

BIOLOGY 666

ANIMAL BEHAVIOR

PAST – PRESENT – FUTURE

Lee C. Drickamer

November 2009

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**

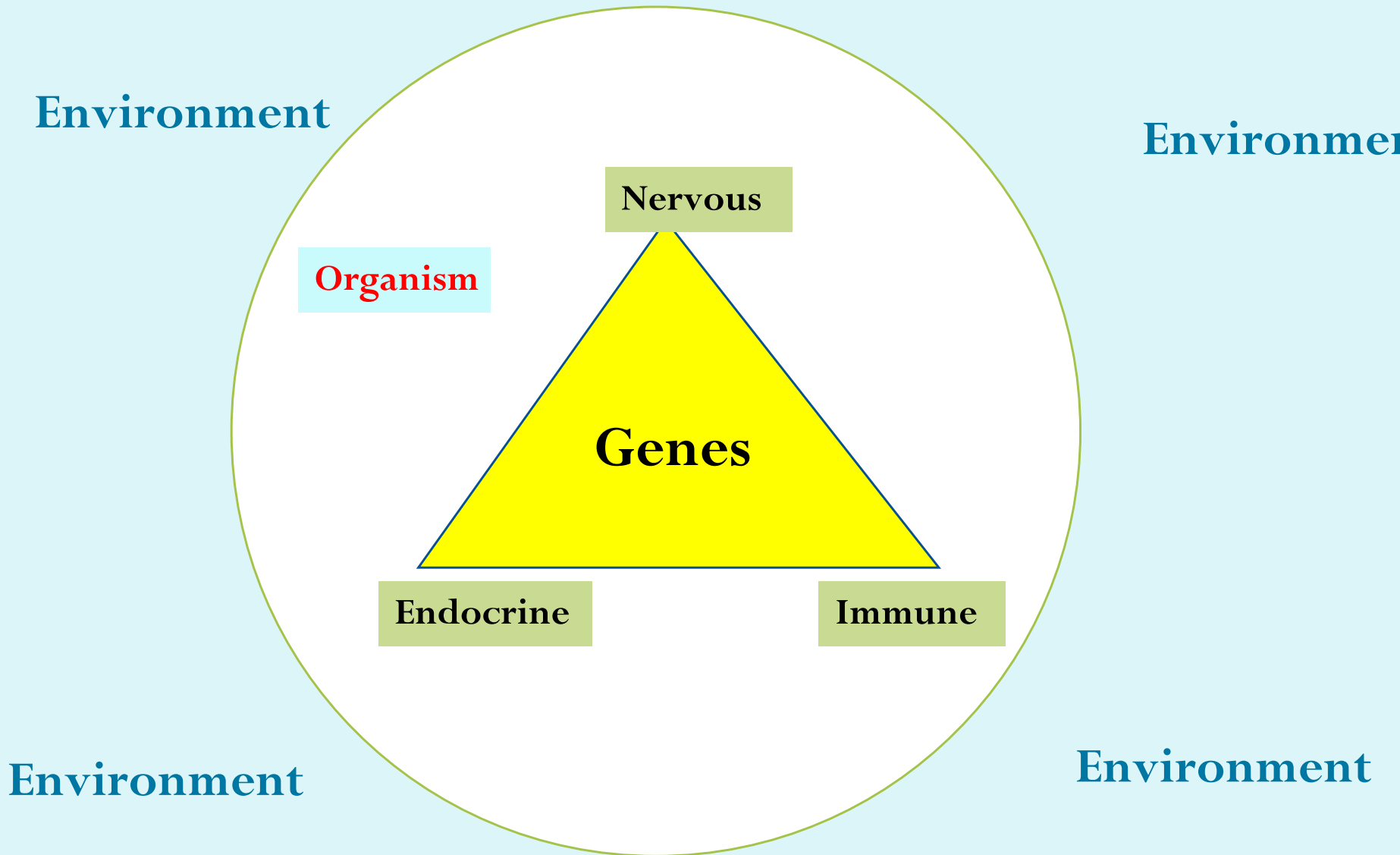
NEW TECHNOLOGIES

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

APPLIED

- **AGRICULTURE**
- **PETS**
- **CONSERVATION**

Systems & Animal Behavior



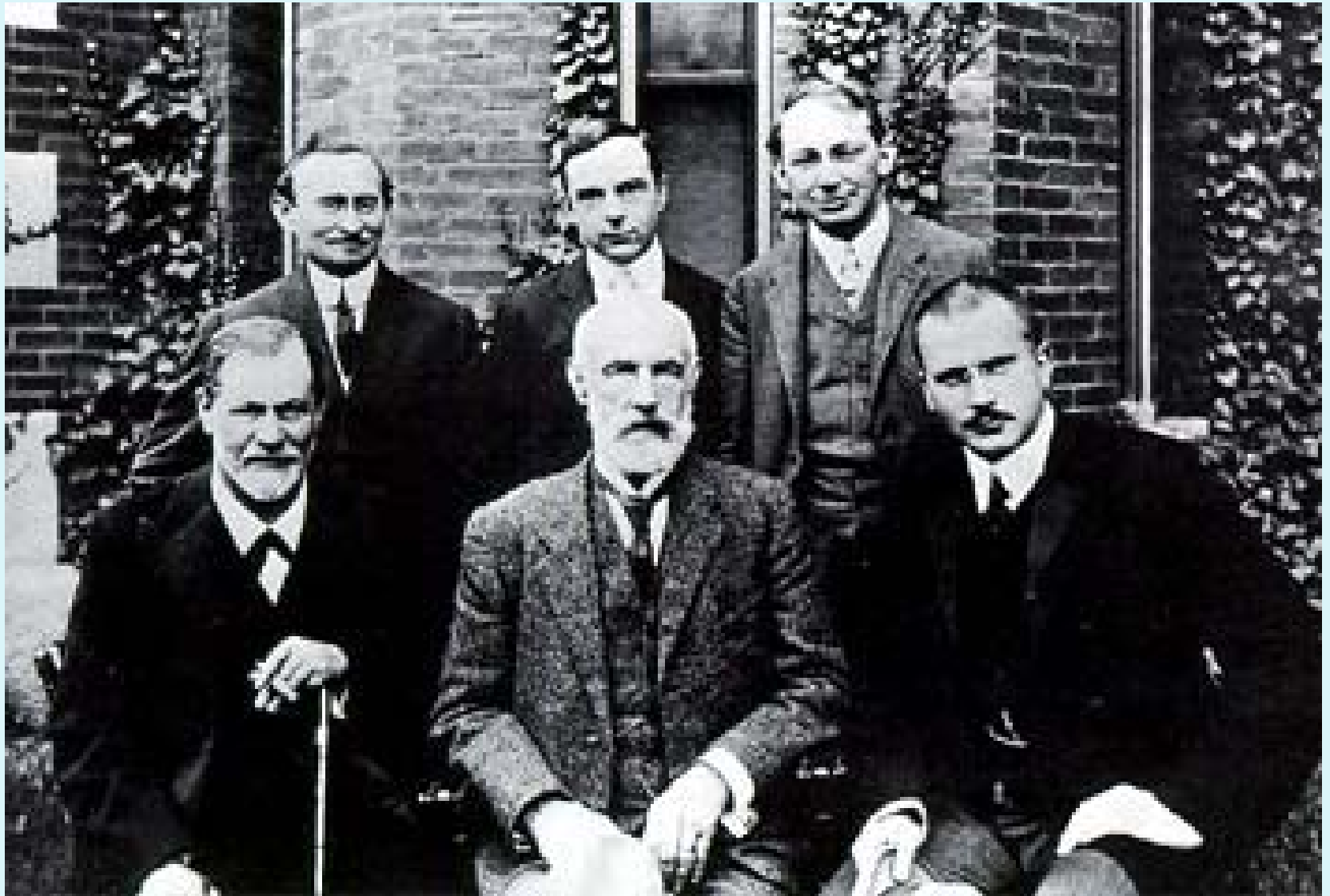
TINBERGEN'S FOUR QUESTIONS

- **ULTIMATE QUESTIONS**
 - **FUNCTION**
 - **EVOLUTION**

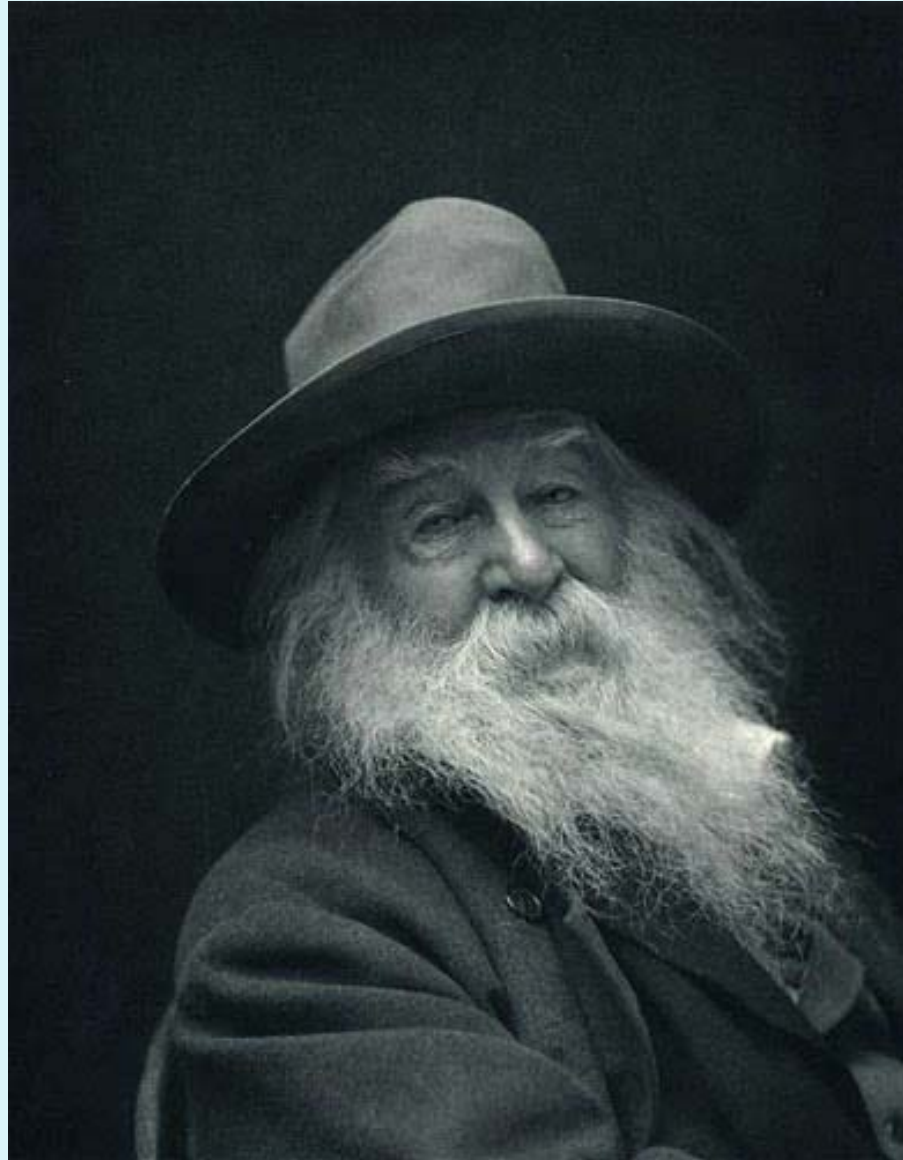
TINBERGEN'S FOUR QUESTIONS

- **PROXIMATE QUESTIONS**
 - **PHYSIOLOGY-
MECHANISMS**
 - **DEVELOPMENT**

G. STANLEY HALL



CHARLES OTIS WHITMAN



C. LLOYD MORGAN



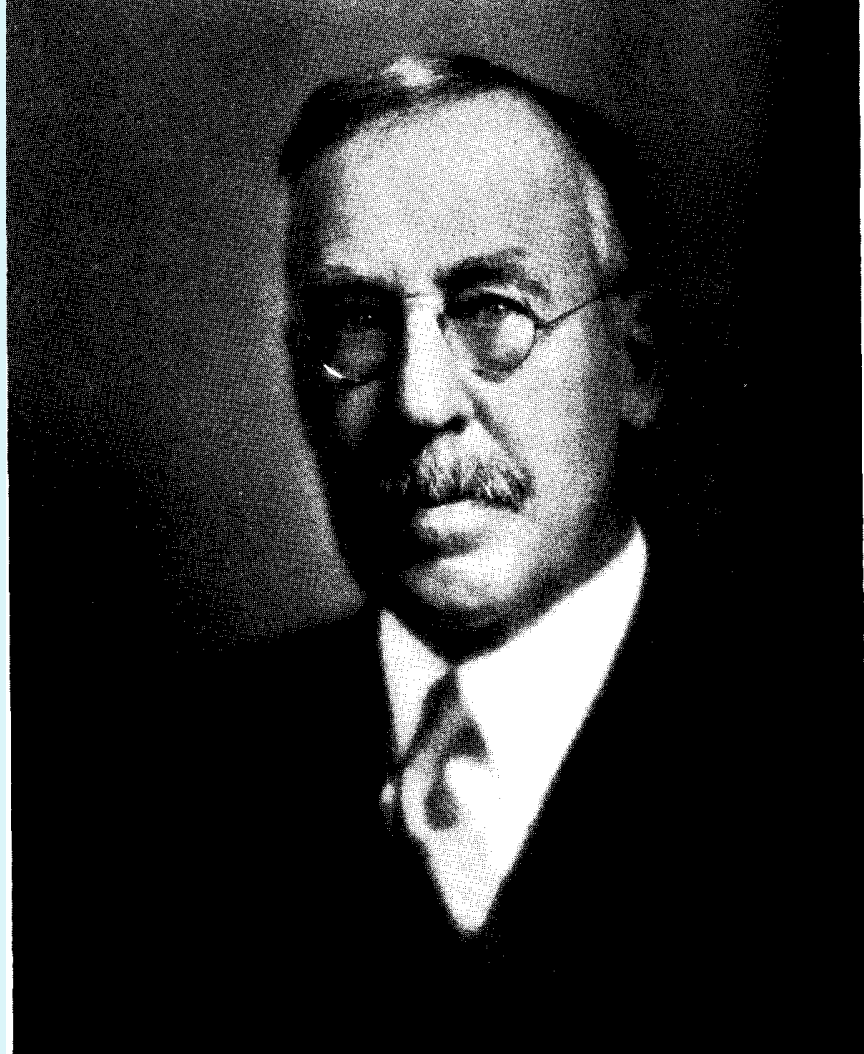
Douglas Spalding



George John Romanes



WILLIAM MORTON WHEELER



NIKO TINBERGEN



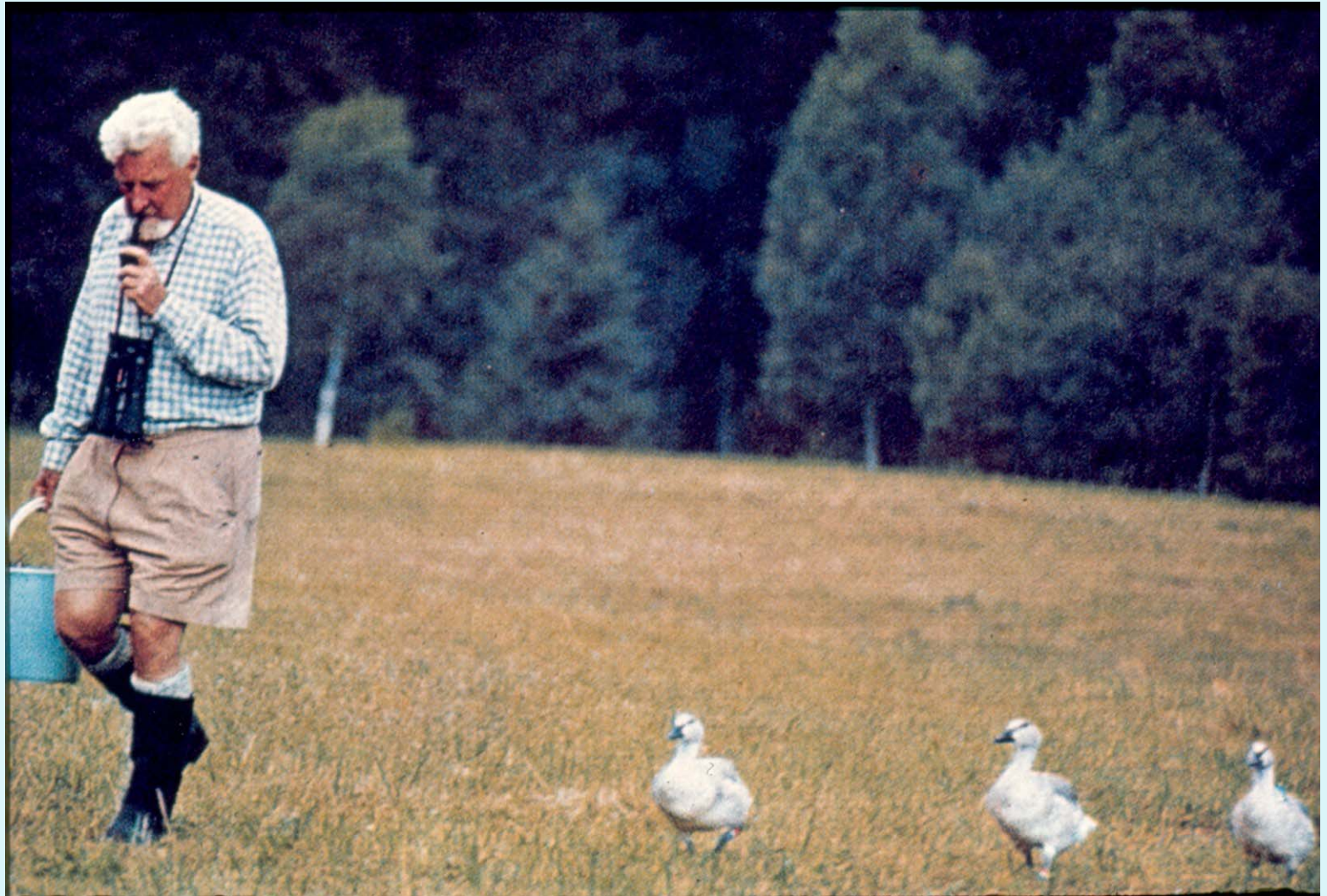
NIKO TINBERGEN



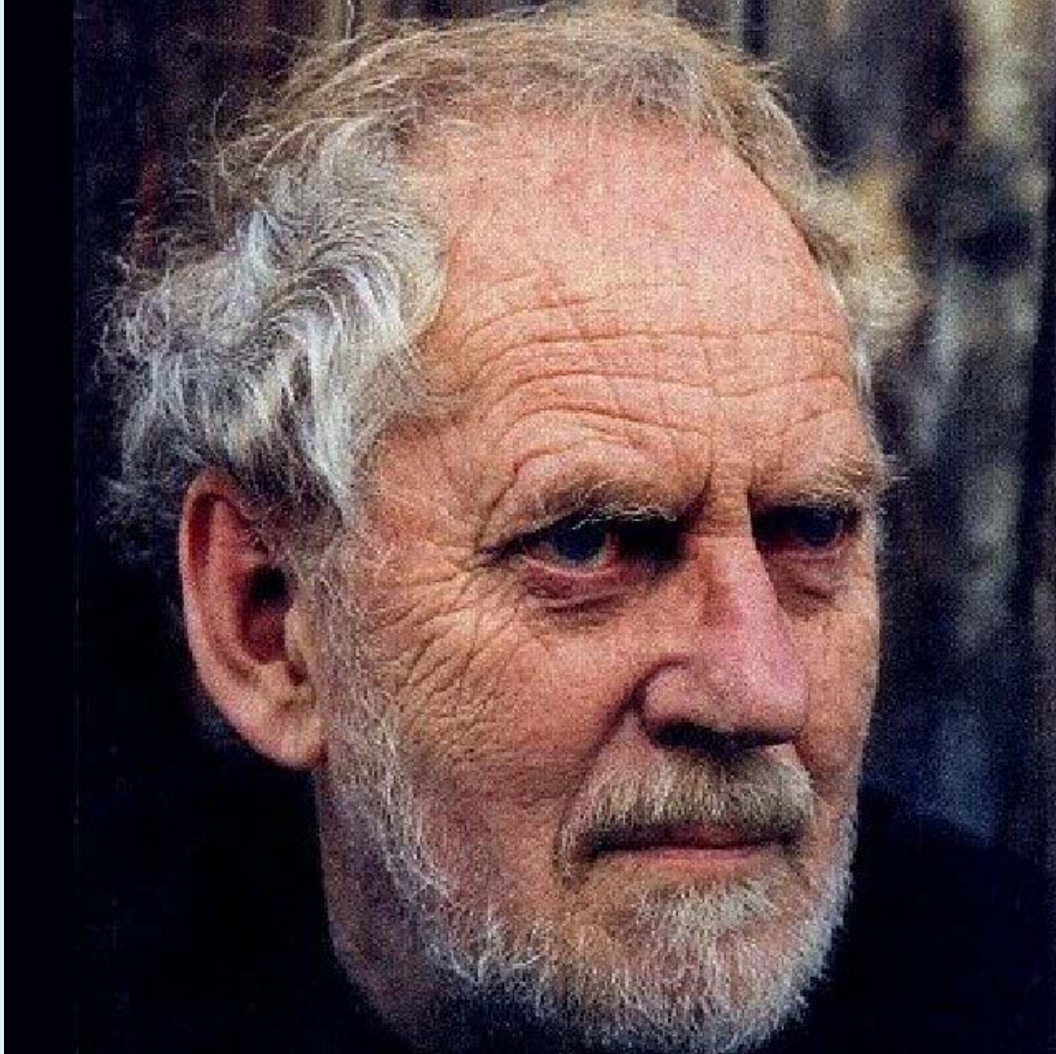
KONRAD LORENZ



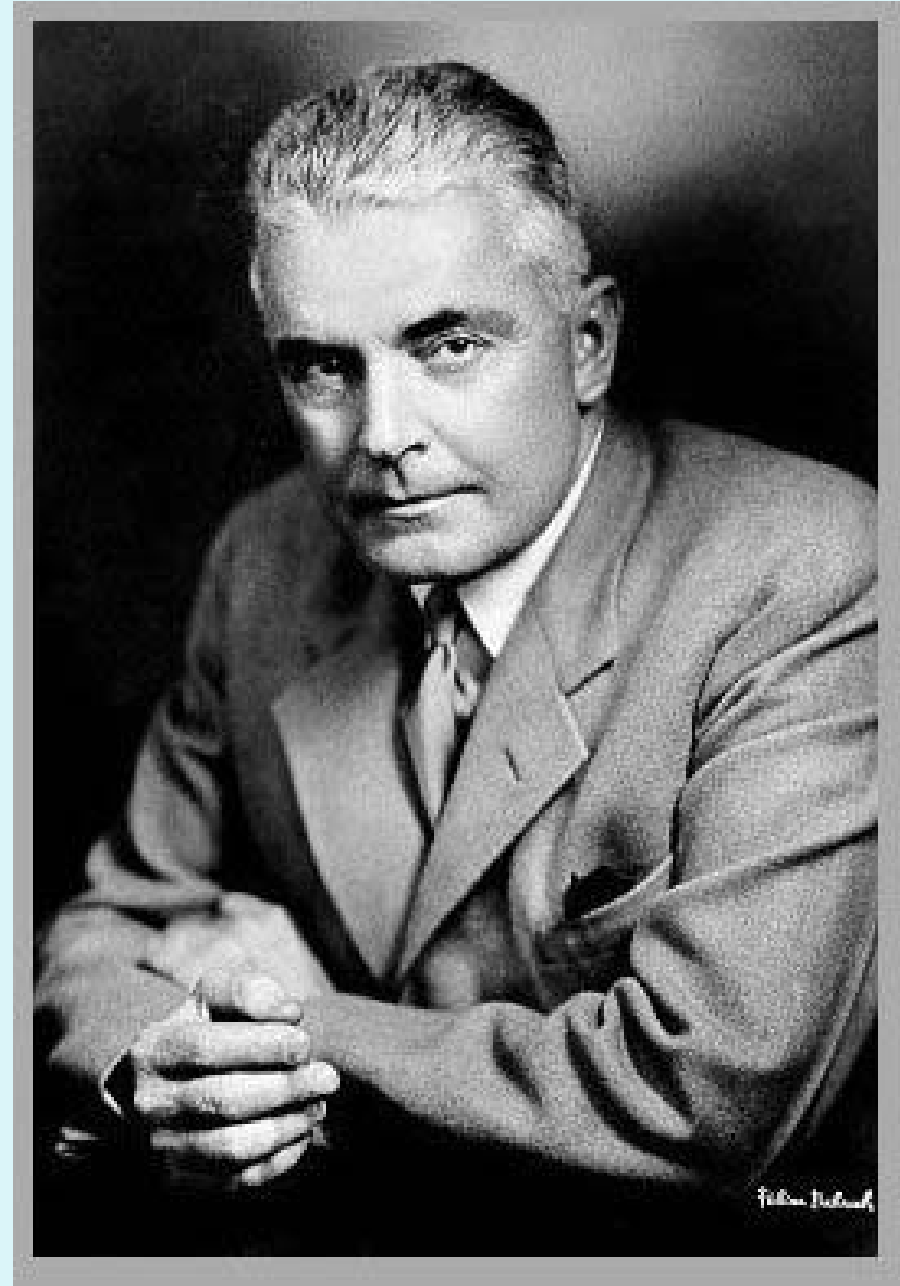
KONRAD LORENZ



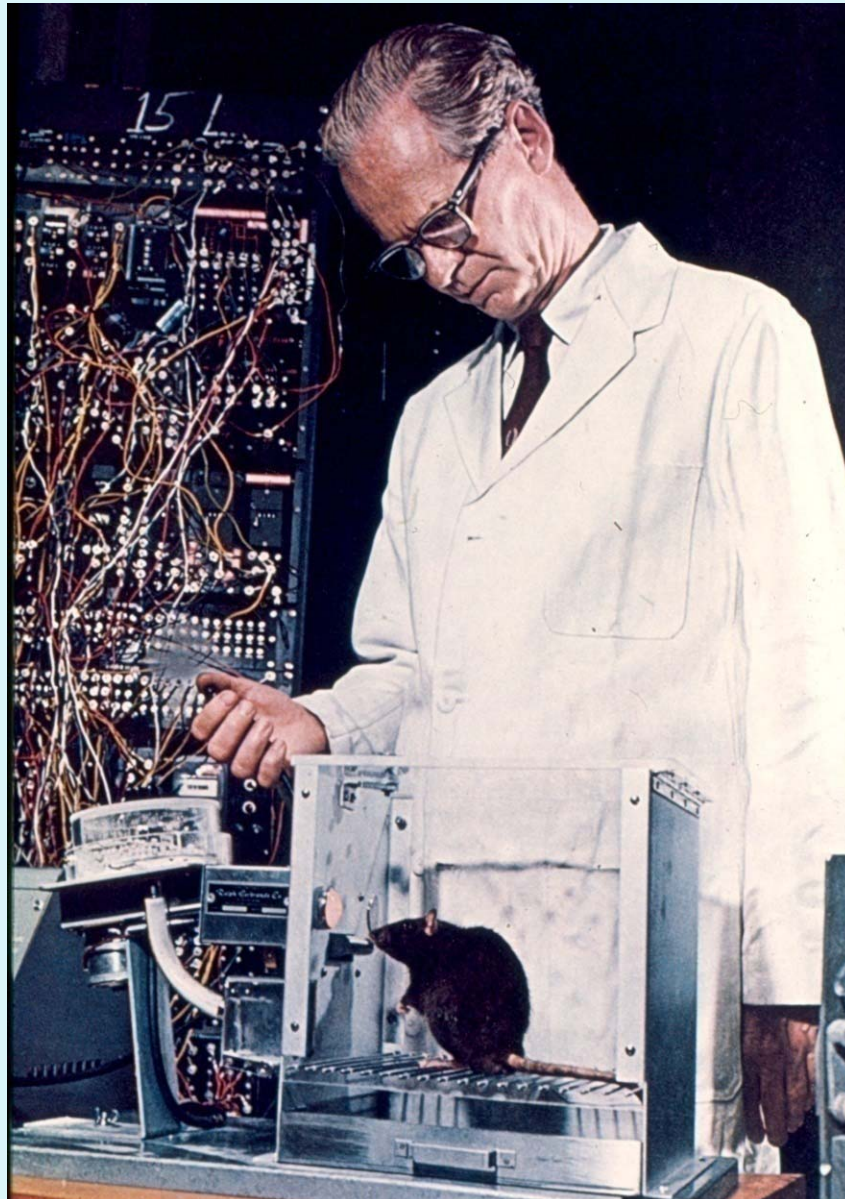
Wolfgang Schleidt



JOHN B. WATSON



B.F. SKINNER



WILLIAM H. THORPE



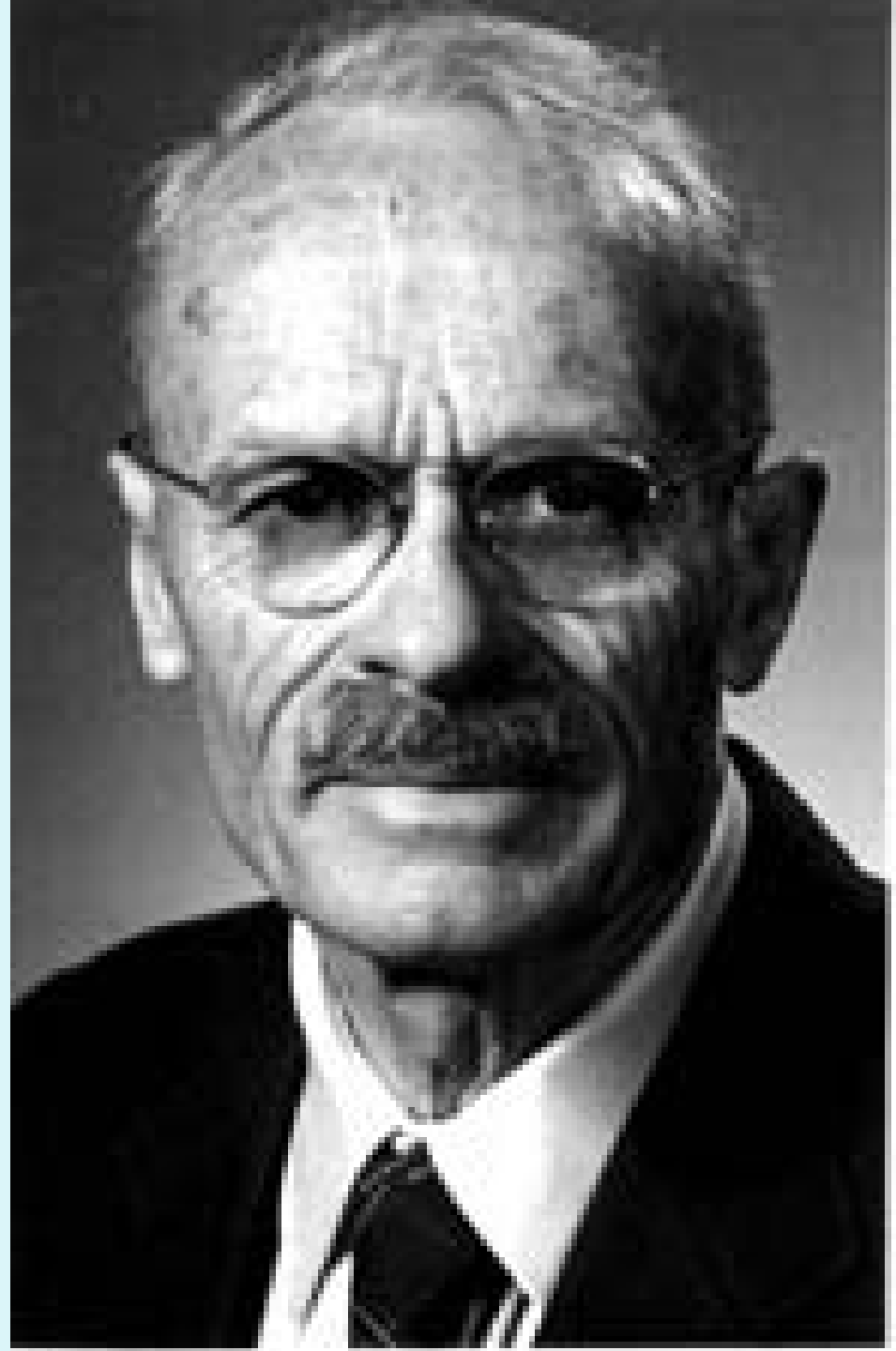
R.A. Fisher



T.C. SCHNEIRLA



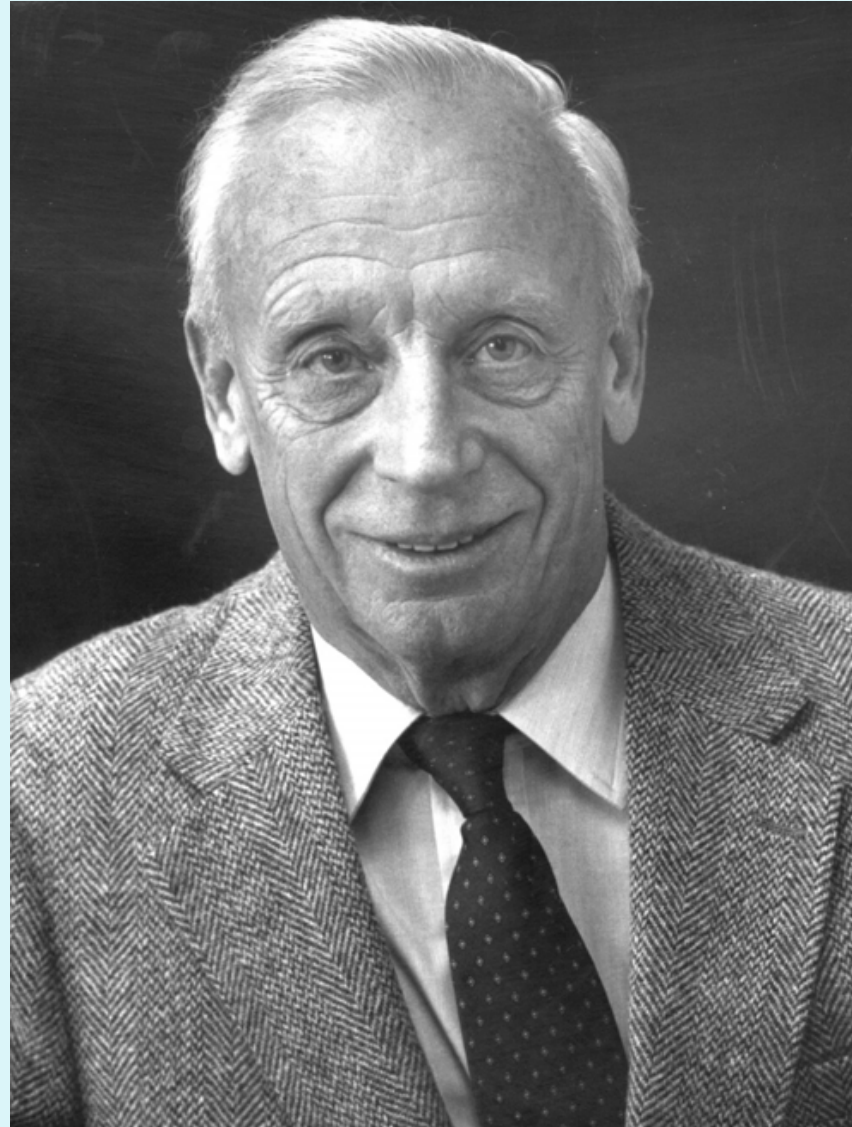
John Paul Scott



GERARD BAERENDS



VINCENT DETHIER



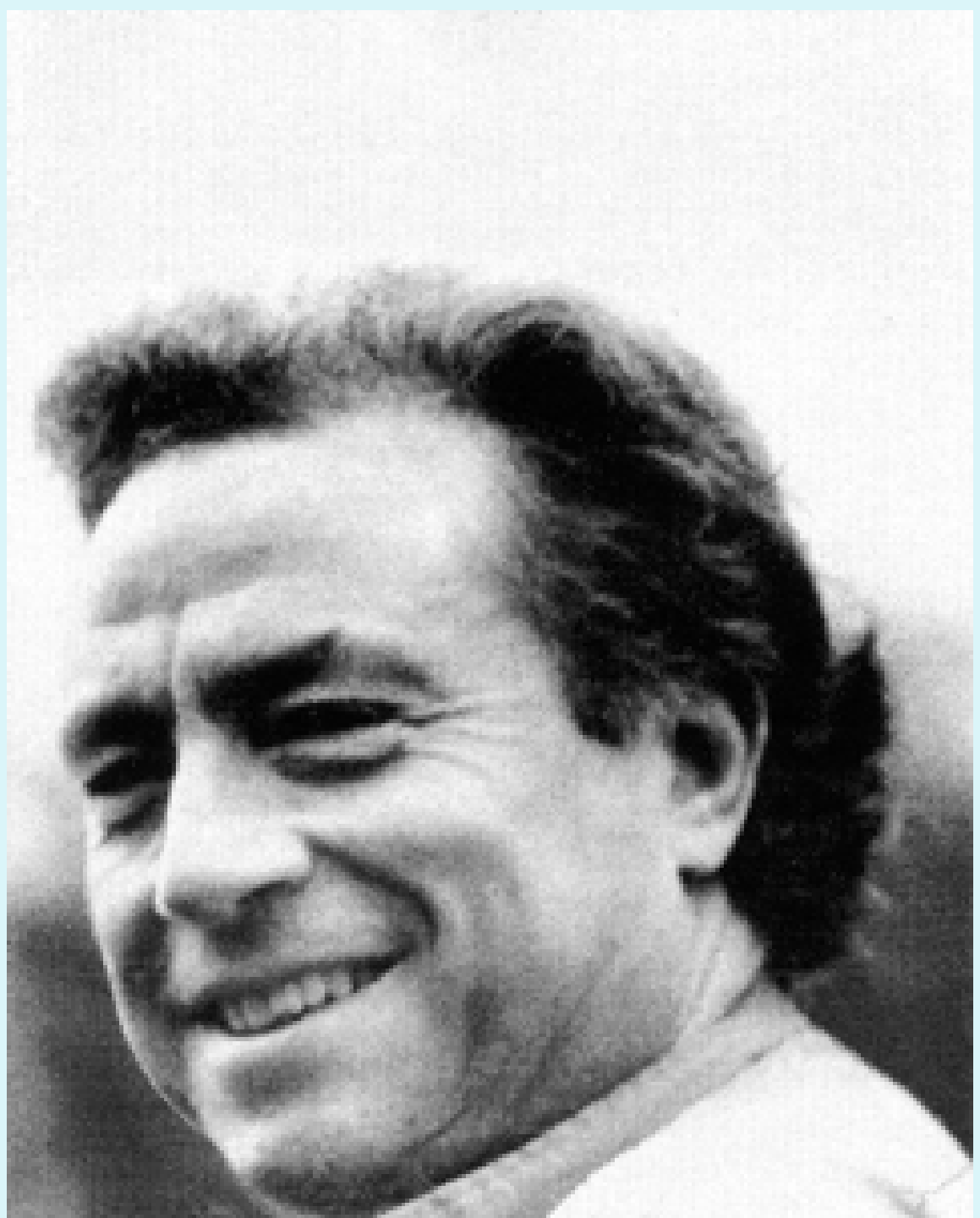
ROBERT HINDE



Frank Beach



Daniel Lehrman



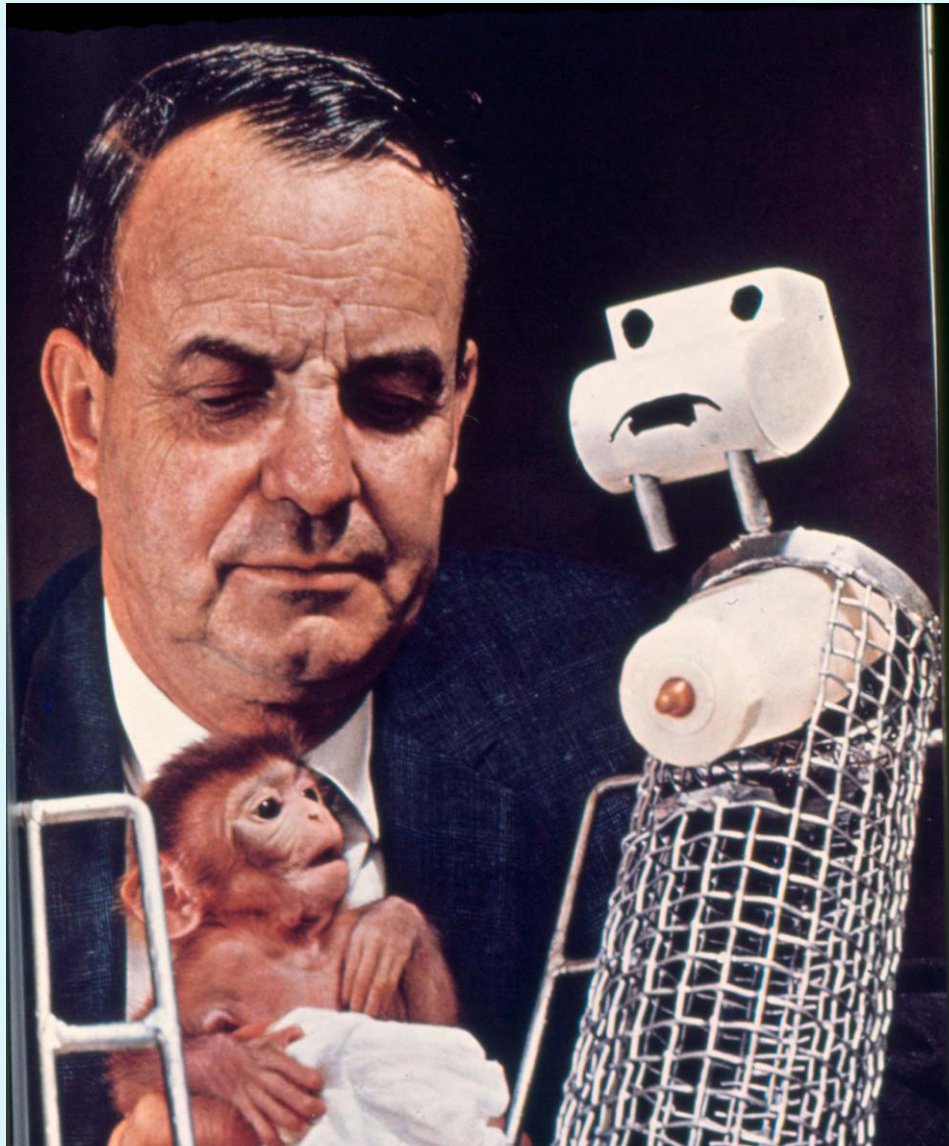
AUBREY MANNING



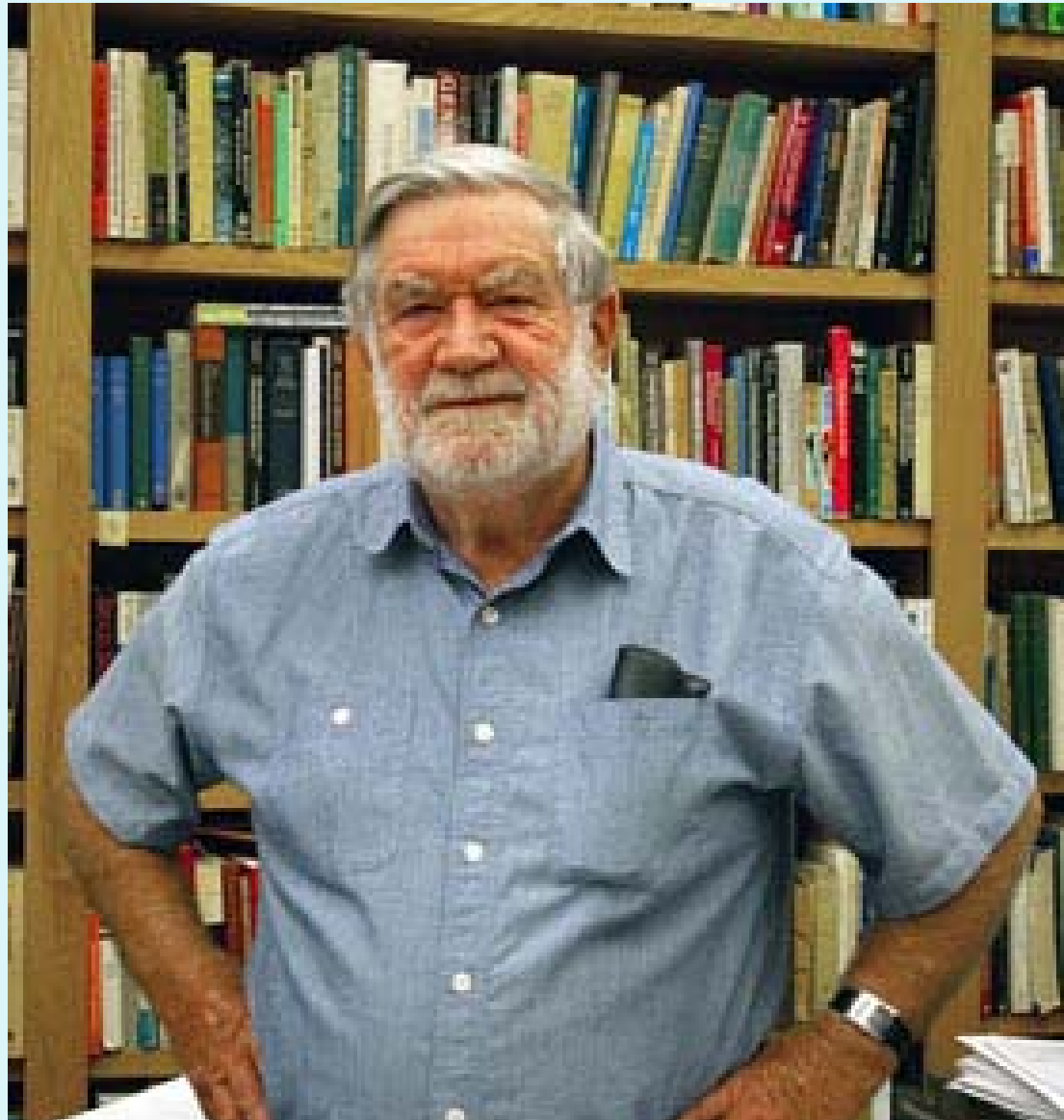
Iraneus Eibl-Eibesfeldt



HARRY HARLOW



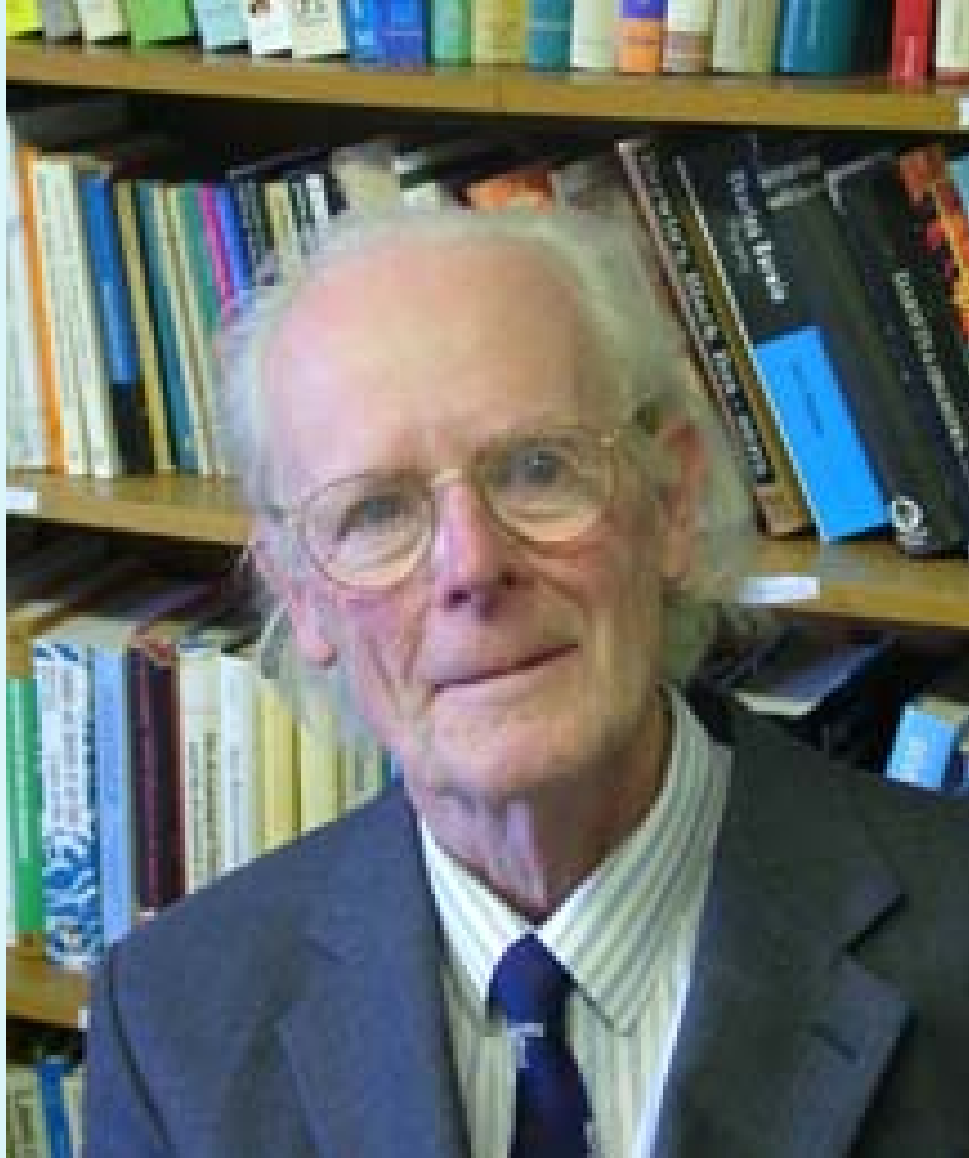
PETER MARLER



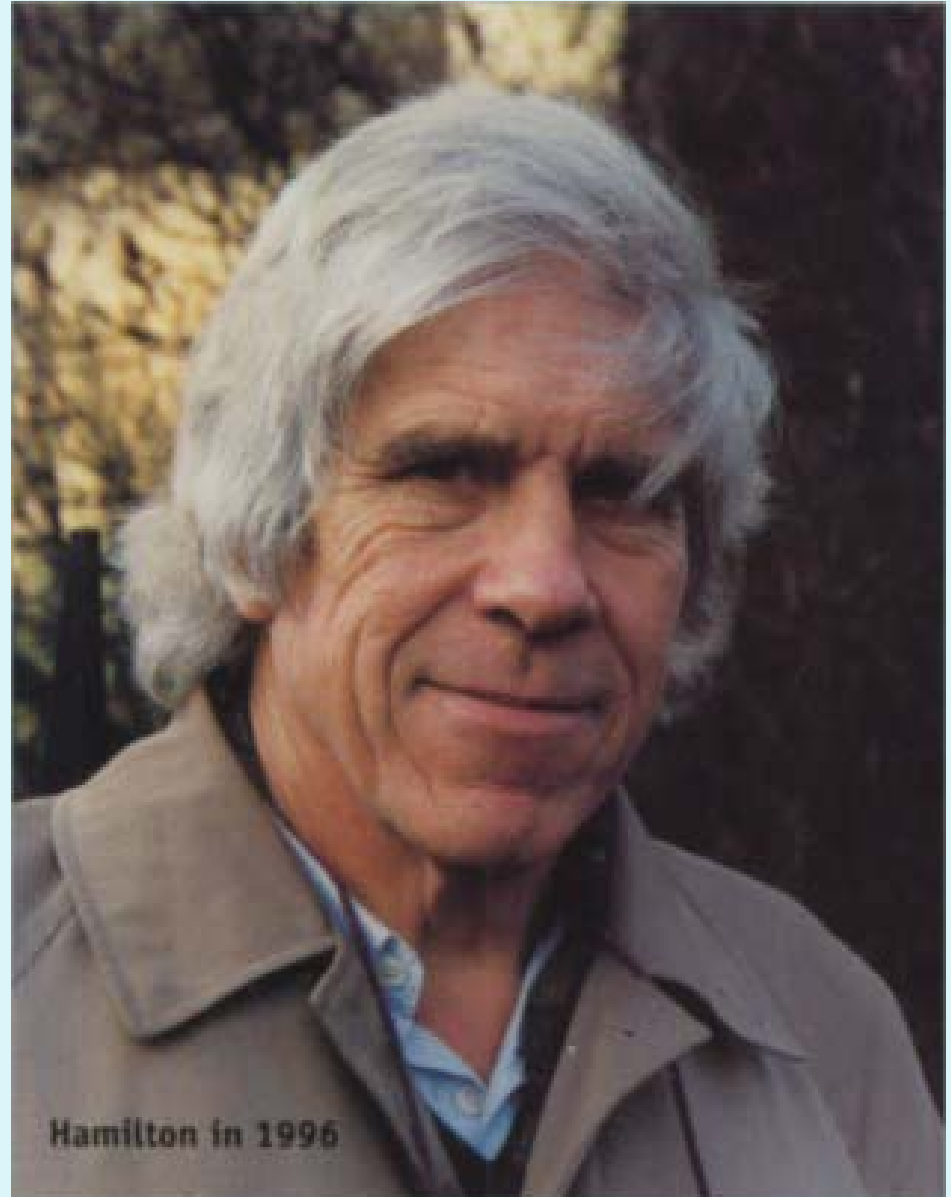
E.O. WILSON



John Maynard Smith



W.D. HAMILTON



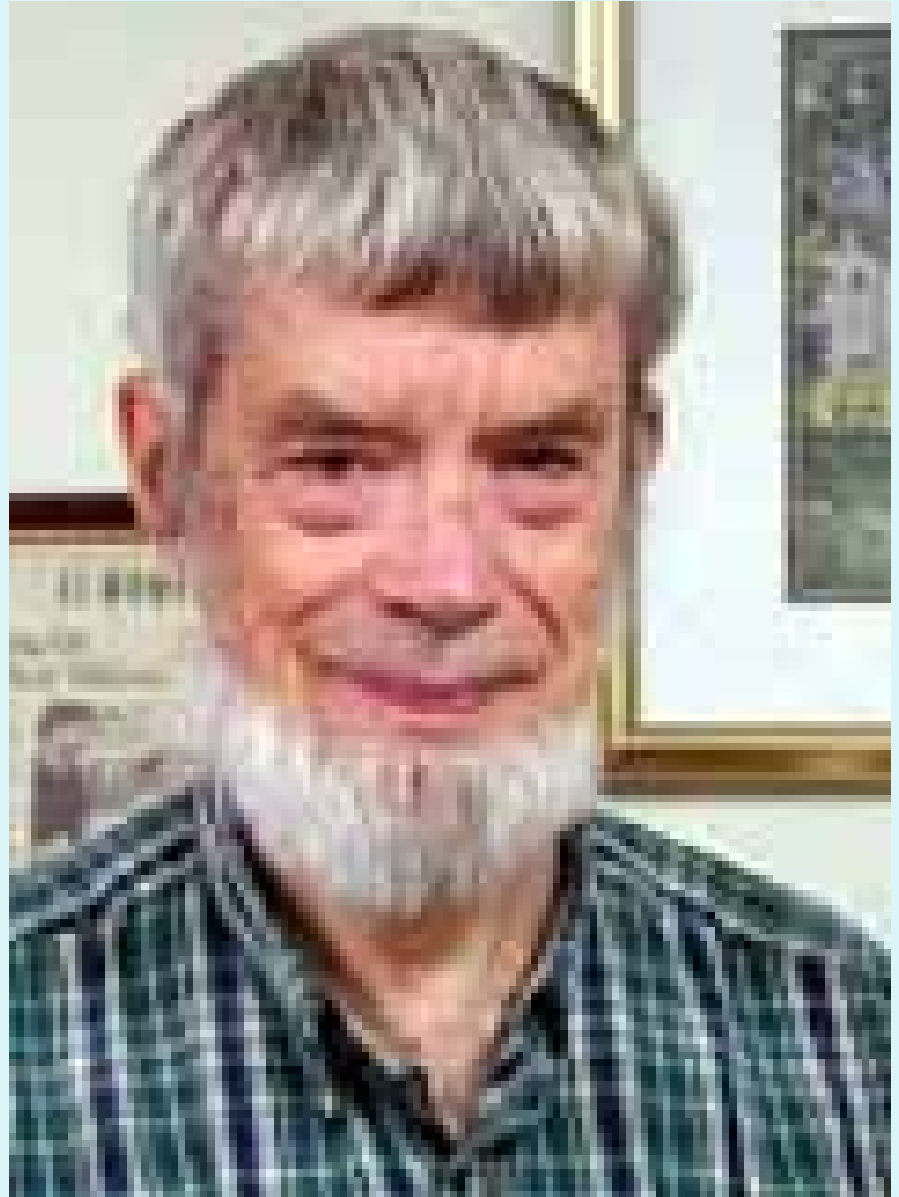
JOHN A. KING



RICHARD ALEXANDER



George C. Williams



AMOTZ ZAHAVI



Robert Trivers



JEANNE ALTMANN



FRANS DE WAAL



JOHN KREBS



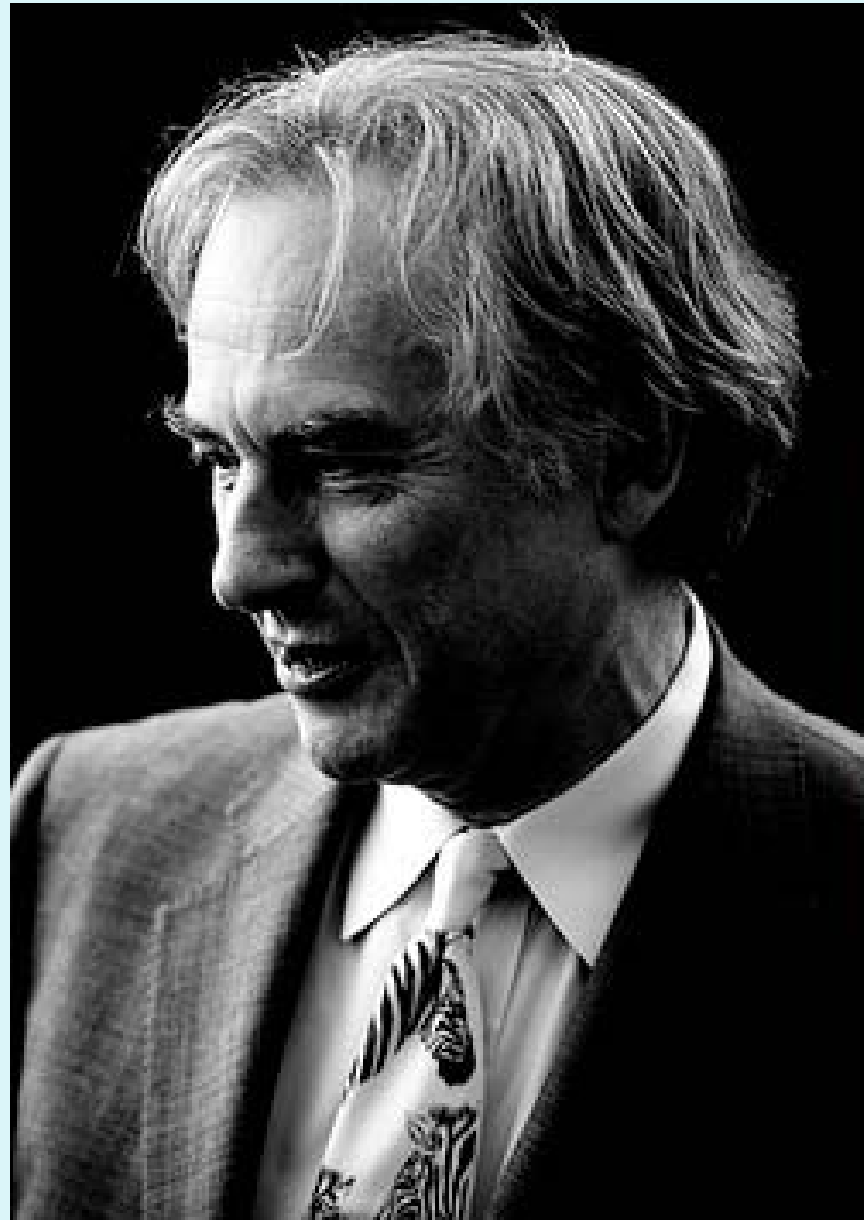
MARIAN DAWKINS



SARAH HRDY



RICHARD DAWKINS



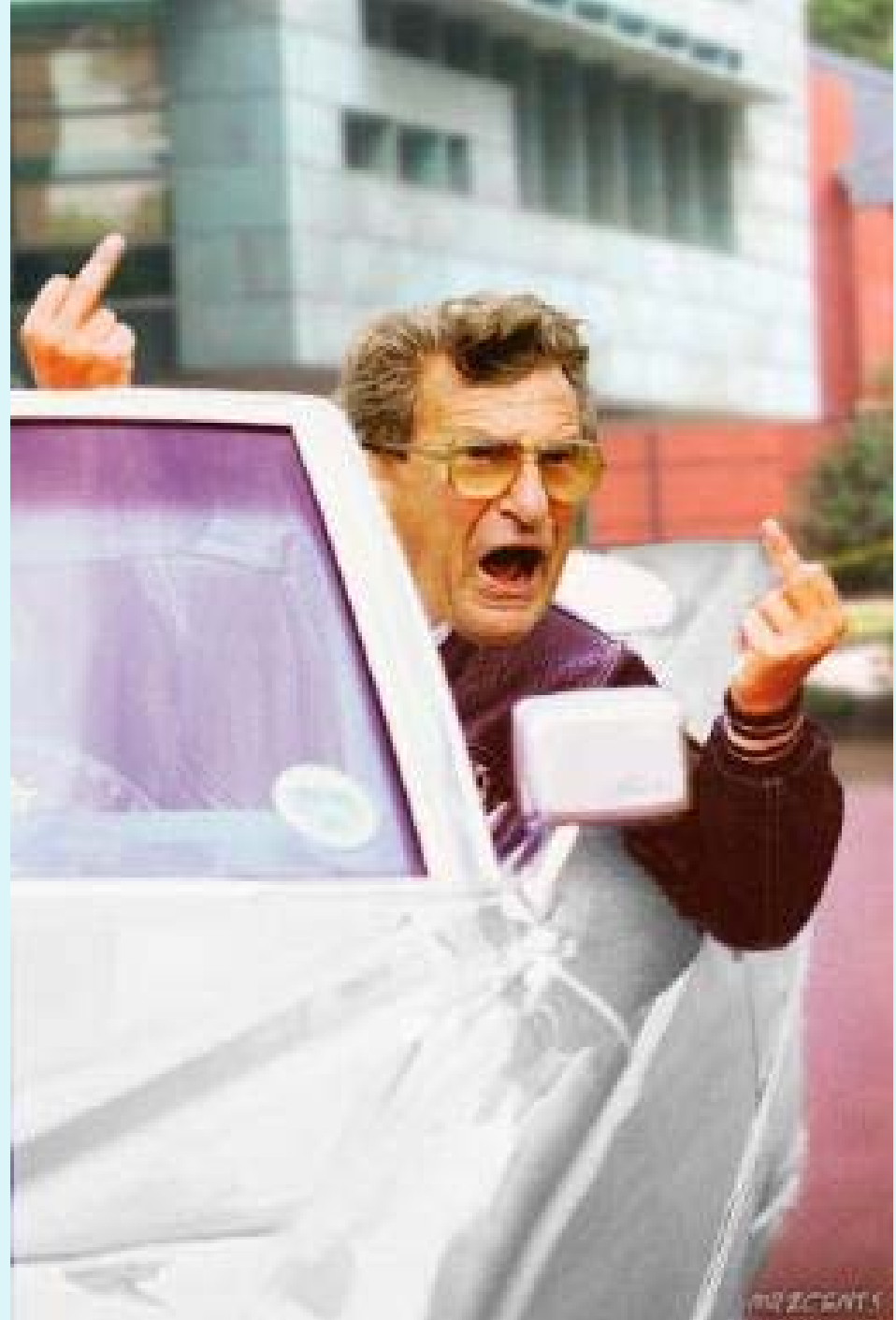
STEPHEN EMLÉN



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

10TH – 16TH CENTURIES

- **MIDDLE AGES – Plague, Not Much Else**
- **RENAISSANCE – Renewal of Science**
- **AGE OF EXPLORATION – Late 15th Century**
- **NATURAL PHILOSOPHY – Splits Into Disciplines**
- **BELIEF IN SOME VITAL SPIRIT OR CREATOR**

17TH TO 19TH CENTURIES

(1) NATURAL HISTORY & EXPLORATION

(2) SYSTEMATICS – LINNEAUS

(3) SHIFT AWAY FROM RELIGION AS

FOUNDATION

17TH & 18TH CENTURIES

(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*

17TH & 18TH CENTURIES

(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 Uexkill – 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

NEUROBIOLOGY

- **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 → 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 INFERENCE

- **RETURN TO TESTABLE HYPOTHESES**
- **TOUGHTFUL 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**