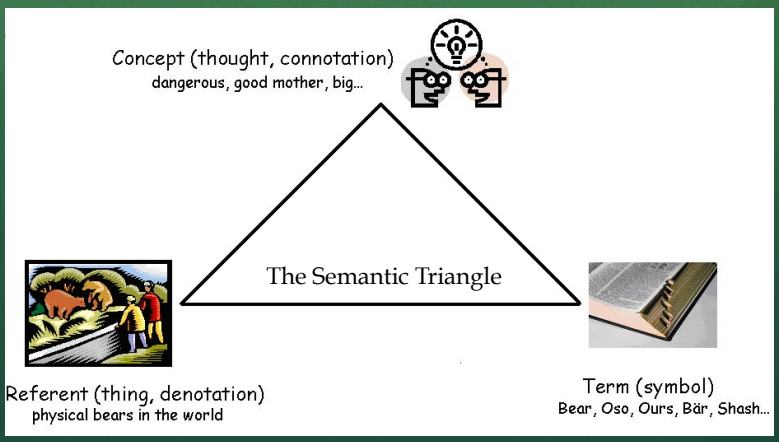
Publication trends in evolutionary medicine: 20 years in MeSH

Background

- The purpose of this study is to characterize trends in the application of evolutionary biology in health and disease.
- The focus of this study is whether evolutionary medicine can be considered a distinct scientific discipline.

Key Question

- What is evolutionary medicine?



from ravensara.blogspot.com

Evolutionary Medicine

- A concept
- A referent (the scientific discipline)
- A term (the words that are used to describe a referent or concept)

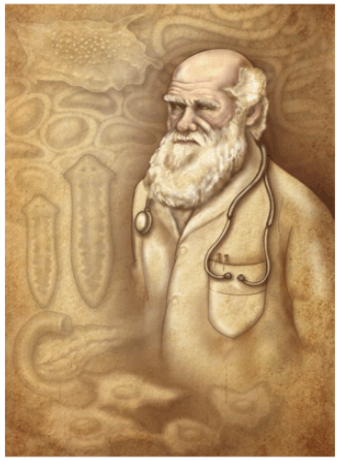
- We will explore each angle of the semantic triangle

The concept - background

- Medicine and evolutionary biology progressed along different paths for much of the 20th century.
- The Modern Synthesis – integrated Darwinian evolution by natural selection with Mendelian genetics, providing a unified framework for biology.
- Medicine largely left out.
- A few pioneers applied ideas of population genetics and natural selection to human diseases in 1950s. Allison proposed that the sickle cell trait provides a survival benefit in malaria.

Evolution: not a prominent concept in biomedicine

- Medical education omits evolutionary biology.
- Mechanistic reductionistic approaches continue to take precedence (e.g much of molecular biology)



Science 2011. 334(6062): 1486-1487

The Term "Darwinian Medicine" or "Evolutionary Medicine"

- Evolutionary (Darwinian) medicine is defined as the application of concepts of evolutionary biology to health and disease.
- Although the earliest examples of evolutionary medicine date to the late 1800s, the term "Darwinian Medicine" gained currency in 1991 (Williams and Nesse).

The Dawn of Darwinian Medicine

Quarterly Review of Biology, 1991

Randolph Nesse MD
Psychiatrist, University of Michigan

George C. Williams PhD
Evolutionary Biologist, University of Michigan

Two decades later…

- Matter of debate:
- Is there a distinct scientific discipline called "Evolutionary medicine?"
- What are the metrics by which we will know if this scientific approach is a success?

Bibliometric Approach

- Performed an analysis of evolutionary biology concepts indexed in the National Library of Medicine.
- Explored the use of evolutionary concepts using a controlled terminology, MeSH terms.
- Also searched alternative databases to assess publication trends

MeSH

- Medical Subject headings
- A controlled terminology used to index publications in Medline, were first published in 1963, with 5,700 terms.
- Today, there are more than 25,000 terms.
- MeSH terms are updated annually by NLM.

Methods

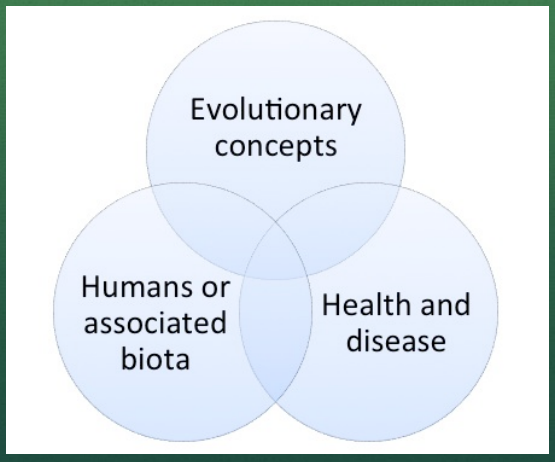
- Examine all MeSH terms for articles identified by keywords “evolutionary medicine”or “Darwinian medicine” 1991 to 2010.
- Perform additional searches using MeSH terms that map to evolutionary concepts.
- In what journals are these articles published?
- What are the impact factors of these journals.

Scientific discipline

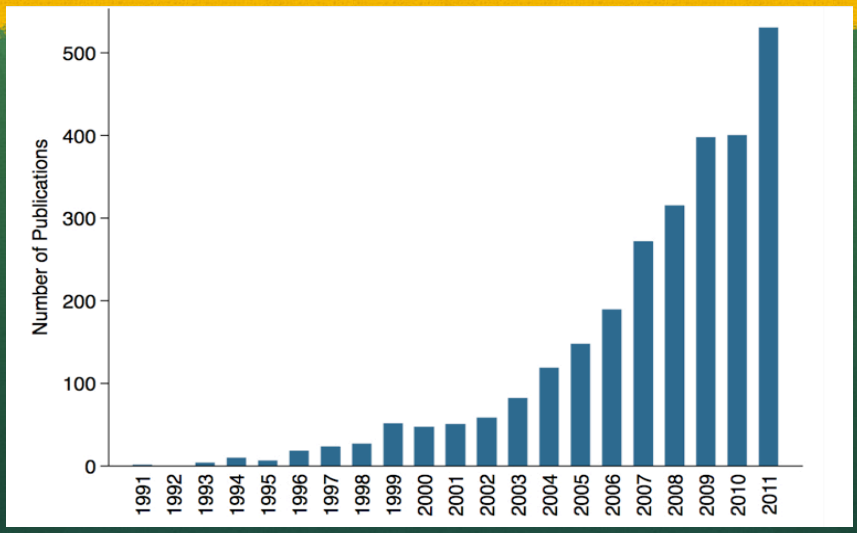
- We use two metrics to determine whether evolutionary medicine can be considered a distinct scientific field.
- Is the growth of scientific publication exponential, and does it outpace the general growth in scientific literature?
- Are there opportunities for the exchange of scientific ideas and collaboration in evolutionary medicine?

How to distinguish true positives among search results?

Publication contains all three domains below:

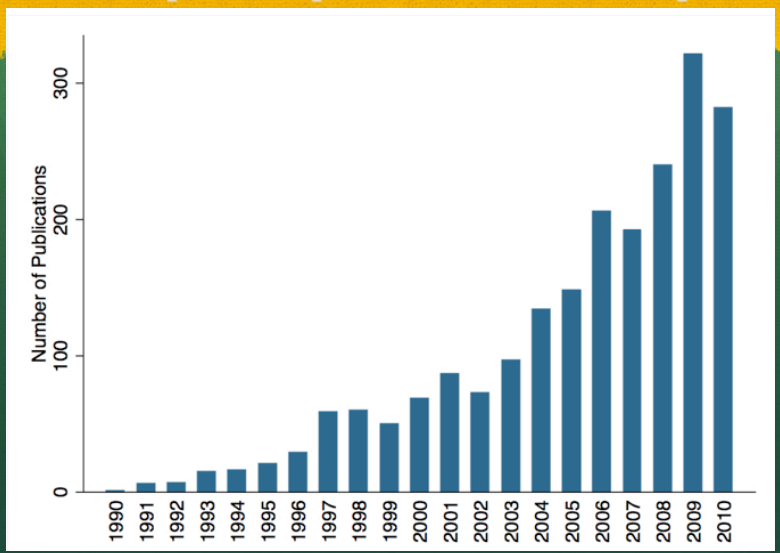


Growth in publications with "evolutionary medicine" or "Darwinian medicine



Database: Google Scholar

Growth in publications with Biological Evolution"[MeSH] AND "Medicine"[MeSH]



Database: PubMed

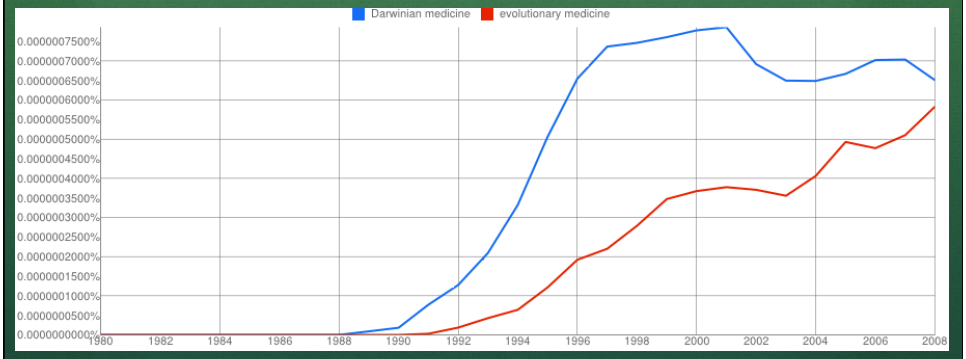
Exponential growth

- 26.5 % annual growth in publications with MeSH terms Biological Evolution and Medicine
- Compare that to a 4% annual growth in PubMed overall.

Results: Terminology

- Evolutionary Medicine vs. Darwinian Medicine
- Evolutionary Medicine is preferred term in PubMed and ISI Web of Knowledge.
- Among digitized books, “evolutionary medicine” is gaining on “Darwinian medicine”.

N-gram viewer – digitized books



The term “evolutionary medicine” is gaining on “Darwinian medicine” in published books

Which MeSH terms map best to evolution in medicine?

- MeSH terms of articles identified with keywords “Darwinian medicine” or “evolutionary medicine.”

MeSH term	Number (%)	Major
Humans	**84 (89%)**	0
Biological Evolution	**62 (66%)**	13
Selection, Genetic	23 (24%)	10
Adaptation, Physiological	13 (14%)	6
Evolution, Molecular	11 (12%)	6
Medicine	11 (12%)	11
Adaptation, Biological	7 (7%)	1
Phylogeny	3 (3%)	1

Only 94 articles in PubMed with "Evolutionary medicine" or "Darwinian medicine"

- Clearly any search with 1 or 2 MeSH terms will miss some of these 94 publications.
- Conversely there are many more than 94 articles on the topic of evolution and medicine. These are missed by searching for the keywords "evolutionary medicine" or "Darwinian Medicine"
- There is no MeSH term for Evolutionary Medicine (more on that later).

Biological Evolution

MeSH term	Concepts Included	Definition (from MeSH Descriptor Data)	Indexed under*
Biological Evolution	Biological evolution	The process of cumulative change over successive generations through which organisms acquire their distinguishing morphological and physiologocial characteristics.	Genetic Processes

A MeSH term for evolution was first introduced in 1966. The term in current use dates to 1989 and the qualifier 'Biological' was added in 2011.

Biological evolution[MeSH] not mapped to this seminal citation

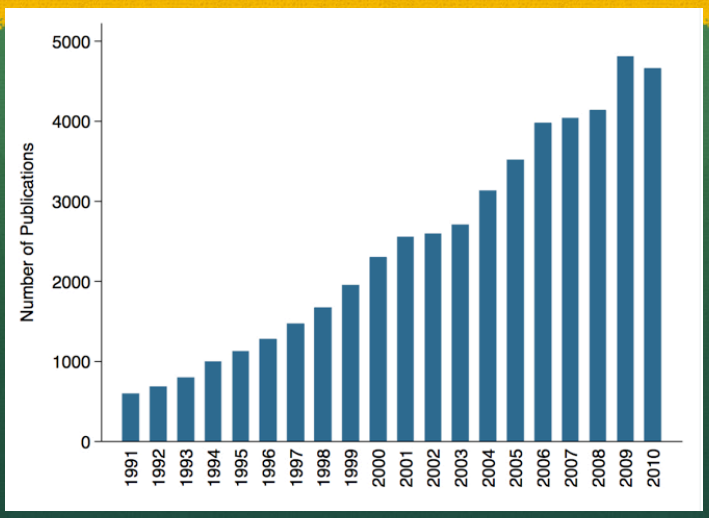
The dawn of Darwinian medicine.

Williams GC, Nesse RM
Quarterly Review of Biology, 1991

"While evolution by natural selection has long been a foundation for biomedical science, it has recently gained new power to explain many aspects of disease. This progress results largely from the disciplined application of what has been called the adaptationist program. We show that this increasingly significant research paradigm can predict otherwise unsuspected facets of human biology, and that it provides new insights into the causes of medical disorders..."

MeSH Terms
- Adaptation, Physiological/genetics
- Animals
- Environment
- Genetics, Medical
- Humans
- Models, Genetic
- **Selection, Genetic***

Biological Evolution



Corresponds to a 11.6% annual average rate of increase. Database: PubMed.

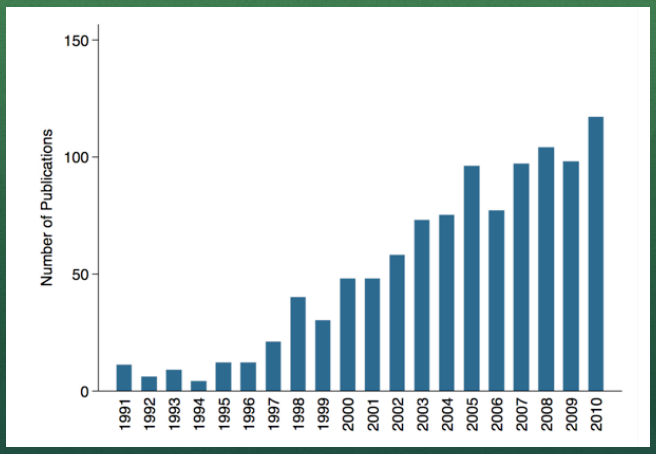
Phylogeny[MeSH]

- Huge area of evolutionary medicine, about half of the citations identified by Biological Evolution also have this identifier.
- in 2011 there were 2179 publications
- Use evolution as a foundational science, relying on common descent.
- Many of these articles are descriptive.
- Minority (3%) of self identified evolutionary medicine publications were given Phylogeny MeSH terms.

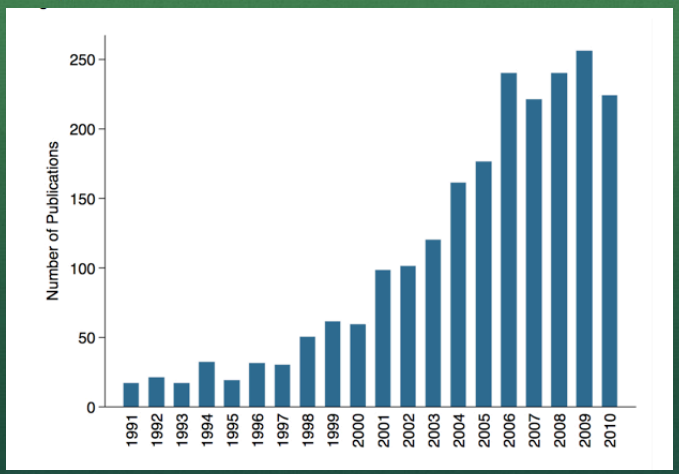
Adaptation and Selection

- Natural and sexual section are the engines of the evolution.
- "Adaptation, biological"[MeSH] AND "Biological Evolution"[MeSH} yielded 1384 total results in PubMed.
- "Selection, Genetic"[MeSH] AND "Human"[MeSH] yielded a total of 5769 results in PubMed. many of these relate to evolution in health and disease.
- Still these MeSH descriptors did not identify the majority of citations with keywords "evolutionary medicine" and "Darwinian medicine"

Biological Evolution[Mesh] AND Adaptation, Biological[MeSH]



Biological Evolution[Mesh] AND Selection, Genetic[MeSH]



The tapering off of growth may reflect instead a temporary uptick of publication in 2009, the 200th anniversary of Darwin's birth

Journals that publish evolutionary medicine

- AIDS Research and Human Retroviruses
- American Journal of Human Biology
- BMC Evolutionary Biology
- Emerging Infectious Diseases
- Infection Genetics and Evolution
- International Journal of Antimicrobial Agents
- The Journal of Clinical Microbiology
- Journal of Medical Virology
- Journal of the Royal Society of Medicine
- Journal of Virology
- Medical Hypotheses
- PloS One
- Proceedings of the National Academy of Sciences USA
- The Quarterly Review of Biology
- Science

Many have excellent impact factors and Eigenfactor scores

PubMed Search Strategy

- Cast the largest net with Mesh terms Biological Evolution and Humans.
- Add an additional search term (e.g. Malaria)
- Searches with key words “evolutionary medicine” inadequate.
- Many important works are indexed under mesh terms: Phylogeny, Adaptation, and Selection, Genetic.

Not all journals are indexed in Medline

Evolutionary Applications

Evolutionary approaches to environmental, biomedical and socio-economic issues

How evolutionary principles improve the understanding of human health and disease

Peter D. Gluckman[1], Felicia M. Low[1], Tatjana Buklijas[1], Mark A. Hanson[2], Alan S. Beedle[1]

Article first published online: 17 FEB 2011

DOI: 10.1111/j.1752-4571.2010.00164.x

Issue

Evolutionary Applications

Special Issue: In the light of evolution: interdisciplinary challenges in food, health, and the environment

Volume 4, Issue 2, pages 249–263, March 2011

Open access, but not in PubMed, yet.

A call for new terminology

- Since evolutionary medicine as a keyword has not yet become ubiquitous, perhaps a new term:

  evomedicine?

  evolution in health and disease?

- Ongoing semantic issues hinder development of field.
- However, citation growth supports the notion of a MeSH term for evolutionary medicine

Comparison to another new field

- Systems biology" added as MeSH term in 2005.
- Shares some similarities with evolutionary medicine in that it takes an approach that is less rigidly mechanistic and does not rely on reductionistic explanations.
- It does not use a neologism or unique word to describe their new approach. (unlike nanotechnology or genomics).
- In PubMed, the keywords "systems biology" identify 9103 citations in the time frame 1991-2010, in contrast to < 100 for "evolutionary medicine"

New Institutions

Phylomedicine: Darwin for disease

Posted: April 06, 2012

If the much-touted era of personalized medicine is to become a reality, a tighter fit between the universe of gene mutations found in human populations and the complex diseases they correlate with will have to be established.

Researchers pursuing this quest have found an invaluable, if unlikely, ally: Charles Darwin. Although evolutionary theory forms the cornerstone of biology, it has only recently been exploited as a rich source of clinical insight into the causes and possible treatments for disease.

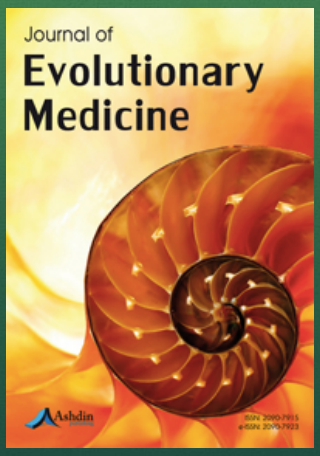
The advent of rapid, lower-cost genetic sequencing has opened the floodgates for comparative genomic research, adding human full-genome sequences to a burgeoning library while filling out the branches of the Tree of Life with the genomes of thousands of other living

Sudhir Kumar is the director of the Center for Evolutionary Medicine and Informatics (CEMI) at the Biodesign Institute, Arizona State University.

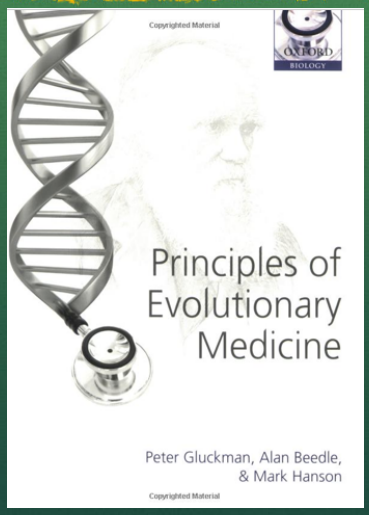
Evolution and Cancer Care

- While phylomedicine depends on phylogeny, other institutions have taken adaptation to the cellular level:

New Journals



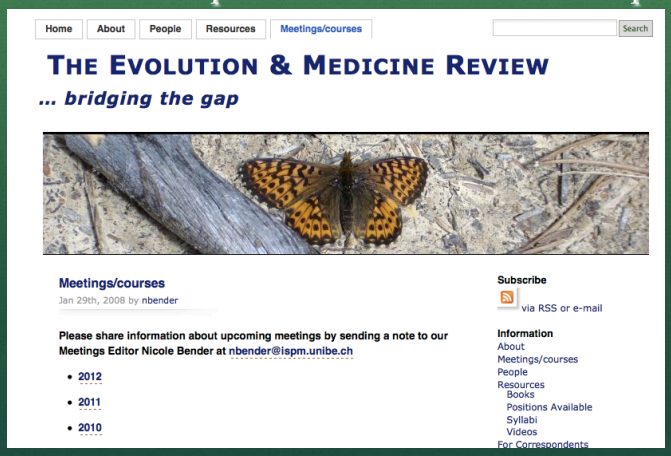
New Textbooks



New Training Opportunities

Distinct Scientific Field

- Meets criteria required of a new scientific discipline.



Summary: still a developing field

- Prolonged dawn for Darwinian medicine may be brightening.
- There is a need for uniformity in the use of terminology among evolutionary medicine researchers. A new MeSH term would help scholarly activity in this area.
- Some new centers for research have emerged – some are shifting evolutionary medicine in unexpected directions, like "phylomedicine."
- Two new journals are being launched
- Yearly training and continuing medical education is now being offered.