

# Contents

<b>1</b>	<b>Morphology — 1</b>
1.1	Integument — 1
1.1.1	Cuticle and epidermis — 1
1.1.2	Canals and pores — 3
1.1.3	Surface structures, microtrichia and setae — 4
1.1.4	Cuticular sensilla — 5
1.1.5	Scolopidia — 7
1.1.6	Integumental gland cells — 9
1.1.7	Ecdysis — 10
1.2	Head — 12
1.2.1	Segmentation, sutures and cephalic regions — 12
1.2.2	Head capsule — 13
1.2.3	Cephalic endoskeleton — 16
1.2.4	Labrum and epipharynx — 17
1.2.5	Antennae — 19
1.2.6	Mandibles — 20
1.2.7	Maxillae — 21
1.2.8	Labium — 21
1.2.9	Hypopharynx — 22
1.2.10	Salivarium — 23
1.3	Thorax — 29
1.3.1	Segmentation and composition of segments — 29
1.3.2	Prothorax — 32
1.3.3	Pterothoracic segments — 33
1.3.4	Legs — 38
1.3.5	Attachment structures — 41
1.3.6	Wings — 45
1.4	Abdomen — 59
1.4.1	General organization — 59
1.4.2	External structures of the male and female postabdomen — 62
1.4.3	Male and female internal genital organs — 63
1.5	Nervous system — 67
1.5.1	Brain — 69
1.5.2	Suboesophageal complex — 73
1.5.3	Postcephalic ganglionic chain — 74
1.5.4	Visceral nervous system (VNS) — 74
1.6	Photoreceptor organs — 75
1.6.1	Extraocular photoreception — 75
1.6.2	Compound eyes — 76
1.6.3	Ocelli — 80

1.6.4	Stemmata —	<b>81</b>
1.7	Tracheal system —	<b>82</b>
1.8	Circulatory system —	<b>87</b>
1.8.1	Haemocoel, diaphragmata and alary muscles —	<b>87</b>
1.8.2	Dorsal vessel —	<b>88</b>
1.8.3	Accessory pulsatile organs —	<b>91</b>
1.8.4	Haemolymph —	<b>91</b>
1.9	Digestive tract —	<b>93</b>
1.9.1	Preoral cavity —	<b>93</b>
1.9.2	Foregut —	<b>93</b>
1.9.3	Midgut —	<b>95</b>
1.9.4	Hindgut —	<b>96</b>
1.10	Excretory organs —	<b>97</b>
1.11	Endocrine organs and the hormone system —	<b>99</b>
1.12	Fat body —	<b>102</b>
<b>2</b>	<b>Reproduction, development and immature stages —</b>	<b>104</b>
2.1	Fertilization and egg structure —	<b>104</b>
2.2	Embryonic development —	<b>106</b>
2.2.1	Cleavage and germ band formation —	<b>106</b>
2.2.2	Short germ and long germ embryos —	<b>108</b>
2.2.3	Germ layer formation and blastokinesis —	<b>109</b>
2.2.4	Segmentation —	<b>111</b>
2.2.5	Organogenesis —	<b>112</b>
2.3	Postembryonic development —	<b>113</b>
2.4	Larval and pupal forms —	<b>115</b>
<b>3</b>	<b>Glossary —</b>	<b>117</b>
3.1	Morphology —	<b>117</b>
3.1.1	General terms —	<b>117</b>
3.1.2	Integument —	<b>117</b>
3.1.3	Sensilla and sensory organs —	<b>118</b>
3.1.4	Head capsule —	<b>119</b>
3.1.5	Head appendages —	<b>122</b>
3.1.6	Thorax —	<b>123</b>
3.1.7	Legs —	<b>126</b>
3.1.8	Wings —	<b>127</b>
3.1.9	Abdomen —	<b>128</b>
3.1.10	Male genital organs —	<b>129</b>
3.1.11	Female genital organs —	<b>130</b>
3.1.12	Nervous system and associated structures —	<b>131</b>
3.1.13	Photoreceptor organs —	<b>134</b>

- 3.1.14 Tracheal system — 135
- 3.1.15 Circulatory system — 135
- 3.1.16 Digestive tract — 137
- 3.1.17 Excretory organs — 138
- 3.1.18 Endocrine organs and the hormone system — 139
- 3.1.19 Fat Body — 139
- 3.2 Reproduction, development and immature stages — 140
- 3.2.1 Fertilization and egg structure — 140
- 3.2.2 Cleavage and embryonic development — 140
- 3.2.3 Postembryonic development — 141
- 3.2.4 Larval and pupal forms — 142
  
- 4 Traditional and modern techniques in insect morphology — 143**
- 4.1 Fixation — 143
- 4.2 Dissection — 144
- 4.3 Maceration — 145
- 4.4 Scanning electron microscopy (SEM) — 146
- 4.5 Transmission electron microscopy (TEM) — 148
- 4.6 Histology — 150
- 4.7 Serial Block-Face Scanning Electron Microscopy (SBFSEM) — 152
- 4.8 Focused Ion Beam (FIB) — 153
- 4.9 Confocal laser scanning microscopy (CLSM) — 154
- 4.10 Micro-computer tomography ( $\mu$ -CT) — 155
- 4.11 Computer-based 3-dimensional reconstruction — 157
- 4.12 Geometric morphometrics (Ming Bai) — 158
- 4.12.1 Terminology and principles — 159
- 4.12.2 Geometric morphometrics analysis — 161
  
- 5 Phylogenetic reconstruction based on morphology — 164**
- 5.1 Hennigian terminology and principles — 164
- 5.2 Cladistics — 168
- 5.2.1 Taxon sampling — 168
- 5.2.2 Selection of characters — 169
- 5.2.3 Character state coding and building a list of characters — 170
- 5.2.4 Data matrix — 171
- 5.2.5 Parsimony analyses — 171
- 5.2.6 Trees, their presentation and statistics — 172
  
- 6 The orders of Hexapoda — 174**
- 6.1 Collembola (common name: springtails) — 178
- 6.2 Protura (common name: coneheads) — 184
- 6.3 Diplura (common name: two-pronged bristletails) — 188

- 6.4 Archaeognatha (common name: jumping bristletails) — **196**
- 6.5 Zygentoma (common names: silverfish and firebrats) — **201**
- 6.6 Ephemeroptera (common name: mayflies) — **209**
- 6.7 Odonata (common names: damselflies, dragonflies) — **217**
- 6.8 Plecoptera (common name: stoneflies) — **229**
- 6.9 Dermaptera (common name: earwigs) — **236**
- 6.10 Embioptera (common name: webspinners) — **242**
- 6.11 Phasmatodea (common names: stick and leaf insects) — **246**
- 6.12 Orthoptera (common names: katydids = bush-crickets, crickets, grasshoppers, locusts) — **251**
- 6.13 Zoraptera (common names: ground lice, angel insects) — **257**
- 6.14 Grylloblattodea (common names: ice crawlers, rock crawlers, icebugs) (Benjamin Wipfler) — **265**
- 6.15 Mantophasmatodea (common names: heelwalkers, gladiators) (Benjamin Wipfler) — **272**
- 6.16 Mantodea (common names: mantises, praying mantises) (Benjamin Wipfler) — **277**
- 6.17 Blattodea (common names: roaches and termites) (Benjamin Wipfler) — **282**
- 6.18 Psocoptera (common names: barklice, booklice, barkflies) — **296**
- 6.19 Phthiraptera (common name: true lice) — **304**
- 6.20 Thysanoptera (common names: thrips, fringe wings) — **313**
- 6.21 Auchenorrhyncha (common names: Cicadas, leafhoppers, planthoppers, froghoppers or spittle bugs, treehoppers) — **320**
- 6.22 Sternorrhyncha (common name: plantlice) — **326**
- 6.22.1 Psyllina, Psylloidea (common names: psyllids, jumping plantlice, lerp insects) — **328**
- 6.22.2 Aleyrodina, Aleyrodoidea (common name: whiteflies) — **331**
- 6.22.3 Aphidina (common name: aphids) — **334**
- 6.22.4 Coccina (common names: scale insects, mealy bugs) — **338**
- 6.23 Coleorrhyncha (common name: moss bugs) — **341**
- 6.24 Heteroptera (common name: true bugs) — **347**
- 6.25 Hymenoptera (common names: sawflies, wood wasps, bees, wasps, ants) — **364**
- 6.26 Neuroptera (common name: net-winged insects) — **376**
- 6.27 Megaloptera (common names: alderflies, dobsonflies, fishflies) — **385**
- 6.28 Raphidioptera (common names: snakeflies, camelneck flies) — **393**
- 6.29 Coleoptera (common name: beetles) — **401**
- 6.30 Strepsiptera (common name: twisted wing parasites) (Hans Pohl & Rolf G. Beutel) — **415**
- 6.31 Trichoptera (common name: caddisflies) — **423**
- 6.32 Lepidoptera (common names: moths and butterflies) — **433**

- 6.33 Mecoptera (common names for subgroups: scorpionflies, hangingflies etc.) — **447**
- 6.34 Siphonaptera (common name: fleas) — **457**
- 6.35 Diptera (common name: true flies) (Katharina Schneeberg & Rolf G. Beutel) — **465**
  
- 7 Literature — 480**
  - 7.1 Textbooks and comprehensive works — **480**
  - 7.2 Review articles — **482**
  - 7.3 Cladistic software and related studies — **483**
  - 7.4 Complete references — **483**
  
- Taxonomic Index — 508**