

# The Post-Modern Synthesis Movements in Organismal Evolution

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# Un- and Under-Acknowledged Pioneers

- Richard Goldschmidt (1878 -1958) Evo-Devo, Macroevolution ≠ Microevolution
- Barbara McClintock (1902-1991), Chromosome restructuring and mobile DNA “controlling elements”
- G. Ledyard Stebbins (1906-2000), “Cataclysmic Evolution” by hybrid speciation
- Conrad Waddington (1905-1975), Epigenetic control of genome function
- Roy J. Britten (1919 -2012), repetitive DNA
- Carl Woese (1928-2012), discovery of *Archaea*, a third realm of life
- Lynn Margulis (1938-2011), symbiogenetic *Origin of Eukaryotic Cells* 1970
- Stephen Jay Gould (1941-2002) Punctuated equilibrium

All these have minimal or zero recognition  
in standard Evolutionary Biology textbooks

Uniformly sidelined for working outside The Modern Synthesis

# Active vs Passive Views of Evolution

- Passive nature of Modern Synthesis (random mutations + Natural Selection ==> nothing for organism to do but reproduce differentially)
- What does “Active Evolution” mean?
  - Infectious heredity
  - Horizontal DNA transfer
  - Symbiogenesis and “Holobiont” symbioses
  - Natural Genetic Engineering (mutagenic repair, mutator polymerases & deaminases, mobile DNA elements)
  - Evolutionary and epigenetic responses to ecological changes
  - Speciation by inter-specific hybridization
  - Active organismal modification of selective environment (Niche Construction)

# Macroevolution is not the same as Microevolution

- Microevolution = accumulation of independent localized mutations optimizing individual adaptations, as Darwin described in 1859.
- Macroevolution = major chromosome restructuring generating new species and new taxa

- Goldschmidt, R. (1940). The Material Basis of Evolution (The Silliman Memorial Lectures Series), Reissued 1982. New Haven CT, Yale

Univ.Press

- White, M. J. D. (1945). Animal cytology and evolution, Cambridge University Press. (3<sup>rd</sup> Edition, 1973)

- Heng, H. H. (2019). Genome Chaos: Rethinking Genetics, Evolution, and Molecular Medicine, Academic Press.

# Not All Hereditary Variation is Vertically Transmitted or Limited to the Germline

- Transmissible plasmids and bacterial antibiotic resistance (our largest evolutionary experiment)
- Lysogenic conversion of bacterial pathogens
- Cross-Taxon transfer by naked DNA, viruses and “gene transfer agents” (GTAs), microbial infections and parasitism
- The giant virus-amoeba “evolutionary melting pot”
- Soma-germline transmission by extracellular vesicles (“exosomes”)

# THE END OF “SELFISH” OR “JUNK” DNA

- Repetitive DNA is abundant in genomes of complex organisms and tracks complexity better than coding DNA
- Repetitive DNA can format genomic networks
- Repetitive DNA is actively transcribed
- Repetitive DNA is key to transcriptional networks, such as viviparous reproduction in mammals
- Non-coding RNAs are functional and key to splicing, epigenetic regulation (siRNAs) and determination of major phenotypes, such as pluripotency (lncRNAs)

# THE THIRD WAY OF EVOLUTION

- Formed 2013 by James Shapiro, Denis Noble and Raju Pookottil.
- Aim: to create a space in which dissenters from the Modern Synthesis can work and develop insights.
- The THIRDDWAY rejects Creationism as unscientific and the Modern Synthesis as too restrictive and unable to incorporate discoveries in genomics.
- Independent of any particular “synthesis”
- It seeks to validate and open new research lines in evolutionary biology
- <https://www.thethirdwayofevolution.com/>

# Website statement



evolution in the era of genomics and epigenomics

**Rationale**

People

Books

Related reading

Contact

The vast majority of people believe that there are only two alternative ways to explain the origins of biological diversity. One way is Creationism that depends upon intervention by a divine Creator. That is clearly unscientific because it brings an arbitrary supernatural force into the evolution process. The commonly accepted alternative is Neo-Darwinism, which is clearly naturalistic science but ignores much contemporary molecular evidence and invokes a set of unsupported assumptions about the accidental nature of hereditary variation. Neo-Darwinism ignores important rapid evolutionary processes such as symbiogenesis, horizontal DNA transfer, action of mobile DNA and epigenetic modifications. Moreover, some Neo-Darwinists have elevated Natural Selection into a unique creative force that solves all the difficult evolutionary problems without a real empirical basis. Many scientists today see the need for a deeper and more complete exploration of all aspects of the evolutionary process.



# DEVELOPMENTS OUTSIDE MODERN SYNTHESIS 1

⊕ Dates	People	Discovery/Field/topic
1910 1924 1971	<u>Mereschkowsky</u> <u>Kozo-Polyansky</u> <u>Lynn Margulis</u>	Macroevolution by <u>symbiogenesis</u>
1940 2019	<u>Goldschmidt</u> <u>Heng</u>	Distinction between Darwinian microevolution and non-Darwinian macroevolution
1950-1953	Barbara McClintock	Transposable elements
1952-1953	Conrad Waddington	<u>Transgenerational</u> inheritance of acquired traits
1952-3	Lederberg et al	Infective heredity and horizontal DNA transfer in bacteria
1953 1966 1998	<u>Weigle</u> <u>Witkin</u> Goodman	Cell-induced mutability <u>Mutator</u> polymerases Error-prone DNA repair
1964, 1970	Temin	Reverse transcription of RNA into <u>cDNA</u>
1968	Britten	Repetitive DNA content of complex genomes
1971	Britten & Davidson	Concept of repetitive DNA elements providing regulatory signals
1972 1975 1975	<u>Pigott &amp; Carr</u> <u>Bonen &amp; Doolittle</u> <u>Zablen, Kissel et al</u>	Chloroplasts originating from <u>cyanobacterial endosymbionts</u>
1977	<u>Maxam &amp; Gilbert</u> <u>Sanger, Air et al</u>	DNA sequencing

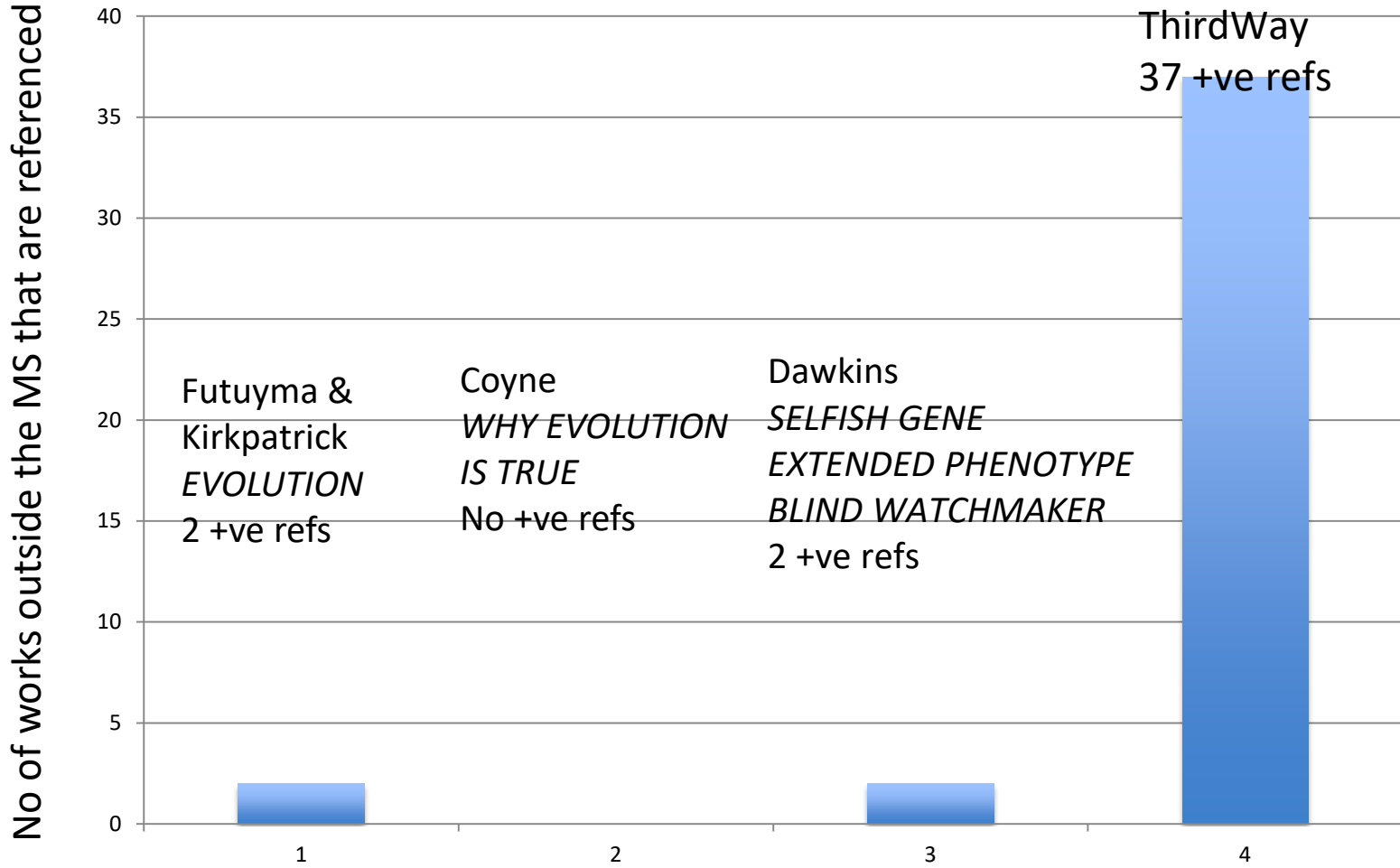
## DEVELOPMENTS OUTSIDE MODERN SYNTHESIS 2

Dates	People	Discovery/Field/topic
1977	<u>Bukhari</u>	Broad taxonomic and mechanistic diversity of mobile genetic elements
1977	<u>Woese</u>	Existence of second prokaryote kingdom
1977	<u>Woese &amp; Fox</u>	
1983	Harding, <u>Heuser et al</u>	Extracellular vesicle and sperm-mediated
1983	Pan & <u>Johnstone</u>	Soma- <u>Germline</u> DNA transfer
1992	Ting, Rosenberg et al	Endogenous retroviruses as transcriptional
1993	Boyd, <u>Bax et al</u>	signals and contributors to placental
1995	<u>Venables</u> , Brookes et al	evolution
1998	Fire, <u>Xu</u> , et al	Genome regulation by noncoding RNA
2002	<u>Kapranov</u> , <u>Cawley et al</u>	
2002	Okazaki, <u>Furuno et al</u>	
2008	Dinger, <u>Amaral et al</u>	
1997	<u>Torkelson</u> , Harris et al	Ecological Activation of NGE activities and
1998	<u>Nevo</u>	<u>Hypermutable</u> States
1999	Lombardo, <u>Torkelson et al</u>	
2001	Lander, Linton et al	Sequencing of the human genome
2009	Mercer, Dinger et al	Recognition of regulatory properties of long non-coding RNAs
2013	Guerrero, <u>Margulis et al</u>	<u>Microbiomes</u> and <u>holobiont</u> evolution by <u>symbiont</u> gain and loss

# Statistics

- The group has so far identified at least 40 discoveries and publications that go beyond the framework of The Modern Synthesis
- A systematic search through 5 of the most-used textbooks and popular accounts shows exceedingly few acknowledgements of the discoveries and fields identified

# Positive references to discoveries outside Modern Synthesis



# Third Way Books - 1

Over 70 members interested in new approaches to evolution in all fields (95+ titles):

- Shapiro, J. A. (1983). Mobile Genetic Elements. New York, Academic Press.
- Keller, E. F. (1984). A Feeling for the Organism, 10th Anniversary Edition: The Life and Work of Barbara McClintock. New York, Henry Holt
- Ho, M.-W. and P. Saunders (1984). Beyond Neo-Darwinism. New York, Academic Press.
- Karlin, S. and E. Nevo, Eds. (1986). Evolutionary Processes and Theory, Academic Press.
- Sapp, J. (1987). Beyond the Gene: Cytoplasmic Inheritance and the Struggle for Authority in Genetics, Oxford University Press
- Root-Bernstein, R. (1989). Discovering. Finding and Solving Problems at the Frontiers of Science, Harvard University Press.
- Dupré, J. (1993). The Disorder of Things: Metaphysical Foundations of the Disunity of Science Cambridge, MA, Harvard.
- Root-Bernstein, R. (1993). Rethinking AIDS: The Tragic Cost of Premature Consensus, Free Press.
- Sapp, J. (1994). Evolution by Association: A History of Symbiosis. United Kingdom, Oxford University Press.
- de Loof, A. (1996). WAT IS LEVEN ? de onstoffelijke dimensie (What is Life? The immaterial dimension). Leuven Apeldoorn, Garant.
- Ho, M.-W. (1998; 3rd edition 2008). The Rainbow and the Worm: The Physics of Organisms, World Scientific Publishing Company.
- Ho, M.-W. (1998). Genetic Engineering-Dream or Nightmare?: The Brave New World of Bad Science and Big Business, Gateway Books.

# Third Way Books - 2

- Van de Vijver, G., S. N. Salthe, et al. (1998). Evolutionary Systems: Biological and Epistemological Perspectives on Selection and Self-Organization, Springer.
- Villarreal, L. P., R. F. Conner, et al. (1998). AIDS: Science and Society, Jones & Bartlett.
- Nevo, E. (1999). Mosaic Evolution of Subterranean Mammals: Regression, Progression, and Global Convergence, Oxford University Press
- Root-Bernstein, R. (1999). Sparks of Genius: The Thirteen Thinking Tools of the World's Most Creative People, Houghton Mifflin
- Harold, F. M. (2001). The Way of the Cell: Molecules, Organisms, and the Order of Life, Oxford University Press. .
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- Caporale, L. H. (2002). Darwin in the Genome : Molecular Strategies in Biological Evolution, McGraw-Hill Education.
- Lewkowicz, D. J. and R. Lickliter (2002). Conceptions of Development: Lessons from the Laboratory, Psychology Press.
- Keller, E. F. (2002 ). The Century of the Gene, Harvard University Press
- Muller, G. and S. Newman (2003). Origination of Organismal Form: Beyond the Gene in Developmental and Evolutionary Biology. Cambridge USA, MIT Press.
- Odling-Smee, F. J., K. N. Laland, et al. (2003). Niche Construction : The Neglected Process in Evolution, Princeton University Press.
- Sapp, J. (2003). Genesis: The Evolution of Biology, Oxford University Press

# Third Way Books - 3

- Weiss, K. M. and A. V. Buchanan (2003). Genetics and the Logic of Evolution, John Wiley & Sons.
- Ho, M.-W. (2003). Living with the Fluid Genome, Institute of Science in Society. Jablonka, E., Lamb, M (2005 (2nd revised edition 2014)). Evolution in Four Dimensions. Boston, MIT Press.
- Villarreal, L. P. (2005). Viruses And The Evolution Of Life. Washington DC, ASM Press.
- Sapp, J., Ed. (2005). Microbial Phylogeny and Evolution: Concepts and Controversies. United Kingdom, Oxford University Press.
- Wheeler, W. (2006). The Whole Creature: Complexity, Biosemiotics and the Evolution of Culture, Lawrence & Wishart.
- Caporale, L. H. (2006). The Implicit Genome. Oxford, UK, Oxford University Press.
- Ho, M.-W. and L. L. Ching (2007). GMO Free: Exposing the Hazards of Biotechnology to Ensure the Integrity of Our Food Supply, Square One.
- Bauer, J. (2008 (English 2012)). Das kooperative Gen. Abschied vom Darwinismus. (The Cooperative Gene: Evolution as a creative process), Hoffmann und Campe.
- Roossinck, M. J. (2008). Plant Virus Evolution, Springer.
- Weiss, K. M. (2008). Genetic Variation & Human Disease: Principles and Evolutionary Approaches, Cambridge University Press.
- Noble, D. (2008). The Music of Life: Biology Beyond Genes, Oxford University Press.
- Logan, R. K. (2008). The Extended Mind: The Emergence of Language, the Human Mind, and Culture. Toronto, ON, University of Toronto Press, Scholarly Publishing Division.
- Holdrege, C. and S. Talbott (2008). Beyond Biotechnology: The Barren Promise of Genetic Engineering (Clark Lectures), Publisher: University Press of Kentucky.

# Third Way Books - 4

- Villarreal, L. P. (2008). Origin of Group Identity: Viruses, Addiction and Cooperation, Springer.
- Baluska, F. (2009). Plant-Environment Interactions: From Sensory Plant Biology to Active Plant Behavior (Signaling and Communication in Plants), Springer.
- Hoffmeyer, J. and D. Favareau, Eds. (2009). Biosemiotics An Examination into the Signs of Life and the Life of Signs, Univ of Scranton Press.
- Witzany, G. (2009). Natural Genetic Engineering and Natural Genome Editing, Wiley-Blackwell.
- Witzany, G. (2009). Biocommunication and Natural Genome Editing, Springer.
- Sandín Domínguez, M. (2009). Pensando la evolución : pensando la vida (Thinking about Evolution: Thinking about Life), Cauac Editorial Nativa.
- Weiss, K. M. and A. V. Buchanan (2009). The Mermaid's Tale: Four Billion Years of Cooperation in the Making of Living Things, Harvard University Press
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- Austin, R. H. (2010). The Physics of Proteins: An Introduction to Biological Physics and Molecular Biophysics, Springer.
- Gontier, N., J. P. van Bendegem, et al., Eds. (2010 ). Evolutionary Epistemology, Language and Culture: A Non-Adaptationist, Systems Theoretical Approach. Springer.
- Caetano-Anolles, G. (2010). Evolutionary Genomics and Systems Biology, Wiley-Blackwell.
- Favareau, D., Ed. (2010). Essential Readings in Biosemiotics : Anthology and Commentary, Springer.



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- Shapiro, J. A. (2011). Evolution: A View from the 21st Century. Upper Saddle River, NJ, FT Press Science.
- Koonin, E. V. (2011). The Logic of Chance: The Nature and Origin of Biological Evolution, FT Press.
- Kull, K. (2011). Towards a Semiotic Biology: Life is the Action of Signs, Imperial College Press.
- Lamm, E. (2011). Biological Computation, Taylor & Francis Group.
- Carey, N. (2011). The Epigenetics Revolution: How Modern Biology is Rewriting our Understanding of Genetics, Disease and Inheritance, Icon Books Ltd. Ryan, F. P. (2011). The Mystery of Metamorphosis: A Scientific Detective Story, Chelsea Green Publishing.
- Bejan, A. and J. P. Zane (2012). Design in Nature: How the Constructal Law Governs Evolution in Biology, Physics, Technology, and Social Organization Anchor.
- Witzany, G., Ed. (2012). Viruses: Essential Agents of Life, Springer.
- Witzany, G., Ed. (2012). Biocommunication in Soil Microorganisms, Springer.
- Witzany, G., Ed. (2012). Biocommunication of Fungi, Springer.
- Torday, J. S. and V. K. Rehan (2012). Evolutionary Biology: Cell-Cell Communication, and Complex Disease, Wiley-Blackwell.
- Spadafora, C. (2012). Sperm-Mediated Gene Transfer, Bentham.
- Ryan, F. P. (2013). Violution : The Most Important Evolutionary Book Since Dawkins' Selfish Gene. London, Harper
- Pookottil, R. (2013). BEEM: Biological Emergence-based Evolutionary Mechanism: How Species Direct Their Own Evolution, Fossil Fish Publishing

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- Van De Vijver, G. (2013). Objectivity after Kant: Its Meaning, its Limitations, its Fateful Omissions, Georg Olms Verlag.
- Westling, L. (2013). The Logos of the Living World: Merleau-Ponty, Animals, and Language (Paperback), Fordham University Press.
- Rosslembroich, B. (2014). On the Origin of Autonomy. A New Look at the Major Transitions in Evolution., Cham, Springer.
- Pina, M. and N. Gontier, Eds. (2014). The Evolution of Social Communication in Primates: A Multidisciplinary Approach. Interdisciplinary Evolution Research, Springer.
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- Moelling, K. (2014). Die Supermacht des Lebens. Reisen in die erstaunliche Welt der Viren (The Superpowers of Life. Journeys in the Astonishing World of Viruses). Berlin, Germany, Frölich und Kaufmann.
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- Gontier, N., Ed. (2015). Reticulate Evolution. Symbiogenesis, Lateral Gene Transfer, Hybridization and Infectious Heredity., Cham, Springer.
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- Moore, D. S. (2015). The Developing Genome: An Introduction to Behavioral Epigenetics, Oxford University Press.
- Noble, D. (2016). Dance to the Tune of Life: Biological Relativity. Cambridge, UK, Cambridge University Press.
- Pross, A. (2016). What is Life?: How Chemistry Becomes Biology Oxford University Press,.
- Roossinck, M. J. (2016). Virus: An Illustrated Guide to 101 Incredible Microbes, Princeton University Press.
- Wheeler, W. (2016). Expecting the Earth: Life/Culture/Biosemiotics, Lawrence & Wishart.
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- Serrelli, E. and N. Gontier, Eds. (2016). Macroevolution: Explanation, Interpretation and Evidence (Interdisciplinary Evolution Research), Springer.
- Corning, P. A. (2017). Synergistic Selection: How Cooperation Has Shaped Evolution And The Rise Of Humankind. World Scientific Publishing Company.
- Van De Vijver, G. (2017). Evolutionary Systems: Biological and Epistemological Perspectives on Selection and Self-Organization, Springer.
- Peterson, E. L. (2017). The Life Organic: The Theoretical Biology Club And The Roots Of Epigenetics, University of Pittsburgh Press.

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- Torday, J. S. and V. K. Rehan (2017). Evolution, the Logic of Biology, John Wiley & Sons.
- Hadidi, A., R. Flores, et al., Eds. (2017). Viroids and Satellites, Academic Press.
- Witzany, G., Ed. (2017). Biocommunication of Archaea., Cham, Springer.
- Walsh, D. M. (2018). Organisms, Agency, and Evolution. Cambridge, UK, Cambridge University Press.
- Gontier, N. (2018). On How Epistemology and Ontology Converge Through Evolution: The Applied Evolutionary Epistemological Approach. The Map and the Territory. Foreword by Sir Roger Penrose. Springer.
- Baluska, F., M. Gagliano, et al., Eds. (2018). Memory and Learning in Plants. Berlin, Springer.
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- Jablonka, E., Lamb, M (2020). Inheritance Systems and the Extended Synthesis (Elements in the Philosophy of Biology). Cambridge UK, Cambridge University Press.
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