

Contents

Preface	11
1. Turtle Anatomy and Physiology	13
1.1. The shell	13
1.2. Locomotor System	14
1.3. Coelomic Cavity	16
1.4. Skin	16
1.5. Gastrointestinal Tract	16
1.6. Liver	20
1.7. Pancreas	20
1.8. Respiratory System	21
1.9. Cardiovascular System	23
1.10. Lymphatic System	24
1.11. Urinary Tract	24
1.12. The Sex Organs	26
1.13. Endocrine System endocrine System	28
1.14. CNS and Senses	29
1.15. Body Temperature	30
2. Biology and Husbandry of Turtles	35
2.1. Chelonian Evolution	35
2.2. Taxonomy	36
2.2.1. The Problem with Common Names	38
2.2.2. Overview and Characteristics of Each Family	39
2.3. Biology	50
2.3.1. Relationship of Turtles to their Environment	50
2.3.2. Chelonian Life Cycle	54
2.4. Keeping Turtles	55
2.4.1. Main Reason for Keeping Turtles	55
2.4.2. Light, Heating, Feeding	58
2.4.3. Reproduction	59
2.4.4. Husbandry Risks: Security, Quarantine, Transport	62
2.4.5. Turtle Categories—Classification based on Daily Life and Behavioral Requirements	63
2.4.5.1. Sea turtles and Brackish Water Turtles (Type I)	63
2.4.5.2. Fresh Water Turtles—Inhabitants of Ponds (Type II)	66
2.4.5.3. Freshwater Turtles That Are Good Swimmers (Type III)	66
2.4.5.4. Marsh Turtles (Type IV)	69
2.4.5.5. Inhabitants of Seasonal Water Bodies (Type V)	70
2.4.5.6. Terrestrial Turtles Inhabiting Wooded Areas (Type VI)	71
2.4.5.7. Terrestrial Turtles Inhabiting Arid Areas (Type VII)	72
2.4.6. The Biggest Mistakes of Captivity	74
2.5. Hibernation/Brumation	76
2.6. Protecting Turtles	78

3. General Chelonian Medicine Clinical Nutrition	83
3.1. Clinical Nutrition	83
3.1.1. Supplements and Minerals	91
3.1.2. Artificial, Enteral Feeding	92
3.2. Clinical Examination	95
3.2.1. Basic Clinical Examination	95
3.2.1.1. Identification	95
3.2.1.2. Manual Restraint	95
3.2.1.3. Nutritional Status	98
3.2.1.4. Observation of the Patient	98
3.3. Examination of Organ Systems	101
3.3.1. Skin and Shell	101
3.3.2. Airways	101
3.3.3. Cardiovascular System	104
3.3.4. Digestive Tract	105
3.3.5. Urogenital System	105
3.3.6. Musculoskeletal System—Central Nervous System	106
3.3.7. Ophthalmologic Examination	107
3.4. Special Investigative Techniques	111
3.4.1. Radiographic Examination	111
3.4.2. Ultrasound Examination	118
3.4.3. MRI and CT	123
3.4.4. Endoscopy	124
3.4.4.1. Endoscopy of the Digestive Tract	125
3.4.4.2. Endoscopy of the Cloaca and Urinary Bladder	128
3.4.4.3. Endoscopy of the Respiratory System	130
3.4.4.4. Celioscopy	132
3.5. Laboratory Testing	138
3.5.1. Clinical Bacteriology and Mycology	138
3.5.2. Hematology and Serum Chemistry in Turtles	142
3.5.2.1. Drawing Blood	142
3.5.2.1. Biochemical Testing of Blood	144
3.5.2.3. Blood Cell Count	146
3.5.2.3.1. Red Blood Cells	146
3.5.2.3.2. White Blood Cells	147
3.5.3. Cytology	151
3.5.4. Excisional Biopsy	152
3.5.5. Urine Samples	152
3.5.6. Fecal examination	153
3.5.7. Electron Microscopy	157
3.6. Selected Viral Disease of Turtles	159
3.6.1. Herpes Virus	159
3.6.2. Ranavirus	163
3.7. Pathomorphological Diagnosis	164
3.7.1. Necropsy	164
3.7.1.1. History	164
3.7.1.2. Autolysis	164
3.7.1.3. Artifacts	168
3.7.1.4. Species Specifics	169
3.7.2. Specific Necropsy Technique	171
3.8. Histopathology	172

4. Turtle Parasites	176
4.1. Introduction	176
4.2. Pseudoparasites in Turtle Feces	179
4.3. Fecal Examination Methods	182
4.4. General Guidelines for Treatment and Prevention of Important Parasitic Diseases	184
4.5. Protozoa (Digestive Tract)	190
4.5.1. Flagellates	190
4.5.1.1. <i>Spironucleus</i> spp. (syn. <i>Hexamita</i>)	190
4.5.1.2. Trichomonads	192
4.5.1.3. Ciliates	194
4.5.1.3.1. <i>Balantidium</i> spp. and <i>Nyctotherus</i> spp.	194
4.5.2. Amoebae	196
4.5.2.1. <i>Entamoeba invadens</i> and other <i>Entamoeba</i> spp.	196
4.5.3. Coccidia of the Gastrointestinal Tract	201
4.5.3.1. <i>Eimeria</i> , <i>Choleoeimeria</i> , <i>Isospora</i> , <i>Caryospora</i>	201
4.5.3.1.1. <i>Eimeria</i>	203
4.5.3.1.2. <i>Choleoeimeria</i>	204
4.5.3.1.3. <i>Isospora</i>	204
4.5.3.1.4. <i>Caryospora</i>	205
4.5.4. Intranuclear and Intracytoplasmic Coccidia	205
4.5.5. <i>Cryptosporidium</i> spp.	207
4.6. Blood Protozoans	211
4.6.1. Trypanosomes	211
4.6.2. Haemogregarines	211
4.6.2.1. <i>Hemolivia mauritanica</i>	211
4.6.2.2. <i>Haemogregarina stepanovi</i> , <i>Haemogregarina balli</i> , <i>Haemogregarina nicoriae</i>	212
4.6.2.3. <i>Haemoproteus</i> (Apicomplexa: Haemoproteidae)	214
4.7. Other rare protozoans (with changing taxonomic classification)	215
4.7.1. <i>Blastocystis</i> spp.	215
4.7.2. Microsporidia	215
4.7.3. Myxozoa	216
4.7.3. <i>Myxidium</i> (Myxospora, Bivalvulida)	216
4.8. Helminths ("Worms")	217
4.8.1. Nematodes (Roundworms)	217
4.8.1.1. Oxyurids	218
4.8.1.2. Ascarids	222
4.8.1.3. Strongylids	225
4.8.1.4. Cosmocercoidea	226
4.8.1.4.1. <i>Falcaustra</i> spp. (Family Kathlaniidae)	226
4.8.1.5. <i>Atractis</i> / <i>Proatractis</i> spp. (Family Atractidae)	226
4.8.1.6. Spirurida	227
4.8.1.7. Super family Physalopteroidea	227
4.8.1.7.1. <i>Physaloptera</i>	227
4.8.1.8. Superfamily Gnathostomatoidea	228
4.8.1.8.1 <i>Spiroxys</i>	228
4.8.1.9. Superfamily Camallanoidea	228
4.8.1.9.1. <i>Camallanus</i> and <i>Serpinema</i>	228
4.8.1.10. Superfamily Filarioidea (Filaria)	229
4.8.1.11. Superfamily Dracunculoidea	229
4.8.1.11.1. <i>Dracunculus</i>	229
4.8.1.12. Superfamily Trichuroidea	230

4.8.1.12.1. <i>Capillaria</i> (Hairworms)	230
4.8.2. Cestodes (Tape Worms)	230
4.8.3. Trematodes (Flukes)	231
4.8.3.1. Digenea, Monogenea and Aspidogastrea	231
4.8.4. Acanthocephala (Thorny-headed Worms)	235
4.8.5. Annelids (especially leeches)	237
4.8.6. Pentastomida (Tongue Worms)	242
4.9. Arthropods	243
4.9.1. Mites	243
4.9.1.1. Snake Mites (<i>Ophionyssus natricis</i>)	244
4.9.1.2. Free-living Mites (Storage Mite, Food Mites and others)	244
4.9.1.3. Cloacal Mites (Family Cloacaridae)	245
4.9.1.4. Turtle Mites (Uropodina)	245
4.9.2. Ticks	245
4.9.2.1. Hard and Soft Ticks	252
4.9.3. Flies	252
4.9.3.1 "Wound Myiasis"	253
4.9.3.2. Myiasis in the Incubator	255
5. Administering Medications	263
5.1. Topical Application	263
5.2. Administration into the Lungs	264
5.3. Oral Administration (Per Os)	264
5.4. Cloacal Administration	267
5.5. Parenteral (Injectable) Administration	267
5.6. Euthanasia	269
6. Anaesthesia and Surgery	270
6.1. Anaesthesia	270
6.1.1. Analgesics	271
6.1.2. Injectable Anaesthesia	271
6.1.3. Inhalation Anaesthesia	273
6.1.4. Patient Monitoring	276
6.1.4. Anaesthetic Recovery	278
6.2. Surgery	281
6.2.1. Simple Procedures	281
6.2.1.1. Beak trimming	281
6.2.1.2. Microchip Implantation	281
6.2.1.3. Skin Neoplasms	282
6.2.1.4. Aural Abscesses	283
6.2.1.5. Enucleation of the Eye	284
6.2.2. Coeliotomy	284
6.2.2.1. Indications	284
6.2.2.2. Patient Preparation	285
6.2.2.3. Ventral Plastronotomy	286
6.2.2.4. Prefemoral and Cranial Plastronotomy	290
6.2.2.5. Foreign Bodies	290
6.2.3. General Trauma	292
6.2.3.1. Fracture of the Long Bones	292
6.2.3.2. Shell Fractures	295
6.2.4. Cloacal Prolapses	298

6.2.4.1. Pene Amputation	299
6.2.4.2. Amputation of the Cloaca	299
6.2.4.3. Amputation of the Urinary Bladder	301
6.2.4.4. Amputation of the Oviducts	301
6.2.5. Postoperative Care	301
6.2.5.1 Hospitalization	303
7. Special Section—Turtle Diseases	307
7.1. Anorexia	307
7.1.1. Post-brumation Anorexia (PBA)	309
7.2. Diseases of the Respiratory Tract	313
7.2.1. Diseases of the Upper Respiratory Tract (Upper Respiratory Tract Disease—URTD) = Infectious rhinitis, Runny Nose Syndrome	313
7.2.2. Diseases of the Lower Airways (Pneumonia	318
7.3. Cardiac Diseases	329
7.4. Diseases of the Digestive System	337
7.4.1. Inflammation of the Oral Cavity (Stomatitis, Upper Alimentary Tract Disease—UATD)	337
7.4.2. Diseases of the Stomach	344
7.4.3. Diseases of the Endocrine and Exocrine Pancreas	351
7.4.4. Intestinal Diseases	355
7.4.4.1. Diarrhea	355
7.4.4.2. Constipation (Obstipation)	362
7.4.4.3. Miscellaneous Intestinal Problems	367
7.5. Diseases of the Cloaca	369
7.6. Diseases of the Liver	375
7.7. Diseases of the Urinary Tract	383
7.7.1. Renal Diseases	383
7.7.2. Urinary Calculi	395
7.7.3. Miscellaneous Urinary Bladder Diseases	398
7.8. Diseases of the Female Reproductive System	400
7.8.1. Pathological Gravidity (Egg Binding)	400
7.8.2. Follicular Stasis	408
7.8.3. Oophoritis	411
7.8.4. Prolapse of the clitoris	411
7.9. Diseases of the Male Reproductive Tract	414
7.10. Skin and Shell Diseases	418
7.10.1. Hypervitaminosis A	418
7.10.2. Skin and Shell Wound	419
7.10.3. Abscesses	423
7.10.4. Septicemic Cutaneous Ulcerative Disease (Necrobacillosis)	425
7.10.5. Disfiguring Shell Disease	429
7.10.6. Fungal Diseases of the Skin	429
7.10.7. Shell Necrosis and Shell Gangrene in Tortoises	432
7.10.8. Kachuga Skin Disease	433
7.10.9. Algae	433
7.10.10. Skin Calcification	434
7.10.11. Immune-mediated Dermatitis	435
7.10.12. Neoplasia	435
7.11. Soft Shell ((Metabolic Bone Disease Syndrome, Osteodystrophy)	438

7.12. Diseases of the Nervous System	448
7.12.1. Neurologic Examination	448
7.12.2. Limb Paresis and Plegia	451
7.12.3. Disease of the Central Nervous System (CNS)	452
7.12.4. Frost Damage	456
7.13. Diseases of the Musculo-Skeletal System	458
7.13.1. Joint Diseases	458
7.13.2. Disease of the Long Bones	464
7.14. Diseases of the Eyes	467
7.14.1. Diseases of the Eyelids, Tear Ducts and Conjunctivae	467
7.14.1.1. Hypovitaminosis A	467
7.14.1.2. Eyelid Wounds and Inflammation	468
7.14.1.3. Post Hibernation (Brumation) Keratoconjunctivitis	470
7.14.2. Foreign Bodies	471
7.14.3. Corneal Diseases	471
7.14.3.1. Keratoconjunctivitis sicca—KCS ("Dry Eye Syndrome," "Dry Eye")	471
7.14.3.2. Corneal Ulceration	472
7.14.3.3. Cholesterol Dystrophy of the Cornea	473
7.14.4. Diseases of the Globe, Lens and Retina	474
7.14.5. Congenital Defects	476
7.15. Poisoning	477
7.16. Mycobacteria	479
7.17. Oncology	484
8. Appendix	
8.1. Overview of current turtle species along with maximum lengths	493
8.2. Overview of chelonian incubation data	506
8.3. Diet Recipes	514
8.4. Bibliography	517
8.5. Photo Credits	549
8.6. Medications commonly used for turtles	552
8.7. Clinical Chemistry SI Conversion Factors	559