* 257: R1083-R1088.
14. Moyes, C.D., **R.K. Suarez**, P.W. Hochachka and J.S. Ballantyne. 1990. A comparison of fuel preferences of mitochondria from vertebrates and invertebrates. *Can. J. Zool.* 68: 1337-1349.
15. Farrell, A.P., J.A. Johansen, J.F. Steffensen, C.D. Moyes, T.G. West and **R.K. Suarez**. 1990. Effects of exercise training and coronary ablation on swimming performance, heart size and cardiac enzymes in rainbow trout (*Salmo gairdneri*). *Can. J. Zool.* 68: 1174-1179.
16. **Suarez, R.K.**, J.R.B. Lighton, C.D. Moyes, G.S. Brown, C.L. Gass and P.W. Hochachka. 1990. Fuel selection in rufous hummingbirds: ecological implications of metabolic biochemistry. *Proc. Natl. Acad. Sci. USA* 87: 9207-9210.
17. **Suarez, R.K.**, J.R.B. Lighton, G.S. Brown and O. Mathieu-Costello. 1991. Mitochondrial respiration in hummingbird flight muscles. *Proc. Natl. Acad. Sci. USA* 88: 4870-4873.
18. Moyes, C.D., **R.K. Suarez** and P.W. Hochachka. 1991. Peroxisomal beta-oxidation: insights from comparative biochemistry. *J. Exp. Zool.* 260: 267-273.
19. Farrell, A.P., J.A. Johansen and **R.K. Suarez**. 1991. Effects of exercise training on cardiac performance and muscle enzymes in rainbow trout, *Oncorhynchus mykiss*. *Fish Physiol. Biochem.* 9: 303-312.
20. **Suarez, R.K.** 1992. Hummingbird flight: sustaining the highest mass-specific metabolic rates among vertebrates. *Experientia* 48: 565-570.
21. **Suarez, R.K.** 1992. Ecological implications of metabolic biochemistry: Elephant parts and the third secret of life. *Experientia* 48: 535-536.

22. Mathieu-Costello, O., **R.K. Suarez** and P.W. Hochachka. 1992. Capillary-to-fiber geometry and mitochondrial density in hummingbird flight muscle. *Respir. Physiol.* 89: 113-132.
23. **Suarez, R.K.** 1992. Oxygen and VO_2 max: are muscle mitochondria created equal? In: Hypoxia and Mountain Medicine (Proceedings of the 7th International Hypoxia Symposium), J.R. Sutton, G. Coates, and C.S. Houston, eds., Pergamon Press, Oxford, pp. 136-142.
24. **Suarez, R.K.** and C.D. Moyes. 1992. Mitochondrial respiration in locust flight muscles. *J. Exp. Zool.* 263: 351-355.
25. **Suarez, R.K.** 1993. Oxidative metabolism in hummingbird flight muscles. In: The Vertebrate Gas Transport Cascade: Adaptations To Environment and Mode of Life, E. Bicudo (ed.), CRC Press, Boca Raton, FL, pp. 279-285.
26. West, T.G., P.G. Arthur, **R.K. Suarez**, C.J. Doll and P.W. Hochachka. 1993. *In vivo* utilization of glucose by heart and locomotory muscles of exercising trout (*Onchorhynchus mykiss*). *J. Exp. Biol.* 177: 63-79.
27. Hochachka, P.W., J.C. Nener, J. Hoar, **R.K. Suarez** and S.C. Hand. 1993. Disconnecting metabolism from adenylate control during extreme oxygen limitation. *Can. J. Zool.* 71: 1267-1270.
28. **Suarez, R.K.** 1996. Upper limits to mass-specific metabolic rates. *Ann. Rev. Physiol.* 58: 583-605.
29. **Suarez, R.K.**, J.R.B. Lighton, B. Joos, S.P. Roberts and J.F. Harrison. 1996. Energy metabolism, enzymatic flux capacities and metabolic flux rates in flying honeybees. *Proc. Natl. Acad. Sci. USA* 93: 12616-12620.
30. Joos, B., J.R.B. Lighton, J.F. Harrison, **R.K. Suarez** and S.P. Roberts. 1997. Effects of ambient oxygen tension on flight performance, metabolism and water loss of the honeybee. *Physiol. Zool.* 70: 167-174.
31. Staples, J.F. and **R.K. Suarez**. 1997. Honeybee flight muscle phosphoglucoisomerase: matching enzyme capacities to flux requirements at a near-equilibrium reaction. *J. Exp. Biol.* 200: 1247-1254.
32. **Suarez, R.K.**, J.F. Staples, J.R.B. Lighton, and T.G. West. 1997. Relationships between enzymatic flux capacities and metabolic flux rates in muscles: nonequilibrium reactions in muscle glycolysis. *Proc. Natl. Acad. Sci. USA* 94: 7065-7069.
33. **Suarez, R.K.** 1998. Design of glycolytic and oxidative capacities in muscles. In: Principles of Animal Design. The Optimization and Symmorphosis Debate (E.R. Weibel, C.R. Taylor, L.C. Bolis, eds.), Cambridge Univ. Press, pp. 155-163.
34. **Suarez, R.K.** 1998. Oxygen and the upper limits to animal design and performance. *J. Exp. Biol.* 201: 1065-1072.
35. Hochachka, P.W., G.B. McClelland, G.P. Burness, J.F. Staples and **R.K. Suarez**. 1998. Integrating metabolic pathway fluxes with gene-to-enzyme expression rates. *Comp. Biochem. Physiol.* 120B: 17-26.
36. **Suarez, R.K.**, J.F. Staples and J.R.B. Lighton. 1999. Turnover rates of mitochondrial respiratory chain enzymes in flying honeybees (*Apis mellifera*). *J. Exp. Zool.* 284: 1-6.
37. Gass, C.L., M. Romich and **R.K. Suarez**. 1999. Energetics of hummingbird foraging at low ambient temperature. *Can. J. Zool.* 77:314-320.

38. **Suarez, R.K.**, J.F. Staples, J.R.B. Lighton and O. Mathieu-Costello. 2000. Mitochondrial function in flying honeybees (*Apis mellifera*): respiratory chain enzymes and electron flow from complex III to oxygen. *J. Exp. Biol.* 203: 905-911.
39. **Suarez, R.K.** 2000. Quantitative design of muscle energy metabolism for steady-state work. In: *Cell and Molecular Responses to Stress* (K.B. Storey and J.M. Storey, eds.), Elsevier Press, pp. 17-28.
40. **Suarez, R.K.** 2000. Energy metabolism during insect flight: biochemical design and physiological performance. *Physiol. Biochem. Zool.* 73: 765-771.
41. O'Brien, D.M. and **R.K. Suarez.** 2001. Fuel use in hawkmoth (*Amphion floridensis*) flight muscle: enzyme activities and flux rates. *J. Exp. Zool.* 290: 108-114.
42. Darveau, C.-A., **R.K. Suarez,** R.D. Andrews and P.W. Hochachka. 2002. Allometric cascade as a unifying principle of body mass effects on metabolism. *Nature* 417: 166-170.
43. **Suarez, R.K.** and C.L. Gass. 2002. Hummingbird foraging and the relation between bioenergetics and behaviour. *Comp. Biochem. Physiol.* 133A: 335-343.
44. Thompson, S.N. and **R.K. Suarez.** 2002. Metabolism. In: *Insect Encyclopedia*, R.T. Carde and V.H. Resh (eds.), Academic Press, New York, pp. 703-707.
45. Darveau, C.-A., **R.K. Suarez,** R.D. Andrews and P.W. Hochachka. 2003. Response to Banavar *et al.* and West *et al.* *Nature* 421: 714.
46. Hochachka, P.W., C.-A. Darveau, R.D. Andrews and **R.K. Suarez.** 2003. Allometric cascade: a model for resolving body mass effects on metabolism. *Comp. Biochem. Physiol.* 134A: 675-691.
47. **Suarez, R.K.** 2003. Shaken and stirred: muscle structure and metabolism. *J. Exp. Biol.* 206: 2021-2029.
48. **Suarez, R.K.**, J.J. Childress and C.-A. Darveau. 2004. Metabolic scaling: a many-splendoured thing. *Comp. Biochem. Physiol.* 139B: 531-541.
49. **Suarez, R.K.** and D.R. Jones. 2002. Peter W. Hochachka (1937-2002). *Nature* 420: 140 (Obituary).
50. Harrison, J.F. and **R.K. Suarez.** 2004. Insect flight takes off. *J. Exp. Biol.* 207: 3251-3252 (invited JEB Classics article).
51. **Suarez, R.K.** 2004. Control analysis, mitochondrial bioenergetics and programmed cell death: the Krogh principle in practice. *Am. J. Physiol.* 287: R276 (invited Editorial Focus article).
52. **Suarez, R.K.** and C.A. Darveau. 2005. Multi-level regulation and metabolic scaling. *J. Exp. Biol.* 208: 1627-1634.
53. Somero, G.N. and **R.K. Suarez.** 2005. Peter Hochachka: Adventures in Biochemical Adaptation. *Ann. Rev. Physiol.* 67: 25-37.
54. **Suarez, R.K.**, C.-A. Darveau, K. Welch, Jr., D.M. O'Brien, D.W. Roubik and P.W. Hochachka. 2005. Energy metabolism in orchid bee flight muscles: carbohydrate fuels all. *J. Exp. Biol.* 208: 3573-3579
55. Darveau, C.-A., D.W. Roubik, D.M. O'Brien, K. Welch, P.W. Hochachka and **R.K. Suarez.** 2005. Allometric scaling of flight energetics in Panamanian orchid bees: a comparative phylogenetic approach. *J. Exp. Biol.* 208: 3581-3591
56. Darveau, C.-A., P.W. Hochachka, D.W. Roubik and **R.K. Suarez.** 2005. Allometric scaling of flight energetics in Panamanian orchid bees: Evolution of flux capacities and flux rates. *J. Exp. Biol.* 208: 3593-3602

57. **Suarez, R.K.**, Darveau, C.-A. and P.W. Hochachka. 2005. Roles of hierarchical and metabolic regulation in the allometric scaling of metabolism in Panamanian orchid bees. *J. Exp. Biol.* 208: 3603-3607.
58. Welch, Jr., K.C., Bakken, B.H., del Rio, C.M. and **Suarez, R.K.** 2006. Hummingbirds fuel hovering flight with newly ingested sugar. *Physiol. Biochem. Zool.* 79: 1082-1087.