

Author and subject indexes

Author index

(*Italic type refers to text figures*)

- Albrecht, L., 25
 Allsopp, A., 118
 Arber, A., 185, 213
 Avery, G. S., 81
- Ballard, L. A. T., 1
 Barnard, C., 21, 22, 23, 24, 131, 183, 192, 193, 227
 Blackman, V. H., 9
 Bonnett, O. T., 183
 Bouma, D., 5, 103, 103, 105, 108, 110, 110, 111, 112, 113, 113, 114, 115, 144, 171, 237, 238, 241
 Briggs, G. E., 9
 Brock, T. D., 13
 Broué, P., 25, 26
 Brown, R., 99
- Causton, D. R., 17
 Church, A. H., 27, 35, 42, 51
 Clowes, F. A. L., 7, 215
 Court, R. D., 25
 Cutter, E. G., 220
- Delbruck, M., 13
 Denne, M. P., 101, 107, 108, 109, 218
 Dormer, K. J., 7, 9, 17, 27, 44
- Ellis, E. L., 13
 Erickson, R. O., 43, 129
 Esau, K., 58
 Evans, G. C., 7
- Fisher, J. E., 25
 Friend, D. J. C., 25
 Fujita, T., 31
- Gates, C. T., 25
 Gill, W. R., 212
 Grassia, A., 17
 Greacen, E. L., 212
 Gregory, F. G., 192
 Gregory, R. A., 68
- Hackett, C., 3
 Hagerup, O., 107
 Hannam, R. V., 81, 88, 88, 89, 90, 144, 230
- Haydock, K. P., 25
 Helson, V. A., 25
 Heyes, J. K., 99
 His, W., 4, 227
 Hopkinson, J. M., 88, 88
 Howe, K. J., 127, 128
 Hussey, G., 217, 218, 219, 220
 Hutto, J. M., 206
 Huxley, J., 5
- James, D. B., 206
- Kidd, F., 9
- Langer, R. H. M., 135, 199, 201, 213
 Leigh, E. G., 44
 Lyndon, R. F., 215, 218, 219, 219
- Macdowall, F. D. H., 10, 24, 25
 McIntyre, G. A., 17, 236, 237
 Maksymowych, R., 8
 Metcalf, R. A., 199, 204
 Michelini, F. J., 129
 Miller, R. D., 212
 Milthorpe, F. L., 7
- Neal-Smith, C. A., 25
 Nemeč, B., 213
- Oh, J. S., 212
 Otsuki, Y., 13
- Pattee, H. H., 6
 Petrie, A. H. K., 1
 Phillips, I. D. J., 8
 Plantefol, L., 220
- Richards, F. J., 7, 16, 17, 18, 27, 32, 32, 33, 33, 35, 37, 39, 40, 41, 41, 42, 43, 52, 75, 110, 136, 207, 220, 230
 Rijven, A. H. G. C., 5, 79, 131, 144, 163, 164, 165, 166, 167, 169, 169, 170, 170, 171, 173, 174, 174, 175, 176, 177, 178, 179, 180, 214, 239, 243
 Romberger, J. A., 68
 Rosen, R., 7, 209

Cambridge University Press

978-0-521-11287-1 - The Shoot Apex and Leaf Growth: A Study in Quantitative Biology

R. F. Williams

Index

[More information](#)*Subject index*

- Schwabe, W. W., 27, 221
 Sharman, B. C., 131, 135, 176, 192, 199, 201, 213, 218, 224
 Shimomura, T., 13
 Snow, M., 27, 106, 216, 221
 Snow, R., 27, 64, 107, 213, 216, 220, 221
 Steward, F. C., 7, 9, 17, 127, 128
 Sunderland, N., 99
- Takebe, I., 13
 Thompson, D'Arcy W., 27, 31, 43, 44
 Trinci, A. P. J., 13
 Turpin, P. J. F., 185, 213
- Van Iterson, G., 42, 43
 Vidaver, W., 6
- Ward, M. W., 17
 Wardlaw, C. W., 27, 220
 Wardlaw, I. F., 243
 Wareing, P. F., 8
- Weiss, P. A., 3
 Weisse, A., 213
 West, C., 9
 Whaley, W. G., 8, 13
 Whitehead, A. N., 4
 Williams, C. N., 5, 25, 131, 136, 138, 139, 139, 140, 142, 144, 238
 Williams, R. F., 2, 5, 13, 17, 79, 97, 98, 103, 103, 105, 108, 110, 110, 111, 112, 113, 113, 114, 115, 131, 133, 134, 135, 136, 138, 139, 139, 140, 142, 144, 163, 164, 165, 166, 167, 169, 169, 170, 170, 171, 173, 174, 174, 175, 176, 177, 178, 179, 180, 183, 184, 187, 188, 189, 190, 191, 193, 193, 194, 195, 196, 197, 198, 199, 201, 204, 210, 213, 223, 224, 225, 226, 228, 236, 237, 238, 239, 241
 Williams, W. T., 25
 Woodger, J. H., 4, 220
 Wright, C., 43
 Wright, S. T. C., 175

Subject index

- abstraction, intolerant use of, 4
Acacia mucronata, 34, 158, 159, 160, 160
 age equivalence, 238–9, 239
Agropyron, 218
 algae, growth rate, 13
Anabena cylindrica, growth rate, 13
 apex–primordium area ratio, 39, 41
 in: cauliflower, 94; flax, 66; tobacco, 87
 apical cone, 28, 29, 35, 137
 apical dome, 34–5, 34
 in: cauliflower, 92, 218; clover, 103, 107–8; eucalyptus, 129; flax, 57–9, 58–9; ser-radella, 157, 158; tobacco, 83–4, 83–5, 86; wheat, 132–3, 137, 145
Araucaria excelsa, 33
 area ratio, *see* apex–primordium area ratio
Aspergillus nidulans, growth rate, 13
 autocatalysis, curve of, 18, 20, 21
Avena, 183
 axial growth in: flax, 70–3, 208; wheat, 139–40, 210
 axillary bud in: clover, 113, 114, 115–16, 115; eucalyptus, 120, 121, 124; wheat, 133, 135, 135; *see also* under tillers
- Bacillus stearothermophilus*, growth rate, 13
 bacteria, growth rate, 13
 bacteriophage, growth rate, 13
Brassica oleracea, 29, 30, 35–6, 36, 41, 91–7, 210, 211, 214–18, 215, 232–3, 233, 234, 234
 carpel, 185, 188, 190, 191, 192–3, 195, 195, 196–7, 196, 197
 cauliflower, *see* *Brassica oleracea*
 cell
 counting, 243
 mass flow, 218–19, 219
 number per leaf, 165–6, 166, 174
 volume, 170–1, 175, 177
 cell-wall materials in: clover leaf, 167, 169–72, 170; wheat leaf, 172, 176–7, 176
Chlorella, growth rate, 13
 chrysanthemum, phyllotactic change, 221
 clover, *see* *Trifolium*
 cocksfoot, *see* *Dactylis glomerata*
 corpus tissue
 growth centres in, 220
 growth rate of, 113, 114, 115, 115, 116
Costus cylindrica, 213

Subject index

- covariance, with ratings, 236–7, 237
 curve fitting, 16–24
 exercise in, 20–4
 families of curves, 240–3
 polynomials, 20, 21
 progressive, 20, 241–2
- Dactylis glomerata*, 25, 26
 data processing, 239–42
 developmental space, 132, 155, 211
Dianella, 30, 30, 136, 157–8, 159, 221
 divergence angle, 35–6, 36, 38
 in: clover, 103, 106; flax, 66, 67; tobacco, 87
 DNA-phosphorus
 in: clover leaf, 167, 169–70, 170, 179;
 wheat leaf, 176, 178
 per cell, 166, 174
 doubling time, 13
 conversion table, 244
 in: clover, 113, 114, 179; flax, 79; tobacco, 90;
 wheat, 139, 141, 178, 204
 dry weight change in: clover, 168; wheat, 174
- Ecballium elaterium*, 107
 efficiency index, 9; *see also* relative growth rate
Epilobium, surgical experiments on, 221
 equivalent phyllotaxis index (E.P.I.), 39
Escherichia coli, growth rate, 13
Eucalyptus, 116–31, 210, 211, 230
 juvenile and mature leaves of, 118, 125, 127
 primordium deformation in, 119, 122, 123, 213
Eucalyptus bicostata, 30, 30, 116, 117, 118–19, 119, 120, 121, 122, 123, 123, 124, 125, 126, 127, 128, 129–30, 130
Eucalyptus grandis, 116, 117, 118, 120, 128, 131
Euphorbia, 34
 exponential growth, 22, 23, 24, 24, 25
 in: clover, 109, 111–12, 113, 114, 115, 116, 208–9; eucalyptus, 130; fig, 155–6; tobacco, 210; wheat, 141–2, 144, 209
 not in tiller buds, 202
 Fibonacci angle, 42–55
 in: fig, 217; flax, 66–7; tobacco, 86–7
 optimal leaf display, 43–4
 Fibonacci series, 29
Ficus elastica, 41, 146–56, 211, 213, 217
 fig, *see Ficus elastica*
 flax, 207–8
 methods based on, 231, 231, 232, 233, 233, 234–5, 235, 238, 241–2
 see also Linum usitatissimum
- floret, 183, 186–7, 188, 189, 191, 192, 195–7, 196–7
 form change
 of leaf primordia in: *Acacia*, 158, 159, 160, 160; cauliflower, 91, 92; clover, 101–2, 102, 103, 163–4, 164; *Dianella*, 157–8, 159; eucalyptus, 119, 119, 120, 121, 122, 123, 123; fig, 149, 151–3, 152, 153, 154; lupin, 97, 98; serradella, 157, 158; tobacco, 81–6, 82, 83, 84; wheat, 131–2, 132, 144–6, 145
 of tiller buds, 133, 135, 135, 199–201, 200, 202, 213–14
 see also genesis of form
 fresh weight change in: clover, 110–11, 111, 112, 168; flax, 75, 76, 77
 fungi, growth rate, 13
- generation time, *see* doubling time
 genesis of form, 212–14; *see* form change
 genetic spiral, 36, 36, 91
 geometrical modelling of phyllotaxis
 Fibonacci system: orthogonal 2:3, 46–8, 47, 49, 50; orthogonal 3:5, 44–6, 45, 48; orthogonal 5:8, 48; progression from low to high, 49, 50, 51–2, 51
 first accessory system: orthogonal 3:4, 53–4, 54; orthogonal 4:7, 52–3, 53
 bijugate system, orthogonal 4:6, 54–5, 55
 glumes, 183, 187, 188, 189, 191, 192, 194, 194, 195
 gnomon, to bare apex, 35
 ‘golden’ section, 125, 127
 Gompertz function, 18
 growth
 quantitative description of, 9–26
 see also: axial growth; exponential growth; inflorescence growth; leaf growth; length growth; tillers, growth of; and volume growth
 growth analysis, 10, 25, 26
 ‘growth coefficient’, 10
 growth curves
 analysis of, 10, 11, 12
 composite in: clover, 110–11, 112; eucalyptus, 130, 131; fig, 156; flax, 75, 76, 77; wheat, 138
 Richards’s function, 17–18, 18, 19, 20
 growth hormones and phyllotaxis, 221
- hairs, epidermal
 effects on growth: in lupin, 99; and in tobacco, 81, 85, 211
 glandular, in *Acacia*, 160, 160
 growth rate, in clover, 166, 171–2, 181
Helianthus annuus, 29, 30, 31, 41, 41, 160, 161, 162

Subject index

- hierarchical order and biology, 3–4, 6
 histogenesis, foliar and cauline, 183, 192, 197–8
 ‘holism’ in biology, 3
- inflorescence growth in wheat, 138, 139, 183–98
 internode growth in: flax, 70–3, 71, 73; wheat, 139–40
- leaf growth, 163–82
 in: cauliflower, 94–7; clover, 108–16, 167–72; eucalyptus, 129–31; fig, 153–6; flax, 73–80; lupin, 98–100; tobacco, 89–91; wheat, 140–6, 172–7
- lemma, 183, 188, 189, 191, 192, 194, 194, 195, 196, 196, 210
- length growth
 in: clover, 108–9, 110, 164–5, 165, 168; eucalyptus, 128, 129–30; flax, 72, 74, 75, 77–8, 77; wheat, 172–4, 173
- Linum usitatissimum*, 13, 15, 16, 28, 29, 29, 30, 41, 56–80, 224–7, 225, 226, 229, 229; *see also* flax
- lodicule, 185, 191, 192
 logarithmic scales, use of, 10, 11, 12
Lolium perenne, 206
 longitudinal section
 diagram: for cauliflower, 215; for clover, 108, 114; and for wheat, 142, 143
 photomicrograph: for eucalyptus, 124; for flax, 61; and for wheat, 133
- Lotononis bainesii*, 25
Lufa cylindrica, 107
 lupin, *see* *Lupinus*
Lupinus albus, 64
Lupinus angustifolius, 97–100, 210, 211
- marginal meristems in: cauliflower, 91, 92, 97, 211; clover, 101, 103; fig, 155–6; flax, 59, 80; lupin, 99, 211; serradella, 157
- median-plant techniques, 237–8
Mentha piperita, 127, 128–9, 232
 mitotic index in clover apex, 108
 monomolecular curve, 18
 multivariate analysis, 25–6
- Nicotiana tabacum*, 41, 81–91; *see also* tobacco
- nucleic acids in: clover leaves, 167, 169, 169–71, 170; wheat leaves, 174–7, 176, 177
- nucleoli, size of, 216
 optimality in development, 5, 7, 209, 212
Ornithopus compressus, 157, 158; *see also* serradella
- ovary (and ovule), 185, 191, 196
- palea, 183, 191, 192, 195–6, 195, 196, 210
- parastichies, 28
 Church’s system of, 28
 contact, 28–34
 contact in: cauliflower, 91, 96; fig, 153, 155; flax, 63, 64–5; tobacco, 86–7, 87
 intersection of, 34, 40
- pea, 218–20; *see also* *Pisum sativum*
- percentage cover, 66
 in: cauliflower, 94; flax, 66
- petiole in: clover, 101, 163–4, 164; lupin, 97, 98
- phyllotactic system
 alternate, 38
 bijugate, 29, 38
 decussate, 30, 30, 38, 42, 63, 116–18, 117
 distichous, 29–30, 30, 42, 136
 Fibonacci spiral, 29, 30, 31, 36–8, 40, 160, 161, 162; fully defined by plastochrone ratio, 70; progression through, 65
 first accessory, 29, 38
 multijugate, 29
 spiral, 28–35, 64, 86
 spirodistichous, 106, 213
 whorled, 38, 42
- phyllotaxis, 7, 27–55
 definition, 28
 history, 27
 in: *Acacia*, 160; cauliflower, 91–4; clover, 103, 105–7; *Dianella*, 157; eucalyptus, 123, 125, 127–9; fig, 153, 155; flax, 63–70; lupin, 97–8; sunflower, 160–2; tobacco, 86–9; wheat, 136–8
 independent of primordium shape, 32–5
 measurement, 230–5
 parameters, 35–42
 Richards’s procedures, 27, 41–2
 transverse component, 35
- phyllotaxis index (P.I.), 37–8, 41
 of bijugate systems, 38
 of first accessory systems, 38
 in: cauliflower, 91, 94; clover, 106; *Dianella*, 136, 157; eucalyptus, 128; flax, 65–6; *Mentha*, 129; sunflower, 162, tobacco, 87; wheat, 137
- phyllotaxis theory, 220–1
 field theory, 216–17, 220
 first available space, 216–17, 220
 mechanico-chemical field theory, 220–1
- physical constraint
 as determinant in biology, 5
 by epidermal hairs, 81, 85, 99, 211
 of floral parts, 185; of roots, 212; of tiller buds, 199–206
 and genesis of form, 207, 212–14, 216–17
 and growth rate, 207–12
 and hierarchical control, 6

Subject index

- physical constraint (*cont.*)
 in: cauliflower, 91, 97; eucalyptus, 121, 130, 213; fig, 156; flax, 58, 60, 63, 75; wheat, 133–5, 144
- Picea abies*, 68
- Pisum sativum*, 215, 219; *see also* pea
- plant response, study of, 25
- plastochrone, 35, 67
 in: cauliflower, 215; clover, 109; flax, 67–8, 68; tobacco, 88
- plastochrone index, 129
- plastochrone ratio (*r*), 35–6
 estimation of, 230, 232–5, 234, 235
 in: cauliflower, 91, 94; clover, 106; *Dianella*, 136; eucalyptus, 127–8; flax, 65, 66; lupin, 97; *Mentha*, 128; sunflower, 160, 162; tobacco, 87; wheat, 137
- primordia
 packing of floral, 185
 packing of foliar in: clover, 102, 103, 104, 105, 113, 114; eucalyptus, 123, 125, 126, 130; fig, 146, 148, 149, 150; flax, 57, 58, 58, 62, 75, 80, 80; wheat, 132, 144–5, 145
- primordium attachment area, 28, 29
- progressive thinning for growth studies, 238
- protein nitrogen in: clover leaf, 167, 169–71, 169, 170; wheat leaf, 174–7, 174, 175
- protophloem differentiation, timing of, 144
- quantitative biology
 climate of scientific opinion and, 3–4
 integration and, 7
 magnitude of task, 3
 need for, 3–5
 Plato and, 1
 and size, 3
- radial growth rate in: flax, 59, 69–70, 69; wheat, 140, 142–3; *see also* relative growth rate, radial
- ratings, *see* covariance
- reconstruction, three dimensional
 for: *Acacia*, 159; apical cone, 29; cauliflower, 92; clover, 102, 103, 164; *Dianella*, 159; eucalyptus, 119, 120, 122, 123; fig, 152, 153, 154; flax, 57, 58, 59; lupin, 98, 99; serradella, 158; tobacco, 82, 83, 84; wheat, 132, 135, 145, 190, 200, 202
 method, 223–7
- redistribution of elements, 2
- 'reductionism' in biology, 3
- relative growth rate, 10–14
 axial: in flax, 70–3, 73; and in wheat, 138–40, 143
- compound interest law and, 9–10
 conversion to doubling time, 13, 244
 in: cauliflower, 94; clover, 112–13, 113, 114; *Dactylis*, 26; flax, 79–80, 79; lupin, 99; tobacco, 89–90, 90; wheat, 141–2, 144–6, 146
- linear and volume, 14–16, 15, 16
- radial: in flax, 59, 69; in tobacco, 88; and in wheat, 141, 142
- a sensitive index, 10–12, 11
see also relative rates of change
- relative rates of change, 177–82
 for: cell surface, 178; cell-wall material, 178, 179; DNA-phosphorus, 178, 179; protein-nitrogen, 178, 179; RNA-phosphorus, 178, 179
 one component per unit of another, 179–82
- residual dry weight in: clover leaf, 167, 168–9; wheat leaf, 172, 174–6
- Rheo discolor*, 106
- Richards's function, *see* growth curves
- RNA-phosphorus in: clover leaf, 167, 169–71, 170; wheat leaf, 172, 175–7, 176, 177
- runner bud (clover), *see* axillary bud
- Scenedesmus costulatus*, growth rate, 13
- serial reconstruction
 and volume estimation, 227–30
 Wilhelm His and, 4–5
- serradella, 216
see Ornithopus compressus
- shoot apex
 integrity of, 217
 linear and angular measurement, 231–2, 231
 organization of, 214–22
see also shoot-apical systems and apical dome
- shoot-apical systems, 4, 56–162
 in: cauliflower, 91; clover, 100–3; *Dianella*, 157; eucalyptus, 116–23; fig, 146–54; flax, 56–63; lupin, 97; serradella, 157; sunflower, 160–2; tobacco, 81–6; wheat, 131–5
- spike, 193–4, 193
see also inflorescence
- spikelet, 183, 189, 191, 192, 193, 196, 197
- stamen, 185, 188, 190, 191, 192, 195–7, 195, 196, 197
- stipules in: *Acacia*, 34, 160; cauliflower, 94; chrysanthemum, 221; clover, 101, 103; fig, 147, 148, 149, 149, 150, 151–6, 152, 153, 154, 156, 211; lupin, 97; serradella, 158
- Stylosanthes humilis*, 25

Cambridge University Press

978-0-521-11287-1 - The Shoot Apex and Leaf Growth: A Study in Quantitative Biology

R. F. Williams

Index

[More information](#)*Subject index*

- sub-apical region, growth rate: in flax, 73, 208; and in wheat, 138–9, 210
- sunflower, *see Helianthus annuus*
- Thaladiantha dubia*, 107
- tillers
 'escape' of bud, 201–3, 203
 growth of, 199–206
see also axillary bud
- tobacco, 38, 210, 216
see also Nicotiana tabacum
- tomato, 217, 218, 236
- transverse projection, 28, 29
 ideal, 32, 32, 33, 35–6, 36, 127
 in: cauliflower, 96, 215; clover, 105; eucalyptus, 127; fig, 155; flax, 62, 63, 63; tobacco, 86, 87; wheat, 136, 136
 method, 232–3, 233
- transverse section
 diagram: for cauliflower, 95; for eucalyptus, 125, 126; for fig, 149, 150; for flax, 62, 80; for *Mentha*, 127; and for wheat, 191, 200, 201
 photomicrograph: for *Acacia*, 160; for cauliflower, 93; for clover, 104; for fig, 148; for flax, 60; for tobacco, 85; and for wheat, 134
- Trifolium repens*, 101, 107–8, 108, 109, 218
- Trifolium subterraneum*, 41, 100–16, 163–72, 177–82, 208–9, 210, 217, 221
- Trigonella foenum-graecum*, uni- and tri-foliolate leaves, 214
- tri-iodobenzoic acid, 221
- Triticum aestivum*, 13, 21–4, 30, 30, 41, 131–46, 172–7, 177–82, 183–98, 199–206, 209–10, 217, 227–30, 228, 239
- tunica in: cauliflower, 94, 96; eucalyptus, 120, 124, 230; flax, 61, 228–9, 229; lupin, 100, 100; wheat, 133, 228
- variability
 of leaf length: in clover, 164–5, 165; and in wheat, 173–4, 173
 of organisms, 3
- Vibrio marinus*, growth rate, 13
- virus, T.M.V., growth rate, 13
- volume estimation
 for eucalyptus, 118, 120, 230
 large primordia, 230
 small primordia, 229–30, 229
 by serial reconstruction, 227–30, 228
- volume growth in: cauliflower, 94, 96; clover, 110–13, 112, 168; eucalyptus, 130, 130, 131; fig, 155, 156; flax, 75, 76, 77, 78–9, 78; lupin, 100; tobacco, 189–90, 189; wheat, 138, 140–1, 195–7, 196, 197
- wheat, *see Triticum aestivum*
- Willia anomala*, growth rate, 13
- yeast, growth rate, 13