

SUBJECT INDEX

Note: Page numbers in **bold** face refer to tables, page numbers in *italic* face indicate figures and illustrations. Abbreviations used: LDT for lower development threshold; SET for sum of effective temperatures; SCP for super cooling point;

- Aaron's rod see *Verbascum thapsus*
Abgrallaspis cyanophylli **60**, 87, 91,
190, **204**
Abies balsamea 471
abundance of coccinellids
 absolute and relative 111
 and character of landscape 127
 on crops **129**, **130**
 and habitat fragmentation
 126–127
 link to aphid abundance 117, 118
 methods of estimating 468–472
 reduced tillage 502, 503
 sampling methods 112–114
 transgenic crops 122–123
 on trees **131**, **132**
Abutilon theophrasti 227, 227
Acacia 154, 183, 489
Acalypha ostryaefolia 123, 126, 227,
227
acarina
 Coccipolypus 411–414
 phoretic mites 345, 411
accepted food/prey 143, 144, 145,
146
Aconitum 165
Acraea encedon 425
Acrocephalus schoenobaenus 379
Acutaspis umbonifera **190**
Acyrtosiphon caraganae **58**
Acyrtosiphon ignotum **58**
Acyrtosiphon kondoi 476
Acyrtosiphon nipponicum see
 Neoaulacorthum nipponicum
 241
Acyrtosiphon pisum 57, **58–65**,
74–75, 78, 115, 118, 120,
145, 147, 152–154, 157,
158, 160, 161, **161–163**,
164, 168–9, **168**, **170**, 171,
172, 174, 182, **188–195**,
196, 206, 208, 218, 220,
222–224, 234, 236, **237**,
238, 240, 297, 345, 451,
457, 469, 534
 ant attendance 236, **237**
 consumption rates 160
 essential prey **158**, **162**, 172,
 188–195
 larval period and pupal mass, effect
 on **161**
 nutritive value 196–197
 pea surface wax 217–218
 ratio between disturbed and
 consumed 240
 visual ability 239
Adalia bipunctata 20, **21**, 23–32, 23,
30, 36, 37, 39, 55–57, **58**, 68,
69, 72, 73, 77, 78, **79**, 82–85,
87, 89, 90, 91, **93**, **96**, 113,
117, 119–123, 121, 126,
128, 129, **129–132**, 144–
146, 150, **151**, 151–154,
153, 159, **162**, 163–169,
165, **166**, 172–174, **173**,
179–180, **205**, 209, 211,
212, 215, 216–217, 224,
230, 231, 236, **291**, 305,
306, 308, 309, 311, 318,
320–322, 324–326, 329,
332, 344, 356–358, 363,
376, 377, 378, 391, **392**,
398, **399**, 407, **407**, 408,
412, 413, 414, 416, 417,
417, **420**, **422**, 425, 449,
451, 454–458, 477, 498,
504, 505, **508**
 adaptation ability 157
 aphid prey **153**
 capture of 238, **239**
 development on different **145**,
 147
 rejected/problematic 165–168
 toxic, effects of 161, 162,
 452
 augmentation 498
Coccipolypus hippodamiae, infection
 by 413
colour pattern variation **21**, 22,
23, 25
 assortative mating 27
 evolution of 26
 geographic variation 23–24
diapause regulation 290–291
dormancy behaviour 313–314
egg cannibalism 177–178, 233
essential foods **188**
expansion in Japan 493–494
inbreeding 40
intraguild predation 350,
351–352, 361
larval attachment ability 218
larval food consumption 202,
203
 preference for 452–453

- Adalia bipunctata*, (continued)
 male-killing bacteria, effect of
 421, **422**, 424, 424, 425, 425
 mtDNA and male-killing bacteria
 30–31
 non-insect food 180, 185
 olfaction 225
 oviposition deterrence 228, 229
 larval tracks, chemical
 composition 455
 search patterns 215, 220
 sperm competition/paternity studies
 42–43
 trophic egg laying 173, 177
 wing development 28
- Adalia conglomerata* **131**
- Adalia decempunctata* **21**, 23, 25, 27,
 30, 39, 42, 43, 45, 46, 48,
59, **79**, 84, 85, 100, **129**,
131, 136, **151**, 161, 166,
189, 196, 231, 233, 236,
 238, 248, 309, 339, 347,
 365, 376, 377, 378, **392**,
399, **407**, 408, **412**, 413,
420, **422**, 440, 452, 454,
 460
- Adalia deficiens* **387**, 391
- Adalia fasciatopunctata* see *Adalia*
bipunctata
- Adalia flavomaculata* see *Lioadalia*
flavomaculata
- Adalia tetraspilota* **79**
- additional prey, aggregative response
 212–213
- Adelges cooleyi* **189**
- Adelges laricis* **188**
- Adelges nordmannianae* **189**
- Adelges nusslini* see *Adelges*
nordmannianae
- Adelges piceae* 493
- Adelges tsugae* **66**, 153, 175,
193–196, 344, 471, 493
- adelgids
 control of 493
 as prey 175
- Adonia arctica* see *Hippodamia arctica*
- Adonia variegata* see *Hippodamia*
variegata
- Adonis ladybird see *Hippodamia*
variegata
- adult(s) 76–91
 defence of 357–358
 fecundity 88–90
 longevity 90–91
 mating 82–85
 mean SCP 96
 ovarioles 78–82
 oviposition 85–88
 pre-oviposition period 77–78
 size 78, 95
 teneral development 76–77
 wings and flight 77
- aestivation diapause 276–277
- Afidenta misera* **79**
- Afissula rana* **79**, 316
- Afissula sanscrita* **79**
- Aframomum megueta* 24–26
- age of coccinellids
 growth curves 74
 hatching rate 68
 oviposition rates 86, 87
 at peak oviposition 86
 pupal, respiration rate 75
 and sexual activity 91
 and variation in defensive chemistry
 447
 and willingness to mate 82
- Agelastica coerulea* 167
- aggregations
 chemical implicated in 451, 453,
 457
 dormancy 302, 305–309
 monospecific 308
- aggregative numerical response
 211–213, 227
- Agistemus longisetus* 490
- Agonoscena pistaciae* **195**
- Agonum dorsale* 474
- agricultural practices
 changes in, effects of 126–127
 habitat management 500–502
- Agropyron desertorum* 207
- Aiolocaria hexaspilota* **59**, **79**, 82,
 90, 167, **189**, 197, **197**, 221,
 225, 259, 308, 310, 311,
311, 321, 340, **420**, 426,
 428, 437
 dormancy sites 311
- Aiolocaria mirabilis* see *Aiolocaria*
hexaspilota
- air-currents, use of 302
- alarm pheromone 225, 239, 451,
 468
- Alauda arvensis* 379
- Alcaligenes paradoxus* 421
- alder leaf beetle see *Agelastica coerulea*
- Aleurodicus cocois* 169
- Aleurodicus dispersus* 490
- Aleurotuba jelinekii* **190**
- Aleyrodes proletella* **191**
- alfalfa fields
 alternative prey 170–172, 213
 nutritional value 196–197
 strip-harvesting 501
- alfalfa weevil see *Hypera postica*
- alkaloids 376
 aphid toxicity 163–164, 165
 egg and pupae protection 76, 456
 enemies and competitors 449
 host plant 167
 larvae protection 357
 reflex blood 376, 377, 445–449
- alkanes, larval tracks 455
- Allantonematidae 414
- allelobiosis 458
- allelochemicals 151, 155, 196
 and aphid toxicity 158, 160–161,
 164–165
 DIMBOA in wheat 164, 169
 evolution of adaptive resistance to
 166
 and prey rejection 165–166
- allelopathy 458
- Alloneda dodecaspilota* **79**
- allozymes
 method of analysis **34**
 population genetics 40
 sperm competition 42–43
- Alnus japonica* 167
- Alternaria* 180–181, 183, 184
- alternative foods/prey 146,
 170–174, 187, 302, 344
- biological control 490
 conservation 499–500
 pollen 180
- altruistic behaviour 451
- Amaranthus hybridus* 227, 227
- Amblyseius andersoni* 353
- Amblyseius fallacis* 490
- Ambrosia artemisiifolia* 152
- American hickory see *Carpinus*
caroliniana
- Aminellus* see *Cowperia*
- Aminellus sumatraensis* see *Cowperia*
sumatraensis
- Amphitetranychus viennensis* **67**
- Amplified Fragment Length
 Polymorphism (AFLP) analysis
34
- Anagasta kuehniella* see *Ephestia*
kuehniella
- Anagyrus australiensis* **384**
- Anagyrus* 353, **384**, **386**, 471, 496
- Anagyrus kamali* 496
- Anagyrus lopezi* 471

- Anagyrus pseudococci* 353
Anastatus **386**
Anatis halonis **174**
Anatis labiculata 20, **132**
Anatis mali 122, 185, **189**, 208, **306**, 471
Anatis ocellata 23, 56, **59**, **79**, 80, 85, 102, 122, 128, **131**, 146, 149, 151, **151**, **189**, 214, 221, 223, 256, 314, 355, **389**, **392**, **399**, 406, **407**, 408
Anatis quindecimpunctata **130**, **132**
 anatomical state, diapause
 fat body and digestive tract 316–317
 flight muscles 323
 male gonads 321–323
 ovary and spermatheca 317–321
Anechura harmandi 426
Anegleis cardoni **59**, 68, 86, 87, 91
Anethum graveolens 121
 Angoumois grain moth see *Sitotroga cerealella*
Anisolemnia dilatata see *Megalocaria dilatata*
Anisolemnia tetrasticta 452
Anisolobus indicus **420**
Anisosticta bitriangularis 167, **306**, **308**
Anisosticta novemdecimpunctata 23, 56, **79**, **129**, 151, **151**, 233, 378, **399**, **422**, 442
Anisosticta sibirica **392**
Anisotylus Timberlake see *Homalotylus*
 annual mercury see *Mercurialis annua*
Anopheles quadrimaculatus 474
 antennae
 chemoreceptors on 450, 453
 subfamily characteristics 5–10
Anthus campestris 379
Anthus pratensis 379
Anthus trivialis 379
 antibiosis in plants 504–505
 antibody-based analysis of predation 474–477
 antipodean ladybird see *Harmonia antipoda*
 anti-predator defences
 ladybirds 376–377
 of prey 117–118
 ants
 attendance on honeydew producers 236, 237, 359, 362, 379–382, 502–503
 interaction with ladybirds 236–238, 359–360
 semiochemical repellence 449
Aonidiella aurantii **60**, **190**
Aonidiella orientalis **60**, **189**
Aonidimytilus albus **60**
 apex predators, coccinellids as 354–355
Aphanogmus **387**
 aphid abundance/density 116
 and age of host plant 122
 and climatic changes 115–116
 link to coccinellid abundance 117, 118
 and oviposition 117, 119–120, 456
 simulation of timing of peak 116
 aphid alarm pheromone 225, 239, 451, 468
Aphidecta obliterata **21**, 45, 52, 57, 85, 95, 108, 120, **129**, **131**, 151, **151**, 154, **189**, **205**, 229, 230, 263, 271, 273, 308, 314, 325, 327, 328, 329, 339, 370, **399**, 408, 415, 431, 443, 458, 462, 463, 493, 509
 aphid parasitoids
 avoidance of plants with coccinellids 353
 detection of footprint semiochemicals 455–456
 aphid population cycle, phases of 466–467
 aphid population dynamics 472
 demographic-based estimates 473–474
 multi-species combinations 472–473
 population decline, confounding factors 466
 aphid resistant crops
 Bt toxins, effect on ladybirds 505–506
 synergism with coccinellids 504–505
Aphidentula bisquadripunctata 316
Aphidius colemani 171, 400, 456
Aphidius eadyi 455
Aphidius ervi 232, 450, 455, 472
Aphidoletes aphidimyza 352, 361
 aphids
 alarm pheromone 225, 239, 451, 468
 ant attendance 236–238, 502–503
 biological control of 492–493, 503–504
 colony age and oviposition 227–228
 defensive and escape behaviour 238–241
 dropping behaviour 118
 reduced size, effect on predation 505
 reproduction 492
 social (soldier) 382
 suppression of 467, 472–473
 toxic 157–165
Aphis carduella **192**
Aphis cirsiacanthoidis see *Aphis fabae cirsiacanthoidis*
Aphis craccivora cowpea aphid or groundnut aphid **59–62**, **64–65**, 68, 74, 78, 87, 117, 118, 147, **148**, 160, **161**, 167, **189–195**, 222, 236, **237**, 238, 453, 504
Aphis cytisorum cytisorum **191**
Aphis fabae cirsiacanthoidis **58**
Aphis fabae **58**, 157, 158, 158, 159, 160, 167–168
Aphis farinosa **63–66**, 87, 91, 117, 144, **190–195**, 222, **223**, 237, 361, 469, 480, 495
Aphis glycines 59
Aphis gossypii **59–65**, 73, 75, 88, 91, **148**, 154, 161, **162**, 164, 168, 178–179, **190–196**, 197, **205**, 210, 236, 239, 345, 469
 survival, and increased CO₂ levels 197
Aphis hederæ **188**
Aphis helianthi see *Aphis carduella*
Aphis jacobaeae 163–165, **190**, 446
Aphis laburni see *Aphis cytisorum cytisorum*
Aphis nerii **61**, 68, 147, **148**, 161–163, 179, **190–194**, 446
Aphis pomi **58–65**, 153–154, **155**, 168, **188–195**
Aphis punicae **191–193**
Aphis sambuci 144–146, **145**, **153**, 158, **158–159**, 160, 160, **163**, 164, 166, **188**, **196**

- Aphis spiraeicola* **63, 66**, 123, 146–147, **149**, 163, 176, 183, **194, 228**, 236, 361–362
- Aphis spiraeophaga* **58**
- Aphis spiraeophila* **61, 64–65**
- Aphis urticata* **190**
- Apis mellifera* 174, 179, **189, 193**
- Apolinus lividigaster* **79**, 97, 183, 236, 241, 243, 266, 297, 324, 333, **381**, 439
- diapause 297
- aposematic colouration 445
- anti-predator defence 376
- chemical compounds 445–449
- enemies and competitors, impact on 449
- pupae 75
- toxicity warning signal 358
- apple see *Malus pumila*
- apple powdery mildew see *Podosphaera spphaera leucotricha*
- apple sucker see *Psylla mali*
- Aprostocetus esurus* **388**
- Aprostocetus neglectus* **384**
- Aprostocetus* **384, 388**, 409
- Apus apus* 379
- Araneus diadematus* 449
- Arctia* 164
- Argentine ant see *Linepithema humile*
- Argentipilosini tribe 5
- Arion ater* 477
- Arion hortensis* 477
- aromatic Apiaceae, conservation 501
- arresting responses, plant volatiles inducing 450, 458
- Artemisia tridentata* 225
- Artemisia vulgaris* 117, 121, 126, 501
- artificial diets **161, 166**, 185–187 and conservation 499–500
- artificial infestations, field cages 470
- artificial substrates for pupation 75
- Ascomycota, fungal pathogens 415–418
- ash-gray lady beetle see *Olla v-nigrum*
- Asian citrus psyllid see *Diaphorina citri*
- Asian multi-colored ladybeetle see *Harmonia axyridis*
- Aspidimerini tribe 10
- Aspidiotus destructor* **192**, 236, 492
- Aspidiotus nerii* **60**, 91, 163, **189**, 228
- assemblages of coccinellids, mechanism of 116–117
- associative learning 452–453
- assortative mating 27
- Asterolecanium* sp. 163
- Atriplex sagittata* 119
- Atritomellus* see *Dendrocerus*
- attachment ability of larvae 218
- augmentation of coccinellids 495–496
- dietary requirements 497–498
- life stages for release 498
- mealybug destruction 496
- redistribution 496–497
- source material for 497
- augmentative biocontrol 362
- Aulacaspis tegalensis* **60**
- Aulacaspis tubercularis* **60**
- Aulacorthum magnoliae* see *Neoaulacorthum magnoliae*
- Aulacorthum solani* 78, **153, 188**
- Austroterobia* **386**
- Aximopsis* **388**
- Axinoscyrmus cardilobus* **59**, 75, 87, 88, 89, 90, **93, 96**, 101, **189**, 254
- Azteca instabilis* 237, 360, **381**
- Azya orbiger* **189**, 237, 360, **381**, **384**, 442, 503
- Azya trinitatis* see *Pseudoazyia trinitatis*
- Azyini tribe 7, 9
- Bacillus thuringiensis* 122, 123, 421, 505–506
- bacteria
- general pathogenic 464
- male-killing 349, 421–425
- evolution of 38, 39
- and failure of egg hatching 68
- molecular genetic studies 29–31
- balsam fir see *Abies balsamea*
- balsam woolly adelgid see *Adelges piceae*
- banding, chromosomes 14
- 'barcode' DNA, species identification 29, 36
- bark crevices, dormancy sites 314
- barn swallow see *Hirundo rustica*
- barred warbler see *Sylvia nisoria*
- Baryscapus* **386**, 409
- Baryscapus thanasimi* **386**
- B-chromosomes and sex-ratio 15–16
- Beauveria bassiana* 72, 359, 415, 445, 498, 500
- 'beetle banks' 500
- behaviour patterns in diapause 301
- dormancy phases 301–309
- individual species 309–316
- Bemisia argentifolii* see *Bemisia tabaci*
- Bemisia tabaci* **60**, 87, 172, **189**, **196**, 202
- Benthامidia florida* 201
- benzaldehyde 450
- Berberis vulgaris* 120
- Beta vulgaris* 121
- Betula populifolia* 152, 182
- Betulaphis brevipilosa* 239, **239**
- Betulaphis quadrituberculata* **188**
- Bieri model, peak oviposition rate 86
- big-eyed bug see *Geocoris punctipes*
- big-headed ant see *Pheidole megacephala*
- biological control 150, 154, 222, 489, 524–525
- ancillary factors 502–509
- ant-attendance 502–503
- pesticides, selective use 506–509
- plant structure and chemistry 504–506
- seasonal cycles 503–504
- ants, disruptive impact of 362
- and aphid population cycle 467
- augmentation of coccinellids 495–498
- coccinellid role 466, 489–491
- Coccipolipus* species, use in 413–414
- Col. maculata* 152
- conservation 498–502
- exotic introductions, targets of 491–495
- facilitation and 361–362
- intraguild interactions and 362
- intraguild predation and 361
- large-scale field trials 477
- Pediobius foveolatus*, use in 410–411
- biological invasion 360, 361
- bird cherry-oat aphid see *Rhopalosiphum padi*
- bird predators 377, 378, 379
- bitter melon see *Momordica charantia*
- bivoltinism
- A. bipunctata* 320
- C. novemnotata* 289
- C. s. brucki* 286–287, 287–288, 288, 320
- C. septempunctata* 278, 279, 283

- bivoltinism, (continued)
Har. axyridis 295
Hip. tredecimpunctata 292
black ant or garden ant see *Lasius niger*
black bean aphid see *Aphis fabae*
black citrus aphid see *Toxoptera aurantii*
black nightshade see *Solanum nigrum*
black (or brown) mustard see *Brassica nigra*
black peach aphid see *Brachycaudus persicae*
black redstart see *Phoenicurus ochruros*
blackcap see *Sylvia atricapilla*
black lady beetle see *Rhizobius ventralis*
blood-red lady beetle see *Cycloneda sanguinea*
blue alfalfa aphid see *Acyrtosiphon kondoi*
blue-headed wagtail see *Motacilla flava*
blue tit see *Cyanistes caeruleus*
bluethroat see *Luscinia svecica*
body length 78, 81
body mass 73, 74, 81
body size 78
defensive measure 356
dietary generalists and specialists 151–152
larva 73
link to prey size & density 147–150
niche partition 345
sibling egg cannibalism 176
and size of prey 119
temperature affecting 95
and winter survival 331–332
‘body size-dietary breadth’ hypothesis 151–152
body weight 78
and egg size 56
and number of ovarioles 78, 79–81, 82
Boettcheria latisterna 385
Brachiacantha quadripunctata 380, 417, 418
Brachiacantha ursina 130, 132, 306, 380, 396, 398
Brachiianthini tribe 10
Brachycaudus helichrysi 153, 188, 195
Brachycaudus persicae 188–189, 195, 236
Brachycaudus prunicola 236
Brachycaudus tragopogonis 188
Brachymeria carinatifrons 387
brachypterous individuals 77
Brassica campestris 207
Brassica napus 58, 123, 165, 166, 225
Brassica napus subsp. *oleifera* 58, 123, 165, 166, 225, 452
Brassica nigra 166, 166, 452
Brassica oleracea 217
Brassica oleracea Italica group 121
Brevicoryne brassicae 61–64, 88, 145, 148, 163, 165, 166, 165–166, 166, 168, 168, 190, 193, 225, 451, 468, 490
aphid alarm pheromone 225
control of 490
release of toxic substance 451–452
broad bean or faba bean see *Vicia faba*
broccoli see *Brassica oleracea* Italica group
brown apple mite see *Bryobia rubrioculus*
brown citrus aphid see *Toxoptera citricidus*
brown mite see *Bryobia rubrioculus*
brown planthopper see *Nilaparvata lugens*
Brumoides septentrionis 225
Brumoides suturalis 59, 99, 189, 251, 507, 508
(= *Scymnus suturalis* 39, 81, 129, 308, 314)
Brumus quadripustulatus see *Exochomus quadripustulatus*
Brumus suturalis see *Brumoides suturalis*
Brustiospora indicola 420
Bryobia praetiosa Koch 167
Bryobia rubrioculus 167
bryony ladybird see *Henosepilachna argus*
Budapest slug see *Tandonia budapestensis*
Bulaca lichatschovi 25, 142, 181, 200, 246, 313, 378
bullrush see *Typha latifolia*
butternut see *Juglans cinerea*
cabbage aphid see *Brevicoryne brassicae*
cabbage looper see *Trichoplusia ni*
cage inclusion 470–471
Calandra lark see *Melanocorypha calandra*
Calandrella cinerea 379
California red scale see *Aonidiella aurantii*
Callicaria superba 59, 71, 79
Callipterinella calliptera 239
Calocoris norvegicus 476
Calotropis procera 163, 190
Caltha palustris 313
Calvia albida 79
Calvia decemguttata 59, 79, 356
Calvia duodecimmaculata 59
Calvia muiri 174, 189, 392
Calvia quatuordecimguttata 37, 79, 131, 313, 412, 455
Calvia quindecimguttata 37, 39, 55, 59, 79, 93, 102, 107, 128, 131, 132, 143, 146, 151, 154, 189
essential prey 189
Calvia shiva 79
Calvia shiva pasupati 79
Calvia shiva pinaki 79
Calvia shiva trilochana 79
Campylomma verbasci 350, 353, 532
Cannabis sativa 152, 182
cannibalism 175
non-sibling eggs 177–179
sibling eggs 69, 175–177, 233, 356
Capitophorus elaeagni 193
carbon dioxide concentration see also CO₂ concentration
Aphis gossypii survival 197
and pupation timing 75
Carduus crispus 216, 217
Carinodulini tribe 5
Carpinus caroliniana 152, 182
caryophyllene 451
cassava mealybug see *Phenacoccus manihoti*
cassava scale see *Aonidimytilus albus*
catch per unit effort, sampling 522
Caternaultiella rugosa 452
Catolaccus 388
Caulophyllum robustum 199
Cavariella konoii 58
Centaurea jacea 216, 217
Centistes scymni 384
Centistes subsulcatus 384
Centistina nipponicus 383, 384, 391
Centrosema pubescens 198, 199
Cephaloscymnini tribe 6
Ceratomegilla barovskii kiritschenkoii 181

- Ceratomegilla notata* **131, 181**,
181
food of 180–181
- Ceratomegilla undecimnotata* **59, 79**,
88, 90, 96, 101, 106, 117,
121, **131**, 134, 146, 154,
161, 162, 168, 169, **170**,
174, **189**, 220, 223, 229,
230, 231, 249, 250, 255,
264, 266, 267, 268, 279,
292, **293**, 294, **294, 295**,
298, 300, 301, 302, 303,
305, 307, 308, 309, 310,
311, 312, 314, 315, 316,
317, 318, **320**, 321, 322,
323, 324, 325, 326, 327,
329, 330, 335, 336, 338,
339, 341, 372, 378, **392**,
414, 415, 420, 453, 454,
455, 460, 461, 463, 500,
507, 516
confused with *C. septempunctata*
311
diapause regulation 292–295
migratory and aggregation
behaviour 309–310
- Ceratovacuna lanigera* 241–242, 382,
498
- Cerchysiella* **386**
- Cervaphis quercus* **205**
- Cerylonid complex 2
- Chaetosiphon fragaefolii* 117
- Chaitophorus caprae* 145, 153, **153**,
188–189
- Chaitophorus leucomelas* **188**
- Chaitophorus versicolor* see
Chaitophorus leucomelas
- Chamerion angustifolium* 211
- Chartocerus subaeneus* **389**
- Cheilomenes lunata* **189**, 223, 233,
263, **389, 417**
- Cheilomenes propinqua vicina*
386
- Cheilomenes sexmaculata* see
Menochilus sexmaculatus
- Cheilomenes sulphurea* 73, **392**
- Cheilomenes vicina* see *Cheilomenes*
propinqua vicina
- Cheiloneurus carinatus* **387**
- Cheiloneurus cyanonotus* **387**
- Cheiloneurus liorhipnusi* **387**
- Cheiloneurus orbitalis* **387**
- Cheiracanthium* 478
- chemical cues, plants as source of
120
- chemical defences 38, 76, 355, 356
chemo-mechanical defences, aphids
241
- chemical markers, larvae 222, 226
and oviposition deterrence
228–233
- chemicals
see also allelochemicals:
semiochemicals
stimulating feeding behaviour
199
- chemoreceptors on antennae 450,
453
- Chenopodium* 121
- cherry blackfly see *Myzus cerasi*
- Chetogena claripennis* **385**
- Chilocorinae subfamily 5, 7–8, 9
- Chilocorini tribe 8
- Chilocorus baylei* see *Chilocorus*
malasiae
- Chilocorus bijugus* **79**
- Chilocorus bipustulatus* **60**, 71, 73,
79, 93, 99, 108, 109, 122,
129, 131, 136, 138, 167,
168, **189**, 220, **221**, 254,
272, 273, 276, 287, 289,
298, 298, 299, **299**, 300,
305, 314, 320, 322, 327,
328, 334, 336, 337, 339,
341, **386, 387, 388, 389**,
404, 416, **417**, 421, 434,
443, 472, 485, 492, 513,
518
- Chilocorus braeti* **79**
- Chilocorus cacti* **384, 412**
- Chilocorus circumdatus* **189**
- Chilocorus discoideus* **384**
- Chilocorus distigma* **384**
- Chilocorus geminus* **299**
- Chilocorus hauseri* **79**
- Chilocorus hexacyclus* 14, 17
- Chilocorus infernalis* 163
- Chilocorus inornatus* **389**
- Chilocorus kuwanae* 180, **190**, 202,
220, 258, 261, 266, 434,
486, 503, 516
- Chilocorus malasiae* **190**
- Chilocorus nigripes* **384**
- Chilocorus nigrinus* 36, **60**, 71, 78,
79, 86, 87, 88, 90, 91, 92,
93, 99, 103, 104, 105, 107,
156, 157, **157, 190**, 203,
204, 224, 228, 249, 253,
265, 267, 492, 517
- Chilocorus orbis* 14
- Chilocorus quadrimaculatus* **385**
- Chilocorus renipustulatus* **129, 190**,
298, 320, 324, 325, 326,
327, 339, **389, 417**
- Chilocorus rubidus* 15, **79**, 85, 105,
190, 264, 298, **298**, 324,
325, 326, 327, 328, **329**,
339, **420**
- Chilocorus similis* **386, 388**
- Chilocorus* spp., diapause
298–299
- Chilocorus stigma* 15, 16, 17, 18, 51,
132, 168, **190**, 261, **306**,
386, 412, 417, 421, 509
B-chromosomes 16
chromosomal fusion
polymorphisms 16–17
speciation and cytogenetic change
18
- Chilocorus tricyclus* 14, 17
- Chinese jute see *Abutilon theophrasti*
- Chinese lantern see *Physalis alkekengi*
- Chinese white pine see *Pinus armandii*
- Chionaspis alnus* **190**
- Chionaspis salicis* **190**
- Chnootriba similis* **384, 386**, 427
- chorion, pores in 55
- Choristoneura pinus* 221
- Chromaphis juglandicola* **153, 188**
- chromatographic analysis 145,
165–166, 225
- chromosomal fusions 16–18
geographic distribution 17
- chromosome numbers & banding 14
- chromosomes & cytology 14
B-chromosomes 15–16
cytogenetic changes 16–18
sex determination 14–15
- chrysanthemum aphid see
Macrosiphoniella sanborni
- Chrysocharis johnsoni* **384**
- Chrysomela populi* **189**
- chrysomelids (leaf beetles)
as prey 154, 167, 170–171
larval mortality/pupal weight
143
tritrophic food chain 197
- Chrysomphalus aonidium* **60**, 168,
189
- Chrysomphalus bifasciculatus* **190**
- Chrysonotomyia appannai* **384, 386**
- Chrysopa* 344, 379
- Chrysopa oculata* 161, 352, 456
- Chrysopa perla* 161, 252
- Chrysopa sinica* **225**

- Chrysoperla carnea* 347, 356, 361, 480, 501
- Chrysoperla plorabunda* 352
- Chrysoperla rufilabris* 75, 351, 353
- Chrysophtharta bimaculata* 170, 495
- chrysopid larvae, attack by 358
- Chrysotachina slossonae* **384–385**
- Cinara palaestinensis* **189, 195**
- cinnabar moths see *Tyria*
- circadian rhythms see rhythmicity
- Cirsium arvense* 120, **153, 211**, 224, 236, 458
- Cirsium kagamontanum* 198, 232
- Cirsium kamtschaticum* 199
- cis-jasmone, plant volatile 447, 450
- citrus mealybug see *Planococcus citri*
- citrus mussel scale see *Lepidosaphes beckii*
- Citrus sinensis* **66**
- citrus snow scale see *Unaspis citri*
- Cladosporium* 180–181, 183, 184
- classification, subfamilies
- changes in 3–4
 - future perspectives 10, 521
 - morphologically based 3
 - proposed 5, 6
- Clematis* 200
- Cleobora mellyi* 170, 186, **392, 407**, 489, 499
- climate
- change, predictions 115–116
 - and melanism 26
 - microclimate, effects on host plants 124–125
 - and voltinism 90
- Clitostethus arcuatus* **60, 93**, 103, 108, 154, **190, 244**, 245
- Clitostethus oculus* 56, **60**, 71, 76, 77, 85, 86, 87, 89, **93, 96**, 102, 106, **190**, 219, 258, 266, 484, 490
- cloudberry beetle see *Galerucella sagittariae*
- clover mite see *Bryobia praetiosa*
- cluster size, eggs 56–57, **58–67**
- CO₂ concentration, effects of elevated 75, 197
- Coccidoctonus trinidadensis* **387**
- Coccidophilus citricola* **385**
- Coccidula rufa* **129, 131**, 378, **422**, 424
- Coccidula scutellata* 378
- Coccidulinae subfamily 4, 5, 8–9
- Coccidulini tribe 9
- Coccinella algerica* see *Coccinella septempunctata algerica*
- Coccinella californica* **130**, 201, 202, 209, **292, 420**
- Coccinella explanata* **174**
- Coccinella hieroglyphica* 24, **79, 129**, 143, **143**, 154, **190**, 253, **306**, 313, **392, 399**
- Coccinella leonina transversalis* **60**, 68, 69, 70, 70, 86, 117, 118, 118, 126, 146, 147, 163, 176, 178, 179, 191, **191**, 227, 228, 228, 229, 247, 249, 263, 297, 356, 371, **392, 405, 412, 414, 420**, 478, 485, 506, 510
- diapause regulation 297
 - dormancy behaviour 313
- Coccinella luteopicta* **79**
- Coccinella magnifica* 23, 38, 51, **79**, 90, **151**, 159, **190**, 226, 269, 317, 318, 322, 367, 369, 373, **380, 392, 398, 399**, 408, **412**, 413, 436, 441
- Coccinella monticola* 24
- Coccinella nigrovittata* 183
- Coccinella novemnotata* 24, **60**, 90, 103, 152, 154, 185, 289, 289, 290, 307, 317, 318, 337, **392, 397, 420**, 433, 519
- diapause 289–290
- Coccinella quinquepunctata* 16, 90, **129, 131, 151**, 312, 318, 378, **392, 398, 399, 420**
- dispersal 309
 - hibernation sites 312
 - testicular activity 318, 322
- Coccinella reitteri* 181
- Coccinella repanda* see *Coccinella leonina*
- Coccinella septempunctata* **21**, 30, 32, 39, **61**, 69–70, **79, 93**, 116, 123, 125, **129–132, 143, 147–149, 151**, 155, 158, **159**, 160, **163**, 164, 166, **166**, 168, 172, **173, 180**, 186, **190–191, 197, 205**, 212, **215**, 216, **217, 221**, 224, 225, **225, 230, 237**, 238, 240, **240**, 276, 278, **279–282**, 285–286, 287, **306, 308**, 311–312, 318, 321, 323, 330, 347–348, 358, 376, **388–389, 392, 397, 399, 407, 412, 417**, **420, 422**, 453, 477, **507–508**
- aggregative numerical response 211–213
 - alternative prey 170, 171–172, **173**, 174, 209
 - aphid prey
 - larval development **158, 159, 163, 168**
 - larval survival **149, 159, 163, 166**
 - artificial diets 186
 - consumption rates 160, 201, 202, **205**
 - diapause regulation 278–287
 - dormancy behaviour 311–312
 - essential foods **190–191**
 - exploitative competitors 348
 - foraging behaviour 215–218
 - ant attendance 236, 237
 - intensive search 220, **221**
 - sensory perception 222, 223, 224
 - vagility 234, 235, 236
 - intraguild predation 210, 351–352
 - introduction to North America 493
 - larval development on aphid prey **158, 159, 163, 168**
 - larval survival on aphid prey **149, 159, 163, 166**
 - life history as affected by aphid prey **148**
 - non-insect food 180, 181, 184
 - overall predator voracity 155
 - oviposition and aphid density 226, 228
 - oviposition deterrence 229, **230**, 231, 232–233
 - plant cues attracting 225
 - prey capture 238, 239, 240
 - substitute diets 185, 186, 187
 - tritrophic studies 196–197
 - voltinism **281**, 286–287, 320
- Coccinella septempunctata algerica* **392**
- Coccinella septempunctata brucki* **191**, **221**, 276, 287, 323, **392**, 395, **420, 422**
- autolysis of flight muscles 323
 - bivoltine life cycle 286–287
 - diapause regulation 287–289
- Coccinella sinuatomarginata* see *Coccinula sinuatomarginata*

- Coccinella transversalis* see *Coccinella leonina transversalis*
- Coccinella transversoguttata* 24, **61**, 122, **191**, 344, **412**
- Coccinella transversoguttata richardsoni* 24, **191**
- Coccinella trifasciata* **61**, **130**, **306**, **392**, **420**
- Coccinella undecimpunctata aegyptiaca* see *Coccinella undecimpunctata menetriesi*
- Coccinella undecimpunctata* 39, **62**, **80**, **130**, **151**, 154, 171, **191**, **205**, 353, **389**, 391, **392**, **397**, **399**, **412**, **422**, **507–508**
- importation to New Zealand 492
- Coccinella undecimpunctata menetriesi* **191**
- Coccinellidae family
- characteristics 3
- monophyly 2–3
- Coccinellimeris* see *Hexameris*
- Coccinellinae subfamily
- characteristics of 6–7
- molecular analyses 4–5
- coccinelline 446, 449
- Coccinellini tribe 6, 7
- Coccinula crotchi* **174**, **417**, **422**
- Coccinula quatuordecimpustulata* 23, 25, **80**, 167, 312, 378, **392**, **420**
- Coccinula redimita* **80**
- Coccinula sinensis* **392**, **417**, **422**
- Coccinula sinuatomarginata* 25
- Coccipolipus* **412**
- Coccipolipus africanae* **412**
- Coccipolipus arturi* **412**
- Coccipolipus benoiti* **412**
- Coccipolipus bifasciatae* **412**
- Coccipolipus cacti* **412**
- Coccipolipus camerouni* **412**
- Coccipolipus chilocori* **412**
- Coccipolipus cooremani* **412**
- Coccipolipus epilachnae* **412**
- Coccipolipus hippodamiae* **412**
- Coccipolipus macfarlanei* **412**
- Coccipolipus micraspisi* **412**
- Coccipolipus oconnori* **412**
- Coccipolipus solanophilae* **412**
- Coccipolipus* species (parasitic mite) 411
- in biological control 413–414
- hosts and distribution **412**
- life cycle 412–413
- negative effect on hosts 413
- prevalence 413
- Coccus hesperidum* 157, **190**
- Coccus viridis* 154, **189**, 237, 360, 503
- coconut scale see *Aspidiotus destructor*
- Coelophora biplagiata* **62**, 74, **174**, **192**, 498
- Coelophora bissellata* 56, **62**, **80**
- Coelophora duvaucelii* **80**
- Coelophora inaequalis* **21**, **62**, 69, **149**, 163, **392**, 497
- Coelophora mulsanti* **192**
- Coelophora quadrivittata* **21**, **192**
- Coelophora saucia* **62**, 68, 69, 82, 178, **192**
- co-existence of intraguild prey 360–361
- cold-hardiness 328–332
- Coleomegilla maculata* **62**, 74, 152–153, 173, 182, 313, 354, **388**
- cannibalism, egg 177–178
- consumption
- food deprivation and larval development **207**
- prey density effects on consumption 204, 207
- dormancy behaviour 313
- egg prey 170, 173, 173
- essential foods **192**
- pollen as 152, 181–182, 233
- frequency of short flights 234
- laboratory diet for 185
- larval and adult diets **157**
- nutrient requirements 186–187
- olfaction 224
- oviposition 227
- deterrence 229, 231
- periodicity 218, 219
- vagility 234, 235
- Coleomegilla maculata fuscilabris* **149**
- Coleomegilla maculata lengi* **143**, 182, 354, 532
- Coleomegilla quadrifasciata* 391
- Colorado potato beetle see *Leptinotarsa decemlineata*
- colouration
- aposematic 358, 376
- eggs 55, 56
- pupae 76
- coloured cards, sampling 113
- colour pattern variation 18, 43–44
- genetic determination 20–23
- geographic variation 23–25
- nature of colour patterns 19–20
- significance and origin 25–27
- temporal variation 25
- colour vision 223–224
- commensalism 345, 347
- common Australian lady beetle see *Coelophora inaequalis*
- common barberry see *Berberis vulgaris*
- common chiffchaff see *Phylloscopus collybita*
- common cuckoo see *Cuculus canorus*
- common cutworm see *Spodoptera litura*
- common damsel bug see *Nabis (Reduviolus) americanoferus*
- common froghopper see *Philaenus spumarius*
- common redstart see *Phoenicurus phoenicurus*
- common starling see *Sturnus vulgaris*
- common stonechat see *Saxicola rubicola*
- common swift see *Apus apus*
- common whitethroat see *Sylvia communis*
- community of coccinellid species 111
- composition of, factors determining 114
- dominance, diversity and niches 127–128
- local faunas 114–116
- locality determinants 116–127
- habitat identification 128–132
- competition 347–349
- apparent 349
- exploitative 347
- competitive displacement of native ladybirds 494–495
- competitive IGP hypothesis 351
- complex communities, coccinellid impact 472–474
- conditioning, colour vision 224, 226
- conidia (fungal spores) 183, 184
- conservation 360–361, 498–502, 524
- alternative or supplementary food 499–500
- biocontrol approach 362
- habitat management 500–502
- hibernation refuges 500
- conspecific larval tracks
- egg clustering 454–455
- oviposition deterrence 222, 229–233, 356, 456

- consumed food, conversion and utilization of 209–210
- consumption quantity 201–202
assays 467–468
growth and reproduction
 adult performance 208–209
 larval development 207–208
physical factors
 daily consumption rate 202
 total food consumption 202–204
 and prey density 204–207
- Contarinia nasturtii* 170, 497
- Conura* **387**
- Conura paranensis* **387**
- Conura petioliventris* **387**
- Conura porteri* **387**
- co-occurring prey 207
- Cooley spruce gall adelgid see *Adelges cooleyi*
- coriander see *Coriandrum sativum*
- Coriandrum sativum* 121
- corn earworm see *Helicoverpa zea*
- corn leaf aphid see *Rhopalosiphum maidis*
- corpura allata* (CA) 278, 327–328
- Cosmos* 201
- Cotoneaster integerrima* 120
- Cotoneaster tomentosus* 120
- cotton aphid see *Aphis gossypii*
- cotton bollworm see *Helicoverpa armigera*
- cottony cushion scale see *Icerya purchasi*
- Coturnix coturnix* 449
- Coturnix japonicus* 445
- couch grass see *Elytrigia repens*
- courtship behaviour, *D. coccinellae* males 394
- Cowperia areolata* **383–384, 386–387**, 399–400
- Cowperia indica* 401
- Cowperia punctata* 401
- Cowperia* sp. (parasitoid) **383**, 391, 399, **401**, 401
- Cowperia subnigra* 401
- Cowperia sumatraensis* 401
- Cranophorini tribe 9
- cream-spot ladybird see *Calvia quatuordecimguttata*
- cream-streaked ladybird see *Harmonia quadripunctata*
- creeping thistle see *Cirsium arvense*
- Crematogaster lineolata* 76, 456
- Crematogaster* 76, **381**, 456
- crested wheatgrass see *Agropyron desertorum*
- critical photoperiod 276, 284, 290, 291, 298, 299
- crops
 see also alfalfa fields
 agricultural practices 127
 aphid resistant cultivars 164, 169, 504–505
 coccinellid abundance **130**
 diversification 126
 food spray substitutes 187
 ladybird habitats 128–129
 microclimate effects 124–125
 sampling from 112–113
 strip cutting 126
 timing of colonization 503–504
 weeds in, positive effects of 126
- Crotalaria striata* 183
- crowding
 and egg viability 68, 83
 fecundity, adverse effect on 88
 of larvae, effect on adult size 78
 and ovarian dysfunction 82
 and pupal development 75
 and take-off 77
- cryptically coloured pupae 75, 76
- cryptic species, delimiting 41–42
- Cryptochaetum iceryae* 172
- Cryptognatha nodiceps* 492
- Cryptognatha signata* **383**
- Cryptognatha simillima* **384**
- Cryptognathini tribe 9
- Cryptogonus ariasi* **80**
- Cryptogonus kapuri* 391, 396, **401**
- Cryptogonus orbiculus* **80**
- Cryptogonus postmedialis* Kapur **80**, 316, 527–530
- Cryptogonus quadriguttatus* 80
- Cryptolaemus montrouzieri* 36, 167, 169, 185, **192**, 218, 222, 237, 353, **383, 385–386**, 391, **401**, 492, 496, 505
 control of mealybug and scale insects 496
- Cucujoidea 2
- Cuculus canorus* 379
- Cucurbita maxima* 126
- Culex quinquefasciatus* 479
- Curinus coeruleus* 174, **192**, 217, 223, 362, 493, 497, **507–508**
- cuticular cribriform plate, ductless glands 454
- C-value, genome size 14
- Cyanistes caeruleus* 376
- Cycloneda ancoralis* **192, 330**
- Cycloneda limbifer* **192**, 223, 229, 229, **230**, 231, 232, 454, 455
- Cycloneda munda* 120, 129, **130, 132**, 152, 173, **192**, 305, **392, 397, 417, 418**
- Cycloneda polita* **130, 132**
- Cycloneda sanguinea* 15, 71, 119, **149**, 161, **162**, 163, 174, 175, **175**, 179, 185, **192**, 210, **224**, 357, 360–361, 377, **387, 392, 407, 412, 417, 507–508**
 development time and survival rate **162**
- Cydonia vicina nilotica* see *Cheilomenes propinqua vicina*
- Cymbopogon citratus* 181, 183
- Cyanegetini tribe 7
- cytogenetic changes 16–18, 19
- Dactylopius opuntiae* 178, **192**
- daily fecundity **58–67**, 86, 87, 90
- damson–hop aphid see *Phorodon humuli*
- Danaus plexippus* 170, **205**
- dandelion see *Taraxacum officinale*
- Declivitata* spp. **412**
- defence(s)
 ant attendance 236–238
 aphid 238–241
 plant 200
- defensive mechanisms, coccinellids
 against ants 380
 against intraguild predation 355–358
 against parasitization 394
 against Phalacrotophora 408
 aposematic colouration 358, 376
 morphological adaptations 377
 reflex bleeding 376–377
- Degeeria luctuosa* see *Medina luctuosa*
- Delichon urbica* 377, 379
- Delphastus catalinae* **62**, 68, 89, 91, **93**, 96, **96, 192**, 202, 219, 348, 353, 495
- Delphastus pusillus* 56, 76, 85, 172, 175, **192, 205**, 361
- Delphinobium junackianum* 165
- Dendrocalamus giganteus* 163
- Dendrocerus* **388**

- Dendrocercus ergensis* **388**
Dendrocopos medius 379
Deroceras reticulatum 477
 development
 embryonic 56, 85
 larval 72–73
 pupal 75
 temperature effects 91–97
 eneral 76–77
 development rate isomorphy 95
 development rate and temperature 75, 82, 92, **93–94**, 96
 development time
 effect of CO₂ on pupation 75
 of larvae 72–73
 and temperature 92
Diabrotica virgifera 32
 diamondback moth see *Plutella xylostella*
 diapause/dormancy 276
 see also individual species
 anatomical/physiological changes
 anatomical state 316–323
 metabolic changes 323–327
 behaviour patterns 301
 dormancy phases 277, 301–309
 individual species 309–316
 endocrinological aspects 277–278
 hibernation and aestivation 276–277
 research activity 523
 termination/completion 277
Diaphorina citri 174, 469
Diaspidiotus perniciosus **60**
Dibrachys cavus **383, 385–386, 388**, 405
Dicranolaius bellulus 478
 dietary complementation across life stages 156–157
 dietary generalists and specialists 150–152
 diet(s)
 see also food
 combination and mixed 155–157
 and egg cluster size 57, **58–67**
 longevity, effect on 91
 and reproductive output 78
 substitute and sprays 185–187
 digestion
 during dormancy 316–317
 extra-intestinal 241
 dill see *Anethum graveolens*
 dilution effect 350, 352, 353, 357
 DIMBOA in wheat 164, 169
Dinocampus coccinellae (parasitoid) **383–384**, 391
 development 394–395
 flight performance, effect on 303–304
 host preferences and parasitization rates 396–399
 host range and host suitability **392–393**, 396
 ladybird fertility, effect on 88
 ladybird ovaries, effect on 317
 larval nutrition 395–396
 life cycle 394
 reproduction, mode of 391, 394
 semiochemical attraction 449
Dinocampus **383–384**, 391
Dinocampus nipponicus see *Centistina nipponicus*
Dinocampus terminatus see *Dinocampus coccinellae*
Diomus austrinus 89, **93**, 95, **192**
Diomus hennesseyi **143**, 491
Diomus pumilio **384**
Diomus seminulus **417**
Diomus thoracicus 449
 diploid chromosome numbers 14, 15
 dipterans, in IGP 352–353
 directional selection 28
 direct observation 468, 469, 474, 475
 disc equation, functional response 206
 Discotomini tribe 6
 dispersal flight, dormancy 302, 309
 distribution 110–117, 121–128, 132
 vertical on host plant 122, 125
Diuraphis noxia **63, 66**, 123, 146, **190, 192–195, 205**, 206, 466, 504
 diversity, coccinellid 114
 and geographical latitude 114–115
 studies of 127–128
 tropical/subtropical areas 129
 DNA-based gut content analysis 144–145, 478–481
 DNA sequence-based studies 36, 37–38
Dolichoderus bidens 76
 dominant species 127–128
 dormancy phases 277
 aggregations 305–309
 emergence 309
 migration 302–305
 pre-diapause 301–302
 dormancy sites 282, 309–316
 emergence from 309
Doryphorophaga doryphorae see *Myiopharus doryphorae*
Drepanosiphum platanoidis 145, 153, **153, 188–189**, 238
 drone honeybee powder, substitute food **174**
 dropping behaviour
 aphid escape response 118, 238, 239, 240, 468
 coccinellid escape mechanism 357, 358
Drosophila melanogaster 28
 ductless glands, pheromones released by 454
 duration
 flight 77
 hatching 69
 larval development 72, 73
 mating 82–83, 84
 pupal stage 75
 dusky lady beetle see *Scymnus loewii*
 D-Vac, vacuum sampling by 112
Dysaphis crataegi **64, 194**
Dysaphis devecta **192**
Dysaphis plantaginea **62, 192**
Dysmicoccus **194**
Dytiscus sp. 241
 (E)- β -farnesene (EBF) 225, 447, 451
 early-season predation 477
Echthroplectis see *Homalotylus*
 ECI (efficiency of conversion of ingested material) 209–210
 ecologically relevant temperatures 92
 ecophysiological regulation of diapause 278, 300–301
Adalia bipunctata 290–291
Apolinus lividigaster 297
Ceratomegilla undecimnotata 292–295
Chilocorus species 298–299
Coccinella leonina 297
Coccinella novemnotata 289–290
Coccinella septempunctata 278
 Central Europe 278–282
 Mediterranean region 284–285
 Nearctic region 285–286
 Northern Europe 283–284
 voltinism 286–287
 Western Europe: France 282–283

- ecophysiological regulation of diapause, (continued)
- Coccinella septempunctata brucki*
Central Japan 287–288
Northern Honshu (Japan) 289
Sapporo, Hokkaido (Japan) 288–289
- Harmonia axyridis* 295–297
- Harmonia sedecimnotata* 297–298
- Hippodamia convergens* 292
- Hippodamia tredecimpunctata* 292
- Illeis galbula* 297
- Propylea quatuordecimpunctata* 291
- Stethorus punctum picipes* 299–300
- edelweiss see *Leontopodium alpinum*
- egg cannibalism 68, 69, 175–179, 356
- egg-surface chemicals 455
- semiochemicals, role of 456
- egg production 88–90
- effect of food restriction 209
- multiple matings 82–83
- and ovariole number 57
- rate of 86
- egg protection behaviour
- oviposition on highly pubescent plants 227
- species-specific semiochemicals 456
- egg retention 84
- egg(s) 55
- cluster size 56–68
- defence of 356
- hatching rate 68–69
- mean SCP 96
- morphology 55–56
- nutrient content 233
- size 56
- trophic eggs 69
- egg teeth 56
- eighteen spot ladybird see *Myrrha octodecimguttata*
- Elasmus* **388**
- Elatobium abietinum* **189, 205**
- elder aphid see *Aphis sambuci*
- elder see *Sambucus nigra*
- electroantennograms (EAG) 224, 225, 453
- electrophoretic methods 327–328
- eleven spot ladybird see *Coccinella undecimpunctata*
- ELISA technology 474, 475, 477, 478, 479
- elm leaf beetle see *Xanthogaleruca luteola*
- elytra
- hydrocarbons 454
- inheritance studies **21–22**
- pattern, variation in 19–20
- red morphs, mating disadvantage 26–27
- Elytrigia repens* 120, 224, 458
- embryonic development
- and egg size 56
- optimum microclimate for 85
- emergence from dormancy 309
- emigration 114, 211, 235, 357
- Encarsia sophia* 353
- encounter with prey, effects of 220
- endocrinological pathways, diapause 277–278
- endosymbiotic bacteria 29–31, 38, 39, 41–42, 522
- enzyme-linked immunosorbent assay (ELISA) technology 474, 475, 477, 478, 479
- Eocaria muiri* see *Calvia muiri*
- Ephestia kuehniella* 57, **58**, 73, 153, 156
- Epidinocarsus lopezi* see *Anagyrus lopezi*
- Epilachna 'chrysomelina'* see *Henosepilachna argus* or *Henosepilachna elaterii* or *Henosepilachna vigintioctopunctata*
- Epilachna admirabilis* 72, 90, **405**, 411, 452
- Epilachna bisquadripunctata* see *Aphidentula bisquadripunctata*
- Epilachna boisduvali* see *Henosepilachna boisduvali*
- Epilachna borealis* 76, **385**
- Epilachna canina* **400**
- Epilachna cucurbitae* see *Henosepilachna sumbana*
- Epilachna defecta* **384**
- Epilachna dregei* 316, **384**
- Epilachna dumerili* **80**
- Epilachna eckloni* **384**
- Epilachna enneasticta* see *Henosepilachna enneasticta*
- Epilachna eusema* **385, 387**
- Epilachna karisimbica* **412**
- Epilachna marginella* **385**
- Epilachna marginicollis* **80**
- Epilachna mexicana* **384, 387**
- Epilachna mystica* **80**
- Epilachna nigrolimbata* **412**
- Epilachna niponica* see *Henosepilachna niponica*
- Epilachna paenudata* 76, 355, 447
- Epilachna philippinensis* see *Henosepilachna vigintisexpunctata*
- Epilachna pusillanima* see *Henosepilachna pusillanima*
- Epilachna pustulosa* see *Henosepilachna pustulosa*
- Epilachna quadricollis* **384**
- Epilachna septima* see *Henosepilachna septima*
- Epilachna sparsa orientalis* see *Henosepilachna vigintioctopunctata*
- Epilachna varivestis* 73–74, 76, 187, 198, 200, 224, **384–389**, **405**, 410–411
- Epilachna vigintioctomaculata* see *Henosepilachna vigintioctomaculata*
- Epilachna vigintisexpunctata* **62, 384**, 411
- Epilachna yasutomii* see *Henosepilachna yasutomii*
- Epilachninae subfamily 5, 7
- feeding stimulants 452
- food of 198, 200
- pupal defence 76
- Epilachnini tribe 7
- Episyrphus balteatus* 347, 356, 358
- Epivertina chelonia* 7
- Epivertini tribe 7
- Eremochilini tribe 7
- Eretmocerus mundus* 353
- Eriococcus coriaceus* **195**, 241
- Eriopis connexa* 126, 164, **164, 205**, 224, **330**, 391, **392, 417**, 505
- Eriosoma lanigerum* **193, 205**, 285
- Erysiphe cichoracearum* **66**, 91
- Erysiphe polygoni* 124
- Erythrina corallodendron* 167
- essential foods/prey 146, 187, 196
- list of **188–196**
- psyllids 174
- Eucallipterus tiliae* **58**, 153, **153**, 157, 177, **188–189, 195**, 238–239
- eucalyptus leaf beetle see *Chrysophtharta bimaculata*
- Eucraphis betulae* **58**, 238, **239**

- Eucерaphis punctipennis* **153**,
188–189
- eugregarines, protozoan pathogens
419–421
- Eulecanium caraganae* **190**
- Euonymus japonicus* 202
- Eupelmus* **385–386**, **388**
- Eupelmus urozonus* **386**
- Eupelmus vermai* 385
- Euphorbia* 200
- Eupteromalus* Kurdjumov see
Trichomalopsis Crawford
- Eurasian blackbird see *Turdus merula*
- European black slug see *Arion ater*
- European corn borer see *Ostrinia
nubilalis*
- European earwig see *Forficula
auricularia*
- European honey bee see *Apis
mellifera*
- European red mite see *Panonychus
ulmi*
- European red wood ant see *Formica
polyctena*
- Eurotia ceratoides* 200
- euryphagous species see generalist
species 150–152
- Euthelyconychia epilachmae* **384**,
387–388
- evolutionary history studies
phylogenetics 37–38
phylogeographic studies 38–42
population genetics 38–41
sequence evolution 29–33
techniques 33–37
- exclusion cages, predator impact study
469–470
- Exochomus childreni* 174, **192**,
361
- Exochomus concavus* see *Parexochomus
troberti concavus*
- Exochomus flavipes* 85, 178, **192**,
313, **384**, **387**, **389**
- Exochomus flaviventris* **143**, 169,
169, 222, **384**, 404
- Exochomus fulvimanus* **412**
- Exochomus lituratus* see *Priscibrumus
lituratus*
- Exochomus melanocephalus* see
Parexochomus melanocephalus
- Exochomus nigromaculatus* see
Parexochomus nigromaculatus
- Exochomus quadripustulatus* 16, 27,
32, 57, **62**, 74, **80**, 86, **87**,
87, 96, **131–132**, 161, 164,
168, **192**, 313–314, 329,
377, **389**, **393**, **420**
- Exochomus troberti* see *Parexochomus
troberti*
- Exoplectrinae subfamily 7
- Exoplectrini tribe 7
- Exoristoides slossonae* see *Chrysotachina
slossonae*
- extinction 115
- extrafloral nectaries 183, 499,
504
- eyed ladybird see *Anatis ocellata*
- eyespotted lady beetle see *Anatis mali*
- facilitation, predator 361–362
- facultative diapause 276, **281**, 292,
293, 316
- faeces, oviposition deterrence 231,
232
- fall webworm see *Hyphantria cunea*
- fat body
diapause 316–317
site of synthesis of aposematic
substances 445
- fat reserves during diapause
323–325
- faunas of coccinellid communities
114
climatic changes, effects of
115–116
geographic differences 114–115
invasion & extinction 115
- fecundity 87, 88–90
daily and lifetime **58–67**
diet affecting 88, 91
oviposition rate 86
temperature, effect of 96
- feeding habits 2
- feeding studies, laboratory 467–468
- females
finding oviposition site 226–232
food consumption, effect on
reproduction 208–209
preference for melanic morphs
27, 83–85
size/weight 75, 78
- Ferrisia virgata* **59**, **189**
- fertilization success 42–43
- fescue aphid see *Metopolophium
festucae*
- Ficedula parva* 379
- field cages, predator impact studies
469–470
- fifteen spotted lady beetle see *Anatis
labiculata*
- firebug see *Pyrrhocoris apterus*
- firethorn see *Pyracantha coccinea*
- fireweed see *Chamerion angustifolium*
- first ribosomal internal transcribed
spacer (ITS1) region 31–33
- fitness 56, 86
adaptive food preferences
452–453
cannibalism 176
fitness compensation 424
- five spot ladybird see *Coccinella
quinquepunctata*
- Flavobacterium* 68, 176, **422–423**
- flies, dipteran parasitoids 406–408
- flight 77
frequency of short 234
habitat switching 127
in the landscape 234–235
migratory 303–305
- flightlessness 77
flightless mutants, release of 498
- flight muscles, diapause 304, 321,
323
- floral nectar, sugar as substitute 187
- Florida red scale see *Chrysomphalus
aonidium*
- fluorescent *in situ* hybridization (FISH)
techniques 15
- follicles, ovarioles 57, 78, 82
- food
egg cluster size 57, **58–67**
fecundity link 88
larval instars 73
longevity link 91
and oviposition period 88
preferences, evolution of 38
and pre-oviposition period 78
- food consumption
functional response 204–207
growth and reproduction
207–209
physical factors 202–204
- food conversion 209–210
- food intake 241–242
- food range 142–144
methods for detection of 144–145
- food-related behaviour
food intake 241–242
foraging behaviour 213–238
prey capture 238–241
- food-related semiochemicals
449–452
associative learning 452–453
phagostimulants 452
plant volatiles 449–451

- food-related semiochemicals, (continued)
 prey alarm pheromones 451
 toxic substances in prey 451–452
- food relationships 142
 food-related behaviour 213–242
 quantitative aspects 201–213
 summary 242
- food specificity 142–201, 146, 171, 214, 242, 523
 alternative food 146, 147, 150, 170–174, 171, 180, 187, 214, 242, 302, 344
 cannibalism 175–179
 essential foods 187–196
 food range 142–145
 generalist vs. specialist species 150–155
 lower quality prey 157–169
 mixed and combined diet 155–157
 mycophagous Coccinellidae, food of 200–201
 non-aphid prey 169–175
 non-insect food 180–185
 nutritional suitability 145–147
 phytophagous Coccinellidae, food of 198–200
 prey size-density hypotheses 147–150
 substitute diets and supplements 185–187
 tritrophic studies 196–198
- food sprays 187
- footprint semiochemicals, aphid parasitoid response to 455–456
- foraging behaviour 213–214
 ants, interaction with 236–238
 first instars 233
 indirect factors 215–218
 diurnal periodicity 218
 plant structure 215–217
 plant surface 217–218
 larger scale 234–236
 oviposition site, finding 226–233
 research progress 520–525
 senses, role of 218–226
- Forficula auricularia* 472
Formica 379
Formica obscuripes **380**
Formica polyctena 221, **380**, 449
Formica rufa 449
Formica rufibarbis 236
- fourteen spot ladybird see *Propylea quatuordecimpunctata*
- foxglove aphid see *Aulacorthum solani*
- French bean see *Phaseolus vulgaris*
- fruit, damaged, food source 123
- fruit tree spider mite see *Amphitetranychus viennensis*
- functional response 204–207, 471
- fungal pathogens
Hesperomyces species 308–309, 416–418
 Hypocreales 415–416
 Nosematidae 418–419
- fungal spores, food source 180–184
- Galeruca interrupta arminiaca* 167
Galerucella lineola **195**
Galerucella pusilla 152
 garden pea see *Pisum sativum*
 garden slug see *Arion hortensis*
 garden warbler see *Sylvia borin*
Galerucella sagittariae **143, 190**
Galleria mellonella 328
 gas chromatography-mass spectrometry (GC-MS) 448, 456
- gean or wild cherry see *Prunus avium*
- gel electrophoresis 34, 145, 478, 480
- Gelis agilis* **388**
Gelis instabilis see *Gelis agilis*
Gelis melanocephalus **388**
Gelis **388**
- generalist (euryphagous) species 150–152
Adalia bipunctata 153
Coleomegilla maculata 152–153
Harmonia axyridis 153
Hippodamia species 154
 other generalists 154
 role in biological control 489, 490
- genetically modified (GM) crops 122–123, 505–506
- genetic correlations between traits 28–29
- genetic markers see molecular genetic markers 29
- genetic studies 14, 43–44
 chromosomes & cytology 14–18
 colour pattern variation 18–27
 future research 521–522
 host plant use by phytophagous species 198–199
 inheritance of other traits 27–29
 molecular genetics 29–43
- Genista* 167
 genome size 4, 14
Geocoris punctipes 118
 geographic variation
 in colour patterns 23–25
 diapause expression 332
 latitude and ladybird diversity 114–115
- giant bamboo see *Dendrocalamus giganteus*
- 'gin traps' 357, 377
- glacial lady beetle see *Hippodamia glacialis*
- glasshouse potato aphid see *Aulacorthum solani*
- glasshouse whitefly see *Trialeurodes vaporariorum*
- glassy-winged sharpshooter see *Homalodisca vitripennis*
- Glochidion ferdinandi* 183
- glossy leaves, biocontrol 504
- glucosinolates 165–166, 451–452
- glycogen reserves, diapause 325–326
- glycosides 160, 162, 169, 241
- golden-eyed lacewing see *Chrysopa oculata*
- golden loosestrife beetle see *Galerucella pusilla*
- gonads, diapause/dormancy 317, 321–322
- gorse spider mite see *Tetranychus lintearius*
- grain aphid see *Sitobion avenae*
- grains of paradise see *Aframomum melegueta*
- green apple aphid see *Aphis pomi*
- green citrus aphid see *Aphis spiraecola*
- green coffee scale see *Coccus viridis*
- green lacewing see *Chrysoperla carnea*
- green shield scale see *Pulvinaria psidii*
- greenbug see *Schizaphis graminum*
- Gregarina barbarara* **420**, 421
Gregarina californica **420**
Gregarina chilocori **420**
Gregarina coccinellae **420**
Gregarina dasguptai **420**
Gregarina 419, **420**, 421
Gregarina fragilis **420**
Gregarina hyashii **420**
Gregarina katherina **420**
Gregarina ruskowskii **420**
Gregarina straeleni **420**
 gregariousness, defensive mechanism 307–308, 357

- grey field slug see *Deroceras reticulatum*
grey garden slug see *Deroceras reticulatum*
guilds 344
 spatial 344, 352, 363
 temporal 344–345, 352, 361, 363
 thermal 344
gustatory sense 142, 226, 242
gut content analysis 144–145, 180–181, 478–481
- habitat management 500–501, 524
 floral diversity, non-crop plants 501
 intercropping 501–502
 reduced tillage 502
 strip-harvesting 501
- habitat preferences and semiochemicals 457–458
 attractive plants 458
 avoided plants 458
 plant-plant interactions 458
 plant stand traits 457–458
 role of plant volatiles 457
- habitats 110–132
 artificial substrates as 75
 crops 126, 128–129, **130**
 fragmentation 126–127, 234
 movement among 234–236
 niches 128
 sampling methods 111–114
 spatial guild partition 344
 switching between 127
 trade-off in selection of 357
 trees 129, **131**, **132**
 tropics 129, **132**
 wild herbs 129, **131**
- hairs, pupal defence 76, 357, 456
Halmus chalybeus 57
Halyzia hauseri see *Macroilleis hauseri*
Halyzia sanscrita **80**
Halyzia sedecimguttata **39**, **131**, **392**, **399**
Halyzia straminea **80**
Halyzia tschitscherini 314
Halyziini tribe 6, 7
hand-picking/hand-shaking, sampling methods 112
haricot bean see *Phaseolus vulgaris*
harlequin ladybird see *Harmonia axyridis*
Harmonia antipoda **392**
Harmonia axyridis **21**, **22**, **32**, **41**, **63**, **80**, **87**, **93**, **123**, **122–123**, **129**, **130**, **132**, **149**, **153**, **155**, **160**, **161**, **168**, **170**, **171**, **173**, **173–174**, **175**, **177**, **182**, **185**, **186**, **193**, **203**, **205**, **207**, **208**, **209**, **212**, **223**, **228**, **232**, **295**, **296–297**, **306**, **310**, **331**, **349**, **350**, **352**, **354**, **377**, **386**, **389**, **392**, **397**, **407**, **412**, **417**, **422**, **457**, **494**, **495**, **507–508**, **532**, **535**
- alternative food, effect on egg laying 171
artificial diet 185, 186
colour pattern variation **21–22**, **22**, **23–24**, **25**, **27**
diapause regulation 295–297
displacing native ladybirds 494–495
dormancy behaviour 310–311
essential foods **193**
flightless strain 498
food consumption, effect on growth 207–208
intra-guild predation 210, 350, 351–352
introduction of 494
invasion, genetic studies 40–41
 routes 41
olfaction 222, **223**, **224–225**
overall predator voracity 155
oviposition deterrence 229, 231–232
pest status 495
sperm competition/paternity studies 42, 43
survival rates of larvae fed on aphids 147, **149**
top predator 354
trophic egg laying 173, 177
unsuitable aphid diet 160–161
vagility 234, 235
vision 223–224
wing polymorphism 28
- Harmonia breiti* see *Harmonia expalliata*
Harmonia conformis 154, **193**, **205**, **311**, **393**, **407**
 dormancy behaviour 311
Harmonia dimidiata **80**, **162**, **193**, **205**, **229**, **230**, **393**
Harmonia eucharis **80**, **407**
Harmonia expalliata **407**
Harmonia octomaculata **393**
- Harmonia quadripunctata* **80**, **151**, **393**, **399**, **412**, **420**, **423**
Harmonia sedecimnotata **80**, **193**, 297
 diapause 297–298
Harmonia yedoensis **63**
Harpalus pennsylvanicus 345, 347, 472
hatching rate 68–69
 and lifetime fecundity 69
 and mating duration 82
 and multiple matings 82–83
 and polyandry 83
hatching synchrony 56, 68–69
hawthorn–parsnip aphid see *Dysaphis crataegi*
hawthorn spider mite see *Amphitetranynchus viennensis*
hazel aphid or filbert aphid see *Myzocallis coryli*
heather ladybird see *Chilocorus bipustulatus*
Helianthus annuus 499, 499, 535
Helicobia rapax **385**
Helicoverpa armigera 170, 478, 202
Helicoverpa zea 170, 182, 202, 477, 502
Heliothis virescens 152, 477
helmet scale see *Saissetia coffeae*
Hemaenasioides see *Homalotylus*
Hemberlesia lataniae **60**
hemipterans (non-aphid) as prey 174–175
hemiptera-tending ants 379–382
Hemisarcoptes 411
Hemisarcoptes cooremani 347, **412**
hemlock woolly adelgid see *Adelges tsugae*
Henosepilachna argus 56
Henosepilachna bifasciata **412**
Henosepilachna boisduvali 76
Henosepilachna dodecastigma **80**
Henosepilachna elaterii **21**, **22**, **198**, **387**, **412**
Henosepilachna guttatopustulata **400**
Henosepilachna indica **80**
Henosepilachna niponica 85–86, 232, 332, 404, **405**, 427
Henosepilachna ocellata **80**, **400**
Henosepilachna processa **80**
Henosepilachna pusillanima 76, **80**
Henosepilachna pustulosa 42, **405**, **420**, **427**
Henosepilachna septima 427

- Henosepilachna* species 198, 199
Henosepilachna sumbana **64**
Henosepilachna vigintioctomaculata **19, 19, 80, 85, 400, 404, 405, 416, 421, 427, 427**
Henosepilachna vigintioctopunctata **64, 80, 80, 199, 384, 386, 388, 399, 400, 405, 410, 412, 427, 427**
Henosepilachna vigintisexpunctata **384, 411**
Henosepilachna yasutomii 85, 198, 427
herbaceous stands 128
 sampling from 112
 wild herbs 129, **131**
herbivore-stressed plants, volatiles
 released from 450, 459
heritability studies 28–29
Hesperomyces chilomenis **417**
Hesperomyces coccinelloides 418
Hesperomyces hyperaspidis **402–403, 417**
Hesperomyces species 84, 308, 416–418, **417, 418**
Hesperomyces virescens 84, 308, 416
Heteropsylla cubana **192, 217, 223**
heterospecific aggregations 308
Hexameris 415
hibernation 276
 see also diapause/dormancy
 mating frequency and longevity 91
 movements prior to 127
 mycophagous and phytophagous species 316
 refuges 500
 second 90
Hibiscus 345, 496
hieroglyphic ladybird *see* *Coccinella hieroglyphica*
Hippodamia arctica **393**
Hippodamia caseyi 316
Hippodamia convergens **22, 29, 64, 93, 123–125, 130, 132, 149, 156, 173–174, 186, 193, 207, 231, 234, 292, 303, 305, 306–308, 314–315, 316, 387, 393, 396, 397, 412, 417, 420, 491, 499, 503, 507–508, 535**
 aggregation, olfactory cues 307
 artificial diet 186
 assassin bug preying on 491
 biological control, use in 490, 492, 497
 consumption of mummies 173
 diapause regulation 292
 drinking extra-floral nectar 499
 egg masses laid 231
 essential foods **193**
 food deprivation **207**
 frequency of short flights 234
 migration and aggregation 314–316
 redistribution of overwintering 496–497
 survival rates of larvae fed on aphids 147, **149**
 total egg production as function of food provisioning 156
Hippodamia glacialis **130**
Hippodamia parenthesis **130, 132, 193, 306, 308, 393, 397**
Hippodamia quinquesignata **22, 193, 316, 422, 423**
 diapause behaviour 316
 subnivean hibernator 329
Hippodamia septemmaculata **80**
Hippodamia sinuata **22, 130, 132, 193, 420**
Hippodamia tredecimpunctata 25, 26, **64, 80, 125, 129–130, 151, 193, 292, 306, 308, 378, 389, 393, 420**
 diapause regulation 292
Hippodamia variegata 20, 23, 24, 25, 33, 36, 40, **64, 77, 80, 87, 90, 117, 121, 121, 126–129, 129, 130–131, 145, 146, 151, 162, 170, 177, 194, 211, 235, 307, 309, 312, 330, 353, 360, 377, 378, 386, 389, 393, 398–399, 414, 415, 420, 423, 478, 493**
 hippodamine 448, 449, 456
Hippolais icterina 379
Hirundo rustica 379
hogbrake *see* *Ambrosia artemisiifolia*
Homalodisca vitripennis 480
Homalotyloidea dahlbomii **387**
Homalotylus affinis **383–384, 386–387, 399–400**
Homalotylus africanus **383–384, 386–387, 399–400**
Homalotylus agarwali **383–384, 386–387, 399–400**
Homalotylus albiclavatus **383–384, 386–387, 399–400**
Homalotylus albifrons **383–384, 386–387, 399–400**
Homalotylus albitarsus **383–384, 386–387, 399–400**
Homalotylus aligarhensis **383–384, 386–387, 399–400**
Homalotylus balchanensis **383–384, 387, 399–400**
Homalotylus brevicauda 391, 396, 400, **402–403**
Homalotylus californicus *see* *Homalotylus terminalis*
Homalotylus cockerelli 391, 396, 400, **402–403**
Homalotylus ephippium **383–384, 387, 399–400**
Homalotylus eytelweini **383–384, 387, 399–400**
Homalotylus ferrierei 399–400
Homalotylus flaminus **383–384, 387, 399–400**
Homalotylus formosus **383–384, 387, 399–400**
Homalotylus hemipterinus **383–384, 387, 399–400**
Homalotylus himalayensis 469
Homalotylus hybridus 400
Homalotylus hyperaspicola 406
Homalotylus hyperaspidis 391, 396, 400, **402–403**
Homalotylus hypnos **388–389, 391, 400–401, 402–404, 428**
Homalotylus indicus 399–400
Homalotylus latipes **399, 400, 409**
Homalotylus longicaudus **383–384, 387, 399–400**
Homalotylus longipedicellus **402**
Homalotylus **383–384, 386–387, 399–400**
Homalotylus mexicanus 391, 396, 400, **402–403**
Homalotylus mirabilis 400
Homalotylus mundus **383–384, 387, 399–400**
Homalotylus nigricornis **383–384, 387, 399–400**
Homalotylus oculatus 399–400, 409
Homalotylus pallentipes 391, 396, 400, **402–403**
Homalotylus platynaspidis 400

- Homalotylus punctifrons* 391, 396, 400, **402–403**
- Homalotylus quaylei* 391, 396, 400, **402–403**
- Homalotylus rubricatus* **383–384**, **387**, 399–400
- Homalotylus scutellaris* **383–384**, **387**, 399–400
- Homalotylus scymnivorus* 406
- Homalotylus shuvakhinae* 400–401, **402**
- Homalotylus similis* 405
- Homalotylus sinensis* **383–384**, **387**, 399–400
- Homalotylus singularis* 400
- Homalotylus* sp. 400–401, **402–403**, 404
- Homalotylus terminalis* **383–384**, **387**, 399–400
- Homalotylus trisubalbus* **383–384**, **387**, 399–400
- Homalotylus turkmenicus* 401
- Homalotylus vicinus* **381**
- Homalotylus yunnanensis* **383–384**, **387**, 399–400
- Homalotylus zhaoi* **383–384**, **387**, 399–400
- honeydew
arrestant effects 120, 222
cardenolides in 162
and old prey colony 227–228
- honeydew producers, ant attendance
236, 237, 359, 362,
379–382, 502–503
- honeysuckle see *Lonicera periclymenum*
- hop powdery mildew see *Sphaerotheca castagnei*
- host plants
age, effects of 122, 228, 294
chemical cues/stimuli 120,
199–200, 224–226
co-existence of several ladybird
species 121–122
food of herbivorous Coccinellidae
198–200
genetically modified 122–123
microclimate effect 124–125
preference for type 120–121
resistance 169, 200, 524–525
structure 215–217
surface 123–124, 217–218
- house martin see *Delichon urbica*
- house sparrow see *Passer domesticus*
- Howardula 414
- humidity
and food consumption
203–204
and hatching rate 68
longevity effect 91
- hump earwig see *Anechura harmandi*
- Hyaliodes vitripennis* 207, 353
- Hyalopterus pruni* **58–59**, **63**, **66**,
91, 147, **147**, 153, 165–168,
188, 190–191, 193, 236,
241, 252, 267
- hybridization 85
- hybrid sterility 17–18
- hydrocarbons on elytra 454
- hydroxamic acid DIMBOA 164
- Hypera postica* 170, 171–172, 210,
315, 490
- Hyperaspini tribe 10
- Hyperaspis aestimabilis* **387**
- Hyperaspis bigeminata* **306**
- Hyperaspis binotata* **132**
- Hyperaspis campestris* 71, **80**
- Hyperaspis congressis* see *Hyperaspis conviva*
- Hyperaspis conviva* **380**
- Hyperaspis desertorum* **194**
- Hyperaspis lateralis* **194**, **384**
- Hyperaspis notata* 143, **194**,
491
- Hyperaspis pantherina* **194**
- Hyperaspis raynevali* **143**, **194**
- Hyperaspis reppensis* **80**, **378**, **380**
- Hyperaspis senegalensis hottentotta*
143, **194**
- Hyperaspis senegalensis* **143**, **194**,
389
- Hyperaspis sphaeridioides* 126
- Hyperaspis undulata* **132**, **306**
- Hyperomyzus carduellinus* **63**, **193**
- Hyperomyzus lactucae* 154, **190**
- hyperparasitoids **387–389**
- Hyphantria cunea* 178, **197**
- Hypocreales, fungal pathogens
415–416
- hypotactic orientation/responses
302, 303, 305, 310
- hypotactic species 310–311
- Icerya purchasi* 165, 167, 172
control of 491, 509
- icterine warbler see *Hippolais icterina*
- Illeis bielawskii* **405**
- Illeis cincta* **80**, **393**, **405**
- Illeis galbula* 155, 183, 297, 324
diapause 297
- Illeis koebelei* 200, 201
diet of 200, 201
- immigration 114, 115, 117, 211,
235
- immunolabelling 477–478
- impaction traps 113
- inbreeding studies 40
- Indian hemp see *Cannabis sativa*
- Indian Mallow see *Abutilon theophrasti*
- Indian ricegrass see *Oryzopsis hymenoides*
- induction of diapause 280–281,
282–283, 287
critical photoperiod 290, 291, 299
lack of food 293
stage sensitivity 289, 290
- industrial melanism 25, 26
- inheritance
colour patterns 20–23
experimental evidence **21–22**
life history characters 28–29
wing polymorphism 27–28
- Inkaka quadridentata* **385**
- innate capacity for increase,
temperature dependent 96
- insect growth regulators (IGRs) 509
- insecticides 506–509
- insidious flower bug see *Orius insidiosus*
- instars 71–72
and body size 73, 74, 150
food consumption **159**
foraging of first 233
survival when fed *B. brassicae* **166**
tolerance to extreme temperatures
96–97
- integrated pest management (IPM)
programmes 506
insecticides used in **507–508**
- integrated system
pheromone release 454
pupal defence 76
- intercropping, ladybird diversity
501–502
- interguild effects 362–363
- inter-simple sequence repeat (ISSR)
analysis **35**, 41–42
- interspecific mating 85
- intraguild interactions 344, 346
ant-ladybird interactions
359–360
biological control 361–362
commensalism 345, 347
competition 347–349
conservation 360–361

- intraguild interactions, (continued)
interguild effects 362–363
male-killing bacteria 349
mutualism 345–347
niche partitioning 344–345
- intraguild predation (IGP) 172, 349
and biocontrol 361
and biocontrol limits 490–491
on coccinellids 355, 358–359
defensive mechanisms 355–358
- coccinellids as predators
benefits to coccinellids 350
of coccinellids 351–352
general rules 349–350
hypotheses 350–351
on intraguild parasitoids 353
on intraguild pathogens 354
of non-coccinellids 352–353
top predators 354–355
- definition of 349
nitrogen shortage hypothesis 210
vulnerability to 350–351, 355
- intrinsic rate of population increase 89
food and humidity affecting 91
temperature sensitivity 96
- introductions of coccinellid species 115, 362
aphidophagous 492–493
coccidophagous 491–492
competitive displacement 494–495
invasive species 493–494
- inundative biological control 362, 498
- invasive species 115, 360, 493–494
genetic diversity studies 40–41
- invertebrate predators 377–379
- Iridomyrmex* **381**
- Isaria farinosa* 415
- Isaria fumosorosea* 415–416
- Isodromus niger* **386**
- isothiocyanates 165–166, 225, 452
- isozymes analysis **34**, 41
- Italian rye grass see *Lolium multiflorum*
- ITS-1 (first ribosomal internal transcribed spacer) region, gene sequencing 31–33
- jack pine budworm see *Choristoneura pinus*
- Japanese ant see *Lasius japonicus*
- Japanese quail see *Coturnix japonicus*
- Jauravia quadrinotata* **80**
- Juglans cinerea* 152
- Juniperus virginiana* 120
- juvenile hormone (JH) 327–328
- kairomones 451
- kidney-spot ladybird see *Chilocorus renipustulatus*
- kin recognition, semiochemicals 448
- labial palp, chemoreception 223
- lacewings, IGP 349, 352
- Laingia psammae* **191**
- landscapes
diversity and character 125–127
landscape scale 211
larger scale foraging 234–236
- Lapsana communis* 180, 180
- larch adelgid see *Adelges larcis*
- larch ladybird see *Aphidecta oblitterata*
- Laricobius nigrinus* 353, 358
- larva(e) 71–73
attachment ability 218
body size 73
consumption of 178–179
defence 356–357
development 72–73
instars 71–72
mean SCP 96
morphology 71
parasitization of 391
response to semiochemicals 450–451
- larval development
aphid prey 158, 159, 163, 168
food consumption/deprivation 207–208
- larval tracks, oviposition deterrence 222, 229–233, 356, 454, 456
active substances in 455
- Lasius claviger* **380**
- Lasius japonicus* **237**
- Lasius niger* 85, 236, **380–381**, **404**, 449, 503
- Lasius umbratus* **380**
- leaf-curling plum aphid see *Brachycaudus helichrysi*
- learned response
colour perception 224, 226
intensive search 220
prey selection 452–453
- leaves
and biological control 504
feeding on 184–185, 197
- Lecanicillium lecanii* 415
- Lecanicillium longisporum* see *Lecanicillium lecanii*
- Leis dimidiata* see *Harmonia dimidiata*
- Leis* see *Harmonia*
- Lemnia biplagiata* see *Coelophora biplagiata*
- lemon grass see *Cymbopogon citratus*
- Leontopodium alpinum* 181
- Lepidaphycus* see *Homalotylus*
- lepidopterans as prey 169–170
- Lepidosaphes beckii* 168
- Lepidosaphes cornutus* **60**
- Lepidosaphes ulmi* 167
- Leptinotarsa decemlineata* **62**, 144, 152, 170, **192**, 202, **205**, 326, 490
- Leptothea galbula* see *Illeis galbula*
- Leptus ignotus* 411
- lesser whitethroat see *Sylvia curruca*
- Leucaena* 217
- life history characters 55
adult 76–91
aphid prey effects **148**
egg 55–70
inheritance of 28–29
larva 71–73
pupa 73–76
- life span see longevity
- life tables 471–472
- lifetime fecundity **58–67**, 88
and egg hatching rate 68, 69
higher for once-mated females 83
temperature effects 89
- light traps, sampling 114
- Ligustrum* 183
- lime aphid see *Eucallipterus tiliae*
- Lindorus lophanthae* 36, **81**, **94**, 492
- Linepithema humile* 162, 237, **237**
- Lioadalia flavomaculata* **194**, **393**
- Liosomaphis berberidis* **58**
- Lipaphis pseudobrassicae* **59**, **61**, 68, 88, 91, 147, 164, 168, **190–195**, 207
- lipids, diapause 323–325
- little black ant see *Monomorium minimum*
- local faunas 114
climatic changes 115–116
geographic differences 114–115
invasion and extinction 115
- location of communities, determinants of 116
host plant 120–124
landscape 125–127
microclimate 124–125
prey 116–120

- Lolium multiflorum* 183
Lolium perenne 123, 183, 183–184
longevity
 food affecting 91
 sexual activity affecting 83, 91
 temperature effects 88, 89,
 90–91, 96
 voltinism 90
Longiunguis donacis see *Melanaphis donacis*
Lonicera periclymenum 120
lower development threshold (LDT)
 92
 for pre-imaginal development 92,
 93–94
 relationship with SET 92, 95
 thermal window 95
lupin aphid see *Macrosiphum albifrons*
Lupinus luteus 163
Lupinus mutabilis 163
Luscinia luscinia 379
Luscinia svecica 379
luteolin 7-O-glucoside 199–200
Lydinolydella metallica **385, 387**
Lygocerus see *Dendrocerus*
Lygus 475, 477, 504
Lygus hesperus 477
Lygus lineolaris 475
Lypha slossonae see *Chrysotachina slossonae*
Lysiphlebus fabarum 171, 353
Lysiphlebus testaceipes **173, 353, 504**
- Maconellicoccus hirsutus* **192, 496**
Macroilleis hauseri **194**
Macronaemia hauseri **393**
Macrosiphoniella artemisiae **58, 191, 194**
Macrosiphoniella sanborni **191**
Macrosiphum albifrons 163
 toxicity 163
Macrosiphum euphorbiae 118, 174,
 205, **224, 468**
Macrosiphum ibarae see *Sitobion ibarae*
Macrosiphum rosae **153, 188, 193, 497**
maize (corn in USA) see *Zea mays*
malaise traps 113–114
male gonads, diapause 321–323
male-killing bacteria 349, 421
 diversity of 421, **422–423**
 evolutionary dynamics 423–424
 evolutionary implications
 424–425
 evolutionary rationale 423
 molecular genetic studies 29–31
 phylogenetic studies 38, 39
 and sibling cannibalism 176
male size 78
 and female mating preference
 84–85
 pupal stage 75
Malus pumila 120
mandibles 241
 Tytthaspis sedecimpunctata 183,
 200
Manihot esculenta 169, **169**
Manikara zapota 496
mark-recapture method, sampling
 114, 522
marmalade hover fly see *Episyrphus balteatus*
mating(s)
 duration 82–83, 84
 frequency 82–83
 and fecundity 88
 and longevity 91
 genetic studies 42–43
 hybridization 85
 male selection 83–85
 inbreeding studies 40
 and melanism 83–85
 advantage for melanic morphs
 26–27
 female choice 83–85
 multiple 68
 preference 84
 prior to dispersal 309, 322
 refractory periods 77
 refusal to mate 83
 semiochemicals implicated in
 antennae chemoreceptors
 453
 glands, pheromone release
 454
 hydrocarbons on elytra 454
 sex pheromones 453
 sperm competition 83
 willingness 82
Matsucoccus feytaudi 222
Matsucoccus josephi **189**
Matsucoccus matsumurae 222, 451
maxillary palps
 perception of larval chemical
 marker 222, 223, 226
 prey contact and recognition
 223
meadow pipit see *Anthus pratensis*
meadow spittlebug see *Philaenus spumarius*
mealy plum aphid see *Hyalopterus pruni*
mealybug destroyer see *Cryptolaemus montrouzieri*
mealybugs (Pseudococcidae) 169,
 222, 237
 biological control of 496, 503
Medicago sativa alfalfa (or often
 lucerne in UK) **197, 501**
Medina collaris **384–385**
Medina funebris **384–385**
Medina luctuosa **386**
Medina melania **384–385**
Medina separata **384–385**
Mediterranean flour moth see *Ephestia kuehniella*
Megalocaria dilatata 57, **64, 80, 85, 194, 382**
Megaselia **385**
Megoura viciae 119, 145, 161,
 162–163, 164, 168, 191, 193
Melanaphis donacis **191**
Melanaspis glomerata **60**
melanic (dark) morphs
 environmental conditions
 23–27
 inheritance 19–23
 mating advantage 26–27, 42
melanism
 and mate preference 83–85
 melanization extent, pupae 76
 winter survival, effect on
 331–332
Melanocorypha calandra 379
Melasoma populi see *Chrysomela populi*
melegueta pepper see *Aframomum melegueta*
Melolontha sp. 302
melon aphid see *Aphis gossypii*
Mendozaniella see *Homalotylus*
Menochilus quadriplagiatus see
 Menochilus sexmaculatus
Menochilus sexmaculatus **64, 68, 70, 75, 78, 80, 82, 83, 86, 90, 91, 117, 118, 123, 146, 147, 163, 174, 176, 178, 179, 183, 186, 210, 215, 228, 229, 231, 356, 389, 393, 405, 405, 410, 414, 421, 423, 424, 425, 446, 455, 507, 508**
 essential foods **194**
 and first chemically defined ODS
 231, **232**
 oviposition 228–229

- Mercurialis annua* 183
Merismoclea rojasi **385**, 405
Mermis 414, 415
 Mermithidae 415
 meroistic telotrophic ovarioles 78
Mesopolobus secundus 406
Mesopolobus **385–386**, 406
Mestocharis lividus see *Pediobius foveolatus*
 metabolic changes related to diapause
 glycogen 325–326
 lipids 323–325
 metabolic rate 326–327
 water 326
 metallic blue lady beetle see *Curinus coeruleus*
Metarhizium anisopliae 415, 498
Metastenus caliginosus 406
Metastenus concinnus **383**, 405–406
Metastenus indicus **402**, 406
Metastenus species (parasitoids) 405–406
Metastenus sulcatus 405
Metastenus townsendi **384**, 405–406
Metastenus 405
Metatetranychus ulmi see *Panonychus ulmi*
 methionine 155
 methylalkylpyrazines, reflex blood 377
 methyl linolenate 452
 methyl salicylate 225, 448, 450
 methyl tricosane 448, 454
Metopolophium dirhodum **147**, 156, **159**, **191**, **195**
Metopolophium festucae 475, **475**
 mexican bean beetle see *Epilachna varivestis*
Micraspis allardi **80**
Micraspis discolor **64**, 68, 88, 147, **194**, **393**, **507**
 microarray chips, species identification 36
 microclimate 124–125
Microctonus 394
 microhabitats 233
Microlophium carnosum **58**, **145**, 150, 153, **153**, **188**, **190–191**, 213, 238
 micropyles, egg 55, 55
 microsatellite analysis **35**, 36, 40, 43
Microsphaera alphitoides 184, 200
Microsphaera pulchra 201
 microsporidia 418–419
Microweisea sp. **384**
 Microweiseinae basal subfamily 4, 5
 Microweiseini tribe 5
 middle spotted woodpecker see *Dendrocopos medius*
 migration 302–303
Mindarus abietinus **189**, 471
Misumenops tricuspoidatus 358, 361
 mites
 Coccipolipus 411–414
 commensalism 345
 intraguild predators 353
 phoretic 411
 mitochondrial DNA (mtDNA) 29–31, 36, 37
 mixed and combined diets 155–157
 complementation across life stages 156–157
 prey specialization through selection 157
 prey switching 157
 mixed plant stands, arresting effect 458
 modifier genes, colour pattern variation 22–23
 molecular genetic markers 29
 isozymes for delimiting cryptic species 41
 ISSR, sperm competition 41–42
 mitochondrial DNA (mtDNA) 29–31
 species-specific 33–37
 studies using **34–35**
 molecular genetic studies 4–5, 29
 future research in 521–522
 gut-content analyses 144–145, 358, 478–481, 524
 paternity and sperm competition 42–43
 phylogenetic studies 37–38
 population genetic & phylogeographic studies 38–42
 sequence evolution 29–33
 species identification 33–37
Momordica charantia 410
 monarch butterfly see *Danaus plexippus*
 Monocorynini tribe 9
Monomorium minimum 237
Monophlebulus pilosior **195**, 242
 monophyly
 Coccinellidae family 2–3
 other subfamilies 4
 of six subfamilies 3
 rejection of 5
 morello cherry or amarelle cherry see *Prunus cerasus*
 morphology
 egg 55–56
 inheritance
 colour patterns 19–27
 wing polymorphism 27–28
 larva 71
 pupa 74–75
 mortality
 after consumption of sinigrin 166
 eggs used as diet **170**, 173
 embryonic 85
 larvae fed on aphids **143**, **145**
 risk in newly hatched first instars 233
 stage specific 72
 temperature extremes 96–97
 toxic and rejected prey 158–167
 unsuitable host plants 200
Morus australis 201
 'mosaic dominance' hypothesis 23
Motacilla flava 379
 moulting of larva 70, 71, 72
 mullein bug see *Campylomma verbasci*
 Mullerian mimicry 27
Mulsantina hudsonica **306**
Mulsantina picta 122, **130**, **132**, 344, **423**
 multiple allele effect 22
 multi-species aggregations/
 combinations 308
 aphid suppression 472–473
 multivoltinism 276
A. bipunctata 290, 314
C. septempunctata 281, 283, 284, 286, 320
Har. axyridis 295
Hip. convergens 292
 potential multivoltinism 286–287
 mummies, feeding on 171–172, **173**
Muscicapa striata 379
 mussel scale see *Lepidosaphes ulmi*
 mustard aphid see *Lipaphis pseudobrassicae*
 mutual interference 207
 mutualism 345–347, 350, 351
 ant attendance 236–238, 379–382
 ants and honeydew producers 359, 362
 lacewings 352
 mycophagous Coccinellidae
 food of 200–201
 hibernation 316

- Myiopharus doryphorae* **385**
myrmecophilous ladybirds 360,
380–382
myrmecophily 449
Myrmica ruginodis 236
Myrmica rugulosa **381**
Myrrha octodecimguttata **80**, 122,
128, 149, **151, 194**, 304,
308, **393, 399**, 419, **420**,
421, 449
dormancy, responses 307
hibernation sites 314
Myzia oblongoguttata **80**, 129, **129**,
131, 151, **151**, 314, **389**,
393, 399, 408
Myzia subvittata **132**
Myzocallis boernerii **153, 188–189**
Myzocallis carpini **188**
Myzocallis castanicola **153, 188**
Myzocallis coryli **153, 188–189**
Myzus cerasi **147**, 153, **153, 188**,
191
Myzus persicae **58, 61–65**, 68, 76,
78, 87, 91, 117, 120, **143**,
145, 148, 156, **159, 162–**
163, 165, 165–166, **166**,
168, 168, 170–171, 179,
188–194, 202, **205**, 207,
210, 222, 224, 236, 238,
293, 450–451, 467–490,
498
Myzus persicae nicotianae 120, **191**,
202, 450

Nabis (Reduviolus) americanoferus 472
natality 86, 87
native ladybirds, competitive
displacement of 115, 171,
493, 494–495
natural enemies 376–428
impact on populations 425–428
parasites and pathogens 411–425
parasitoids 383–411
predation 376–382
nectar, feeding on 180, 183, 215,
499–500
Neda marginalis **407**
nematodes 414
Allantonematidae 414
Mermithidae 415
Neoaenasioides see *Homalotylus*
Neoaulacorthum magnoliae 160, 160,
196
Neoaulacorthum nipponicum 241
Neocalvia anastomozans **407**

Neomyzus circumflexus **145, 188**,
238
neonicotinoids, insecticides
506–509
Neophyllaphis podocarpi **191, 193**
Neotainania see *Uga*
Neotyphodium lolii 123
Nephaspis oculatus see *Clitostethus*
oculatus
Nephus bilucernarius **194**, 503
Nephus bisignatus **89, 94, 96**
Nephus flavifrons **132**
Nephus guttulatus **384**
Nephus includens **65, 89, 94**,
194
Nephus kiesewetteri **389**
Nephus ornatus **389**
Nephus quadrimaculatus 314, **385**,
474
Nephus redtenbacheri **80**
Nephus soudanensis **389**
Nerium oleander 161–162, 446
neuropterans, IGP 352
n-heptacosane 456
ni moth see *Trichoplusia ni*
niche differentiation 128
niche overlap 229, 231
niche partitioning 344–345, 472
Nilaparvata lugens **195**
nine-spotted lady beetle see *Coccinella*
novemnotata
nipplewort see *Lapsana communis*
Nitraria 200
Nobrimus see *Homalotylus* 400
non-fertile/non-hatching eggs 68,
69
non-melanic (light) morphs 19
balanced selection 26
female preference 27
paternity and sperm competition
studies 42
non-myrmecophilous coccinellid
species, ant interaction
359–360
non-sibling cannibalism 175
egg consumption 177–178
kin recognition 179
larvae consumption 178–179
population consequences 179
northern wheatear see *Oenanthe*
oenanthe
Nosema coccinellae 418–419
Nosema epilachnae 418
Nosema henosepilachnae 418
Nosema hippodamiae 419

Nosema tracheophila 419
Nosema varivestis 418
Nosematidae (fungal pathogens)
418–419
Nothoserphus admirabilis **405**
Nothoserphus aequalis **405**
Nothoserphus afissae 404, **405**
Nothoserphus boops 404, **405**
Nothoserphus debilis **405**
Nothoserphus epilachnae 418
Nothoserphus fuscipes **405**
Nothoserphus mirabilis 404–405
Nothoserphus partitus **405**
Nothoserphus scymni **384, 405**
Nothoserphus species (parasitoid)
404, **405, 405**
Nothoserphus townesi **405**
‘no-till’ agriculture 502, 503
Noviini tribe 8
N-oxides, *Aphis jacobaeae* 163–164
n-pentacosane 448, 455, 456
n-tricosane 456
numerical response 88, 466, 471
aggregative 204, 227,
347–348
additional prey, importance of
212–213
modelling of 211
temporal and spatial patterns
211
vegetation influence 211–213
nutrition
food suitability 145–147
food unsuitability 164
intraguild predation 210
non-abundant nutrient concept
154–155
nutrients in egg yolk 55
plants providing 196–197
nutritional IGP hypothesis 351
nutritional induction of diapause
292, 293–294
Nysius huttoni 476

obligatory diapause 276
Oenanthe oenanthe 379
Oenopia billieti **80**
Oenopia conglobata 23, **65, 80, 131**,
154, **195**, 308, 314, **330**,
378, **393, 412**, 413, 414,
420
Oenopia kirbyi **80**
Oenopia lyncea **65**
Oenopia sexareata **81**
Oidium monilioides 183, 200

- oil seed rape see *Brassica napus* subsp. *oleifera*
- oleander aphid see *Aphis nerii*
- oleander aphids, toxicity 162–163
- oleander see *Nerium oleander*
- olfaction 224–226
- early studies 220–222
 - host plant odours 120
 - olfactory cues, larval response to 451–452
 - perception distance 222
 - prey odour detection 119, 120
 - receptors in aphidophagous species 223
- olfactometers 222, 223, 224, **225**
- experiments 120, 450, 453, 458
- olive scale see *Saissetia oleae*
- Olla abdominalis* see *Olla v-nigrum*
- Olla v-nigrum* 15, 20, **22**, **65**, 90, **94**, **96**, **130**, **132**, **143**, **149**, 163, 172, **173**, 174–175, 179, 185, **195**, 235, 361, 391, **393**, **407**, 408, 416, **417**, **507–508**
- Omphale epilachni* see *Chrysonotomyia appannai*
- Omphale* **386**
- onion thrips or tobacco thrips see *Thrips tabaci*
- Onoclea sensibilis* 313
- oocytes 57, 82, 317–320
- Ooencyrtus azul* **384**
- Ooencyrtus bedfordi* **384**
- Ooencyrtus camerounensis* **384**, 426
- Ooencyrtus distatus* **387**
- Ooencyrtus epilachnae* **384**
- Ooencyrtus epulus* see *Ooencyrtus camerounensis*
- Ooencyrtus polyphagus* **387**
- Ooencyrtus puparum* **384**
- Ooencyrtus sinis* **384**
- Oomyzus* 409
- Oomyzus mashhoodi* **384**
- Oomyzus scaposus* **384**, **388–389**, 391, 408–409, 428
- Oomyzus sempronius* **386**
- oosorption 82, 317
- food restriction, effect of 209
- Ophelosia bifasciata* **385**
- Ophelosia crawfordi* **388**
- opportunistic IGP hypothesis 351
- optimum temperature
- development rate 92, 97
 - hatching rate 68
 - thermal window 95
- orange ladybird see *Halyzia sedecimguttata*
- Orcus australasiae* **205**, **384**
- Orcus chalybeus* see *Halmus chalybeus*
- Oricoruna* **385**
- Oricoruna orientalis* **385**
- Orius insidiosus* 118, 358, 480
- Ortaliinae subfamily 5, 8, 8–9
- Ortaliini tribe 8, 9
- Orthezia urticae* **194**
- Oryzopsis hymenoides* 206
- Ostrinia nubilalis* 152, 207, 358, 480, 490
- Ouchterlony plate approach, antibody analysis 476
- ovarian development 82, 317–321
- ovarioles 78–82
- and cluster size 57, 82
 - and egg weight 56
 - and female weight & size 78, **79–81**, 81
- overwintering survival **308**, 328–331
- oviposition 85–88, 119
- alternative foods, effects on 171
 - animal protein, importance of 156
 - deterrence 228–233, 454–456
 - diurnal periodicity 218, 219
 - effect of food restriction 209
 - essential foods, effect on 146, 187, 196
 - period 86, 88
 - place 85–86
 - and prey stage 156, **157**
 - rate 86, 87
 - peak of 86
 - rhythmicity 86
 - sites, search for 226–228
 - stimulated by host plant odours 120
 - substitute diets 185–186
 - substrates 85–86
 - termination of 117
 - toxic aphid, negative effect on **162**
 - trophic egg laying 177
- oviposition deterrence pheromones/semiochemicals 117, 229, 231, 356, 358, 454
- active substances in larval tracks 455
 - aphid abundance 456
 - species-specificity 454–455
- oxygen consumption, diapause 326–327
- oystershell scale see *Lepidosaphes ulmi*
- Pachyneuron albutius* **389**
- Pachyneuron altiscuta* **389**
- Pachyneuron chilocori* **389**
- Pachyneuron concolor* see *Pachyneuron muscarum*
- Pachyneuron muscarum* **389**
- Pachyneuron siculum* see *Pachyneuron solitarium* **389**
- Pachyneuron syrphi* see *Pachyneuron albutius*
- Pachyneuron* **389**
- Paecilomyces farinosus* see *Isaria farinosa*
- Paecilomyces fumosoroseus* see *Isaria fumosorosea*
- Paederia foetida* 241
- pair formation 84
- Palaenoda auriculata* **81**
- Palaenoda miniata* see *Palaenoda auriculata*
- Pandora neophidis* 354
- Pania luteopustulata* **81**
- Panonychus mori* **67**
- Panonychus ulmi* 152, 167
- Parachrysocharis* **386**
- Paradexodes epilachnae* see *Euthelyconychia epilachnae*
- Paranaemia vittigera* **195**
- parasitic mites, *Coccipolipus* 411–414
- Parasitlenchus coccinellinae* 414
- parasitization 390–391
- population impact of 426–428
- parasitized aphids, inferior prey 171–172, 173, 353
- parasitoids 88, 383
- ant behaviour towards 237, 360
 - avoidance of coccinellid tracks 232
 - general characteristics 390–391
 - intraguild
 - ants attacking 360
 - coccinellids preying on 353
 - predation on coccinellids by 358
 - primary **383–386**
 - review of important parasitoids 391–411
 - Cowperia* 399, **401**, 401
 - Dinocampus coccinellae* 391–399
 - Homalotylus* 400–404

- review of important parasitoids,
(continued)
Metastenus 405–406
Nothoserphus 404–405
Oomyzus scaposus 408–409
Pediobius foveolatus 409–411
Phalacrotophora 406–408
Uga species 399, 400
secondary **387–389**
semiochemical attraction 449
Parastethorus nigripes **195**
Paratrechina **381**
parenthesis lady beetle see *Hippodamia*
parenthesis
Parexochomus melanocephalus 313
Parexochomus nigromaculatus **89, 94**,
167
Parexochomus troberti **393, 412**, 471
Parexochomus troberti concavus **393**,
412
Parlatoria blanchardi **60, 195**
parsnip see *Pastinaca sativa*
Parus major 376
Passer domesticus 377
Passer montanus 377, 379
Pastinaca sativa 126
paternity studies 42–43
pathogens
bacteria 421–425
fungal 415–419
intraguild
coccinellids preying on 354
commensalism 345
predation on coccinellids by
359
nematodes 414–415
protozoan 419–421
PCR see polymerase chain reaction
29, 145
pea aphid see *Acyrtosiphon pisum*
peach or nectarine see *Prunus persica*
peach–potato aphid see *Myzus persicae*
Pectinophora gossypiella **63**, 477
Pediobius amaurocoelus **388**
Pediobius epilachnae see *Pediobius*
foveolatus
Pediobius foveolatus **384, 388–389**,
391, 409–411, 418, 426
Pediobius mediopunctata see *Pediobius*
foveolatus
Pediobius nishidai **384**
Pediobius simiolus see *Pediobius*
foveolatus
Pediobius 409
pentatomids, IGP 358
Pentilia insidiosa **384**
Pentiliini tribe 10
percentage fertility 68–69
Perilitus americanus see *Dinocampus*
coccinellae
Perilitus coccinellae see *Dinocampus*
coccinellae
Perilitus rutilus 394
Perilitus stuardoi **387**, 391
Perilitus terminatus see *Dinocampus*
coccinellae
periodicity see rhythmicity
Periphyllus californiensis **193**
Periphyllus lyropictus **188**
Periphyllus testudinaceus **153**
pest control
augmentation 495–498
pesticides, selective use 506–509
phagostimulants 452
Phalacrotophora berlinensis
384–385, 406
Phalacrotophora beuki **384–385**, 406
Phalacrotophora decimaculata
384–385, 406
Phalacrotophora delageae **384–385**,
406
Phalacrotophora 75, **384**, 391, 406,
407, 408, 426, 428
Phalacrotophora fasciata 391
Phalacrotophora indiana **384–385**,
406
Phalacrotophora nedae **384–385**,
406
Phalacrotophora philaxyridis
384–385, 406
Phalacrotophora quadrimaculata
384–385, 406
Pharoscyrmus anchorago **420**,
421
Pharoscyrmus numidicus **388**
Pharoscyrmus ovoideus **388**
Phaseolus vulgaris 126
Pheidole megacephala 362, 503
Phenacoccus herreni **194**
Phenacoccus madeirensis **192**
Phenacoccus manihoti 169, **194**,
222, 404, 471
phenotypic plasticity 522
pheromones 117, 222, 224, 225,
239, 240, 241, 454
Philaenus spumarius 476
Phoenicococcus marlatti **194**
Phoenicurus ochruros 379
Phoenicurus phoenicurus 379
phoretic mites 345, 411
Phorodon humuli **58, 188, 191**
photoperiodic activation 277, 281,
282
precocious 295
photoperiodic response 276, 283,
288–289, 295, 300
photoperiods
see also diapause/dormancy
critical 276, 284, 290, 291, 298,
299
egg cluster size 57
hatching rate 68
longevity effects 90–91
Phthorimaea operculella **59**
Phygadeuon subfuscus **388**
Phyllactinia moricola 201
Phyllaphis fagi **153, 188**
Phylloscopus collybita 379
Phylloscopus trochilus 379
Phylloxera glabra 146, **195**
phylogenetic studies 37–38
phylogeny 5–10
phylogeographic studies 38–42
Phymatosternus lewisii 360, **381**
Physalis alkekengi 199
phytophagous Coccinellidae
food of 198–200
hibernation 316
population impact of natural
enemies 426–428
Picea schrenkiana 314
Pieris rapae 170
pine ladybird see *Exochomus*
quadrupustulatus
Pineus pini **188**
pink bollworm see *Pectinophora*
gossypiella
pink hibiscus mealybug see
Maconellicoccus hirsutus
Pinaspis buxi **190**
Pinus armandii **132**
Pinus sylvestris **153**, 449
Pisonia 496
Pisum sativum 124, 124
Pittosporum tobira 227, **228**
Plagiolera versicolora 197, **197**
Planococcus citri **65**, 167, **192**, 222,
496
Planococcus minor **59, 189**
plant antibiosis 504–505
plants
see also crops; host plants
spatial guild partition 344
plant stress 457, 458
plant structure 215–217, 504

- plant surfaces 123–124, 217–218
- plant volatiles
- avoidance of 458
 - conservation 499
 - herbivore-induced 449–450
 - larval response 450–451
 - link to patch preference 457
 - receptors for food-related 450
 - related to aphid density 456
- Platynaspis luteorubra* 55, **81**, **131**, 237, 241, **381**, 404
- Platynus dorsalis* 404
- Pleurotropis* see *Pediobius*
- plum powdery mildew see *Podosphaera tridactyla*
- Plutella xylostella* 124, 170, 504
- Prnigalio agraulis* **386**
- Podisus maculiventris* 145, 354, 354, 532
- Podosphaera leucotricha* **194**, 200
- Podosphaera tridactyla* 201
- poisoning by toxic aphids 157–165
- Policheta unicolor* **385**
- polished lady beetle see *Cycloneda munda*
- pollen, supplementary/alternative food 123, 180–184
- pollinivory 152, 180–182, 185, 200, 282
- pollution and melanic morphs 24, 25, 26
- polyandry 93
- polyazamacrolide alkaloids 456
- pupal defence 76
- polyclonal antibodies, trophic relationships 474–477
- polymerase chain reaction (PCR) 29, 145
- gut-content analysis 478–481
 - species identification **35**, 36
- polyphagous (euryphagous) species see generalist species 150–154
- polyvoltine (multivoltine) species 90
- poplar leaf beetle see *Chrysomela populi*
- population density
- and fecundity 88
 - and larval development 73
- population genetic studies 38–42
- populations of ladybirds, impact of natural enemies 425–428
- Populus* 313
- Porini tribe 9
- post-mortem analysis of predation 474
- antibody-based 474–477
 - prey-specific DNA detection 478–481
 - protein marking 477–478
- post-oviposition period 86
- potato aphid see *Macrosiphum euphorbiae*
- potato ladybird see *Epilachna dregiei*
- potato see *Solanum tuberosum*
- potato tuber moth see *Phthorimaea operculella*
- powdered food, preference for 152
- powdery mildew see *Erysiphe polygoni*
- Praon volucre* 455–456
- precipitin test, predation analysis 474, 475
- precoccinelline 446, 449
- predation 376–382
- see also intraguild predation (IGP)
 - anti-predator defences 376–377
 - chemical protection against 56, 76
 - hemiptera-tending ants 379–382
 - post-mortem analysis 474
 - antibody-based 474–477
 - prey-specific DNA detection 478–481
 - protein marking 477–478
 - social aphids with a soldier caste 382
 - studies quantifying 524
 - traditional study of impact 468–469
 - cage inclusion 470–471
 - field cages 469–470
 - manual removal 471
 - selective exclusion 469
 - predator facilitation 345
 - and biocontrol 361–362
- predators of coccinellids
- ants 379
 - invertebrate 377
 - vertebrate 377
- pre-diapause phase 301–302
- preferential mating 83–85
- pre-oviposition period 77–78
- prepupal stage 73–74
- prey 116
- see also food, see also aphids
 - age, effect on oviposition 227–228
 - alternative 146, 147, 150, 171, 180, 187, 214, 242
 - ant-attended 360
 - anti-predator defences 117–118
 - essential 146, **158**, **162**, 172, 188–195
 - preference 118–119
 - quantifying coccinellid impact 466–467
 - assays of consumption 467–468
 - complex communities 472–474
 - indirect impacts 468
 - post-mortem analysis 474–481
 - statistical approaches 471–472
 - traditional approaches 468–471
- prey abundance see aphid abundance/density
- prey alarm pheromones 451
- prey capture 238–241
- prey choice niches 128
- prey contact
- approach direction 239
 - intensive search behaviour 220, **221**
 - by maxillary palps 223
- prey density
- aggregative numerical response 211
 - aphid infestation 227–228
 - effect on fecundity 88
 - functional response, consumption 204–207
 - and ladybird vagility 234–236
 - minimum threshold 117
 - and oviposition activity 456
 - prey size-density hypothesis 147–150
 - risk to larvae of low 233
- prey discovery, quantifying 471
- prey handling, associative learning 452–453
- prey-induced plant chemicals, attraction to 120, 218–226
- prey preference 118–119
- prey quality
- beneficial effects of 119
 - and larval development 207–208
 - 'problematic' prey 167–169
 - rejected prey 146, 165–168
 - toxic prey 146, 157–165, 452
 - prey selection 153, 207

- prey sex pheromones 451
prey size-density hypothesis
147–151
prey specialization through selection
157
prey specificity 489–490, 523
prey substitutes 169–175
prey suitability 144, 145–147,
173
prey switching 157, 204, 206
prey toxicity 157–165, 451–452
primary parasitoids **383–386**, 390
Priscibrum lituratus **393**
Priscibrum uropygialis **81, 393**
Pristomyrmex pungens **380, 419**
‘problematic’ prey 167–169
Prochiloneurus aegyptiacus **387**
Prochiloneurus nigriflagellum **384**
prolegs, prey detection 223
promiscuity 82
Propylea dissecta **65, 70, 70, 72, 94,**
148, 195, 205, 291
Propylea japonica **22**, 39, **65–66**,
144, **158, 174, 195, 228,**
232, 393, 423
Propylea quatuordecimpunctata **151**,
180, 184, **195**, 355
diapause regulation 291
dispersal from dormancy site
309
hibernation behaviour 313, 321
movement on plant surfaces
217
seasonal distribution of flights
306
protandry 77
protection
eggs 56, 85
pupae 74, 76
protective IGP hypothesis 350–351
protein marking, post-mortem
predation analysis 477–478
protein supplements 187
protogyny 77
protozoan pathogens 419–421
Prunus avium 120
Prunus cerasus **153**
Prunus persica 226
Pseudebenia epilachnae **384**
Pseudoazya trinitatis 236, **384**
Pseudocatolaccus 386
Pseudochermes fraxini **192**
Pseudococcidae (mealybugs) 169,
222, 237
Pseudococcus cryptus 503
Pseudococcus maritimus 237
Pseudococcus viburni 237
Pseudoregma alexanderi **196**
Pseudoregma bambucicola **194, 196**,
382
Pseudoscymnus kurohime see
Sasajiscymnus kurohime
Pseudoscymnus tsugae see
Sasajiscymnus tsugae
Psylla alni **59**
Psylla jucunda 154, **193**
Psylla mali **59**, 154, **189**
Psylla ulmi **59**
Psylla uncatoides **195**
psyllids 174
Psyllobora confluens **66**, 91
Psyllobora vigintiduopunctata 25, **81**,
131, 201, 312, 316, **393**,
399, 417
Psyllobora vigintimaculata **132**, 200,
306, 417, 418
Pterocallis alni **153, 188**
Pterostichus melanarius 479
Pterostyrax hispidus 198
Puccinia 180, 183
Pullus auritus see *Scymnus auritus*
Pullus mediterraneus see *Scymnus*
marinus
Pullus subvillosus see *Scymnus*
subvillosus
Pulvinaria psidii **192**, 496
Pulvinaria urbicola 496
Pulvinaria vitis 152
pupa(e)
colouration 76
defence 76, 357
mean SCP 96
morphology 74–75
prepupal stage 73–74
protection, chemical defence 456
thermal melanism 76
timing of pupation 75
pupation place 75–76
Pyracantha coccinea 201
pyrazines 377, 455
Pyrrhalta luteola see *Xanthogaleruca*
luteola
Pyrrhocoris apterus 327
pyrrolizidine alkaloids 163–164,
165, 445, 446
Quadrastichus ovulorum **385**
quail see *Coturnix coturnix*
quantitative aspects, food relations
201
aggregative numerical response
211–213
food consumption
consumed food, conversion and
utilization of 209–210
effect of physical factors
202–204
effect of prey density: functional
response 204–207
effects on growth and
reproduction 207–209
Quercus rubra 152
quiescence 276, 277, 295
quinolizidine alkaloids 163
radioimmunoassay, vitellogenin
synthesis 328
radish see *Raphanus sativus*
ragwort see *Senecio jacobaea*
Random Amplification of Polymorphic
DNA (RAPD) 33, **34**, 36
Raphanus sativus 121
Rastrococcus invadens 496
Ravinia errabunda **385**
red cedar see *Juniperus virginiana*
red imported fire ant see *Solenopsis*
invicta
red oak see *Quercus rubra*
red spider mite see *Panonychus ulmi*
red-barbed ant see *Formica rufibarbis*
red-capped lark see *Calandrella cinerea*
red-headed flycatcher see *Ficedula*
parva
redistribution of ladybirds, biological
control 496–497
reflex bleeding 376–377, 445
chemical substances 445–449
enemies and competitors 449
molecular genetic studies 29, 42
refractory period, mating 77
refuges
hibernation 500
landscape-scale 127
regression models 471
rejected prey 165–167
relative growth rate (RGR) 73
release of coccinellids, augmentation
495–498
reproduction
and food consumption 208–209
interaction of larval and adult diet
156–157

- reproduction, (continued)
interspecific 85
and longevity 91
net reproduction rate 89, 96
temperature, effects on 96
- reproductive isolation
cytogenetic changes 16, 18
hybridization 85
- reproductive output 90
larval diet linked to 78
- reproductive rate 86, 87
net reproductive rate 89, 91, 96
- reproductive success 42–43
- research, future trends 521–525
- resilience, univoltinism 300
- resistant host plants 91, 164, 200
and biocontrol 504–506
DIMBOA in wheat 164, 169
effect of prey feeding on 169
GM crops 122–123
- respiration rate 75, 287, 304, 326, 327
- Restriction Fragment Length
Polymorphism (RFLP) analysis
33, **34**, 36
- Rhopalosiphum maidis* **148**, 154, 168, **188**, **212**, 212, 225–226
- Rhopalosiphum padi* **188**
- rhythmicity
eclosion 70
hatching 69, 70
mating 70, 82
moulting 70
oviposition 70, 86, 219
pupation 70, 75
- Rhyzobius litura* 155, 183, **195**, 313, **387**, **423**, 424
- Rhyzobius lophanthae* see *Lindorus lophanthae*
- Rhyzobius ventralis* **195**, 241
- ribosomal DNA (rDNA) gene
association with sex chromosomes 15
ITS1 region 32
- Rickettsia* 30–31, 30, 38, 39, 68, 176, 421, **422–423**, 424, 424, 534
- Robinia pseudoacacia* 160
- Rodatus major* **195**, 242, **381**
- Rodolia cardinalis* **94**, 154, 164, 167, 172, 466, 491, 491, **508**, 509, 535
- Rodolia fumida* **385**
- Rodolia guerini* **81**
- Rodolia iceryae* **143**, **386**
- Rodolia occidentalis* **385**
- Rosa multiflora* 201
- rose aphid see *Macrosiphum rosae*
- rose–grain aphid see *Metopolophium dirhodum*
- rose powdery mildew see *Sphaerotheca pannosa*
- rosy apple aphid see *Dysaphis plantaginea*
- rosy leaf-curling aphid see *Dysaphis devecta*
- Rubus occidentalis* 313
- Russian wheat aphid see *Diuraphis noxia*
- rye grass see *Lolium perenne*
- Saccharomyces fragilis* 120
- sagebrush see *Artemisia tridentata*
- Saissetia coffeae* **190**
- Saissetia oleae* 168, **192**, 472
- Salix* **153**
- Sambucus nigra* **153**, 158, 160
- Sambucus racemosa* subsp. *sieboldiana* 160
- sameness
rule of 154–155
- sampling methods 111–114, 469, 471, 522
non-destructive 29
quadrat sampling 112
- sapodilla see *Manikara zapota*
- Sarcophaga helioides* see *Helicobia rapax*
- Sarcophaga latisterna* see *Boettcheria latisterna*
- Sarcophaga reinhardii* see *Ravinia errabunda*
- Sasajiscymnus kurohime* 241–242, 382
- Sasajiscymnus ningshanensis* see *Scymnus ningshanensis*
- Sasajiscymnus tsugae* **66**, 77, **94**, **195**, 358, 471, 493
- Saxicola rubicola* 379
- scale insects, biocontrol 491–492, 496
- scarce seven spot ladybird see *Coccinella magnifica*
- Schizaphis graminum* **157**, 497, 501, 504
- Schizolachnus pineti* **189**
- Schizolachnus piniradiatae* 122, 167
- Schizopepon bryoniaefolius* 198
- scotophase
life events 70
oviposition 86, **299**
pupation 75
- Scots pine see *Pinus sylvestris*
- SCP see supercooling point
- Scymnillini tribe 10
- Scymninae subfamily 5, 9–10
- Scymnini tribe 9, 10
- Scymnodes lividigaster* see *Apolinus lividigaster*
- Scymnophagus* see *Metastenus*
- Scymnophagus mesnili* see *Metastenus concinnus*
- Scymnus (Nephus) quadrimaculatus* see *Nephus quadrimaculatus*
- Scymnus abietis* 72, **131**
- Scymnus aeneipennis* see *Zagloba aeneipennis*
- Scymnus apetzi* **131**, **383**, **401**, **420**
- Scymnus ater* **81**
- Scymnus auritus* 128, **131**, 146, **195**
- Scymnus coccivora* **195**
- Scymnus creperus* **205**
- Scymnus dorcatomoides* **405**
- Scymnus flavifrons* Blackburn (Australia) **132**
- Scymnus flavifrons* Melsheimer (North America) see *Nephus flavifrons*
- Scymnus frontalis* **66**, 77, **81**, 128, **129**, **131**, **195**, 330, **330**, **378**, 505
- Scymnus guttulatus* see *Nephus guttulatus*
- Scymnus haemorrhoidalis* **81**, **129**
- Scymnus hilaris* **174**
- Scymnus hoffmanni* **66**, 85
- Scymnus impexus* **383**
- Scymnus interruptus* **66**, **81**, **131**, 236, **380**
- Scymnus kiesenwetteri* see *Nephus kiesenwetteri*
- Scymnus lacustris* 122, 344
- Scymnus levaillanti* **66**, 71, 88, **89**, **94**, **195**, 210
- Scymnus loewii* **130**
- Scymnus louisianae* 55–56, **66**, 85–86, **87**
- Scymnus marginicollis* **66**, 121
- Scymnus marinus* **66**, **94**, 97, **195**
- Scymnus mediterraneus* see *Scymnus marinus*
- Scymnus morelleti* **387**

- Scymnus nigrinus* **81**, 122, 314, **380, 405**
- Scymnus ningshanensis* 471, 493
- Scymnus ornatus* see *Nephus ornatus*
- Scymnus otohime* **384**
- Scymnus posticalis* **196**, 228, **228**, 360
- Scymnus pyrocheilus* **228**, 229, 356
- Scymnus quadrillum* **389**
- Scymnus rubromaculatus* **81, 131**
- Scymnus sinuanodulus* 55, **55, 66**, 71, 74, 76, 90, **94, 196**
diapause 300
- Scymnus smithianus* 399, **401**
- Scymnus soudanensis* **389**
- Scymnus subvillosus* **66**, 88, 89, **89**, 91, **94, 96, 131**, 159, **196**, 241
- Scymnus suturalis* **81, 129**, 308, 314
- Scymnus syriacus* **66, 94**
- Scymnus tardus* **417**
- searching (foraging) behaviour 213–236
intensive 211, 214, 220
- seasonal changes
in frequency of colour morphs 25, 83–84
and thermal properties of morphs 26–27
and habitat switching 127
- seasonal cycles of crop colonization by coccinellids 503–504
- second hibernation 90, 321
- sedge warbler see *Acrocephalus schoenobaenus*
- selection
directional 28
- selective exclusion, predation impact measure 469
- self-selection model, optimal diets 155
- Selvadiini tribe 9, 10
- Semiadalia undecimnotata* see *Ceratomegilla undecimnotata*
- semiochemicals 214, 445
aggregation 307
aposematism and reflex bleeding 445–449
egg and pupa protection 456
food-related 449–453
future challenges 459–460
future research 523–524
habitat preferences 457–458
hibernation and aggregation 457
mating and sex pheromones 453–454
olfactory response to 224–226
oviposition 454–456
oviposition-detering 229, 231
- Senecio jacobaea* 165, 446
- sensitive stage, pupal melanization 76
- sensory orientation/perception 218–220, 226
earlier observations 220–222
effect of encounter 220
honeydew, arrestant 222
olfaction 224–226
sensory receptors 223
vision 223–224
- septate eugregarines 419–421
- sequence evolution 29–33
ITS-1 region 31–33
mitochondrial DNA (mtDNA) 29–31
- Serangiini tribe 5
- Serangium parcesetosum* **66**, 72, 91, 155, **196**, 353, 416
- serological assays 144, 145
predator-prey research 474–477
- seven spot ladybird see *Coccinella septempunctata*
- sex determination 14–15
- sex differences, antennal receptors 453
- sex pheromones
prey attractant 222, 224
of prey, response to 451
promoting coccinellid mating 453
- sex ratio 77
- sexual activity
longevity, effect on 91
of melanic forms 84
- sexual maturation 76–77
- sexual selection 27
- shifting habitat hypothesis 360
- Shirozuellini tribe 6
- shrubs, sampling from 113
- sibling egg cannibalism 175–177, 233
- Sidis* see *Nephus*
- Sidnia kinbergi* 476
- Sigmoepilachna indica* **385–386**
- Sinapis alba* **58**, 123, 165, 165–166, 225, 452
- Singhikaliini tribe 6
- sinigrin 451–452
- Siphoninus phillyreae* **60, 190**
- Sitobion akebiae* 78
- Sitobion avenae* **61**, 77, 88, **116**
- Sitobion ibarae* **193**, 222, 451
- Sitona discoideus* **393**
- Sitotroga cerealella* **63**, 169
- Sitta europaea* **153**
- sixteen spot ladybird see *Tytthaspis sedecimpunctata*
- size
see also body size
egg 56
egg clusters 56–68
larval instar 73
- sky lark see *Alauda arvensis*
- small cabbage white butterfly see *Pieris rapae*
- smoke pollution and melanism 26
- social aphids, soldier caste 382
- soft brown scale see *Coccus hesperidum*
- soft green scale see *Coccus viridis*
- Solanum japonense* 198
- Solanum nigrum* 198, 199
- Solanum tuberosum* 198, 452
- Solenopsis invicta* 236, 502
- Solidago canadensis* 126
- song thrush see *Turdus philomelos*
- Sospita vigintiguttata* **407**
- southern house mosquito see *Culex quinquefasciatus*
- sowthistle aphid see *Hyperomyzus lactucae*
- soybean aphid see *Aphis glycines*
- Spanish broom see *Spartium junceum*
- spartein 163, 167
- Spartium junceum* 167
- spatial guild partition 344
- spatial matching, predator-prey 211
- spatial niches 128
- specialist species 142–143, 150–152, 154
non-abundant nutrient concept 154–155
role in biological control 490
- speciation 16–18
- species identification
molecular genetic studies 33–37
pupal colouration providing 76
- species specific chemistry
oviposition deterrence substances 454–455
reflex bleeding substances 448–449
- spermatheca **296, 318, 320**

- spermatophores **425**
 nuptial gift 83
 protein source 173–174
 sperm competition 42–43, 83
Sphaerotheca castagnei 184, 200
Sphaerotheca cucurbitae 200, 201
Sphaerotheca pannosa 200, 201
 spider-mite destroyer see *Stethorus punctum*
 spiders 354, 358, 377–378, 449
Spiladelphia barovskii kiritschenkoi see *Ceratomegilla barovskii kiritschenkoi*
 spined soldier bug see *Podisus maculiventris*
Spiraea **66**
 spiraea aphid see *Aphis spiraeicola*
 spiralling whitefly see *Aleurodicus dispersus*
Spiroplasmataceae 30, 30, 68, 176, 421, **422**, 424–425
Spodoptera litura 379
 spores, fungal 180
 collection of by larvae 183
 found in gut 180
 spot pattern, variation in 19–20, 20, **21–22**, 22, 24, 25
 spotted alfalfa aphid see *Therioaphis trifolii*
 spotted flycatcher see *Muscicapa striata*
 spotted lady beetle see *Coleomegilla maculata*
 sprays of food substitutes 187, 222, 499
 spruce aphid see *Elatobium abietinum*
 squash beetle see *Epilachna borealis*
 squash or pumpkin see *Cucurbita maxima*
 starvation 202
 aphid defensive measures causing 241
 foraging activity, effect on 218, 221
 and ovarian development 78, 82
 pollen feeding preventing 181
 temporary, effect on reproduction 209
 statistical approaches, predation 471–472
 steelblue lady beetle see *Halmus chalybeus*
 stenophagous species see specialist species 154
Stenotarsus rotundus (Endomychidae) 276
 Stethorini tribe 9–10
Stethorus bifidus **66, 196**, 206, 206
Stethorus gilvifrons **67**, 90, 96, 167, **196**, 498
Stethorus japonicus **67, 94**, 187, **196**, 300
 diapause 300
Stethorus loxtoni see *Parastethorus nigripes*
Stethorus madecassus **143**
Stethorus picipes see *Stethorus punctum picipes*
Stethorus punctillum see *Stethorus pusillus*
Stethorus punctum 145, **196**, 218, 224, 493
Stethorus punctum picipes **143**, 221, 299, 450, 499
 diapause 299–300
Stethorus pusillus 56, **81**, 82, 89, 90, **94**, 96, **131**, **143**, 167, 183, **196**, 217, **218**, 299, 313–314, 322, 353, 378, **417**, 418, 490, 493, **533**
Stethorus species, biocontrol 490
Stethorus tridens **196**, 205
Stethorus vegans 490
 Sticholotidinae subfamily
 characteristics 5–6
 division of 3–4
 sticky cards, sampling 113
 stinging nettle see *Urtica dioica*
 strawberry aphid see *Chaetosiphon fragaefolii*
 strawberry bug see *Calocoris norvegicus*
 strip cutting/harvesting 126, 501
 striped ladybird see *Myzia oblongoguttata*
 striped mealybug see *Ferrisia virgata*
Strongygaster triangulifera **386**
Sturnus vulgaris 379
Styrax **382**
Subcoccinella vigintiquatuorpunctata 28, 39, **67**, 76, **81**, 312, 378, **385–386**, **389**, 456
 subfamilies (of Coccinellidae)
 characteristics of 5–10
 classification changes 3–5
 parasitoids of **390**
 proposed classification 5, 6
 subnivean hibernators 328, 329
 substitute diets 185–187
 substitute prey 169–185
 substrates
 foraging (host plant) 206–207
 oviposition 85–86, 119–120
 pupation 75–76
 sucrose, alternative diet 169–170, 185, 222
 sugar beet and garden beet see *Beta vulgaris*
 sugar cane scale see *Aulacaspis tegalensis*
 sugar cane woolly aphid see *Ceratovacuna lanigera*
 sugar spraying 187, 222
 suitability of food/prey 144, 145–147, **173**
 food combinations 155, 156
 Sukunahikonini tribe 5
 sulphur dioxide pollution 26
 sum of effective temperatures (SET) 92
 relationship with LDT 92, **93–94**, 95
 teneral pre-oviposition period **96**
 sunflower see *Helianthus annuus*
 sunshine hours and melanism 26
 supercooling point (SCP) 96, 328–329
 outdoor and indoor overwintering 331
 supergenes 22
 supernumerary (B) chromosomes 15–16
 supplementary food 123
 supranivean hibernators 328, 329–330
 survival
 on aphid prey **149, 162**
 on artificial diets 186
 hibernating on higher ground 305
 overwintering **308**, 312, 328–330, 331
 on plant foods 199
 and temperature extremes 96–97
 swarms 235–236
 sweeping, sampling method 112
 sweet orange see *Citrus sinensis*
 swede midge see *Contarinia nasturtii*
 sycamore aphid see *Drepanosiphum platanoidis*
Sylvia atricapilla 379

- Sylvia borin* 379
Sylvia communis 379
Sylvia curruca 379
Sylvia nisoria 379
Symphoricarpos rivularis 120
Symydobius oblongus **143**
synchronization of hatching 56, 68–69
Synharmonia conglobata see *Oenopia conglobata*
Synona obscura **405**
Synonycha grandis 57, **67**, 163, **196**, 382, 498
Syntomosphyrus taprobanes see *Oomyzus scaposus*
syrphid larvae, attack by 358
Syrphoctonus tarsatorius **388**
- Tachyporus* sp. 277, 288
take-off, flight behaviour 77, 304
Talinum triangulare 169
Tamarix 200, 361, 470
Tamarixia radiata 361, 470
Tanacetum vulgare 126
Tandonia budapestensis 477
tansy see *Tanacetum vulgare*
Tapinoma nigerrimum **380**
Taraxacum officinale 501
tarnished plant bug see *Lygus lineolaris*
Tasmanian ladybird see *Cleobora mellyi*
tawny pipit see *Anthus campestris*
tea aphid see *Toxoptera aurantii*
Telsimiini tribe 5, 8
temperature
adult size 78
and development 91–97
determining course of events in adult life 95–96
relationship between LDT and SET 92–95
and diapause 276–279, 280, 285, 289
effects of low 328–332
extremes, tolerance to 96–97
fecundity 88, 89, 90, 96
and food consumption 202–203
and frequency of short flights 234
hatching rate varying with 68
life span decrease with 90–91
and melanism 26
mating advantage 26–27
and oviposition 233
oviposition period 88
pupal colouration 76
pupal size 74
pupation timing and 75
and rate of natural increase **143**
reproduction, effect on 96
storage, developmental stages 332
tolerance to extreme 96–97
temporal guild partition 344
temporal niches 128
temporal patterns, prey density 211
temporal variation, colour pattern polymorphism 25
ten spot ladybird see *Adalia decempunctata*
teneral development 76–77
thermal requirements 95–96
terpenoids, coccinellid avoidance of 458
testicular follicles, diapause 283, 310, 318, 321–323
tethered flight 303, 315–316
Tetrabrachini tribe 9
Tetramorium caespitum **381**
Tetranychus evansi 119, **196**, **205**, 224
Tetranychus lintearius 119, 200, 224, 299, 498, 506
Tetranychus mcdanieli 196, 490
Tetranychus telarius see *Tetranychus urticae*
Tetranychus urticae **67**, 152, 187, **196**, **354**, **532**
Tetrastichus coccinellae see *Oomyzus scaposus*
Tetrastichus cydoniae **386**
Tetrastichus decrescens **385**
Tetrastichus epilachnae **385**
Tetrastichus 409
Tetrastichus orissaensis **386**
Tetrastichus melanis see *Oomyzus scaposus*
Tetrastichus sexmaculatus see *Oomyzus scaposus*
Thalassa saginata 76
Thanatus 354, 532
Thea vigintiduopunctata see *Psyllobora vigintiduopunctata*
Thelaxes dryophila **189**
thelytokous parthenogenesis 391, 406
Therioaphis maculata see *Therioaphis trifolii*
Therioaphis trifolii **193**, 211
thermal constants 92
thermal guild partition 344–345
thermal melanism, pupae 76
thermal microhabitats 75
thermal window 95
thermoregulatory basking 125
thirteen spot ladybird see *Hippodamia tredecimpunctata*
Thomsonina see *Nothoserphus*
three-banded lady beetle see *Coccinella trifasciata*
three-striped lady beetle see *Brumoides suturalis*
Thrips tabaci 75, 174
thrush nightingale see *Luscinia luscinia*
tiger moths see *Arctia*
tillage, reduction of 502, 503
tobacco budworm see *Heliothis virescens*
top predators, coccinellids as 354–355
total food consumption 202–204
toxicity, pesticides 506–509
toxic prey 146, 157–165
toxic substances in prey 451–452
toxins, insect-resistant GM crops 505–506
Toxoptera aurantii **225**, 450
Toxoptera citricidus 146, 163, 196
control of 494
Toxoptera graminum see *Schizaphis graminum*
tracks, larval, oviposition deterrence 229–233
trade-offs, genetic 28–29
transgenic plants 122–123
transverse lady beetle see *Coccinella transversoguttata*
traps for sampling 113–114
tree pipit see *Anthus trivialis*
tree sparrow see *Passer montanus*
trees
age of 122
and coccinellid abundance **131**, **132**
habitats 129
sampling from 113
Trialetrodes vaporariorum **66**, 174, **195**
triangular fecundity function 86, 87
Trichogramma evanescens 170, 353
Trichogramma 358, 363, **386**
Trichomalopsis acuminata **386**

- Trichomalopsis* **386, 389**
Trichomalopsis dubia **389**
 trichomes 200, 217, 227, 353, 504
Trichoplusia ni 170, 353, 479
Trichosanthes kirilowii 201
Tripleurospermum maritimum 117, 121
Tripolycystus see *Metastenus*
Triticum 153
 tritrophic studies 196–198
 trophic eggs 69, 177
 trophic pathway 475, 476, 477, 481
Tsuga 153, 175
Tuberculatus annulatus **58, 153, 158**
Tuberolachnus salignus **153, 188**
Tubulinosema hippodamiae 418–419
Turdus merula 379
Turdus philomelos 379
 turnip aphid see *Lipaphis pteudobrassicae*
 twelve spotted ladybeetle see *Coleomegilla maculata lengi*
 twenty four spot ladybird see *Subcoccinella vigintiquatuorpunktata*
 twenty-spotted lady beetle see *Psyllobora vigintimaculata*
 twenty two spot ladybird see *Psyllobora vigintiduopunctata*
 twice-stabbed lady beetle see *Chilocorus stigma*
 two spot ladybird see *Adalia bipunctata*
 two-spotted spider mite see *Tetranychus urticae*
Typha latifolia 152
Tyria 164
 Tythaspidini tribe 6–7
Tythaspis sedecimpunctata **81, 131, 142, 155, 183, 184, 200, 241, 309, 312, 378, 393, 399, 420**
 diet of 200–201
 dormancy behaviour 312–313
 mandible 183
Tythaspis trilineata see *Coccinella nigrovittata*
Uga colliscutellum **400**
Uga coriacea **400**
Uga digitata **400**
Uga hemicarinata **400**
Uga javanica **400**
Uga menoni **400**
Uga sinensis **400**
Uga species 399, **400, 400**
Ulmus 314
Unaspis citri 492
Unaspis euonymi **190, 202**
Unaspis yanonensis **190**
 univoltine species 90
 univoltinism
 Chilocorus spp. 298
 C. septempunctata 279, 280, 281, 283, 284, 285
 Hip. convergens 292
 potential multivoltines 286–287
 resilience 300
 upper temperature threshold 92
Uroleucon aeneum 158, **191**
Uroleucon ambrosiae 163
Uroleucon cichorii **217, 238**
Uroleucon cirsii **153, 188, 191, 195**
Uroleucon compositae **61, 148, 195**
Uroleucon formosanum **195**
Uroleucon jaceae **195, 217**
Uroleucon nigrotuberculatum 126
Uroleucon species **148, 216, 217, 238**
Urtica dioica 117, 121, 126, 150, **153, 501**
 vacuum sampling, D-Vac 112
 vagility, interspecific differences in 234
 variegated lady beetle see *Hippodamia variegata*
 vedalia beetle see *Rodolia cardinalis*
 vegetation diversity and aggregative numerical response 213
Verania see *Micraspis*
Verbascum thapsus 312
 vertebrate predators 377
 vertical distribution of coccinellids on host plant 122, 125
Verticillium lecanii see *Lecanicillium lecanii*
Vesiculaphis caricis **191**
 vetch aphid see *Megoura viciae*
 vetch or tare see *Vicia sativa*
Vibidia duodecimguttata **81, 313, 316, 378**
Vicia faba **58, 88, 91, 123, 160–161, 165, 169, 196, 197, 210, 225, 237, 452**
Vicia sativa 160
Vigna unguiculata subsp. *cylindrica* 160
 Virginian pencil cedar see *Juniperus virginiana*
 vision 222, 223–224, 239
 visual counting, sampling method 112
 vitellogenin synthesis 327–328
 volatiles, plant 200, 224–226, 449–451
 link to aphid density 456
 link to patch preference 457
 voltinism 90, 300–301, 301
 see also bivoltinism; multivoltinism; univoltinism
 voracity 155, 489
 quantifying 467–468
 walnut aphid see *Chromaphis juglandicola*
 warm acclimation 326
Wasmannia auropunctata 449
Watanabeia see *Nothoserphus* 404
 water content, diapause 326
 water ladybird see *Anisosticta novemdecimpunctata*
 wax moth see *Galleria mellonella*
 waxy surfaces
 aphid prey 165, 166
 and biological control 504
 host plants 124, 206, 217–218
 larval protection 236, 237, 241
 weeds, positive effect of 120, 121, 126
 weight
 adults 78–82
 egg clusters 57
 eggs 56
 larvae 73
 pupae 74–75
 western corn rootworm see *Diabrotica virgifera*
 western plant bug see *Lygus hesperus*
 wheat bug see *Nysius huttoni*
 wheat see *Triticum*
 white (or yellow) mustard see *Sinapis alba*
 wild herb habitats 127, 128, 129, **131**
 willow aphid see *Tuberolachnus salignus*
 willow warbler see *Phylloscopus trochilus*
 window traps 113, 305
 wing polymorphism 27–28
 wings and winglessness 77

-
- Withania somnifera* 410
Wolbachia 30, 30, 38, 39, 68, 176,
349, 421, **422–423**,
424–425
wood ant see *Formica rufa*
wood nuthatch see *Sitta europaea*
woolly apple aphid see *Eriosoma*
lanigerum
woolly vine scale see *Pulvinaria vitis*
wormwood see *Artemisia vulgaris*
Xanthogaleruca luteola 170
Xy parachute (Xyp) system 14–15
yellow lupin see *Lupinus luteus*
yolk, eggs 55, 56, 82
Y-tube olfactometers 222, 223, 224,
225
(Z)-jasmone 450
(Z)-pentacos-12-ene, in larval tracks
231, 455
Zagloba aeneipennis 236
Zea mays 152, 182, 182, 227