BIOLOGY 666
ANIMAL BEHAVIOR

PAST – PRESENT – FUTURE

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PLAN OF ACTION

- INTRODUCTORY THOUGHTS
- HISTORY OF ANIMAL BEHAVIOR
- RECENT DECADES AND THE PRESENT
- FUTURE PATHWAYS
INTRODUCTION

- Personal History
- Ladder of Life
- Sources of Questions
- Model System
- Tinbergen’s Four Questions
PERSONAL HISTORY

- FAMILY OF ACADEMICS – UNIVERSITY OF ILLINOIS
- UNIVERSITY HIGH SCHOOL
- OBERLIN
- MICHIGAN STATE
- NORTH CAROLINA STATE
- PUERTO RICO
- WILLIAMS COLLEGE
- SOUTHERN ILLINOIS UNIVERSITY
- NORTHERN ARIZONA UNIVERSITY
LADDER OF LIFE - I

- CHEMISTRY
- ORGANELLES
- CELLS
- TISSUES
- ORGANS
- ORGAN SYSTEMS
- ORGANISM – ANIMAL BEHAVIOR
LADDER OF LIFE - II

- ORGANISM – ANIMAL BEHAVIOR
- POPULATION
- COMMUNITY
- ECOSYSTEM
- BIOSPHERE (BIOMES)
SOURCES OF QUESTIONS

• OBSERVATION – NATURAL HISTORY
• TESTING THEORY
• TECHNOLOGY CHANGES
• APPLIED
OBSERVATIONS

- DUCKLINGS FOLLOWING MOTHER
- TWO SPECIES OF PEROMYSCUS
- MOBBING BEHAVIOR IN BIRDS

- SPEND TIME WITH SUBJECT ANIMAL(S) IN THEIR NATURAL ENVIRONMENT
- UMWELT CONCEPT
TESTING THEORY

- FORAGING THEORY
- KIN SELECTION THEORY
- SEXUAL SELECTION
NEW TECHNOLOGIES

- RADIO-TRACKING
- DNA TECHNOLOGY
- HORMONES – COLLECTIONS & ASSAYS
APPLIED

• AGRICULTURE
• PETS
• CONSERVATION
TINBERGEN’S FOUR QUESTIONS

- ULTIMATE QUESTIONS
- FUNCTION
- EVOLUTION
TINBERGEN’S FOUR QUESTIONS

• PROXIMATE QUESTIONS

• PHYSIOLOGY-MECHANISMS

• DEVELOPMENT
G. STANLEY HALL
CHARLES OTIS WHITMAN
C. LLOYD MORGAN
Douglas Spalding
George John Romanes
WILLIAM MORTON WHEELER
NIKO TINBERGEN
KONRAD LORENZ
KONRAD LORENZ
Wolfgang Schleidt
JOHN B. WATSON
B.F. SKINNER
WILLIAM H. THORPE
R.A. Fisher
T.C. SCHNEIRLA
VINCENT DETHIER
Frank Beach
Daniel Lehrman
Iraneus Eibl-Eibesfeldt
HARRY HARLOW
PETER MARLER
John Maynard Smith
W.D. HAMILTON
JOHN A. KING
George C. Williams
AMOTZ ZAHAVI
Robert Trivers
JEANNE ALTMANN
FRANS DE WAAL
JOHN KREBS
MARIAN DAWKINS
SARAH HRDY
STEPHEN EMLLEN
MARY JANE WEST-EBERHARD
JOE WHO?
HISTORY OF ANIMAL BEHAVIOR

ANCIENT HISTORY

GREEKS AND ROMANS

10TH - 18TH CENTURIES

19TH CENTURY
ANCIENT HISTORY

Early Humans

Food – Hunting

Predators
ANCIENT HISTORY

Early Humans

• Artwork and Artifacts
• Domestication
• Companion Animals
• Livestock
DOMESTICATION

• (1) COMPANIONSHIP & PROTECTION

• (2) FOOD

• (3) ANIMAL PARTS FOR CLOTHING & UTENSILS

• (4) TRANSPORTATION
ANCIENT HISTORY

Early Humans

• Agriculture
  * Pest Organisms – Rodents & Insects & Birds
GREEKS

(1) Anatomy –
  • Understanding the Human Body
(2) Natural History –
  • Systematic Observations
SCIENTIFIC ANIMAL BEHAVIOR

(1) ARISTOTLE – Marine Biology, Birds, Fish
  • First Real Ethograms

(2) SYSTEMATIC RECORDED NATURAL HISTORY - Consistent Methods of Observing & Recording

(3) USE OF COMPARATIVE METHOD
  • Reproductive Systems

(4) APPLIED ASPECTS OF BEHAVIOR
  • Domestic Stocks

(5) CLASSIFICATION SCHEME
ROMANS

(1) EMPHASIS ON ANATOMY
   Galen – Relating Anatomy to Function (Locomotion)

(2) NATURAL HISTORY
   Pliny – 37 Volumes on Natural History

(3) TRAVEL – EXPLORATION
   More Exotics Brought to Rome
MIDDLE EAST & ASIA

(1) RELIGIONS
Animal Depictions, Myths, Deities

(2) ARAB AGRICULTURAL REVOLUTION
- Food Chains
- Struggle for Existence
- Environmental Determinism
10\textsuperscript{TH} – 16\textsuperscript{TH} CENTURIES

- MIDDLE AGES – Plague, Not Much Else
- RENAISSANCE – Renewal of Science
- AGE OF EXPLORATION – Late 15\textsuperscript{th} Century
- NATURAL PHILOSOPHY – Splits Into Disciplines
- BELIEF IN SOME VITAL SPIRIT OR CREATOR
17th to 19th centuries

(1) Natural History & Exploration

(2) Systematics – Linnaeus

(3) Shift away from religion as foundation
(4) Descartes – *Discourse on Method*

- **Divide the Problem into Separate Parts and Work on Those Individually**

- **Conduct Investigation in Stepwise Fashion**

- **All Information Must Be Factual and Objective**
(1) ZOOLOGICAL PARKS – Private Until 1860s

(2) MUSEUMS

(3) SOCIETIES

(4) JOURNALS – Really Shared Papers
17th & 18th Centuries

- Lamarck
- Buffon
- Linneaus
- Erasmus Darwin
- Malthus
- Gilbert White
- John Bartram
ANIMAL BEHAVIOR BEGINS

Charles G. Leroy – Versailles Menagerie

1750s – 1780s

Game Keeper

Wrote on Animal Intelligence

Describes

Ethogram

Life History Traits

Compares Herbivores & Carnivores
19th Century – First Half

- Cuvier – St. Hillarie Debate
  Nature-Nurture Discussion

- Charles Lyell – Geology
  Continual Changes Over Time
  Slow & Gradual

- Notions About Populations & Communities

- Physiology Comes of Age
19TH CENTURY – SECOND HALF

- Darwin and Evolution Dominate
- Douglas Spalding
  Experimental Approach
  Bird Flight
  Instinct Guides Learning
- George John Romanes
  Invertebrates and Physiology
  *Animal Intelligence & Mental Evolution in Animals*
19TH CENTURY – SECOND HALF

- Charles Otis Whitman (MBL Founder)
  - Pigeons
  - Zoology as Independent Discipline
  - Evolutionary Bases for Behavior

- C. Lloyd Morgan
  - Morgan’s Canon
  - *Animal Behavior* – First ‘Textbook’ in this Field
  - Comparing Animal and Human Minds
19TH CENTURY – SECOND HALF

- Jacques Loeb – Animal Movements, Tropisms
- Jakob von Uexkull – Umwelt Concept
- William Morton Wheeler – Social Life of Ants
- Jean Henri Fabre – Insect Behavior & Descriptions
THREE THREADS EMERGE

- PSYCHOLOGY – AMERICAN
- ETHOLOGY – EUROPEAN
- ZOOLOGY – AMERICA & EUROPE
20TH CENTURY ANIMAL BEHAVIOR

- 1900-1950s – BEGINNING OF MODERN ANIMAL BEHAVIOR

- 1950s-1970s – GROWTH OF ANIMAL BEHAVIOR AS A DISCIPLINE

- 1970s – 1990s – MATURATION OF ANIMAL BEHAVIOR AS A DISCIPLINE
1900 – 1960 - BEGINNINGS

• PSYCHOLOGY – Thorndike Watson Skinner Yerkes
1900 – 1960 - BEGINNINGS

• ZOOLOGY
  W.C. Allee
  Sewall Wright
  G.K. Noble
1900 – 1960 - BEGINNINGS

- ETHOLOGY
  - Oskar Heinroth
  - William Thorpe
  - Karl von Frisch
  - Gerard Baerends
  - Niko Tinbergen
  - Konrad Lorenz
1950s-1970s – GROWTH

- **JOURNALS**
  - *BEHAVIOUR*
  - *ANIMAL BEHAVIOUR*

- **SOCIETIES**
  - ASAB
  - ABS (from ESA and ASZ)
  - IEC
  - APA – Section 6
1960s – 1990s – MATURATION

- TEXTBOOKS
  - Marler & Hamilton – *Mechanisms of Behavior*
  - Hinde – *Behaviour*
  - Manning – *Patterns of Animal Behaviour*
  - Alcock – *Animal Behavior*
  - Drickamer & Vessey – *Animal Behavior*
1970s – 1990s – MATURATION

- Peak in Positions for Animal Behaviorists
- MANY More Journals
- More Societies & Meetings
- KEY – Maturation Means Specialization
BEHAVIORAL ECOLOGY

- G.C. Williams
- E.O. Wilson
- Robert Trivers
- John Maynard Smith
- W.D. Hamilton

- These and Others – Underpinnings of the Surge in Behavioral Ecology
1990s – Decade of the Brain

Physiological Psychology

Brain Imaging
JOINING APPROACHES

- Behavioral Ecologists – Started to ask about what is happening inside the animal

- Neurobiologists – Started to ask about the meaning of their findings in the whole animal and in nature

- Simplified View – But, connections have begun and are growing
FUTURE DEVELOPMENTS

- INTEGRATION
- IMMUNOLOGY
- PHENOTYPIC FLEXIBILITY
- MATHEMATICS FOR MODELS AND THEORY
- NEW TECHNOLOGIES
- STRONG INFERENCE WITH ALTERNATIVE HYPOTHESES
INTEGRATION

- FIELD & LABORATORY
- PROXIMATE & ULTIMATE CAUSATION
- Wingfield – birds and stress
- Bass – neurobiology and fish communication
- Ryan – frog calls and mating systems
IMMUNOLOGY

- STRESS & IMMUNE FUNCTION
  Good and Bad Aspects
- SOCIAL BEHAVIOR & IMMUNE FUNCTION
- IMMUNE FUNCTION, DISEASE RESISTANCE & MATE SELECTION
- IMMUNE SYSTEM, CNS, & ENDOCRINES
- ANIMAL WELFARE ISSUES
PHENOTYPIC FLEXIBILITY

- ALTERNATE NAMES
  Phenotypic Plasticity
  Developmental Plasticity

- EVOLUTIONARY DEVELOPMENTAL BIOLOGY
  Eco-Evo-Devo

- EPIGENETICS – WADDINGTON
  Epigenetic Landscape Pathways
  Canalization
Types or Levels of Evolution

- NATURAL SELECTION
- SEXUAL SELECTION
- KIN SELECTION & RECIPROCAL ALTRUISM
- GROUP SELECTION
- COMMUNITY AND ECOSYSTEM SELECTION
- OTHERS?
MODELS - I

- **WORD MODELS**
  Learning Processes

- **MATHEMATICAL MODELS**
  Shuster
  Foraging Behavior
  Mate Choice – Mate Selection

- **COMPUTER MODELS**
  Input Information $\rightarrow$ Iterations & Output
  Populations of House Mice

- **SIMULATION MODELS**
MODELS - II

- ROBOTICS – Models of Sensory System
- ANIMAL MODELS
NEW TECHNOLOGIES

- FREE-RANGING TELEMETRY & SATELLITES
- DNA ANALYSES
  - GENETIC RELATIONSHIPS
  - POPULATION GENETICS
- FREE-RANGING SAMPLE COLLECTION
  - HORMONES
- BRAIN IMAGING
METHODS – STRONG INFERENC

- RETURN TO TESTABLE HYPOTHESES
- TOUGTHFUL EXPERIMENTAL MANIPULATIONS
- BUILD ANSWERS IN STEPS
- USE OF MODELS FOR GENERATING IDEAS AND PREDICTIONS
RESEARCH ANIMALS

- CONTINUED INTEREST IN PRIMATES & HUMANS
- OTHER VERTEBRATES
- CONSERVATION EFFORTS
- INVERTEBRATES, INVERTEBRATES, INSECTS
CLOSING THOUGHTS

- COLLABORATIONS
- MULTI-DISCIPLINARY
- COMBINING LABORATORY AND FIELD WORK
- TRAINING STUDENTS – BROADER VIEW
  MODELING
  STATISTICS
  EXPERIMENTAL DESIGN
  KNOWLEDGE OF ALL ASPECTS OF ANIMAL BEHAVIOR