
Contents

<i>Foreword to the second edition by Professor Elizabeth Bernays</i>	<i>vii</i>
<i>Preface to the second edition</i>	<i>ix</i>
<i>Preface to the first edition</i>	<i>x</i>
1 Introduction	1
1.1 Increased attention: why?	1
1.2 Relationships between insects and plants	1
1.3 Relevance for agriculture	2
1.4 Insect–plant research involves many biological subdisciplines	2
1.5 References	3
2 Herbivorous insects: something for everyone	5
2.1 Host-plant specialization	6
2.2 Food-plant range and host-plant range	10
2.3 Specialization on plant parts	11
2.3.1 Above-ground herbivory	11
2.3.2 Below-ground herbivory	13
2.4 Number of insect species per plant species	13
2.5 Herbivorous insects: are they plant taxonomists?	15
2.6 Host plant is more than food plant	16
2.7 Microclimates around plants	17
2.8 Extent of insect damage in natural and agricultural ecosystems	18
2.9 Compensation for herbivore damage	23
2.10 Conclusions	24
2.11 References	24
3 Plant structure: the solidity of anti-herbivore protection	29
3.1 Insect feeding systems	29
3.2 Leaf surface	31
3.2.1 Epicuticular waxes	31
3.2.2 Trichomes	35
3.3 Leaf toughness	36
3.3.1 Mandible wear	36
3.3.2 C ₃ and C ₄ plants	39
3.4 Structures involved in mutualistic relationships	40
3.5 Plant galls	41

3.6	Plant architecture	42
3.7	Conclusions	43
3.8	References	44
4	Plant chemistry: endless variety	48
4.1	Plant biochemistry	49
4.1.1	Primary plant metabolism	50
4.1.2	Secondary plant substances	50
4.2	Alkaloids	51
4.3	Terpenoids and steroids	52
4.4	Phenolics	55
4.5	Glucosinolates	57
4.6	Cyanogenics	57
4.7	Leaf surface chemistry	58
4.8	Plant volatiles	59
4.9	Concentrations of secondary plant substances	63
4.10	Production costs	65
4.11	Compartmentation	67
4.12	Temporal variability	68
4.12.1	Seasonal effects	69
4.12.2	Day/night effects	70
4.12.3	Interyear variation	71
4.13	Effects of location and fertilizers	71
4.13.1	Sun and shade	71
4.13.2	Soil factors	73
4.14	Induced resistance	74
4.14.1	Induced direct resistance	75
4.14.2	Induced indirect resistance	75
4.14.3	Variation in herbivore-induced changes	77
4.14.4	Genomic and metabolomic changes induced by herbivory	77
4.14.5	Systemic effects	78
4.14.6	Long-term responses	79
4.14.7	Signal transduction	80
4.14.8	Interaction between herbivore-induced and pathogen-induced changes	80
4.14.9	Plant–plant interactions	81
4.15	Genotypic variation	81
4.15.1	Inter-individual variation in plant chemistry	81
4.15.2	Intra-individual variation in plant chemistry	83
4.15.3	Plant sex affects insect susceptibility	84
4.16	Conclusions	85
4.17	Literature	85
4.18	References	86
5	Plants as insect food: not the ideal	99
5.1	Plants are suboptimal food	101
5.1.1	Nitrogen	102
5.1.2	Water	104
5.2	Artificial diets	105

5.3 Consumption and utilization	106
5.3.1 Food quantities eaten	106
5.3.2 Utilization	106
5.3.3 Suboptimal food and compensatory feeding behaviour	111
5.3.4 Allelochemicals and food utilization	113
5.3.5 Detoxification of plant allelochemicals	116
5.4 Symbionts	120
5.4.1 Food utilization and supplementation	120
5.4.2 Detoxification of plant allelochemicals	121
5.5 Host-plant quality affected by microorganisms	121
5.5.1 Plant pathogens	122
5.5.2 Endophytic fungi	122
5.6 Host-plant effects on herbivore susceptibility to pathogens and insecticides	124
5.7 Food-plant quality in relation to environmental factors	125
5.7.1 Drought	125
5.7.2 Air pollution	125
5.8 Conclusions	127
5.9 References	127
6 Host-plant selection: how to find a host plant	135
6.1 Terminology	136
6.2 Host-plant selection: a catenary process	137
6.3 Searching mechanisms	138
6.4 Orientation to host plants	143
6.4.1 Optical versus chemical cues	143
6.4.2 Visual responses to host-plant characteristics	145
6.4.3 Olfactory responses to host plants	149
6.4.4 Flying moths and walking beetles: two cases of olfactory orientation	149
6.5 Chemosensory basis of host-plant odour detection	152
6.5.1 Morphology of olfactory sensilla	152
6.5.2 Olfactory transduction	153
6.5.3 Olfactory electrophysiology and sensitivity	154
6.5.4 Olfactory specificity and coding	157
6.6 Host-plant searching in nature	158
6.7 Conclusions	160
6.8 References	160
7 Host-plant selection: when to accept a plant	169
7.1 The contact phase of host-plant selection: elaborate evaluation of plant traits	169
7.2 Physical plant features acting during contact	170
7.2.1 Trichomes	170
7.2.2 Surface texture	172
7.3 Plant chemistry: contact-chemosensory evaluation	172
7.4 The importance of plant chemistry for host-plant selection: a historical intermezzo	173

7.5	Stimulation of feeding and oviposition	174
7.5.1	Primary plant metabolites	174
7.5.2	Plant secondary metabolites promoting acceptance: token stimuli	176
7.5.3	Generally occurring secondary plant metabolites acting as stimulants	179
7.6	Inhibition of feeding and oviposition	180
7.6.1	Deterency as a general principle in host-range determination	181
7.6.2	Host-marking as a mechanism to avoid herbivore competition	181
7.7	Plant acceptability: a balance between stimulation and deterency	182
7.8	Contact-chemosensory basis of host-plant selection behaviour	183
7.8.1	Contact chemoreceptors	183
7.8.2	Gustatory coding	183
7.8.3	Caterpillars as models for coding principles	185
7.8.4	Token stimulus receptors: unsurpassed specialists	186
7.8.5	Sugar and amino acid receptors: detectors of nutrients	188
7.8.6	Deterrent receptors: generalist taste neurons	188
7.8.7	Peripheral interactions	190
7.8.8	Host-plant selection by piercing–sucking insects	192
7.8.9	Oviposition preference	194
7.8.10	Host-plant selection: a three-tier system	195
7.9	Evolution of the chemosensory system and host-plant preferences	197
7.10	Conclusions	198
7.11	References	199
8	Host-plant selection: variation is the rule	209
8.1	Geographical variation	209
8.2	Differences between populations in the same region	211
8.3	Differences between individuals	212
8.4	Environmental factors causing changes in host-plant preference	213
8.4.1	Seasonality	213
8.4.2	Temperature	214
8.4.3	Predation risks	215
8.5	Internal factors causing changes in host-plant preference	215
8.5.1	Developmental stage	215
8.5.2	Insect sex affects food choice	216
8.6	Experience-induced changes in host-plant preference	217
8.6.1	Non-associative changes	217
8.6.2	Associative changes	221
8.7	Pre- and early-adult experience	224
8.8	Adaptive significance of experience-induced changes in host preference	225
8.9	Conclusions	226
8.10	References	227
9	The endocrine system of herbivores listens to host-plant signals	233
9.1	Development	233
9.1.1	Morphism	233
9.1.2	Diapause	236

9.2	Reproduction	237
9.2.1	Maturation	237
9.2.2	Mating behaviour	239
9.3	Conclusions	241
9.4	References	241
10	Ecology: living apart together	244
10.1	Effects of plants on insects	245
10.1.1	Plant phenology	246
10.1.2	Plant chemistry	247
10.1.3	Plant morphology	249
10.1.4	Alternative food	249
10.2	Effects of herbivores on plants	251
10.3	Above-ground and below-ground insect–plant interactions	252
10.4	Microorganisms and insect–plant interactions	252
10.5	Vertebrates and insect–plant interactions	254
10.6	Indirect species interactions in communities	254
10.6.1	Exploitative competition	256
10.6.2	Apparent competition	257
10.6.3	Trophic cascades	257
10.7	Species interactions and phenotypic plasticity	259
10.8	Top-down versus bottom-up forces	260
10.9	Food webs and infochemical webs	261
10.9.1	Food webs	261
10.9.2	Infochemical webs	263
10.10	Communities	264
10.10.1	Why are so many herbivorous insect species ‘rare’?	265
10.10.2	Colonization	265
10.10.3	Community development	266
10.11	Molecular ecology	267
10.12	Conclusions	269
10.13	References	270
11	Evolution: insects and plants forever in combat	278
11.1	Fossilized records of insect–plant interactions	279
11.2	Speciation	282
11.2.1	Reproductive isolation	283
11.2.2	Rates of speciation	286
11.2.3	Reciprocal speciation	286
11.3	Genetic variation in host-plant preference of insects	287
11.3.1	Interspecific differences	287
11.3.2	Intraspecific differences	287
11.3.3	Preference–performance correlation	289
11.3.4	Genetic variation and local host-plant adaptation	289
11.4	Genetic variation in plant resistance against insects	290
11.5	Selection and adaptation	291
11.6	Evolution of insect diversity	292

11.7	Evolution of host-plant specialization	293
11.7.1	Coping with plant secondary metabolites	293
11.7.2	Competition	294
11.7.3	Reduced mortality from natural enemies	294
11.7.4	Phylogenetic relationships	294
11.8	Reciprocal evolution of herbivorous insects and their host plants	296
11.8.1	Criticism of the theory of co-evolution	297
11.8.2	Support for the theory of co-evolution	298
11.9	Conclusions	300
11.10	References	300
12	Insects and flowers: mutualism par excellence	306
12.1	Mutualism	308
12.2	Flower constancy	311
12.2.1	Flower recognition	312
12.2.2	Flower handling	314
12.3	Pollination energetics	316
12.3.1	Distance	316
12.3.2	Accessibility	317
12.3.3	Temperature	317
12.3.4	Food-source evaluation	318
12.3.5	Reward strategy	319
12.3.6	Signalling nectar status	320
12.4	Pollinator movement within multiple-flower inflorescences	321
12.5	Competition	322
12.6	Evolution	324
12.7	Nature conservation	329
12.8	Economy	330
12.9	Conclusions	330
12.10	References	331
13	Insects and plants: how to apply our knowledge	336
13.1	Which herbivorous insect species become pests and why?	337
13.1.1	Characteristics of herbivorous pest species	337
13.1.2	Consequences of crop-plant introductions	337
13.1.3	Agricultural practices promote the occurrence of pest problems	338
13.2	Host-plant resistance	339
13.2.1	Host-plant resistance mechanisms	339
13.2.2	Partial resistance	340
13.2.3	Plant characteristics associated with resistance	341
13.2.4	Methodology of resistance breeding	342
13.3	Polycultures: why fewer pests?	345
13.3.1	The disruptive-crop hypothesis	348
13.3.2	The enemies hypothesis	348
13.3.3	Trap-cropping and crop-weed systems	349
13.3.4	Diversity as a guiding principle	350

13.4 Plant-derived insecticides and antifeedants	350
13.4.1 Antifeedants	351
13.4.2 Neem tree, azadirachtin	352
13.4.3 Outlook for antifeedants as crop protectants	353
13.5 Weed control by herbivorous insects	355
13.5.1 <i>Opuntia</i> and <i>Salvinia</i>	355
13.5.2 Success rate of biological weed-control programmes	356
13.6 Conclusion: diversification holds the clue to the control of pestiferous insects	357
13.7 References	358
Appendices	
A: Further reading	364
Books that focus wholly or to a large extent on insect–plant interactions	364
Proceedings of international symposia on insect–plant relationships	365
B: Structural formulae of selected secondary plant compounds	367
C: Methodology	373
C.1 Choice of plants and insects	373
C.1.1 Plants	373
C.1.2 Insects	374
C.2 Behaviour	374
C.2.1 Olfactory orientation	375
C.2.2 Feeding	376
C.2.3 Oviposition	377
C.3 Sensory physiology	378
C.3.1 Ablation	378
C.3.2 Electrophysiology	378
C.4 Plant chemistry	378
C.4.1 Headspace	378
C.4.2 Leaf surface	378
C.4.3 Plant interior	379
C.4.4 Gene expression patterns	379
C.5 References	380
Taxonomic index	387
Author index	393
Subject index	412

Subject Index

Numbers in *italics* refer to illustrations.

- abietic acid 54
ablation of sensilla 128
abundance
 of herbivores 13, 43, 260, 265, 347
 of plants 258, 289
acarodomatia 40
acceptance, *see* host plant
acid rain 126
across-fibre patterns, *see* sensory coding
active space
 definition 144
 odour 144, 145
adaptation to new host 267, 291
aescin 54
age 110; *see also* leaf age
aggregation pheromone 160
agriculture 330, 336–57
 sustainable 358
air pollution 125–6
ajugarin 54, 182
alkaloids 51–2, 58, 65, 66, 122
 toxicity 117
allelochemics
 definition 50
 and food utilization 113–6
allelopathy 50, 348
allochryony 284
allomone 137
allopatric speciation 212, 283–4
amino acid receptor 175, 188–9
amino acids 41, 71, 112, 125, 175, 234
amylase 114
 inhibitors 343
anemotaxis 142, 149, 150, 159
angiosperms
 appearance 283
 radiation, *see* evolution
anthocyanins 55, 56, 191, 321
antibiosis 290, 341
 definition 339
antifeedant 350–4, 377; *see also*
 azadirachtin
 index 190
antirrhinocide 65
antixenosis 341
 definition 339
ants 216, 235, 249, 251, 254,
 264, 290
aphids
 host selection behaviour 147–9
 polymorphism 213, 234
 sexual forms 213, 235
 wing development 234
apple maggot fly (*Rhagoletis pomonella*)
 colour vision 147, 159
 EAG 287
 host selection 146
 searching 159
 vision 146
approximate digestibility (AD) 37,
 107–9, 111
aristolochic acid 176, 198, 217, 354
arms race 299
arrestant definition 137
arrestment 160, 169
artificial diet 101, 105–6, 175, 219
 for aphids 234
 and insect quality 106
associative learning, *see* learning
attractant 252, 351
 definition 137
atropine 51
automimicry and nectar
 production 319
aversion learning, *see* learning
azadirachtin 54, 182, 190, 192, 217,
 351, 352–3, 377
baculovirus 124
bark beetles 11, 83, 160, 241
 host selection behaviour 139
bees as pollinators 308–30
below-ground herbivory, *see* root herbivory
benzyl isoquinoline 51
berberine 51, 56, 67
bioassay 16, 178, 339, 376
 guided fractionation 176
biological control 350; *see also* weed control
biomass
 of humans 2, 23, 264
 of insects 1, 2, 107
 loss of plant biomass 18, 336
 of plants 2, 5, 65
biosynthesis of secondary plant substances 50, 74, 78, 269
biotype
 definition 210
 insect 211, 278, 330
botanical instinct 15, 16, 173
boundary layer 17, 143, 170
bracken fern biological control 356
broom 262, 266
bud break 246
budget equation 107
bumblebees 308–30
 energy requirements 318
C₃ and C₄ plants 39–40
cabbage white butterfly, *see* *Pieris* spp.
cabbage root fly
 colour vision 147
 oviposition 148
cafeteria 111, 376
caffeic acid 55, 179
caffeine 52, 64, 182
caloric value 100, 319
cannabidiol 54
cannibalism 216
carbohydrates 37, 50, 101, 159, 174,
 223; *see also* sugars
carbon dioxide (CO₂) 125, 126
cardenolides 53, 56, 190, 195, 212
carnivores
 attracted by plants 75, 77
 effects on plants 258, 300
 and induced plant responses 182
 and waxbloom 33
carotenoids 53
casting 143, 149
catechin 56

- cDNA microarray technology 267
 cellulose 36, 38, 50, 101, 102, 105
 central nervous system (CNS) 138, 156, 158, 184, 191, 195–6, 218, 221
 chalcones 55, 197
 character displacement 210, 323
 chemical gestalt 221
 chemical legacy hypothesis 225
 chemoreceptors; *see also* receptors
 evolution 197–8, 297
 generalists 188, 190
 internal 112, 183, 196
 peripheral interactions 190–2
 specialists 186, 188, 190
 chemotaxis 140, 152
 chemotaxonomy 173
 cherry fruit fly (*Rhagoletis cerasi*)
 host marking 181
 chlorogenic acid 179, 182
 choice experiments 376
 cholesterol 54
 cibarium 30
 CIF 179
 cladograms 294, 296, 298
 clerodin 54
 climatic change 246
 clone 82, 83
 cocaine 51
 co-evolution 298–300, 326
 criticism of the co-evolution
 theory 297
 definition 296
 diffuse 297
 diversifying 286
 geographical mosaic theory 297–8
 colonization 265, 257, 286, 298
 of introduced plants 267
 Colorado potato beetle (*Leptinotarsa decemlineata*)
 anemotaxis 150, 159
 EAG 155
 green leaf volatiles 61, 156
 and leaf age 136
 orientation 150
 taste hair responses 186
 colour vision 145–9
 community
 definition 264
 composition 267
 compartmentation, *see* secondary
 plant substances
 compensation 23–4
 overcompensation 23
 compensatory feeding 109, 111–3
 competition
 apparent 257
 exploitative 256
 for pollinators 322
 among insects 255, 323
 interspecific 210, 252, 257, 294,
 competitive displacement 267
 conditioning, *see* learning
 constitutive resistance 75, 337
 consumption rate 109, 112
 contact chemoreception 152, 160, 170
 contact chemoreceptors 29, 183–92
 contact testing 138
 evaluation 138, 170
 convergence neural 155–7
 cost
 of growth 110, 111
 of detoxification 110
 cost-benefit
 flower visitation 316
 costs of defence, *see* secondary plant
 substances
 coumarins 55, 67, 68
 crops
 losses to herbivory 3, 22, 336
 pollination 309–30
 cross-habituation 217
 cucurbitacin 54, 82
 cultivars
 concentration secondary
 compounds 342
 trichomes 35, 171
 volatiles 61
 cyanin 56, 191
 cyanogenics 51, 57–8, 64, 116
 cyclic outbreaks 80, 260
 cytochrome P450 115, 117, 269; *see also*
 polysubstrate monooxygenases
 damage 18–24; *see also* compensation
 in agroecosystems 22, 336, 337
 artificial 61, 63, 76, 80
 caused by insects 18, 20, 21, 22–3,
 61, 251
 differences between plants 290
 and plant fitness 292
 volatiles 62
 defence 49, 50
 constitutive 291
 direct 74, 245, 263
 indirect 74, 245, 269, 290, 299
 defoliation 13, 18, 20, 79, 264
 artificial 21
 deme 284
 desert locust reproduction 237
 desiccation 31, 104
 deterrents 181, 197, 217, 351; *see also*
 antifeedant
 definition 137
 and evolution 293
 receptors 186–8, 190
 detoxification 113, 116–9
 enzyme induction 118–9
 enzymes 117–20
 of plant allelochemicals 31
 by symbionts 121
 dhurrin 67, 68, 269
 diapause and leaf age 236
 effect of host plant 237
 diet, *see also* artificial diet
 breadth 16, 42, 198
 mixed 221–4
 self-selection 111–2, 215, 222
 switch 214, 215, 233
 digestibility 37; *see also* approximate
 digestibility
 reducing factors 70, 115
 digestion 37, 75, 113, 114, 253,
 digestive enzymes 107, 115, 353
 DIMBOA 194
 dioecy 84, 85, 308
 dioscin 54
 direct resistance definition 75
 directed movement 140
 dispersal capacity of insects 283, 338
 disruptive selection 252
 disruptive-crop hypothesis 348
 diterpenoids 54
 diversification 279, 349, 358
 crop 347
 insect 31, 279
 plant 279, 298
 in plant substances 31
 diversity 357
 flower types 321
 insects 43, 279, 292
 and pest insect damage 350
 plants 159, 327, 329
 DNA sequencing 5, 154, 269, 379
 domatia 40, 260; *see also*
 acarodomatia
 drinking 105
 tests 377
 drought 50
 stress 125
 drumming 146, 170
 dual discrimination theory 173
 dulcitol 176, 188, 198
 Dutch elm disease 83
 EAG, *see* electroantennogram
 ecdysone 54
 ecological saturation hypothesis 292
 ecosystem
 agroecosystem 22, 338, 346, 347
 natural 18, 24, 330, 336, 338, 358
 ectophagy 15, 265

- efficiency
 of conversion of digested food 107–9
 of conversion of ingested food 107–9
 metabolic 107, 109, 110, 127
 egg load 170
 elaiosome 251
 electrical penetration graph
 (EPG) 193–4, 377
 electroantennogram (EAG) 154, 155
 technique 378
 of sibling species 287
 electrophysiology 154–7, 184–92, 378
 empodia 35
 endophagy 15, 42, 265
 endophyte 122–3, 263
 enemy hypothesis 260, 348, 349
 enemy-free space 16, 261
 energy
 budget 11, 112, 316
 flow 108
 entomopathogen susceptibility 121,
 123–4, 247, 253
 environmental genomics 379
 EPG, *see* electrical penetration graph
 epicuticular wax bloom, *see* leaf
 epideictic pheromone, *see* pheromone
 epidermis
 and chemical resistance 64
 as feeding site 11, 30, 64, 194
 vacuole contents 67
 epipharyngeal sensilla 183, 186, 193
 essential oils 53, 59, 64, 67, 173
 ethylene 80, 240, 321
 euryphagy 337
 evolution, *see also* co-evolution
 angiosperms 280, 324
 insect taxa 281, 282–3
 molecular clocks 298
 nervous system 197
 of plant breeding systems 85
 of plant preference 297
 plants 308
 reciprocal 296, 298
 sequential 297, 298
 excretion 116, 117, 293
 exotics, *see also* introduced species
 insects 267
 plants 267, 355
 expanding resource hypothesis 292
 experience 216–27; *see also* learning
 exploitative competition 256
 extrafloral nectar 13
 extrafloral nectaries, *see* nectaries

 farnesene 63
 feeding
 activity and metabolic rate 111
 deterrents, *see* deterrents
 periods 261
 rate 106, 111, 175
 rhythms 71
 site 215, 216
 stimulants, *see* phagostimulants
 systems 215–6
 fertilizer 73, 103, 112, 125
 fig pollination 308, 326
 fitness
 insect 198, 226, 252, 263, 289;
 plant, *see* plant fitness
 flavonoids 55, 180, 190
 flavonols 55, 66
 flower
 age 321
 automimicry 320
 colour 312–3
 colour changes 321
 constancy 311–2
 diversity 326, 327
 evolution of shape 326–7
 handling 315, 317
 odour composition 314
 odour trail 314
 recognition 312–4
 symmetry 313, 327
 texture 314
 types 321
 flowering time 322
 food quantity 106, 112
 food plant
 effects on entomopathogens 121,
 123, 124, 247, 253
 preference test 219
 quality 101, 122, 123, 125–7,
 152, 265
 range 10–11
 food web 258, 261–3
 forest
 fertilization effects 73
 insect feeding strategy 63
 insects 43, 160, 292, 338
 leaf toughness 36
 losses to insects 18, 20, 21
 pest outbreaks 125, 264, 329
 pollination 325
 tannins 65, 66, 79
 fossils
 insects 279, 281, 282
 plants 279–81
 furanocoumarins 58, 63, 115, 118,
 119, 269, 291, 298

 GABA, *see* gamma-aminobutyric
 acid
 gallic acid 57

 galls induced by insects 41–3, 64, 284
 distribution 63, 83, 84
 gamma-aminobutyric acid 188
 gender (plant), *see* plant sex
 gene banks, *see* germplasm collections
 gene expression 267, 379
 gene-for-gene interactions 340
 gene silencing 269
 generalist receptor neuron 157
 generalists
 definition 7
 genetic
 changes 210
 covariance 289
 engineering 345
 modification 339
 variation 82, 269, 286, 289–91
 genetics of chemoreception 197
 genomic changes 78, 198
 geographic mosaic theory of
 co-evolution, *see* co-evolution
 geographical variation of host
 range 210, 211, 289
 geographical range of plants 265
 geraniol 53
 germplasm collections 339, 343
 Gestalt 221
 gibberellin 54
 gibberellic acid 321
 glabrous leaves 35
 glaucolide-A 54
 glaucous plant surface 146
 glomeruli 154, 156, 158
 glossy plant surface 33, 146
 glucobrassicin 58, 176, 177, 178
 glucosinolate receptor 179, 186, 192
 glucosinolates 7, 51, 57, 67, 68,
 173, 176, 178, 211, 342
 as oviposition stimulants 194, 195
 glutathione 126, 154
 gossypol 54, 82, 113
 grass fungal endophytes 123
 gravimetric method 107
 green leaf volatiles 60, 61, 239
 greenhouse
 effects on secondary
 metabolites 73, 373
 pollination 330
 growth rate in insects; *see also* relative
 growth rate
 and air pollution 126
 differences between species 110, 11
 and energy production 110
 and induced plant response 13
 locusts 110
 and secondary plant substances 115
 and water 104

- growth rate in plants
 and phenolics 65, 66
 guild 44, 107, 109, 322, 357
 gustation, *see* contact chemoreception
 gustatory coding 183–8
 gut 115, 117, 120, 121, 124
 gypsy moth (*Lymantria dispar*)
 artificial diet 105
 change in food preference 215
 change in nutritional
 requirements 215, 216
 food preferences 9, 11, 72
 feeding rhythm 71
 and Lyme disease 264
 susceptibility to virus 124
- habitat diversity 329, 338
 habitat-heterogeneity hypothesis 338
 habituation 217–8, 225, 226, 353;
 see also learning
 hairs, *see* trichomes
 haustellate mouthparts 30, 31
 headspace 60, 61, 62, 160, 378, 379
Helicoverpa spp.
 artificial diet 106
 host selection behaviour 219, 288
 pheromone production 240
 and tannins 110
 taste receptors 186, 189
 hemicellulose 39, 50, 102
 herbivore interactions 252
 hexenal 60, 155
 hexenol 60
 hexenyl acetate 63
 honey production 310
 honeybee foraging distance 317
 honeydew
 food for ants and predators 251,
 290, 349
 food for herbivores 121, 159
 Hopkins host-selection principle 224
 hormones, *see* plant; *see also*
 neuroendocrine system
 host alternation 148, 213
 host finding 159, 224, 348,
 host marking 181
 host-plant
 acceptability 136, 182–3, 212, 374
 acceptance 138, 170
 acceptance definition 136
 effects on diapause 236, 237
 effects on insecticide
 sensitivity 119
 effects on mating 239–41
 effects on morphism 234, 235
 effects on reproduction 237–41
 and insecticide tolerance 125
- more than food plant 16
 morphology 172
 physical traits 170
 preference definition 136
 quality and natural enemies 236,
 247
 range 7, 9–11, 42, 209, 212
 recognition definition 136
 resistance 344
 selection 10, 136, 176–80,
 192–6, 293
 specialization 6–9, 13, 22, 212
 host preference
 age effects 135
 change 215, 225–6
 developmental stage 215, 216
 genetic changes 210
 genetic variation 209, 287–90
 induction 218–21
 seasonal changes 213, 214
 sex differences 216
 temperature effects 214
 host race 210, 285
 host range expansion 210
 host shift 197, 214, 295, 338
 hybrid incompatibility 238, 285, 286
 hybrids 289
 host preference 197, 287, 288
 hydrogen cyanide (HCN) 58, 67,
 68, 116
 hygrometry 153
 hypericin 56, 63
 hyperparasitoids 123, 261
- idioblast 67
 imprinting, *see* learning
 indioside D 179, 221
 indirect resistance definition 75
 indole alkaloids 50, 51
 induced preference, *see* learning
 induced resistance 74–81, 152
 delayed responses 79
 herbivore specific responses 77
 heritability 82
 and natural enemies 74, 75, 259
 and plant pathogens 8
 systemic signal transmission 78–80,
 252, 257
 transfer to neighbours 81, 263, 300
 volatiles 80, 263
 induction, *see* detoxification; *see also*
 learning; *see also* resistance
 infochemical 152, 245, 255
 definition 137
 web 263, 264
 inositol 175
 inositol receptor 189, 191
- insect pathogens, *see* pathogens of
 insects
 insect phenology 14, 233, 247
 insect rarity 15
 insect selection pressure on plants 85,
 286, 292, 297, 313, 326
 insecticide
 resistance 279
 susceptibility 119, 120, 124, 125
 insecticide treatment 19, 120
 and seed production 20
 insecticides 119, 278, 279, 329, 330,
 349, 354
 of plant origin 56, 117, 351–4
 insects and plant viruses 122,
 152, 352
 instinct 1; *see also* botanical instinct
 interactions between species 255, 257
 intercropping definition 346
 introduced species
 insects 267, 329, 338, 357
 plants 266, 285, 289, 337
 plants and toxicity 216, 289
 weeds 355, 356
 iridoid glycoside 54, 56, 65
 isoprene 51, 53, 62
 isoquercitrin 180
 isothiocyanates 57, 61, 237, 238
- jasmonic acid 80, 81, 120, 251,
 268, 293
 juvenile hormone (JH) 235, 236, 241
- kaempferol 55
 kairomone 137, 175, 238, 240, 253
 key-lock model 195–6
 kineses 140
 klinokinesis 140
 Kranz anatomy 39
- labelled line, *see* sensory coding
 lantadenes 54
 latex 53, 54, 67, 71, 212
 laticifer 67
 latitude, *see* tropics/temperate zones
 differences
 leachate 121
 leaf
 age 8, 63, 65, 247
 age and diapause 236
 age and feeding preference 8, 9, 103
 boundary layer 17, 170
 discs 183, 192, 219, 374, 376–7
 shape 146, 214, 224
 size 17
 structure 39, 170

- leaf (*cont.*)
 surface 17, 121, 125
 surface chemistry 58–9, 73, 176, 179, 378
 surface waxes 31–5, 148
 temperature 17
 toughness, *see* toughness
 washings 58
- leaf-hoppers
 feeding site 11, 103
 food-plant range 7, 234
 food quantity 103
 and plant diversification 349
- leaf-miners
 demes 284
 feeding site 11, 12,
 food-plant range 7
- learning 217–24; *see also* habituation;
see also chemical legacy
 hypothesis
 adaptive value 225
 associative 160, 217, 223, 259,
 297, 313
 food aversion learning 221–3, 225
 conditioning 225, 331
 enemy avoidance 215
 flower 313
 flower handling 315–6, 317
 food imprinting 219
 and metamorphosis 225
 oviposition behaviour 146, 224,
 226, 313
 peripheral 217, 221
 preference induction 215, 218–21,
 226, 374
- lectins 343
- Leptinotarsa decemlineata*, *see*
 Colorado potato beetle
- light intensity 71, 72, 108, 144
- lignan 55, 115
- lignin 36, 50, 55, 101
- lignocellulose 50
- Lyme disease 264
- limonene 53, 237
- limonoids 53, 54, 352
- linalool 63
- lipoxygenase 60
- lipoxygenase gene 268, 293
- locomotion compensator 150, 375
- losses
 to insects 18, 20–2, 125, 336
 to sucking insects 18, 20
- lupin alkaloids 52, 70, 342
- luteolin 55, 176
- Lycaenidae 9, 250
 change in food choice 216
- Lymantria dispar*, *see* gypsy moth
- maintenance costs 109, 111
- mandible 29, 36, 38
 morphology 38
 wear 36, 38
- mandibulate
 mouthparts 29, 30
 species and food utilization 109
- Manduca sexta*, *see* tobacco hornworm
- manganese 36
- marking pheromone, *see* pheromone
- masking, *see* odour masking
- mating and host plants 237,
 239–40, 284
- maxilla 29–30
- maxillary taste hairs 173, 185, 186,
 188–92
- meal size 181, 377
- mechanoreceptors 29, 30, 142, 149,
 153, 170, 183
- menotaxis definition 142
- meristem 23, 251
- mesophyll 11, 64, 67, 68, 194, 356
- metabolism
 insect 110, 112, 117
 plant primary 49, 175, 299
 plant secondary 50
- metabolic load hypothesis 110
- metabolomic changes 78
- metabolomics technology 379
- metapopulations 289
- methyl salicylate 75, 77
- MFOs, *see* polysubstrate
 monooxygenases (PSMOs)
- microclimate 16, 17, 19, 103,
 338, 347
- microorganisms 120, 121, 123, 252–4
- mixed cropping 347
- mixed diet 17, 221–4
- mixed-function oxydases (MFOs), *see*
 polysubstrate monooxygenases
 (PSMOs)
- mixtures
 of antifeedants 353
 of chemical stimuli 158, 190–2
 flower odour 314
 of host plant species 224
 plant substances 64, 65, 112,
 119, 178
- models
 key-lock 195, 197
 mathematical 299
 neural integration 182, 186, 187
 nutritional 112
 olfactory transduction process 153
 plant architecture 42
- modular structure of plants 23, 83
- molecular clock and evolution 298
- molecular marker-assisted selection
 (MAS) 339
- monoculture 83, 260, 338, 345
- monophagy 6, 7
- monoterpenoids 17, 53, 61, 69,
 118, 313
- morphine 51
- mosaic resistance 83, 84
- motivation definition 195
- mouthparts
 morphology 29–31
- multiple cropping definition 347
- multitrophic interaction 123, 252, 269
- mustard oil glucosides 57, 67, 173
- mutations, *see also* somatic mutation
 of chemoreceptors 199
 and food-plant range 197, 198
 and plant architecture 249
 rate 286
- mutualism
 flowers and pollinators 308–10
 plant structures 40
 plants and carnivores 253, 299
 plants and endophytes 121, 122
- muzigadial 351
- mycetome 121
- mycoplasmas 31
- mycorrhizal fungi 252, 253, 254
- myristicin 115, 116
- myrosinase 57, 67
- myxomatosis 264
- N-oximes 61
- naringenin 55
- natural enemies 126, 261, 294
 and plant architecture 42
 and secondary plant
 substances 247
- nectar
 amino acid contents 310, 314, 320
 automimicry 319
 discovery of function 306
 extrafloral 13
 flow 319
 guide 313
 as insect food 350
 and natural enemies 249
 production 318, 319
 production costs 319
 status 320
 sugar content 308, 310, 323
 toxic 310
- nectaries
 extrafloral 40, 252
 extrafloral and natural enemies 250,
 251
 location 250, 315, 316

- nematodes 123, 124
neo-Hopkins host-selection principle 235
neophilia 223, 324
neural capacity 9, 213, 226, 315
neuroendocrine system
 affected by host plant 237, 241
net primary production (NPP) 18, 23
 niche 43, 267, 292, 297
 food 210, 337
 saturation hypothesis 292
 'vacant' 256, 266
nicotine 51, 63, 64, 66, 78, 117, 217, 218, 247, 293, 351
 in roots 252
nitric oxide 125
nitriles 57
nitrogen 66, 73, 74, 102–4, 125
 availability 66
 in plant tissues 99
 and season 104
non-preference definition 339
northern blotting 268, 379
novelty 223
number of arthropods below ground 13
number of insect individuals per plant 21
number of sensilla 153, 186
 and developmental stage 186
 in relation to diet 223
number of olfactory neurons 152, 153, 154
number of species 5, 6
 crop plants 22
 herbivorous insects 5
 insect pests 22, 338
 insect species per plant 14, 15
 plants 5
 weeds 355
nutrients
 chemoreception 188
 essential nutrients 101
 interactions with secondary metabolites 114
 on leaf surface 121
 in pollen 308, 326
 role in morph determination 235
 role of symbionts 121, 253
nutritional feedback 111, 112, 175, 196, 215
nutritional indices 107–9
nutritional quality 17, 69, 70, 79, 100–1, 112, 223, 294
 and air pollution 126
 and evolution 297
 and polymorphism 234
nutritional requirements 101, 110, 120
 age effects 215, 227
oak (*Quercus* spp.)
 catkins herbivory 235
 effects on pathogen susceptibility 253
 galls 41
 number of insect species 15, 31
 phenology and herbivory 246
 seasonal effects on chemistry 69
 seed production 20, 264
 tannins 64, 69, 235
 volatiles 239
octadecanoid pathway 253
odorant binding protein (OBP) 153, 154
odour
 distance attraction 144, 145
 gradient 140
 masking 152, 159, 348
 plume 142, 144, 149
 trap 144, 239
oil cells, *see* idioblast
olfaction
 central processes 140, 154–8
 olfactometer 375
 olfactory chemoreceptors 152–3
 chemoreceptor sensitivity 154–7
 coding 157
 coding across-fibre patterns 158–9
 coding labelled lines 158
 transduction 153–4
 olfactory orientation 149–52, 375–6
 oligophagy 6, 7, 9
 oogenesis 216, 237–8
 optimal foraging theory 263, 265, 310, 316
orchids 308
 pollination 327–9
orientation 140
 Colorado potato beetle 150
 methods 375–6
 to odour 143
 to visual cues 146, 160, 224, 312–3
orthokinesis 140
overcompensation, *see* compensation
oviposition 10–11, 194, 195, 377
 cabbage root fly 147, 172
 deterrents 181, 195
 induced preference 224, 226
 mistakes 212, 213, 263
 preference and larval performance 10, 11, 289
 stimulant definition 137
 stimulants 57, 176, 178
oxalic acid 122
ozone 125
palisade parenchyma 11, 12, 64
palpation 58, 138, 170, 221
papaverine 51
Papilio oviposition 10, 178, 224, 287–8
parasitization 16, 17, 35
parasitoid effect on host preference 261
parasitoids
 diapause 236
 and endophytes 123
 in food webs 261–4
 habitat effects 265
 host hormones 241
 and induced resistance 74, 75, 77–80, 182, 248
 insecticide susceptibility 120
 kairomone 175, 253
 learning 259
 and plant quality 246
 and trichomes 35
 pathogens 253
 and plant architecture 42
 and secondary plant substances 247, 294
parenchyma 11, 12, 30
pathogen genes 343
pathogens of insects 123, 124, 247, 253; *see also* plant pathogens
PBAN (pheromone biosynthesis activating neuropeptide) 240, 241
performance 10
peripheral interactions 190–2, 199
pest insects 337
 number of species 22, 338
 pest outbreak factors 125, 338
phagostimulant 190, 377
 definition 137
phaseolin 56
phenolics 41, 55–7, 63, 64, 65
phenology 233
 flowering 32
 insect 14, 247
 plant 58, 85, 246
pheromone(s)
 aggregation 160
 epideictic 181
 and evolution 284
 and flower visitation 320–1, 328
 marking 181
 production 239–41
 sex 149, 150, 328
pheromone biosynthesis activating neuropeptide, *see* PBAN

- phloem 102, 194
 composition 31, 70, 71, 213, 379
 hydrostatic pressure 30
 phloridzin 58, 121, 176, 182
 phospholipids 175
 photomenotaxis 142, 143, 159
 photoperiodism 214, 236
 photoreceptor 142, 145, 149
 photosynthesis 21, 23, 39, 70, 71, 78, 108
 phylogenetic tree 294–6, 298
 physical defence 31–42
 physiological efficiency
 hypothesis 110
 phytochemistry 49–85
 phytoecdysteroids 51, 54
 piercing-sucking insects 30, 192–4, 279
Pieris spp.
 colour vision 146
 deterrent receptor 190, 191
 geographical variation 211
 glucosinolate preference
 hierarchy 195
 glucosinolate receptor 173, 186
 low-glucosinolate preference 82
 oviposition 73, 146, 178
 oviposition deterrent 182
 tarsal taste hairs 184, 185
 pinene 53, 118, 237
 plant
 architecture 15, 42–3, 292
 chemical profile 16, 69
 chemistry 100, 173, 249, 379
 competitiveness 255, 259
 damage and natural enemies 74–8
 disease and insect
 susceptibility 122
 distribution and insects 251
 effects on insect hormone
 production 233–8
 effects on insect pheromone
 production 239–41
 epicuticle 179
 epicuticular wax 32–5, 58
 fitness 13, 63, 65, 290, 292
 height 42, 43, 66
 heterogeneity 127
 hormone 54, 237, 240, 321
 hypersensitive response 42, 75
 induced resistance 74–81
 lifespan 83
 morphology 29, 249, 251
 pathogens 81, 103, 122, 152, 253, 267, 340, 357
 pathogens and food quality 122, 253
 phenology 246
 responses to galling insects 41–3
 sex 84
 size 15, 85, 147, 265
 surface 148, 170, 173
 taxonomy and insects 16
 texture 170, 172
 virus and food quality 152
 volatiles, *see* volatiles
 plant architecture
 and natural enemies 43
 and number of insects 43
 plant-carnivore mutualism 253
 plasmalemma 67
 pollen 311
 basket 310, 326
 as carnivore food 250
 digestion 326
 as herbivore food 257, 308
 odour 314
 pollination
 beetles 325
 efficiency 308, 309, 321
 energetics 316–21, 325
 evolution 324–9
 and patch size 265
 wind 85, 325
 pollution 125–6
 polycultures 260, 345–9
 polygodial 53, 351
 polyphagy 6, 7
 polyphenism 233–5
 polysubstrate monooxygenases (PSMOs) 110, 117–20
 population dynamics of insects
 effects of defoliation 79
 effects of plant architecture 42, 249
 effects of plant phenology
 and induced responses 260
 and plant mixtures 260
 population dynamics of plants
 effects of herbivory 24, 251, 254
 polyhydroxy alkaloids 52
 potato odour 61, 150, 159, 348
 predation risk 113, 215, 216, 261, 294
 and herbivore response 259
 preference, *see also* host plant
 evolution 297
 and developmental stage 215, 216
 induction, *see* learning and food
 quality 70
 order 374
 performance relationship 10, 11, 122, 289
 and plant age 147
 and plant sex 85
 ranking 209, 210
 test 219
 primary host 213, 235
 primary plant metabolism 49, 50
 effects of sun and shade 71–2
 primary plant metabolites
 and food selection 174–6
 production costs 65
 probing 138, 170, 176
 production costs, *see* secondary plant
 substances
 proline role in drought stress 125
 prosystemin gene 75
 protease inhibitors 64, 75, 78, 80, 114, 291, 343
 protease encoding genes 114
 protein
 and air pollution 126
 amounts in plants 102, 235
 amounts in different tissues 64
 digestibility 37, 114
 effects of sun and shade 72
 and gossypol 114
 induction 74, 118
 in insect cuticle 102
 insect nutrition 102–4
 and tannins 65, 115
 protein: carbohydrate ratio 101, 104, 113–4, 126, 215
 proximate factors 3, 173
 prunasin 57
 PSMOs, *see* polysubstrate
 monooxygenases
 pubescence 35
 purine alkaloids 52
 pyrethrins 351
 pyrrolizidine alkaloids (PAs) 52, 63, 64, 82, 176, 187, 221, 252, 290
 quassinoids 352
Quercus spp., *see* oak
 quinine 51
 quinolizidine alkaloids 52, 70
 radius
 of bee foraging 316
 of detection 159
 of effective attraction 144
 fruit 341
 rainy season 237
 rarity 265
 reaction chains 137
 receptor
 genetic basis of specificity 197
 potential 152
 sensitivity 157
 sensitivity change 215, 217, 221, 223
 sensitivity of hybrids 287
 specificity 157, 185

- sensilla numbers 153, 183
- transduction 153–4, 198
- recognition, *see* host plant recognition
- recording techniques 375
- reflectance 17, 143, 144, 147, 148,
- regurgitant 63, 77, 80, 248
- rejection 138, 181, 182, 185, 194, 222
- relative consumption rate 108, 109
- relative growth rate 108, 109, 111
- relative humidity 17
- repellents 351
 - definition 137
- reproduction
 - host effects on oogenesis 237–8
 - desert locust 237
- reproductive isolation 283–5, 328
- resin 54, 55, 58, 65, 67, 70, 72
- resistance
 - constitutive 75
 - definition 49
 - horizontal 340
 - induced 74–81; *see also* induced resistance
 - mechanisms 339–40
 - and molecular biology 343–5
 - monogenic 291, 340, 343
 - mosaic 84
 - partial 340, 341
 - polygenic 291, 340, 341, 343
 - pubescence 35
 - quantitative factors 70
 - and secondary plant substances 342, 350–3
 - stability 340–1
 - to antifeedant treatment 353–4
 - to insect herbivory 290–2
 - to insect pests 339–45, 357
 - vertical 344
- resistance breeding
 - and biotechnology 343–5
 - methods 342–5
 - and natural enemies 342
- resource availability hypothesis 70
- resource concentration
 - hypothesis 260, 348
- resource partitioning 323
- respiration
 - insects 107, 111
 - plants 107, 108
- respirometry 110
- Rhagoletis pomonella*, *see* apple maggot fly
- rhythm, *see* feeding rhythm
- root damage and extrafloral nectar 13, 252
- root herbivory 13
 - attractants and stimulants 152
 - effects on above-ground herbivores 13, 252, 257
 - effects on natural enemies 252
 - feeding 252
 - induced response 81
 - root nodule bacteria 245
 - root secondary plant substances 63, 64, 78, 123
 - rotenone 56, 351
 - rutin 114, 124, 180
- salannin 190, 353
- salicin 70, 82, 198, 217
- salicylic acid pathway 81, 120, 253
- saliva 30
 - aphids 192–4
- sambunigrin 58
- sandwich test 377
- saponins 57, 64
- sclerenchyma 36, 41
- scopolamine 51
- scopoletin 55
- screen test 375
- search
 - image 214, 224, 311
 - random 138, 140
- searching 138
 - definition 136
 - mechanisms 143
 - patterns 141
- seasonal effects on insects 70, 213, 214
- secondary host 213
- secondary plant substances
 - age 65, 69
 - autotoxicity 53, 65
 - biosynthesis 78
 - compartmentation 67–8
 - concentration 63–5, 70
 - concentration in crop plants 342
 - day/night effects 68, 70–1
 - definition 50
 - different plant parts 63–4
 - effect of fertilizers 73
 - effect on natural enemies 248
 - effect of plant damage 248
 - function 173
 - genotypic variation 82, 252, 290
 - interyear variation 71
 - number 50
 - precursors 50, 51
 - production costs 65–7, 291
 - in roots 63, 64, 78, 123
 - seasonal variation 70
 - sequestration 187, 247, 294
 - storage 65, 67
 - synthesis 49
 - toxicity 116, 216, 291, 298
 - turnover 65, 68
- seed
 - secondary plant substances 64, 238
 - feeders 251, 257
 - production 20, 21, 24, , 291–2, 308
 - production in crops 308–9
 - quality 329
- selection, *see* host plant
- self-fertilization 308
- self-selection 111, 112, 215, 222
- semiochemicals definition 137
- senecionine 52
- senescence and herbivory 103, 122
- sensilla basiconica 152
- sensilla styloconica, *see* maxillary taste hairs
- sensory coding 185–8, 192, 195
 - across-fibre patterns 158, 185, 187
 - deterrents 188, 190
 - labelled line 158, 185, 190
- sequential evolution 297
- sequestration of secondary plant substances 53, 248
- sesquiterpenoids 54, 176, 313
- sexupara 213, 235
- shade 9, 71–2
- shelter 40, 245, 339, 349
- sibling species 211, 239
 - host preference 284
- sign stimuli, *see* token stimuli
- silicon 38, 170
- sinalbin 61, 194
- single-cell-recording 154, 156
- sinigrin 61, 182, 191, 221
- sitosterol 54
- size, *see also* plant
 - body size 8, 12, 246
 - and feeding strategy 31
 - food particles 37
 - fruit 147, 159, 259, 341
 - leaf 17, 147
 - meal 181, 377
- soil factors 73
- solar radiation, *see* sun exposure
- somatic mutation 83, 84
- sorbitol 49, 188
- specialist receptor neuron 157
- specialists 192, 260
 - definition 7
- specialization
 - and body size 8
 - and colonization of novel species 267
 - and insensitivity to toxicants 293, 298
 - on plant parts 11–13

- speciation
 and allochrone life histories 284
 allopatric 212, 283
 insects 282, 283
 rate 286
 reciprocal 286, 287
 sympatric 210, 283, 284
- species diversification 280
 species rarity 265
 species richness 266
 species-area relationships 265, 266
 specific hunger 223
 spectral reflectance 143; *see also*
 reflectance
- spiders 112, 215, 259
 stacked genes 343
 statistical methods 116, 375, 376
 stemborers 13
 steroids 54, 177
 sterols 53, 101, 120
 stomata 17, 39, 59, 179
 structural formulas 85, 367–72
 strychnine 51, 182
 stylet pathway 193, 194
 stylets 30, 192–4
 styropor 377
 suberin 36
 suboesophageal ganglion 183, 195
 sugar alcohols 188
 sugars 126, 174
 oviposition 176
 phagostimulants 175
 receptors 175, 188
- sulphur dioxide (SO₂) 125, 126
 sun
 effect on herbivory 9
 exposure 72
- sustainable agriculture 358
 symbionts 120–1, 253, 285
 sympatric speciation 210, 283, 284;
see also speciation
- synchronization of life cycle 233–41,
 246
- synergism 115, 116, 191, 192, 353
 synomone 137
 systemic induced resistance 78, 79,
 252, 257
- tannic acid 114, 115
 tannin/protein ratio 292
 tannins 7, 8, 56, 64, 66, 235
 condensed 51, 57, 65, 69, 72,
 110, 126
 and food utilization 56, 115
 hydrolysable 57, 124
 non-hydrolysable 57
- target-site insensitivity 116, 117
- tarsal taste hairs 184
 neural responses 195
- taste
 hairs, *see* maxillary taste hairs
 receptors, *see* contact
 chemoreceptors
- taxis 140
 taxol 49
 temperate, *see* tropics/temperate
 zones differences
- temperature, *see also* microclimate
 climatic change 246
 effect on food preferences 214
 emission of volatiles 53, 63
 at leaf surface 17, 18
 morph determination 235
 nectar production 318
 pollinator activity 317–8
 pollinator body 310
 variation in the field 19
 variation in vegetations 17
- terpenoids 52–5, 61, 65, 75, 77,
 173, 284
- test biting 170, 176
 thermoreceptors 153
- tobacco hornworm (*Manduca sexta*)
 antennal sensilla 153, 157
 detoxification mechanisms 117
 host selection behaviour 179
 low-nicotine preference 63
 orientation 149
 taste receptors 186, 198
- tocopherol 54
 token stimuli 173, 176–9, 186–7,
 194, 198
- tolerance 340
 definition 339
- tomatine 124
 tonoplast 67
- toosendanin 190, 191, 353
 toughness 36–8, 39, 69, 72, 104,
 125, 170
- toxicants and evolution 291
 toxicity, *see* secondary plant
 substances
- transduction, *see* olfactory
 chemoreceptors; *see also*
 receptors
- transgenic plants 78, 80, 267, 343–5
 trap cropping 347
- transcriptome changes by insect
 feeding 194
- trichome induction 35
 trichomes 35–6, 170, 292, 342
 glandular 59, 60, 171
- triterpenoids 54, 352
 tropane alkaloids 51
- trophic levels 257, 258, 342
- tropics/temperate zones differences
 alkaloid content 65
 C₄ plants distribution 39
 generalists/specialists ratio 9
 leaf toughness 36
 losses to herbivory 18
 tannin content 65
 wind pollination 325
- tropotaxis 142
- trypsin protease inhibitor 291
 tubocurarine 51
 turnover, *see* secondary plant
 substances
- ultimate factor 3, 214
 ultraviolet 147
 perception 145
 reflection 321
 and secondary compounds 50
- umbelliferone 55
 utilization 73, 106–114, 123,
 226, 353
 plots 107
- vacuoles 55, 58, 67
 vanillic acid 55
- variation in host-plant preference
 individual 212
 interpopulational 210
 interspecific 287–9
 intraspecific 210–2, 215
 seasonal 213–4
- variation in plant chemistry 64, 65,
 69–74, 77, 81–5
- vector of plant pathogens 340
- vertebrates 264
 biomass 2, 23
 interactions with insects 254
 nutritional requirements 101
 sensitivity to plant toxins 117
- virus 31, 122, 124, 152
- vision, *see also* leaf shape
 colour 145, 159
 silhouette 146
- volatiles 59–63, 75–7, 248
- warburganal 54, 351
- water
 content of leaf 69, 104–5
 receptor 185
 requirement 104
 stress 105, 125, 194
- waxes 31–5, 58
 weed control 355–7
 weeds and natural enemies 349

wind speed 17
windtunnel 150, 375
wounding effects 74–81, 267

xenobiotics 121
xylem 11, 30, 102, 103, 106

yellow attractivity 146, 148, 159, 238
yew number of insect species 15
yield losses 21

Yponomeuta
 host switch 199
 hybrids 197, 287

phyletic relation with hosts 197
plant volatiles and mating 239
taste receptors 188

zigzag flight 143, 149
zinc 26

