Smokejacks Pit, Ockley, Surrey

[TQ 113 373]

Highlights

Smokejacks Pit, Ockley is famous as the site which yielded *Baryonyx, the* meat-eating dinosaur with a giant hook claw. This recent dinosaur find supplements earlier discoveries of *Iguanodon* and crocodilians at Smokejacks, and bones and teeth have now been found at several levels.

Introduction

Smokejacks Pit at Wallis Wood, Ockley, near Dorking, Surrey (Figure 8.1) has been operated as a private brickworks for some time and is presently under the ownership of the London Brick Company (bought from the Ockley Brick Company). The quarry exposes sections in the Weald Clay, in the Barremian (Early Cretaceous). Remains of the dinosaur *Iguanodon atherfieldensis* were collected in 1945–6, and further material of this species, and of *I. bernissartensis,* has been collected since. The discovery, in 1983 of the theropod *Baryonyx walkeri,* with its 300 mm long claw (Figure 8.9), has brought the locality to attention. Since 1983 fossil reptile material has been recovered from several horizons within the quarry. The pit is still operational and, because work is relatively slow, fresh bones are occasionally seen and collected.

The first finds of dinosaurs from Smokejacks Pit were reported by Rivett (1953, 1956) who collected 'upwards of 100 bones' belonging to several individuals of *Iguanodon atherfieldensis.* Further specimens were excavated by the BMNH, but not reported. In January 1983 William Walker discovered an ironstone nodule in the pit which contained a giant claw. A rescue excavation by staff from the BMNH led to the discovery in the following month of a partial skeleton of a theropod dinosaur, which Charig and Milner (1986, 1990) named *Baryonyx walkeri.* The specimen has taken nearly 10 years of laborious preparation because of the impenetrability of the ironstone matrix.

Subsequent collecting by a variety of people has produced evidence of reptiles at several horizons and in several parts of the pit. John Cooper of Worthing found scattered large *Iguanodon* bones in 1987 and these were excavated with the assistance of the BMNH. Further material of the same individual was excavated by David Cooper, M.J.B. and colleagues from Bristol University in 1992 (Figure 8.6) and (Figure 8.7). Allen (1976, 1981) and Jarzembowski (1991a) have given preliminary descriptions of the site.

Description

Smokejacks Pit shows a section in the clays and subordinate sandstones of the Weald Clay, which lies above the Hastings Beds in the Early Cretaceous (Barremian) (Rawson *et al.,* 1978). Topley (1875, p. 106) mentioned the Weald Clay of Smokejacks Farm, and included it in his 'No 5. Sand and Sandstone with Calcareous Grit'. The sediments currently exposed in the pit represent about 27 m of Weald Clay below BGS bed no. 5c (Alfold Sand Member; Allen, 1976), which suggests that it is in the Upper Weald Clay, and is dated as early Barremian (Jarzembowski, 1991a).

Rivett (1956) recorded several general sections in the brickpit, the one for the central part being:

	Depth (in)
Topsoil turning to clay	0–12
Red Clay	12–36
Sandy Clay	36–60
Reddish Clay	60–72
Thinly bedded sandstone	72–108
Sandy clay and sandstone	108–174

The original discoveries of *Iguanodon* bones were in the 'harder rock' from 6–12 feet from the surface'. Rivett (1956) later gave the depth beneath the surface as '8 to 15 feet'. Nevertheless, it seems that they came from the two sandstone beds listed above. Rivett (1953, 1956) noted further that iron pyrites was found associated with, and impregnating, some of the bones, and that the bones were 'often resting on, or embedded in, the sand beds.' Some of the bones were broken and water-worn and they had evidently been transported, but most were relatively well preserved. Rivett (1953, 1956) also noted the presence of rounded pebbles, which he interpreted as gastroliths.

Other fossils known from Smokejacks Pit include plants (ferns, conifers), with some specimens interpreted as angiosperm-like vegetative parts (Hill *et al.,* 1992). If this interpretation is correct, these could be the oldest angiosperm macrofossils known. The invertebrate fauna includes ostracods, conchostracans, egg cases of cartilaginous fishes, molluscs and insects. The insect fauna consists of cockroaches, beetles, true flies, bugs, termites, crickets, grasshoppers, lacewings, scorpionflies, wasps and dragonflies (Jarzembowski, 1991a, 1991b).

The excavation of *Baryonyx* provides information on the taphonomy of large vertebrate remains from the Weald Clay in Smokejacks Pit. The bones located *in situ,* although largely disarticulated and scattered, all came from within the confines of an area measuring 5 m by 2 m, and the general arrangement of the bones demonstrated that none was far from its natural position; most of the pieces of skull, pectoral girdle and forelimbs were located at one end and most of the pelvic girdle and hindlimbs at the other. In general, the bones of *Baryonyx* were not found to be distorted or crushed to any significant extent. This may relate to the mode of fossilization, for most of the remains became encased in ironstone, presumably not long after burial. However, the few bones preserved in clay also appear to be unaffected by compaction. It may be significant that many of the bones appear to have become disarticulated prior to fossilization.

There are other modes of fossil reptile occurrence in Smokejacks Pit. Teeth and scutes of crocodilians and dinosaurs have been found seemingly isolated, and fish remains occur in lenses of siltstone. Others, such as the *Iguanodon* skeleton excavated in 1987–92, are remains of a single large dinosaur skeleton, but disarticulated and scattered over a wider area, in this case some 200 bones recovered from an area measuring approximately 7 m by 4 m. The sedimentary situation in this case seems to represent overbank deposits produced during a flood (E. Cook, pers. comm., 1993).

Fauna

The Rivett collection is housed in the BMNH. Rivett (1953, 1956) ascribed his finds to *Iguanodon* and some he identified as belonging to a large sauropod. Other material from Smokejacks is also in the BMNH.

Archosauria: Dinosauria: Crocodilia:

Goniopholididae

Isolated teeth of ?goniopholidids.

Archosauria: Dinosauria: Saurischia: Theropoda:

Baryonychidae

Baryonyx walkeri Charig and Milner, 1986 Type specimen: BMNH R9951

Archosauria: Dinosauria: Saurischia: Sauropoda:

Titanosauridae

Titanosaurus-like sauropod (Rivett, 1953)

Archosauria: Dinosauria: Ornithischia: Ornithopoda: Iguanodontidae

Iguanodon bernissartensis Roulenger, 1881 BMNH and David Cooper collection

Iguanodon atherfieldensis Hooley, 1925 BMNH R6432–640

Interpretation

Allen (1976, p. 414; 1990) interpreted the Weald Clay, including that at Smokejacks Brickworks, as having been deposited in an alluvial and lagoonal mudplain with short-lived sand channels (Figure 8.8). Salinities varied from freshwater to nearly marine. All facies were liable to exposure, as shown by large footprints in sandstone (at Capel, [TQ 1829 4048]), suncracks and mudflake conglomerates, as well as soil beds and the presence of horsetails. The fauna is terrestrial and aquatic (fresh-brackish), containing numerous insect remains in addition to the reptiles, but with freshwater aquatic insects and fishes.

Crocodilian teeth and scutes are found, scat tered about the site, and possibly coming from various horizons. They have been collected by many visitors to the site, but not curated or studied yet.

Iguanodon atherfieldensis, a large, herbivorous, bipedal or facultatively quadrupedal ornithopod dinosaur, is represented by vertebrae and limb bones, mostly the remains of small or immature animals. *I. atherfieldensis* isfar more gracile than the other well-known forms of *Iguanodon* from the Hastings Beds (*I. dawsoni, I. anglicus, I. fitton:*) and it is notable for its distinctive postcranial morphology (Norman, 1986). The large contemporary form *I. bernissartensis,* found rarely in the Wealden Marls of the Isle of Wight (Barremian–Early Aptian), but better known from the Early Cretaceous on the continent (Norman, 1980, 1987; Norman *et al.,* 1987), is represented by the 1987–92 specimen found by David Cooper.

To date more than half of the skeleton of *Baryonyx walkeri* has been recovered (Figure 8.9). This includes parts of the skull (conjoined premaxilla, anterior left maxilla, conjoined nasals, lacrimal, frontals, anterior braincase and occiput), lower jaw (left dentary with some associated post-dentary elements), axial skeleton (axis, one cervical vertebra, some dorsal vertebrae, a caudal vertebra, cervical ribs, dorsal ribs, gastralia, chevrons) and limb skeleton (both scapulae, both coracoids, ?clavicle, fragments of ilia, pubes and ischium, both humeri, phalanges of the manus including unguals [?large claw], portions of left and right femur, left fibula, right calcaneum, and elements of the pes). Teeth are present in both upper and lower jaws and also in isolation. Associated with the remains of *Baryonyx* were fish teeth and scales, an isolated humerus from a small individual of *Iguanodon,* and a small claw. Polished lithic fragments also found associated have been interpreted as probable gastroliths.

Baryonyx possesses some unique characters: an extremely narrow snout with a spatulate expansion at the tip and a slight downturn of the premaxilla seen in lateral view; a long low external naris situated far back from the front of the snout; and a probable mobile articulation involving a loose 'hinge' between the premaxilla and maxilla. *Baryonyx* possesses an unusually high number of marginal teeth (32 alveoli in the lower jaw, compared with the usual theropod count of 16), and in the postcranial skeleton, the upward bend of the neck seen in all other theropods is not developed. The femur indicates a bipedal stance, but the massive humeri demonstrate that there must have been a degree of quadrupedality, and *Baryonyx* is regarded as a facultative quadruped, again a feature unknown in other theropods.

The mode of life of *Baryonyx* is difficult to determine. Charig and Milner (1986, 1990) argued for ichthyophagy on the basis of the enlarged claw, the numerous finely serrated teeth, the superficially crocodilian-like appearance of the skull, and the fish scales in its gut region. They envisioned *Baryonyx* as a quadrupedal predator crouching on river banks and using the large claw (presumably on the hand) like a gaff (Figure 8.10), in a way comparable to the method used by grizzly bears today. Kitchener (1987) took a contrasting approach, suggesting that the combination of the flexible snout tip, large sharp talon, the powerfully developed forelimbs and the narrow snout could be adaptations toward a scavenging lifestyle. However, Reid (1987) was not convinced by a carrion-feeding habit for the animal.

The unusual characters of *Baryonyx* have presented problems in classification. Charig and Milner (1986) considered that its specializations merited erection of a new theropod family which they named Baryonychidae. The only other material directly comparable with *Baryonyx* consisted of two fragmentary snouts from the Aptian (late Early Cretaceous) of Niger previously ascribed to the mandibular symphysis of a spinosaurid dinosaur. Buffetaut (1989, 1992) noted that, although there were some differences between *Spinosaurus* and *Baryonyx,* they share several characters, particularly the structure of the teeth and jaws. These characteristics suggested that they were closely related to each other and might

indicate the inclusion of *Baryonyx* in the family Spinosauridae. Charig and Milner (1990) accepted the similarity of *Baryonyx* to the fragmentary skull specimens from Niger and southern Morocco, but argued that the latter were not spinosaurids. Molnar (1990) referred *Baryonyx* provisionally to 'problematic carnosaurs' .

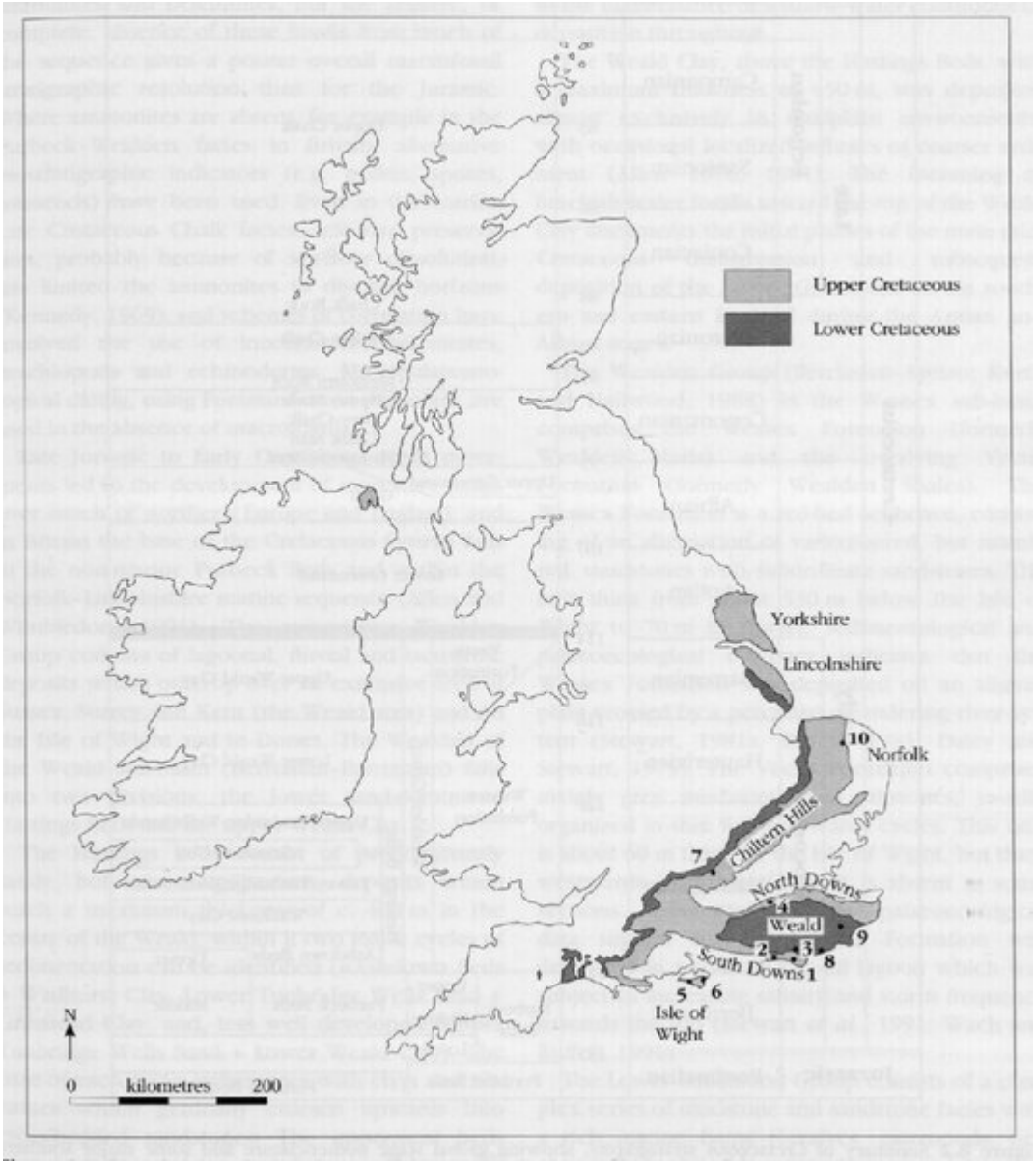
Comparison with other localities

Reptiles are rare in the Weald Clay. The only other important site is at Berwick, East Sussex the Cuckmere Brick Co. pit ([TQ 523 070]) which has yielded the turtle *Plesiochelys* sp., and much of the skull and skeleton of a plesiosaur, the type specimen of *Leptocleidus superstes* Andrews, 1922. Other Weald Clay sites include Clockhouse, Rudgwick and Keymer (see above). The so-called spinosaurids from the Gadoufauna of Nigar (Aptian) and from southern Morocco (Early Cretaceous) are the nearest relatives of *Baryonyx.*

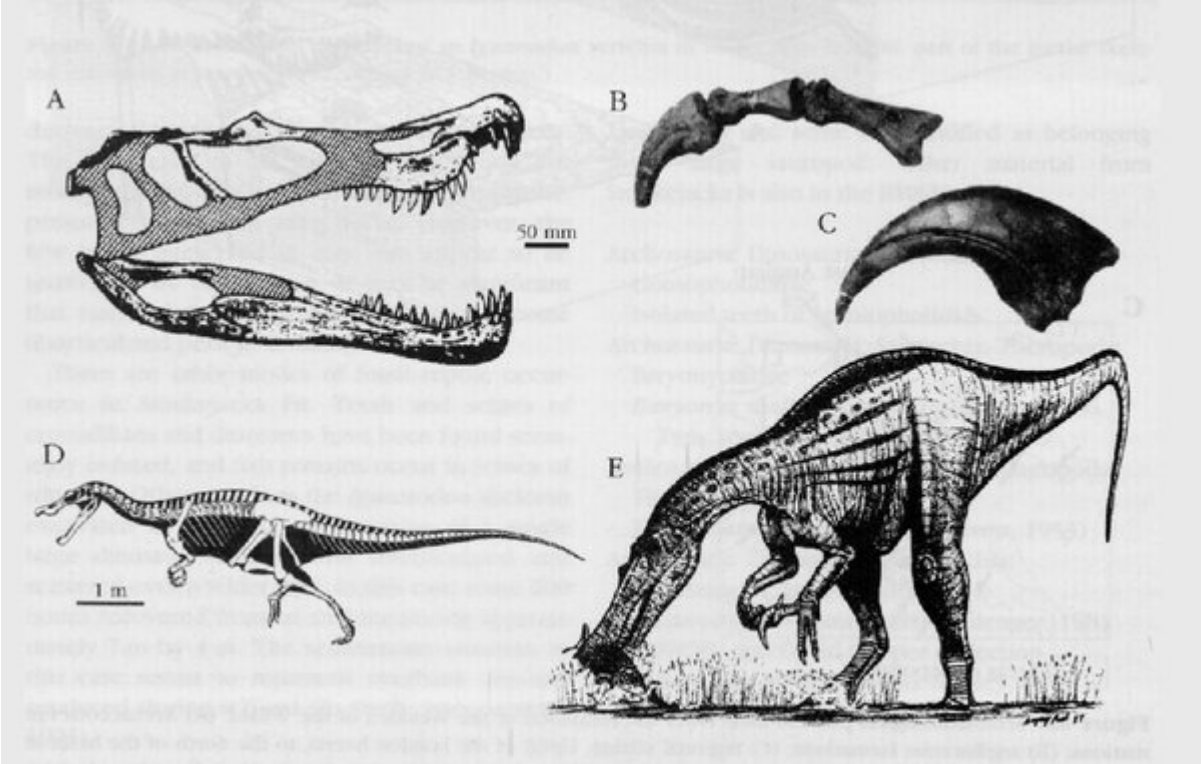
Conclusions

The general rarity of fossil reptiles in the Weald Clay makes Smokejacks Pit important. Furthermore, the abundance of the remains of *Iguanodon* collected in the 1940s and 1990s suggests that there are pockets containing concentrations of bones. This seems to be corroborated by the taphonomic data obtained from the *Baryonyx* excavation. *Baryonyx walkeri* is known only from Smokejacks Pit and is unique among all other theropod dinosaurs. The unusual features of *Baryonyx* have not only resulted in the establishment of a new genus and species for the animal, but also a new family of theropods, the Baryonychidae. *Baryonyx* is the most dramatic new dinosaur discovery from Europe for a long time. The site has tremendous potential for further finds and this contributes significantly to its conservation value.

References



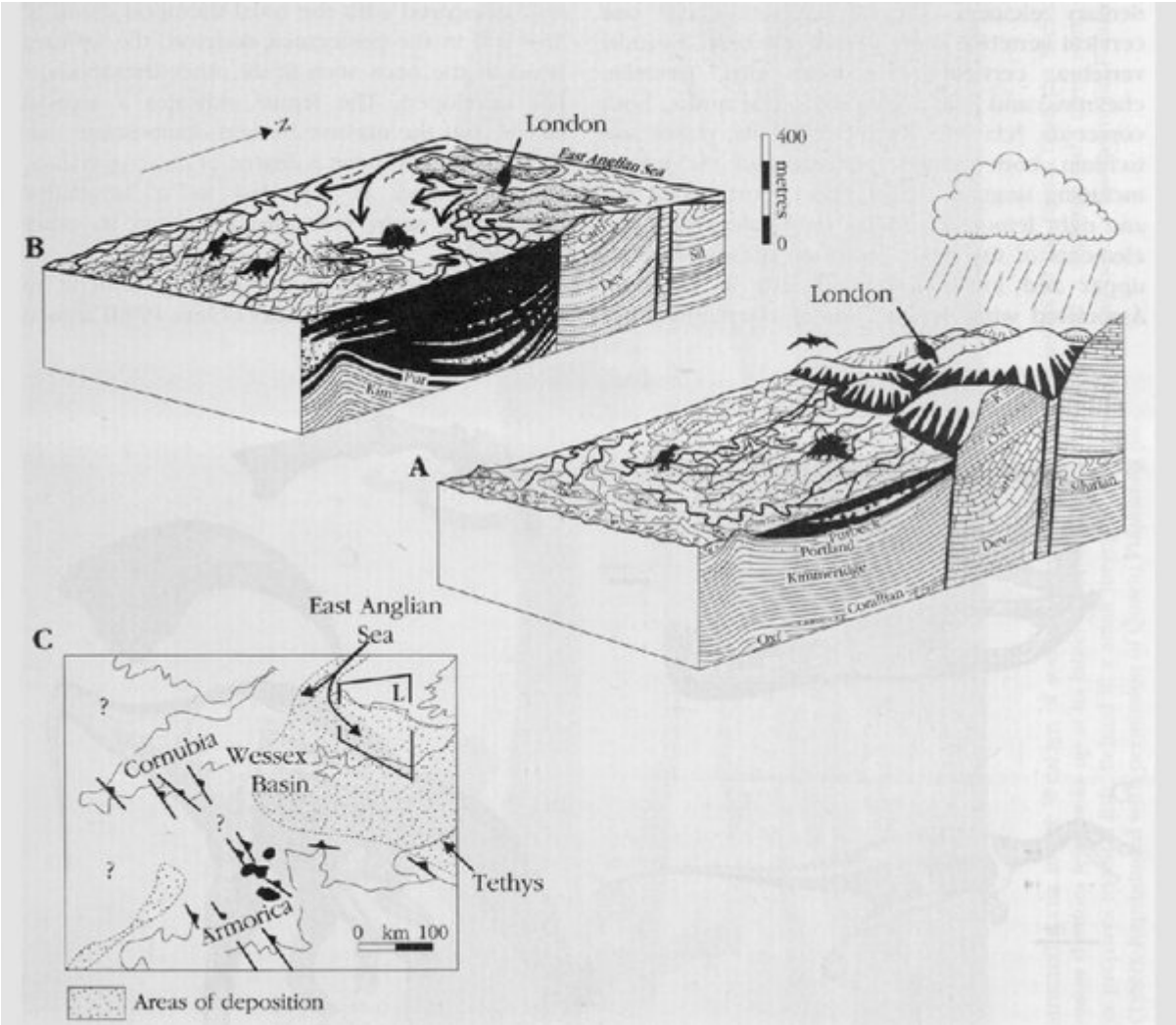
(Figure 8.1) Map showing the distribution of Cretaceous (Lower and Upper) rocks in Great Britain. GCR Cretaceous reptile sites: (1) Hastings; (2) Black Horse Quarry, Telham; (3) Hare Farm, Brede; (4) Smokejacks Pit, Ockley; (5) Brook–Atherfield Point, Isle of Wight; (6) Yaverland; (7) Wicklesham Pit, Faringdon; (8) East Wear Bay, Folkestone; (9) Culand Pits, Burham; (10) St James's Pit, Norwich.



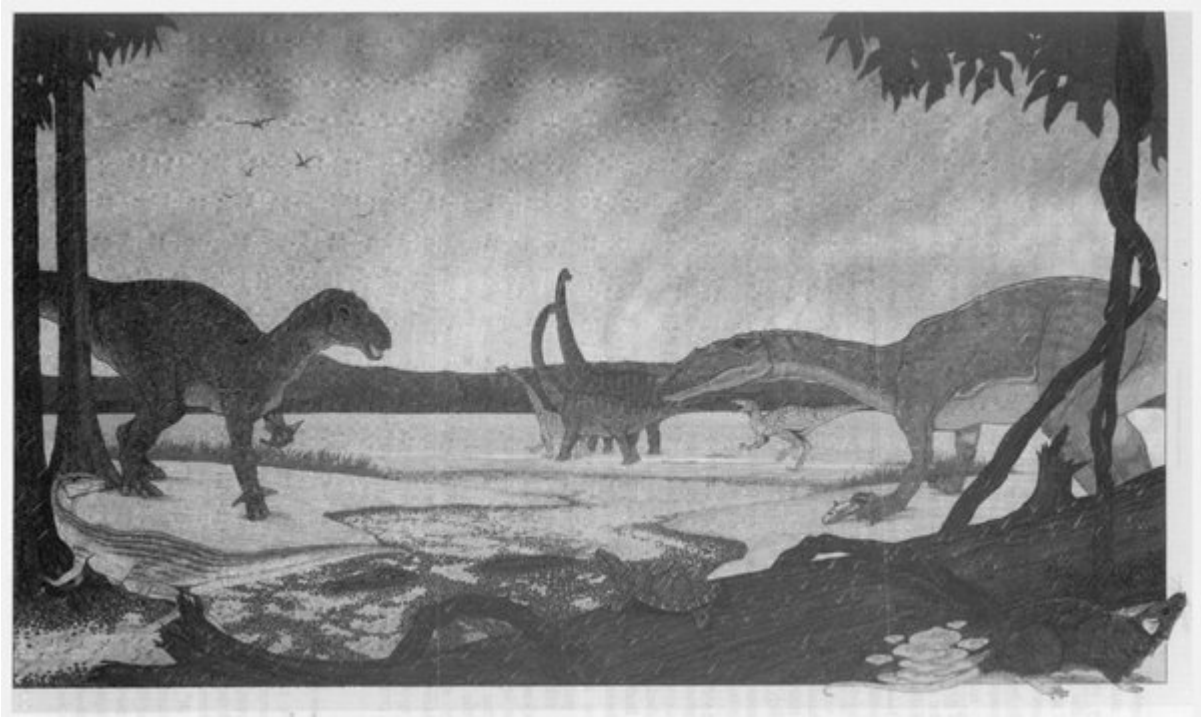
(Figure 8.9) The most famous recent British dinosaur discovery, the enigmatic theropod Baryonyx walkeri Charig and Milner, 1986 ('Superclaw'), from the Early Cretaceous Weald Clay of Smokejacks Pit, Ockley, Surrey. (A) Skull bones as preserved; (B) normal digit, presumably from the hand; (C) the claw; (D) restoration of the skeleton; (E), imagined life appearance. (A) and (C) after Charig and Milner (1990); (B), (D) and (E) after Milner (1987).

(Figure 8.6) Excavation of a partial Iguanodon skeleton at Smokejacks Brickpit in summer, 1992. (Photo: M.J. Benton.)

(Figure 8.7) Dr Glenn Storrs consolidates an Iguanodon vertebra in Smokejacks Brickpit, part of the partial skeleton excavated in summer, 1992. (Photo: M.J. Benton.)



(Figure 8.8) Sedimentological process models for the formation of the Wealden of the Weald. (A) Arenaceous formations; (B) argillaceous formations; (C) regional setting. Uplift of the London horsts, to the north of the basin of deposition, produced an area of high relief and an extensive source of sediment (A). Braided alluvial sand plains expanded southwards from the uplands, and the lowlands supported diverse floras and faunas, including dinosaurs (A). Downfaulting and denudation of the London horsts reduced relief and the rate of sediment supply (B), and the Weald area became a brackish–freshwater lagoonal–alluvial mudplain. Again, abundant vegetation grew around the lakes, and a diverse fauna of fishes, insects and reptiles inhabited the area.



(Figure 8.10) A reconstructed scene in the Wealden of southern England, combining elements of the faunas from the Weald and from the Isle of Wight. The small ornithopod Hypsilophodon (bottom left) looks up at its larger relative Iguanodon, just behind. A mammal and a turtle stand in the bottom right, while behind them the theropod Baryonyx prepares to eat a fish. Behind it, a small theropod runs towards a small herd of the sauropod Pelorosaurus. Based on a painting by Graham Rosewarne in Benton (1989). Reproduced with permission of Quarto Publishing plc.