

## Glossary of terms

This section provides very brief definitions of some of the geological/palaeontological and biological/biogeographical terms used by the authors in this book. The intention of the glossary is to make the book comprehensible to the non-specialist reader rather than to provide a comprehensive discussion of, in some cases, controversial terms.

### *Geological, including palaeontological, terms*

*agnostid*: type of Lower Palaeozoic trilobite.

*allochthon*: body of rock tectonically displaced from its place of formation.

*andesite*: volcanic rock of intermediate composition typical of island arcs.

*antiarch*: primitive Palaeozoic fish.

*APWP*: apparent polar wander path. Diagram used in palaeomagnetic work displaying a series of palaeo-poles for a fixed continent to represent the relative motion of the continent with respect to magnetic north. It is of course the continent that moves, but it is simpler to display a series of palaeo-poles on a diagram than plot diagrams showing moving continents with a fixed magnetic pole; APWPs for different continents can then be more easily compared.

*backarc basins*: small basins floored by oceanic crust formed above subduction zones behind island arcs by poorly understood mechanisms.

*basalt*: volcanic rock of basic composition typical of oceanic crust.

*basement*: the underlying or deeper rocks. Typically basement rocks are thought of as the deeper igneous and metamorphic rocks found beneath a sedimentary cover. The term is used to distinguish cover rock sequences from underlying rocks. However, the term is relative, and there is no implied age for the underlying rocks, and can be used to distinguish older sedimentary rocks from younger sedimentary rocks.

*bioclastic*: character of fragmental material in rocks which is organic debris, typically calcium carbonate shells and skeletons.

*biofacies*: characteristic assemblage of fossil fauna.

*blueschist*: rock type formed at high pressures and low temperatures in subduction zone settings, and characterised by the presence of the blue amphibole glaucophane.

*calcalkaline*: range of igneous rock compositions typical of volcanic arcs, including basalt, andesite and dacite.

*carbonates*: sedimentary rocks formed of carbonate minerals, principally calcite and dolomite, sometimes with aragonite.

*chert*: rock formed of fine-grained silica, typically the remains of organisms with siliceous skeletons and commonly found in deep marine environments.

*clastic*: type of sedimentary rock formed of fragments of rocks and minerals.

*conodont*: oral apparatus of primitive Palaeozoic craniates (vertebrates).

*craton*: continental region that has been tectonically stable for a long period, typically for more than several hundred million years.

*cyclopygid*: type of trilobite.

*dacite*: volcanic rock of intermediate composition typical of island arcs, especially those underlain by continental crust.

*depocentre*: site of deposition of sedimentary rocks, in principle the place of the thickest sequence, although the term is often used generally to include the whole area of deposition as a synonym of sedimentary basin.

*diamictite*: fragmental rock with angular clasts in a mud matrix interpreted as having a glaciomarine origin.

*dicynodont*: Permian mammal-like reptile.

*dikelocephalinid*: type of trilobite.

*East India letter classification*: biostratigraphic scheme for subdivision of Tertiary rocks of SE Asia based on large benthic foraminifera.

*eclogite*: rock of basic composition which consists essentially of a high density garnet-pyroxene mineralogy indicating metamorphism under high pressures typical of the lower crust or deeper.

*Euler pole*: the pole of rotation of two tectonic plates on a sphere. Definition of the pole and the angular motion of one plate relative to another fully describes their relative motion.

*eustasy*: concept of sea level change which affects the whole globe, and is not caused by local tectonics. Causes of eustatic sea level change could include changes in volume of polar ice caps, changes in volume of ocean basins due to displacement of water by sediment, or changes in volume of the mid-ocean ridge system.

*extrusive*: igneous rocks that are erupted at the surface.

*flysch*: term of Alpine origin for clastic rocks, typically thick sequences of deep marine sandstones and mudstones, deposited during the early stages of development of a mountain belt and said to be 'syn-orogenic'. These rocks are often deposits of continental slopes formed by turbidity currents.

*forearc*: region between island arc and trench.

*fusulinid*: large foraminifera of Carboniferous-Permian age.

*glyptomenid*: type of brachiopod.

*graben*: fault-bounded elongate depression characterised by steep and straight bounding faults at the margins with a central subsided block.

*granitoid*: igneous rocks of granitic composition dominated by quartz and feldspars.

*graptolite*: order of marine hemichordates of (mainly Lower) Palaeozoic age.

*imbricate thrust slices*: slices of rocks stacked together by contraction, separated by low angle and sub-parallel thrust faults.

*intrusive*: igneous rocks intruded within the crust and slowly cooled.

*island arc*: chain of volcanic islands formed above a subduction zone where oceanic lithosphere is thrust into the mantle.

*lithosphere*: the outer rigid part of the Earth, including the crust and part of the mantle to depths of about 100 km, forming the tectonic plates.

*lowstand*: period when eustatic sea level was relatively low.

*lyttoniid*: group of articulate brachiopods of Permian age.

*mafic*: igneous material of dark colour. As applied to rocks usually indicates a basic composition with relatively low silica content and is often incorrectly used as a synonym of basic.

*magmatism*: igneous activity as a result of melting of the crust or mantle.

*magnetic anomalies*: lineations within the ocean crust formed by igneous activity at linear mid-ocean ridges and alternations in the polarity of the Earth's magnetic field. The anomalies can be mapped and dated and provide the means to trace the motions of plates during the past 200 million years.

*marl*: calcareous mudrock with more than 25% carbonate.

*melange*: rock composed of a mixture of blocks in a fine-grained matrix. This mixture may have been formed by sedimentary processes (such as submarine debris flows) or by tectonic mechanisms. Rock of this type are common in active orogenic settings.

*molasse*: term of Alpine origin for clastic rocks, typically sequences of continental and shallow marine conglomerates and sandstones, deposited late in the development of a mountain belt and often said to be 'post-orogenic'.

*nannofossils*: fossils of ultramicroscopic size, representing the remains of zooplankton and phytoplankton.

*nappe*: large thrust body of rock, typically with basal thrust that is sub-horizontal and has a displacement of several tens of kilometres.

*obduction*: poorly understood process by which rocks of broadly oceanic character known as ophiolites are thrust onto land.

*ophiolite*: association of rocks similar to those representative of oceanic crust and mantle but now found on land in orogenic belts. In the ideal ophiolite there are peridotites, gabbros, basalts and pelagic sedimentary rocks in a layered sequence. Some ophiolites may have formed at mid-ocean ridges of major ocean basins but most represent lithospheric fragments from arc-related settings such as backarc basins or forearc regions.

*orogeny*: process of mountain-building.

*orthid*: type of brachiopod.

*palaeomagnetism*: the Earth's magnetic field as recorded in rocks. Palaeomagnetic studies can determine palaeo-latitudes of rocks at the time of their deposition or formation, and can determine rotations since formation. This type of information can contribute to reconstructing the history of plate movements.

*palynology*: study of microscopic plant material.

*palynomorphs*: microscopic remains of plant origin, such as pollen grains and spores.

*plectambonitoid*: type of articulate brachiopod.

*pluton*: large igneous body intruded into the crust.

*rhyolite*: volcanic rock of acid composition typical of volcanic arcs formed on continental crust, and commonly erupted explosively.

*rifting*: process of breaking the crust and lithosphere by extension.

*rudist*: reef-building bivalve with coral-like appearance of late Mesozoic age.

*schist*: metamorphic rock with closely spaced planar fabric (schistosity), commonly due to preferred orientation of mica, produced by metamorphic recrystallisation accompanied by directed stress.

*siliciclastic*: type of sedimentary rock formed of clastic grains of silicate rocks and minerals.

*sinolepid*: type of Devonian armoured fish.

*slab-pull*: force exerted by a sinking lithospheric slab at a subduction zone.

*splays*: strands of a fault, typically in the zone where the fault terminates.

*stratigraphy*: geological discipline concerned with the description, organisation and classification of stratified rocks, fundamental to our understanding of the history of the Earth.

*strike-slip*: type of fault or motion in which two blocks of rocks move past one another with essentially horizontal motion.

*strophomenoid*: type of articulate brachiopod.

*subduction*: process by which lithosphere, mainly oceanic, is thrust deep into the mantle at convergent plate boundaries. The principal surface expressions of subduction are the deep oceanic trenches and the volcanic arcs of active margins.

*syntaxis*: region of abrupt change in orientation of an orogenic belt.

*tectonic block*: fault-bounded fragment of crust or lithosphere with its own characteristic sequence of strata. Size is not implied, but in many cases the term block as used in regional geology implies microcontinent or island arc-scale fragments.

*tectonostratigraphy*: study of the stratigraphy of terranes recognising that normal stratigraphic principles need to be applied with caution because of the important tectonic influence on sequences. Relative ages of events within and across terranes can be identified by conventional stratigraphic methods and the sequence of both strata and tectonic events can be displayed on composite diagrams.

*terrane*: fault-bounded fragment of the crust or lithosphere with its own characteristic stratigraphic sequence. Many mountain belts are now interpreted to be composed of large numbers of terranes which have become fragmented and amalgamated by tectonic processes including plate rifting, subduction, collision and strike-slip faulting.

*till*: deposit of glacial origin.

*trachyandesite*: volcanic rock of intermediate composition, but with a more alkaline composition than a normal andesite, common in island arcs.

*transform fault*: originally defined as type of fault which offsets a mid-ocean ridge but now commonly used for a strike-slip fault which penetrates deep into the lithosphere and forms a plate boundary.

*transpression*: combination of strike-slip motion and contraction.

*transtension*: combination of strike-slip motion and extension.

*trilobite*: Palaeozoic marine arthropod.

*turbidites*: clastic sedimentary rocks deposited in deep water on or below the continental slopes by currents containing dense mixtures of sediment and water.

*ultramafic*: material of very dark colour. As applied to rocks normally refers to peridotites or serpentinites, their hydrated equivalents, containing minerals such as olivine and pyroxene, representing mantle material.

*unconformity*: fundamental discordance in a stratified sequence of rocks representing a break in deposition and time.

*yunnanolepid*: armoured fish of Late Silurian-Devonian age.

*zircon U-Pb ages*: absolute ages determined by a method of dating using the mineral zircon (zirconium silicate) which contains radioactive uranium isotopes which decay to lead isotopes.

#### *Biological and biogeographical terms*

*allopatric*: distributions of taxa which are separate, not coincident, overlapping or abutting.

*allozymes*: enzyme alleles at genetic loci used in electrophoretic analysis of genetic variation between organisms.

*anagenesis*: transformation in an evolutionary lineage. The transformed states of genes or chemical or morphological characters serve to identify the descendants of the lineage subsequent to the transformation. *See also* apomorphy.

*apomorphy*: derived (transformed by anagenesis) character or character state. *See also* plesiomorphy.

*aril*: fleshy, edible surround to a seed.

*assumptions 0, 1 and 2*: in biogeography, methods of overcoming problems of widespread taxa and redundancy in areas of endemism, given the goal of every area only occurring once in an area cladogram. Assumption 0 treats widespread taxa as monophyletic and allows no manipulation of areas. The other assumptions also allow the area relationships of widespread taxa to be paraphyletic (1) or polyphyletic (2) in order to retrieve information about general area relationships.

*autapomorphy*: apomorphy that is restricted to a single taxon: that taxon is defined by autapomorphies.

*autecology*: ecology of a single species.

*benthic*: aquatic, bottom-living.

*bottleneck, genetic*: drastic reduction in genetic diversity of an organism by a period of ex-

- remely low population, for example, during a colonisation event. *See also* founder effect.
- branch-and-bound*: algorithm for cladogram construction that starts with a cladogram from a heuristic search (*q.v.*) and then searches for cladograms with topologies of progressively shorter lengths than that of the original, discarding all those that exceed it.
- branch swapping*: procedure for moving clades (branches) around a cladogram in a search for a more parsimonious solution or topology.
- CAFCA*: computer program for cladistic analysis.
- clade*: monophyletic group of organisms.
- cladistics*: method of classification that groups taxa hierarchically on the basis of homologies (shared apomorphies-synapomorphies) into nested sets, conventionally represented as a cladogram.
- cladogenesis*: splitting of an evolutionary lineage into discrete daughter lineages.
- cladogram (taxon or area)*: branching diagram indicating hierarchic relationships amongst taxa (or areas) based upon the sharing of apomorphies (or related taxa).
- cluster analysis*: method of classification that groups items hierarchically into nested sets or non-hierarchically (overlapping clusters that can share items) in terms of overall similarity of their attributes.
- coding*: in cladistics, conversion of observations on characters and character states into alpha-numerical format for cladistic analysis.
- COMPONENT*: computer method for comparing, and identifying common features (congruence) in, the structure of cladograms where the terminal items of each are the same (areas in area cladograms from different groups of organisms) or related (*e.g.*, parasites and their hosts).
- component (of tree)*: group of taxa (or areas) related by the branching structure in a cladogram.
- component analysis*: method of identifying the degree of commonality of components (congruence) between trees (*e.g.*, COMPONENT).
- congruence (of trees)*: agreement in tree topology. *See also* component analysis and COMPONENT.
- consensus tree (strict, Adams, Nelson)*: tree (cladogram) produced by a consensus method. Methods of cladistic analysis can yield several trees of different topology but the same minimum length. Consensus methods combine the grouping information in these into a single topology known as the consensus tree.
- consistency index (CI)*: strictly the ensemble consistency index. Measure of the amount of homoplasy (repeated changes in characters) in a data matrix relative to a cladogram derived from it. CI has an upper bound value (no homoplasy) of 1 and a theoretical lower bound of 0 (though this cannot be attained in practice).
- contact zone*: meeting zone of parapatric (*q.v.*) species.
- dendrogram*: tree diagram derived in application of a hierarchic method of cluster analysis.
- depauperate*: biota with fewer taxa than expected (for example, in relation to area, representation of higher groups, etc.).
- diploid*: organism with a standard pairing of chromosomes. *See also* polyploid.
- disjunction*: major geographical gap in distribution of an organism that may not necessarily be caused by the absence of suitable habitat.
- endemic*: found only in the area under consideration.
- euphotic zone*: stratum near surface of water where sufficient light penetrates to permit photosynthesis.
- eurhythermal*: tolerant of wide variations in temperature.
- founder effect*: reduction in genetic diversity in an initial colonising population, often followed by genetic drift. *See also* bottleneck.
- general area cladogram*: cladogram of areas where the topology represents the most parsimonious summary of information in a set of area cladograms for individual taxonomic groups, in some ways a consensus cladogram.
- generalised tracks*: significantly coincident distribution patterns in panbiogeography.
- genetic drift*: enhanced, stochastic changes in genetic diversity of small, colonising populations of organisms. *See also* founder effect.
- Hennig86*: computer program used for cladistic analysis.
- heuristic search*: method of constructing cladograms that is not guaranteed to find the most parsimonious solution.
- homoplasy*: any derived character that is not a synapomorphy in relation to a particular tree (cladogram) topology.
- ingroup*: group of taxa under study in a cladistic analysis. *See also* outgroup.
- introgression, genetic*: infiltration of genetic material of one species into the genotype of another.
- length of cladogram/tree*: minimum number of character changes or steps on a cladogram required to account for the data.



- lineage*: all descendant taxa through time of a common ancestor.
- massing centres*: concentrations of species within a panbiogeographic track.
- megaherbivore*: large plant-eating vertebrate.
- metapopulations*: populations of species occupying discrete patches of suitable habitat and interacting through migration.
- monophyly (-letic group)*: clade defined by synapomorphies; a group that includes all, and only all, of the descendant taxa of a common ancestor.
- monotypic*: higher taxon consisting of only a single lower taxon (usually a species).
- mtDNA*: mitochondrial DNA.
- node, cladistic*: branching point on a cladogram.
- node, panbiogeographic*: intersection point of two or more generalised tracks.
- non-metric multidimensional scaling*: method of summarising the distribution of points in multidimensional space in a smaller number of dimensions by minimising disturbance to the rank order of distances between the points.
- outgroup*: taxon used in cladistic analysis for comparison with group under study (ingroup) to determine character polarisation.
- pandemic*: taxon distributed universally through the geographical area being studied.
- paralogy*: (as in paralogy-free subtree analysis) term borrowed from genetics to denote repetition of information in area cladograms.
- parapatric*: distributions that abut at a contact zone but do not overlap, usually of closely related or sister species.
- paraphyly (-letic group)*: group of taxa in a monophyletic group from which one or more components are excluded.
- parsimony*: choosing the hypothesis that explains the data most simply. In cladistic analysis this is achieved by minimising the number of character changes inherent in a cladogram topology.
- PAUP*: A computer program for cladistic analysis.
- PeeWee (PIWE)*: a computer program for cladistic analysis.
- phanerogam*: seed-plant (conifers and angiosperms).
- phenetics*: classification of organisms and other items based on overall similarity of their attributes. *See also* cluster analysis.
- phylogeny*: hypothesis of genealogical relationships of taxa, imposing concepts of ancestry and a time axis on a cladogram.
- planktonic*: organisms that drift almost passively in bodies of water, usually in the surface layers.
- plesiomorphy*: ancestral or primitive character state, which may also be an apomorphy of a more inclusive hierarchical level than that under consideration.
- polarisation (of characters)*: determination of the apomorphic and plesiomorphic states of a character, often by outgroup comparison.
- polymerase chain reaction (PCR)*: method of multiplying extracted DNA to facilitate its analysis and comparison.
- polyploid*: organism with multiples above two (diploid) of the haploid number of chromosomes.
- polytomy*: node in a tree or cladogram which has three or more distal branches. *See also* resolution.
- Q-mode analysis*: in a two-way table, classification/comparison of the columns in respect of values in the rows.
- R-mode analysis*: in a two-way table, classification/comparison of the rows in respect of values in the columns.
- redundancy*: in trees, refers to repeated information about the relationships of constituent items.
- relict*: localised remnant of a previously much wider distribution pattern.
- resolution (cladistic)*: extent to which the branching in a tree or cladogram approaches the fully dichotomous.
- retention index (RI)*: strictly the ensemble retention index. For a given cladogram, this measures the amount of similarity in the original data matrix that can be interpreted as synapomorphy, by comparing the actual amount of homoplasy as a fraction of the maximum possible homoplasy. The RI equals 1 for a data set comprising only unique and unreversed synapomorphies (no homoplasy), whereas a value of 0 implies no grouping information at all in the data.
- sibling species*: closely related species only recently diverged from a common ancestor, probably showing close sister relationship.
- sister relationship*: shown by two taxa that are more closely related to each other than either is to a third taxon.
- subtree*: branch of a tree or cladogram.
- successive approximation weighting*: procedure for *a posteriori* weighting of characters according to their cladistic consistency, for example as indicated by the (rescaled) consistency index for the characters.
- sympatry*: co-occurrence of taxa in an area.
- synapomorphy*: apomorphy shared by taxa in a monophyletic group.

*synecology*: the study of associations or communities of species.

*three-item statements (TAS)*: expression of the relationship between three taxa or areas where two are more closely related to each other than either is to the third.

*track*: in panbiogeography, the distribution of a taxon, often depicted by lines (representing the shortest distances) linking the localities where it occurs.

*ultrametric*: distance measures between items being classified form, for any three, an isosceles triangle. In a phylogenetic tree, each terminal taxon would show (if this could be measured precisely) an equal amount of divergence in characters from those of the common ancestor of all the taxa.

*vicariance*: fragmentation of ancestral species ranges by the appearance of physical (or ecological) barriers.

# Index

## A

acritarch 28  
Alpine-Himalayan belt 99  
amphibians 83–89, 135, 136  
  temnospondyl 85  
Andaman  
  Islands 240, 250, 266, 385  
  Sea 104, 270, 363  
angiosperm 17, 18, 135, 148, 211–229, 244, 255, 279  
  origin 211–229  
  radiation 212  
anoa 136  
Antarctica 39, 50, 95, 102, 134, 215, 378  
antelope 398  
*Antidesma* 243, 250–251  
*Aporosa*  
  biogeography 279–289  
  cladistic analysis 279  
  distribution 283, 310  
  phylogeny 280–283  
*Apsilochorema*  
  distribution 91–98  
  phylogeny 93–94  
areas of endemism 8, 275, 341, 344  
  cicadas and Lepidoptera 5, 291–312  
  definition 5  
  Malesian plants 256  
  marine water striders 5, 344  
  Moluccan butterflies 317  
  *Spatolobus* 263  
Arfak 283, 317, 331  
Aru  
  basin 114  
  Islands 248  
Asian plate 217, 225  
Assam 94, 218, 239  
Australasia 1, 34, 78, 108, 211, 235, 294, 374, 393  
Australia 5, 28, 43, 57, 85, 91, 99–123, 134, 172, 200, 212,  
  237, 244, 267, 285, 291, 317, 330, 342, 362  
azooxanthellate corals 168

## B

Bali 133, 251, 355, 393  
Banda  
  arc 10, 114, 279, 291, 328, 384  
  Sea 107  
Banggai-Sula 27, 140  
Baoshan 57–70  
bats 16, 136, 292, 385  
bears 135  
beetles 309, 310, 355  
Biak 317, 331  
biogeography  
  analytical 243–244  
  descriptive 243–244  
  dispersalist 292  
  empirical 243–244  
  historical 315

  methodology 3, 262, 291–292, 316–317, 344–346  
  molecular 197  
  narrative 243–244  
  Permian 57–70  
  studies 243–244  
  vicariant 292  
birds 9, 135, 293, 316  
  Banda arc 384  
  Fiji 365  
  Indo-Pacific 361–390  
  Maluku 374, 384  
  New Caledonia 362–363  
  New Guinea 369  
  New Zealand 362  
  Norfolk Island 365  
  Samoa 365  
  Sulawesi 136, 375, 384  
  Tonga 365  
Bird's Head 9, 107, 227, 283, 304, 317, 352, 382  
Bismarck  
  arc 328  
  archipelago 243, 285, 320, 343, 382  
  Islands 18, 293, 382  
Bonins 12  
Borneo 4, 25, 94, 107, 169, 173, 236, 246, 259, 268, 293,  
  358, 375, 393  
  fauna 135  
  flora 135  
  geological evolution 133–151  
  geology 137  
  palaeogeography 133  
  tectonics 137  
brachiopods 27, 28, 43–54, 57–70  
  Ordovician 43–54  
  Permian 57–70  
Brunei 19, 144, 239, 244  
Burma 17, 25, 43, 58, 91, 171, 251, 267, 343, 385, 399  
  plate 111, 267  
Buru 19, 171, 240, 285, 303, 316, 374  
Buton 140, 144, 146, 385  
butterflies 6, 292, 293, 315, 355. *See also* Lepidoptera  
  Seram and Halmahera 315–324

## C

caddisfly 17, 91  
Cambodia 58, 344  
Caribbean 2, 165, 169, 185, 204, 250, 292, 293, 343, 347  
Caroline  
  arc. *See* South Caroline arc  
  Islands 12, 248  
  plate 111  
  Ridge 108  
  Sea 108  
Cathaysia 25, 57, 68, 69, 73, 78, 79  
cats 135, 136, 398  
cattle 398  
Celebes Sea 108, 140, 269  
Ceno-Tethys 25, 385  
centre of accumulation 166

- centre of origin 165, 203, 206, 323, 400  
   Paleogene corals 165–192  
 centre of richness 294  
 centre of survival 166  
 cephalopods 51  
 Chagos Islands 11  
 Changning-Menglian 37, 58  
 China 43, 247, 400  
   North 25, 27–30, 43, 85  
   South 25, 43, 57, 83, 108, 137, 237, 267  
 chital 398  
*Chitaura* 355–359  
 Christmas Island  
   Indian Ocean 11  
   Pacific 200, 203  
 cicadas 9, 136, 293, 304–305  
   Indo-Australian tropics 291–312  
 Cimmerian 6, 14, 33, 37, 57, 63, 66  
 civets 398  
 cladistic  
   analysis 3, 243  
   biogeography 3, 291, 316, 341  
 climate 19, 99, 122, 150, 287, 393  
   and plate tectonics 211–229  
   Cenozoic change 235  
   mid and late Tertiary 220  
 climatic barriers 393  
 cluster analysis 6, 291, 293, 295, 299  
 Cocos-Keeling Islands 11–12  
 conifers 6, 18, 225  
 conodonts 27  
 Coral Sea 107, 201, 295, 330, 375  
 coralline algae 165, 171, 201  
 corals 27, 341, 352  
   algal symbiosis inferred in fossils 169  
   Cenozoic links to plate tectonics 172  
   cladistic biogeographic analysis 206  
   distributional change 183  
   Eocene 165, 175–176  
   global biogeography 182  
   implications of Mesozoic record 190  
   Indian Ocean 7  
   maintenance factors 182–183  
   Mesozoic scleractinian records 171  
   Miocene 179  
   Neogene 179  
   Oligocene 176  
   originations 185–189  
   Paleogene 165–192  
   Paleogene gap in Indo-West Pacific 169  
   records 169  
   zooxanthellate 168  
 crabs, coconut 206  
 crocodilian 85–89  
 Croizat 3, 316, 361  
 crustaceans 6
- D**
- deer 136, 398  
 deforestation  
   ages 396–397  
 diamictites 29, 59, 68
- dinosaurs 83–89  
 dipterocarps 17, 222  
 dispersal. *See also* rafting  
   barrier, Borneo 401  
   barriers 393  
   island hopping 399  
   migration 292  
   model 7–9, 206, 292  
   mountain plants 211  
   path, late Cretaceous and early Tertiary 213–214  
   reality of events 255  
   timing 198  
 DNA 198  
   hybridization 16  
   mitochondrial 199–207, 355  
   mutation 198  
   sequence data 355–359  
 dogs 136, 398
- E**
- East India Letter Classification 169  
 East Philippines arc 108, 317  
 echinoids 171  
 Elaeocarpaceae 243–256  
*Elaeocarpus* 243, 253–255  
 elephants 136  
 Ephemeroptera 97  
*Eugeissona* 214, 219, 225, 248  
 Euphorbiaceae 17, 216, 243, 279–289  
   geological history 285  
 Euphorbiaceae-Phyllanthoideae 250–251  
 Eurasia 25, 39, 57, 83, 84, 99–123, 137, 168, 267  
 expanding Earth 14, 79, 101  
 extinction 14, 15, 18, 20, 183, 203, 240, 255, 263, 288,  
   318, 320, 321, 352, 362, 398, 399, 401  
   events 247  
   factor 8  
   K-T 182, 190  
   rates 207  
 extrusion hypothesis. *See* indenter hypothesis
- F**
- Fanning Island 200  
 Fiji 13, 93, 204, 223, 243, 301, 322, 343, 361  
 fish 83, 84, 135, 136, 201, 294, 401  
   antiarch 36  
   sinolepid 36  
   yunnanolepid 36  
 floras  
   Carboniferous 73  
   Carboniferous and younger 29  
   dispersals from Asia 225–226  
   dispersals from Australasia 227  
   east of Wallace's Line 223–225  
   Eocene 211, 217–219  
   Indian Ocean 12  
   Jambi 75  
   Miocene migrations 222–223  
   Permian 73, 74  
   Permian, Irian Jaya 78  
   Permian, Laos 78



- Permian, New Guinea 78  
 Permian, Papua New Guinea 79  
 Permian, Thailand 75  
 Permian, West Malaysia 78  
 Upper Palaeozoic 73–81  
 West Malaysia, Sumatra and Thailand 74  
 foraminifera 64, 70, 87, 165, 171, 176, 399  
 fossil record  
   angiosperms 212–213  
   Java mammals 398–399  
   Leguminosae 269  
   pollen 212  
   *Spinizonocolpites* 246  
   value of evidence 14  
 frogs 134, 309, 385
- G**
- Gag 316  
 gastropods 27, 51  
 Gebe 316  
 gene flow 197  
   Pacific patterns 200  
 genetic change in populations 198  
 genetic data  
   nature and utility 8, 16, 198–200, 357  
   SE Asian marine species 200  
 genetic surveys  
   Indian and Pacific oceans 203–204  
 genetics  
   population 198  
 geological evolution  
   Cambrian 34  
   Carboniferous 37  
   Cenozoic 99–123  
   Cretaceous 39  
   Devonian 35  
   Jurassic 38  
   Ordovician 34, 43–54  
   Palaeozoic and Mesozoic 25–39  
   Permian 37–41, 57–70  
   Silurian 35  
   Tertiary, Borneo and Sulawesi 133–151  
   Triassic 37  
 Gerromorpha 341  
   Indo-Pacific 341–353  
 giant clam 197, 201  
   geographic variation 201–203  
 gibbons 16, 136, 393, 394  
 glacial  
   cycles 393  
   maxima 397  
 Gondwanaland 4, 17, 25–39, 73, 78, 79, 94, 150, 211, 267, 386  
 Gramineae 243, 248  
   Bambuseae 248–250  
 grasshoppers 355  
   distribution 356  
   Sulawesi 355–359  
 Great Barrier Reef 172, 201  
 Guangxi 73  
 Gulf of Thailand 111, 226  
 gymnosperm 18, 78, 79, 215–229, 333
- H**
- Hainan 30, 52, 236, 267  
 Halmahera 12, 107, 220, 238, 289, 315, 374  
   arc 108, 317, 385  
   butterflies 315–324  
   geology 317  
 Hawaii 5, 8, 13, 200, 239, 253, 311  
 Hawaiian-Emperor seamount chain 108, 183  
 Heteroptera 327, 341  
   aquatic 327  
   Indo-Pacific 341–353  
 Heteroptera distributions 333–339  
   Australia 333  
   influence of rock type 335  
   Melanesian arc 333  
   Papuan arc 334  
   Solomons arc 336  
   Vogelkop 333  
 Himalaya 33, 57, 61, 94, 211, 237, 250, 267, 279, 387  
 Huxley's line 393, 401  
 hybridisation 4, 279, 355  
 Hydrobiosidae 17, 91–98  
 hyenas 398
- I**
- indentor hypothesis 9, 102–123  
 India 25, 66, 214, 239, 248, 267, 394  
 India-Asia collision 9, 106, 172, 269  
 Indian  
   Ocean 11, 38, 103, 173, 197, 341  
   plate 12, 91, 107, 211, 240, 267  
 Indo-Malayan 168, 352  
 Indo-Pacific 197, 341  
 Indo-Pacific gateway 172  
 Indo-West Pacific 165–192, 168  
 Indochina 25, 43, 57, 83, 99, 137, 190, 223, 236, 244, 267, 336, 387, 393  
 Indonesia 13, 30, 43, 75, 100, 150, 173, 225, 240, 244, 285, 315, 342, 388, 394  
 Indonesian archipelago 133, 169, 171, 190, 205, 289  
 Indoralian 57, 67  
 insects  
   aquatic 91–98, 327–339. *See also* Heteroptera; Hydrobiosidae  
   marine 341–353. *See also* Gerromorpha; Heteroptera  
   terrestrial 291–312, 315–324, 355–359. *See also* butterflies; cicadas; grasshoppers; Lepidoptera  
 Irian Jaya 63, 73, 213, 239, 255, 289, 328  
 island arc accretion  
   New Guinea 327–339  
   SE Asia and SW Pacific 107–123  
 island hopping 133, 149–151, 393  
 Isthmus of Kra 251, 259, 269  
 Izu-Bonin-Mariana arc 108
- J**
- Japan 15, 25, 88, 107, 172, 211, 236, 253, 344  
 Java 11, 107, 133, 169, 176, 217, 236, 247, 267, 282, 293, 355, 375, 393  
   Sea 137, 219, 246

**K**

Kalimantan 120, 133, 217, 236, 385, 400  
 Kazakhstan 25, 37, 50, 57  
 Kerala 266  
 Khorat plateau 83  
   vertebrates 83–89  
 Krakatau 256, 393  
 Kurosegawa 25, 30

**L**

Langkawi Island 46–48, 59  
 Laos 58, 73, 88, 267  
 Laurasia 25, 75, 84, 91  
 Laurasian 225  
 Laurentia 29, 44  
 Leguminosae 221, 259  
 lemurs 136  
 leopard 398  
 Lepidoptera 11–13, 136, 293, 384  
   Gondwanan groups 17–18  
   Halmahera and Seram 315–324  
   Indo-Australian tropics 291–312  
 Lesser Sunda Islands 6, 133, 236, 251, 287, 302, 321, 344,  
   385, 393  
 Lhasa 25, 57, 83, 91, 269  
 Lombok 133, 239, 393  
 lorises 136, 393  
 Loyalty Rise 107  
 Luzon 108, 220, 236, 251, 269, 343, 397  
   arc 114  
 Lydekker's line 133, 393

**M**

macaques 16, 355, 358, 393–402  
 Madagascar 18, 96, 211, 239, 243, 285, 344  
 Mahakam delta 145, 222  
 Makassar Strait 108, 133, 235, 268, 393  
 Malawa Formation 217  
 Malay  
   basins 222, 226  
   peninsula 43, 107, 168, 212, 236, 247, 259, 282, 385,  
   394  
 Malaya 57, 267, 285  
 Malaysia 5, 37, 43, 48, 58, 73, 137, 219, 244, 287, 293,  
   321, 344, 358, 397  
 Malesia 229, 235, 243, 247, 279, 285, 341, 343, 344  
 Malesian plants  
   distribution patterns 243–256  
 Maluku 243, 248, 315, 343, 361. *See also* Moluccas  
   geological history 383–384  
 mammals 19, 134, 214, 385, 398  
   glacial and pre-glacial distributions 393–402  
 Mangkalihat peninsula 142, 217  
 mangroves 19, 220, 341, 352  
 Maramuni arc 114  
 Marianas 12, 108, 173  
 marine biodiversity 197  
 marine organisms  
   genetic structure 197–207  
 Marshall Islands 12, 173, 200

marsupials 136, 385  
 mayflies 97  
 Mayu 315  
 Melanesia 327  
   geological history 105–123  
 Melanesian  
   arc 9, 108, 279, 302, 328, 378  
   archipelago 291  
 Mentawai  
   archipelago 393  
   Islands 16, 393  
 Meratus 259, 268  
 Mergui/Tenasserim 267  
 Meso-Tethys 25  
 metapopulation dynamics 8  
 Micronesian island arcs 12  
 Mindanao 237, 247, 289, 293, 334, 383, 401  
 Mindoro 113, 224, 236, 269  
 Misool 171  
 modelling dispersal, speciation and vicariance 7  
 molecular  
   analysis 357–358  
   clock 14, 311, 355, 357  
   phylogeny 355  
 moles 136  
 mollusca 44, 171  
 Molucca Sea plate 111  
 Moluccas 9, 150, 223, 286, 293, 315, 355, 401  
   geological history 105–123  
 Mongolia 64, 83  
 monkeys 16, 393–402  
 Morotai 333, 374  
 mosses 235  
   disjunctive patterns 236–241  
   Malesian 235–241  
   Malesian biogeography 235–236  
   speciation 236  
 mountain plants  
   dispersal 225–226  
 Müller's line 402

**N**

Nanggulan Formation 217  
 Natuna basins 226  
 nautiloids 27, 44  
 Nepal 33, 93, 240, 253, 267  
 New Britain 108, 361  
   arc 331  
 New Caledonia 107, 173, 176, 228, 236, 244, 301, 333,  
   361, 378  
   Rise 107  
 New Guinea 9, 94, 168, 236, 243, 279, 293, 315, 327, 352  
   geological history 105–123, 328–330  
 New Guinea arc 111  
 New Hebrides arc 114  
 New Zealand 169  
   geological history 375–378  
   parallel arcs model 19, 292, 379  
 Nicobar Islands 248, 267  
 nightjars 361  
   evolution 387  
 Ninetyeast Ridge 173, 184, 218

- non-metric multidimensional scaling 6, 292
- Norfolk  
 basin 111  
 Island 292, 321, 362  
 Ridge 378
- North Fiji basin 13, 115, 381
- Northern New Guinea plate 107
- Nyba* 243, 244–246
- O**
- Obi 308, 315, 383
- ocean floor magnetic anomalies 99
- oceanic circulation 122
- Ontong Java plateau 111, 122, 329
- ophiolite  
 New Caledonia 108  
 New Guinea 339  
 Papuan 107  
 Sepik 107  
 Sulawesi 111, 140
- orang-utans 393, 400
- Orthoptera 355  
 molecular phylogeny 355–359
- otters 136
- P**
- Pacific 99, 244  
 marine organisms 197–207  
 Ocean 12, 103, 173, 203, 344  
 plate 103, 168, 173, 317, 328, 352, 378
- Palaeo-Tethys 25
- palaeogeographic evolution  
 Cenozoic 99  
 Mesozoic 25–39  
 Palaeozoic 25–39  
 Sulawesi and Borneo 133–151  
 Tertiary 133
- palaeogeography  
 Australasia 43  
 Borneo and Sulawesi  
 Eocene 140  
 Miocene 144–146  
 Oligocene 144  
 Pliocene-Recent 147
- palaeomagnetic data 1, 29, 99
- Palau 12, 344, 389
- Palau-Kyushu ridge 111
- Palawan 19, 39, 107, 226, 235, 243, 269, 321, 336, 343, 355
- palm 17, 243
- Palmae 243, 244–247
- palynology 211–229  
 evidence for Tertiary plant dispersals 211–229
- palynomorphs 84, 213  
*Eugeissona* 248
- panbiogeography 3, 291
- Pangaea 37, 43, 91, 240
- pangolins 136, 398
- Papua New Guinea 79, 108, 169, 213, 238, 244, 317, 330
- Papuan  
 arc 327  
 peninsula 286, 309
- Papuasia 247, 255, 344
- paralogy 5, 294, 341, 350
- Parece Vela basin 111
- Penang/Kedah 267
- Penyu basin 226
- Permian biogeography 57–70
- Phalacrocoracidae 379–380
- phalangers 401
- phenetic  
 biogeographic methods 5, 291, 292  
 classification 243
- Philippine Sea plate 103, 168, 269, 381
- Philippines 10, 39, 101, 133, 172, 200, 236, 244, 248, 259, 282, 291, 331, 342, 375, 393
- Philippines-Halmahera arc 108
- phytogeography 73–81, 211–229, 235–241, 243–256, 259–275, 279–289
- phytosaur 84
- plant dispersal 211–229  
 by birds 255  
 plate tectonics and climate 211–229
- plants  
 distribution  
 Malesian, eastern 243  
 Malesian, Sundaic 243  
 Malesian 243–256
- plate motions 100
- plate tectonics 1, 99  
 and climate 211–229  
 Cenozoic 99–123  
 Palaeozoic and Mesozoic 25–39  
 Paleogene 165
- Plecoptera 97
- Polynesia 13
- population genetics 197
- porcupines 136
- primates 16, 135, 393–402  
 Borneo 393–402  
 Borneo impoverishment 400  
 distributions 394  
 modern Borneo diversity 400
- proto-South China Sea 39, 107
- Psittacidae 379
- Q**
- Q-mode analysis 3, 293, 294
- Qiangtang 25
- R**
- R-mode analysis 3, 291–312
- rafting 91, 133, 219, 393, 394, 399
- rainforest  
 expansion and contraction 393–402  
 glacial refugia 402  
 refugia 393
- rarity 8
- reconstruction  
 Cambro-Ordovician 34  
 Carboniferous 37  
 Cretaceous 39

- Devonian 35  
 Eocene 106–107, 107–108  
 Jurassic 38  
 Miocene 111–114  
 Oligo-Miocene 110–111  
 Oligocene 108  
 Ordovician 50  
 Permian 37  
 Silurian 35  
 Triassic 37  
 Red River fault 107  
 Reed Bank-Dangerous Grounds 25  
 regional evolution  
   Cenozoic 99–123  
   Mesozoic 25–39  
   Palaeozoic 25–39  
 reptiles 134, 135, 136  
   dicynodont 37  
   Mesozoic 83–89  
 rhinoceroses 135, 136, 398  
 rifting  
   Carboniferous-Permian 32  
   Devonian 32  
   Triassic-Jurassic 33  
 rifting and separation  
   Gondwanaland terranes 32  
 rodents 16, 383  
 Rotuma 13, 301  
 Ryukyu Islands 113, 244, 309, 342
- S**
- Sabah 19, 120, 135, 179, 227, 238, 251, 270, 402  
 Sagaing fault 111  
 Sahul shelf 19, 393, 401  
 Sakhalin 93  
 Samoa 13, 301, 343, 361  
 Sangihe 148, 293  
 Sapindaceae 214, 310  
 Sarawak 19, 120, 140, 175, 215, 239, 251, 400  
 Sarawak/C Borneo 268  
 scleractinian coral 165  
   ecology 168–169  
 sea level 122, 197  
   Eocene-Pliocene 259, 270–274  
   Pleistocene 16  
 sea urchins 203  
 sea-floor spreading 1  
 Semitau 25, 144, 259, 268  
 Sepik basin 330  
 Sepik-Papuan arc 107  
 Seram 19, 114, 171, 177, 225, 237, 285, 303, 315, 355, 374  
   butterflies 315–324  
   geology 317–318  
 Shan-Thai 43, 57, 83, 239. *See also* Sibumasu  
 sharks 86  
 Shikoku basin 111  
 shrews 16, 135, 136  
 Siberia 25, 37, 44, 57, 88, 91  
 Sibumasu 25, 43, 57, 267, 285. *See also* Shan-Thai  
   geological history 29–39  
   Ordovician biogeography 43–54  
   Permian biogeography 57–70
- Simao 37, 57  
 Singapore 244, 267, 343, 399  
 Solomon  
   arc 327  
   Islands 9, 108, 244, 289, 293, 378  
   Sea 108  
 South Caroline arc 9, 108  
 South China Sea 19, 25, 102, 221, 237, 269  
 South Fiji basin 108, 380  
*Spatholobus*  
   biogeography 259, 259–275  
   cladistic biogeography 262–263  
   history 274  
   phylogeny 260  
 speciation 4, 120, 197, 198, 250, 259, 280, 292, 317, 336,  
   351, 355  
 species-area relationship 7  
*Spinizonocolpites* 243, 244  
 squirrels 135, 398  
 Sri Lanka 18, 219, 239, 244, 279, 343  
 starfish 197, 203  
 stegodonts 149, 401  
 stoneflies 97  
 stromatoporoids 27  
 Sula 114, 307, 315, 344, 375  
 Sulawesi 5, 30, 96, 99, 137, 165, 225, 236, 243, 259, 285,  
   291, 315, 334, 343, 355, 361, 393  
   fauna 135  
   flora 136  
   geological evolution 133–151  
   geology 137  
   palaeogeography 133  
   tectonics 137  
 Sulu 239  
   arc 108  
 Sumatra 16, 172, 236, 247, 267, 288, 309, 393  
 Sunda shelf 19, 135, 259, 401  
 Sunda-Java-Sulawesi arcs 108  
 Sundaic 136, 247, 248, 267  
 Sundaland 4, 101, 175, 247, 285, 291, 306  
 Sundanian 16, 211, 279, 291  
 surelis 393, 394  
 SW Pacific 91  
   geological evolution 99–123
- T**
- Taiwan 107, 226, 237, 251, 344  
 tapirs 136  
 Tarim 25, 213  
 tarsiers 393  
 Tarutao Island 46  
 Tasman Sea 107, 378  
 Tasmania 48, 93, 238, 246, 321  
 temnospondyls 85  
 Tengchong 57  
 terranes 25  
   amalgamation and accretion 33  
   New Guinea 317, 381  
   origins, East and SE Asian 27–30  
 Thailand 37, 43, 58, 73, 83, 110, 171, 212, 247, 266, 321,  
   344, 397  
   basins 226

- Ordovician sequence 46–48
  - vertebrates 83–89
  - Three Kings Rise 111
  - Tibet 29, 64, 83, 213, 240
  - Tifore 315
  - tigers 398
  - Timor 63, 114, 171, 304, 321, 361, 401
  - Tonga 173, 327, 343, 344, 361
  - Tonga-Kermadec 108
  - Triassic 25
  - Trichoptera 91
  - trilobites 27, 43–54
    - Ordovician 44–54
  - tropical rain forest 19, 211–229, 250, 266, 358
    - expansion 211
  - Tukang Besi 114, 140
  - turtles 84, 86
- V**
- Vanuatu 13, 243, 301, 344, 362
  - vertebrates
    - Borneo primates 393–402
    - Cretaceous 87
    - Jurassic 85
    - Mesozoic 83–89
    - Triassic 84
  - vicariance
    - aquatic Heteroptera 338
    - biogeography, biogeographers 57, 255
    - cicadas 307
    - dispersive 293
    - events, interpreting cladograms 262
    - grasshoppers 358
    - importance 4
    - Lepidoptera 300
    - Mesozoic plants 17
    - model for tropical marine organisms 206
    - modelling 7
    - Proteaceae 18
    - rejection of dispersal 291
    - result of passive allopatric speciation 263
    - school 292
    - shrews 16
    - surface circulation 167
    - tectonic, Shan-Thai, Tengchong, Baoshan blocks 65
    - Vietnam 19, 31, 46, 58, 109, 223, 344, 396
    - Vietnamese basins 226
    - Visayas 239
    - Vogelkop 79, 255, 308, 329. *See also* Bird's Head
- W**
- Waigeo 9, 316, 330
  - Wallace 100, 316, 374
  - Wallacea 1, 9, 133, 224, 375, 393, 401
    - climatic origin 401
  - Wallace's line 116, 133, 211, 222, 343, 393, 401
  - water bugs 9, 327
    - New Guinea region 327–339
  - water striders 341
    - distribution 342–343
    - Indo-Pacific 341–353
  - weasels 136
  - Weber's line 6, 134, 299, 402
  - West Philippine basin 108
  - Woodlark basin 115
  - Woyla 17, 25, 95, 267
- Y**
- Yapen 317, 331
  - Yunnan 46, 58, 73, 84, 171, 237, 255, 267
  - Yunnan/N Thailand 267
- Z**
- Zamboanga 107
  - zoogeography 91, 330, 393
  - zooxanthellate coral 165–192

