

Contents

Preface	V
Introduction	VII
 CHAPTER 1 Concepts, Methods, and Techniques	1
1.1 Fossils and Fossilization	1
1.1.1 Fossils	1
1.1.2 Fossilization	1
1.1.3 Paleontological Deposits	1
1.1.4 Paleontological Techniques	5
1.2 Species and Classification of Populations	5
1.2.1 The Concept of Species	5
1.2.2 Paleontological and Biological Species	7
1.2.3 Biometrical Analyses	8
1.3 Analysis of Characteristics and Classifications	8
1.3.1 Classical Systematics	8
1.3.2 Evolutionary Systematics	8
1.3.3 Phylogenetic Systematics or Cladism	9
1.3.4 Phenetic Taxonomy	14
1.3.5 The Choice of a Phylogenetic Systematics and Evolutionary Mechanisms Analysis	14
1.4 The Search for a Mechanism of Evolutionary Change: Heterochrony	15
 CHAPTER 2 The Vertebrates	21
2.1 The Vertebrate Organization Plan	21
2.2 Origin of Vertebrates	22
2.2.1 The Chordata	22
2.2.2 Scenario and Phyletic Relationships among the Chordata	23

2.3 Diversity of Vertebrates	24
2.4 Temporal Distribution of Vertebrates	24
2.5 Spatial Distribution of Vertebrates	25
2.6 An Attempt at Vertebrate Classification	26
 CHAPTER 3 The Conquest of the Aquatic Environment	 31
3.1 The First Vertebrates	31
3.2 Relationships of Agnatha	33
3.3 Myxines	33
3.4 Conodonts	33
3.5 Pteraspidomorpha	35
3.5.1 Characteristics	35
3.5.2 Heterostraci	35
3.5.3 Thelodontia	37
3.6 Lampreys (Petromyzontidae) and Cephalaspidomorpha	39
3.6.1 Characteristics	39
3.6.2 Lampreys	39
3.6.3 Osteostraci	39
3.6.4 Anaspidae	41
3.6.5 Galeaspidae	43
3.6.6 Modes of Life	43
3.7 Gnathostomata	44
3.7.1 Jaws and Fins	44
3.7.2 Diversity and Phylogenetic Relationships of the First Gnathostomata	44
3.7.3 Placoderms	45
3.7.4 Chondrichthyes	49
3.8 Teleostomi	52
3.8.1 Characteristics and Phylogenetic Relationships	52
3.8.2 Acanthodia	53
3.8.3 Osteichthyes	53

CHAPTER 4 From the Aquatic to the Terrestrial Environment:	
The Tetrapoda	63
4.1 Problems of Adaptation	63
4.1.1 Respiration	63
4.1.2 Thermoregulation	63
4.1.3 Locomotion	64
4.1.4 Reproduction	64
4.2 Adaptations	64
4.2.1 Skeleton	65
4.2.2 Reproduction	67
4.3 Paleontological History of the First Tetrapoda	69
4.3.1 Ichthyostegidae	69
4.3.2 Loxommatidae and <i>Crassigyrinus</i>	69
4.3.3 Temnospondyli	70
4.3.4 Lissamphibia	70
4.3.5 Primitive Amniota or "Anthracosauria"	73
4.4 Developmental Heterochronies	73
4.4.1 Neoteny	74
4.4.2 Progenesis	76
CHAPTER 5 The Conquest of the Terrestrial Environment:	
The Amniota	77
5.1 Characteristics and Phylogenetic Relationships	77
5.1.1 Reproduction	77
5.1.2 Thermoregulation	77
5.1.3 Phylogenetic Relationships	79
5.1.4 Cranial Structures	79
5.2 The First Amniota	79
5.2.1 Captorhinomorphs	81
5.2.2 Procolophonia and Others	81
5.3 Turtles	81
5.4 Lepidosauromorpha	83
5.4.1 Younginiformes	83
5.4.2 Sphenodontia	83
5.4.3 Lizards	84
5.4.4 Snakes	84

5.5 Archosauromorpha	84
5.5.1 Rhynchosauria	84
5.5.2 Archosauria	85
5.5.3 Dinosaurs	86
5.5.4 Birds	92
5.5.5 Pterosaurs	92
5.5.6 Diapsids incertae sedis: Kuehneosaurids	93
5.5.7 Crocodiles	93
5.6 Ichthyosaurs	94
5.7 Plesiosaurs	94
5.8 Placodontia	94
 CHAPTER 6 The Conquest of the Aerial Environment	95
6.1 The Constraints of Flight	95
6.2 Pterosaurs	95
6.3 Birds	98
6.3.1 <i>Archaeopteryx</i>	98
6.3.2 Landmarks in the History of the Birds	100
6.4 Chiroptera	101
 CHAPTER 7 The Radiations of Mammals	103
7.1 From Pelycosaurs to Mammals	103
7.1.1 Pelycosaurs	103
7.1.2 Therapsidae	105
7.2 Acquisition of Mammalian Characteristics	109
7.2.1 From the Therapsid to Mammalian Articulation	109
7.2.2 Structure of the Middle Ear in Mammals	111
7.2.3 Other Mammalian Characteristics	111
7.3 Mesozoic Mammals	112
7.3.1 Prototheria	112
7.3.2 Theria	115
7.4 Marsupials	117

7.5 Placentals	121
7.5.1 Mesozoic Placentals	121
7.5.2 Radiations of the Placentals	123
7.5.3 Insectivora and Dermoptera	123
7.5.4 Pantodonta	125
7.5.5 Taeniodonta and Amblypoda	125
7.5.6 Condylarthra	125
7.5.7 Ungulata of South America	126
7.5.8 Perissodactyli	126
7.5.9 Artiodactyli	133
7.5.10 Proboscidea	133
7.5.11 Carnivora	135
7.5.12 Cetacea	137
7.5.13 Xenarthra	137
7.5.14 Lagomorpha	139
7.5.15 Rodents	139
 CHAPTER 8 The Primates and Hominization	145
8.1 Characteristics and Phylogenetic Relationships	145
8.1.1 Characteristics	145
8.1.2 Phylogenetic Relationships	145
8.2 Strepsirhini	145
8.2.1 Plesiadapiformes, Adapiformes and Omomyids	147
8.3 Haplorhini	147
8.3.1 Tarsids	147
8.3.2 Platyrrhini	148
8.3.3 Catarrhini	148
8.4 Relationships Between Pongidae and Hominidae	150
8.4.1 Comparisons and Consequences	150
8.4.2 Australopithecids	150
8.4.3 The Human Lineage	153
8.4.4 A New Explanatory Theory	153
 CHAPTER 9 From Fossils to Explanatory Theories	155
9.1 Paleontology, the Science of Time	155
9.2 The Lessons of the Fossils	155

9.3 From Fossils to Theories	156
9.4 Towards a Unifying Theory of Evolution	157
CHAPTER 10 Applied Paleontology	163
10.1 Biostratigraphy	163
10.1.1 Principles	163
10.1.2 High-Resolution Biostratigraphy	163
10.1.3 Biostratigraphies of Vertebrates	164
10.2 Reconstruction of Paleoenvironments and Climates	164
10.2.1 The “Grande Coupure” oligocene	165
10.2.2 Quaternary Environments and Climates	165
10.3 Contributions of Paleontology to Global Tectonics	165
10.3.1 Influence of Paleogeography on Evolution	165
10.3.2 Paleontology as a Test of Geodynamic models	167
References	169
Subject Index	181