Index

A
Abdomen
  structure of, 11–13
Abundance and biomass
  estimates tabulated, 479
Acetate
  use in termite respiration, 448
Acetogenesis
  in hindgut, overview, 451
Acquired enzyme
  hypothesis of cellulose digestion, 55
Actinobacteria
  in mounds of soil-feeding termites, 430
  predominance in mounds, 385
Adaptive microbiology
  explanation of eusociality, 376
Alate characters
  importance in phylogeny, 35
Alate development
  regulation of, 139
Alates
  general description, 6
Alate sex ratio, 266
Alkalinity
  consequences of in soil-feeder guts, 464
Alkaliphiles
  components of intestinal microbiota, 388
Allogrooming
  in the dampwood setting, 153
  distributing immune proteins, 176
  as a hygienic behaviour, 179
  in incipient colonies, 259
  reducing cuticle microbial loads, 170
Allometric growth
  and termite caste differentiation, 230
Allometry
  in social Hymenoptera, 105
Alloparental care
  definition and significance, 72
  role in evolution of eusociality, 82
  selection for, 84
Alloparents, 17
  as antecedents of soldiers, 86
  arrested reproduction, 83
Allozyme loci
  use in genetic analysis, 324
Altricial development
  loss of redundant characters, 78
  role of male parent, 81
  in wood-feeding cockroaches, 74
Altriciality
  definition and significance, 73
Altricial morphotype
  and termite evolution, 88
Altricial neonates
  metabolic demands of, 79
Altricial offspring
  precondition of eusociality, 79
Altruistic helpers
  selection factors, 99
Amietermes group III and IV, 492
Amietermes meridionalis
  anomalies in mound orientation, 362
  rationale of elongated mounds, 363
Ammonia
  accumulation in soil-feeder hindgut, 463
  uptake by flagellate endosymbionts, 461
Amplicon pyrosequencing, 171
Anoploterme III clades, 491
Anoplotermes groups III and IV, 492
Ant-actinomycete mutualism, 175
Anti-bacterial enzymes
  in termite saliva, 259
Antimicrobial compounds, 171
Antimicrobial peptides
  evolution in termites, 178
Ants
  encouragement as termite predators, 509
Apicotermes-IV clade, 491
Apicotermittinae
  position within Termitidae, 44
  subfamily status of, 3
Apomictic parthenogenesis, 262
Apparency
  in recognition of invasive species, 548
Apterous line
  in termite development, 102
AQS systems
  compared in termites and ants, 272–274
Archaea
  components of intestinal microbiota, 400, 419
Ascomycetes
  in soil-feeder mounds, 430
Assured fitness, 116
Asymmetric trophallaxis, 260
Attine ants
  distribution and biology, 195
Automixis
  with terminal fusion, 262

B
Bacteria
  overview of the intestinal community, 417
  role in cellulose degradation, overview, 443
Bacterial diversity
  of intestinal community, estimated, 417
  of lower and higher termites, compared, 418
Bacteroidales
  ectosymbionts of protists, 424
  endosymbionts of protists, 426
Bacteroidetes
  components of intestinal microbiota, 414
Beauveria bassiana
  potential efficacy against termites, 510
Bernoulli principle
  in mound ventilation, 359
Biogeographical realm, 480
Biogeography of termites
  overview, 478
Biological control
  of pest termites, discussed, 509
Biomes inhabited by termites
  listed, 479
Blattabacterium
  in Mastotermes, 29
Blattabacterium cuenoti
  biology and co-cladogenesis, 31
Brachypterous neotenics, 143
Breeding structure
  adaptation to local conditions, 335
  deduction via genetic analysis, 322
  inferred from markers, 329
Brood care
  in evolution of eusociality, 73
Budding
  in subterranean colonies, 336
Building pheromone
  and pellet deposition, 368

C
Cannibalism
  as hygienic behaviour, 179
Carbamates
  as termiticides, 506
Carton nests
  defined, 21
Cassava (= manioc)
  attacks by termites, 505
Caste determination, 102
Caste differentiation
  Nijhout and Wheeler model, 228
  variation amongst termites, 213
Caste regulatory mechanisms
  via hexamerins, 217
Castes
  listed, 5
  patterns of development, 136
Cathedral mounds
  described, 352
  internal diurnal gas fluxes, 355
Cell-1 gene
  as RNAi target, 224
Celllobiohydrolases, 52
Cellulase
  caste-dependent expression, 63
  expression in neonates, 73
  expressions in fungus-growers, 63
Cellulase genes
  sequencing of, 55–57
Cellulose
  crystallinity of, 52
  definition and digestion of, 52
Cellulose digestion
  by bacteria in higher termites, 444
Cement-pheromones
  and deposition zones, 368
Chlorinated phenols
  as termiticides, 506
Chlorpyriphos
  success in protecting groundnuts and eucalypts, 506
Chromosome multivalents, 261
Index

Chromosome numbers, 260
Clostridia
  components of intestinal microbiota, 389
Clostridiales
  components of intestinal microbiota, 419
Cockroach
  intestinal physiology compared with termite, 390
Cockroach ontogeny, 71
Co-cladogenesis with symbionts, 28
Cockroach
  components of intestinal microbiota, 389
Cocoa
  attacks by termites, 505
Coconut
  attacks by termites, 501
Coevolution
  and evolution of eusociality, 121
Co-evolution
  between ants and fungi, 195
  of protists and prokaryotes, discussed, 427
Coffee
  attacks by termites, 504
Colony establishment
  risks of infection, 183
Colony founders
  relatedness, 328
Colony fusions, 113
Colony genetic structure
  contributing factors, 326
Colony-release effects
  on hormones and gene expression, 222
Complete cellulases
  contribution to digestion, 61
  defined, 53
  endogenous production, 55
Conditional parthenogenesis, 268
Conflict
  between mutualists, 203
Conidiospores
  propagating Termiteomyces, 200
Cooperative defense
  in ants and termites, 109
Coprophagy
  to establish gut microbiota, 78
  and evolution of eusociality, 402
Coptotermes
  caste development, 143
  competitive release by human disturbance, 553
  genus notably producing invasive species, 545
Coptotermes acinaciformis
  expanding distribution, 535
  expanding distribution, 535
  origins in China and Taiwan, 523
Coptotermes gestroi
  expanding distribution, 536
  synonym of C. havilandi, 523
Co-speciation of protists and prokaryotes, 428
Cotton
  attacks by termites, 506
Cryptocercus
  microbial load of cuticle, 167
  phylogenetic position of, 30
  representing termite ancestors, 29
  as sister group, 2, 70
  subsociality in, 99
Cryptotermes brevis
  expanding distribution, 534
  origins in S. America, 522
Cryptotermes cynocephalus
  expanding distribution, 534
Cryptotermes domesticus
  expanding distribution, 534
Cryptotermes dudleyi
  expanding distribution, 534
Cryptotermes havilandi
  discussed, 522
  expanding distribution, 534
Cubitermes clade, 491
Cultural control
  of pest termites, discussed, 508
Culture-independent methods
  for characterisation of intestinal microbiota, 440
Cuticles
  antimicrobial chemistry of, 170
Cuticular hydrocarbons
  and nestmate discrimination, 292
CYP4 genes
  coding for P450, 219
  expression in workers, 219
Cytochrome oxidase I
  expression in soldiers, 220
Cytochrome oxidase I or II genes
  use in genetic analysis, 324
Cytophaga-Flexibacter-Bacteroides
  components of intestinal microbiota, 397

D
Dampwood termites
  pathogen loads, 153
Density dependent prophylaxis, 180
Developmental arrest, 107
Developmental repression and the evolution of eusociality, 213
Development times, 108
*Deviate* gene
odorant binding protein, 224
Diapause groundplan hypothesis of parental care, 107
Dictyoptera concepts of, 29
Disease
susceptibility with termite age, 184
Dispersal distances of colony founders, 326
and outbreeding, 327
Dispersal secretions, 280
Dodecatrienol double functions of, 309
as a sex-pairing pheromone, 290
as trail-following pheromone, 295
Dome mounds
internal diurnal gas fluxes, 356
Downstream pathways in soldier and alate morphogenesis, 233
Drought and termite attacks on crops, 508
Drywood termites pathogen loads, 153

**E**

Ecdysteroids and caste differentiation, 228
Ecdysteroid levels regulating JH biosynthesis, 228
Elusimicrobia formerly phylum TG1, 426
Encapsulation in immune responses, 174
Endemic term defined, 520
Endo-β-1,4-glucanases, 52
Endogenous cellulases overview of, 442
Endoglucanase genes in transcriptome of *Nasutitermes*, 444
Endoglucanases cloning and sites of expression, 58–60
 evolution of in cockroaches and termites, 58–60
Endomicobia endosymbionts of protists, 426
Endosymbionts biosynthesis of amino acids in flagellates, 461
manual isolation and genome sequencing, 429
Enteric valve configurations and armature, 381
posterior eversion, 383–384
Sands’s (1998) illustrations, 381
seating, 381
Enteric valve seating use in phylogeny, 37
Epidemiology modelled, 166
Epigeal nests hazards and advantages, 364
Ergatoid neotenics, 143
in Termitidae, 145
Ergatoid reproducitives characteristic of invasive species, 543
Erpacide® success against Macrotermitinae, 507
Escovopsis parasite of ant-associated fungi, 202
Established term defined, 521
Eucalyptus attacks by termites, 501
Eusociality ecological explanations of, 101
as key termite character, 70
origins in Hymenoptera, 100
stages of evolution, 72
Evo-devo in eusocial insects, 72
of termite caste body plans, 229
Evolutionary stability of fungus-insect mutualisms, 203–205
Exemplar ecosystems, 479
Exploratory trails and recruitment, 294
Extended families defined and discussed, 332
prevalence in lower termites, 329
External rumen in evolution of eusociality, 403

**F**

Faecal pellets role in trail-building, 295
Faeces use in construction, 381
False workers, 135
rationale of, 156
Family groups, 70
Feeding groups
Donovan’s classification, 14, 379, 480
Female-female
  colony foundation, 258
Female-only helpers
  in social Hymenoptera, 101
Female sex-pairing pheromone, 310
Fermentation
  of carbohydrates, overview, 446
  in termites, overview, 392
Ferric iron
  chemical reduction during gut passage, 452
Fiber digestion
  in midgut and hindgut, 441
Fibrobacteria
  components of intestinal microbiota, 419
$F_{IC}$, coefficient of inbreeding, 332
Filamentous prokaryotes
  enigmatic components of intestinal microbiota, 388
Filter dispersal
  from African rainforests, 492
Fipronil
  success in protecting sugar cane, 507
  as a termiticide, 507
Firmicutes
  abundant bacteria in higher termites, 429
  components of intestinal microbiota, 397, 418
  occurrence in alkaline hindgut regions, 430
FISH
  in situ localisation of microbiota, 422
$F_{IT}$, coefficient of homozygosity, 331
Flagellate community
  cellulase production by, 442
  specialisations of, 441
Flagellate fauna
  co-cladogenesis with termites, 43
Flagellate protists
  accommodation and role, overview, 387
Flagellates
  acquisition of, 32
  digestion of cellulose, 55
Flagellate symbionts
  dependence on in lower termites, 441
Food consumption data
  difficulties of estimation, 493
Foragers
  relative size of, 111
Foraging
  exploration and trail-building, 294
  secretions, 280
  and worker evolution, 152
Foraging areas
  possible scent marking of, 294
Foraging behaviours
  importance to control strategies, 511
Foraminitermitinae
  position within Termitidae, 44
  subfamily status of, 3
Foregut
  general structure of, 15
Fossils
  of cockroaches and termites, 33
Fractionation
  of ingested soil, 384
$F_{ST}$, coefficient of subpopulation variance, 331
FTHFS genes
  in metagenomic datasets, 451
Functional genomics
  defined, 220
Functional taxonomic groups
  concept and use, 480
Fungal infection
  interspecific differences, 170
Fungal lineages
  in termites and ants compared, 203
Fungal symbiont
  mutualistic diversification in ants, 200
Fungiculture
  evolution in termites and ants, 194–196
Fungistatic compounds
  in faeces, 172
Fungistatic proteins
  in humoral immunity, 175
Fungus
  role in fungus-growing ants, 199
Fungus comb
  construction of, 350, 353
Fungus garden
  establishment in termites and ants, 196
  protection of in termites and ants, 201
  structures of in termites and ants, 197
Fungus growing termites
  advantages to fungus, 352–354
  distribution and biology, 194
  gut microbiotas of, 200
G
Gene expression
  caste development, 151
Gene expression in caste differentiation, 237
Gene network
  in caste regulation, 222
Generic assemblage
  functional structure, 479
Generic richness
  mapping of, 478
Genetic bottlenecks
  in symbiont fungus propagation, 204
Genetic conflict
  in asexual queen succession, 270
  genetic consequences of, 326
Genetic diversity
  and colony fitness, 257
Genetic drift
  role in population divergence, 336
Genetic variation
  in symbiont fungi, 203
Genomics
  insights into caste differentiation, 212
Genotypes
  fidelity in ant-associated fungi, 204
β-(1,3)-Glucanases
  antifungal properties in faeces, 172
β-(1,3)-Glucans
  as immune elicitors, 176
β-Glucosidase gene
  role in regulation of worker behaviour, 218
β-Glucosidases, 52
  sites of expression, 60
  suppressing worker aggression, 225
Glycosyl-hydrolases
  affiliation of termite endoglucanase, 56
  classification of, 54
  phylogeny of in cockroaches and termites, 442
Gram negative binding proteins
  in immunity, 176
Groundnuts
  attacks by termites, 504
Group III humus-feeders, 491
Group II wood-feeders, 491
Group IV soil-feeders, 491
Group I wood-feeders, 493
Group selection, 114
  theories of, 116
Gut bacteria
  congeneric fidelity, 421
  novel types in termites, 418
Gut compartmentalization
  in higher termites, 463
Gut configuration
  uses in taxonomy, 383
Gut contents
  microscopic analysis, 380
Gut genes
  and caste regulation, 220
  gene up-regulation and down-regulation, 215
  role of JHA, 215
Gut microbial community
  co-evolution with termite host, 420
  spatial distributions, 422
  variation with age, 429
Gut microbiota
  possible functions listed, 376
Guts
  general structure, 15
Gut structure
  Sands’s (1998) illustrations, 381

H
Haplodiploidy of social Hymenotera, 101
  advantages and disadvantages, 111
Head
  structure of, 7
Helper forms
  selection factors for, 99
Helpers
  benefits in wood-dwelling, 154
Helping behaviours, 121
Hemicellulases
  production by symbionts, 54
Hemicellulose
  digestion of, 395
  removal of, 54
Heterochrony
  of trait expression, 107
Hexaflumuron
  as a termiticide, 507
Hexaflumuron baits
  success in protecting citrus orchards, 507
Hexagonal radial symmetry
  of intestine, 384
 Higher classification
  of Engel (2009), 2
Higher termites
  overview of gut microbial community, 429
Hindgut
  accommodation of microbiota, 387
  general structure, 16
Hodotermitidae
  caste development, 141
  general description of, 3
  as pests of agriculture, 500
  phylogenetic position, 39
Homoacetogens
  coexistence with methanogens in gut, 452
Humic substances
  solubilised in soil-feeder gut, 464

Index
Humification of nest microorganisms, 169
Inquilines
term defined, 22
Intermediate nester
classification of invasive species, 542
defined, 20
Intestinal microbial community
and innate immunity, 178
Intestinal microbiota
overview, 414
Intestine
reduction profiles, 389
structural diversity, 378
Introduced
as an alternative term to invasion, 520
term defined, 521
Introduced populations
breeding structure of, 340
genetic variation of, 340
Invaded habitats
discussed, 546
Invaded regions
tabulated, 546
Invaders
26 species listed, 523
Invasive
term defined, 521
Invasive termites
population genetics, 338
typical features, 538
Isoptera
changing concept of, 29

J
Juvenile hormone (JH) titles
and neotenic reproductives, 141
in nymphal development, 149
and soldier development, 151

K
Kalotermitidae
caste development, 138
general description of, 2
higher proportion of invasive
species, 544
new invasive species, 523
as pests of agriculture, 500
phylogenetic position, 40
Kin-biased foraging, 333
Kin discrimination
in mate choice, 327
Kin selection, 114
King-daughter inbreeding, 265
King longevity, 265
L

Laccases
  in foregut, evidence from a metatranscriptome, 466
  production in *Termomyces*, 465
Lactate
  consumption by hindgut bacteria, 447
Larvae
  term defined, 5, 135
  Leaf cutter ants
    specialisations of, 196
Legs
  structure of, 11
Lepiotaceae
  fungal symbionts of attine ants, 195
Life types
  Abe’s (1987) definitions, 136
Lignin
  degradation by termites, overview, 464
  enrichment in termite faeces, 391
  marginal digestion of, 393
  part mineralisation by fungus comb, 391
  structural change during gut passage, 466
Lignin model compounds
  degradation of in termite gut, 465
Lignocellulose
  degradation by symbiont fungi, 198
  overview of digestion, 440
Lignocellulose digestion
  endogenous vs symbiont, 390
  secondary evolution in Termitidae, 378
Lysozyme
  secretion by salivary glands, 398
  as immune proteins, 177

M

*Macrotermes bellicosus*
  mound heat and gas exchanges, 355
  mound architecture and construction, 354–358
  vertical transmission of fungal symbiont, 197
*Macrotermes michaelseni*
  mound architecture and construction, 358
Macrotermes
  as dominant fresh-litter feeders, 493
  foraging and consumption, 396
  intestinal microbiota of, 396
  overview of symbiosis, 395
  as pests of agriculture, 500
  position within Termitidae, 44
  subfamily status of, 3
‘Magnetic’ termites
  mound architecture and construction, 361
  rationale of mound shape, 362
Maize
  attacks by termites, 503
Male sex-pairing pheromone, 309
Malpighian tubules
  number, 384
  partial enclosure, 379
  Sands’s (1998) illustrations, 381
Mangos
  attacks by termites, 502
Manioc (= cassava)
  attacks by termites, 505
Mass recruitment
  evolution of, 293
*Mastotermes darwiniensis*
  caste development, 138
  expanding distribution, 533
Mastotermitidae
  general description of, 2
  as pests of agriculture, 500
  phylogenetic position, 39
Matrilines
  determined by genetic markers, 329
Metagenomic analysis
  of gut microbial community, 430
*Metharhizium anisopliae*
  potential efficacy against termites, 510
  susceptibility to, 180
Methane
  absence of oxidation in termites, 456
  emission rates in different termites, 449
  formation from hydrogen or formate, 449
Methanobacteriaceae
  in posterior hindgut of higher termites, 430
*Methanobrevibacter*
  methanogen in lower termites, 419
Methanogenesis
  overview, 392
Methanogenic symbionts
  value of, 450
Methanogens
  association with gut wall, 450
  associated with protists, 423
  classified, 450
  coexistence with acetogens in gut, 453
  in higher termites, 419
  location in posterior soil-feeder hindgut, 35
Methanomicrobiales
  in posterior hindgut of higher termites, 430
*Methanomicrococcus*
  motility symbiosis, 424
Microbial growth
in termite nests, 166
Microsatellites
use in genetic analysis, 325
use in population genetics, 325
Microsensor measurements
reveal intestinal gradients, 452
use in intestinal microbial physiology, 440
*Microtermes*
colonisation of Madagascar, 492
vertical transmission of fungal symbiont, 197
Midgut
general structure, 15
Minisatellites
use in genetic analysis, 324
Mitochondrial COII data
use in phylogeny, 38
Mixed family colonies
possible causes of, 333
Mixed segment
evolution of, 379
role in fluid fluxes and pH elevation, 390
ultrastructure, 390
Molecular markers
choice of in termite population
 genetics, 323
 unmasking invasive species, 553
Molecular sequencing
to identify gut microbiota, overview, 386
Monandry
in eusocial evolution, 112
Monoculture
and termite attacks on crops, 508
Monogyny
in eusocial evolution, 112
Monophyly
of termite clades, 38
Mound
defined, 20
fortification of, 22
Mound architecture
constraints in arid or cold areas, 364
intraspecific variability, 352
tradeoffs between insulation and gas
exchange, 358
MtDNA markers
indicate sources of invasions, 339
N
*Nasutitermes corniger*
synonyms, invasive termitid, 523
Nasutitermitinae
as pests of agriculture, 500
position within Termitidae, 44
subfamily status of, 3
Native
term defined, 520
Native habitats
vulnerability to invasion, 549
Naturalised species
future prospects of, 550
Neocembrene
as a sex-pairing pheromone, 295
as trail-following pheromone, 295
Neotenic development
control of, 120
Neotenic queens, 258
Neotenic reproduction
critically discussed, 155
Neotenic reproductives
postponed benefits, 155
Neotenics
prevalence in lower termites, 329
as replacement reproductives, 118
Nepotism
in queen-tending, 334
Nest
defined, 20
value of, 109
*NifH* gene
wide distribution in termite gut microbiota,
458–459
Nitrogen fixation
in flagellates, 460–461
by gut microbiota, overview, 458
Nymphal pathway, 106
Nymphoid neotenics, 143
Nymphoid secondary reproductives
characteristic of invasive species, 543
Nymphs
defined, 5, 135
O
O2 consumption
by flagellates, proposed, 456
Oceanic wood rafting, 492
One-piece nesters, 20
Open mounds
of some Macrotermitinae, 359–361
Organochlorine insecticides
discontinued use of, 506
Organophosphates
as termiticides, 506
*Oriensubulitermes*-III clades, 492
Orientation systems

Index 571
requirements of different life-types, 293
Outbreeding
and colony fitness, 182
Ovarian groundplan hypothesis
of parental care, 107
Oviposition
and reduced immunity, 183
Oxic–anoxic boundary
effects on bacterial distributions in hindgut, 454
Oxygen
gradients in termite gut, 452
Oxygen reduction
by hindgut bacteria, 454
Oxymonad flagellates
uncertain digestive functions, 443
Oxymonads
cocladeogenesis with, 31
components of intestinal microbiota, 414
phylogenetics of, 416

P
Paedomorphosis
of termite characters, 29
Pairing
and prophylactic immunity, 183
Pairing behaviour
of termite alates, 280
Panesthiinae
biparental care in, 74
Parabasalian systematics, 416
Parabasalids
cocladeogenesis with, 31
components of intestinal microbiota, 414
Parental care
in wood-feeding cockroaches, 77
Parental manipulation, 114
and evolution of eusociality, 119
Parthenogenesis
faculative, 258
in social insects, 257
Parthenogens survival rate, 263
Pastures
indirect degradation by termites, 505
Pathogen alarm behaviour, 180
Pathogen transmission
and eusociality, 183
PCR primers
in identification of intestinal microbiota, 414
Peptide depletion
in faeces of soil-feeding termites, 401
Peptidic components
preferential digestion in soil-feeders, 462
Pericapritermes groups III and IV, 492
Persistence
lack of in modern insecticides, 507
Pest
term defined, 521
Phagocytosis
in immune responses, 173
pH elevation
in higher termite hindguts, 388
Phenoloxidase
in immune responses, 174
Phenotypic plasticity
retention in termites, 88
Pheromonal parsimony, 309
Pheromone longevity, 295
Pheromone production
differences between castes, 294
Philopatry
term defined, 108
Phragmosis, 19
Phylogenetic markers
in intestinal protists, 415
Phylogenetic position of termites
within Dictyoptera, 2
Phylogeography
defined, 337
Phylotypes
defined, for bacterial identification, 417
Planctomycetes
abundance in soil-feeder guts, 464
components of intestinal microbiota,
388, 419
Pleometrosis
advantages of, 328
Pleural glands, 285
Polyethism
in fungus-growing termites and ants, 197
Polysaccharide
efficient digestion of, 395
high digestion efficiency in termites, 441
Population divergence
roles of genetic drift
Population genetic structure
introduction, 322
Porotermes adamsoni
invasive dampwood termite, 541
Porotermitinae
subfamily status of, 3
P3/P4 epithelia
ultrastructure, 383
Proctodeal trophallaxis
and nitrogen economy, 457
Index

and parental care, 153
role in symbiont transfer, 420
Protease
activity in midgut, 398
Proteobacteria
components of intestinal microbiota, 397
Protist–prokaryote associations, 423
Protists
archaeal and bacterial associates, 422
endoglucanase activity of, 62
multiple associations with prokaryotes, 427
Pseudergates
described and defined, 6, 153
evolution of, 146
functional roles, 135
rationale of, 157
Purging selection, 269
Pyrethroids
as termiticides, 507
Pyruvate
metabolism in hindgut, hypothesised, 448
Q
Queen pheromone
and building templates, 368
R
Recognition epitopes
of pathogens, 174
Refugia
during glacial periods, 338
Regressive moults, 137
Relatedness asymmetries, 111–112
Reproductives
general description, 3
Reproductive skew, 115
Reproductive soldiers, 141
Resilience
of biogeographic regions to invasion, 550
Reticulitermes
caste development, 143
Reticulitermes flavipes
expanding distribution, 535
synonym of *R. santonensis*, 523
Reticulitermes speratus
secondary queens, 263
Rhinotermitidae
caste development, 141
general description of, 3
higher proportion of invasive species, 544
new invasive species, 532
as pests of agriculture, 500
phylogenetic position, 41
Rhinotermitinae
subfamily status of, 3
Rice
attacks by termites, 503
Royal cell
experimental re-construction, 366
rRNA gene sequences
in phylogenetic profiling of intestinal microbiota, 414
S
Sampling design
standardisation of, 479
Savanna woodland
generic richness of, 481
Secondary fermentations
by hindgut microbiota, proposed, 447
Secondary queens, 266
Secondary reproducives
abundance of in invasive species, 543
exemplify plastic caste system, 71
Selfish driver gene, 271
Self-organization
in mound-building, 366
Semi-deserts
generic richness of, 481
Separate-piece nesters
defined, 20
Serritermitidae
caste development, 141
general description of, 3
Sex-mating pheromones
initiating copulation, 281
Sex-pairing pheromones, 281
chemical nature of, 285
secretion levels, 290
species specificity, 291
Sex ratio
of alates, 327
Sex ratio, 144
Short-chain fatty acids
end products of microbial metabolism, 445
Simple families, 332
Single-piece nesters
characteristic of invasive species, 542
Socioecoimmunology, 174
Soil-feeders
derivation from litter transformers, 385
Soil-feeding
advantages of, 385
as a derived trait, 381
Soil-feeding termites
overview of the digestive process, 398
Soil mounds, 21
Soils
effects of termites on, 386
Soldier morphogenesis, 230–231
described, 230–231
Soldier morphology
importance in phylogeny, 35
Soldier-organised foraging, 294
Soldiers
absence in many Hymenoptera, 105
development and evolution, 134
evolution of roles, 104
gene expression in, 214
general description, 4
morphology and behaviour, 18
origin and weaponry, 109
as a source of primer pheromones, 234
Soldier secretions
gene expression in, 216
Solid phase microextraction
for pheromone characterisation, 280
Sorghum
attacks by termites, 504
Sphaerotermitinae
position within Termitidae, 44
subfamily status of, 3
Spinigerin
as antifungal peptide, 180
Spirochaetes
components of intestinal microbiota, 418
16S rDNA gene
use in genetic analysis, 324
16S rRNA genes
to define intestinal bacterial communities, 417
Steineremna
susceptibility of termites to infection, 510
Steineremna carpocapsae
behavioral responses to, 18
Sternal gland
role in attraction and excitement, 284
structure and presentation, 298
Stigmergy
in mound-building, 366
Stoloetermitidae
phylogenetic position, 39
Stoloetermitinae
subfamily status of, 3
Stomodaeal trophallaxis, 75
Subfertile workers
in social Hymenoptera, 106
Subfertility
in specialised workers, 120
Sublittermes clades, 492
Suboesophageal ganglion
of soldiers, 231
Subsocial species
absence in termites, 99
Subterranean termites
breeding system inferred, 263
Sugar cane
termite pests of, 502
Sulphate-reducing bacteria
possible roles in termite guts, 451
Superorganism
concept of, 4
defined, 2
Sweepstakes dispersal, 492
Symbiont transcriptome/metagenome sequencing
from termite guts, 220
Symbiont transcriptomes
and lignocellulose digestion, 220
Symbiont transfers
in cockroaches and termites, 99
Symbiosis
defined, 194
Symbiotic fungi
source of nitrogen in some Macrotermitinae, 458
Syntermitinae
position within Termitidae, 39
subfamily status of, 3
T
Takeout proteins, 226
Tandem running
by alates, 6
Tandem running pair, 258
Task allocation
polyethism in termites, 212
Tea
attacks by termites, 505
Tefluthrin
success in protecting eucalypts, 507
Temperate forests
generic richness of, 481
Temperate rainforest
generic richness of, 481
Temperature
and caste composition, 222
Temperature control
in nests and mounds, 22
Templates
in mound-building, 366
Tergal glands, 283
and tandem behaviour, 283
Index

**Termes-III clade**, 492
Termicin
- as an antimicrobial effector, 176
- evolution in termites, 178
Termitidae
- caste development in, 141
- general description of, 3
- new invasive species, 533
- phylogenetic position and structure, 39
Termitinae
- as pests of agriculture, 500
- position within Termitidae, 44
- subfamily status of, 3
Termitoidae
- proposed epifamily, 34
**Termitomyces**
- benefits to termites, 352
- co-cladogenesis with termites, 44
- fungicides against, 507
- mutualistic diversification, 199
- physiological requirements, 354
- proposed functions, 199
- sharing between termite species, 194
- as a symbiont of termites, 194
- temperature sensitivity of, 357
**Termopsidae**
- basal status of, 100
- caste development, 138
- general description of, 2
- phylogenetic position, 39
**Termopsinae**
- subfamily status of, 3
**Terpenoids**
- antimicrobial properties, 171
**TG1 phylum**
- components of intestinal microbiota, 418
**TG3 phylum**
- components of intestinal microbiota, 419, 444
**Thelytoky**
- term defined, 255
**Thermoregulation of mounds**, 8
**Thermosiphon hypothesis**
- in mound ventilation, 359
**Thorax**
- structure of, 7
**Tomatoes**
- attacks by termites, 506
**Trade**
- as driver of termite invasions, 552
**Trail-following pheromones**, 280
- chemical nature and diversity, 298
- chemical synthesis, 300
- concentration thresholds, 305
- conserved in evolution, 307
- multiple components, 306
- optimal active concentrations, 305
- possible role in recruitment, 306
- species specificity, 307
- stereoisomerism, 306
- universal use in termites, 306
- variations with termite phylogeny, 306
**Trail polarity**, 295
**Tramp termites**
- with panglobal distribution, 522
**Transepithelial fluid transfer**
- between gut regions, 383
**Transfer**
- term defined, 521
**Transferin**
- upregulation in immunity, 175
**Treponema**
- ectosymbiont of protists, 423
**Trophallactic feeding**
- and soldier evolution, 86
**Trophic shift hypothesis**, 81
**Tropical forest assemblages**
- documented, 479
**Tropical rainforest**
- generic richness of, 481
**True workers**
- defined, 106
- origins of, 148
- rationale of, 157

**U**
**Uric acid**
- recycling by gut microbiota, 457

**V**
**Ventilation of mounds**
- tidal mechanisms, 359
- by wind, 365
**Venturi mechanism**
- in mound ventilation, 360
**Vitellogenesis hormonal regulation of**, 228
**Vitellogenin 1 and 2**
- and experimental JH treatment, 221
W
Wheat
attacks by termites, 503

Wings
structure and variations, 10

Wood
commination of, 441
Wood-dwelling
and resource competition, 152
and worker evolution, 152

Wooden ships
as historical agents of termite invasions, 552

Wood-feeding
characteristic of invasive species, 538

Wood hardness
and worker evolution, 152

Worker gut anatomy
importance in phylogeny, 37

Worker mandibles
importance in phylogeny, 35

Workers
foraging and feeding by, 13
gene expression in, 216
general description, 4
lines of development, 136
specialisations of, 120
true and totipotent forms, 103
variety of definitions, 136

X
Xylan
digestion in termites, 443
Xylanase gene
in transcriptome of Nasutitermes, 444–445

Xylaria
role in termite fungus gardens, 201

Y
Yams
attacks by termites, 505