

Krister T. Smith, Stephan F. K. Schaal, Jörg Habersetzer (Eds)

MESSEL – An Ancient Greenhouse Ecosystem

Senckenberg Gesellschaft für Naturforschung

Contents

Dedication.....	V
Forewords	VII
Preface	X
Chapter 1 Messel – Eventful Past, Exciting Future	1
Chapter 2 The Formation of the Messel Maar	7
The volcano and the maar at Messel.....	8
The Middle Messel Formation with oil shale	9
Sand and ash: the Lower Messel Formation.....	11
What did the Messel Maar look like?	12
The crater’s history	13
Chapter 3 Paleoclimate – Learning from the Past for the Future	17
Pollen and spores – A means for documenting climate fluctuations	18
Varves – “Annual rings” in the lake sediment	20
The oil shale – A unique Eocene climate archive	21
Chapter 4 Joined in Death – the Burial Community of Messel	25
Distortion in the course of time	26
The mystery of the bats	28
Fossil color preservation	30
Cause of death: Unknown	32
Chapter 5 Messel Research – Methods and Concepts	35
Excavation, conservation, preparation	35
Examination by means of X-ray techniques and electron microscopy	37
Taxonomy and Phylogeny	38
Species diversity, viewed mathematically	40
Chapter 6 The Fossil Flora of Messel.....	43
History of study	43
The state of preservation of plant remnants	46
Systematics of the flora	48
Algae, mosses, ferns	48
Gymnosperms	50
Primitive flowering plants or basal angiosperms.....	51
Monocotyledonous flowering plants or monocots.....	52
Higher flowering plants or eudicotyledons	54
The vegetation surrounding the maar lake.....	59

Chapter 7 Jewels in the Oil Shale – Insects and Other Invertebrates	63
Sponges (Porifera).....	64
Paleobiogeography and paleoenvironment	65
Mollusks (Mollusca).....	65
Mystery snails (Viviparidae).....	66
Ramshorn snails (Planorbidae).....	66
Arthropods (Arthropoda).....	66
Spiders (Araneae).....	67
Harvestmen (Opiliones)	69
Crustaceans (Crustacea).....	69
Water fleas (Cladocera).....	69
Seed shrimp (Ostracoda).....	69
Decapods (Decapoda).....	69
Insects (Insecta, Hexapoda).....	70
Abundance of the different insect groups in Messel	71
Mayflies (Ephemeroptera).....	72
Dragonflies and damselflies (Odonata)	72
Stoneflies (Plecoptera).....	72
Earwigs (Dermaptera).....	73
Grasshoppers, crickets and katydids (Orthoptera)	74
Stick insects (Phasmatodea).....	74
Cockroaches and termites (Blattodea).....	75
Thrips (Thysanoptera).....	76
Cicadas and “hoppers” (Auchenorrhyncha).....	76
Plant lice, scale insects and whiteflies (Sternorrhyncha)	76
True bugs (Heteroptera).....	77
Hymenopterans (Hymenoptera): Sawflies and parasites.....	79
Hymenopterans (Hymenoptera): Bees and wasps	82
Hymenopterans (Hymenoptera): Ants	84
Net-winged insects (Neuroptera).....	88
Twisted-wing parasites (Strepsiptera).....	89
Beetles (Coleoptera): Primitive groups.....	90
Beetles (Coleoptera): Rove beetles, water dwellers and other handsome beetles	91
Beetles (Coleoptera): Various plant eaters	95
Caddisflies (Trichoptera).....	97
Butterflies and moths (Lepidoptera).....	99
Flies (Diptera).....	100
Scorpionflies (Mecoptera).....	101
Paleobiogeography of the insects in Messel	101
Chapter 8 Actinopterygians – the Fishes of the Messel Lake	105
Range of species	105
Paleobiology.....	109
Paleogeography	110

Chapter 9 Amphibians in Messel – in the Water and on Land	113
Frog fauna	113
Terrestrial: <i>Eopelobates wagneri</i>	113
Aquatic: <i>Palaeobatrachus tobieni</i>	114
<i>Lutetiobatrachus gracilis</i> , an almost blank canvas	117
Salamanders	117
Chapter 10 Amniotes – Mammals, Birds and Reptiles	121
Chapter 10.1 Lizards and Snakes – Warmth-loving Sunbathers	123
The Messel gecko	123
<i>Ornatocephalus</i>	124
Lacertiformes: the early success	125
Iguanidae: Immigrants from the New World	132
Creepers in the underbrush	134
<i>Eurheloderma</i> : an early Gila Monster	136
The semi-aquatic shinisaurs	138
Necrosaurs: the “death lizards”	139
Small and large boas	140
Palaeopython	144
The squamate community	145
Chapter 10.2 Turtles – Armored Survivalists	149
<i>Palaeoemys messeliana</i>	151
<i>Neochelys franzeni</i>	153
<i>Allaeochelys crassesculpta</i>	154
<i>Palaeoamyda messeliana</i>	154
Chapter 10.3 Crocodyliforms – Large-bodied Carnivores	159
<i>Diplocynodon darwini</i>	159
<i>Diplocynodon deponiae</i>	160
<i>Hassiacosuchus haupti</i>	160
<i>Asiatosuchus germanicus</i>	164
Tomistominae – Gharials in Europe	164
<i>Boverisuchus</i> – the “hoofed” crocodyliform	165
<i>Bergisuchus</i> – a southern immigrant	166
The crocodyliform community	167
Chapter 11 Birds – the Most Species-rich Vertebrate Group in Messel	169
Large ratites and other terrestrial species	170
The palaeognathous birds in the Messel forest	171
Gastornithidae	174
The gallinaceous bird <i>Paraortygoides</i>	174
Seriemas	174
<i>Strigogyps</i>	176
The Messel rail	177
Bird life at water’s edge	181
The aerial insect hunters	182
Nightjars and allies	182
Swifts and early relatives of the hummingbirds	185

<i>Scaniacypselus</i>	186
<i>Parargornis</i>	187
The arboreal birds of the Messel forest	188
Mousebird diversity	190
Parrots and passerines	194
Surprising relationships	195
Trogon and Coraciiformes	199
Trogon	199
The Messel hoopoes	200
Rollers	200
A kingfisher relative.....	203
Several mystery birds	204
Biogeographic connections.....	206
Messel birds and tropical avifaunas	209
What remains to be discovered	211
Chapter 12 Mammalia – Another Success Story	215
Chapter 12.1 Marsupials – a Surprise in Messel	217
Anatomy and morphology.....	217
Paleoecology.....	219
Evolution and biogeography of the marsupials from Messel.....	221
Chapter 12.2 Four Archaic Yet Highly Specialized Mammals	223
The remarkable adaptations of <i>Leptictidium</i>	224
The piscivore <i>Buxolestes</i>	227
The tree-climbing <i>Kopidodon macrognathus</i>	229
The long-fingered <i>Heterohyus nanus</i>	231
Paleobiogeography	232
Chapter 12.3 With and Without Spines – the Hedgehog Kindred from Messel	235
A fish-loving hedgehog	236
<i>Macrocranion tenerum</i> : the smallest lipotyphlan from Messel	237
A spiny, strong-headed, and scaly-tailed hedgehog.....	238
Paleobiogeography and Paleoenvironment.....	239
Chapter 12.4 Primates – Rarities in Messel	241
The first discoveries.....	242
Ida, the little diva of Messel.....	244
Further discoveries.....	246
Chapter 12.5 Bats – Highly Specialized Nocturnal Hunters with Echolocation	249
The bats at the Messel Lake.....	249
Wing shapes and hunting modes	250
Stomach contents.....	251
What the cochlea reveals.....	254
The evolution of echolocation	257
Summary of Eocene bats worldwide.....	261

Chapter 12.6 Rodents – Gnawing Their Way to Success	263
Systematics	263
The large leaf-eater <i>Ailuravus</i>	265
The short-legged climber <i>Masillamys</i>	266
<i>Hartenbergeromys</i> : a still enigmatic rodent.....	267
<i>Eogiliravus</i> : The oldest dormouse	267
Paleobiogeography and paleoenvironment	268
Chapter 12.7 Ferae – Animals that Eat Animals	271
Systematics of Carnivoraformes and Pholidotamorpha	271
<i>Lesmesodon</i> : the Messel hyaenodontan.....	272
<i>Paroodectes feisti</i> : an agile climber	274
<i>Messelogale kessleri</i> : a small predator.....	276
<i>Eomanis waldi</i> : the oldest pangolin	277
<i>Euromanis krebsi</i> : the headless anteater	279
<i>Eurotamandua joresi</i> : a doubtful South American	281
Paleogeography	283
Chapter 12.8 The Advent of Even-toed Hoofed Mammals	285
<i>Messelobunodon</i> : a primitive even-toed ungulate	285
<i>Aumelasia</i> : a cousin from France	287
<i>Eurodexis</i> : the smallest artiodactyl from Messel.....	288
<i>Masillabune</i> : a robust browser	289
Paleobiogeography and Paleoenvironment	290
Chapter 12.9 Odd-toed Ungulates – Early Horses and Tapiromorphs	293
The early horses (Equoidea).....	293
The life of the early horses.....	295
From leaf browser to grass eater.....	298
The tapir-like animals (Tapiromorpha)	299
Chapter 13 The Messel Ecosystem	303
Topography and lake chemistry.....	303
The aquatic ecosystem	305
The shore and possible tributaries.....	305
The terrestrial ecosystem	309
Reasons for the great species diversity in Messel	309
The role of niches	311
Future prospects.....	313
References	315
List of Authors	339
Index	343
Acknowledgments and Image Credits	349