

*Biology and
Comparative Physiology of*
BIRDS

Edited by
A. J. MARSHALL

*Monash University
Victoria, Australia*

VOLUME I



1960

ACADEMIC PRESS
NEW YORK and LONDON

Contents

CONTRIBUTORS TO VOLUME I.....	v
PREFACE.....	vii
CONTENTS OF VOLUME II.....	xii

Chapter I. The Origin of Birds

W. E. SWINTON

I. Introduction.....	1
II. The Osteology of <i>Archaeopteryx</i>	2
III. The Relative Resemblances of <i>Archaeopteryx</i> to Reptiles and Birds	5
IV. Affinities with the Thecodontia.....	7
V. Arboreal Adaptations.....	10
VI. The Development of Homoiothermy.....	11
VII. The Third <i>Archaeopteryx</i>	13
References	13

Chapter II. Adaptive Radiation in Birds

ROBERT W. STORER

I. Introduction	15
II. Problems in Size. The Surface: Volume Ratio.....	17
III. Locomotor Adaptations	19
IV. Feeding Adaptations.....	33
V. Adaptive Radiation within Families of Birds.....	48
VI. The History of Adaptive Radiation	50
References	53

Chapter III. The Classification of Birds

ROBERT W. STORER

I. Introduction.....	57
II. Evolution and Taxonomy.....	58
III. Practical Systematics.....	60
IV. Problems in Avian Classification.....	61
V. A Classification of Birds.....	63
References	91

Chapter IV. Geographical Distribution of Living Birds

D. L. SERVENTY

I. Historical Introduction.....	95
II. The Nature and Delimitation of Regions.....	97
III. Natural Regions and Historicofaunal Studies.....	100
IV. The Natural Regions.....	106
References	124

CONTENTS

Chapter V. Development of Birds

RUTH BELLAIRS

I. Introduction.....	127
II. The Egg.....	134
III. The Beginning of Development.....	136
IV. Gastrulation.....	138
V. The Coordination of Development.....	142
VI. The Laying Down of the Organs.....	146
VII. Body Shape.....	153
VIII. The Food Supply of the Embryo.....	155
IX. The Extraembryonic Membranes.....	156
X. The Blood System.....	158
XI. The Gut and the Respiratory Tract.....	162
XII. The Coelom.....	164
XIII. The Urogenital System.....	165
XIV. The Adrenals.....	168
XV. The Nervous System.....	170
XVI. The Organs of Special Sense.....	172
XVII. The Muscles and Limbs.....	175
XVIII. The Feathers.....	178
XIX. Hatching.....	178
References	180

Chapter VI. The Integumentary System

MARY E. RAWLES

I. The Skin.....	190
II. Derivatives of the Skin.....	193
III. Integumentary Pigmentation.....	212
IV. The Development of Patterns of Melanin Pigmentation.....	225
References	236

Chapter VII. The Skeleton of Birds

A. D'A. BELLAIRS AND C. R. JENKIN

I. Introduction.....	241
II. Evolution.....	243
III. The Vertebrae and Ribs.....	245
IV. The Shoulder Girdle.....	251
V. The Wings.....	255
VI. Wing Movements.....	258
VII. The Pelvic Girdle and Hind Limb.....	258
VIII. The Skull.....	265
IX. The Intrinsic Skeleton of the Eye.....	288
X. Pneumatization.....	289
XI. Ossification and Growth.....	293
XII. Anomalies.....	295
References	295

CONTENTS

Chapter VIII. The Musculature

ANDREW J. BERGER

I. Introduction.....	301
II. Striated (Skeletal or Voluntary) Muscles.....	302
III. Actions of Muscles.....	303
IV. Muscles Used in the Classification of Birds.....	305
V. Descriptions of Muscles of the Pectoral Appendage.....	312
VI. Descriptions of Muscles of the Pelvic Appendage.....	326
References	342

Chapter IX. The Blood-Vascular System

J. R. SIMONS

I. General.....	345
II. The Heart.....	346
III. The Arterial System.....	354
IV. The Venous System.....	356
V. The Blood.....	358
VI. The Lymphatic System.....	360
References	361

Chapter X. The Respiratory System

G. W. SALT AND ERIK ZEUTHEN

I. Introduction.....	363
II. Anatomy.....	365
III. Ventilation of the Respiratory Tract While Standing.....	376
IV. The Regulation of Respiratory Movements.....	388
V. Heat Regulation by the Respiratory System.....	392
VI. Respiration during Specialized Activities.....	396
References	404

Chapter XI. Digestion and the Digestive System

DONALD S. FARNER

I. Introduction.....	411
II. The Buccal Cavity, Buccal Glands, and Pharynx.....	412
III. The Esophagus and Crop.....	416
IV. The Gastric Apparatus.....	423
V. The Intestine.....	435
VI. The Liver.....	446
VII. The Pancreas.....	448
References	449

Chapter XII. Excretion

IVAN SPERBER

I. Introduction.....	469
II. Anatomy of the Avian Kidney.....	470
III. Physiology of the Avian Kidney.....	478
IV. Non-renal Excretion.....	488
References	489

AUTHOR INDEX.....	493
SUBJECT INDEX.....	505

Contents of Volume II

- XIII The Central Nervous System** BY ADOLF PORTMANN AND
WERNER STINGELIN
- XIV Sensory Organs: Skin, Taste and Olfaction** BY ADOLF PORTMANN
- XV Sensory Organs: Vision and Audition** BY R. J. PUMPHREY, F.R.S.
- XVI The Endocrine Glands** BY E. OTTO HÖHN
- XVII Sex and Secondary Sexual Characters** BY EMIL WITSCHI
- XVIII Reproduction** BY A. J. MARSHALL
- XIX Energy Metabolism, Thermoregulation and Body Temperature**
BY JAMES R. KING AND DONALD S. FARNER
- XX Flight** BY R. H. J. BROWN
- XXI Breeding Seasons and Migration** BY A. J. MARSHALL
- XXII Long-Distance Orientation** BY THE LATE G. KRAMER
- XXIII Behavior** BY R. A. HINDE
- XXIV Bird Populations** BY JOHN A. GIBB

*Biology and
Comparative Physiology of*
BIRDS

Edited by
A. J. MARSHALL

*Monash University
Victoria, Australia*

VOLUME II



1961

ACADEMIC PRESS
NEW YORK and LONDON

Contents

CONTRIBUTORS TO VOLUME II.....	v
CONTENTS OF VOLUME I.....	x

Chapter XIII. The Central Nervous System

ADOLF PORTMANN AND WERNER STINGELIN

I. The Brain.....	1
II. Spinal Cord.....	26
III. The Autonomic Nervous System.....	28
IV. Cerebralization and Related Problems.....	29
References	35

Chapter XIV. Part I. Sensory Organs: Skin, Taste, and Olfaction

A. PORTMANN

I. Skin.....	37
II. Taste.....	41
III. Olfaction.....	42
References	48

Chapter XIV. Part II. Sensory Organs: Equilibration

A. PORTMANN

I. General Structure.....	49
II. Sensory Structures and Their Nerves.....	51
III. Regulation of Somatic Musculature.....	53
References	54

Chapter XV. Part I. Sensory Organs: Vision

R. J. PUMPHREY

I. Introduction.....	55
II. The Retina.....	56
III. Color Vision.....	63
IV. Nocturnality.....	64
V. Accommodation.....	66
VI. Size.....	67
References	68

Chapter XV. Part II. Sensory Organs: Hearing

R. J. PUMPHREY

I. Introduction.....	69
II. Structure of the Ear.....	70
III. The Performance of the Bird's Ear.....	81
IV. Conclusion.....	85
References	85

CONTENTS

Chapter XVI. Endocrine Glands, Thymus, and Pineal Body

E. OTTO HÖHN

I. Introduction.....	87
II. The Pituitary or Hypophysis.....	90
III. The Thyroid.....	95
IV. The Adrenal Glands.....	102
V. The Parathyroid Glands.....	108
VI. The Thymus and Pineal.....	110
References	112

Chapter XVII. Sex and Secondary Sexual Characters

EMIL WITSCHI

I. Genetic Sex and Sex Differentiation.....	115
II. Secondary Sex Characters.....	135
References	164

Chapter XVIII. Reproduction

A. J. MARSHALL

I. Introduction.....	169
II. The Anterior Pituitary.....	171
III. The Testis.....	181
IV. The Ovary.....	192
V. Accessory Sexual Organs.....	198
References	204

Chapter XIX. Energy Metabolism, Thermoregulation, and Body Temperature

JAMES R. KING AND DONALD S. FARNER

I. Introduction.....	215
II. Energy Categories and Calorimetry.....	217
III. Standard Metabolic Rate and Body Weight.....	221
IV. Energy Metabolism and Ambient Temperature.....	231
V. Diurnal Variation in Energy Metabolism.....	244
VI. Energy Metabolism and Molt.....	246
VII. Thermoregulation.....	248
VIII. Body Temperature.....	268
IX. Temporary Hypothermia.....	276
References	279

Chapter XX. Flight

R. H. J. BROWN

I. Aerodynamics of Flight	289
II. Gliding Flight.....	292
III. Flapping Flight.....	294
IV. Wing Shape.....	299
V. Stability and Control.....	301
VI. Theoretical Work.....	303
References	304

CONTENTS

Chapter XXI. Breeding Seasons and Migration

A. J. MARSHALL

I. Introduction.....	307
II. Internal Regulation of Breeding.....	309
III. External Regulation of Breeding.....	318
IV. Discussion.....	327
References	322

Chapter XXII. Long-Distance Orientation

G. KRAMER

I. Introduction.....	341
II. Field Experiments Not Directly Concerning the Mechanism of Orientation.....	342
III. An Established Mechanism of Diurnal Direction Finding: Sun Orientation.....	347
IV. Homing Orientation.....	349
V. Nocturnal Orientation.....	362
VI. Facts of Visible Migration versus Experimental Evidence.....	365
VII. Birds and Bees.....	367
References	369

Chapter XXIII. Behavior

R. A. HINDE

I. Introduction.....	373
II. The Analysis of Bird Behavior.....	375
III. Bird Behavior Illustrated by Functional Groups of Activities....	393
References	407

Chapter XXIV. Bird Populations

JOHN A. GIBB

I. Introduction.....	413
II. The Measurement of Bird Populations	414
III. Longevity, Mortality, and Sex Ratio	417
IV. Rates of Reproduction and Juvenile Mortality.....	419
V. Changes in Bird Populations.....	425
VI. The Natural Regulation of Bird Populations.....	430
VII. The Territorial Behavior of Birds as a Possible Regulating Mechanism.....	438
References	441

AUTHOR INDEX.....	447
SUBJECT INDEX.....	459

Contents of Volume I

- I The Origin of Birds** BY W. E. SWINTON
- II Adaptive Radiation in Birds** BY ROBERT W. STORER
- III The Classification of Birds** BY ROBERT W. STORER
- IV Geographical Distribution of Living Birds** BY D. L. SERVENTY
- V Development of Birds** BY RUTH BELLAIRS
- VI The Integumentary System** BY MARY E. RAWLES
- VII The Skeleton of Birds** BY A. D'A. BELLAIRS AND C. R. JENKIN
- VIII The Musculature** BY ANDREW J. BERGER
- IX The Blood-Vascular System** BY J. R. SIMONS
- X The Respiratory System** BY G. W. SALT AND ERIK ZEUTHEN
- XI Digestion and the Digestive System** BY DONALD S. FARNER
- XII Excretion** BY IVAN SPERBER

CONRAD BURRI

PETROCHEMICAL CALCULATIONS

based on equivalents

(Methods of Paul Niggli)

Translated from German

Distributed by:
OLDBOURNE PRESS
1-5 Portpool Lane, London, E.C.1.

Israel Program for Scientific Translations
Jerusalem 1964

TABLE OF CONTENTS

	English page	German page
PREFACE	1	7
A. INTRODUCTION	3	13
I. The Significance and Representation of Rock Chemistry in General	3	13
1. Chemical rock analysis	3	13
2. Calculation and projection methods	7	18
II. Methods of Graphical Representation	8	19
1. Illustration of the behavior of a single variable . .	9	19
2. Illustration of the interdependence between two variables	17	28
3. Illustration of the mutual relations between two, three, and four variables having a constant sum . . .	20	32
a) Two variables: The concentration line	20	33
b) Three variables: The concentration triangle .	21	33
c) Four variables: The concentration tetrahedron	26	38
III. Aids for the Calculation	31	44
B. PETROCHEMICAL CALCULATION METHODS BASED ON EQUIVALENCE ACCORDING TO P. NIGGLI	34	47
I. The Niggli-Values <i>si, al, fm, c, alk, k, mg, ti, p</i> , etc, and Their Applications	34	47
1. The calculation of the Niggli-values	34	47
a) Niggli-values and weight percentages	34	47
α) Calculation of the Niggli-values from the weight percentages	34	47
Examples	37	50
β) Calculation of weight percentages from given Niggli-values	38	52
Examples	39	53
b) Niggli-values and cation percentages	41	55
α) Definition and calculation of the cation percentages	41	55
Examples	42	55
β) Relationships between cation percentages and Niggli-values	43	56
γ) Calculation of the cation percentages from given Niggli-values	43	57
Examples	44	57

	English page	German page
δ) Calculation of the Niggli-values from given cation percentages	44	58
Examples	45	58
c) Niggli-values and molecular equivalent per- centages (molecular percentages)	46	59
α) Calculation of the Niggli-values from the molecular equivalent percentages	46	59
Example	46	60
β) Calculation of the molecular equivalent percentages from given Niggli-values	47	60
2. The representation of fundamental petrochemical relationships by means of the Niggli-values	47	60
a) The quartz number q_z as an expression of satura- tion with respect to SiO_2	47	60
b) The alumina excess	49	63
c) Derivation of a simplified normative mineral composition from the Niggli-values	50	64
3. Application limits of the Niggli-values	52	66
4. Further applications of the Niggli-values	55	70
a) Compositional and quantitative relations of the normative feldspars	55	70
b) The state of silication	61	75
c) The <i>al-fm-c-alk</i> -tetrahedron and the representa- tion of the igneous field	62	77
d) Further representations of the igneous field . .	64	80
e) The variation diagram	67	83
f) Schematic review of the mutual dependence between <i>si</i> and <i>alk</i> for certain idealized normative mineral compositions	73	88
g) Distribution of SiO_2 among normative leucoc- ratic and melanocratic components	75	90
5. Magma-types	76	92
a) The concept of a magma-type	76	92
b) Review of magma-types (C. Burri and P. Niggli, 1945)	78	94
II. The Equivalent Norm	84	100
1. General consideration of experiments for the cal- culation of the normative mineral composition . . .	84	100
2. The principle of Niggli's equivalent norm	87	103
3. The basis and the calculation of the basis compo- nents	90	106

	English page	German page
Examples	93	109
4. Basis and cation percentages	95	112
a) Relationships between basis bonds and cation percentages	95	112
b) Calculation of the basis from given cation per- centages	95	112
Examples	95	112
c) Calculation of the cation percentages from the basis	97	114
Examples	97	114
5. Derivation of normative mineral compositions from the basis	99	116
a) The standard katanorm and its derivation from the basis	104	121
Examples	110	128
b) The formation of variants of the standard katanorm	114	133
6. The standard katanorm and cation percentages . . .	116	135
a) Relationships between cation percentages and the standard katanorm	116	135
b) Calculation of the standard katanorm from given cation percentages	117	136
Examples	117	136
c) Calculation of the cation percentages from the standard katanorm	118	138
Examples	119	139
7. Standard katanorm and Niggli-values	120	140
a) Calculation of the standard katanorm from given Niggli-values	121	140
Examples	121	141
b) Calculation of the Niggli-values from the stan- dard katanorm	124	144
Examples	125	145
8. The application of the equivalent norm to the study of heteromorphic relations	127	147
a) The vaugnerite from Vaugneray (Dép. du Rhône, France)	128	148
b) Selected examples of the heteromorphic possibilities of alkali-gabbroidal magmas	136	157
α) Maifraite, luscladite, and berondrite.	136	157
β) The Fasinite	142	164

	English page	German page
9. Equivalent norm, weight and volume percentages .	147	170
a) Equivalent percentages and weight percentages	147	170
b) Equivalent percentages and volume percentages	153	176
c) Volume percentages and weight percentages . .	155	179
10. Graphic representation of the chemism of the rock based on the basis components	156	181
a) The basic-group values Q , L , M and the QLM - triangle	156	181
b) The $KNaCa$ - and $MgFeCa$ -triangles and the determination of normative feldspar relations . .	161	186
c) The method of the remainder triangle	169	194
11. The direct calculation of the basis group values Q , L , M from Niggli-values	172	198
12. The application of the equivalent norm to the study of metamorphic rocks	175	200
a) General	175	200
b) The standard katanorm of metamorphic rocks .	179	206
Examples	181	207
c) The epinorm of metamorphic rocks	187	214
α) General	187	214
β) The calculation of a standardized epinorm	192	219
Examples	199	226
γ) Variants of the calculated modus of the standard epinorm	203	230
Examples	205	233
δ) The calculation of epinorm variants adapt- ed to the modus	208	236
d) Additional selected examples for the calcula- tions of metamorphic rocks	210	238
 C. THE SUGGESTIONS OF T.F.W. BARTH AND P. ESKOLA FOR THE CONSIDERATION OF ANIONS IN PETROCHEM- ICAL CALCULATIONS, AND THEIR RELATIONSHIP TO NIGGLI'S EQUIVALENT NORM	230	260
I. General	230	260
II. The Calculation of Rock Analyses with Consideration of the Anions	230	260
1. Calculation starting from the weight percentages .	231	261
2. Calculation starting from the Niggli-values	232	262
3. Calculation involving the presence of additional anions	233	263
III. Barth's Standard Cell	233	263

	English page	German page
1. Quartz-diorite, Spanish Peak, California (calculation from the cation percentages)	234	264
2. Quartz-diorite, Spanish Peak, California (calculation from the weight percentages)	234	265
3. Quartz-diorite, Spanish Peak, California (calculation from the Niggli-values)	235	265
4. The norm of the standard cell	236	266
5. The application of Barth's standard cell for the representation of the material balance of iso-volumetric metasomatic processes	237	267
D. APPENDIX	241	272
I. Alphabetical Index of Used Basis- and Equivalent-Normative Components	241	272
II. Compilation of Important Reaction Relations Between Basis- and Equivalent-Normative Components	243	274
III. Tables of the Molecular and Atomic Equivalent Numbers, Multiplied by 1000, for the Important Rock-Forming Oxides	249	280
E. BIBLIOGRAPHY	286	318
F. AUTHOR INDEX	291	323
G. SUBJECT INDEX	293	325

All cross references in this book allude to the original German page numbers indicated in the left-hand margin