Chapter V

PALAEONTOLOGY OF THE GAULT

INTRODUCTION

THE FOSSILS of the Gault provide a glimpse of life in a fairly shallow muddy-bottomed sea which covered much of southern and eastern England towards the end of the Lower Cretaceous epoch. The formation is best known for its molluscs, fishes and crustacea and for its well-preserved microzoa. Compared with that of the Lower Greensand the Gault fauna is marked by a great increase in prominence of the Ammonoidea, the rarity of clear-water organisms such as brachiopods, sponges and polyzoa, and the absence of ponderous, thick-shelled bivalves like *Exogyra latissima* (Lamarck) and *Gervillella sublanceolata* (d'Orbigny), which were presumably adapted to living in shallow, current-swept waters. The Gault is poorer in echinoids, brachiopods and sponges than the Lower Chalk, but richer in gastropods and bivalves. It tells us practically nothing about life on land at the time of its deposition, since its yield of terrestrial organisms comprises only some pine-cones, drift wood and the remains of a few pterodactyls which had been carried out to sea. Evidence from other sources makes it certain, however, that during the Gault period the dinosaurs still dominated the land fauna (although mammals had been in existence since the Trias), that flowering plants had established themselves among the conifers and cycadophytes and that birds co-existed with air-borne reptiles.

Attempts have been made to deduce the depth and temperature of the Gault sea on the assumption that the habitat of fossil assemblages was similar to that of their analogues among the Recent faunas. Thus, Price (1875), working on the mollusca, deduced that the Lower Gault sea-bed did not exceed 100 fathoms in depth, though he believed that the Upper Gault had been deposited in deeper water. Jukes-Browne (1900, pp. 413–5), by using only the bivalves, estimated a depth of 150 to 180 fathoms for the Lower Gault sea and 200 fathoms for that of the Upper Gault. Chapman (1898), in studying the foraminifera, applied bathymetric data of Recent species to arrive at figures of 830 fathoms and 860 fathoms for the depths of the Lower Gault and Upper Gault seas respectively. Khan (1950b), however, has pointed out that Chapman's method of calculation is statistically unsound and that his figures are excessive; he has himself expressed the belief that the foraminifera indicate that the Gault of south-east England was laid down in a temperate and relatively shallow marine environment.

Concerning the temperature of the Gault sea, Price (1879) took up the suggestion of earlier authors that the Cambridge phosphate bed was produced by cold northerly currents. He asserted that decapod crustacea were characteristic of the Gault phosphatic nodule-beds and that in the present-day North Atlantic Ocean this group of organisms is most numerous in cold-water areas. On the other hand, the recently introduced method of

palaeotemperature measurement by assaying oxygen isotopes in fossil organic carbonates suggests that the Gault was deposited during a period of climatic maximum. Data derived from analyses of guards of the belemnite *Neohibolites minimus* (Miller) from the Gault of Folkestone give temperatures of 20° to 23·3°C (Bowen 1961), compared with 6° to 17·5°C which obtain in the Strait of Dover at the present time.

Some of the oldest and most familiar names of Gault fossils originate in the works of J. Parkinson (1811, 1819), J. Sowerby (1812–22) and J. de C. Sowerby (1823–46), Mantell (1822) and W. Fitton (1836). Many were first named by the great French palaeontologist d'Orbigny, who obtained much of his material from Wissant, on the north coast of France, opposite Folkestone. Gault fossils, mostly from Folkestone, figure prominently in the monographs of the Palaeontographical Society, such as those on the Cretaceous Lamellibranchia (Woods 1899–1913), Cretaceous Entomostraca (Jones 1850; Jones and Hinde 1890), Crustacea (Bell 1858–62; Woods 1924–31) and Lower Cretaceous belemnites (Swinnerton 1955). The Ammonoidea of the Gault were made the subject of a special monograph by Spath (1923–43). Charles Darwin himself dealt with the Cirripedes (Darwin 1851–5).

Catalogues issued by the British Museum (Natural History) are another source of information on Gault fossils, notably for Reptilia and Amphibia (Lydekker 1888–90), Fishes (Woodward 1889–1901), Nautiloid Cephalopods (Foord 1891) and Cirripedes (Withers 1935). Among the numerous papers devoted to special aspects of Gault palaeontology, mention may be made of those by Starkie Gardner (1873–80) on Gastropoda and Scaphopoda, Chapman and Sherborn (1893) on Ostracoda, Carruthers (1866–71) on pinecones, Chapman (1891–8) and Khan (1950a, 1952) on Foraminifera, and Casey (1936–60) on Ammonoidea.

SYSTEMATIC ACCOUNT

Foraminifera

Chapman's work on the foraminifera of the Gault is now out of date and a complete revision has yet to be attempted. Khan has given some attention to the fauna of the Lower Gault, primarily that of Copt Point, Folkestone. He has found that while some species like *Hormosina folkestoniensis* Khan, *Vaginulina neocomiana* Chapman and *Spiroplectinata annectens* (Parker and Jones) have a short vertical distribution, others such as *Bolivina textilarioides* Reuss, *Pleurostomella alternans* Schwager, *Siphogenerina asperula* (Chapman), *Epistomina spinulifera* (Reuss) and *Arenobulimina macfadyeni* Cushman, though having a longer vertical range, occur in greatest abundance only within restricted limits. Using the frequency-occurrence of certain species, Khan established the following three zones in the Lower Gault:

3. *Epistomina spinulifera–Arenobulimina macfadyeni* Zone (Beds VII & VIII), characterized by the index species and *Pleurostomella alternans* Schwager, *Spiroplectinata annectens* (Parker and Jones), *Bifarina tenuilissa* Tappan and *Tritaxia pyramidata* Reuss.
2. *Siphogenerina asperula* Zone (Beds III to VI), characterized by the index species and *Haplophragmoides latidorsatum* (Bornemann) and *Lagena sulcata* (Walker and Jacob).

1. *Bolivina textilarioides–Pleurostomella alternans* Zone (Beds I & II), characterized by the index species and *Hormosina folkestoniensis* Khan, *Vaginulina neocomiana* Chapman, *Dorothia gradata* (Berthelin), *Haplophragmoides latidorsatum* (Bornemann), *Verneuilina chapmani* Ten Dam, and *Marssonella oxycona* (Reuss).

The adherent foraminifer *Bullopora laevis* (Sollas) has been found on shells and nodules.

Porifera, Anthozoa, Annelida, Echinodermata, Brachiopoda

Among the phosphatic nodules at the base of the greensand Bed XII are a few rolled Lithistid sponges, such as *Jerea pyriformis* Lamouroux and *Siphonia tulipa* Zittel, the occurrence being a feeble reflection of the rich Lithistid faunas of the Blackdown and Warminster Greensands.

Serpula antiquata J. Sowerby, *Hamulus curvatus* (Gardner), *Rotularia polygonalis* (J. de C. Sowerby), *Sarcinella socialis* (Goldfuss) and *Glomerula gordialis* (Schlotheim) are the chief representatives of the Annelida. The last forms winding threads and loops on the outsides of nodules and larger fossils. Burrows lined with fish-scales have been attributed to a Terebelloid worm '*Terebella*' *lutensis* Bather. The structure known as *Granularia*, consisting of tiny ovoid pellets arranged in a tube, was also thought to be of annelid origin by Bather (1911).

Echinoids are not common and are invariably crushed. *Hemiaster asterias* Forbes and *H. bailyi* Forbes occur in most of the beds, especially Bed III. *Polydiadema wiltshirei* (Wright) is a Lower Gault species; *Typocidaris gaultinus* (Forbes) is characteristic of Bed X. Columnals of the crinoid *Nielsenicrinus cretaceus* (Leymerie) (=*Pentacrinus fittoni* of authors) are also found in Bed X. The mobile Comatulids *Glenotremites aequimarginatus* (Carpenter) and *Palaeocomaster loveni* (Carpenter) and the micro-crinoid *Styracocrinus peracutus* (Peck) have all been found in the Gault of Folkestone.

EXPLANATION OF PLATE IV

Fig. 1. 'Button-coral', *Discocyathus fittoni* (Edwards and Haime), Lower Gault. (GSM. 108208).

Fig. 2. Gastropod, *Anchura carinata* (Mantell), Lower Gault. (GSM. 1739).

Fig. 3. Uncoiled ammonite, *Heteroclinus nodosus* (J. Sowerby), Lower Gault. (GSM. 1785).

Fig. 4. Bivalve, *Inoceramus concentricus* Parkinson, Lower Gault. (GSM. 21145).

Fig. 5. Bivalve, *Inoceramus subsulcatus* Wiltshire, Lower Gault. (GSM. 21156).

Fig. 6. Bivalve, *Inoceramus sulcatus* Parkinson, Upper Gault. (GSM. 21161).

Fig. 7. Belemnite, *Neohibolites minimus* (Miller), Lower Gault. (GSM. 92911).

Fig. 8. Ammonite, *Hysteroceras orbignyi* (Spath), Upper Gault. (GSM. 108470).

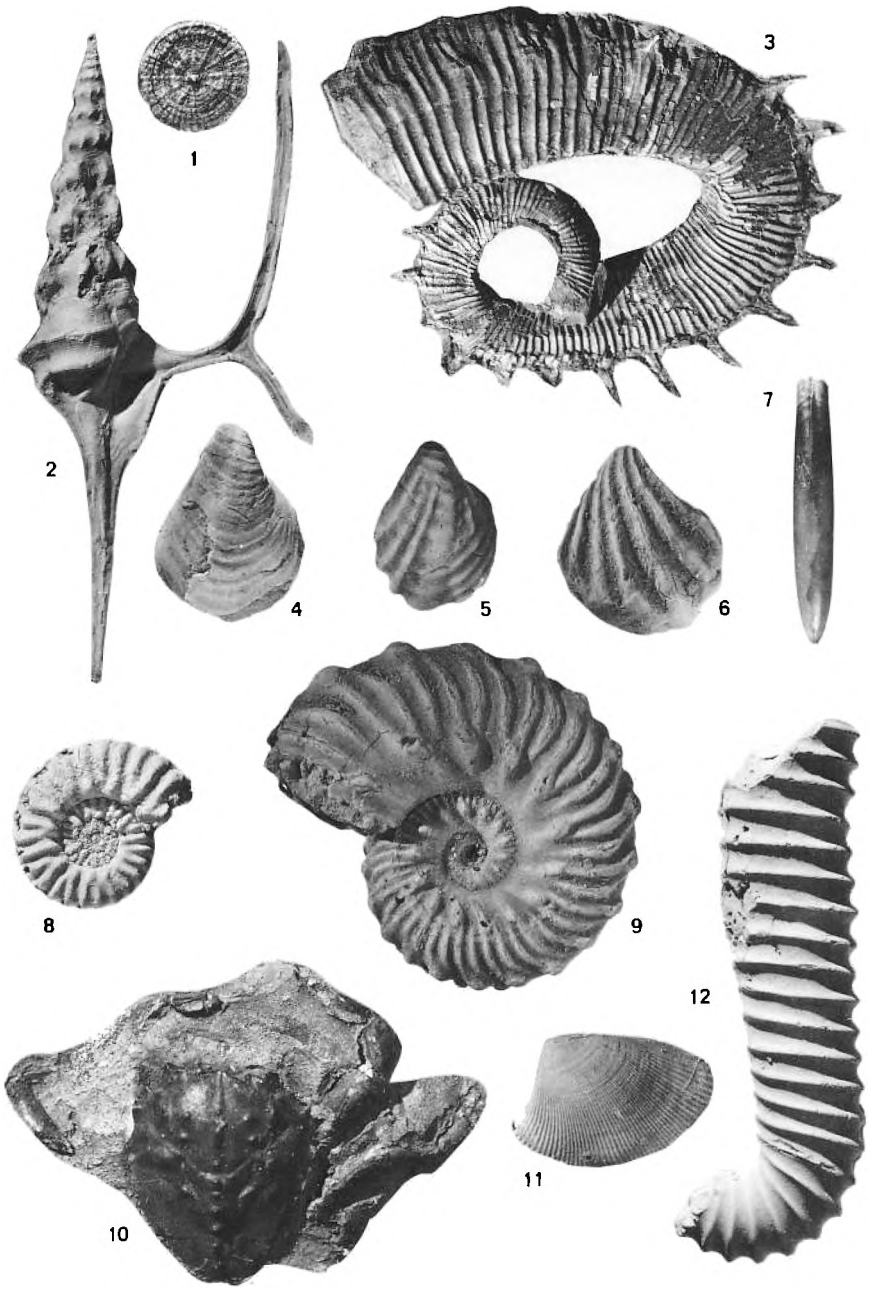
Fig. 9. Ammonite, *Euhoplites truncatus* Spath, Lower Gault. (GSM. 31024).

Fig. 10. Crab, *Notopocorystes stokesi* (Mantell), Lower Gault. (GSM. 1854).

Fig. 11. Bivalve, *Nucula* (*Pectinucula*) *pectinata* J. Sowerby, Lower Gault. (GSM. 1641).

Fig. 12. Uncoiled ammonite, *Hamites gibbosus* J. Sowerby, Lower Gault. (GSM. 60788).

All figures natural size.



FOSSILS FROM THE GAULT OF FOLKESTONE

Gault Anthozoa are mostly small button or cup corals and are met with more frequently in the lower beds, particularly in Bed V, which Price termed the 'coral bed'. The commonest are *Bathycyathus sowerbyi* Edwards and Haime, *Discocyathus fittoni* Edwards and *Trochocyathus harveyanus* Edwards.

The muddy waters of the Gault did not suit the brachiopods, though *Kingena lima* (Defrance) and *'Terebratula' dutempleana* (d'Orbigny) (= *'T.' biplicata* of authors) may be successfully sought for in Bed X.

Mollusca (Bivalvia)

All the beds yield *Inoceramus*, of which the best known is *Inoceramus concentricus* Parkinson (Beds I to XI). *Inoceramus anglicus* Woods (Beds VIII to XIII), *I. tenuis* Mantell (Beds XII and XIII) and *I. crippsi* Mantell (Bed XIII) also occur, the last becoming more common in the Chalk above. The radially fluted *I. sulcatus* Parkinson (sometimes placed in a separate genus or subgenus, *Actinoceramus*) is confined to Beds VIII and IX and is an easily recognizable guide to the junction of the Lower and Upper Gault. It is accompanied by a curious hybrid form, *I. subsulcatus* Wiltshire, specimens of which show every stage of transition from *I. concentricus* to *I. sulcatus*; seemingly conspecific forms are found as far afield as Mexico and Russia. *Inoceramus* is the most likely source of the fossil pearls that are found as occasional curiosities in the Gault. Next in abundance are the 'nut' shells, especially *Nucula* (*Pectinucula*) *pectinata* J. Sowerby and *N.* (*Leionucula*) *ovata* Mantell. These two occur all through the Gault, but *N.* (*L.*) *albensis* d'Orbigny, *Acila* (*Truncacila*) *bivirgata* (J. de C. Sowerby) and *Mesosaccella mariae* (d'Orbigny) are more typical of the Lower Gault. Other long-ranging bivalves are the scallop *Entolium orbiculare* (J. Sowerby), the Spondylid *Plicatula gurgitis* Pictet and Roux, *Pseudocardia tenuicosta* (J. de C. Sowerby), a member of the Carditidae, and the Arcid *Nanonavis carinata* (J. Sowerby). Oysters (e.g. *Gryphaeostrea canaliculata* J. Sowerby sp. and *Pycnodonte vesicularis* Lamarck sp.) are more commonly found in the Upper Gault. Species confined to or especially characteristic of one particular bed include *Linotrigonia fittoni* (Deshayes) (Bed I), *Corbula gaultina* Pictet and Campiche (Bed II), the Arcid *Cucullaea* (*Idonearca*) *glabra* Parkinson (Bed VIII), the Arcticid *Proveniella quadrata* (d'Orbigny) (Bed VIII), the scallops *Chlamys elongata* (Lamarck) (base of Bed XI) and *Aequipecten beaveri* (J. Sowerby) (Bed X), and the Aucellid *Aucellina coquandiana* (d'Orbigny) (Bed XII). Drift wood is commonly riddled with the crypts of bivalves whose timber-boring mode of life was comparable with that of the modern shipworm, the principal forms being *Opertochasma constrictum* (Phillips), *Terebrimya gaultina* (Woods) and *Xylophagella zonata* Casey. *Astarte*, *Lucina*, *Anomia*, *Pinna*, *Isognomon*, *Pseudolimea*, *Thracia* and *Eopecten* are some of the many other genera represented.

Mollusca (Gastropoda and Scaphopoda)

Gault gastropods are rich in variety and numbers. *Nummocalcar fittoni* (Roemer) (=*Solarium ornatum* of authors) ranges through almost the whole of the formation and is a survivor of the ancient family that is typified by the Palaeozoic *Euomphalus*. Another ancient family (but with living representatives), the Pleurotomariidae, is exemplified in the Gault by *Leptomaria pricei* Cox, *Conotomaria folkestonensis* Cox and *Pleurotomaria plicata*

(J. Sowerby). The last is fairly common in Bed VIII and passes up into Bed IX. The Aporrhaidae, a family which reached its maximum in the Cretaceous and is characterized by finger-like extensions of the aperture, is well represented. This family includes the long-ranging *Anchura carinata* (Mantell) and *Tessarolax retusum* (J. de C. Sowerby) ; *A. carinella* (d'Orbigny) and *A. marginata* (J. de C. Sowerby) are found in the higher beds of the Lower Gault ; *Dimorphosoma calcaratum* (J. de C. Sowerby) is confined to Bed II. The present-day whelks have their counterparts in *Buccinofusus clementinus* (d'Orbigny) and *Sipho gaultinus* (d'Orbigny), the winkle in *Gyrodes genti* (J. Sowerby), all of which occur sporadically through the Gault. Other typical Gault gastropods are the Cerithioids *Mesalia* (*Bathraspira*) *tecta* (d'Orbigny) and *Metacerithium trimonile* (Michelin), the Scalariids *Confusiscala dupiniana* (d'Orbigny) and *Claviscala clementina* (d'Orbigny), the Turritellid *Torquesia vibrayeana* (d'Orbigny), the limpet '*Acmaea*' *tenuicosta* (d'Orbigny), the Solariids *Semisolarium moniliferum* (Michelin) and '*Trochus*' *conoideus* J. Sowerby, and the Opisthobranchs *Acteon affinis* (d'Orbigny) and *Ringinella inflata* (d'Orbigny). The little *Bellerophina minuta* (J. Sowerby) (Beds V to VII), once thought to be a cephalopod, is now believed to be the first of a group of pelagic prosobranchs, the Heteropoda.

The two families of scaphopoda, the Dentaliidae and the Siphodentaliidae, are both present in the Gault. The former is represented chiefly by the ubiquitous *Dentalium* (*Fissidentalium*) *decussatum* (J. Sowerby), resembling an elephant's tusk in miniature ; *Cadulus* (*Gadila*) *gaultinus* Gardner belongs to the latter family. Small hooked or curved tubes formerly ascribed to *Siphodentalium* belong properly to the annelid *Hamulus*.

Mollusca (Cephalopoda)

The richness of the ammonite fauna of the Gault is not due entirely to favourable conditions of preservation but reflects a world-wide burst of evolutionary activity that took place in the group towards the end of the Lower Cretaceous. With few exceptions Gault ammonites belong to the 'Trachyostraca', the highly ornamented types that are believed to have flourished in the shelf seas, and nearly all of these belong to the three superfamilies Hoplitaceae, Acanthocerataceae and Turrilitaceae. The first takes in the ventrally grooved ammonites such as *Hoplites*, *Euhoplites*, *Anahoplites* and *Dimorphoplites*, which dominate the Lower Gault, and *Epihoplites*, *Callihoplites* and the rare *Discohoplites*, which characterize the Upper Gault. Also included among the Hoplitids are *Lepthoplites*, *Pleurohoplites* and *Arrhaphoceras*. These occur sparsely in the highest bed of the Gault and have a raised siphonal line foreshadowing the Cenomanian keeled family Schloenbachiidae. Gault ammonites with a keel at some stage of growth or with a median row of nodes on the venter belong to the Acanthocerataceae. *Hysteroceras*, *Prohysteroceras*, *Mortoniceras* and *Dipoloceras* are typical keeled genera ; *Neophlycticeras*, with cockscomb venter, is rather scarce. Although represented in the *dentatus* Zone by *Mojsisovicsia*, and rare *Eubrancoceras* and *Oxytropidoceras*, this superfamily did not become important until the top of the Lower Gault, after which it gained supremacy over the Hoplitaceae. The Turrilitaceae comprises heteromorphs or abnormally coiled types such as *Hamites*, *Anisoceras*, *Heteroclinus*, *Pseudhelicoceras*

Turrilitoides and *Mariella* (but not the Scaphitids, which are judged as constituting a separate superfamily). Except for the Desmoceratid *Beudanticeras*, which is not uncommon at the junction of the Lower and Upper Gault, the 'Leiostraca', or smooth ammonites, are known from the Gault only by a few chance finds of *Hypophylloceras* (Phylloceratáceae), *Tetragonites*, *Pictetia* (Lytoceratáceae), *Desmoceras*, *Puzosia* and *Uhligella* (Desmoceratáceae). These ammonites are thought to have preferred open waters and to have had their European centre of dispersal in the Mediterranean region. The Placenticeratáceae are another exotic element in the Gault; this superfamily is represented by isolated finds of the Engonoceratid *Engonoceras iris* Spath in the *dentatus* Zone of the Lower Gault and by the Placenticeratid *Hengestites applanatus* Casey in the *inflatum* Zone of the Upper Gault. The Engonoceratidae, with their curiously modified ('pseudoceratitic') suture-lines, characterize Albian deposits of equatorial regions and seldom strayed into the northern waters where Hoplitids abounded. A short-term penetration into the Gault Hoplitid province by the Haploceratáceae is indicated by the occurrence of the primitive Binneyitid *Falciferella milbournei* Casey in Bed II. That the Gault sea was open to immigrants from the north was proved by the discovery in Bed VIII at Folkestone of the Canadian genus *Gastroplites*, a member of an Arctic branch of the Hoplitidae.

In contrast to the Ammonoidea, Nautiloid cephalopods are relatively infrequent and belong to a few long-ranging genera of world-wide distribution. *Eutrephoceras clementinum* (d'Orbigny), *E. bouchardianum* (d'Orbigny) and *Cymatoceras albense* (d'Orbigny) occur in the Lower Gault and the earliest beds of the Upper Gault. Calcified beaks of Nautiloids, known as *Rhynchoteuthis*, have also been found.

Guards of the belemnite *Neohibolites minimus* (Miller) and varieties are ubiquitous in the Gault of this region and because of their resistant nature make up a large part of the weathered-out fossil debris.

A list of Ammonoidea from the Gault of Folkestone is given in Table 2.

TABLE 2

List of Ammonoidea from the Gault of Folkestone

	BED
Hypophylloceras subalpinum (d'Orbigny) Spath	VIII
Tetragonites kitchini (Krenkel)	II
Pictetia astieriana (d'Orbigny)	I
Desmoceras latidorsatum (Michelin)	II
Beudanticeras beudanti (Brongniart)	VIII–X
,, ,, *ibiciforme* Spath	IX
,, *sphaerotum* (Seeley)	IX
,, *subparandieri* Spath	VIII–IX
Puzosia (*Puzosia*) *spathi* Breistroffer	X
Puzosia (*Anapuzosia*) *provincialis* Parona & Bonarelli	II
Uhligella derancei Casey	II
,, ,, *erugata* Casey	II
Hoplites (*Isohoplites*) *eodentatus* Casey	I
Hoplites (*Hoplites*) *dentatus* (J. Sowerby)	I
,, ,, ,, *robustus* Spath	I

	BED
Hoplites (*Hoplites*) *spathi* Breistroffer	... I
,, ,, *paronai* Spath	... I
,, ,, *persulcatus* Spath	... I
,, ,, *rudis* Parona & Bonarelli ...	... I
,, ,, *similis* Spath	... I
,, ,, *canavarii* Parona & Bonarelli	... I
,, ,, *benettianus* (J. de C. Sowerby)	... I
,, ,, *escragnollensis* Spath ...	... I
,, ,, *dentatiformis* Spath	... II
,, ,, *spp. nov.*	... I–II
Anahoplites praecox (Spath)	... I–II
,, *intermedius* Spath	... I–II
,, *mantelli* Spath	... I–II
,, *planus* (Mantell)	... I–XI
,, ,, *gracilis* Spath	... I–VIII
,, ,, *discoideus* Spath	... I–VIII
,, *splendens* (J. Sowerby)	II–VII
,, *pleurophorus* Spath	... IV
,, *picteti* Spath	... IX–X
,, *daviesi* Spath	... VII
,, ,, *ornatus* Spath	... VII
,, *sp. nov.*	... XI
Dimorphoplites niobe Spath	... II–IV
,, *doris* Spath	... IV
,, *pinax* Spath	... II–V
,, *glaber* Spath	II–VIII
,, *chloris* Spath	II–VIII
,, *tethydis* (Bayle)	III–VIII
,, *biplicatus* (Mantell)	IV–VII
,, *parkinsoni* (Spath)	V–VIII
,, *? silenus* Spath	... VIII
Metaclavites metamorphicus (Spath)	... VIII
,, *trifidus* (Spath)	... IX–X
,, *compressus* (Parona & Bonarelli) ...	VIII–IX
Epihoplites denarius (J. de C. Sowerby)	... X
,, *deluci* (Brongniart)	... X
,, *glyptus* Spath	... X
,, *gibbosus* Spath	... X–XI
Semenovites gracilis (Spath)	... X
,, *iphitus* (Spath)	... X
Callihoplites catillus (J. de C. Sowerby)	... XI
,, *patella* Spath	... XI
,, *strigosus* Spath	XI–XII
,, *auritus* (J. Sowerby)	... XI
,, *seeleyi* Spath	... XIII
,, *tetragonus* (Seeley)	... XIII
,, *glossonotus* (Seeley)	... XII
,, *leptus* Spath	... XII
,, *pulcher* Spath	... XIII
Lepthoplites falcoides Spath	... XIII
Pleurohoplites subvarians Spath	... XIII
Arrhaphoceras substuderi Spath	... XIII
Euhoplites truncatus Spath	... V–IX
,, *lautus* (Parkinson)	V–VIII
,, ,, *bilobus* Spath	... V

BED

Euhoplites alphalautus Spath ... ... X–XI
„ *microceras* Spath ... ... II–IV
„ *subtabulatus* Spath II
„ *aspasia* Spath ... ... II–V
„ „ *cantianus* Spath V
„ *loricatus* Spath ... ... II–V
„ *meandrinus* Spath ... ... II–V
„ *pricei* Spath ... ... II–IV
„ *subtuberculatus* Spath ... ... II–IV
„ *opalinus* Spath ... ... V–IX
„ *bucklandi* Spath ... ... V–VIII
„ *nitidus* Spath ... ... V–VIII
„ *proboscideus* Spath ... ... V–X
„ „ *intermedius* Spath VIII
„ „ *ultimus* Spath X
„ *armatus* Spath ... ... VIII–X
„ *trapezoidalis* Spath ... ... VIII–IX
„ „ *formosus* Spath VIII
„ *serotinus* Spath ... ... VIII–IX
„ *solenotus* (Seeley) ... ... VIII–IX
„ *ochetonotus* (Seeley) ... ... VIII–IX
„ *sublautus* Spath ... ... VIII–IX
„ „ *monacanthus* Spath ... ... VIII–IX
„ *subcrenatus* Spath IX
„ *inornatus* Spath IX
„ *vulgaris* Spath ... ... IX–XI
„ *boloniensis* Spath ... ... IX–X
Discohoplites coelonotus (Seeley) XII
Gastroplites cantianus Spath VIII
Engonoceras iris Spath III
Neophlycticeras (*Neophlycticeras*) *brottianum* (d'Orbigny) ... VIII–IX
„ „ *gibbosum* Spath ... ... VIII–IX
Neophlycticeras (*Eotropitoides*) *jayeti* Breistroffer ... ... VIII–IX
Neophlycticeras (*Protissotia*) *itierianum* (d'Orbigny) VIII
„ „ *orion* Casey VIII
Stoliczkaia sp. XIII
Oxytropidoceras roissyanum (d'Orbigny) I
„ *mirapelianum* (d'Orbigny) I
„ *sp. nov.* I
„ *cantianum* Spath VIII
„ „ *excentricum* Spath VIII
Mojsisovicsia (*Dipoloceroides*) *subdelaruei* (Spath) IV
„ „ *remota* (Spath) IV
„ „ *spinulosa* (Spath) IV
„ „ *cornuta* (Pictet) V
„ „ *equicostata* (Spath) V
Dipoloceras cristatum (Brongniart) VIII
„ *corbulatum* Spath VIII
„ *multispinosum* Spath VIII
„ *fredericksburgense* Scott *britannicum* Breistroffer ... VIII
„ *pseudaon* Spath ... ... VIII–IX
„ „ *moniliforme* Spath ... ... VIII–IX
„ *bouchardianum* (d'Orbigny) ... ... VIII–IX
„ „ *alticarinatum* Spath VIII
Mortoniceras (*Mortoniceras*) *inflatum* (J. Sowerby) ... ... XI–XII

	BED
Mortoniceras (*Mortoniceras*) *inflatum picteti* Spath	XI
,, ,, ,, *gibbosum* Spath	XI
,, ,, *pricei* Spath	IX–XI
,, ,, ,, *intermedius* Spath	IX
,, ,, *geometricum* Spath	X
,, ,, *fissicostatum* Spath	XI
,, ,, ,, *ascendens* Spath	XI
,, ,, *commune* Spath	XI
,, ,, *potternense* Spath	XI
,, ,, *evolutum* Spath	XI
,, ,, *rostratum* (J. Sowerby)	XIII
,, ,, *kiliani* (Lasswitz) *altonense* Breistroffer...	XII
,, ,, *rigidum* Spath	VIII
Mortoniceras (*Deiradoceras*) *cunningtoni* Spath...	IX–XI
,, ,, ,, *flexuosum* Spath	IX–XI
,, ,, *bipunctatum* Spath	IX–X
,, ,, *devonense* Spath	IX–X
,, ,, *albense* Spath	IX–X
,, ,, ,, *transitorium* Spath	IX–X
Cantabrigites cantabrigensis (Spath)	XII
Elobiceras pseudelobiense (Spath)...	XI
Prohysteroceras (*Goodhallites*) *goodhalli* (J. Sowerby) ...	IX–XI
,, ,, ,, ,, *shenleyensis* Spath ...	IX–XI
,, ,, ,, ,, *tuberculatum* Spath ...	IX–XI
,, ,, ,, ,, *aplanatum* Spath ...	IX–XI
,, ,, *candollianum* Spath *non* Pictet ...	XII
,, ,, *delabechei* Spath	X
,, ,, ,, *robustum* Spath	X
Prohysteroceras (*Neoharpoceras*) *coptense* Spath	XI
Eubrancoceras cricki (Spath)	II–III
,, *spp.*...	I–III
Hysteroceras varicosum (J. de C. Sowerby)	IX–X
,, ,, *binodosum* (Stieler)	IX–X
,, *binum* (J. Sowerby)	IX–X
,, *subbinum* Spath	IX–XI
,, *carinatum* Spath	IX–XII
,, ,, *ascendens* Spath	IX–XII
,, *orbignyi* (Spath)	VIII–XI
,, aff. *choffati* Spath	IX
,, *bucklandi* (Spath)	XI
,, *capricornu* Spath	VIII
,, *pseudocornutum* Spath	VIII
,, [*Dipoloceras?*] *symmetricum* (J. de C. Sowerby) ...	VIII
,, *simplicicosta* Spath	VIII
,, *serpentinum* Spath	VIII
Hengestites applanatus Casey	XI
Falciferella milbournei Casey	II
Eoscaphites circularis (J. de C. Sowerby)	X
,, ,, *depressus* Spath	X
,, ,, *rugosus* Spath	X
,, *subcircularis* Spath	X–XI
Scaphites simplex Jukes-Browne	X–XII
Mariella cf. *escheriana* (Pictet)	XI
Proturrilitoides densicostatus (Passendorfer)	V
Pseudhelicoceras robertianum (d'Orbigny)	IX–XI

	BED
Pseudhelicoceras robertianum ornatum Spath	... IX–XI
„ *pseudoelegans* Spath	... VIII
„ *subcatenatum* Spath	... II
„ *? gaultinum* Spath	... X
Anisoceras armatum (J. Sowerby)	... XII
„ *perarmatum* (Pictet & Campiche)	XII–XIII
„ *saussureanum* (Pictet)	XI–XII
„ *subarcuatum* Spath	... X–XI
Protanisoceras moreanum (Buvignier)	... I
„ cf. *halleri* (Pictet & Campiche)	... II
Heteroclinus nodosus (J. Sowerby)	... I–II
„ „ *splendens* Spath	... I–II
„ *flexuosus* (d'Orbigny)	... I–II
Metahamites sp. nov.	... I
Idiohamites tuberculatus (J. Sowerby)	... IX–XI
„ *spiniger* (J. Sowerby)	... IX–XI
„ *subspiniger* Spath	... IX–X
„ *turgidus* (J. Sowerby)	... X–XI
„ „ *robustus* Spath	... X–XI
„ „ *subannulatus* Spath	... X–XI
„ *spinulosus* (J. Sowerby)	... X–XI
„ *favrinus* (Pictet)	... X–XI
„ *ellipticoides* Spath	... X
„ *? incertus* Spath	... X–XI
„ „ *costatus* Spath	... X–XI
Hamitoides? rusticus Spath	... VIII
Hamites attenuatus J. Sowerby	... I–IV
„ *tenuicostatus* Spath	... II–IV
„ *rotundus* J. Sowerby	... I–V
„ *subrotundus* Spath	IV–VII
„ *compressus* J. Sowerby	II–VIII
„ „ *gracilis* Spath	II–VIII
„ *incurvatus* Brown	VIII–IX
„ *maximus* J. Sowerby	... V–IX
„ „ *rectus* Brown	... V–IX
„ *gibbosus* J. Sowerby	II–VIII
„ *tenuis* J. Sowerby	V–VIII
„ *intermedius* J. Sowerby	... IX
„ „ *opalinus* Spath	... IX
„ „ *distinctus* Spath	... IX
„ (*Stomohamites*) *sp.* cf. *parkinsoni* (Fleming) ...	... XI
„ (*Psilohamites*) *bouchardianus* d'Orbigny ...	... X
Ptychoceras (*Mastigoceras*) *adpressum* (J. Sowerby) ...	... X
Lechites gaudini Pictet and Campiche	... XI

Crustacea

Decapod crustaceans (crabs, shrimps and lobsters) are fairly common on some horizons, especially the nodule beds. The crab *Notopocorystes stokesi* (Mantell) is found in practically all the beds but reaches its maximum in the line of nodules at the top of Bed III, named the 'crab bed' by the early collectors. Other crabs are *Eucorystes broderipi* (Mantell), *Necrocarcinus bechei* (Deslongchamps), *Homolopsis edwardsii* Bell and *Etyus martini* Mantell. The lobster *Homarus longimanus* G. B. Sowerby ranges up from

the Lower Greensand. Valves of the pedunculate cirripedes (stalked barnacles) *Cretiscalpellum unguis* (J. de C. Sowerby) and *Pycnolepas rigida* (J. de C. Sowerby) and, less commonly, *Scalpellum* (*Arcoscalpellum*) *arcuatum* Darwin and *Zeugmatolepas mockleri* Withers, occur principally in the lower part of the Upper Gault.

Though ostracods are limited to a few species in the lower part of the Gault, individuals are locally very abundant. By the incoming of new species the fauna becomes more varied with time and in the upper half of the Gault at least twenty-two species are recognizable. *Cytherella ovata* (Roemer), *C. muensteri* (Roemer), *Cythereis reticulata* Jones and Hinde, *C. lurmannae* Triebel and *Protocythere auriculata* (Cornuel) are the commonest species at Folkestone, with *Cythereis bonnemai* Triebel, *Cytherelloidea stricta* (Jones and Hinde), *Schuleridea jonesiana* (Bosquet), *Platycythereis gaultina* (Jones) and *Protocythere lineata* (Chapman and Sherborn). *Cytherelloidea chapmani* (Jones & Hinde), *Haplocytheridea nana* Triebel and *Eucythere trigonalis* (Jones) are fairly common, whilst those of rare occurrence are *Paracypris gracilis* (Bosquet), *Bairdia subdeltoidea* (Münster), Auctt., *Bythocypris harrisiana* (Jones), *Dolerocytheridea bosquetiana* (Jones & Hinde), *Haplocytheridea rara* Triebel, *Eucytherura ansata* (Weingeist), *Monoceratina umbonata* (Williamson), *Isocythereis fortinodis* Triebel and *I. fissicostis* Triebel. As yet insufficient detailed collecting has been done to determine whether or not the distribution of ostracods in the Gault has any zonal significance.

Pisces

The Gault yields a good fish fauna, especially from its upper beds. Isolated teeth and vertebral discs of elasmobranchs (sharks and rays) are common. Most belong to the shark *Lamna appendiculata* Agassiz, though *Acrodus laevis* Woodward, *Lamna macrorhiza* Cope, *Isurus mantelli* Agassiz, *Cestracion canaliculatus* Egerton, *Corax pristodontus* Agassiz, *Notidanus lanceolatus* Woodward, *Scapanorhynchus subulatus* Agassiz and species of *Hybodus*, *Synechodus* and *Ptychodus* also represent this class. Dental plates of Chimaeroids, a group which includes the living rabbit-fish, have been found and are identified as belonging to *Ischyodus thurmanni* Pictet and Campiche, *Edaphodon sedgwickii* (Agassiz) and *E. laminosus* Newton. The Teleostomi, or bony fishes, are represented by *Portheus gaultinus* Newton, *Thrissopater salmoneus* Günther, *Apateodus glyphodus* (Blake), *Syllaemus anglicus* (Dixon) and *Protosphyraena ferox* Leidy. Fish remains also include ear-bones (otoliths) and coprolites. Burrows attributed to Terebelloid worms are commonly lined with fish-scales.

Reptilia

Teeth and bones of the large marine reptiles *Ichthyosaurus campylodon* Carter, *Polyptychodon interruptus* Owen and *Cimoliasaurus constrictus* Owen (= *Mauisaurus gardneri* Seeley) have been collected. An incomplete skeleton of the last species, estimated to be 12 ft in length, was found in Bed II at Copt Point by John Griffith, the professional fossil-collector of Folkestone in the last century. Associated with the bones were about a quart of rolled and smooth-surfaced quartz pebbles, evidently 'gastroliths' or stomach-stones (Price 1879, p. 15). Remains of the turtles *Chelone benstedi* Owen,

Ch. jessoni Lydekker, and *Rhinochelys elegans* Lydekker, and of the flying reptile *Ornithocheirus compressirostris* Owen, have been recorded from the Upper Gault. From Bed X of the Upper Gault Price (ibid., p. 21) reported the discovery by Griffith of crushed bodies resembling crocodile eggs; one of these is now in the Geological Survey Museum.

Plantae

Pine and *Sequoia*-like cones from the Gault, mostly from Beds IX and X, were described by Carruthers under the names *Pinites gracilis*, *P. hexagonus*, *P. pricei*, *Sequoites gardneri* and *S. ovalis*. Pieces of coniferous drift wood are commonplace and the cycadophyte *Benettites* has also been identified. Resin has been recorded from Bed V. Some of the beds contain branching filaments described by early writers as 'fucoid markings'. Lenses of clay ironstone in Bed III and Bed V are full of *Chondrites*, a structure once thought to be of vegetable origin but now believed to be the work of some burrowing organism. R.C.