Aster 154
Atriplex 154
Aulacomya ater 391
autochthonous nitrogen 14, 19, 22, 24, 53, 206
Avicennia 154
Azospirillum 87
Azotobacter 87, 109
  A. chroococcum 86

bacteria 8, 10, 60
  and ammonification regeneration 17–18, 51
  chemolithautotrophic, growth yields of 79
  as consumers of ammonium 8
  denitrifying 267–70
  diazotrophic 114
  direct counts of 182
  flux of materials through 384–8
  green sulfur 92
  heterotrophic 103, 110, 222, 344
  hydrocarbon-oxidizing 94
  hydrogen-oxidizing 90
  methanogenic 90, 162, 163
  and mineralization 4, 8, 61, 175–7
  nitrate-reducing 267–70
  nitrifying 222, 223, 225–6, 230, 231
    potential activities of 212–13
  nitrogen assimilation by 181
  nitrogen regenerating 380–1
  nitrogen-fixing 86–92
  non-photosynthetic 76
  photosynthetic 92
  production 175–90
  quaternary amines in 152–4
  remineralization of 4, 8
  substrates utilized by 382–4
  sulfate-reducing 136, 162, 177, 180
  sulfide-oxidizing 77, 90, 113
Beggiatoa 78, 79, 87
benthic fauna 275–99
  and mineralization 275, 276, 283–9
benthic flux 18
benthic food chains 191–206
benthic nitrogen fixation 85–123
  and oxygen 99, 100–2, 114
benthic nitrogen recycling, modelling of 364–72
benthic photosynthesis 69–76, 79–80
benthos
  and ammonium regeneration 17
  mineralization 175–90
  mobile 324
  nitrogen regeneration by 380
  nutrition, role of nitrogen in 191–2
  sedentary 324
Beta 154
betaines 145–6
biogenic microenvironments 301–2
biogenic particle mixing 275–6, 277–8
biomass 4
Bryopsis 154
burrows, infauna 227–30, 276
  ammonia production in 227–30, 285–8, 289, 319–20
  composition and geometrical structure of 280
  linings 227–9, 280–1, 284, 289
  microenvironments 302–10, 330–1
    and bulk sediment distributions 315–28
    models of 316–18
  nitrate in 292–3
  nitrification
    of walls of 227–9, 319–28
    and denitrification in 289–93
  oxygen supply to 229, 230, 281–2, 302–3
  quantification of solute distributions around 310–15
  ventilation of 277–80, 289
  water irrigation of 277, 284, 303, 332
γ-butyrobetaine 153

cadaverine 128
Calanus 131
Campylobacter 87
Capitella capitata 196, 197
'carbon conversion efficiency' 385
carbon dioxide and nitrification 223–4
carbon flux, organic 209, 379–80
carbon:nitrogen ratios 39–40, 61, 62, 136–7, 191, 212, 219, 222, 360–1, 364
  in community nitrogen models 384, 386–7, 390–1, 393–4, 395, 406–7
carbon:phosphorus ratios 61
Carmarthen Bay
  ammonification in 432–3
  bay circulation 424–5
  bay fronts 434–5
  conceptual nitrogen flow model for 416, 417, 419

Index

Abra 276
Acartia clausi 435
acetone 211
'acetylene inhibition technique' 259–61, 270
acetylene reduction
  assay 86, 87, 93–4, 95–6, 103–4, 114
  effect of oxygen on 102
  rates of, and nitrogen fixation 110
acridine orange direct counts 385
acrylic acid 145
adenosine assimilation 181–2, 183
Aeromonas 268
α-alanine betaine 145, 146, 162
algae 35, 154, 199
  blue-green 34
  green 49
  nitrogen uptake by 35–40
  quaternary amines in 154
alkyl amines 143
allochthonous nitrogen 4, 5, 14, 17, 19, 22, 24, 53, 207
allylthiourea (ATU) 211
amines
  analysis of free 128
  distribution of 125–41
  hydrolysis of 127
  see also alkyl amines; quarternary amines
amino acids 24, 34
  analysis of free 127–8, 180
  distribution of 125–41
  hydrolysis of bound 127
  and plankton 131, 128–37
amino compounds, particulate 128–37
  decomposition of 134–5
  in sediments 135–7
  transformation of 131–4
ammonification 233, 239–40, 432–3
ammonium (NH_4^+) 3, 9, 33, 34–5, 41, 51–3, 206
  bacteria consumption of 8
  cycling 7
  exchange measurements of 179
  flux across sediment–water interface 370–2
  incorporation of 183–4
  inhibition threshold 47–8
  and nitrification 223
  nitrogen fixation and 102–7
  oxidation 78–9, 206
  plankton utilization rates of 8, 13, 44
  production in burrows 227–30, 285–8, 289, 290, 319–20
  profiles, effect of burrows on 319–20
  regeneration 17–19, 63
    benthos 17
    time scale of 18–19
  regional and seasonal variation in 21, 22
  remineralization 17, 23
  and sediment incubations 178–9
  sediment production rates of 329–30
  turnover of 52–3
  uptake 20, 37, 47, 63
    calculation of 10–12
    light requirement for 38–9
    maximum specific rate of 6–7
    short-term 7–8
ammonium tetrathiocyanodiammonochromate (Reineche salt) 147
amoebae 59
Ampelisca 233, 236
Amphitrite 276
  A. ornata 280–1, 287, 304
Anabaena 91
anoxyphotobacteria 82, 109
Arenicola marina 229
Aroclor 1254 109
arsenobetaine 158, 162, 166–7
arsenofuranoside 167
arsine 167

nitrate distribution 429–32
nitrogen budget of 432–3, 437–8
nutrient distributions in 419–24
physiography 415–17
seasonal distribution of nitrogen in 425–9
water residence time in 424–5
zooplankton excretion in 435–6
cellular nutritional status, indices of 15–17
Ceramium 154
Ceriantheopsis 306, 307
Chaetomorpha 154
Chaetopterus variopedatus 280
chemiluminescent technique
for determination of nitrate 8–9
chemostat enrichment technique 268
Chenopodium 154
CHN analysis 385
choanoflagellates 60
choline 143, 145, 151, 161, 162, 165–6
choline oxidase 151
Chromatiaceae 92
chromatography
gas 126, 128, 130, 148–9, 151, 252
EC (electron capture) 259
high-pressure liquid (HPLC) 126, 127, 128, 131, 146, 149, 151, 152
ion exchange 146–7, 148, 149–50, 152
thin-layer 148, 151
ciliates 59, 60–1
Cladophora 154
Clostridium 87, 162
C. sporogenes 162
Clymenella torquata 276
Codium fragile 109
'conveyor-belt' feeders 192, 276, 277
coprophagy 194–5
Corophium 276, 302, 322
C. volutator 282, 289, 293
cyanobacteria 34, 49, 60, 75, 76, 91, 94, 109
and quaternary amines 153–4
cytochrome c 225

dansyl chloride 128
DDT 109
denitrification 208, 222, 233–8, 239, 331, 364–5
by benthic fauna 275
in burrows 289–93
diel variation of 266–7
in marine sediments 251–72
assays of 255–61
'potential' for 268–70, 271
regional variation of 261–4
seasonal variation of 264–6, 365, 367–9
denitrifiers 94
deposit feeders 192
Desulfovibrio 162, 166
detritivores 191
'metabolic requirements of' 199
potential and food resources for 193–4
detritus 14, 97
'aging' 195
nitrogen changes in 197–201
food chain 193–7
temporal changes in food resources to 201–2
'diagenic modeling' 240, 242
diatoms 80, 199, 226–7
dimethylamine (DMA) 126, 134, 136–7, 143, 159, 162, 166
dimethyloxyarsylethanol 167
dimethylsulfide (DMS) 144, 145, 151–2
dimethylsulfoniopropionate (DMSP) 145, 151–2, 154, 155, 162
'dinitrogenase' 86
dinoflagellates 61
Diploliamella chitwoodi 197
dissolved organic carbon (DOC) 388, 389
dissolved organic matter (DOM) 225, 360, 388
dissolved organic nitrogen (DON) 253, 254, 275, 427–8
Dragendroff's reagent 148

Ecklonia maxima 388
ectoin 146
Ectothiorhodospira 146, 152
'effective distance' 242
endrin 109
Enteromorpha 154
ethylene production 93, 94–5
Eubacterium limosum 162, 166
euphotic zone 4
eutrophication 49–50
exchange measurements 179

'*f*' ratio 16, 17, 21–2
faecal pellets 134, 237, 276, 293–4, 295, 378
  and deposit feeders 193–6
  microbial oxygen consumption in 294
  potential nitrification of 230, 290
Fick's Law 319
flagellates 61
  grazing rates of 60
  heterotrophic 60
  non-photosynthetic 59
fluorescamine 128
food chains
  benthic 191–206
  detritus-based 193–7, 201–2
  pelagic 59–65
formaldehyde 161, 162
frequency of dividing cells (FDC) 182

gas chromatography 126, 128, 130, 148–9, 252
  electron capture 259
Gigartina 154
glucosylglycerol 154
glutamine synthetase 86, 102, 106
glycine betaine (GBT) 145–6, 148, 149–50, 153–6, 158–60, 161–2, 165–6
gradient measurements 180
Gyrodinium 396
  G. aureolum 46

Halobacterium 152
Halococcus 152
Halodula wrightii 110
Halomonas 152
heptachlor 109
Heteromastus filiformis 276
high-pressure liquid chromatography (HPLC) 126, 127, 128, 131, 146, 149, 151, 152
Hoffman elimination 144–5, 151
homarine 162
Hydrobia 195
hydrogen sulphide 285
hydroxylamine 208, 210, 240
4-hydroxystachydrine 154

incubation experiments 5–12
  and direct counts 182
  sediment 178
  ^{15}N-ammonium 178–9
indices
  of cellular nutritional status 15–17
  of nitrogen nutrition 40–3
ion exchange chromatography 146–7, 148, 149–50, 152
isotope dilution 10–11
  N-fertilizer 99
isotope tracer techniques 5–12, 33
  ^{13}C 6
  ^{14}C technique 6
  ^{15}N technique 6, 34, 209–10, 257–9, 261, 270
  $^{15}NH_4^+$ 10–11, 12
  NH_4^+ 6
  NO_3^+ 6
  ^{18}O 6
  problems associated with 6–9, 37

Juncus 154

kelp 388–94
  C:N flow model for 290–4
kinetics
  of isotopes 13
  Michaelis–Menten 223, 349, 402
  'multi Gs—first-order' 358–60
  of sedimentary processes 355–64
Klebsiella pneumoniae 153

Laminaria 293
  L. pallida 388
Lanice conchilega 290
light 4
  limiting productivity 3
  and nitrate uptake 38
  and nitrification 224–5
  and nitrogen fixation 99, 100
  and nitrogen uptake 38–9
Limonium 155
Limulus polyphemus 161
Littorella uniflora 233
Littorina littorea 293

Macoma 276
  M. baltica 230, 293, 294
macroelectrodes 70
macrofauna 80
  and nitrification 227–31, 240
  reworking by 276–7
macroplankton 59
macrozooplankton 14
  and ammonium regeneration 18–19
mannitol 388

mass spectrometry 97
  membrane leak 99
meiofauna 80, 283
Mercenaria 233, 236
Mesodinium rubrum 59
methane 143, 162, 163, 165
methane oxidizers 93
Methanococcus 162
methanogens 93
methanogenesis 144, 163–5
Methanosarcina 162
methionine sulfoximine 96
L-methionine-D,L-sulfoximine (MSX) 104–6
methyl amines 156, 161, 162, 163, 165, 166
methylamine 126, 128, 143
Michaelis–Menten kinetics 223
microalgae 34, 69, 73
'Microbial Exchanges and Couplings in Coastal Atlantic Systems' (MECCAS) 17
Microcoleus 109
microelectrode technique 69–76, 253
'microheterotrophs' 51, 53
microplankton 14, 19, 22–4, 59
  and ammonium regeneration 17–18
  rates of nitrogen release by 10
microzooplankton 8, 12, 14, 18
mineralization 61–3
  bacterial 4, 8, 61, 175–7
  benthic 175–90
    fauna 275, 276, 283–9
  pelagic 5
  rates of 177–80
  in sediments 358–61
  specific N-substrate 180
  zones of 176–7
models 343
  of benthic nitrogen recycling 364–72
  of burrow microenvironments 316–19
  C:N 184–5
  closed system
    three-compartmental 344–7
    seven-compartment 348–51
  conceptual, for community material fluxes 380–8
  for development of bay fronts 434–5
  diagenic 240, 242, 255
  diffusion analogue mixing 277
  diffusion-advection 255, 261
  diffusion reaction 310, 318
  euphotic zone 402–4
  of Fick's Law 319
  flow, for Carmathen Bay 416, 417, 419
  freshwater and seawater mixing 419–22
  for kelp 390–4
  nitrification and denitrification 235, 237–8, 240–1, 312–13
  nitrogen flow, for pelagic system 394–401
  nitrogen mass balance 401, 402
  open system 352–5
  of potential food resources to detritivores 193–4
  pycnocline zone 404–6
  of radial distribution around burrows 310–15
  of season variations in nitrogen cycling 343–55
  source-sink 328–9
molybdenum 100
monomethylamine 126, 159
montmorillonites 137
most probable number (MPN) 213–15, 219, 230, 267–8
Mucrogammorus mucronatus 197
muramic acid 133
Mya arenaria 289
Myriophyllum spicatum 232
Mytilis edulis 230

^{15}N isotope technique 6, 34, 209–10, 257–9, 261, 270
nanoplankton 19, 59
Neanthes japonica 237
near-saturating levels 10
Nephtys 233, 236
Nereis 289, 302, 312
  N. diversicolor 276, 281
  N. succinea 391
  N. virens 230, 231, 237, 278–80, 281, 282, 284, 286, 287, 288, 290, 292, 293, 295, 308
netplankton 19
'new nitrogen' 41, 51, 85
  rates of supply of 19–23
  supply and utilization 43–50
    in open shelf waters 43–6
    in inshore waters 47–50
  thermal stratification and 46

'new production' 3, 4, 13, 44, 372, 374, 398
see also 'new nitrogen'
nitrapyrin (N-serve (2-chloro-6-trichloromethylpyridine)) 210–12
nitrate 3, 33, 53
in burrows 292–3
chemiluminescent determination of 8–9
distribution in Carmarthen Bay 429–32
exchange 179
flux 13, 21–2
across sediment water interface 370–1
and 'new production' 44
and nitrification 207–9
and nitrogen fixation 106–7
pelagic concentrations of 34–5
porewater distributions of 322–3
profiles 252–3
reduction 251–73
assays of 255–61
pathways of microbial 251, 252
'potential' for 268–70
in sediments 361, 363–4
regional and seasonal variation in 21, 46
transport 14
uptake 20, 37–8, 47
light requirement for 38
utilization, ammonium inhibition of 47–8
'nitrate ammonification' 252
nitrate reductase 161
nitrate utilization ratio (f') 44–6, 47
nitric oxide 240
nitrification 206–49, 253, 331
ammonification, denitrification and 233–8
ammonium and 223
by benthic fauna 275
in burrows 289–93
carbon dioxide, pH and 223–4
diatoms and 226–7
diel cycles of 218
and dissolved organic matter 225
effect of temperature on 220–2
of faecal pellets 230, 290
^{15}N isotope dilution and 209–10
inhibition of 210–12
light and 224–5
and macrofauna 227–31, 240
macrophyte effects on 232–3
measurement of 209–15
and nitrate 207
in nitrogen and oxygen budgets 238–40
oxygen and 209, 215, 217, 219–20, 222–3, 238–9, 243
potential, at sediment surface 230–1
and salinity 224–5
sediment 209, 243, 361–3
and sediment nitrogen budgets 239–40
spatial patterns of 218–20
and sulfur compounds 225
surface area and 225–6
temporal patterns of 215–18
nitrification:denitrification (N:D) 234–5
nitrification-denitrification processes, diurnal variations in 77
nitrifiers 93
nitrite 3, 4, 34, 48, 253
exchange 179
reduction, microbial 251
Nitrobacter 208, 222, 223
N. agilis 214
nitrogen assimilation
in Carmarthen Bay 432–3
rates of 181–4, 186
nitrogen budget 295
in Carmarthan Bay 432–3, 437–8
nitrification in 238–40
'nitrogen conversion efficiency' 385
nitrogen diagenesis 369–72
nitrogen fixation
and acetylene reduction 110
ammonium, nitrate and 102–7, 114
bacterial 86–92, 232
benthic 85–123
factors regulating 99–109
inhibitors of 107–9
and light 99, 100
in marine environments 109–14
methods of determining 92–9
and nitrogenase 85–6, 100
and organic substrate 107, 114
and oxygen 99, 100–2, 114
and pH 100
rates, calculation of 96
seasonal patterns of 100

nitrogen nutrition, indices of 40–3
nitrogen uptake
  calculation of 10–12
  and light 38–9
  nonlinearity in 8
  rates 35–40, 53
nitrogenase 87, 90–3, 96, 99
  and nitrogen fixation 85–6, 100
    root/rhizome 110
    in shallow sediments 111
Nitrosococcus oceanus 214, 223
Nitrosomonas 208, 220–5
  N. marina 214
  N. oceanus 225
nitrous oxide 208, 222, 240
Noctiluca scintillans 435
nuclear magnetic resonance (NMR) 146
Nucula 233, 236
nutritional status, indices of 15–17

Oceanospirillum 87
Onuphis 306, 307, 308, 309
  O. jenneri 290
'operational diffusivity' 242
ornithine 133
Oscillatoria 109
oxic-anoxic interface 76, 77–9, 81, 102, 306, 330
oxygen
  accumulation and utilization rates 14
  and benthic nitrogen fixation 99, 100–2, 114
  effect on acetylene reduction 102
  flux 209, 215, 217, 232
    across sediment-water interface 370–1
  microbial consumption of, in faecal pellets 294
  and nitrification 209, 215, 217, 219–20, 222–3, 238–9, 243
  penetration into sediments 213, 281, 302–3
  photosynthetic activity, microprofile of 70–2
  profiles 69–83, 252–3
  supply to burrows 229, 230, 281–2, 302–3

particulate matter
  amino nitrogen compounds in 128–37
    decomposition of 134–5
    sources of 129–31
    transformation of 131–4
  flux of 21–2
  in sediments 138
particulate organic carbon (POC) 383, 385, 387, 391, 402, 404, 407
particulate organic matter (POM) 402
particulate organic nitrogen (PON) 13, 14, 21, 22, 137–8
PCP 109
pelagic food chains 59–65
pelagic primary production 33–57
pH
  benthic nitrogen fixation and 100
  microprofiles 70–2
  and nitrification 223–4
Phaeocystis 154
phenanthrene 109
phosphate 3, 80
phospholipid measurements 183
phosphorus 33
photosynthesis
  'anoxygenic' 75, 76
  benthic 69–76, 79–80
    depth distribution of 74
    rates of 74–5
  oxygenic 70–2, 76
  phytoplankton 33
o-phthaldialdehyde (OPA) 127–8
phytoplankton 12, 14, 19, 21–4
  amino acid composition of 131
  ammonium utilization rates 13, 44
  biomass 3
  bloom 397–8
  decomposition rates 135
  deposition 357–8
  growth, rates of 3, 4
  index of grazing pressure on 17
  models of 344–55
  nitrate uptake by 13, 21
  nitrogen regeneration 4
  nitrogen uptake in 8, 35–40
    water column rates of 4
  nutritional status of 15–17
  photosynthesis 33
  production 12–13, 379
  seasonal variations in 343–4
  sinking 356–7
  zooplankton grazing and 4
picoplankton 59

plankton
and amino acids 131
and sediments 341
utilization rates of 8, 13, 44
planktonic food web, new paradigm of the 59
Pleurobrachia pileus 436
polyols 156
polyunsaturated fatty acids (PUFA) 199
Posidonia 155
Potamogeton perfoliatus 232, 233
predator-prey interactions 63
primary production 3–31
benthic 69–83, 294
methods for determining 5
nitrogen 35–40
pelagic 33–57
Prochloron 91
produced dissolved organic carbon (PDOC) 381, 382–3, 385, 387–8, 389–90, 391–2, 394, 401–2, 407
protozoa 17, 59, 62, 80, 199
Pseudocalanus 435
putrescine 128, 134
Pygiospio 302

quarternary amines 143–73
in algae 154
in animals 156–8
in bacteria 152–4
chemistry of 144–6
distribution of 144, 152–60
function of 143–4
methods for the analysis of 146–52
physiology and metabolism of 144, 160–7
in plants 154–6
in sediments 158–60

radiotracers 150–1
'Redfield ratio' 39, 77, 255, 407, 419, 422, 432, 437
'regenerated nitrogen' 19–23, 41, 42, 207, 372
supply and utilization of 51–3
'regenerated production' 3–4, 398
see also 'regenerated nitrogen'
Reineche salt 147
relative preference index (PRI) 42–3
remineralization 10–12, 17, 23
Rhizobium meliloti 153
Rhodospirillaceae 92
RUBP-carboxylase 80

Salicornia 155
salinity and nitrification 224–5
Salmonella typhimurium 153
scavenging/carnivorous feeders 192
Scirpus 155
sediment oxygen demand (SOD) 239
sediments
amino nitrogen compounds in 135–7
bulk distributions 315–28
denitrification in marine 251–73
incubations and ammonium 178–9
mineralization in 358–61
nitrate reduction in 361, 363–4
nitrification 361–3
particulate matter in 138
and plankton system 341
production rates of ammonium in 329–30
quaternary amines in 158–60
reworking 276–7, 302
Spartina 87, 94, 97, 106, 107, 155, 199
S. alterniflora 110, 155, 156, 161
S. foliosa 158
sodium chlorate 212
spectrophotometry 147–8
Spirulina subsalsa 159
Sporomusa 162, 166
stachydrine 153, 154, 162
Sueda 155
sulfate reducers 94
sulfide 225
oxidation 77–9, 81
suspension feeders 192–3

taurine 146
Temora longicornis 435
Thalassia testudinum 110
thin-layer chromatography (TLC) 148, 151
Thiobacillus 90
Thiovolum 79
thymidine assimilation 181, 183, 186
Tisbe cucumariae 197
TMAO 151, 152, 158, 161, 162
TMAO reductase 161
toxaphene 109
trace enrichment levels 10
trace metal toxicity 6

tracer-incubation techniques 5–12, 178–9, 182
trichloroacetic acid (TCA) 15
trigonelline 162
trimethylamine (TMA) 126, 128, 134, 136–7, 143, 144–5, 151–2, 158, 159–60, 161–3, 165
trimethylamine monoxygenase 161
trimethylarsine 167
1,2,4-trimethylbenzene 107
Tubiflex 292
'turbidity maximum' zone 231

Uca 306, 307, 308
Ulva 202
  U. lactuca 154
Ulvaceae 154
Upogebia 306, 307, 308, 309
  U. pugettensis 305
urea 3, 17, 24, 33
  concentrations 34–5, 49
  and phytoplankton nitrogen nutrition 44
  regional and seasonal variation 12, 21
  turnover 52–3
  uptake rates 37, 41, 48–9
'utilizable nitrogen' 387

V-core system 278, 279
vanadium 100
vertical eddy diffusion 41, 44
Vibrio 87, 268

water residence time 424–5

yeast 251

zoobenthos 231
zooflagellates 60
zooplankton 10, 20, 380, 396–7
  amino acid composition of 131
  and ammonium regeneration 17
  excretion 3, 8, 435–6
  grazing and phytoplankton growth 4
Zostera marina 110, 111, 155, 232