

Fossil Fishes of Great Britain

D.L. Dineley

Department of Geology University of Bristol Bristol, UK

and

S.J. Metcalf

Humber Estuary Discovery Centre, North East Lincolnshire Council Cleethorpes, UK

GCR Editor: D. Palmer



Glossary

This glossary provides explanations of the more important technical and arcane terms used in the introductions to the chapters and in the 'Highlights' and 'Conclusions'. These explanations do not pretend to be scientific definitions but are intended to help the general reader. Detailed stratigraphical terms are omitted as they are given context within the tables and figures. Systematic names for groups of organisms are given with the formal version followed by the informal plural suffix in brackets. This is followed by a vernacular translation of the Greek or Latin roots of the terms.

- Acanthodii (-ians): 'spiny', a member of the extinct class of **Palaeozoic** (Silurian– Permian) primitive jawed fish, the so-called 'spiny sharks' with spine supported fins and a covering of small scales, which occupied both marine and fresh waters.
- Acanthomorpha (-phs): 'spine form', a group of advanced spiny **neoteleosts** with true dorsal and anal fin spines.
- Acanthopterygii (-ians): 'spiny fin', an advanced group of neoteleosts with spiny fins, ranging from the Upper Cretaceous(?) to the present, including living perch, mackerel, plaice etc.
- Achanolepid (-ids): one of five types of thelodont scale, very small with no pulp cavity, a bulging base and crown made up of dentine-type tissue; regarded as the most primitive type.
- Acme: 'prime', the high point attained by an organism or group of organisms, as measured by some aspect of **phylogenetic** success, e.g. number of species; in palaeontology this depends on relative abundance of preserved fossils in a body of strata.
- Actinopterygii (-ians): 'ray fin', (one of) the largest and most diverse of extant vertebrate groups, including many extinct forms and most living bony fishes; characterized by a

hypermineralized cap to the teeth, and only one dorsal fin, although it may be subdivided; they also have **ganoid** scales, reduced pelvic girdles and usually paired fins with broad bases.

- Actualism: a methodological approach to the interpretation of geological phenomena, based purely on an understanding of present processes on Earth.
- Aeolian: 'of *Aeolus*, god of winds', sediments carried and deposited by the wind.
- Agnatha (-ns): 'without jaws', a class of primitive jawless vertebrates, including a large number of extinct marine and freshwater groups but now reduced to two – the hagfish and lampreys.
- Albanerpetontidae (-ids): 'alba reptile', an extinct and enigmatic group of freshwater salamanders.
- Ammocoete larva: 'sand bed-mask', larval form of the lampreys.
- Ammonitina (-ites): 'horn of (Ammon) Jupiter', an advanced group of ammonoids, characterized by the complexity of the sutures between septal chamber walls and the outer wall of the shell.
- Ammonoidea (-oids): 'horn of (Ammon) Jupiter', members of an extinct group of marine cephalopods, whose nearest living

Glossary

relative is the *Nautilus*, and are generally characterized by a coiled shell, regularly partitioned into chambers (Devonian–end Cretaceous).

- Amniota (-otes): 'foetal membrane', a group of craniates including reptiles, birds and mammals having an amnion (foetal membrane) around the embryo.
- Amphibia (-ians): 'both life', a class of amniote tetrapod vertebrates with larval gills but adult lungs and a skin usually without scales; includes both living Lissamphibia – frogs, salamanders, etc.– and a large number of extinct fossil groups, whose characterization as amphibians is often problematic especially amongst early representatives.

Anaerobic: literally 'without air' or oxygen.

- Anaspida (-ids): 'without shield', a group of extinct small agnathans with fusiform bodies and heads and bodies covered by small bony scales.
- Angiospermae (-erms): 'vessel seed', a major division of the plant kingdom, commonly referred to as the flowering plants, with seeds developed in a closed 'vessel', the ovary.
- Anoxic: literally 'without oxygen', synonymous with anaerobic.
- Anthracosauria (-aurs): 'charcoal lizards', a group of 'labyrinthodont' fish-eating tetrapods (early Carboniferous to Permian in age), some of which were terrestrial but others were aquatic; they may include the ancestors of the reptiles and are often referred to as reptilomorphs.
- Antiarchi (-archs): 'against first', an extinct group of Devonian placoderms, whose bodies are covered in bony plates, with two median dorsal plates and in which the paired pectoral fins are replaced by long, jointed bony appendages.
- Anura (-ans): 'without tail', a major group of living amphibians including the frogs and toads.
- Arachnida (-ids): 'spider form', a large group of carnivorous chelicerate arthropods, mainly terrestrial, including the scorpions and spiders.
- Arenite (-aceous): 'sand', a clastic sediment made of sand-sized particles.
- Argillite (-aceous): 'clay', a fine-grained sediment made of silt, or clay-sized particles.
- Arthrodira (-ires): 'jointed neck', a group of placoderm fishes (Devonian to Carboniferous), characterized by bony

shields covering the head and thorax, which are articulated by a joint.

- **Aspidin:** 'shield', an acellular bone-like material found in the bony plates and scales of some extinct jawless fish.
- Aspidorhynchidae (-ids): 'shield snout', an extinct group of basal teleosts with long bodies and long pointed snouts.
- Astraspida (-s): 'star shield', a group of extinct early agnathans, characterized by thick enameloid caps to the tubercles of the skin scales; the head armour is made of loosely linked polygonal plates.
- Autostylic: 'self pillar', a means of jaw suspension whereby the mandibular arch is self-supporting and articulates directly with the skull.
- Avalonia: 'Avalon Peninsula, Newfoundland', an early Palaeozoic crustal plate consisting of Newfoundland, England, Wales, south-east Ireland and part of western Europe, which was brought together with Laurentia at the end of the Silurian.
- **Baltica:** 'Baltic', an early **Palaeozoic** crustal plate consisting of much of present day north-western Europe, including Scandinavia, European Russia and central Europe; the plate formed the south-eastern continental margin of the **Iapetus** Ocean and collided with **Laurentia** to form the Caledonian mountain belt when the ocean was subducted.
- Batoidea (-oids): 'thorn bush', a group of neoselachian elasmobranch fishes (Jurassic-extant), such as the skates and rays, with dorso-ventrally flattened bodies, enlargened pectoral fins for locomotion and a reduced tail and other fins.
- Belemnite: 'javelin form', a member of an extinct group of cephalopod marine molluscs related to the squids, having an internal solid calcium carbonate 'bullet-shaped' and posterior skeletal element (predominantly Jurassic–Cretaceous but with problematic earlier Carboniferous and Triassic forms and a later questionable Tertiary form).

Benthic: 'depths', living on or in the substrate.

- Benthosuchidae (-ids): 'deep lizard', an extinct group of Triassic stereospondyls which may be paraphyletic and thus not a valid entity.
- **Biocoenose:** 'life in common', a living community of organisms occupying a particular **biotope.**

Biostratigraphy: 'life layer writing', the subdi-

vision and correlation of sedimentary strata based on their fossil content.

- **Biota:** 'life', the flora and fauna of a particular place.
- **Biotope**: 'life place', habitats within which the environmental conditions are relatively uniform and similar assemblages of inhabitants recur.
- **Bioturbation:** 'life disorder', any physical disturbance of the substrate, such as burrows and feeding traces, by the organisms living on or in it. These traces are often preserved in ancient sediments.
- **Biozone:** a stratigraphically restricted unit of sedimentary rocks defined by its fossil content, most usefully by species of narrowly defined temporal range, and named after a single characteristic species.
- **Bloom:** a seasonal and often dramatic increase in numbers of **phytoplankton** due to simultaneous reproduction.
- **Bone-bed:** a stratigraphically restricted sedimentary accumulation and concentration of bones, or other vertebrate remains such as teeth or scales, often worn by transport and associated with fluviatile deposition, especially channel **lag** deposits or marine nearshore conglomerates. Bone beds may reflect a lack of other coarse grained sediment or a mass or catastrophic extinction event and occasionally are an economic source of **phosphates**. They represent an important source of palaeontological and geological information.
- **Bowfins:** common name for the amiiforms, an extant group of primitive **neopterygians**, characterized by the living *Amia*.
- **Brachiopoda (-ods):** 'arm footed' a phylum of bivalved and lophophorate shellfish, superficially similar to the bivalved molluscs but distinguished by a different anatomy. Particularly common in the Palaeozoic seas but replaced by the molluscs as the dominant shellfish since Mesozoic times.
- Bradydonti (-onts): 'slow toothed', a group of holocephalan fishes.
- **Breccia:** a fragmental clastic sediment, characterized by angular grains.
- **Caecilia (-ians):** 'blind', a group of limbless burrowing amphibians.
- **Calcrete:** a deposit of a semi-arid region cemented by calcium carbonate, often referring to a superficial terrestrial soil.

Caledonides: 'of Caledonia', the Palaeozoic

mountain chain extending in a northeast-south-west direction in Spitsbergen, eastern Greenland, Scandinavia, Scotland, northern Ireland, the Lake District of England, Wales and continued in Eastern Canada, which resulted from the closure of the **Iapetus** ocean.

- Capitosauridae (-ids): 'head lizard', a member of a group of temnospondyl labyrinthodont amphibians with flattened skulls, some of which were 'crocodile-like' and reached considerable size (Triassic).
- **Cartilage (-inous):** 'gristly', a strong elastic connective tissue, which is an important skeletal material in the vertebrates and the sole skeletal material in the **chondrichthyan** fishes.
- Caturidae (-ids): 'of *Caturus*', a small group of extinct amiiform halecomorph neoptery-gians.
- **Cenozoic:** 'recent life', the division of geological time which succeeds the Mesozoic and is characterized by the radiation of the mammals, flowering plants, insects, etc.
- **Cephalaspida (-ids):** 'head-shield', an extinct group of **osteostracan** agnathans characterized by a solid bony head-shield and broad cornual processes.
- **Cephalochordata (-ates):** 'head string', a group of primitive **chordates**, commonly called the lancelets and are thought to typify an ancestral form for the vertebrates; metamerically segmented, with an axial stiffening rod, the **notochord**, persisting in the adult and a perforated pharynx for feeding and respiration.
- Ceratodidae (-ids): 'horn', an extant group of freshwater lungfishes.
- Ceratodontidae (-ids): 'horn teeth', a group of extinct freshwater and marine lungfishes.
- Chimaeridae (-aeras): 'monster shape', extant group of durophagous holocephalans with tooth plates, holostylic jaw suspension, an articulated dorsal spine, pelvic claspers and long narrowing tail (hence common name – rat-fish).
- Chondrichthyes (-yans): 'cartilage fish', a major group of fish, commonly called the cartilaginous fishes, which have a cartilaginous endoskeleton, no lungs or air bladder and a spiral valve in the gut; typified at present by the sharks and rays.
- Chondrostei (-ians): 'cartilage bone', a group of primitive actinopterygians with a hetero-

cercal tail and a spiracle, typified at present by the sturgeons and paddlefish.

- Chordata (-ates): 'string', major group of coelomate animals, characterized by a **notochord** and perforated pharynx at some stage in the life history and a dorsal hollow nerve cord.
- Chronostratigraphy (-ical): 'time layer writing', the subdivision of geological time into a hierarchy of sequential units to which the layers (strata) of sedimentary rocks are allocated.
- **Cladistic analysis:** 'branch analysis', an attempt to characterize natural groupings of organisms by means of a search for shared derived characters.
- Cladodont: 'branch tooth', teeth with a prominent central cusp and smaller lateral cusps.
- Cladogram: 'branch picture', a branched treelike classification diagram produced by cladistic analysis.
- **Clastic:** 'broken in pieces', fragmental sediment composed mainly of particles derived from pre-existing rocks or minerals, including organic remains (designated as bioclastic).
- Cleithrum: 'bar', the clavicular elements of some fish.
- **Climatiidae (-iids):** *'Climatius* shape', a group of extinct **acanthodians** with two dorsal fins and a row of spines between the pectoral and pelvic fins.
- Clupeocephala (-ans): 'herring head', an extinct group of Jurassic advanced teleosts derived from the elopocephalans and characterized by tooth plates fused with endoskeletal gill-arch elements.
- **Clupeomorpha(-orphs):** 'herring form', a group of primitive **teleosts** ranging from the Jurassic to the present and including the living salmon and herring.
- **Coccolith (-iths):** 'berry stone', a member of a palaeontologically important group of unicellular flagellate and planktic marine microorganisms producing a calcium carbonate skeleton made up of a series of plates. The Cretaceous chalk limestone is often largely made up of coccolith skeletons (Upper Triassic-Recent).
- **Coccosteidae (-ids):** 'berry bone', an extinct group of **arthrodire** gnathostomes with an embayment in the central plate for the preorbital plate.

Coelacanth: 'hollow spine', a group of sar-

copterygians, the actinistians with a reduced air bladder and no choana, characterized by the 'living fossil' coelacanth *Latimeria*.

- **Coelolepida (-ids):** 'hollow scale', synonymous with **thelodont**, a group of extinct jawless **ostracoderms**, characterized by a covering of small **shagreen**-like scales, which can be used to identify them and are of considerable use in **biostratigraphy**.
- **Conchostraca (-ans):** 'shelled shell', members of a group of freshwater crustaceans (the clam shrimps) in which the body is contained within a chitinous bivalved shell (Devonian–Recent).
- **Conodonta (-onts):** 'cone teeth', an extinct group of small eel-like marine coelomates, characterized by assemblages of paired teeth made of bone-like material; recently considered to be chordates or possibly primitive **agnathan** vertebrates. The teeth have considerable use in **biostratigraphy**.
- **Coprolite:** 'dung stone', petrified or fossil faecal material which may contain identifiable food remains and occasionally abundant enough to be a source of **phosphate**.
- **Coquina:** 'of shells', a limestone deposit largely made of shells or their fragments.
- **Cornstone:** a concretionary limestone deposit, characteristic of arid terrestrial environments.
- **Cornua(-ates):** 'horn', a horn or horn-like projection.
- **Cosmine:** 'order', a kind of **dentine** found in the cosmoid scales, which have an outer layer of enamel, then cosmine and an inner layer of bone; found in **crossopterygians** and early lungfish.
- Craniata (-ates): 'skull', synonymous with Vertebrata, a major subdivision of the chordates, in which there is a high degree of cephalisation, producing a brain enclosed in a protective 'skull' and an endoskeleton consisting of a backbone, paired girdles and attached locomotory appendages.
- **Creatine:** 'flesh', a biochemical found in all vertebrate muscle.
- Crinoidea (-oids): 'lily form', a group of echinoderms, characterized by roots, stems, cups and arms made of jointed plates of calcium carbonate, hence the common name – 'sea lily'; the carbonate skeleton is readily fossilized and they were particularly common from the Middle Palaeozoic to Mesozoic but

less so in more recent times.

Crossopterygia (-ians): 'tassle finned' an old classificatory term for a mainly extinct group of **sarcopterygian** fish which includes the living **coelacanth**.

Cryogenic: 'frost kin', produced by freezing.

- **Cryptozoic:** 'hidden life', synonymous with Archean, the earliest phase of Earth history prior to 2600 Ma ago, during which life originated and from which only a few primitive organisms have been fossilized.
- Ctenacanthiformes (-orms): 'comb thorn form', an extinct group of elasmobranch sharks, with flexible jaw systems and enhanced sensory apparatus, from which the neoselachians may have originated.
- Cyathaspida (-ids): 'cup shield', an extinct group of heterostracans, characterized by a fusiform dorsal head-shield in a single plate, ornamented with longitudinal parallel dentine ridges and the body scales are relatively large.
- Cycloid: 'circle form', scales with an evenly curved free edge.
- **Cyclostomata (-omes):** 'circle mouth', a grouping of living **agnathans** without bone or paired fins, the **hagfish** and **lampreys**, on the basis of a number of shared characters such as the structure of the 'tongue'.
- **Cyclothem:** 'circle laid down', a succession of sedimentary layers, representing a sequence of depositional events which tend to be repeated.
- **Denticle:** 'little tooth', small tooth-like processes and scales.
- **Dentine:** 'tooth', a hard material resembling bone, which makes up the greater part of teeth.
- **Dermal bone:** 'skin bone', bony elements which develop within the skin and may be thickened into tough 'leathery armour-like' plates of varying size.
- **Diachronous:** 'through time', relating to sedimentary or stratigraphical units where the environmental or facies boundaries cut across the time boundaries in the succession of deposition. Diachronism reflects the migration of a geological event through time so that the sediment produced by that event is not everywhere the same age.
- **Diastrophism:** 'through turning point', largescale movement and deformation of the Earth's crust.

- **Dinoflagellate:** 'rotating whip', a member of a large and diverse group of aquatic unicellular micro-organisms, loosely placed with the algae, which swim by means of flagellae and some of which are covered with cellulose plates that can be preserved in the fossil record (Mid-Triassic–Recent).
- **Diphycercal:** 'two-fold tail', a tail fin in which the vertebral column runs straight through to the tip and divides the fin into two symmetrical lobes.
- **Dipnoi (-oans):** 'two times to breathe', a group of primitive bony fishes with both gills and lungs for breathing, hence the common name – lungfish.
- **Dipteridae** (-ids): 'of *Dipterus*,' similar to the lungfish *Dipterus*.
- Discoglossidae (-ids): 'round flat tongue', a member of a group of primitive frogs (anurans) with a long fossil record (Upper Jurassic-Recent) and both aquatic and terrestrial representatives.
- **Disconformity:** 'asunder with form', a break in time, during which no sediment is deposited or the sediment that is deposited is subsequently eroded before the succession of strata continues without angular discordance.
- **Dolomite:** a carbonate mineral containing a significant amount of magnesium carbonate, forming extensive deposits, often as a result of secondary, post-depositional chemical changes to limestones.
- **Durophagous:** 'hard to eat', consuming prey with hard parts, which need to be crushed, such as shellfish and crustaceans.
- **Ecostratigraphy:** 'household layers, writing of', the study of the changing relationships between organisms, their evolution and their environments through time.
- Elasmobranchii (-anchs): 'to draw out gills', a group of chondrichthyans with placoid scales, a spiracle and no operculum over the gills, such as the sharks, skates and rays; many forms have the two dorsal fins armed with large spines, which are amongst the few features that are fossilized.
- **Elopocephala (-ans):** 'fish head', an extant group of advanced **teleosts** which gave rise to the **clupeocephalans**.
- **Elopomorpha (-orphs):** 'fish form', a primitive group of **teleosts**, which includes the eels.
- **Embolomeri (-eres):** 'wedge part', in earlier classifications an extinct group of primitive

'labyrinthodonts', originally thought to be characterized by a particular vertebral structure.

- Entopterygoid (-oids): 'within wing form', a dorsal membrane bone behind the palatine in some fishes.
- **Epeiric:** 'mainland', produced by large-scale uplift or subsidence of crustal rocks without the severe deformation associated with orogeny.
- **Epicontinental:** 'upon continent', located on a continent or the surrounding continental shelf.
- **Epilimnion**: 'upon lake', the upper layer of warm water, formed in summer, within a thermally stratified lake.
- Eriptychiformes (-orms): 'very folded form', a poorly known extinct group of tesselated heterostracans.
- **Erratic:** 'mistake', a rock which seems out of place within the sedimentary environment within which it is found, especially glacial erratics which have been carried great distances by glaciers or ice-bergs before being dumped wherever the ice melts.
- **Eugenodontiformes (-orms):** 'well-born tooth form' an extinct group of **cladoselachian elasmobranchs**, some of which were large shark-like forms, characterized by a median series of large teeth on the lower jaw, which is scrolled into a tooth spiral in some, lacking anal and pelvic fins.
- **Euramerica:** 'Europe–America', continental mass of north-western Europe and North America, formed when the **Iapetus** Ocean was subducted during the **Caledonian** orogeny; also used to denote a biogeographical province.
- **Eurypterida (-ids):** 'of *Eurypterus*, broad fern', an extinct group of large aquatic arthropods which superficially resemble scorpions.
- **Euteleosta (-osts):** 'wide finished', the largest group of **teleosts**, which includes over 17 000 species, belonging to three main groupings ranging from pike to goldfish and salmon.
- **Evaporite:** sediments and minerals grown from a saline solution by evaporation of the solvent – normally water, which may be marine or continental in origin. A wide range of mineral salts may be precipitated depending on the original composition of the solvent, e.g. carbonates, sulphates and chlorides, and mixed with other types of sediment, often

finely laminated.

- Fish: the common and convenient name for a wide range of aquatic vertebrates, which used to be united under the old classificatory term Pisces.
- **Fissure-filling:** cavities, often formed by solution of limestone host rock, infilled with relatively younger deposits, which may be of particular interest when they contain fossils, especially **microvertebrates** that are not preserved elsewhere.
- Flash flood: an infrequent and ephemeral flood, characteriztic of semi-arid regions and often associated with storms. The water may evaporate and dump its sediment load before discharging into the sea.
- **Flint:** a hard, glassy and non-crystalline mineral form of silicon dioxide (quartz), frequently found in carbonate sediments, where it has developed from dissolved silica derived from sponges.
- **Flood basalts:** widespread layers of basaltic lava, generally derived from the relatively quiet fissure-type eruption of free-running basic lavas.
- Foraminifera (-ans): 'carrying an opening ', a member of a group of small unicellular aquatic organisms which secrete a coiled shell of various materials; often very abundant in marine waters with representatives that are **benthic** and **planktic** (Cambrian–Recent).
- Gadiiformes (-orms): 'Gadus or cod shape' a group of neoteleosts with an air bladder and soft jointed fins, which includes cod, hake, mackerel and whiting.
- Galeaspida (-ids): 'helmet shield', an extinct group of agnathans endemic to China and the surrounding region, characterized by their broad bony headshields, with a large median dorsal opening which connects with the oralo-branchial cavity.
- Galeomorphii (-orphs): 'of *Galus* form', the largest group of **neoselachians**, including the dogfishes and modern sharks.
- **Ganoid:** 'sheen', rhombic scales with outer layers of **ganoine**, **cosmine** below and then lamellar bone.
- Ganoidei (-oids): 'sheen form', a group of primitive actinopterygians with ganoid scales.
- Ganoine: 'sheen', enamel-like material on the outside of ganoid scales, which are rhomboid in shape and have layers of ganoine, cos-

mine and lamellar bone; found in primitive actinopterygians.

- Gar: 'spear', common name for the lepisosteids, a primitive group of **neopterygians**, characterized by the living pike-like *Lepisosteus*.
- Genotype: 'race image', type species of a genus.
- Geochronometry (-etric): 'earth time measure', the method of measuring geological time in years before present, commonly using the known decay rates of the daughter isotopes of radioactive minerals; mainly derived from igneous rocks.
- **Glauconite:** 'sea stone', containing the diagenetic (growing in place) mineral glauconite, a complex green-coloured hydrous potassium iron silicate which is sufficiently common in some shallow-water marine sediments to give them an overall green coloration e.g. Cretaceous greensands.
- **Gnathostomata (-omes):** 'jaw mouth', a group of vertebrates with jaws, derived from the anterior gill-arches, and a considerable degree of cephalization.
- **Gondwanaland:** a grouping of the major southern continental plates of Africa, Australasia, Antarctica, South America, India, several smaller plates and fragments of what are now parts of Mediterranean Europe, which formed a massive southern supercontinent in upper **Palaeozoic** times.
- **Goniatite:** 'angle-like', an extinct group of upper **Palaeozoic ammonoid** cephalopods with coiled shells.
- **Graben:** a linear block of crust downthrown between two parallel faults.
- **Graptolithina (-lites):** 'writing stone', an extinct group of marine colonial hemichordates, which secreted a proteinaceous skeleton in the form of an interconnected series of cups to house and protect the zooids.
- **Gymnophiona (-ones):** 'naked snake-like', synonymous with **caecilians** and apodans, a group of limbless burrowing amphibians, with an absent or reduced larval stage, a stoutly built skull, small calcareous **denticles** in the skin and an elongate trunk with up to 200 vertebrae.
- **Gymnospermae** (-erms): 'naked seed', members of a major division of the plant kingdom, consisting of woody plants with alternation of generations and seeds produced on the surface of the sporophylls and not enclosed in an ovary, e.g. seed ferns and conifers (late

Devonian-Recent).

- Hagfish: common name for the living myxinoids, a marine group of the surviving agnathans.
- Halite: 'salt-like', common salt, NaCl, a naturally occurring mineral particularly associated with evaporite deposits from sea water.
- **Hardground:** a sediment surface preserved within a sequence of strata, which has hardened through early diagenetic processes and whose ecology has changed as it came to be occupied by different organisms.
- Hemicyclaspida (-ids): 'half round shield', an extinct group of ateleaspid osteostracans distinguished by a distinct cornual angle and a rounded rostral angle to the headshield.
- Hercynian: (= Variscan) an upper Palaeozoic phase of mountain building following subduction of a WSW–ENE oriented ocean, from south-west England through Scania, central and southern Europe and the Iberian Peninsula.
- Heterocercal: 'other tail', where the vertebral column terminates in the upper lobe of the tail, whose lobe is usually larger than the lower lobe.
- Heterostraci (-acans): 'other shell', an extinct group of agnathans, with extensive head armour of large plates and a pair of common branchial openings on either side.
- **Histology:** 'tissue discourse', the detailed study of plant and animal tissues.
- Holocephali (-ans): 'whole head', a group of mainly fossil cartilaginous fish with holostylic jaws, gills covered by an operculum, narrowing whip-like tail and crushing teeth; includes the surviving chimaeras.
- Holoptychidae (-ids): 'whole plate', an extinct group of porolepiform sarcopterygians with scales and dermal bones covered with dentine and cosmine.
- Holostei (-eans): 'whole bone', a grouping of largely fossil actinopterygians, intermediate between the palaeoniscids and teleosts, which includes many Mesozoic taxa and the surviving bow fin and gar pike.
- Holostylic: 'whole pillar', a type of jaw suspension in which the palatoquadrate bone is fused directly to the cranium, as found in the holocephalans.
- **Holotype:** 'whole pattern', the single specimen selected to characterize a species.
- Homocercal: 'same tail', where the vertebral axis ends near the middle of the base and

there are similar-sized upper and lower lobes.

- Horsetail: common name for the sphenopsid pteridophytes with jointed stems and leaves in whorls; abundant in the upper Palaeozoic and surviving to the present day.
- Horst: an upfaulted block of crustal rocks, often on either side of a graben.
- Hybodont: 'hump tooth', a grouping of extinct elasmobranchs, characterized by their elongate and low hybodont teeth, ornamented with sinuous ridges and pierced by numerous nutrient canals, with placoid scales and calcified pleural ribs.
- Hypersaline: 'above salt', when the salinity of water exceeds 40 parts per thousand; a condition which can only be tolerated by those halophilic organisms adapted to the conditions; the mean salinity of sea water is 35 parts per thousand.
- **Hypochordal:** 'under cord', where the vertebral column descends into the lower lobe of the tail, which is generally larger than the upper one.
- **Hypolimnion:** 'under lake', the layer of water below the **thermocline** in a lake.
- Iapetus: a 'proto-Atlantic' ocean, which separated the Lower Palaeozoic crustal plates of Laurentia and Baltica and divided the present British Isles until the ocean floor was finally subducted in Ordovician–Silurian times.
- Ichnofossil: 'track fauna', an assemblage of trace fossils that records life in sediments disturbed by the activity of organisms, e.g. worm burrows or foot prints (see bioturbation).
- Ichthyodectidae (-ids): 'fish acceptable', an extinct group of important large predatory teleosts of the Jurassic and Cretaceous.
- **Ichthyology:** 'fish discourse', the study of fishes.
- Ichthyostegidae (-ids): 'fish roof', an extinct group of primitive tetrapods, which retain many fish-like characteristics such as a laterally_flattened tail and lateral line system, which evolved from the rhipidistians.
- **Index fossil:** a particular fossil species which characterizes a named **biozone** within a **biostratigraphical** subdivision.
- Inoceramid (-ids): 'strong clay pot', a member of a large group of extinct pterioid marine bivalves, which have been used for biostratigraphical subdivision (Triassic-end

Cretaceous).

- Intraclast (conglomerate): 'within fragments', a carbonate fragment derived by erosion from local contemporaneous strata within the same depositional basin.
- **Ischnacanthidae (-ids):** 'hip thorn', a extinct group of **acanthodians**, often with large teeth, two dorsal fins and no spines between the pelvic and pectoral fins.
- **Kaolinite:** a mud rock consisting mainly of the potassium-rich clay mineral kaolin from which china clay is made.
- **Katoporid (-ids):** one of five **thelodont** scales with a large open pulp cavity with extensions into dentine tubules.
- **Kerogen:** a naturally occurring organic material which yields petroleum-like hydrocarbons on heating and distillation.
- Labyrinthine: 'labyrinth', having an infolded structure such as the dentine of 'labyrinthodont teeth'.
- Labyrinthodont: 'labyrinth tooth', traditionally one of three groups of stem tetrapods that included the first land vertebrates, and which are characterized by teeth with compex infolding of the dentine, large body size and compound vertebrae; no longer a valid entity as it is not monophyletic (late Devonian– Triassic).
- Lag (deposit): a layer of larger or denser clasts, such as pebbles or bones, which have accumulated in the bottom of a channel during deposition.
- Lagerstätten (fossil): a rock containing wellpreserved fossils that are worth exploiting for their intrinsic interest; their nature implies some unusual circumstances of preservation.
- Laminites: thin layers of generally fine-grained sediment, reflecting rapidly fluctuating, often seasonal, changes in sediment supply or environmental conditions; characteristic of lakes and other shallow basins of deposition where there is a restricted bottom fauna.
- Lamprey: 'Lampetra', common name for one of the surviving agnathan groups, the petromyzontids.
- Laurasia: 'St Lawrence-Asia' the northern supercontinental mass formed in the early Mesozoic by the rifting of Pangaea with the opening of the Tethys and Atlantic Oceans; comprised of the amalgamated plates of North America, Greenland, Europe and Asia.
- Laurentia: 'St Lawrence', North American crustal plate in lower Palaeozoic times, prior

to the subduction of the **Iapetus** Ocean; comprised mainly of the ancient **Precambrian** core of the Canadian Shield and Greenland plus Scotland and north-west Ireland.

- Laurussia: 'St Lawrence–Russia', the amalgamated plates of North America and Russia, following the subduction of the Iapetus Ocean.
- Lectotype: 'chosen pattern', a specimen chosen from available syntypes to be the designated type of the species.
- Lepospondyli (-yles): 'husk vertebrae', a traditional grouping of basal tetrapods, characterized by small size, simple tooth structure and spool-shaped vertebrae, which are formed as single structures, such as is found in the urodeles and apodans; cladistic analysis has shown that the group is not monophyletic, thereby undermining its validity.
- Leptolepidae (-ids): 'slender scale', a group of halecostome neopterygians which show some early teleost characters, such as no enamel layer on the skull bones and a vertically keeled rostrum.
- Lingulida (-ids): 'tongue', a group of extant brachiopod shellfish, which were much more abundant in the Palaeozoic than at present.
- Lissamphibia (-ians): 'smooth both lives', a grouping which includes all the living and diverse amphibians with reduced or absent scales and skin respiration, i.e. anurans (frogs and toads), urodeles (newts and salamanders) and apodans (the limbless caecilians).
- Lithostratigraphy: 'rock layer writing', the organisation and division of strata into units and their correlation based entirely upon their lithological (rock compositional) characteristics.
- Littoral: 'seashore', the zone between high and low water marks on a shoreline.
- Loganellida (-ids): 'Logan (Water)', a group of thelodont agnathans with a characteristic form of scale.

Lungfish: see Dipnoi.

- **Maceration:** 'softening', the process of softening or isolating tissue and separating cells.
- Mastodonsauridae (-ids): 'breast tooth lizard', an extinct group of freshwater Triassic stereospondyls.
- Maxilla: 'jaw', part of the upper jaw behind the premaxilla.

Mesoderm: 'middle skin', the embryonic cell

layer between the ectoderm and endoderm.

- Mesosauridae (-ids): 'middle lizard', an extinct group of small Upper Palaeozoic fish-eating reptiles with elongate bodies, necks and long narrow jaws; they were the first known marine amniotes.
- **Mesozoic:** 'middle life', the middle division of geological time with abundant life, after the **Palaeozoic**, before the **Cenozoic** and containing the Triassic, Jurassic and Cretaceous periods.
- Metamorphosis: 'change of form', a significant change of structure and form undergone by an organism between the embryonic and adult stage, such as is found in insects and amphibians with a tadpole larva preceding the adult tetrapod.
- **Micrite:** the fine-grained microcrystalline carbonate matrix of limestones, much of which is chemically precipitated as a lime mud but which may also include a significant proportion of organic-derived mud.
- Microvertebrate: often referred to as 'ichthyoliths', literally the small fossil remains of vertebrates, such as scales, teeth and bones, which may be barely visible with the unaided eye when disarticulated. They can be separated from many kinds of rock matrix by careful acid preparation and are then available for microscopic study. Although they have been known for over 150 years, their potential for revealing so much about the palaeontology of vertebrates and their use in **biostratigraphy**, has only been realized in the last decade or so.
- **Miospore** (-ores): 'less seed', a fossil plant spore less than 0.22 mm in diameter, for which the parent plant is often unknown.
- **Molasse:** a terrestrial **clastic** deposit, generally of poorly sorted, immature sediment associated with the uplift and rapid erosion of newly formed mountain belts; often accumulating to considerable thickness in marginal or intermontane basins.
- **Monophyletic:** a natural taxonomic group that includes all descendants of a single common ancestor, e.g. the **Amniota** which include the reptiles, birds and mammals.
- Myriacanthoidea (-oids): 'numberless spines' an extinct group of Palaeozoic holocephalians with loss of mandibular plates.
- Myxinoidea (-oids): 'Myxine slime form', an extant group of marine agnathans, commonly referred to as the hagfish.

- Nasohypophysial: 'nose under growth', a keyhole-shaped opening on the dorsal surface of the head in lampreys and the extinct osteostracans, which combines a single nasal opening with a blind hypophysial tube, allowing water to enter and leave the olfactory organ.
- Nautiloidea (-oids): 'nautilus form', an almost extinct group of cephalopods with straight or coiled conical shells, which were more abundant in the **Palaeozoic** but survive in only one genus, *Nautilus*.
- **Nekton:** 'swimming', those organisms which actively swim in water.
- **Neocatastrophism:** the doctrine that the most important driving forces in Earth history and the evolution of life have not been those of gradual change, but a variety of catastrophic events, both internal and extra-terrestrial.
- Neopterygii (-ians): 'new fin', a group of Recent actinopterygians characterized by an equal number of fin rays of the dorsal and anal fins and the reduction or loss of the clavicle; includes the ginglymods, halecomorphs and teleosts.
- Neoselachii (-ians): 'new sharks', a moderntype group which includes all extant elasmobranchs, characterized by enameloid on the teeth and scales and a septate notochordal canal.
- Neoteleosti (-osts): 'new bone', an extant group of advanced bony fishes (teleosts).
- **Neotype:** 'new pattern', a new or replacement type specimen taken from the original type locality.
- Neural crest: 'nerve crest', an ectodermal thickening of a dorsal groove, which gives rise in embryological development of the living agnathans and cephalochordates to the central nervous system.
- **Neurocranium:** 'nerve skull', the **cartilaginous** or bony encasement to the brain and special sense organs.
- **Nodule:** 'knob', a spherical or elliptical mineral concretion, generally grown post-depositionally within a sediment, as the result of the concentration of a particular mineral around a nucleus.
- **Nomen nudum:** 'name naked', in taxonomy, an invalid name because the organism to which it is attached was inadequately described or illustrated.
- Notochord: 'back cord', a stiff flexible rod of large vacuolated cells which acts as an anteri-

or-posterior axis between the gut and dorsal nerve cord in **chordates**.

- **Old Red Sandstone:** a classic term still applied to the terrestrial, largely **clastic** facies of the Devonian in Britain, characterized by conglomerates and red sandstones.
- **Oolitic:** 'egg stone', a sedimentary rock, usually a limestone made up of small (1–10 mm) ovoid accretionary bodies cemented together. The ovoids resemble fish eggs but are formed by the precipitation of layers of calcium carbonate concentrically arranged around a nucleus, e.g. a sand grain, as it is rolled around on the sea floor by waves and currents, especially in shallow tropical and subtropical seas.
- **Orobranchial:** 'mouth gills', in association with the mouth and gills as in orobranchial cavity.
- **Orogeny:** 'mountain genesis' a process of mountain building during which the rocks and sediments of a particular area of a continent(s) are deformed and uplifted to form mountain belts. Although these processes take a long time, they can be distinguished as recognizable and discrete phases in Earth history and are named accordingly, e.g. **Variscan** orogeny.
- **Ossiferous:** 'bone make', made up from bones or their fragments.
- **Osteichthyes (-yans):** 'bone fish', all fishes whose endoskeletons are made from bone, usually having an air bladder and operculum covering the gills.
- Osteoglossomorpha (-orphs): 'bone tongue form', an extant group of freshwater teleosts.
- Osteolepiformes (-orms): 'bone scale form', an extinct group of rhipidistian sarcopterygians with labyrinthine teeth, long considered to be ancestral to the tetrapods because of the endoskeletal structure of the paired fins.
- **Osteostraci** (-ans): 'bone shell', an extinct group of **agnathans** with both exoskeleton and endoskeleton of bone, characterized by median and lateral depressions on the surface of the dorsal head-shield, which has a 'horseshoe' shape and a pair of pectoral flapshaped fins; also, generally there is a peculiar horizontal fin below the main tail fin.
- Ostracoda (-ods): 'shell-like', members of a group of small crustaceans having a bivalved shell around the body. Throughout their long geological history (Cambrian–Recent)

they have diversified into a wide range of aquatic ecological niches both on land and at sea.

- Ostracoderma (-erms): 'shell skin', all those jawless craniates with an exoskelton of dermal bone, i.e. the fossil agnathans.
- **Otolith:** 'ear stone', a calcareous structure found in the otocyst capsule and used to maintain orientation in relation to gravity and balance; they are often the only structures to be fossilized from many **teleosts**, and individual otoliths can be identified specifically.
- Pachycormidae (-ids): 'thick trunk shape', a group of Mesozoic basal teleosts, characterized by a mobile premaxilla and long swordfish-like jaws.
- **Palaeocurrent:** a flow direction deduced form sedimentary structures associated with an ancient depositional or erosive event.
- **Palaeoecology:** 'ancient household discourse', the study of the relationship between organisms and their environments in the past.
- **Palaeokarst:** 'ancient karst', fossil solutional features associated with buried limestone topography.
- Palaeonisciformes (-orms): 'Palaeoniscus ancient small form', a group of almost extinct early actinopterygians, typically carnivorous in habit with markedly heterocercal tails; traditionally regarded as chondrostean grade but more recently as neopterygians, including the living sturgeons and paddlefish.
- **Palaeoslope:** 'ancient slope', the orientation of an original inclined surface as determined from an ancient depositional or erosive event.
- **Palaeosol:** 'ancient soil', a 'fossil' soil deposit characterizing a terrestrial environment.
- **Palaeozoic:** 'ancient life', the first major division of geological time which is characterized by abundant life and which is preceded by the **Proterozoic** and succeeded by the **Mesozoic**; divided into six or seven periods from the Cambrian to the Permian.
- **Palatine**: 'palate', in the region of the palate or roof of the mouth.
- **Palinspastic:** 'again draw', restored to an original condition, or in the case of a map to represent original conditions or features.
- **Palynology:** 'pollen discourse', the study of plant spores and pollen and their distribution, which has proved to be of considerable

biostratigraphical use.

- **Palynomorph:** 'pollen form', a microscopic, resistant, walled organic body found in palynological preparations, including both plantderived bodies such as spores and pollen and also other acid-resistant remains such as acritarchs and chitinozoans.
- **Palynozone:** 'pollen zone', a **biostratigraphical** subdivision characterized by an assemblage of pollen 'species'.
- **Panderichthyida (-ids):** 'Pander's fish', an extinct group of thin streamlined **rhipidisteans** with long, dorso-ventrally flattened skulls and only paired pelvic and pectoral fins, without the midline paired fins of their relatives; they are now considered to be very close to the early **tetrapods**.
- **Pangaea:** 'the whole Gaea', a supercontinent formed by ocean-floor subduction, plate collision and assembly of all continents in the late Permian.
- **Paraphyletic:** 'beside tribe', arising from a single common ancestor but not including all descendants, e.g. Class **Reptilia** which does not include the descendant birds and mammals.
- **Paratypes:** 'beside pattern', a specimen or specimens in the same series or collection from which the **holotype** has been selected.
- **Pedocal:** 'ground calcium', an arid or semi-arid soil-type deposit, characterized by the presence of calcium carbonate, e.g. the '*Psammosteus* Limestone'.
- **Peneplain:** 'almost plain', a landscape surface with greatly reduced features as a result of prolonged weathering and erosion.
- **Perichondral bone:** 'around cartilage bone', ossification of **cartilage** from the outside.
- **Perleidiformes (-orms):** *'Perleidus*-form', an extinct group of basal **actinopterygians**, of **'chondrostean'** grade, with **ganoid** scales, nearly symmetrical tail fins and small slender bodies, best known from the Triassic.
- **Petalodont:** 'leaf tooth', an extinct group of Upper Palaeozoic **holocephalans**, known only from fossils of their leaf-shaped teeth.
- Petromyzontiformes (-orms): 'Petromyzon rock suck form', an extant group of freshwater agnathans, commonly called lampreys, with a semi-parasitic mode of life, elongate eel-like bodies, no body armour or paired fins.
- **Pharyngeal:** 'gullet', a structure or tissue associated with the gullet.

- Pholidophoridae (-ids): 'bearing scales' an extinct group of Mesozoic neopterygian halecostomes, which show some characteristics of the primitive teleosts, such as cycloid scales and the loss of enamel from most skull bones.
- **Phosphate:** a phosphorus salt associated with mineral **phosphate** in bone.
- **Phylogeny:** 'race descent', the evolutionary relationships and history of a species or group of organisms.
- **Phytoplankton:** 'plant wandering', free-living plants within an aquatic environment, often microscopic and with limited powers of locomotion, so mainly dispersed by wind and tide.
- **Pineal:** 'of the pine', cone shaped, as in pineal gland which is often externally visible in lower **vertebrates** and may have endocrine functions and be sensitive to light.
- **Pituaraspida (-ids):** 'phlegm broad', a small group of poorly preserved **agnathans** only known from a few Devonian sandstone impressions in Australia.
- **Placodermi** (-erms): 'plate skin', an extinct group of primitive **Palaeozoic** jawed fishes, with a dermal armour in two parts, one covering the head, the other the trunk, which are sometimes articulated, e.g. the **arthrodires**.
- **Placoid scale:** 'plate form scale', scales which are structured and formed similar to teeth and are characteristically found covering the elasmobranchs as shagreen.
- **Planktonic:** 'wandering', belonging to the plankton; those generally small organisms which drift in water bodies and have limited powers of locomotion.
- **Playa:** the flat dry bottom of a desert basin, often the bed of an ephemeral lake and underlain by **evaporites**.
- **Pleuracanth:** 'side thorn', a small extinct group of Palaeozoic freshwater **elasmobranch** sharks.
- **Point-bar:** a low bank of sediment on the inside bend of a river channel, consisting of material derived from the eroded outside bank.
- **Precambrian:** 'before Cambrian', the first major division of geological time which includes the first 4 billion or so years of Earth history before abundant metazoan life capable of secreting skeletons had evolved; the top of the **Precambrian** is defined by the base of the Cambrian Period in the **Palaeozoic** Era.

- **Prokaryote:** 'before nucleus', organisms such as blue-green algae and bacteria whose chromosomes are not surrounded by a nuclear membrane.
- **Proterozoic:** 'former life', the younger subdivision of **Precambrian** time from 2.5 Ga ago until the beginning of the Cambrian at the base of the **Palaeozoic**; when primitive life had evolved and has been preserved as rare fossils of **prokaryotes** and soft-bodied metazoans in the youngest rocks of the division.
- **Protobranch:** 'first gills', a member of a 'primitive' group of marine bivalve molluscs with a very long fossil record (Lower Cambrian-Recent) that commonly occupy mud substrates and feed by extracting organic material from the mud, e.g. the nuculids.
- Protochordata (-ates): 'first string', a group of primitive chordates, which have 'tadpolelike' larvae with a perforated pharynx, notochord, hollow dorsal nerve cord and postanal tail.
- **Protopteraspidae (-ids):** 'first *Pteraspis* wing shield', one of a number of extinct **pteraspid** groups, which retains some features of the **cyathaspids**, from which the pteraspids are thought to have originated; characterized by the supra-orbital canal passing through the **pineal** plate.
- **Psammosteiformes (-orms):** 'sand bone form', an extinct group of large **pteraspidiform heterostracans** with a secondary tuberculate ornamentation to the dermal armour and two orbital plates.
- Pteraspida (-ids): 'of *Pteraspis* wing shield', an extinct group **Palaeozoic heterostra**cans, which had head-shields made of several large and independent bony plates, ornamented with concentric ridges.
- **Pycnodontiformes (-orms):** 'dense tooth', a large extinct group of marine **neopterygians**, mostly deep-bodied forms, characterized by symmetrical (**homocercal**) tail fins.
- **Pyrite:** 'fire stone', an iron sulphide mineral common within sediments, resulting from the biochemical action of bacteria within **anaerobic** environments.
- **Pyroclastic:** 'fire fragments', the fragmentation of igneous rock materials during volcanic eruption, ranging from large rock bombs to pulverized rock dust and ash.
- **Radio-isotope:** 'ray equal place', the isotopes of radioactive elements which have the same atomic number but different atomic weights.

Ratfish: see chimaeras.

- **Red beds:** sedimentary deposits that are predominantly red in colour, generally as a result of abundant iron oxides, which often reflect deposition in an oxidizing situation, e.g. in an arid terrestrial environment and may be associated with **evaporites**.
- **Regression:** referring to the retreat of the sea from land areas as a result of a fall in sea level or elevation of the landmass.
- **Reptilia** (-iles): 'creeping animals', members of a large class of **amniote** vertebrates, having a long fossil history extending back to the Carboniferous, with a dry, waterproof horny skin of scales, plates or scutes, functional lungs, a four-chambered heart and laying eggs fertilized inside the female's body.
- **Reptilomorph (-orphs):** 'creeping animal form', term applied to many early fossil **tetrapods** which are difficult to characterize as either reptile or amphibian.
- Rhipidistia (-ians): 'fan', an extinct group of Upper Palaeozoic 'lobe-finned' sarcopterygian fish which are considered ancestral to the tetrapods.
- Rhizodontidae (-ids): 'root teeth', a poorly known extinct group of very large 'rhipidisteans' with thin and loosely attached skull bones, characterized by dermal fin rays with a long unsegmented portion, covered by rounded scales; the folded teeth are polyplocodont like those of osteolepiforms and tetrapods.
- Rhizodontiformes (-orms): 'root tooth form' an extinct group of poorly known, large sarcopterygians, probably effective predators, with thin and loosely attached skull bones and dermal fin rays with a long unsegmented portion.
- **Rhythmic sequence:** a regularly banded vertical sequence of sediments, reflecting rhythmic changes in the supply of sediment often related to seasonal changes e.g. the **varved** couplets of silt and clay in glacial lakes.
- **Rötliegendes:** 'red layers', a German stratigraphical term applied to the largely continental deposits of Lower to Middle Permian times, which are often reddened with iron oxide minerals.
- **Rudist:** 'rough', a member of an unusual and varied group of extinct marine cemented bivalve molluscs (also known as hippuritoids), which flourished in the shallow tropical seas of the **Tethyan** area and in places

formed reef-like clusters. Some had thick cone-shaped shells up to 1 m long, whilst others had coiled 'snail-like' shells (Upper Jurassic-end Cretaceous).

- Sabkha: a halite-encrusted surface of salt flats, which are often developed just inland parallel to dry hot tropical coastlines, where periodic flooding by the sea is evaporated with precipitation of various evaporite minerals and laminae of dried algae.
- Sacculus: 'small bag', lower part of the ear vestibule, which contain the otoliths of some teleosts.
- Sapropel: 'rotten mud', anaerobic mud often enriched in bacteria.
- Sarcopterygii (-ians): 'fleshy or lobe fin', a group of bony fishes, characterized by paired 'fleshy fins' and internal nostrils in some groups; includes the crossopterygians and dipnoans.
- Scale: 'husk', a flat, plate-like protective structure for the skin, generally small and in rows to allow flexibility; may be either dermal or epidermal in origin.
- Scapherpetontidae (-ids): 'boat reptile form', an extinct group of **neotonous** salamanders.
- Sclerite: 'hard', an exoskeletal element in the form of spines or plates, often mineralized.
- Scolenaspidea (-ids): 'worm broad form', one of five extinct groups of cornuate osteostracans, abundant in the Lower Devonian of Britain, Spitsbergen, North America and Podolia.
- **Scorpionid (-ids):** 'scorpion', a group of arachnids which includes the scorpions.
- Sea-squirt: common name for the hemichordate ascidians, marine organisms with a freeswimming larva and a sessile benthic adult.
- Selachii (-ians): 'shark', a grouping of elasmobranch fishes, which includes fossil and living sharks and dogfish and ranges from the Devonian to the present; see Neoselachii.
- Semicircular canals: the ducts of the ear labyrinth.
- Semionotidae (-ids): 'Semionotus half-pointed dorsal fin shape', an extant and ancient group of basal **neopterygians**, with median neural spines, which includes the **gar** pikes and originated in Permian times.
- Serpulid (-ids): 'small snake', a small tubular fossil, mineralized with calcium carbonate and generally regarded as related to the living polychaete worms, which have similar form and encrusting habits.

- Shagreen: common name for shark skin with its covering of many small overlapping dermal denticles.
- Siliciclastic: 'hard stone fragments', a fragmental deposit, consisting mainly of grains of silica minerals, especially quartz.
- **Somite (-ites):** 'body', the body compartments of metamerically segmented animals.
- Sphenopsida (-ids): 'wedge shape', commonly referred to as 'horsetails', a group of pteridophyte plants with jointed stems and leaves arranged in whorls; of considerable importance in the Upper Palaeozoic, when some grew to tree size, but now much smaller and fewer in kind.
- Squamata (-ates): 'scaly', a member of a large group of lepidosaur reptiles that includes the lizards and snakes and whose inter-relationships are not clear (Upper Jurassic–Recent).
- Squamation: 'scale', the arrangement of dermal scales.
- Squamosal: 'scale nature', a membrane bone forming part of the side wall of the vertebrate skull.
- SSSI: Site of Special Scientific Interest.
- **Stegocephalia (-ians):** 'roof head', an extinct group of amphibians with salamander-like body form.
- **Stem group:** in **cladistics**, an extinct and presumed ancestral group, defined on the absence of features of the presumed descendants.
- **Stereospondyli** (-yles): 'solid vertebrae', an extinct group of **labyrinthodont** amphibians having fused vertebrae.
- **Stratotype:** 'layer pattern', a sequence of strata at a particular location, which has been internationally recognized as the definitive section for a particular **chronostratigraphical** subdivision of geological time.
- Strike: the trend of a geological surface measured at right angles to the direction of slope.
- **Stromatolite:** 'bedded stone', layered structures built up by mats of blue-green algae, which trap fine sediment as they grow; typically found in shallow tropical seas and extend back as fossils for some 30 Ga.
- **Subduction:** 'under lead', the descent of large slabs of relatively dense ocean floor crust below less dense continental crust rocks, as the result of the collision of two crustal plates, with the release of vast amounts of energy in the form of earthquakes and often accompanied by vulcanicity.

- Sulphate: a chemical compound containing sulphur and oxygen, which forms common sedimentary minerals with a variety of other elements, epecially in evaporite deposits.
- Suture: 'seam', the line of collision between two crustal plates following the subduction of any intervening crust.
- Symmoriiformes (-orms): 'in proportion form', an extinct group of shark-like elasmobranchs, characterized by a very long rod in the pectoral fins and a peculiar arrow-shaped element in the dorsal fin supports.
- **Synapomorphy:** 'joined together shape', a shared derived character(s) which defines a sister-group in **cladistic** analysis.
- Syntype: 'with pattern', any one of a series of specimens which characterize a species when there are no designated **holotype** and **paratypes**.
- **Taphonomy:** 'burial cutting', the study of the processes of death, decay and burial by which organisms become selected and recruited to the fossil record.
- **Tectonism:** 'builder', the processes of crustal deformation, often associated with plate tectonics and mountain building.
- Teleostei (-osts): 'end bone', an extant and major group of advanced **neopterygians**, which includes the majority of living bony fishes; characterized by an air bladder, loss of enamel layer on skull bones, **homocercal** tail and thin bony **cycloid** scales.
- Temnospondyli (-yles): 'cut vertebra', an extinct group of Upper Palaeozoic labyrinthodonts, with flattened skulls.
- **Terrane:** 'earth', a small crustal plate or fragment of a larger plate, with distinctive characteristics, which can be displaced considerable distances from its original site and added to another plate during plate tectonic movement.
- Tethys: 'Tethys, a mythical titaness and wife of Oceanus', an east-west-extending major ocean, which separated the southern supercontinent of Gondwanaland from Laurasia in Mesozoic times; subducted to form the Alpine-Himalaya mountain belt.
- **Tetrapoda (-ods):** 'four footed', developmentally four-footed **vertebrates** including amphibians, reptiles and mammals.
- Thanatocoenose: 'death common', an assemblage of fossil organisms which have been brought together by the processes of sedimentation, following their death, so that the

assemblage may contain organisms that did not originally live near one another.

- Thelodonta (-onts): 'teat teeth', an extinct group of agnathans, characterized by their shark-like dermal denticles, which are commonly fossilized as separate elements within the sediment.
- Thermocline: 'heat swerve', a layer of water with fluctuating temperatures, which forms in summer and separates the epilimnion above from the hypolimnion below.
- Theromorpha (-orphs): 'summer form', an extinct group of Upper Palaeozoic primitive mammal-like reptiles with a sprawling gait, including a group with heat exchange 'sailfins'.
- Thyestida (-ids): 'pestle', an extinct group of cornuate osteostracans with an infra-orbital sensory line passing medially to the lateral fields.
- **Transgression:** 'across walk', referring to the encroachment of the sea across a landscape as a result of either a rise in sea level or subsidence of the land.
- Tremataspida (-ids): 'hole shield', an extinct group of cornuate osteostracans within the thyestids, which have lost their paired fins and cornual processes and have a 'tadpoleshaped' head.
- **Trophic pyramid:** 'food pyramid', a layered subdivision of the food chain with the broad base of numerous primary producers at the base rising to the relatively few top carnivores at the apex of the 'pyramid'.
- **Tuff:** volcanic ash, comprising rock and crystal fragments from an explosive eruption.
- **Turbidite:** the deposit of a gravity-controlled turbidity current.
- **Unconformity:** a break in the relationship between successive rocks in a sequence as a

result of a variety of causes, from a lack of deposition to an intervening phase of **tectonism** and erosion; consequently the missing time interval may also vary enormously.

- Urochordata (-ates): 'tail cord', a group of protochordates in which the chordate features are often only expressed in the larval stages; see sea-squirts.
- Uronemidae (-ids): 'tail thread', one of five extinct groups of Carboniferous dipnoans.
- Variscan: 'land of the Varisci or Vogtland', synonymous with Hercynian.
- **Varved:** a **laminite** deposit in which the layers of sediment are graded and generally result from a seasonal influx of sediment-laden water into a low-energy water body such as a lake or lagoon.
- Vascular (plant): 'small vessel', the major group of tracheophyte plants, in which there are special cells for the transmission of fluids.
- Vertebrata (-ates): 'back bone', synonymous with Craniata, those metamerically segmented chordates in which the notochord is replaced by a backbone as part of an endoskeleton of cartilage or bone and with a high degree of cephalization.
- **Viviparous:** 'live bearing', producing live young, as in the mammals, rather than eggs.
- Xenacanthiformes (-orms): 'strange spine', an extinct group of shark-like elasmobranchs with a long dorsal spine on the head and diplodont teeth with a divergent crown and small median cusps.
- Zechstein: a European stratigraphical name for Upper Permian deposits, including carbonates and evaporites of a shallow sea in northern Germany and the North Sea area.
- **Zone:** a division of geological or stratigraphical time defined by fossil content, see **biozone**.

Note: Page numbers in **bold** and *italic* type refer to **tables** and *figures* respectively

Aalenian 356 Abbey Wood 500-3, 501 interpretation 502-3 comparison with other localities 502-3 Abbotts Cliff Chalk Formation 443 Abden 301-2 fauna 302, 303 interpretation 303 Abden Bone Bed 301-2 Abdon Group 110, 114 Abdon Limestone Formation 110 Aberlemno Quarry 152, 160-2 best surviving site, Turin Hill 161 - 2interpretation 161 Acanthodes 306, 311 Acanthodes nitidus 288, 290 Acanthodes ovensi 275, 275 Acanthodes sulcatus 282, 285, 299, 308 Acanthodians 36, 61, 62, 67, 248 demise of 317 Carboniferous 271, 298 Ardross Castle 299 Bearsden 307, 308, 311 Cheese Bay 297 East Kirkton 547, 548, 548, 553 Foulden 274, 275, 275 **Glencartholm 288** Wardie 280, 282

Scottish Early Devonian 150, 154, 155 **Tillywhandland Quarry** 158, 159 Whitehouse Den 164, 165 Scottish Mid-Devonian 173-4, 204, 205, 206, 212, 215 Achanarras Quarry 179-80, 181 Black Park, Edderton 191 Cruaday Quarry 187, 188 Den of Findon, Gamrie 194, 195 Tynet Burn 198, 199 Scottish Late Devonian 248 Welsh Borders Early Devonian 113 Besom Farm Quarry 139, 142 Oak Dingle, Tugford 125, 127 Wayne Herbert Quarry 132, 133, 135, 137 Welsh Borders Late Silurian 70.73-4 Bradnor Hill Quarry 105, 106 Downton Castle area 102, 103 Ludlow Bone Bed 81, 83-4 Lydney 100–1 Temeside, Ludlow 92, 93-4, 94-5

Acanthodii 15 Acanthostega 538, 539 Acentrophorus 320-1, 321 Achanarras Fish Bed/Horizon 172, 174, 179-81, 184 osteichthyans 174 Achanarras Limestone Member 170. 178 faunal introductions 184 Achanarras Quarry 174, 178-84 fauna 182-3 interpretation 181, 184 Acipenser 524 Acipenseriforms 362, 366 Acrodus 361, 365, 368, 382, 387, 388 Acrodus laevis 438 Acrognathus 468 Acrognathus boops 470 Acrolepis 320 Acrolepis exsculpta 320 Acrolepis ortholepis 287 Acrolepis sedgwickii 320 Acrotemnus faba 465 Actinopterygians 17, 174 decline of 18 Cenozoic 507 Isle of Sheppey 509, 512 Cretaceous, Early 424 Iurassic advanced, dominance of 359 Lyme Regis coast 362, 364, 366 primitive 366

Triassic, expansion in 331 Carboniferous 268-9, 297, 298 Bearsden 307, 308, 309 early, described 268-9, 290 - 1East Kirkton 547, 548, 553 Foulden 274, 278 Glencartholm 288, 290-1, 290 Wardie 281, 282, 283 Adroichthys 291 Aduella blainvillei 269 Aetheretmon valentiacum 278 Aetobatus irregularis 511 Afon y Waen 238-9 facies 239 interpretation 239 stratigraphical section 238 Afon y Waen Fish Bed 238-9 Agaleus dorsetensis 365, 372, 373 Agassiz, Louis 23, 172-3 and the 'Gamrie ichthyolites' 193 work on fossil fish of Scottish ORS 3 Agglestone Grit 484 Agkistracanthus mitgelensis 349 Agnathan-gnathostome relationship 14 Agnathans 7, 13, 35 agnathan faunas, biostratigraphical value of 40, 74 hagfish and lampreys 3 Palaeozoic 7 a paraphyletic group 14 Siluro-Devonian of the ORS continent, stratigraphical distribution 73 South American and Australian 10 Ainiktozoon loganense 40, 45 Aistopods 538, 549, 551, 553 Albanerpeton 545, 546 Albanerpetontids 394-5, 414, 546 Albian 420, 437 early 421 Mid-Late 441 Albula 522 Aldergrove Beds 329

Aldwick Beds 505 fish-bearing horizons 506, 507 Alecephalus 453 Algal blooms 180, 181, 188 Allothrissops 389, 389, 405 Allothrissops disjectus 389 Alpine orogeny 485 Althaspis leachi 141 Althaspis senniensis 141, 142, 143 type and only locality, Hoel Senni Quarry 143 Alum Bay 508 Alum Shale Member 375, 375, 376 Alum Shales 356 Alves Beds 170, 245, 254, 254, 260 Amblypterus striatus 299 Amia 524 Amiids, Durlston Bay 413-14 Amiopsis, 413-14 Amiopsis austeni 413 Amiopsis damoni 411, 413 Ammonites in east Dorset succession 398 Gault Clay 441 and Jurassic biostratigraphical correlation 357, 371 problems of change in zone nomenclature 376 Amniota 538 Ampheristus toliapicus 513 Amphibians 4, 537, 538 British sites 541-5 evolution through the Mesozoic and Cenozoic 540 fossil, British sites 26 modern 540, 546 Cenozoic Headon Hill 556-7 Hordle Cliff 26, 528-9 Jurassic Durlston Bay 414-15 Kirtlington 393, 394-5, 394 non-marine and freshwater aquatic 359 Watton Cliff, Forest Marble 399-400

Triassic 333 Bromsgrove 334 temnospondyl 333, 338-9, 349 Permian 315, 324 see also stem tetrapods Ampthill Clay 356 Anachronistes fordi 304 Anaspids 8, 73 Scottish Silurian 35-6, 37-8 Ardmore-Gallanach 61-12 **Dippal Burn 50** Dunside 46 Shiel Burn 49 Slot Burn 51, 53 The Toutties 57 Anatolepis 8 Andriochthys tuberculatus 269 Anglaspis 100 Anglo-Brabant Landmass 381 see also London-Brabant massif Anglo-Welsh Basin 111 alluvial plains 109 late Silurian-Devonian formations, correlation 66 Lower and Upper Old Red Sandstone divisions 117 marine Mid- to Upper Devonian sediments 225-6 Mid- and Late Devonian 227 comparison with other regions 239 sedimentary history of 69 vertebrate biostratigraphy of Lower ORS 20-1 Welsh Borders part of in early Devonian 109-10 Anguilliformes 452 Anisian 329, 330, 338 Anomoedus angustus 465 Anomoedus cretaceus 438 Anomotodon 442 Anoxic (anaerobic) conditions 19, 45, 180, 180, 188, 213 deposition of Marl Slate 317 and preservation of Whitby fish 376 Anthracosaurids 540, 548, 551 Antiarchs Scottish Late Devonian freshwater forms 247 Remigolepis 250 Scottish Mid-Devonian 174

Anura 556, 557 Apateodus 438, 442 Apateodus glyphodus 438, 442 Apateodus striatus 453, 466, 469 Aphanoptyxis ardlevensis Bed 391 Apsopelix 442 Apsopelix anglicus 452 Aptian 420, 421, 437 Arbuthnott Group 117, 148, 149, 164 fish faunas possibly coeval with Early Devonian in Welsh Borders 149 top of, Aberlemno Quarry 161 Archaegonaspis ludensis 76, 77 Church Hill Quarry 77, 78 Arden Sandstone Member 329, 339 Ardley Member 392, 393 Ardmore-Gallanach 60-2 description 61-2 fish beds occur in association with Lorne lavas 60 interpretation 62 Ardross Castle 299-301 interpretation 301 Ardross Shrimp Bed see Abden fauna Argillites, tectonized, Bedruthan Steps 228 Arlesey Quarries, Hitchin 459 Armatus Limestone 356, 361 Arthrodires 62, 113, 115, 174, 210, 232, 234 Besom Hill Quarry 141-2 Portishead, Groenlandaspis 232, 234, 235 Spittal Quarry 207, 208, 208 Arthrodon intermedius 433 Arthropods 81, 102, 133, 234 trackways 165 Asbian 296 Ashdown Beds 420 fish remains 425 Askrigg Block 266 Aspidorhynchids 414, 435, 452, 465 Aspidorbynchus 383, 404, 422 Aspidorbynchus crassus 389 Aspidorbynchus fisheri 414

Astarte Bed 506 Astarte-Trigonia Bed 391 Asteracanthus 399, 412 heterodont dentition 387 Asteracanthus semiverucosus 412 - 13Asteracanthus (Stophodus) lingualis 387 Asteracanthus (Stophodus) magnus 387 Asteracanthus (Stophodus) tenuis 387 Asteracanthus teniustriatus 387 Asteracanthus verrucosus 412-13, 412 Asterodermus 404 Asterolepis 246, 247 Asterolepis maxima 233, 253, 254, 255 Asterolepis orcadensis 174 Asterolepis thule 174, 221, 221, 404 Asthenocormus 383 Ateleaspids 8, 62 Ateleaspis 72-3 Ateleaspis tessellata 38-9, 54-5.56 Atherfield Bone Bed 431 Atherfield Clay Formation 420, 429, 430-1, 435, 437 fossil localities 433 Auchenaspis 88, 92 Auchenaspis egertoni 86, 89 described 88 Auchenaspis salteri 88, 94 Aulolepis 453 Aulolepis typus 467, 469 Aust Cliff 342-50 flexing and faulting 343 geological map and section 343, 344 interpretation 346-9 comparison with other localities 349 autissiodorensis Zone, Kimmeridge Bay 402 Aylesbeare Group 329 Aymestry Group 102

Badbea Breccia Baggy Beds *110*, 225, *229*, 231 Bagshot Beds **485**, 503, Bagshot Formation **Bagshot Sands** 484 **Bailey Hill Formation 66** Bajocian 356 see also Lower Bajocian Balanerpeton 553, 555 Balanerpeton woodi 548-9, 549, 550 Balnagown Group 170 Banniskirk Quarry 209-10 at the Eifelian-Givetian boundary 210 interpretation 210 Barn Rock Bed 505 Barnes Chine Sandstone 430, 431 Barnes High Sandstone Member 430, 431, 435 Barnstone 368, 369 Barremian 420, 437 Barren or Basement Group 170 Barrow-on-Soar, old brickpits 368 Barton Beds 484, 485 stratigraphy discussed 524 Barton Clay Formation described 525-7 fauna, Beds A1-A3 526 fauna, Beds B-H 526-7 Barton Cliff 524-7 interpretation 527 comparison with other localities 527 Barton Group 484 Barton Sands 518 Basal Permian Breccia 315, 319 Basin inversion, southern Britain 485 Bath Geological Museum, Charles Moore's Upper Lias fish collection 380 Bathonian 356, 380 Kirtlington biostratigraphy 393 environmental interpretations 393 lagoonal and littoral facies of 380, 382 older localities, rich freshwater faunas 396 regressive facies 357, 382 succession at Stonesfield 386 see also Upper Bathonian

Batomorphs Boxford 478-9 Burnham-on-Crouch 517 Isle of Sheppey 510, 512, 514 Upnor 500 Beachy Head Sponge Beds 463 Beachy Head-Brighton cliff section 479 Bearsden 306-12 interpretation 310, 312 Becton Bunny Bed 525 Becton Sand Formation 526 Bedford Museum, Southerham Chalk pits fossil collection 462, 465 Bedford Museum (BMB), Totternhoe fossils 456 Bedruthan Steps, 228 Beeding Hardgrounds 463 Beetle Bed 505 Belemnite Marls 356, 361, 362, 371 Belemnite Stone 361, 362, 371 Belonorbynchus 379 Belonorbynchus brevis 379 Belonostomus, controversy over Whitby specimens 379 Belonostomus cinctus 452, 465 Belonostomus boolevi 429, 435. 437 Belonostomus leptosteus 389 Beltinge Fish Bed 490, 493, 496 Bembridge Beds 484, 485 Bembridge Limestone 484, 518, 532, 533 Bembridge Marl Member 486, 518 Benneviaspis salopiensis 141 Benton, M.J. and Spencer, P.S. on fauna from the Otter Sandstone 545 locality description, Headon Hill Formation 546 Berriasian 356, 420 Berriedale Flagstone Formation 170 Berriedale Sandstone Formation 170 Beryciformes 453-4 Berycopsis 468 Berycopsis elegans 453-4, 470

Besom Farm Quarry 138-42 interpretation and comparison with other localities 142 Betwixt Member 306 Bexhill-Hastings region 423 Bexhill-on-Sea 429 Bilsdean Sandstone 251 Biostratigraphy 20-2 ammonite, Gault Clay 441 Dinantian and Namurian marine beds 266 Biozones, based on acanthodians 115 Birgeria acuminata 348 Birk Knowes 40-5 interpretation: transition from marine to fluviatile/deltaic conditions 45 older age of not recognized in earlier collections 42 Birkenhead Burn 51, 56-7 Birkenhead Burn fish beds 55-6 comparable to Slot Burn fish beds 56 Birkenhead Sandstone 36, 41 Birkenia 38, 47, 53-4, 54 suctorial or not? 53-4 Birkenia elegans 47, 53 Birrenswark-Kelso lavas 243. 245, 266 Bittadon Tuff Bed 110, 230, 235 Bituminous Shales 375, 375, 376 pyritized fish remains 375 Black Cock Formation 66, 76 Black Horse Quarry, Telham 429 Black Nore Sandstone 110, 234 Black Park, Edderton 189-93 section 190 interpretation 192-3 mortality cause does not include anoxia 192 quality of preservation of fishes 190-1, 193 section Read (1923) 194 Trewin and Kneller (19987) 194, 194 Black Ven Marls 356, 36-3

Blackband Ironstone fauna, Niddrie see Abden fauna **Blackheath Beds** Abbey Wood 501 selachian fauna 502 grade into Harefield Beds 503 Blackheath and Oldhaven Formation 487, 501 Oldhaven Beds 492, 493-4 Bladon Member 392, 393 Blaeberry Formation 36, 41 Blea Wyke Sands 356 Blisworth 380 Blisworth Clay 356 Blockley Station Quarry 368, 369-74 description 370-2 ammonite faunas, correlation with Dorset coast fauna 371 section 370-1 interpretation 372-4 Blue Anchor Formation 329 Aust Cliff 343, 343, 344, 344 Blue Bell Hill 442 Blue Bell Hill Pits 446-54, 469 Culand Pits 446-9 combined section 447 interpretation 449-54 Blue Lias 356, 361-3 Boghole Beds 245, 253, 254, 254 early Frasnian age 256 and Whitmire Beds 170 Boghole, Muckle Burn 252-6 stratigraphical relationships 254-5 interpretation 256 **Bognor Member 505** Bognor Regis 504-9 composite section 505-6 interpretation 507-8 comparison with other localities 508 nearshore marine environment 507 Bognor Rock Bed 505 **Bognor Rock Group 505** Bone beds Abden Bone Bed 301-2 Brede Bone Bed 429 Cliff End Bone Bed 424, 425, 426-7, 426, 427, 429

Downton Bone Bed 102, 103 Hugh Miller's Bone Bed 382 Ludlow Bone Bed 78, 79, 102, 103 see also Ludlow Bone **Bed Member** Rhaetic Bone Bed 339, 342-50 Telham Bone Bed 429 Temeside Bone Bed 91, 92, 93 Border Group 266 Boscombe Sand 484 Bothriolepis 226, 227, 230, 232, 233, 238 Scottish Late Devonian 246, 247, 256 Bothriolepis havi 248 Bothriolepis macrocephala 236, 236-7 Bothriolepis major 254 Bothriolepis paradoxa 259, 260 Bothriolepis taylori 255 Boueti Bed 356, 397, 398 Bouldnor Formation 484, 518 predominantly freshwater fauna 486 **Bournemouth Freshwater Beds** 484 Bournemouth Group 484 **Bournemouth Marine Beds** 484 Bovey Tracey 483 Oligocene deposits 485 Boxford Chalk Pit 476-9 section 477 interpretation 478-9 comparison with other localities 479 phosphatic horizons 476 Brachymylus 404 Bracklesham Bay 519-22 fauna in Bracklesham Group 520-1 interpretation 521-2 Bracklesham Beds 485, 525 Selsey Peninsula 520 Bracklesham Group 484, 503, 517 - 18fauna 522-4 marine and continental beds 520

Bradnor Hill Quarry 98, 104-6 interpretation, thelodont fauna 106 Bradydonts, Carboniferous 293-4, 294, 302, 306, 310 Branksome Sand 484 Breccias red water-laid 315 west of Chiselbury Bay, tetrapods 337 Breconian 65, 67 Brede Bone Bed 429 Bressay Flagstone Facies 170 Bridgewick Marls 463 Bridgnorth Sandstone 329 Bridport/Yeovil Sands 356, 357 Brigantian 298, 299, 547 **Brighstone Anticline 431** Brighstone Sandstone 430, 431 Brindister Flags 170, 218, 219, 221 **Bringewood Formation 96** Bringewood Group 66, 80, 102 Brinkmarsh Beds 37 Bristol Basin, subsidence during Triassic 328 Bristol City Museum Geology Collection, Martyn collection 234 **British Isles** geological background 4-7 possible evolution scenario 6 principal outcrops, main stratigraphical units pertinent to fossil fishes 5 Cenozoic, Early, uplift and subsidence 484, 485 Jurassic, early, overlap of Tethyan and Boreal faunal realms 356 northern, floodplain environment, Aalenian-Bathonian 382 Permian late, Zechstein Cycle I 316 early, upland with molasse troughs and desert basins 315 Carboniferous, position during 266 Broken Beds Member 409 **Broken Shell Limestone** Member 406, 408, 409, 410

Bromsgrove Sandstone Formation 329, 333, 339 at Bromsgrove, fauna 333-4 Brook-Atherfield Point 423, 429-37 locality details 430 location map 432 modes of preservation 434 interpretation 435-7 comparison with other localities 437 Brownstone Group 110, 153-4 Brush spine, Stethacanthus 308, 310 Brychaetus muelleri 513 Buckie Beds 170 **Budleigh Salterton Pebble** Beds 329, 335 Budleigh Salterton-Sidmouth, Otter Sandstone Formation 334 Bullhead Bed 488, 489 **Burdiehouse Limestone 298** Burnham Chalk Formation 443 Burnham-on-Crouch 515-17 Burnhamia daviesi 511 **Burnside Formation 245 Butcombe Sandstone Member** 329 Caburn Marl 463 Cadeby Formation 317 Cainocrinus Bed 505 Caithness 170, 172 Caithness Flagstone Series 171 Calcareous Shales 356 Calciferous Sandstone Group 245 **Calciferous Sandstone Series** 299 uppermost, Abden Bone Bed 301-2 Calcirudite bed (Mammal Bed) 397-400 may represent offshore shell debris 399 Calcrete 328 Otter Sandstone formation in semi-arid conditions 337 Otterton Point 336 Calcrete soils, Elgin-Nairn sequence 243

Caledonian Basin 65, 111 separate from Anglo-Welsh Basin 147, 148 Caledonide orogenic belt 147 Callovian 356, 380 see also Oxford Clav Cambridge Greensand 421, 437 a remanié deposit 437 Campanian 420, 443 Canada, thelodonts 13 Canobius 290 Canobius elegantulus 289, 291 Canobius ramsavi 289, 291 Canterland Den 148, 152 Canterland Den Fish Bed 149 Cantioscyllium decipiens 446, 449, 450 Caproberyx suberbus 470 Carbonates shallow-marine 382 shelf 357 Carboniferous environments 266, 268 fish faunas 268-70 fossil amphibian sites 541-3 outcrops in Britain 268 palaeogeography and stratigraphy 265-6, 267 **Carboniferous** Limestone Series 267 Carcharias see Synodontaspis Carcharias hopei 511 Carcharopsis 304 Carn Powell Member 76 Carnian 329, 330 **Carron Formation 57** Carron Sandstone and Tuff 59 Carstone 421 Castle Formation 36, 41 Castle Mill Quarry, Downton **Castle Sandstone Member** 102 Cattle Ledge Stone Band, marker band 402, 403 Caturids 383, 429 new jaw structure 366, 368 Kimmeridge Bay 404 Lyme Regis 366 Whitby 379 Caturus 379, 383, 404 described 413 Caturus (Callopterus) latidens 429

Caturus purbeckensis 412, 413 Caturus tenuidens 413 Cawdor Limestones 303 Cederstroemia 440 Celtedens 394 Cement Shales 375, 375 Cementstone Group 245, 267, 274. 278. 287 Cementstones, Hawk's Heugh, miospore dates 252 Cementstones facies 266 Cenomanian 420, 421, 457 Upper, Middle and Lower 443 Cenozoic environments 485-6 fish faunas 486-7 fossil amphibian sites 545 palaeogeography and stratigraphy 483-5 summary, Early Cenozoic stratigraphy, southern England 484 Centrolepis aspera 366 Cephalaspids 133 articulated 128 usually found as adults 132 Scottish Mid-Devonian large, Caithness 173 Spittal Quarry 207, 208, 208 Scottish Early Devonian 150-1, 152, 156, 159 Wayne Herbert Quarry 132 Wolf's Hole Quarry 162, 163 Welsh Borders Early Devonian 113, 114, 127, 129 - 30Scottish Silurian 35, 36 Ardmore-Gallanach 61 Welsh Borders Late Silurian 84 Cephalaspis 127, 150 Cephalaspis abergavenniensis 131 Cephalaspis cradleyensis 129-130, 130, 132 Cephalaspis cwmmillensis 130-1, 130 Cephalaspis lornensis 61, 61-2 Cephalaspis lyelli 150, 151, 163

Cephalaspis magnifica 173 Spittal Quarry 207, 208, 208, 209 Cephalaspis pagei 161 Cephalaspis Sandstone 119-20, 121 Cephalaspis scotica 162, 163 Cephalaspis sensu lato species, morphological differences 115 Cephalaspis woodwardi 127 Cephalochordates 7, 8 Cephalopod Bed 356 Cephalopod limestones, condensed 357 Cephalopterus pagei see Turinia pagei Cephalothorax, Nikolivia milesi 135 Ceratiocaris Beds 41, 42, 45-46, 56 Dunside 46, 47 Ceratodus 8 Ceratodus laevissimus 333, 334. 545 Ceratodus latissimus 347, 349 type locality, Aust Cliff 343, 346 Ceratodus parvus 346 Ceratodus phillipsi 388 Cetiosaurus oxoniensis 392 Chale Clay Member 431, 433 The Chalk 420, 421, 422, 443-79, 509 basement bed 421 Northern and Southern Provinces 443, 444 selective preservation 419 subdivision by zone fossils 444 see also Lower Chalk; Middle Chalk; Upper Chalk Chalk Marl 420, 463 Southerham Grey Pit 471-2 Southerham (Machine Bottom Pit) 459, 461, 462 Totternhoe 455, 455, 456 Chalk Marl-Grey Chalk boundary, Southerham Grey Pit 461, 471 Chama Bed 525 Chandlers Yard see Southerham (Lime Kiln Quarries)

Channel infills, fish-bearing 92, 502 Channel lag deposits, Southerham Grey Pit 472-3 Chapelcorner Fish Bed 532 Chara Bed 520, 525, 528 Charlbury Formation 386, 387 Charlton Pits, Kent 479 **Chawley Brick Pit 405** Cheese Bay 296-7, 541 interpretation 297 type locality for Rhadinichthys formosus 296 Cheiracanthus latus 199, 200 Cheiracanthus murchisoni 187, 191, 195, 199 Cheiracanthus uragus 193 Cheirodopsis 291 Cheirodopsis geikiei 291-2, 292 Cheirodus 291, 302, 309 Cheirodus crassus 302 Cheirolepis 198 Cheirolepis canadensis 269 Cheirolepis trailli 175, 196 Chelotriton cf. paradoxus 557 Cherry Hinton, Cambridge 459 Cherty Beds 359 Cherty Freshwater Beds 407, 408 **Cherty Freshwater Member** 409, 410 amphibians 414 Cheshire Basin, subsidence during Triassic 328 Chief Beef Beds 407, 408 Chief Beef Member 409 Chilton Chine Sandstone 430, 431, 433 Chimaeriforms 17, 365 Chimaeroids 271, 348, 361, 382, 404, 441 Blue Bell Hill Pits 449, 452 Lee-on-Solent 522, 523 Southerham (Machine Bottom Pit) 464, 465 Chine Farm Sandstone 430, 431 **Chipping Norton Limestone** Formation 386 Chirodus crassus 301 Chiselbury Bay 334 Chit Rocks 334

Chondrenchelys problematica 294-5, 294 Chondrichthyans 10, 268 living, features of 271 Cenozoic 508 Abbey Wood 502 Barton Cliff 524, 526, 526-7 Bognor Regis 506, 507-8 Bracklesham Bay 521 Burnham-on-Crouch 515, 517 Herne Bay 493, 494, 495-6 Hordle Cliff 530 Isle of Sheppey 510, 512, 514, 516 Pegwell Bay 489 selachians, Lee-on-Solent 522-3, 524 Cretaceous, Late Blue Bell Hill Pits 448, 449, 452 Boxford Chalk Pit 478 Southerham Grey Pit 472, 473 Southerham (Limekiln Quarries) 475-6 Southerham (Machine Bottom Pit) 462-3, 464 Totternhoe 456, 457, 459 Cretaceous, Early (Mid-), East Wear Bay 442 Cretaceous, Early 422, 427 Isle of Wight 434, 435 Jurassic 359 Kimmeridge Bay 404 Kirtlington 392, 394 Lyme Regis coast 362, 365-6 Stonesfield 385, 387-8 Triassic Aust Cliff 345, 346, 347, 348 evolution within the 331 Permian 318 Middridge 320, 321 Carboniferous 270, 271 Ardross Castle 299, 301 Bearsden 307, 308, 310, 311, 312 **Glencartholm 288** Steeplehouse Quarry 303, 304, 305

Chondrichthyes 15 **Chondrosteans** 17 decline during the Jurassic 359 Lyme Regis coast 362, 365-6 Chondrosteus, described 366 Chondrosteus acipenseroides 366, 367, 378 Chondrosteus pachyurus 366 Chordates aquatic 7 Urochordates and Cephalochordates 8 within the stratigraphical record 9 Christchurch Bay, cliffs from Chewton Bunny to Becton Bunny 524 Christian Malford, Wilts. 383 Chronostratigraphy 21 **Church Hill Channel 78** Church Hill Ouarry 77-8 description 77-8 interpretation 78 Cimolichthys lewesiensis 453, 467 described 470 Cinder Bed 407, 408 Cinder Bed 'event' 359 Cinder Member 409 Cladoselache 271, 310 Clavgate Beds 503 Clee Formation 110 Clee Hills 65, 91, 124-5 Heightingtonaspis anglica 141 localities with Europrotaspis crenulata 142 Old Red Sandstone 111 Prescott Corner 236-8 The Cletts, Exnaboe 218-21 interpretation 219, 221 Cleveland Basin 357, 358 **Cleveland Ironstone Formation** 356. 375 Cliff End Bone Bed 425, 426-7 described 426-7 further exposures 429 a high-energy lag 427 laterally impersistent 425, 426 ?correlation with Telham Bone Bed 426 microvertebrate remains 424

Cliff End, Hastings 424, 425 **Cliff End Member 555** Cliff End Pebble Conglomerate 425 Cliff End Sandstone 425, 426 Cliffe Hardground 463 Climatiids 94-5, 101 Climatius 159 Climatius reticulatus 154 Cloughton Formation 356 Clupeomorphs (herrings) 422 Clyde Plateau Lavas 267 Clydoniceras (Delecticeras) cf. ptychophorum 398 Clydoniceras bollandi 398 Clypeus Grit Formation 386 Clyth Subgroup 170 Cnoc Fyrish Conglomerate 170 Coal Measures 266 see also Lower Coal Measures; Middle Coal Measures Coccolepis 428-9 Coccolepis bucklandi 367 Coccolepis liassica, 366 Coccolith ooze 421 Coccosteus 191, 201, 221 expansion of, Achanarras Quarry 184 Woodhill Bay Fish Bed 235 Coccosteus Bed, Tynet Burn 198 Coccosteus cuspidatus 174, 188, 195, 203, 204 Coelacanths 18, 302, 321, 331 Cretaceous 422, 454 Carboniferous 270 Ardross Castle 299-300 Cheese Bay 297 Glencartholm 288, 290 Jurassic 361 Durlston Bay 405, 411, 414 Coelacanthus 297, 324 Coelacanthus granulatus 321, 322 Coelodus 424, 428, 429 Coelodus ellipticus 438 Coelodus mantelli 428, 435 Coelodus multidens 433, 434, 435, 436, 437 Coelodus parallelus 465 Colwell Bay Member 518, 528, 555

Comacanthus 255 **Combe Martin Limestone 231** Compton Bay-Atherfield section 429, 430-1 Conchodus ostreiformis 256, 260 Scaat Craig 260 Concretions, calcareous, Jamoytius horizon 42 Condensed sequences, carbonate 421 Conger 524 Coniacian 420, 443 Conodont biozones, Welsh Borders, Late Silurian 66 Conodonts 7.8 of the Ludlow Bone Bed 81 Continental deposits, Late Devonian 225 Cooden, East Sussex 429 Coolevella 304 Cooleyella fordi 304 Coprolites 441, 454, 475 Aust Cliff 345, 348 Copt Point, section at 441 Coquinas 76-7 Black Cock Beds 76 Lessness Shell Bed 501-2 Coral Rag 400 Coral-Epithyris Limestone 391 typical White Limestone fauna 392 Corallian 356 Corallian Beds 400 Coralline Crag, invertebrate fossils 486 Corbula Beds 407, 408 Corbula Member 409, 410 Corfe Clay 484 Cornbrash 356 see also Lower Cornbrash; Upper Cornbrash Cornstone Beds 245, 254 Cornstone Group 251 Cornstones 245, 251 Cornua, Sclerodus 104 Cornual processes, osteostracan 38 Cornubia 381, 404 fossil fishes in marine Midto Upper Devonian sediments 225-6 Cornubian Basin, sediment infill derived from north 225

Cornubian island 356-7, 358 Corvaspis 100 Corvedale 66 Cosmacanthus malcolmsoni 257, 259-60 **Cosmine 269–70** Cosmolepis see Oxyagnathus Cosmoptychius 548 genus retained 283 Cosmoptychius striatus 278, 281, 283 Cotham Marble Member 349 Coton End 333, 339, 543 Coton End Quarry, tetrapods 545 Cotswold Slate 389, 390 Cotswold-Weald Shelf 357 Cotswolds, Upper Lias 380 Cotteswold Sand 356 Cove Harbour Sandstone 251 Cove Lower Marine Band 251 Cove Oil Shale 251 Cove Upper Marine Band 251 **Cowie Formation 57** Cowie Harbour see The Toutties Cowie (Harbour) Fish Bed 57, 58 Cowie Tuffs 36 Cowleaze Chine Member 430, 431 Crackers Member 433, 437 Craigwell Bed 505 Crangonopsis Bed 299 Cranmore Ledge, Bouldnor 557 Crassigyrinus 544 Craven Basin 266 Crawton Group 148 **Crawton Volcanic Formation** 148 Cretaceous environments 419, 421 expansion and diversification of higher bony fishes 422 fish faunas 422 palaeogeography and stratigraphy 419, 420 see also Early Cretaceous; Early (Mid-) Cretaceous; Late Cretaceous (The Chalk); Upper Cretaceous Cretolamna 442, 475, 478

Cretolamna appendiculata 438, 439, 441, 449, 457, 465 Cretolamna woodwardi 442, 465 Cretoxyrbina 442 Cretoxyrbina mantelli 438, 449, 465 Cretoxyrbina (Oxyrbina) mantelli 475 Crinoid-Belemnite Bed 370, 371 microvertebrate remains 373 Crocodile Bed, Durlston Bay 410 Crocodile Bed, Lower Headon Beds/Totland Bay Member 528, 529, 529-30 Crocodilians, Stonesfield 389 Cross-bedding 111, 250 Boghole, Muckle Burn 253 Sandstone Member 81 crouchi Zone 114 Crovie Group 170, 194 Cruaday Quarry 175, 185-9 divided into two layers 186, 188 interpretation 188-8 Crushing dentition/teeth 271, 291, 359 Cheirodopsis 291 hybodont 332, 387-8, 427 neoselachian 399 plethodont 453, 469 Ptychodus 422, 464 Cryogenic folding, Speeton Clay 437 Ctenacanths, final radiation, Early Jurassic 359 Ctenacanthus 292 Ctenacanthus costellatus 293 Ctenothrissa 453, 459 Ctenothrissa microcephala 469 Ctenothrissa radians 469 Cuckmere Sponge Bed 463 Culand Pits, Blue Bell Hill 446 Lower Pit, Lower Chalk 446 Upper Pit, Middle and Upper Chalk 446, 447 Culver Member 443 Cumbrian-Alston Block 266 Cushnie Burn 194 Cwar Glas 75-7 interpretation 76-7

Cwm Mill 128-32 succession 128, 129 interpretation 131-2 comparison with other localities 132 Cwmaspis billcrofti 131 Cvathaspids 78, 113 Cyathaspis 95, 97-8 Cyathaspis banksi 97, 97, 105-6 Cyathaspis campbelli 57, 60 Cyclical sedimentation Barton Clay Formation and **Becton Sands Formation** 527 Bracklesham Group 521 Hastings Beds 419 Otter Sandstone 336 **Thanet Formation 489** Vectis Formation 435 Westbury Formation 340 Cycloptychius 290 Cycloptychius concentricus 290 Cyclothems at Cwm Mill 128, 129 explanations 131-2 Ledbury Group 88 Lower Ditton Group 126 St Maughan's Group, tidal 100 Cylindracanthus rectus 506 Cyprina Bed 505 Cypris Freestone 407 Cypris Freestones Member 409 Jurassic-Cretaceous boundary within 409

Dalintart railway cutting 61 Dane Hills Sandstone Member 339 Danian 420 Dapedium 366 controversy over Whitby specimens 379 Dapedium politus 363, 364, 367 Dapedius micans 376 Dapediids 383 Dartmouth Beds, age of pteraspids 228 Dartmouth Slate 225, 229 Dasyatis wochadunensis 496 Dasyceps bucklandi 324

Deltoptychius 293-4, 306, 310, 311 Deltoptychius armigerus 293, 294, 294, 302 Den of Findon, Gamrie 193-6, 209 Denea 270 Dercetis 469 Dercetis elongatus 459, 470 Desert pavement 336 Dessication events, and fish mortality 245, 248, 250 Devils Hole 119-25 main fossil-bearing beds 119 - 20stratigraphical section 120 interpretation 123-5 comparison with other localities 124-5 Devon and Cornwall marine Middle and Upper Devonian 225 fish-bearing rocks 225, 229 south, Lower Devonian 225 Devonian continental facies of 20 debate concerning stem tetrapods 537 extinction event towards end of 8 fossil amphibian site 541 stratigraphical section, Welsh Borderland-South-west England 110 tetrapods and amphibia 538-9 see also Late Devonian; Middle Devonian, Scotland; Upper Devonian, Scotland Devonian genera, known in Britain now recognized elsewhere 24 Devonian-Carboniferous boundary Hawk's Heugh 251 uncertain in Scotland 245 Diastrophism 110, 225 Dick, Robert, at Pennyland 214 Dickosteus threiplandi 174, 206, 207, 208, 210, 212 Spittal Quarry type locality 209

Dictvocaris Beds/Band/Member 35, 36, 57.59 Didymaspis grindrodi 86, 88, 89, 90, 91 Dieppe Basin 483 Digona Bed 397, 398, 399 Dinelops 452 Dingle-Shannon Basin 111 **Dinosaurs** 392 Dinsosporites devonicus 184 Diplacanthus crassisimus 187 Diplacanthus striatus 187, 200 Diplacanthus tenuistriatus 195 Diplocercides 270 Diplocerides davisi 302 Diplodoselache 270, 284 Diplodoselache fauna non-marine 306, 307 Wardie 280, 286 Diplodoselache woodi 284, 285, 286 Dipnoans 175, 181, 188, 207, 256 Carboniferous 270 Late Devonian, Scaat Craig 259, 260 Mid-Devonian, Westerdale Quarry 177, 178 Dippal Burn fish bed 41, 55, 56 correlation with Fish Bed Formation 50 **Dippal Burn 50** Dippal Burn Formation 36, 41, 50 Dipple Brae 205-7 interpretation 207 Dipple (Brae) Fish Bed 197 section 206 younger than Achanarras Horizon 205 Dipteronotus cyphus 334, 338 dorsal hump 339 Dipterus 175, 176, 179, 184, 198, 209, 215, 221 Exnaboe 219, 221 Spittal Quarry 208-9 Dipterus macrolepidus 209 Dipterus valenciennesii 175, 177, 178, 183, 203, 209, 210, 214 Ditton Formation 112

Ditton Group 67, 101, 110, 111, 112, 114, 236 cornuate osteostracans 124 fluvial sandstones 123 return to a wetter climate 69 Wayne Herbert Quarry 133 see also Lower Ditton Group Ditton Series 110 Dittonian 65, 67, 92 Dixon, Frank, collections from Southerham Chalk pits 460, 462 Dogger 356, 380-400 Doggers (animal dogger) 375, 376, 378 Don Group 317 Dorypterus 320 Dorypterus boffmani 320, 321 Douglas Water Arenite 36, 48 Dovestone Redbeds 36, 48 Downie Point Conglomerate 148 Downton Bone Bed 102, 103 Downton Castle area 101-4 Downton Castle Bridge, fishbearing exposures 103 Downton Castle fish beds, interpretation 104 **Downton Castle Sandstone** 110 Downton Castle (Sandstone) Formation 65, 66, 67, 79, 110 Downton Castle area 102 Ludford Lane/Ludford Corner 80, 84, 85 Ludlow Bone Bed Member at base of 79 Tite's Point 95, 96 Downton Castle Sandstone Member 66, 102 Downton Gorge 93 Downton Group 110, 112, 114 fishes, non-marine in Britain 124 upper, non-marine in Welsh Borders 123 Downton Sandstones 86, 87 Downton Series 65 Downtonian 65, 67 upper 92 stratigraphical log at The **Toutties 59** Duff, Patrick see Malcolmson, J.

Dumbleton Hill, 'Fish Bed' 380 Dumfregia buxleyi 290 Dundee Formation 62, 148, 158 fish beds 149 Dungavel Group 36 Dunnet Head (Sandstone) Group 170, 171, 243 Dunottar Castle Conglomerate 148 Dunottar Group 148 Dunside 45-7 interpretation 47 Dunside Formation 36, 41 Dunstable Plateau 454 Dura Den Formation 245 Durlston Bay 401, 404, 405, 405-15, 406 amphibians 544 stratigraphical section 406, 408, 409 interpretation 412-15 comparison with other localities 415 Durlston Formation 409, 409 Durophagy, Bathonian 394

Early Cretaceous 420 environments 419 Wealden Group (Berriasian-Barremian) 423-37 comparable European faunas 424 Early Jurassic 360-80 Early Lias 359 Central England depositional basin 372 Early (Mid-) Cretaceous 437-43 Early Permian, Britain generally a low arid desert 315 Earnley Formation 484, 520 Earnley Sand 484 Earth movements Caledonian 33 Late Jurassic-Early Cretaceous 419 Lower Carboniferous 315 Permo-Carboniferous 327 Earthy Bed 525, 526 East Anglia-North Sea deposition basin 419

East Kirkton, Bathgate 546-54 amphibian/tetrapod remains 26. 541 interpretation 552-4 comparison with other localities 554 lake environment 552-4, 554, 555 East Kirkton Limestone 546, 547 East Midlands Shelf 358 East Wear Bay 440-3 interpretation 442 East Wear Bay Formation 443 Eastchurch Gap 510 Eastern Hole Conglomerate 252 Eastwoods Cement Company Pit 471 Edaphodon 438, 442, 449, 465 Edaphodon agassizi 465, 467 Edaphodon mantelli 465 Edaphodon sedgwicki 465 Eday Beds 170 Eday Flagstone 170, 218 Eday Group 218 Eday Marls 170 Edderton Fish Bed 170 age equivalent to Achanarras Fish Bed 190 nodule bed 190, 190 preservation 190-1 Edenkillie Beds 255, 354 **Edzell Mudstones** 148 **Edzell Sandstones** 148 Egerton collection 209 Egertonia 522 Eifelian 176 at Bedruthan Steps 228 radiation, beginning of 245 Eifelian-Givetian boundary Achanarras Fish Bed 184 Achanarras Limestone Member 178 Banniskirk Quarry 210 Elasmobranchs 17, 245, 271, 318, 331 Cenozoic Isle of Sheppey 509, 510, 511, 512 London Clay 489, 493-4, 499-500, 502, 507 Thanet Formation 493, 494, 495-6

Cretaceous Gault Clay 438, 441 Totternhoe 456, 457, 459 Jurassic Bathonian 398, 398 **Blockley Station Quarry** 372 Carboniferous 271, 298, 299 articulated, Upper and Lower Oil Shale groups 284 East Kirkton 547, 553 Glencartholm 288, 292-23 preservation of 286 Steeplehouse Quarry 304, 305 Wardie 280, 284, 285, 286 Elasmodectes secans 465 Elasmodectes willetti 449, 465, 466 Elasmodus kempi 522 Eldeceeon 555 Eldeceeon rolfei 551, 552 elegans Zone, Kimmeridge Bay 402 Elgin Museum, collections from Scaat Craig 257 Elginerpeton pancheni 260, 261 Ellen's Goe Conglomerate 170 Eller Beck Formation 356 Elmore Member 527 Elonichthys 283, 290, 548 Elonichthys pulcherrimus 290 Elonichthys robisoni 281, 283, 300 Elonichthys serratus 290 Elonichthys striatulatus 283 Elopiforms 452, 469 Elopomorpha 452 Elpistostege 538 Elton Group 66, 80 Ely, Cambs. 405 Emborough Quarry 350 Emsian 65, 228 Enchelurus anglicans 452 Enchodonts 453, 469-70 Enchodus lewesiensis 438, 453, 468, 469 Enchodus pulchellus 451, 453, 469 Endeiolepis 37

England and Wales Mid- and Late Devonian continental facies 225 environments 225 fish faunas 225-7 fish sites 227 palaeogeography and stratigraphy 225, 226, 227 Enterospirae 348, 454 Enville Group 324 Environments Cenozoic 485-6 Cretaceous 419, 421 Jurassic 357, 359 Mid-Jurassic 380 Permian 317 Carboniferous 266, 268 Early Devonian Scotland 149 Welsh Borders 111 Late Devonian, Scotland 245 Mid- and Late Devonian, England and Wales 225 Mid-Devonian, Scotland 172 late Silurian, Welsh Borders 69 Silurian, Scotland 35 Eocene 484 fishes in London Basin deposits 486 Lower 490 Eocyclotosaurus 338, 545 Eodiscoglossus oxoniensis 394, 545-6 Eoherpeton 544 Eomesodon, cf. Mesodon 413 Eomesodon barnesi 413 Eomesodon bucklandi 394 Eomesodon depressus 413 Eopelobates cf. hinschei 557 Eothynnus salmonens 513 **Epeiric** seas hypersaline 330 Iurassic early, northern Europe 355-6 fish fauna 359 Epithyris Limestone 391 **Eppleton Quarry 324 Eriptychiformes 113** Errivaspis waynensis 133, 134 Esha Ness and Papa Stour Volcanic Rocks 170

Esha Ness sequence 201 Etches, Steven, Kimmeridge Bay fauna collection 404 Eucentrus paradoxus 301 Eucephalaspis agassizi 123 Eudoxus Zone, Kimmeridge **Bay 402** Eugnathus 379 Eugnathus fasciculatus 379 Eukeraspis pustuliferus 84 Europrotaspis crenulata 139, 141 Eurvcormus 405 Eurynotus 284, 291548, 553 Eurynotus crenatus 284 Eurypholis pulchellus 453 Euselachians, complete specimens, Lyme Regis 360-1 Eustbenopteron 247, 255, 256 Eusthenopteron farloviensis 236, 237, 237 Eustbenopteron traquairi 253, 255-6 **Euteleosts** Blue Bell Hill Pits 449, 453 **Bognor Regis 507** Isle of Sheppey 512 Southerham (Machine Bottom Pit) 464, 467-70 Euthacanthus macnicoli 154, 155.159 Euthynotus 380 Eutrichiurides 522 **Evaporites** lacustrine 328 sabkha 315 sulphate 330 Exmouth Sandstone and Mudstone Formation 329 Exnaboe Fish Bed 218-21 Exoskeleton, Sclerodus 104 Extinction events 7, 8 Devonian 184 end Cretaceous 421 Eve Pit 400 Eyes, Jamoytius kerwoodi 44 Evford Member 387, 388, 389 Eyford Quarries 389 Faecal pellets 348

Famennian 65, 231, 235 Farlovian 65 correlation with Frasnian 236 Farlow Group 110, 237 Faulting block-faulting, British Isles 315 Cheese Bay 296 foreshore between Thurso and Scrabster 214 transcurrent 218 Faunal introductions, Achanarras Limestone 184 Faunal migration 124, 148, 262 Fell Sandstone Group 267 Ferriby Chalk Formation 443 Ferruginous infiltrations, Mill **Rock 230** Ffinnant Sandstone 76 Fimbriatus-waltoni Beds 390, 391 sedimentology and environmental interpretation 393 Shipton-on-Cherwell quarry 395 vertebrates in 392 zonal placing 393 Fin folds anaspid 54 lateral fin fold theory 44 Finavon Conglomerate 148 Findon Group 194 Fining-upwards cycles 111, 162 Fish Bed Formation 36 fish bed in 48 Shiel Burn 47-50 Fish beds Carboniferous Foulden 272, 273, 274-80 **Glencartholm 287** Cenozoic Beltinge Fish Bed 490, 493, 496 Chapelcorner Fish Bed 532 Cretaceous, freshwater, Wealden Group 423-37 Scottish Early Devonian 149 Scottish Mid-Devonian Achanarras fish bed 178-81 as marker beds 172 Lower Devonian, Lydney 98-101 Welsh Borders Early Devonian 111, 112

Welsh Borders Late Silurian correlation with standard marine sequence 67 higher St Maughan's Group 100-1 Ledbury, Temeside and Ludlow railway cutting faunas compared 91, 111, 112 Scottish Silurian complex stratigraphical relationships between Hagshaw Hills and Lesmahagow inliers 55-6 dating debate 56 Lorne area 60-2 see also individual beds and sites Fish Conglomerate (Intraclast conglomerate) 98, 99, 100 Fish faunas Cenozoic 486-7 Cretaceous 422 **Jurassic 359** and amphibian faunas, Triassic 331-3 Triassic, not widespread 331 Permian 317-18 Silurian, Scottish and Baltic separate from Anglo-Welsh borders 37 Carboniferous 268-70 England and Wales, Midand Late Devonian 225-7 Scotland Early Devonian 149-56 Late Devonian 245-8 Mid-Devonian 172-5 Silurian 35-9 Welsh Borders Early Devonian 111-15, 117 Late Silurian 69, 74-5, 104-6 Fish sites 3, 25, 27-9 selection of 3 Cenozoic Late Palaeogene, Hampshire Basin 518 London Clay Formation 504 pre-London Clay Tertiaries, London Basin 487-8

Cretaceous Early (Mid-) Cretaceous 438-40 Wealden of the Weald 423-4 Late Cretaceous 445-6 Jurassic 360 late Triassic, Central and South-West England 340-2 Carboniferous 272 Late Devonian, Scotland 248 Mid- and Late Devonian, England and Wales 227 Mid-Devonian, Scotland 175 Early Devonian Scotland 156 Welsh Borders 117, 119 Silurian Late, Welsh Borders 74-5 Scotland 39-40 Flamborough Chalk Formation 443 The Flats Stone Band 402, 403 Flint nodules 421 Folding, south-west England 315 Folkestone, Gault Clay in cliff sections 438-9 Folkestone Beds 441 Footprints, amphibian 324, 545 Ford Formation 317 Forest of Dean/South Wales Coalfield (E. Crop), Devonian 110 Forest Marble Formation 356, 359, 382, 388, 390, 391 base of 391-2 Leigh Delamere Service Station 396 Swyre and Watton Cliff 395 Tarlton Clay Pit 395 Watton Cliff channel deposits 395, 396 complete section 397 west Dorset, biostratigraphical correlation difficult 398 Forfar, Lake 159, 160, 165 Forfarshire Fish Bed see Tillywhandland fish bed Fossil heritage achieving positive management xviii conservation of xvii-xviii

Fossil-lagerstätten 19 Fossils code of good practice xviii responsible collecting xvii-xviii Foula Beds 201 Foulden 272-80 amphibians 541 interpretation 278-80 Foulden Fish Bed 272, 273 fauna 274-8 semi-permanent freshwater lake 279 Fouldenia ottadinica 278, 291 'Fragment Bed' 93 Frasnian 65 Frederichthys musadentatus 308 Freshwater Point 403 Frodingham Ironstone 356 Frogs 540 disglossid 394, 414, 556 Fuller's Earth 397 Fuller's Earth Clay 356, 357 Gadiiforms (mackerel) 422 Galeaspids 8, 13 Galeomorphs 399, 514, 517 Bluebell Hill Pits 448, 449 Boxford Clay Pit 478 Brook-Atherton 434, 437 Southerham (Machine Bottom Pit) 465 Totternhoe 456, 457, 459 Upnor 500 Galeorbinus lefevrei 496 Gallanach Lodge 61 Gamrie Fish Bed 193-6 'Gamrie ichthyolites' 193 Ganodus 388 Ganodus dentatus 388 Ganodus oweni 388 Ganodus rugulosus 388 Ganodus semistriatus 382 Ganoine 175 Ganopristis 479 Gardner's Bank, Shropshie, Traquairaspis symondsi 101 Garvock Group 148, 149, 161 Gault Clay Formation 419, 420, 422, 437, 438-9 basinal marine mudstone 421, 442 East Wear Bay 441-3

Gaulter's Gap Shales 402 Gillingham, Dorset 405 Givetian-Frasnian boundary, Sumburgh Head 222 Glacial erratic, Elgin, Rhaetian sediments in 342 Glauconite 474-5, 477, 527 Glauconitic Mark 420 Glenbuck Group 36, 47, 48 fish beds 52 Glencartholm 286-96 complete fishes 286 interpretation 295-6 conditions of preservation 295 death assemblage 295 similarities and differences to Bear Gulch and Mazon Creek 395 Victorian collections 287 Glencartholm fish beds Scorpion Bed 287 Shrimp Bed 287 Glenvale Formation 245 Global stratigraphical column 6-7.22 Globulodus 320 Glynde Marls 463 Glypopomus kinnairdi 233 Glyptolepis 184, 196, 215 Glyptolepis cf. leptopterus 203 Glyptolepis paucidens 175 shallow water only 184 Glyptopomus minor 254 Gnathostomes 3, 8, 10, 13-14, 35 Gomphodus 83 Gonatodus 283 Gonatodus puctatus 281, 283, 283-4 Goniporus alatus 132 Goodrichthys 292-3 Goodrichthys eskdalensis 293 Gordon, G.G. and Malcolmson, I. 196-7 Gorstian 66, 67, 79, 96 fish sites 74 Grange Chine Black Band 430, 431 Grange Chine Sandstone 430, 431 Grantham Formation 356 Granton Shrimp Bed, faunal assemblage 297

Graptolite biozones, Welsh Borders, Late Silurian 66 Gravel Caverns Conglomerate 229 Great Estuarine Group 357 lagoonal facies of 382 Great Oolite Group 357, 382, 385, 386 Green Ammonite Beds 356, 361, 362 Green Downton Bed 66 Green Downton Formation 65, 105 Grey Chalk 420, 447, 463 Folkestone 442 Southerham Grev Pit 471-2 Machine Bottom Pit 459, 461.462 Totternhoe 454, 455, 455 Grey Farlow Sandstone Formation 110, 236 Grey Grits 110, 238 Grey Ledge Stone Band, marker band 402, 403 Grev Shales 356 Grey Shales Member 375, 375 Greywacke Conglomerate 36 Grinstead Clay 420 Groenlandaspis 232, 246 Portishead 232, 234, 235 indicates open migration routes 236 Gully Redbeds 36, 48 Guy's Cliffe 339 fauna 333, 543, 545 Gylenaspis 62 Gyracanthus 274, 275, 544 Gyrodus 404 Gyrodus atherfieldensis 433, 437, 438 Gyrodus trigonus 389 Gyrolepis 339 Gyrolepis alberti 333, 334, 348 Gyronchus (Macromesodon) rugulosus 389 Gyronchus (Mesodon) tenuidens 389 Gyroptychius 196, 198, 203 casts of ethmoid endo-cranial cavity 207 Gyroptychius agassizi 175, 189, 203 Gyrosteus mirabilis 376, 378

Habitats reduction during the Permian 317 shifting, Palaeogene 485-6, 485 Hagfish 3, 14 Hagshaw Group 36, 48 Hagshaw Hills inlier 33, 35, 37, 38 Shiel Burn 47-50 position of Fish Bed Formation 49 succession 36 Halec eupteryginus 453, 468, 470 Halecomorphs 404 Bexhill-on-Sea 429 Blue Bell Hill Pits 452 Durlston Bay 410, 413 Southerham (Machine Bottom Pit) 465, 467 Whitby 378, 379 Halecostomids Brook-Atherfield 434-5 Durlston Bay 410, 413 Hastings 427, 428-9 Kimmeridge Bay 404 Lyme Regis 366 Whitby 378, 378-9 Haling and South Croydon pits 479 Ham-Skarfskerry Subgroup 170, 211, 214 Hampen Marly Formation 384, 386 Hampshire Basin 483 Bartonian marine and nonmarine provinces 527 cyclic patterns of transgressions 485, 527 fish in Late Eocene deposits 496 Late Palaeogene of 517-33 fish sites 518 London Clay Formation 502 stratigraphy 484-5, 484 Hamstead Beds 484, 485, 518, 533 Hamstead Member 486, 546 Hangman Grits 225, 229 Hangman Sandstone Group 110 Harbour Cove Slates 229 Hard Cockle Member 409

Hard Shales 375, 375, 376 Hardgrounds condensed 421 Hope Gap Hardground 463 phosphatized, Boxford Chalk Pit 477, 478 Strahan's Hardground 473, 474-5 Harding Sandstone, new discoveries of primitive scales 8 Hareshaw Conglomerate 36, 48, 50 Harpagofututor vollsellorrbinus 295 Harra Ebb Formation 170 Hartlepool Anhydrite 317 Hastings 424-9 stratigraphical log 426 interpretation 427-9 comparison with other localities 429 Hastings Beds/Formation 419, 420, 421, 422, 423 Hastings 424, 425 Hatherwood Limestone Member 555 Hauterivian 420 Hawk's Heugh 250-2 interpretation 252 age of fish-bearing beds uncertain 252 Hay Burn Formation 356 Hayton Anhydrite 315, 317 Headington Pits 400 Headon Beds 484, 485, 486, 533 Hordle Cliff 529 Headon Hill Formation 484, 518, 528, 546, 554 section 556 Headon Hill, Isle of Wight 531, 545, 554-7 comparison with other localities 556-7 generalized section 555-6 interpretation 556 Headshields arthrodire 174 Ateleaspis 73 Auchenaspis 88 Auchenaspis salteri 94 cephalaspid 159 Cephalaspis cradleyensis 126-30

Chondrosteus 366 with cornual processes, osteostracan 38 Cwmaspis billcrofti 131 Deltoptychius 271 dermal, osteostracan 114 Didymaspis grindrodi 90 from Cephalaspis Sandstone 121 Hemicyclaspis 95, 103 heterostracan 71, 76 Menaspis 271 Pennyland 214-15 Sclerodus 84, 104 Scolenaspis 121 Heathery Heugh Sandstone 251 Heightingtonaspis anglica 141 Heightingtonaspis willsi 141 Helman Head Beds 170 Hemicyclaspids 57 Temeside, Ludlow 92, 93, 94, 95 Hemicyclaspis 57, 89, 102 index fossil for lowest Downton Group 94 Hemicyclaspis lightbodii 94 Hemicyclaspis murchisoni 89, 90, 92 Temeside, Ludlow 94 Hemiscyllium 475, 548 Hemiteleaspis beintzi 57 Hen Cliff Shales 402 Hen Cliff Stone Band 403 Hengistbury Beds 484 Herne Bay 490-7 composite section 492-3 sedimentary log, Hern Bay Cliffs 491 interpretation 494-7 comparison with other localities 496-7 Heterodontus 399, 433, 442 Heterodontus canaliculatus 438, 439 Heterodontus sulcatus 438 Heterodonty, Hybodus 365 Heterolepidotes 378, 379, 383 Heterostracans 13, 73 Scottish Late Devonian 247, 247-8 Boghole, Muckle Burn 255 Scaat Craig 258, 259

Scottish Early Devonian 150, 156 Wolf's Hole Quarry 162-3 Scottish Silurian 36 Ardmore-Gallanach 61-2 The Toutties 57, 60 South-West England, Bedruthan Steps 228 Welsh Borders early Devonian 111-12, 143 Besom Farm Quarry 139, 140 - 1Cwm Mill 129 Devil's Hole 120, 121-2, 124 Oak Dingle, Tugford 125, 127 Wayne Herbert Quarry 133-5 Welsh Borders Late Silurian 70, 71, 71 Bradnor Hill Quarry 105-6 Church Hill Quarry 77, 78 Cwar Glas 75, 76 Ledbury cutting 88, 90 Lydney 100, 101 Tite's Point (Purton Passage) 97-8 Heterostrophus 383 Hettangian 356 Hexanchus agassizi 516 Hexanchus microdon 457 Hexanchus (Notidanus) microdon 449 Hibbertopterus 555 High Peak, Sidmouth 334, 335, 336 Hill Head Red Bed Subgroup 170 Hillhead Group 170 Hillside Dol Formation 110 Histionotus angularis 411, 413 Hoel Senni Quarry 142-4 interpretation 143-4 comparison with other localities 144 Holacephalians 361 Holborn Head, geology of 211 Holborn Head Quarry 210-13 distribution and abundance of fish 212, 213 interpretation 213

Holdgate Sandstone Formation 112 Holocephalians 271, 348, 507 Glencartholm 293-4 Holonema 230 Holophagus, type locality Lyme Regis 361 Holophagus gulo 367, 368 Holophagus purbeckensis, Durlston Bay 406, 411, 414 Holopteryx 453, 470 Holopteryx lewesiensis 466, 470 Holopteryx simus 453 Holoptychius 26, 226, 227, 230, 232, 233, 238, 247, 252, 254, 299 Holoptychius nobilissimus 251, 259, 260 Holosteans 394 Holurus 292 Holurus parki 292, 292 Holwell fissure fill 349 Holwell Southern Quarry, Frome 350 Homonotichthys, described 453 Homonotichthys dorsalis 453 Homonotichthys rotundus 453 Homosteus 203, 215, 216 Homosteus milleri 174, 204, 214 Hope Gap Hardground 463 Hordle Cliff 26, 527-31, 556, 557 amphibian fauna 26, 545, 546 Becton Bunny to Milford-on-Sea 528-31 position of collected amphibians 528-9 interpretation 531 comparison with other localities 531 Hornsleasow Quarry 396 Horse Road Sandstone 251 Tournaisian or lowest **Carboniferous 252** How Ledge Limestone 555, 556, 556 Hoy Sandstone (Group) 170, 243 Hoy Volcanics 170 Hugh Miller collection 209

Hugh Miller's Bone Bed 382 Hunstanton Formation 421, 442, 444 microshark fauna 437 Hunterian Museum, excavation at Bearsden 306 Huntingbridge Beds 484 Huntingbridge Division 522 fauna 523 Huntsmans Quarry 389, 396 Hutchinson, P.O., collecting near Sidmouth 337 Hybodonts Cretaceous 422 Cretaceous, Late, Southerham (Machine Bottom Pit) 462, 464 Cretaceous, Early 434, 435 Hastings 424 Jurassic 359, 382, 394 Durlston Bay 410, 412-13 Lyme Regis coast 365 Stonesfield 385, 387 ubiquity of 399 Triassic 343 Aust Cliff 345, 346, 347 development of 331-2 misidentified 332-3 with durophagous dentition 332 Permian 318 Carboniferous 284, 285, 286, 293, 293, 306, 310 Hybodus 361, 367, 382, 387, 399, 404, 438 ubiquity in Great Oolite sequences 393 Hybodus apicalis 387, 388 Hybodus basanus 433, 434, 435, 436, 437 Hybodus brevicostatus 433, 434 Hybodus dorsalis 387, 388 Hybodus ensis 411, 412, 436 Hybodus grossiconus 387, 387 Hybodus jugosus 387 Hybodus marginatus 387 Hybodus parvidens 427, 428 Hastings type locality 424 Hybodus polyprion 387, 387 Hybodus reticularis 365 Hybodus strictus 412 Hylaeobatis ornata 427, 433, 437

Hypolophodon (Hypolophus) sylvestris 496, 502 Hypotodus robustus 495-6 Hypotodus verticalis 495-6, 516 Hypsilophodon Bed 431 Hypsocormus 383, 403, 404 Iapetus Ocean 33, 34 Iapetus Suture 34 Ichthyodectes 453 Ichthyodectes minor 469 Ichthyodectes tenuidens 451, 453 Ichthyodectids 414, 422, 452-3, 469 Ichthyokentema 414 Ichthyostega 256, 538, 539 as ancestor 539 Ilfracombe Beds 110, 229 Inches and Holm Burn Flagstone Group 170 Inchkeith 298-9 interpretation 298-9 Inferior Oolite Group 382 see also Upper Inferior Oolite Intermarine Beds 407, 408 Intermarine Member 409, 410 International Geological Correlation Project No. 328 (Palaeozoic Microvertebrates) stratigraphic table 21, 22, 23 Intraclast conglomerate (cornstone) bands, Besom Farm Quarry 138-9 **Invertebrates 3** Tillywhandland Quarry 159 Ironstone Bed 528 **Ironstone Shales 356** Ischnacanthus 142, 159 Ischnacanthus gracilis 154, 155, 158-9, 159 Ischyodus 387, 388, 389, 404, 442 Ischyodus colei 388 Ischyodus egertoni 382 Ischyodus emarginatus 388 Ischyodus incisus 450, 452 Ischyodus thurmanni 438, 449, 452 Isistius triangularis 507 Isle of Portland coast 400 Isurolamna affinis 507

type locality of Cyathaspis banksi 105 Jamoytius 37, 40 affinities problematic 44 Jamoytius horizon 41, 42, 43, 45, 56 Jamoytius kerwoodi 40, 42, 44 Janessa 321, 324 Janessa bituminosa 321, 322 Jet Rock 356, 357, 375, 375 fish preservation 376 Jet Rock Member 375, 375 John o'Groats, Caithness 216 - 18section at the site 217 interpretation 218 John o'Groats Fish Bed 216-18 John o'Groats Sandstone Group 170, 214, 216, 218 Johnshaven Formation 148 'Jukes-Brown Bed 7' 461, 462, 471 Junction Bed 356 Jurassic environments 357, 359 fish faunas 359 fossil amphibian sites 544 palaeogeography and stratigraphy 355-7, 358 shallow marine rocks 357 see also Early Jurassic; Late Jurassic or Malm; Mid-Jurassic Jurassic-Cretaceous boundary 401, 409 Kacak event 184 Kallostrakon 90, 91 Katoporodus-Loganellia kummerowi thelodont assemblage 106 Keele Beds, amphibian footprints 545 Keele Group, trace fossils and footprint beds 324 Kellaways Beds 356 **Kellaways Clay 382** Kellaways Sand 382 fauna 382-3 Kelso Lavas 245 Kelso-Birrenswark Lavas see

Ivy Chimney Quarry 98, 105

Birrenswark–Kelso Lavas

Kembeck Formation 245 Kenilworth, Lower Permian amphibian-reptile association 315, 324 Kerrera Island fish beds 61, 62 age of cephalaspids important 62 Kettleness, old alum quarries 380 'Keuper Marls' 344 Kilkenny Bay, Portishead see Portishead Kilmalaug Formation, Marmorerpeton 396 Kilmorack Group 170 Kimmeridge Bay (Gaulter Gap-Broad Bench) 400, 401, 402 - 7interpretation 404-6 comparison with other localities 405 Kimmeridge Clay 356, 359, 400, 401, 402-7 fauna restricted to mudstones/bituminous shale units 403 represents argillaceous sedimentation 404 Kimmeridge Ledges 403 Kimmeridgian 356 see also Upper Kimmeridgian, sensu anglico King's Quay 531-3 section 532 interpretation 533 comparison with other localities 533 bone-bed horizons 531 Kinnesswood Formation 245 Kip Burn Formation 36, 41 Ceratiocaris Beds 46 Kip Carle Sandstone 251 Kirtlington Mammal Bed 390, 391, 396 environmental interpretation 393 fauna 392-3, 394-5, 544 lens 391 zonal placing 393 Kirtlington Old Cement Works Quarry 390-6 amphibian fauna 544, 545-6 composite section 391

interpretation 393-6 biostratigraphy difficult 393 comparison with other localities 395-6 environmental interpretations 393 unique freshwater assemblage 390 Knighton and Old Radnor 66 Knock Farril Conglomerate 170 **Knox Pulpit Formation 245** Knucklas Castle Beds 66, 105 Koalliella 500 Kujdanowiaspis 140 Kujdanowiaspis anglica 141 Kujdanowiaspis willsi 141-2 Kupferschiefer (Germany) 324 fish fauna 323 Kyneton Thorns Quarry 389 Labyrinthodonts 537, 539

division into temnospondyls and anthracosaurs 539 lachi zone 114 Ladinian 329 Lag deposits channel lag, Southerham Grey Pit 472-3 Strahan's Hardground 474-5 Totternhoe Stone 457 phosphate-rich basal lag 454 Laminites Arbuthnott Group 154, 158 calcareous, Weydale Quarry 213-14 carbonate, East Kirkton 547 Holborn Head Quarry 211 limestone Achanarras Limestone 178, 181 lacustrine, Exnaboe 218 Lower Old Red Sandstone 149 Melby, differ from other Orcadian Basin laminites 204 Pennyland 214-15 Spittal Quarry, lacustrine dolomitic 207 Whitehouse Den 164, 165 Lamna 433 Lampreys 3, 14

Lanarkia 37 Lanarkia species, distinguished from Loganellia 52 Lanarkia spinosa 153 Land plants, Ludlow Bone Bed 81 Langport Member 330 Lang's Bed 361, 371 Lasanius 38, 54 Lasanius problematicus, 54, 54 Last House Formation 216 Late Cretaceous (The Chalk) 419, 419, 420, 443-79 Late Devonian British continental faunas 226-7 South Wales and Welsh Borders 225 tetrapods on road to terrestrial adaptation 537 Late Jurassic or Malm 400-15 Late Silurian, biostratigraphy based on fish remains 67 Late Triassic, central and south-west England 339-51 Latherton Subgroup 170, 207 Laurussia see Old Red Sandstone Continent Lawling Creek, Blackwater Estuary see Maylandsea, Essex Leaf Bed 528, 529 Leamington Old Quarry, Mid-Triassic fauna 333 Leanach and Dores Sandstone 170 leathensis zone 114 Leaze Formation 36 Ledbury Beds 91 Ledbury Cutting 86–92 interpretation 91-2 Ledbury Formation 65, 66, 69, 79, 80, 85, 110 fish sites 75 Ledbury Grits 91 Ledbury Group 110 correlated with Ledbury Formation 87-8 section 86-8, 86, 91 Lee Ness Sandstone 420, 425, 426 Lee-on-Solent 522-4 fauna 522-4 interpretation 524

Leedsichthys 383 Legnonotus cothamensis 349 Leintwardine, Ludlovian with slumps and marine erosion 78 Leintwardine Formation 95, 96 Leintwardine Group 66, 80, 102 Lepidotes 383, 404, 412 Lepidotes latissimus 378 Lepidotes macrochireus 383 Lepidotes mantelli 428, 434, 435 Lepidotes notopterus 413 Lepidotes semiserratus 373, 377, 378 Lepidotes tuberculatus 389 Lepidotus minor 411, 413 Lepisosteus 500 Lepospondyls 540 limbs 539 Leptoacanthus semistriatus 387 Leptoacanthus striatus 387 Leptolepis 383, 389, 404, 414 Leptolepis saltviciensis 379 Leptolepis woodwardi 389 Leptostyrax 442, 457, 458 Leptostyrax macrorbiza 438 Lerwick Sandstone Facies 170 Lesmahagow inlier 33, 35, 37, 38 Birk Knowes 40-5 Iamovtius horizon 40, 41, 42, 45, 56 Birkenhead Burn 56-7 **Dippal Burn 50** Dunside, Ceratiocaris Beds 46, 47, 56 Slot Burn 50-6 succession 36 upward decrease in salinity 55 Lessness Abbey Wood Nature Reserve see Abbey Wood Lessness Shell Bed 501, 501-2, 503 Lethen Bar fish site 197 Lethiscus stocki 285, 551 Lewes important in Chalk biostratigraphy 462 lithology and biostratigraphy of Chalk pits near 463

Lewes fish collections 459, 460, 464 Lewes Flints 463 Lewes Marl 463 Lewes Member 443, 463, 473 Lewes Nodular Chalks 463 Lias 344, 355, 359, 360-80 shale groups 357 fish sites 360 marine clay-shale facies 357 shallow-water facies 357 see also Early Lias; Lower Lias: Upper Lias Light Point Hardgrounds 463 Lignite Bed 556 Lilstock Formation 329, 330, 343, 349 Lime Kiln Quarries see Southerham (Lime Kiln Quarries) Limestone Coal Group 267 Limestone and shale, marine, areas of Carboniferous deposition 266 Limnaea Limestone, Colwell **Bay Member 555** Limnaea Limestone, Totland Bay Member 528, 555 Limnaea Marl 529 Lincoln, Kellaways Sand exposure 382 Lincolnshire Limestone 356 Lingula cornea 93 Lingula Member 306 Linstone Chine Member 555 Lissamphibia 538, 540 Lissodus 304, 305, 365, 395, 399, 427 Lissodus breve breve 433 Lissodus breve pustulatum 433 Lissodus leiodus 382, 388 Lissodus minimus 346, 347 type locality Aust Cliff 343 Lissodus pattersoni 398, 399 Lissodus rhizion 428 Lissodus striatum 433 Lissodus wardi 398, 399 Lissodus wirkworthensis 304, 305 Listracanthus 304 Little Cliff Shale 548 Littleham Mudstone Formation 329 Llan-Wen Hill Bed 66, 105

Llandovery 35 fish sites 74 Llandovery/Llangadog 66 Lochkovian 65, 111, 114, 143, 161 Lochkovian-Pragian boundary, within the Senni Beds 144 Logan Formation 36, 41 Logan Water 46 Loganellia avonia 37 Loganellia ludlowensis 82, 83, 83 Loganellia scotica 40, 42, 44-45, 46, 153 correlation 45 Lonchidium 427 Lonchidium breve pustulatum 437 Lonchidium rhizion 424, 427 London Basin 483 cyclic transgressions 485 London Clay Formation 486, 503 pre-London Clay Tertiaries 487 fish sites 487-8 London Clay Formation 484, 485, 485, 486, 487, 503-17 basal beds 490 Basement Bed 503 Herne Bay 492, 494 Division A (A2 and A3), Bognor Regis 505-6 Division B Bognor Regis 505, 506-8 Herne Bay 492, 494 **Division** C Bognor Regis 505 Maylandsea 508-9 **Division** D Burnham-on-Crouch 515-17 Isle of Sheppey 510 divisions A to E 503 fauna and flora 503-4 fish sites 504 Herne Bay 490, 491, 492, 494 Isle of Sheppey 509 London Basin 486, 503 Upnor 498 London Clay Member 508 London Clay sea, transgressive, coarse basal beds 502

London-Ardennes Landmass 386, 404 London-Brabant massif 356-7. 358 Long Mead End Bed 525 Long Quarry Formation 66, 76 Longcarrow Cove Beds 229 Longford Downs Block 266 Lopbiostomus 468 Lorne fish beds age of 62 see also Ardmore-Gallanach Lorne lavas 60 Lovell's Quarry 415 Lower Aldwick Beds 505 Lower Bajocian 382 Lower Barton Beds 525 Lower Blaisdon Beds 96 Lower Bringewood Formation 79 Lower Caithness Flagstone **Group** 170 Lower Cattle Ledge Stone Band 402 Lower Chalk 444, 447, 460, 462, 463 shelly limestone sequences, Totternhoe 456 Lower Clay and Atherfield Bone Bed 431, 433 Lower Coal Measures 267 Lower Cornbrash 356, 391 Lower Cretaceous 419 Lower Cwm Clyd Formation 66 Lower Ditton Group 125 non-marine in Welsh Borders 123 section through cyclothem 126 Lower Dolomites 344 Lower Eday Sandstones 170, 185 Lower Elton Formation 79 Lower Estuarine see Grantham Formation Lower Fish-tooth Bed 505 Lower Fullers Earth 382 Lower Gault 438, 441 Lower Gramscatho 229 Lower Greensand 419, 420, 422, 430, 431, 437, 441 end of deposition in early Albian 421 fish remains 438

Lower Headon Beds 525, 526, 556, 557 see also Totland Bay Member Lower Inferior Oolite 356 Lower Leintwardine Formation 66, 77, 79, 85, 96 Lower Lias 343, 343 Lower Lias clays 356 palaeoenvironment, English Midlands 369 Sidmouth-Lyme Regis 363 Upper Clays 369, 370 Lower Limestone 344 Lower Limestone Group 267 Lower London Tertiaries 490 Lower Lothian Group 280 Lower Magnesian Limestone 315, 319 Lower Oil Shale Group 267, 278, 296 Lower Old Red Sandstone 36. 65 Forfar and Kincardine, key early fish beds 148-9 Midland Valley shale and mudstone formations 149 volcanic units 149 Lower Oxford Clay main vertebrate-bearing localities 383 marine faunas 383 'Lower Pecten Bed' 344, 345 Lower Permiam Yellow Sands 319 see also Yellow (Early Permian) Sands Lower Red Downton Formation/Temeside Shale Formation 112 Lower Roman Camp Formation 66, 76 Lower Stromness Flags 170, 185 Lower Temeside Shale Formation 92 Lower Tunbridge Wells Clay 420 Lower Weald Clay 419, 420 Lower Whitcliffe Formation 79, 85 Ludford Lane and Ludford Corner 78-86

Ludfordian 66, 67, 79, 96 fish sites 75 Ludlovian, fish sites 74-5 Ludlow Anticline 66 Ludlow Bone Bed 78, 79, 102, 103 Ludlow Bone Bed Formation 112 Ludlow Bone Bed Member 65, 66, 67, 78-9, 79 base of 79 interpretation 84 as a marker horizon 84 Ledbury Cutting 88, 91 Thelodus parvidens fish fauna 84 Tite's Point 96 Ludlow railway cutting, faunal assemblages compared with Temeside and Ledbury 91 Ludlow Series 66, 79, 96, 105, 112 division of 66, 67 with intraformational conglomerate 96 stratotype sections for 86 Lulworth Formation 409, 409 Lungfishes 15, 18 Lybster Subgroup 170 Lydney 98-101 Allen's bivalve bed 100, 101 sketch map and section, cliffs and foreshore 99 interpretation 101 Lye Brook beds (LB1; LB2; LB4) 119, 121 Lyme Regis Coast (Pinhay Bay-Charmouth) 360-9 general succession 361 interpretation 365-9 comparison with other localities 368-9 Lynton Beds 110, 229 Maastrichtian 420, 443 Macconochie, A., collections from Glencartholm 287 Macromesodon daviesi 411 Macropoma 454, 459, 479 Macropoma mantelli 454, 468, 470 Macropoma praecursor 454 Main Alum Shales 373, 375

Malcolmson, J. discovery of fish beds at Dipple Burn, Tynet Burn, Lethen Bar and Clune 257 visit to Scaat Craig 256-7 Malling Street Marls 463 Malm see Late Jurassic or Malm Mammal Bed, Durlston 407, 410 Mammal Bed, Lower Headon Beds/Totland Bay Member 525, 528, 529, 530 Man Brook, Trimpley, Přídolí assemblage 74 Manse Burn, Bearsden, fish beds 306 Manse Burn Formation 306 depositional environment 310 Mantell, Gideon, collections from Southerham Chalk pits 460, 462 Mantelliana Band 447 Maple Ledge Shales 402 Maple Ledge Stone Band 402, 403 Maplehurst Wood 429 Marine regressions 111 end Cretaceous 421 mid-Woolwich 500 Palaeogene, correlated with climatic cooling 485 **Turonian** 421 Marine transgressions Aptian 421, 435 Callovian 359 Early Carboniferous 225, 266 Late Devonian-Early Carboniferous 239 Late Permian 315, 317 later Triassic 327-8 main Cretaceous 421 Mid-Cretaceous 419, 442 Palaeogene 484, 487 Rhaetian 355, 357 Marine-estuarine transition, Welsh Borders Late Silurian 84.102 Marker bands/beds/horizons Achanarras horizon 172 Cattle Ledge Stone Band 402, 403 in the Chalk 444

Grey Ledge Stone Band 402, 403 in Lewes chalk pits 463 Ludlow Bone Bed 84 phosphate-rich basal lag, Totternhoe Stone 454 Psammosteus Limestone 101 Scottish Mid-Devonisn fish beds 172 top of Raglan Marl Group as 98, 100 Yellow Ledge Stone Band 402, 403 Marl Slate 315, 317 correlated with Kupferscheifer (Germany) 315 deposition seasonal 317 a shallow-water marine deposit 324 initial deposit of the Zechstein transgression 317 Middridge 318, 319 silty dolomite-shale 315, 317 a stratigraphical marker 324 Marlstone Rock Bed 356 Marly Freshwater Beds 407, 408 Marly Freshwater Member 409 Marmorerpeton freemani 395, 545, 546 Marmorerpeton kermacki 395, 545, 546 Marsh Farm Beds 484 Marsh Farm Formation 484, 520 fauna 522-3 Mass extinctions end Famennian 245 end Masozoic 486 Mass mortality events Achanarras Limestone 180, 184 end Mesozoic 540 Foulden Fish Bed 279 Osborne Beds, by asphyxiation 531, 533 Mastodonsaurus 333, 545 Mastodonsaurus lavisi 334, 338, 545 Matta Taing, Upper Melby Fish Bed 204

Maylandsea, Essex 508-9 maximum marine transgression 508 Meadfoot and Staddon Beds 225, 229 Megalichthys 290, 295 Megascyliorbinus cooperi 516 Meikle Daan Conglomerate 190 Melanecta annaea 309 Melbourn Rock 420, 447, 460, 463 Melby 201-4 Fish Beds 170, 201-4, 205 correlate to Achanarras Horizon 201 Lower Bed 201, 202, 203, 205 stratal settings 202 Upper Bed 203-4 interpretation 204 lacustrine conditions 204 Melby Formation 170, 201, 205 Melgund Formation 161 Mercia Mudstone Group 330, 335, 336, 343 flexing and faulting cause by 343 Mesacanthus 159, 188, 204 Mesacanthus mitchelli 61, 62, 62, 154, 155, 156 Tillywhandland Quarry 158-9, 159 Mesodon daviesi, described 413 Mesolepis 291 Mesolepis tuberculatus 291 Mesopoma 290, 291, 308, 548 Mesopoma carricki 308, 309 Mesopoma crassum 290 Mesopoma politum 290, 291 Mesopoma pulchellum 291 Metaxygnathus 538 Metopacanthus granulatus 365 Mey Beds fauna, Pennyland 215 Mey Subgroup 170, 214 Michel Dean Flint 463 Microbrachius 246 Microbrachius dicki 174, 216, 218 Exnaboe 219, 220, 221 Microchoerus Bed 555, 556

Micron radiatus 411 Mid-Jurassic (or Dogger) 380-400 fish and tetrapod sites 384 major regression 357, 380 palaeogeography 381 Mid-Late Devonian boundary 256 Mid-North Sea High 358 Mid-Triassic central and southern England 333-9 fish and amphibian sites 334 transgressive intertidal facies in 328 Middle Barton Beds 525 Middle Chalk 420, 444, 447, 460, 463 Middle Clay 505 Middle Coal Measures 267 Middle Devonian, Scotland 148 higher strata more fluvial 218 Middle Eday Sandstone 170 Middle Elton Formation 79 Middle Headon Beds 556 Middle Inferior Oolite 356 Middle Limestone Group 267 Middle Oil Shales Group 298 Middle Old Red Sandstone fish zones, rhipidistians in 175 Orcadian Basin 169 range of common fossil fishes cf. E Baltic vertebrate biozones 171 Scotland, stratigraphical sections 170 Middlefield Conglomerate 36, 41.50 Middridge, Co. Durham 315, 318-24 sections at new pit 319 interpretation 324 Midland Shelf, shallow-water marginal-marine conditions 357 Midland Valley Basin 266 Midland Valley inliers 35, 35 Silurian successions 36 upper fishbed thelodonts 52 see also Hagshaw Hills inlier; Lesmahagow inlier

Midland Valley of Scotland 34, 36 calcretes in Upper Old Red Sandstone 243, 245 Carboniferous sedimentation 266, 268 Early Devonian rocks 147-8 tetrapod record 541 Upper Old Red Sandstone successions 243 Migration between parts of the old Euramerican continent 262 of juvenile forms from marine to freshwater 124 Milford Marine Bed/Band 525, 528, 531 microshark fauna 531 Mill Rock 230-2 cleaved granular bands 230 distinctive preservation 230 interpretation 231 intriguing faunal composition 231-2 Millbuie Sandstone Group 170 Miller, Hugh Footprints of the Creator 23 The Old Red Sandstone or New Walks in an Old Field 23, 173 and Scaat Craig teeth 257 see also Hugh Miller collection Millerosteus minor 174, 214, 215-16 further occurrences 215-16 Millstone Grit 266 Millstone Grit Series 267 Milner, A.R., biogeography of Palaeozoic tetrapods 540 Milverton Conglomerate 329 **Mio-Pliocene occurrences** 483-4 Miospore assemblage, Hoel Senni Quarry 143 Mirestone Quarry, Carsegownie 161 Modiolopsis complanata var. trimpeyensis 100 Molasse, post-orogenic, Midland Valley of Scotland 147 4

Mona Complex, southward transport from 234 Monkeys Fold Formation 110 Monkolepis maculatus 51, 52, 55 Monks Water, Hagshaw Hill inlier 47 Monograptus parultimus **Biozone 67** Monograptus uniformis Biozone 67 Monster Bed, Woodeaton Quarry 395 Montrose Museum, collections from Turin Hill 157 Montrose Volcanic Formation 148 Monument Formation 36, 41 Morte Slates 110, 229 Mousa Fish Bed 222 Mouths, Birkenia 53-4 Moycanthus thomasi 304 Moythomasia nitida 269 Muckle Burn see Bog Hole, Muckle Burn Murchison, R.I. and Banniskirk rocks 209 interest in Temeside Bone Bed 92, 93 Lias at Purton Passage 97 and Sedgewick, A., visit to Caithness 209 visited Gamrie 193 Muschelkalk (Germany), correlatives in Lower Mercia Mudstone Group 328 Museums, information lacking for Chalk specimens 447-8 Myliobatis 514 Myliobatis dixoni 507 Myracanthus paradoxus 348 Myriacanthids, Lyme Regis 362, 364-5 Myriacanthus paradoxus 365 Myxinoids 8 Nairn Beds 245, 254 Nairn Sandstones 254, 254, 255 Nairnside and Clava Basal Conglomerate 170 Namurian fossil amphibian sites 542 palaeogeography 265

Nannocardioceras Bed 402 Natural History Museum 23, 24 **Beccles Collection 429** Brickenden collection 260 collections from Scaat Craig 257 collections from Turin Hill 157 fish remains from Barton Cliff 526 Hastings collections 528, 530 invertebrate fauna, Blue Bell Hill Pits 448 Isle of Sheppey fossil collections 510 Late Palaeogene fossil fish collections 518 London Clay fossil fish collections 504 Ludlow Bone Bed specimens 91 Southerham Chalk pits fossil collection 462 Whitby fish 376 Navigation Marls 463 Navigation (Snowdrop) Pit see Southerham (Lime Kiln Quarries) 'Near-tetrapods' 537 Nemacanthus brevis 387 Nemacanthus filifer 348 Nemacanthus monilifer 346, 347. 348 Nematoptychius 283 Nematoptychius greenocki 281, 283 a predator 283 Neocomian 420 Neodiversograptus nilssoni Biozone 66, 67 Neogene 483 North Sea Basin subsidence 386 Neopterygians Jurassic 359 Durlston Bay 410, 413 Triassic Aust Cliff 345-6, 349 main lines of development 331 Permian, Middridge 320-1 Neopterygii 17 Neorbombolepis 452

Neorbombolepis excelsus 451 Neorbombolepis puctatus 452 Neorbombolepis valdensis 429 Neoselachians 17 Cenozoic, Abbey Wood 502 Cretaceous Boxford Chalk Pit 478 in Lewes fauna 465 Southerham Grey Pit 472, 473 Southerham (Lime Kiln Quarries) 475 Jurassic 359, 361, 382, 404 collection bias in Stonesfield Slates 389-90 Lyme Regis 361, 362, 365 Stonesfield 387 Watton Cliff 398, 399 Triassic 332 Aust Cliff 345, 346, 347, 348 Carboniferous, Steeplehouse Quarry 303, 304, 305 Neoteleosts, Burnham 453-4 Neritina Bed 555, 556 New Forge Rough Weir, Ludlow Bone Bed 102 New Pit Beds (Ranscombe Griotte Chalk Member) 474, 475 New Pit Marls 463 Newhaven Member 443 Newsham, Northumberland, Coal Measures, tetrapods 545 Nikolivia milesi 135, 136 Nodular Shale Member 306 Non-marine transgressions 427 Nordybank Formation 110 Norfolk-Lincolnshire marine sequence 419 Norian 329, 330 North America, 19th century fossil fish bonanzas 24 North Atlantic, rifting/widening 484, 485 North Curry Sandstone Member 329 North Devon coast, Devonian 110 North Sea, northern, high sedimentation rate 357 North Sea Basin 483, 484 Neogene subsidence of 386 Northampton Ironstone 356

Northumberland Basin 266 Notidanodon lanceolatus 438 Notidanodon loozi 496 Notidanodon (Notidanus) lanceolatus 442 Notidanodus 495 Notochord acanthodian 282 actinopterygian 268 rhizodont 277 Notorbynchus 443, 473 Notorbynchus aptiensis 442, 444, 473 Notorbynchus serratissimus 516 Nynehead Sandstones 329 Oak Dingle, Tugford 125-8 interpretation 127 Obruchevichthys 538 Obtusum Shale 362 Oday Hill landfill site 400, 405 **Odontaspis** 475 Odontaspis (Synodontaspis) macrota 495 Odontaspis winkleri 516 Oil shales 268 Oil Shales, Midland Valley, conditions of deposition 286 Old Red Sandstone Bristol area, dating 235-6 diachronous facies in Welsh Borders 111 onset of ORS facies in Britain 84 Scotland 3, 23, 33 Welsh Borders 65 see also Lower Old Red Sandstone; Middle Old Red Sandstone; Upper Old **Red Sandstone** Old Red Sandstone Continent 109, 109 Old Towns Quarry 319 Oldhaven Beds 490 Herne Bay 492, 493-4, 494 Upnor 497, 498 basal shell bed 499 fauna 499 Oldhaven and Blackheath Beds 485, 489 Oldhaven Formation 490, 491, 500, 506 Abbey Wood, shell bed 501

Oligocene 484 effects of glaciation 485 **Onchus besomensis** 142 Onchus murchisoni 83-4 **Onchus wheatbillensis** 142 **Onychoselache** 293 Onvchoselache traquairi 284. 285, 293, 310 **Oolitic ironstone 357** Ophiderpeton kirktonense 549, 551, 551 Ophiomorpha 527 Ophiopsis dorsalis 411, 413, 414 Ophiopsis penicillata 414 Orcadian Basin 169 lakes, shallow and productive 172 reconstruction of marginal environments 173 sea-way to South 171 sharp environmental change 184 transgressions by Lake Orcadie 172 Upper Red Sandstone beds 243 Westerdale Quarry fish horizon 178 Orcadie, Lake 172, 243 Orectolobids 365, 399 Orectoloboides 442 Orkney 170, 175 Orkney Islands 170 Cruaday Quarry 185-9 transgression (Lake Orcadie) 172 Ornithocheirus 449 Osborne Beds 484, 485, 486, 518, 556 King's Quay 531-3 fresh- and brackish-water assemblages 533 Osmeroides levis 452, 469 Osmeroides lewesiensis 469 Osteichthyans 303 Cenozoic Bracklesham Bay 520-1 Upnor 500 Cretaceous, Late Blue Bell Hill Pits 448-9, 452-4 Southerham (Machine Bottom Pit) 463-4

Cretaceous, Early (Mid-), East Wear Bay 442 Cretaceous, Early 427 Brook-Atherfield 434-5 Iurassic Durlston Bay 410, 413 Kimmeridge Bay 404 Stonesfield 385-6, 388-9 Whitby 377, 378 Triassic 332 Aust Cliff 345-6, 348-9 Sidmouth 338, 339 Permian, Middridge 319, 320-1 Carboniferous 298 Abden 302 Ardross Castle 299-301 Bearsden 307, 308 Cheese Bay 297 Foulden 274, 275, 276-8 **Glencartholm 288** Wardie 282, 282-4 Anglo-Welsh Basin Late Devonian Afon y Waen 238 Portishead 232, 233, 234 Prescott Corner 236, 237 Scottish Late Devonian 247 Boghole, Muckle Burn 255-6 Hawk's Heugh 251, 252 **Oxendean Burn 249** Scottish Mid-Devonian 173, 174-5, 181, 191, 200, 204, 207, 212 Banniskirk Quarry 210 Cruaday Quarry 188, 189 Den of Findon, Gamrie 195-6 Exnaboe 219 John o'Groats 218 Pennyland 215 Westerdale Quarry 176, 177 - 8Weydale Quarry 214 South-West England Midand Late Devonian, Mill **Rock 230** Osteichthyes 15 Osteolepids 178, 181, 188, 195, 196 Holborn Head Quarry 210, 211, 212-13 Weydale Quarry 213, 214

Osteolepis 198, 215 Osteolepis arenatus 193 'Osteolepis' Bed, Tynet Burn 198 Osteolepis macrolepidotus 175, 188, 189, 196, 213 Osteolepis panderi 214 Holborn Head Quarry 210, 211, 212, 212-13 Osteorachis 383, 404 Osteostracans 13, 38-9, 73 cornuate Scottish Early Devonian 150 - 1Welsh Borders Early Devonian 121, 124 Scottish Early Devonian 149-50, 150-1 Aberlemno Quarry 161 **Tillywhandland Quarry** 158 Wolf's Hole Ouarry 162 Scottish Mid-Devonian 207 Scottish Silurian 36 Ardmore–Gallanach 61–2 Shiel Burn 49 Slot Burn 51-2, 54-5 The Toutties 57 Welsh Borders early Devonian 113, 114-15 Besom Farm Quarry 139, 141 Cwm Mill 129-30 Devil's Hole 120, 123, 125 Oak Dingle, Tugford 125, 127 Wayne Herbert Quarry 133, 135 Welsh Borders Late Silurian 70, 72-3, 101 Bradnor Hill Quarry 105, 106 Downton Castle area 102, 103 - 4Ledbury Cutting 88, 89, 90 Ludlow Bone Bed 81, 84 Temeside, Ludlow 93, 94, 95 Ostracoderms, Slot Burn 51 Ostrea Beds 363 equivalent to Pre-planorbis Beds 361 Otodus obliquus 507

Otoliths 279, 441, 443, 486-7, 501, 522 Otter Sandstone Formation 329. 333. 334 fluvial and aeolian deposits 337 Sidmouth-Budleigh Salterton 334, 335 fine-grained red sandstones 336 sparsely fossiliferous 335 temnospondyls 545 Ousdale Arkose 170 Ovatum Band 375 Overbank deposits 232 Downtonian 123 Oxendean Burn 248-50 measured section 249 fish-bearing beds 248, 249 interpretation 250 depositional environment uncertain 250 Oxford Clay 356, 359, 382 Middle-Upper, fish remains 400 marine vertebrates 383 see also Lower Oxford Clay Oxfordian 356 Oxyagnathus 366 Oxyodon 324 Oyster-Epithyris Marl 391, 392 Pachycormids 383, 452 Kimmeridge Bay 404 Whitby 379 Pachycormus 404 Pachycormus acutirostris 379 Pachycormus curtus 377 Pachycormus latirostris 379 Pachycormus macropterus 379 Pachyrhizodonts 452 Pachyrhizodus 442, 469 Pachyrhizodus basalis 450, 452 Pachyrhizodus dibleyi 450, 452 Pachyrhizodus gardneri 469 Pachyrhizodus megalops 469 Pachyrhizodus salmoneus 438 Pachyrhizodus (Thrissopater) salmoneus 442 Pachythrissops 405 Pachythrissops laevis 412, 414 **Durlston Bay 406**

Pachythrissops vectensis 429. 433, 435, 436, 437 Paddy's Point 510 Paedomorphosis 290 Pagham Rock 505 Palaeobates (Acrodus) keuperinus 333-4 Palaeocarcharias 399 Palaeocene 484 Palaeocene-Eocene boundary 487 Palaeoclimate, of Bognor fish assemblages 507 Palaeoecology 19-20 Palaeogaleus vincenti 495, 496 Palaeogene Atlantic Ocean connection to North Sea Basin 485 Bouldnor Formation fauna mainly freshwater forms 486 climatic cooling 485 marine transgression 484 sedimentation during 485-6 Palaeoniscids 268-9 Foulden 274, 278 Middridge 320 a paraphyletic form 269 Palaeoniscus 320 Palaeontological conservation 24-5 Palaeoslope, Triassic, south to north 328 Palaeospinax 348,382 Palaeospinax egertoni 387 Palaeospinax rhaeticus 347 Palaeospondylus gunni 181, 183 at Achanarras 174 Palaeozoic, early, arrangement of continents and oceans 33 Paleoniscus freislebeni 320, 320 Panderichthys 539 Pangaea fragmentation of 355 possible effects of 317 Papa Stour 204-5 interpretation 205 rocks mainly igneous 205 sedimentary beds 205 equivalent to Achanarras Horizon 205 unusual site 204

Paramesolepis 291 Paranomotodon 442, 457 Paranomotodon angustidens 449.476 Paranomotodon (Oxyrbina) angustidens 475 Paraorthacodus 437, 458, 459 Pararbincodon 437 Pararbincodon crochardi 478 Paratriakis 478 Parexus recurvus 156 Parisholm Conglomerate 36, 48 Passage Beds 87, 170 Passage Formation 36, 41 Passage Group 267 Patrick Burn Formation 36, 41, 45 Jamoytius horizon 42 Pattenaspis artesensis 140 Peak Shales 356 Peamarsh 429 Pease Bay Beds 250 fish, Famennian age 252 Pecten Bed 371 Pecten (Chamlys) fissicosta 456 Pedocal development 245 Pedocals 250 Pegwell Bay 488-90, 496 Pegwell Marl Member 496 Pegwell Marls 489 Penarth Group 330, 340, 343, 343, 344, 356, 363 Rhaetic Bone Bed 339 Pendleian 306 Pennine Landmass 381 Pennine-Welsh Landmass 381, 386 Pennyland 214-16 Pentire Pillow Lavas 229 Pentire Slates 229 Pentlandia macroptera 218 Percostma angustum 514 Permian amphibian faunas and sites 315, 324 environments 317 fish faunas 317-18 palaeogeography and stratigraphy 315-17 Perna Beds Member 431, 433 Petalodonts, Janassa 321 Peterborough 382

Petrockstow 483 Oligocene deposits 485 Petrodus patelliformis 303, 303-4 Phacodus bennetti 465 Phacodus punctatus 465 Phanerosteon, loss of body scales 290 Phanerosteon mirabile 277, 278 Phanerosteon ovensi 278 Pheobodonts 304 Phialaspis pococki 60 see also Cyathaspis campbelli Phlebolepis 38 Pholadomava Bed 505 Pholidophoridae 422 Pholidophorids, Kimmeridge Bay 404-5 Pholidophorus 349, 367, 388, 389, 404 pectinate- and smoothscaled forms, Jurassic 414 Pholidophorus germanicus 379 Pholidophorus granulatus 414 Pholidophorus bigginsi 349 Pholidophorus ornatus 414 Phyllolepis 246 Phyllolepis concentrica 254 Physogaleus secundus 511 Pickwell Down Sandstone 110, 225, 229 deposition 231 possibily Famennian age 231 Pikaia 8 Pilton Beds 110, 229 Pilton Formation, lenticular bone beds 239 'Pine Raft' Bed 434 Pineal plate, Birkenia 53 Pishlinn Burn 194 Pitch Coppice 67 Pittendriech Limestone 148 Pituriaspids 13 Placodermi 14-15 Placoderms 36, 61, 62, 113 decline in the Eifelian 245 Anglo-Welsh Basin Late Devonian Afon y Waen 238 Portishead 232, 233, 234 Prescott Corner 236-7

Scottish Late Devonian 247 Boghole, Muckle Burn 253, 254, 255 Hawk's Heugh 250-2 Oxendean Burn 249-50 Scaat Craig 258, 259-60 Scottish Mid-Devonian 174, 181, 188, 200, 203, 204, 205, 206-7 Banniskirk Quarry 210 Black Park, Edderton 191, 191, 192 Den of Findon, Gamrie 195, 195 Holborn Head Quarry 212 John o'Groats 216, 218 Pennyland 214, 215-16 Spittal Quarry 207, 208, 208 Sumburgh Head 221 The Cletts, Exnaboe 219, 220, 221 Wevdale Quarry 214 South-West England Midand Late Devonian, Mill **Rock 230** Plagiolophus cartailhaci 527 Planorbis Beds 343 Plant remains Hoel Senni Quarry 143 Whitehouse Den 165 Zosterophyllum Zone, Aberlemno Quarry 161 Plateau Beds 110, 238 Platey Shale Member 306 Platyschisma belicites 81, 102 Platyschisma belicites Formation 65, 105 Platyschisma Shale Member 65, 79, 81, 84 Platysiagum 366 Platysomids Glencartholm 288, 291 Middridge 320 Wardie 284 Platysomus 268, 291, 292, 320 Platysomus superbus 291, 292 Platyxystrodus 295 Plectrodus, possibly two species at Temeside 94 Plectrodus mirabilis 82, 83, 94 Plectrodus pleiopristis 83 Pleistocene, cooling and warming episodes 486

Plenus Marls 420, 447, 460, 461, 463 Plenus Marls Formation 443 Plethodonts 453, 469 Plethodus 453, 469 Plethodus expansus 469 Plethodus pentagon 469 Pleuropholis 414 Plewlands Sandstone 36, 41 Plicatolamna 433, 437 Plicatolamna crassidens 465, 476 Plicatolamna (Oxyrbina) crassidens 475 Plicatolamna sulcata 465 Pliensbachian 356, 369 Plourdosteus 247, 255 Pobie Skeo, Upper Melby Fish Bed 203-4 pococki zone 114 Point-bar conglomerates 111, 117 Point-bar gravels 100, 101 Polyacrodus 399, 433 Polyacrodus cloacinus 346, 347 Polyacrodus illingworthi 464 Polymixiids 453-4 Polyplocodus 247 Polyplocodus leptognathus 255 Polzeath Slates 229 Pomatoschistus cf. bleicheri 532 Poole Formation 484 Poraspis 121 evolutionary changes 138 Poraspis sericea 135, 136 Port Royal 334 Portishead 232-6 interpretation 234-6 predatory fish fauna 234-5 sketch map and section 231 Portishead Beds 110 lenticular pebbly beds 232 Portland Beds 356, 401, 420 Portland Group 359 Portland Harbour 405 Portland, Isle of 415 Portland and Purbeck beds 355, 357 Portland Stone 407

Portlandian 356, 420 preferred to Tithonian 400-1 Portlandian-Berriasian boundary 401, 409 Porton Railway Cutting 479 Portsdown Member 443 Posidonia Member 306 Posidonienschiefer 380 Postcleithrum, lacking in Watsonichthys 301 Pragian 65, 114, 143, 228 Pre-London Clay Tertiaries, London Basin 487-503 fish sites 487-8 Pre-planorbis Beds 343 Prearcturus gigas 133 Prescott Corner 236-8 description 236-7 Farlovian fish assemblage, localized 237-8 interpretation 237 Priabonian 528, 554 Přídolí palaeogeography of southern Britain 68 see also Downtonian; Upper Přídolí Přídolí (Downtonian) Series 65 Přídolí Series 66, 66, 67, 79, 95, 105 Přídolí-Lochkovian boundary 124 Přídolían faunas, appear impoverished 70 Priesthill Group 36, 45 Primrose Hill Quarry, Rhinopteraspis dunensis 143-4 Pristacanthus securis 387 Procinates biserialis 389 Procinates radiatus, described 413 Promegalops signeuxae 513 Protaspis (Europrotaspis) crenulata 140 Protelops anglicus 469 Prothyestids, phylogenetic series of 88 Protodus scoticus 154 Protoeurynotus 291 Protoeurynotus traquairi 291 Protogyrinus 544

Protopteraspids 114 Protopteraspis gosseleti, Devil's Hole 121, 123, 124, 125 Protopteraspis leathensis 100 protopteraspis Zone 67 Protosphyraena 438, 439, 442, 452, 465 Protosphyraena ferox 452 Protosphyraena minor 452 Protospinax 398, 399 Protosqualus 442, 457, 458, 473. 475 teeth of 457 Psammolepis 258 Psammosteus 247-8 Psammosteus cf. falcatus 259, 260 Psammosteus Limestone 67, 69 Devil's Hole 119 a marker horizon 101 signalling aridity 69, 124 Psammosteus Limestone escarpment 119 Psammosteus Limestone Member 112 Psammosteus taylori 255 Pseudodalatias barnstonensis 348.349 Pseudosauripterus 237 Pseudosauripterus anglicus 237 Pteraspids 100 Bedruthan Steps 228 Besom Farm Quarry 139, 140 Cornwall 228 evolution of 114 first appearance 113 rare in Scotland 163 distribution in Welsh Borders 116 swimming method 137-8 Wayne Herbert Quarry 134 Pteraspis 114, 116 unusual in Scotland 164 Pteraspis cornubica 228 Pteraspis jackana 133, 134, 135 Pteraspis ludensis see Archaegonaspis ludensis Pteraspis mitchelli 163, 164

Pteraspis rostrata 133-4, 134-5 Ireland, Fintona Beds 163 Pteraspis rostrata var. toombsi 133, 134, 137 Pteraspis rostrata var. trimplevensis 125, 127, 127 Pteraspis rostrata var. waynensis 133 Pteraspis waynensis 134 Pterichtbyodes 198, 246 Pterichtbyodes milleri 174, 181, 182-3, 192, 195, 203, 204 as an index fossil 201 Pteroscillium 442 Ptomacanthus anglicus 136-7, 137 Ptychodonts 427, 435, 457 Ptychodus 422, 449, 464, 475 Ptychodus decurrens 449, 476 Ptycholepis 377, 379 Ptycholepis bollensis 379 Ptyctodonts 191, 192 body armour 193 Pullastra beds 345 Purbeck Beds 356, 409, 419, 420 base of Cretaceous within 419 marine incursions 359 Purbeck 'Building Stones' 406 **Purbeck Limestone Formation** 401 Purbeck Limestone Group pholidophorids of 414 spans Jurassic-Cretaceous boundary 409 stratigraphical section 408 stratal units 409 type locality Durlston Bay 406 Purple and Green Slates of Watergate Bay 110, 228 Purton Passage, exposures now buried 97 Pycnodonts 413 Kirtlington 394 Southerham (Machine Bottom Pit) 465 Stonesfield, taxonomy 388-9 Pycnodus latirostris 389 Pycnodus parvus 389

Pygopterus 323, 324 Pyritous Shales 356

Quarrington Quarry 324 Quarry Arenite 48 Quartz Conglomerate Group 110

Rackwell Wood, Crowhurst 429 Radioactivity, in Caithness fossil fish 216 Raglan Marl Formation 98 Raglan Marl Group 66, 76, 98, 110 Lydney 98, 99, 100 top of as marker horizon 98, 100 Raglan Marl Group-St Maughans Group boundary, pedogenic carbonates at 98 Raisby Formation 315, 317 Ramna Geo 186 Ranscombe (Griotte Chalk) Member 443, 460, 463, 473 Reading Beds 485, 496 Reading Bottom Bed 483 Reading facies 483 **Reading Formation 517 Reading and Woolwich** Formation see Woolwich and **Reading Formation Reculver Point 490** Reculver Silts Member 489, 492-3, 496 Recurvacanthus uniserialis 365 Red Bay Group 138 Red Chalk see Hunstanton Formation Red Crag, invertebrate fossils 486 Red Downton Formation 65, 105 Red Downton Group 66 Red Marls 110 Red Rag 410 Red Sandstone Marine Band 59 Red-bed sedimentation, Triassic 327 **Red-beds** Elgin, vertebrates in 315 Midland Valley of Scotland 147

Redend Sandstone 484 Redhall Quarry, Fochabers 260 Ree Burn Formation 36, 48 Remigolepis 246, 247 Hawk's Heugh 250-2 pectoral assemblage 251, 252 Reptile remains 333 Rhaetic bone bed 346 Southerham (Machine Bottom Pit) 470 Reptiles 548, 551-2, 553 Rhabdoderma 270, 297, 300, 301 Rhabdoderma ? abdenense 302 Rhabdoderma ? davisi see Diplocercides davisi Rhabdoderma ardrossense 299-300 'Rhadinacanthus' Diplacanthus longispinus 187 Rhadinichthys 290 Rhadinichthys brevis 284 Rhadinichthys canobensis 289, 290 Rhadinichthys carinatus 284, 300 Rhadinichthys ferrox 281, 284 Rhadinichthys formosus 296, 297 Rhadinichthys fusiformis 289, 290 Rhadinichthys macconochii 290 Rhadinichthys tuberculatus 290 Rhadiniscus 300 Rhadiniscus wrighti 300, 300 Rhaetian 329, 330, 340, 356 Rhaetic Bone Bed 339 Aust Cliff 342-50 conglomeratic component 345 deposited under marine coastal conditions 346 occurs as grit or intraformational conglomerate 344-5 origins 345 some post-mortem transport 345

Rhamphodopsis 179, 184, 190 Rhamphodopsis Bed 190, 191-2 Rhamphodopsis threiplandi 191-2 Rhamphodopsis trispinatus 200 Rhinobatos described 478-9 Rhinocephalus planiceps 508, 514 Rhinopteraspis 132 Rhinopteraspis crouchi 140 Cwm Mill 128, 129, 131, 132 Rhinopteraspis crouchi Zone 113, 133 Rhipidistians, Sottish Mid-Devonian 175 Rhizodont tooth 230 Rhizodonts 260 Carboniferous 270, 275 Foulden 276-8, 279-80 Wardie 282 Rhizodus 296 Rhizodus hibberti 282 Rhynchosaurus 334 Rhythmic sedimentation 172 above Achanarras fish bed 178 - 9in the Jurassic 357 **Richards Castle 79** RIGS scheme, and site conservation 4 Rimasventeraspis angusta 60 **Ringstead Bay 400** Robbery Head Subgroup 170, 178 Roddam Dean 245 Rodent Bed 528, 529 Rolled-Bone Bed 528, 529, 530 Rope Head Lake 403 Rosebrae Beds 170, 245, 254, 254, 260 Roseland Volcanics 229 **Rotliegendes 315** desert basin flooded by Zechstein Sea 317 Rousay Flags 170, 185 Rova Head Facies 170 Conglomerate and Brindister Flagstone Facies 170 Rushall Beds 110 Ruthery Head Breccia 36 Rye 429

Sabrinacanthus 100 type locality 98 Sabrinacanthus arcuatus 100, 101 Saetograptus leintwardinensis Biozone 66, 67 St Audrie's Shale 329 St George's Land 265, 266 St Leonards 429 St Maughan's Group 66, 67, 76, 98, 99, 110 Salamanders 394, 395 Salamondra sansaniensis 531, 557 Saltwick 380 Sand sheet, transgressive 494 Sandgate Beds 441 Sandness Formation 170 Sandsfoot Formation 405 Sandsting Plutonic Complex 170 Sandstone Member 65, 79, 80, 81 Sandwick Beds 174 Sandwick Fish Bed 170, 175, 185 Cruaday Quarry 186-9 correlation with Achanarras Fish Bed 184, 188 division of 186 Santonian 420, 443, 477 Sarclet Group 170, 171 Sarclet Mudstone Formation 170 Sarclet Sandstone Formation 170 Sarcopterygians 174-5, 230, 234 Carboniferous East Kirkton 547, 548, 553 Foulden 274, 276, 276 radiation during 269-70 Sarcopterygii 15 Sardinoides illustrans 451, 453 Sargodon tomicus 349 'Saurian Shales', equals Lang's Bed 362 Sauripterus anglicus 237 Saurorbynchus (Belonorbynchus) brevirostris 366

Saurostomus esocinus 379 Sawdde Sandstone Formation 76 Scaat Craig 256-62 fragmentary nature of fossils 257, 258 interpretation 260, 262 Baltic correlation 260 character of sandstones 260 fluvial sediments 262 tetrapod-like remains 246, 540 unique fauna 256 Scaat Craig Beds 170, 245, 254, 254, 260 Scalby Formation 356 Scallop Beds 407, 408 Scallop Member 409 Scapanorbynchus 433, 437 Scapanorbynchus raphiodon 438, 449, 465 Scapanorbynchus subulatus 438, 439, 449, 457, 465 Scarborough Formation 356 Sciaenurus bowerbanki 514 scitulus Zone, Kimmeridge Bay 402 Sclerodontids 103-4 Sclerodus 83, 84, 101 Sclerodus pustuliferus 84, 102 discussed 103-4 Sclerorhynchoids 479 Scolenaspidians 151 Scolenaspis 121, 123 Scotland Old Red Sandstone 3, 33 fossil fishes interesting to academics and amateurs 23 Late Devonian cosmopolitan fish faunas 248. 262 environments 245 fish faunas 245-8 fish sites 248 palaeogepgraphy and stratigraphy 243-5 Mid-Devonian environments 172 fish faunas 172-5 fish sites 175 palaeogeography and stratigraphy 169-72

Early Devonian environments 149 fish faunas 149-56 palaeogeography and stratigraphy 147-9 Silurian environments 35 fish faunas 35-9 palaeogeography and stratigraphy 33-4 vertebrate sites distinct from the Anglo-Welsh area 40 Scottish Borders (Cheviot) Basin 243 Scottish Landmass 381 Scremerston Coal Group 267 Scyliorbinus 442, 457-9, 475, 478 Scyliorbinus antiquus 449, 450, 459 Scyliorbinus biauriculatus 496 Scyliorbinus dubius 459 Scyliorbinus gilberti 496 Scythian 329 Sea level fluctuations 265 lowering of, late Lochkovian to Pragian times 144 Seaford Member 443, 463, 473 Seagrove Bay Member 518 Securiaspis caledonica 162, 163 Securiaspis waterstoni 162, 163 Sedgwick Museum Isle of Sheppey fossil collections 510 Southerham Chalk pits fossil collection 462 Sedimentary cycles, Zechstein 315 Segholm/Seggieholm see Slot Burn Selma Cottage Cliff 61 Selsey Formation 520 Selsey Sand 484 Selsy Division 522 Semionotids 383 Blockley 373 **Durlston Bay 413** Lyme Regis, conservative jaw structure 366 Rhaetic Bone Bed 345, 349

Senni Beds 110 Lochkovian-Pragian boundary within 144 vertebrates rare in 142 Senonian 420 Septarian bands, London Clay 505, 506 Seven Sisters Flint Band 463 Severn, River 98 Devonian east of 110 Severnichthyes 345 Severnichthyes acuminatus 347, 348-9, 349 type locality Aust Cliff 343 Sexual dimorphism chondrichthyan 295 Rhamphodopsis 192-3 Shales with Beef beds 356, 361-2, 363 Sharks 8 anacanthous 286 **Kimmeridge Clay 404** marine, Glencartholme 288, 292-5, 308 non-marine, Bearsden 307, 308, 310, 311, 312 Wardie 280 see also neoselachians; xenacanths Sharp's Hill Formation 386, 387 Shelf areas, Jurassic Sea 357, 358 Shepherds Chine Member 430, 431 Sheppey, Isle of 509-15, 509 interpretation 512, 514 comparison with other localities 515 Sherwood Sandstone Group 328, 330 Sherwood Sandstone Group-Mercia Mudstone Group boundary, diachronous 328 Shetland, south-east, geology of 219 Shiel Burn 47-50 fish bed 55 Shielia taiti described 52 Ship Ledge Sandstone 430, 431 Shipton Member 393 Shipton-on-Cherwell quarry, fimbriatus-waltoni Beds 395

Shoreham Marls 463 Shoulder girdles climatiid 94-5 Sabrinacanthus, pinnal region 101 Shrimp Bed Cheese Bay 296, 297 **Glencartholm 287** Granton 297 Shrimp Member 306 Sidmouth 334-9 amphibian fauna 543-4 interpretation 338-9 Silesian fossil amphibian sites 542-3 major regression 266 palaeogeography of British Isles 266 Siliceous Shales 356 Siltstone, pyritiferous 55 Silurian agnathans diversified and well distributed 10 international standard for dating of 67 microvertebrate zonation, largely based on thelodonts 37 outcrops in Britain 33 see also Late Silurian Silurian-Devonian boundary base of Turinia pagei assemblage 153 upper part of Downton Group 111 Silvanerpeton miripedes, described 551, 552 Sinemurian 356 Skull, Millerosteus minor 215 Slates of Newquay and Mawgan Porth 110 Slates of Porth Cothan 110, 228 Slickstones (Cromhall) Quarry 350 Slot Burn 47, 50-6 fossil preservation 51 interpretation 55-6 Slot Burn fish beds 41, 51, 55, 56 Slot Burn Formation 36, 41, 51 Slump structures 45 Smallmouth Sands Harbour 400, 405

Smith Woodward, A., 23-4 Smithy Burn Siltstone/Formation 36, 48 Smokejacks Pit, Ockley 437 Soft Cockle Beds 407 Soft Cockle Member 409 Solenodus 295 Solent Group 518 Somerset Halite Formation 329 South Downs, Chalk fish collections from 444 South Ferriby, Black Band 444 South Ferriby Brickpit 443 South Wales, central, Devonian 110 South-east Shetland Devonian Basin 218 South-West England Mid- and Late Devonian outcrops 227 vertebrate-bearing cave deposits and fissure-fillings 330, 339, 340 Southerham 442 Southerham Grey Pit 471-3 channel structure with infill 471-2 interpretation 472-3 log of Chalk section 461 Southerham (Lime Kiln Quarries) 473-6 interpretation 475-6 comparison with other localities 476 Southerham (Machine Bottom Pit) 449, 453, 459-71 confusion over name 460 interpretation 464-71 locality for 19th century Chalk fish collections 459 log of Chalk section 461 Southerham Marls 463 Southerham Works Quarry see Southerham (Lime Kiln **Ouarries**) Southern England, Bathonian rocks 357 Southern Uplands, in Llandovery and Wenlock times 33 Southern Uplands Block 265, 266 Southern Uplands Fault 35 Sparnacian 483

Spathicephalus 544 Spathobatis 399 Speeton Bay 'primus' event marl 444 **Reighton Gap and Speeton** Beck, Kimmeridge Clay 437 Speeton Clay 356, 437 Speeton Clay Formation 437 Speeton Cliffs 438 Sphaerodus neocomiensis 438 Sphenacanthus 292, 293 Sphenacanthus costellatus 293 Sphenacanthus serrulatus 284, 293 Sphenodus 382 Sphenonchus 433 Sphenopteris 555 Sphyraenodus 522 Spilsby Sandstone 356 Spittal Beds 170, 207 Spittal Quarry 173, 207-9 fish bed, quarry base may be Achanarras Horizon equivalent 208-9 fishes younger than Achanarras 207 interpretation 208-9 Sprotborough Member 317 Squalicorax 442, 478 Squalicorax (C.) kaupi 465 Squalicorax falcatus 449, 457, 465, 475 Squalicorax pristodontus 438 Squaloraja polyspondyla 365 Squaloraja tenuispina 365 Squalus 442 Squalus minor 495 Squatina 433, 438, 442, 444, 478 described 457 Squatina prima 502, 511, 514, 517 Squatirbina 443, 458, 459 Staddon Grit 110 possibly Emsian 228 Staithes Formation 356 Starfish Bed, Bognor Regis 505, 506 Starfish Beds, Church Hill Quarry 77-8 Steeplehouse Quarry 303-6, 305 interpretation 306

Stegotrachelus finlayi 218, 219, 220 Stem tetrapods and amphibia in the British record 540-6 classification and evolution 538-40 Steno, Nicolaus 23 Stenotosaurus (Cyclotosaurus) leptognathus 545 Stensiöpelta 127 Stethacanthus 306, 308, 310, 311, 312 brush organ/spine 308, 310 interpretation 310-11 Sticklepath-Lustleigh fault zone 485 Stone Hole Quarry, Stone 429 Stonehaven Silurian succession 36 strata correlate with Downton Group of Welsh Borders 35 Stonehaven Group 34, 57, 149 Stonesfield 396 Stonesfield 384-90 stratigraphical section 384-5 interpretation 386-90 mines and workings in the Stonesfield Slate 383 Stonesfield Slate(s) 359, 383, 384-90 dating and problematic stratigraphical position 387 fauna 385 sedimentary structures in 386 tilestone facies 385 Stourmouth Clays 489 Strahan's Hardground 473, 474-5 Strath Rory Group 170, 190 Strathlethan Formation 148 Strathmore Group 148, 149 Strathmore Syncline, later variation in Lower Devonian strata 148 Strathpeffer Group 170 Stratigraphy, procedures in 21 Street 368 Strepheoschema fouldenensis 277, 278 Strepsodus aulaconamensis 275, 277

Striatulus Shales 356 'Stromatolite communities' 297 Stromness Flagstones 186 Strophodus lingualis 387 Strophodus magnus 387 Strophodus tenuis 387 Struie Group 170 Styracopterus 290, 291 Styracopterus fulcratus 278, 291 Subrostral surface, Althaspis leachi 141 Subsidence extensional. late Permian-early Triassic 328 late Lower Lias 372-3 Sudmoor Point Sandstone 430, 433 Suffolk Pebble Bed, Ferry Cliff 500 Sumburgh Head 221-2 Sunnydown Farm, Langton Matravers 414, 415 amphibian fauna 544 Suttle's Quarry 415 Swalecliff, Kent 508 Swanscombe Member 497 Swanscombe quarries 496 Swindon Brick and Tile Pits 400 Swindon Brick and Tile Works 407 Syllaemus anglicus 439 symondsi zone 114 Synechodus 365, 372, 433, 478 Early (Mid-) Cretaceous 437, 439, 442 Totternhoe 458, 459 Synechodus dubrisiensis 449, 459 Synechodus enniskillenii 374 Synechodus eocaenus 496 Synechodus nitidus 459 Synechodus occultidens 374 Synechodus rhaeticus, fin spines of 348 Synodontaspis 290, 502 Synodontaspis (Carcharias) striatula 290, 459 Synodontaspis striatus 495, 496 Synodontaspis teretidens 495, 496, 502

Taphonomy 19 Tarassius 268, 292 Tarassius problematicus 292, 292 Tarlton Clay Pit, Forest Marble 395 Tarras Water Foot see Glencartholm Tarrywarrant Quarry see Boghole, Muckle Burn **Taynton Limestone Formation** 384-5, 386 Tea Green Marls see Blue Anchor Formation Tealliocaris 296 Teeth Acrodus 368, 388 bradydont 271 Carcharopsis 304 Conchodus ostreiformis 260 Coolevella 304 crocodilian 433 cuspidate 346 Cycloptychius 290 Elonichthys 283 Gonatodus puctatus 283 Hemiscyllium 475 heterodont 365, 399, 452 hybodont 387-8 Hybodus 387 and jaws, amioid, **Kirtlington 394** labyrinthodont 537 lamnid 465 Leptostyrax 457 Lissodus 304, 305 Mesopoma 290 multicusped (cladodont) 271 neoselachian 394 Palaeocarcharias 399 Protosqualus 457 Pseudodalatias barnstonensis 348 ptvchodont 435 Rhadinichthys 290 rhizodont 276, 279 sarcopterygian 269 Scaat Craig 256, 257 scyliorhinid 399 shark mid-Jurassic 382 **Thanet Sands 488** Wealden 433

Teichichnus 456 Teleosts 10, 18-19, 364, 368 Cenozoic Bognor Regis 506-7, 508 Elmore Member 527 numbers and types 486 Isle of Sheppey 512 Palaeogene 485-6 Cretaceous, evolution of 422 Cretaceous, Late Blue Bell Hill Pits 448-9, 452-4 Southerham (Machine Bottom Pit) 464, 466-8, 468-9 Cretaceous, Early (Mid-), East Wear Bay 442 Cretaceous, Early, Brook-Atherfield 435 Iurassic Durlston Bay 410, 414 Kimmeridge Bay 404-5 Whitby 378, 379 Triassic 331 Aust Cliff 349 Telham Bone Bed 429 Temeside Beds 86, 87 Temeside Bone Bed 91, 92, 93 Temeside (Eurypterid) Shales 102 Temeside Formation 110 Temeside Group 102 fish beds 91 Temeside, Ludlow 92-5 stratigraphical section 93 interpretation 95 Temeside Shale Member 65 Temeside Shales Formation 66, 79, 80, 85, 92, 102, 103 Temnospondyls 539-40 Carboniferous 548-9, 549, 550, 553 Triassic 333, 338-9, 349 Terranes, Silurian, Scotland 33 Tertiary sediments, southern England 485-6 Tesseraspis tesselata 69, 72, 100, 121, 124 Tetragonolepis discus 380 Tetrapods 245-6, 250, 324 advent of 262 earliest 8, 26, 260 evidence for 15-16 descendants 537

Cenozoic Barton Cliff 526 Hordle Cliff 530-1 Iurassic Kirtlington 393, 394-5 Kirtlington Mammal Bed 393 Palaeozoic biogeography of reviewed by A.R. Milner 540 Triassic 333 Sidmouth 334, 337-8, 338, 338-9 Carboniferous 537-8 East Kirkton 547-8, 548-51 Devonian evolution during 537 Elginerpeton pancheni 260, 261 tetrapod-like bones, Scaat Craig 257 see also stem tetrapods and amphibia Thalassinoides burrows 456 Thames Group 487, 490 Thanet Beds 483, 485 Thanet Formation 484, 486, 487, 491, 509 Herne Bay 494 Pegwell Bay 488–90 Reculver Silts Member 492-3 fauna 493 onset of Palaeocene transgression 488 Thanetian 483 Thelodonts 8, 10, 13, 40, 67 articulated 44, 135 in the Jamoytius horizon 42, 47 in biostratigraphy 115 Canadian, anatomy 37 provinces, Britain 36 Silurian and Devonian of Western Europe 38 Scottish Early Devonian 150, 151 - 4Scottish Silurian 35, 36-7 Ardmore-Gallanach 61 Birk Knowes 42, 44-5 Dippal Burn 50 Dunside 46, 47 Shiel Burn 49 Slot Burn 51, 52, 52

Silurian, Late 69 Upper Silurian-Lower Devonian ORS, Anglo-Welsh Basin 114, 115 Welsh Borders early Devonian 113, 120, 123, 139 Cwm Mill 129, 132 Wayne Herbert Quarry 133, 135 69g 69 Welsh Borders Late Silurian 70, 71-2, 77 biostratigraphical potential 84 Bradnor Hill Quarry 105, 106 Downton Castle area 102 Ludlow Bone Bed 81, 82-3 Lydney 101 Tite's Point 95, 97 Thelodus 61 Thelodus bicostatus 83, 83 Thelodus pagei 153 Thelodus parvidens 82-3, 82, 83 Thelodus parvidens assemblage/fauna 88, 95, 97 Thelodus pugniformis 83, 83 Thelodus scoticus 44-5, 46 Thelodus trilobatus 83, 83 Thickley Quarry 319 Thin Shell Bed, reptiles 530 Thornbury Beds 66, 96, 96 bone bed at base of 97-8 Thornbury Sandstone, sandstone channels cutting into Whitcliffe Formation 96-7 Thrinacodus ferox 304 Thrissopater 469 Thrissopater megalops 466 Thrissops 403, 405 Thrissops curtus 414 Thrissops molossus 414 Durlston Bay 406 Thursius 176, 177, 214, 215 Thursius macrolepidotus 177, 178 Thursius moy-thomasi 178 Thurso Flagstone Group 213 Tigh (Teigh) Farm 429 Tilestones, Stonesfield 385, 387 **Tilestones Formation 65**

Tillywhandland fish bed, basal Lochkovian 157 Tillywhandland Quarry 156-60 section 158 interpretation 159 Tin Mill Race, bone beds 103 'Tin Mill Shales' 103 Tintern Sandstone 110 Tite's Point (Purton Passage) 95-8 Toarcian 356 Tomognathus mordax 452, 465, 466 Toombsaspis 60 Tooth plates bradydont 301 Chondrenchelys problematica 294-5 Ceratodus latissimus 346 chimaeroid 490 ctenodontids and uronemids 270 Dipterus 175 psammodont and cochliodont 346 Top Ashdown Pebble Bed 425, 426 Top Cliff End Pebble Bed 426 **Top Hosie Marine Band 306** Tortworth inlier 37 Tortworth-Tites Point 66 Totland Bay Member 518, 528, 555, 556 Totternhoe (Chalk Quarry) 454-9 interpretation 457-9 comparison with other localities 459 Totternhoe Stone 454, 455-6 gritty texture 456 lag deposit 457 phosphate-rich basal lag 454 reworked and winnowed deposit 456 stratigraphical log 455 Tournaisian 235 late, palaeogeography 265 Tournaisian Gap 537, 539, 541 The Toutties 57-60 stratigraphical log, uppermost Downtonian 59 interpretation 60 only Scottish Silurian heterostracan 39

Townsend Tuff Bed 67, 111 Trace fossils 159, 165, 456, 527 Trachithvoids 453 Trackways 26, 165 Traill, Prof. T.S., and Cruaday 185 Traquair, R.H. 23 description of Lesmahagow vertebrate fauna 46-7 problems in reporting Birkenia 53 Traquairaspids 60 Traquairaspis 60, 100 Traquairaspis campbelli 39, 60 Traquairaspis (Philiaspis) symondsi 69, 121, 122 Traquairaspis pococki 71, 72 Traquairaspis symondsi 100, 124 Traquairosteus pustulatus, assigned to Psammosteus 259 Tremataspids, non-cornuate 39 Tremuda Bay Volcanic Formation 148 Tresglen Formation 66, 76 Trevose Grits, Givetian invertebrates 65, 228 Trevose Slates 229 Trewin, N.H., and the Achanarras fish bed 179 Triadobatrachus 546 Triakis wardi 516 Triassic 328, 330 amphibians in the Midlands and SW England 543, 545 appearance of modern Amphibia 540 fish and amphibian faunas 331-3 palaeogeography and stratigraphy 327-8, 329 facies variation and diachronism 328 lithostratigraphical classification 328, 329 vigorous physical weathering 326 problems in correlation 328 see also Late Triassic, central and south-west England; **Mid-Triassic** Trichûg Formation 66, 76

Tristichopterus 221-2 Tristicbopterus alatus 218, 219 Tristychius 306, 310 Tristychius arcuatus 284, 285, 286, 293, 293 Tulerpeton 538, 539 **Tunbridge Wells Sand 425** Turbidites 35, 78 Turin Hill 156 collections from 157 Turinia 138 Turinia pagei 140, 152-3, 153 occurs in Dittonian and possibly in Breconian 154 other occurrences 154 Turinia pagei biozone 37 Turinia pagei thelodont assemblage/fauna 101, 114, 153 Arbuthnott Group 117 Devil's Hole 121, 124 Lepidaspis in 115 Wayne Herbert Quarry 133 Turonian 420, 443 Turonibatis cappettai 459, 475 Turriff Outlier 170 Twyford Beds 329 Tynet Burn, Elgin 196-201 with nodule beds 197-8 section 197-8, 197 interpretation 200 Tynet Burn Fish Beds 196 marginal position on Lake Orcadie 200 Tytherington Quarry, reworked Rhaetian fish fauna 350

Udimore 429 Ulbster Riera Geo Mudstone Formation 170 Ulbster Riera Geo Sandstone Formation 170 Unio Bed(s) 525, 528, 529 Unio Member 409 University Museum, Oxford, Kallostrakon mislabelled 90 Upcott Beds 110, 225, 229 Uplift eastern parts, London Basin 500 Scotland Late Devonian 245 Southern Uplands, late Silurian 33

Upnor sand pit 496, 497-501 composite section 498-9 interpretation 500 comparison with other localities 500 **Upper Aldwick Beds 505** Upper (Barren) Coal Measures 267 Upper Barton Beds 525 Upper Bathonian, Watton Cliff, 396 **Upper Bringewood Formation** 79,85 Upper Building Stones see Intermarine Member **Upper Caithness Flagstone** Group 170 Upper Cattle Ledge Stone Band 402 Upper Chalk 420, 447, 463 Boxford Chalk Pit 476-9 Upper Clays, Lower Lias, importance of 369, 370 **Upper Coal Measures 267** Upper Cornbrash 356, 382 **Upper Cretaceous** 355 Chalk Group 443 Upper Cwm Clyd Formation 66, 76 Upper Cypris Shales and Clays Member 409 Upper Devonian, Scotland 243 stratigraphical sequence in Highland 153, 154 Upper Eday Sandstone 170 **Upper Elton Formation 79 Upper Estuarine 356** Upper Fish-tooth Bed 505 Upper Gault 438, 441 Upper Gramscatho 229 Upper Greensand 419, 420, 422, 437 fish remains 437 **Upper Greensand Formation** 421 Upper Headon Beds 556 **Upper Inferior Oolite 356** Upper Kimmeridgian, sensu anglico 401 Upper Ledbury Formation 114 **Upper Leintwardine Formation** 66, 79, 85 Upper Lias 380 Whitby 373, 373-79

Upper Limestone Group 267 Upper Ludlow Group 102 Upper Oil Shale Group 267 Upper Old Red Sandstone 65, 267 Anglo-Welsh Basin 232, 234 Scotland faunal succession 246, 2.47 Midland Valley 243, 244, 245 correlation of Moray-Nairn area with other successions 254, 254 Scotland Boghole, Muckle Burn 253 Wales and Welsh Borders 225 'Upper Pecten Bed' 344 Upper Plateau Beds 239 Upper Přídolí, Lydney 98-101 Upper Roman Camp Formation 66 Upper Sedimentary Group 267 Upper Slot Burn Fish Bed 50 Upper Stromness Flags 170, 185 Upper Tunbridge Wells Sands 420 Upper Viséan 303 Upper Weald Clay 419, 420 Upper Whitcliffe Beds 79 Upper Whitcliffe Formation 65, 79.85 **Urochordates 8** Valanginian 420, 437 Vallis Vale, Somerset 349 Vallisia coppi 349 Vectichthys vectensis 531, 532 Vectis Formation 420, 430, 431, 421 facies of 435 fossil localities 433-4 Ventifact horizon, Budleigh Salterton Pebble Beds 336 Venus Bed 555, 556, 557 Vernicomacanthus uncinatus 154 Vernicomacanthus waynensis 137

Vertebrate zones, lower Devonian, Anglo-Welsh Basin 111

Vertebrates 3 earliest remains 10 early, relationship with conodonts 8 Late Devonian, Scotland, of stratigraphical value 243 microfossils 67 modes of occurrence in the Old Red Sandstone 118-19 origin of still argued 7-8 rare in Senni Beds 142 Triassic, limited 328 Vervan Limestones 229 Vieraella 546 Viséan 298 fossil amphibian sites 541-2, 546-54 late, palaeogeography 265 tetrapod record renewed 541 see also Upper Viséan Viviparus Limestones/Shales and Clays 407, 408 Volcanic component, Thanet Formation 489 Volcanism 494 Carboniferous, Midland Valley 268 Early Tertiary 483, 484 and tectonism, Devon and Cornwall 225 Wadhurst Clay 420, 424, 425 interpretations, palaeoenvironment 427 types of bone-rich accumulations 426 Wales-Brabant High 265, 266 Walls Formation 170 Walton Member 505 Warboys Brick Pit 400 Warden Point 510 Wardichthys 284, 291 Wardichthys cyclosoma 284 Wardie 279-6, 541 assemblages 280 elasmobranchs 280, 284, 285, 286

complete 284 non-marine 286 sketch map and section 280 Wardie Coal 280 Wardie Shales 280 anisopods 551 Wardie Syncline 280 Wardour, Vale of 415 Ware Cliffs 361 Ware/West Cliff see Watton Cliff Warebeth Red Bed Formation 170 Washing Ledge Shales (upper and lower) 402 Washing Ledge Stone Band 402, 403 Watergate Bay Devonian 110 purple and green slates of 110 slates of Newquay and Mawgan Porth 110 slates of Port Cothan and Bedruthan Steps 110 Staddon Grit of Trenance **Point 110** Waterhead Group 36 fish beds 52 Watsonichthys distinguished from Elonichthys 300 terminal group 301 Watsonichthys pectinatus 300, 301 Watsonosteus fletti 174, 219, 220 Watton Cliff 395, 396-400 section 397 fauna 396-7, 398, 399-400, 544 interpretation 398-400 Wayne Herbert Quarry 132-8 interpretation 135-8 comparison with other localities 138 Weald Basin 358 Weald Clay Formation 422, 423 deposition in mudplain environments 421 Weald-Northern France depositional basin 419 Wealden 355 Wealden Beds 431, 433 Wealden Group 419, 420, 422 Weald and Isle of White 423-37 Brook-Atherfield, Isle of Wight 429-37 Wessex sub-basin 421 Weigeltaspis 125, 127, 135

Wellingborough 380 Welsh Basin biostratigraphy 67 late Silurian clastic filling 65 Welsh Borders early Devonian environments 111 fish faunas 111-15, 117 fish sites 117, 119 palaeogeography and stratigraphy 109-11 late Silurian environments 69 fish faunas 70-4 fish sites 74-5 palaeogeography and stratigraphy 65-7, 68 Welton Chalk Formation 443 Wenlock 35 fish sites 74 Wern Quarry Beds 66, 105 Wessex Formation 420, 421, 430 fossil localities 434 interpretation 435 West Lothian Oil Shale Formation 546 West Midlands, Devonian 110 Westbury Clay Pit 400 Westbury Formation 329, 340, 343 Rhaetic Bone Bed 339-40 Westerdale Quarry 176-8 section 176 interpretation 178 Westlothiana lizziae, described 551-2, 553 Weston Mouth Sandstone Member 329 Wetherby Member 317 Wetherellus cristatus 514 Weydale Quarry 213-14 fish bed 213-14 interpretation 214 stratigraphical position of face unclear 213 Weymouth 415 Whaddon-Swaffham Fen, phosphate workings 437 Wheathillaspis wickhamkingi 141, 142 wheatleyensis Zone, Kimmeridge Bay 402 Whita Sandstone 245

Whitby Coast (East Pier-Whitestone Point) 373-80 fossil provenance problem 375-6 succession 375 geology near 373 interpretation 378-80 comparison with other localities 379-80 serpentinus Zone 376 Whitby Mudstone Formation 375, 375 Whitcliffe Formation 66, 84, 96, 98 upper, bone beds 97 Whitcliffe Group 66, 80, 102 Whitcliffe Quarry 78 White Limestone 356 White Limestone Formation 386, 391 zonation of members 393 White Limestone-Forest Marble boundary 391-2 Whitecliff Bay 508 Whitehouse Den 164-5 introduction 164-5 lacustrine shales 164 Whitemire Beds 254 Whitemire Quarry see Boghole, Muckle Burn Wight, Isle of Wealden Beds 424 see also Isle of Wight GCR and potential GCR sites Winchester Pits 479 Windsor Hill Quarry, Shepton Mallet 351

reworked Rhaetian 350 Witherington Railway Cutting 479 Wittering Formation 484, 520, 522 Wodnika striatula 322, 324 Wolf's Hole Quarry 162-4 interpretation 163-4 Woodbank Group 110 Woodcock Covert Quarry 78 Woodham brickpit 400 Woodhill Bay Conglomerate 231, 232 Woodhill Bay Fish Bed 231, 232, 233, 234 Woodward, A.S., monograph on Chalk fishes 444 Woolwich Beds 485, 490 facies changes in 500 Herne Bay 490, 492 Upnor 497, 498-9 fauna of low diversity 500 Woolwich Bottom Bed 492, 494, 498 Beltinge Fish Bed 490, 493, 496 Woolwich Formation 498 Woolwich and Reading Beds 485. 487 Woolwich and Reading Formation 484, 487, 491 Woolwich Beds 485, 490, 492, 494, 497, 498-9, 500 Woolwich Bottom Bed 490, 492, 493, 494, 496, 498 Woolwich Shell Beds 496, 498 Woolwich Shell Beds 496, 498

Wootton Bassett 405 Wootton Creek, Fishbourne 556 Worcester Graben, Triassic subsidence 327–8

Xenacanths 548, 553 origins of 286 Wardie 284, 286 *Xenacanthus 270 Xiphactinus 442, 453 Xiphactinus gaultinus 438 Xiphactinus mantelli 469 Xiphactinus (Portheus) gaultinus 442 Xiphodlamia ecocaena 516*

Yaverland, Sandown 437 Yellow Downton Bed 66 Yellow Downton Formation 65, 105 Yellow (Early Permian) Sands 315, 317 Yellow Farlow Sandstone Formation 110, 236 Yellow Ledge Stone Band, marker band 402, 403 Yesnaby Sandstone Formation 170 Yunnanozoon 8

Zechstein north-east England, sedimentary cycles 315 Zechstein Sea 317 transgression of 315