THE SUTTON STONE: AN EARLY JURASSIC ROCKY SHORE DEPOSIT IN SOUTH WALES

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ABSTRACT. The unconformity between Jurassic and Carboniferous carbonates at Southerndown, near Ogmore-by-Sea, Mid-Glamorgan, represents an ancient rocky shoreline which has had a long history of study. Henry De la Beche discussed the ecological details of the unconformity surface, but subsequent debates focused more on the age and depositional setting of the basal Jurassic conglomerate known as the Sutton Stone. Our contribution returns to the theme of faunal development on the unconformity surface. The Jurassic corals, *Allocoeniopsis gibbosa* and *Heterastraea* sp., occur as encrusters of the Carboniferous substrate on a tidal abrasion platform. Serpulid-worm colonies may be observed in life position above the stepped unconformity, but not attached to it. These and other features of a physical and biological nature suggest sporadic preservation in rapidly changing ecological settings during an Early Jurassic marine transgression.

CLIFFS on the Bristol Channel coast at Southerndown, near Ogmore-by-Sea, South Wales, expose segments of a well preserved Jurassic coastline forming part of a small, rocky island (Bradshaw *et al.* 1992, p. 108) composed of thick-bedded Carboniferous Limestone (Wilson *et al.* 1990). The unconformity is overlain by the Sutton Stone (De la Beche 1846), a Lower Jurassic (Hettangian) conglomerate.

Convincing descriptions of ancient rocky shores in the geological literature are very few. Only 155 references (covering both the Precambrian and Phanerozoic) are cited in the most recent bibliography (Johnson 1992). Among these, only nine citations refer to Jurassic rocky shores, but over half of them relate to the Vale of Glamorgan. In addition, there have been numerous palaeontological publications on the area, and the unconformity has been discussed in many more general works: from Conybeare and Phillips (1822) to Bradshaw *et al.* (1992). The Hettangian rocky shoreline at Southerndown is both the longest studied and most argued about feature of its kind anywhere in the world. Much of the debate has concerned the age of the unconformity, the applicability of stratigraphical units assigned to rocks above the unconformity, the nature of fauna colonizing the shoreline, and the depositional environment on the shoreline.

Despite its intense history of study, the locality still yields additional observations of interest. As an outstanding example of a Jurassic, tidal-abrasian platform, Southerndown is an especially suitable place to look for a fossil community characterized by borers, encrusters, and clingers adapted to life in the surf zone. Faunas associated with submarine hardgrounds are thoroughly reviewed by Wilson and Palmer (1992), but very little is known about the evolution of rocky-shore communities through geological time (Johnson 1988; 1992).

The objectives of this paper are to review the history of research at Southerndown and to report on new discoveries of encrusting organisms on the surfaces of the eroded Carboniferous Limestone.

LOCATION AND GEOLOGICAL SETTING

On the Heritage Coast south of the Ogmore River, 2·5 km of nearly continuous section show Triassic and Jurassic strata resting unconformably on Carboniferous Limestone. The Triassic rocks are poorly sorted terrestrial breccias, while the Jurassic rocks consist of marine conglomerates and bioclastic limestones. The Triassic breccias are assigned to the Late Triassic Mercia Mudstone Group, because elsewhere in the Bristol Channel area equivalent beds are conformably below the

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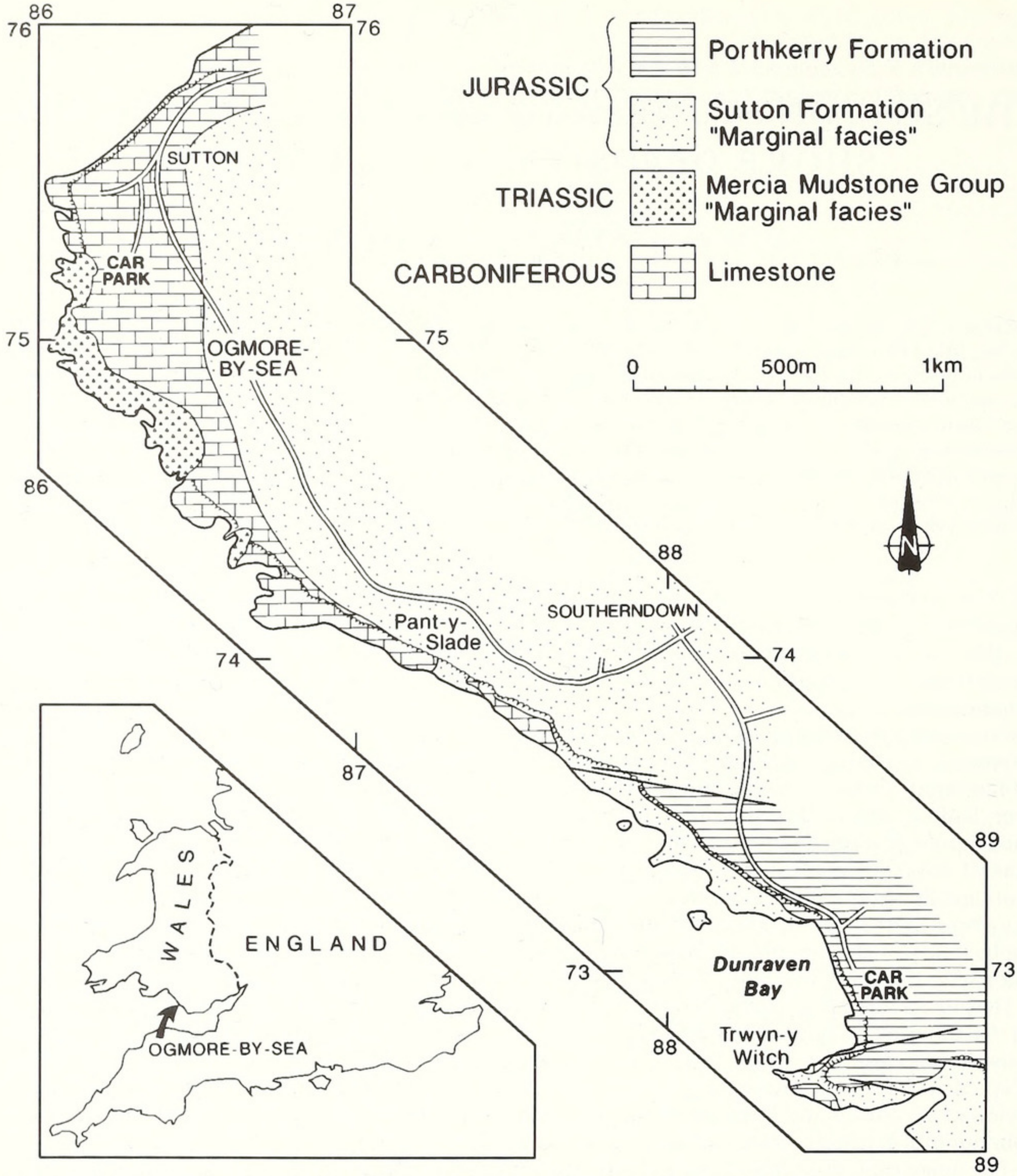


TEXT-FIG. 1. Map of the coast between Ogmore-by-Sea and Dunraven Bay (modified from Wilson *et al.* 1990, p. 48). The British National Grid lines are indicated on the margins; insert shows position of Ogmore-by-Sea on the coast of South Wales.

Penarth Group of known Rhaetian age (Wilson *et al.* 1990). The Jurassic bioclastic limestones contain Hettangian and Sinemurian ammonites (Hodges 1986).

The Triassic breccias of Glamorgan and Somerset were deposited in valleys with a relief not very different from that of those occurring today in south Glamorgan and the Mendip Hills. However, the deposits at Ogmore are so coarse (with some clasts over 1 m in diameter) and unsorted that they represent a very different environment from the present; they have been interpreted as flash flood deposits by ephemeral rivers, but they may also be related to contemporary earth movements (Tucker 1977). There are two outcrops of Triassic breccias on the shore at Ogmore (Text-fig. 1); the northern one (extending 850 m from SS 861753 to 864744) appears to have been deposited in a broad irregular valley and the southern one (at SS 866743) is exposed in a narrow valley (less than 100 m wide) with a steep gradient down to the south-west. Both Triassic deposits accumulated rapidly, perhaps 'on a Tuesday afternoon' (cf. Ager 1986, p. 35).

The sub-Jurassic unconformity is very different from the sub-Triassic one, both in its morphology and in the bedded nature of the overlying deposits. Marine planation on the Carboniferous Limestone surface has produced gently inclined platforms on which the basal Jurassic conglomerates rest. The exposed surface near the foot of the gulley named Pant-y-Slade (SS 871741; Text-fig. 1) has been termed Platform A (Fletcher 1988); towards the southeast (SS 875378) the basal deposits on this platform overlie topographically earlier deposits on two lower platforms (B and C). All the platforms are generally smooth, except for some channels and ridges towards the southeast limit of Platform A (Fletcher 1988, fig. 3) and a few isolated low rises where the flat-bedded Carboniferous Limestone may extend a few decimetres above the general level. To the south-east, the unconformity descends below sea level in Dunraven Bay. North of the car park in the bay, the high (and dangerous) cliffs are composed of conglomerates and calcarenites of the 'marginal facies' Sutton Formation (Sutton Stone and Southerndown Beds) lying below the offshore facies of the 'Blue Lias' Porthkerry Formation (Wilson *et al.* 1990). To the south of Dunraven Bay, there is a much more pronounced angular unconformity on the promontory of Trwyn-y-Witch (SS 885726), which is best exposed (at low tide) on the south side of the point.

PREVIOUS RESEARCH

The earliest reference in the geological literature to the unconformity between Palaeozoic and Mesozoic rocks in South Wales was made by Conybeare and Phillips (1822, p. 31). They described 'horizontal deposits of calcereo-magnesian conglomerates, new red standstone and lias' as a sequence of formations which 'rest on the back of the most southerly zone of carboniferous lime along the coast from the mouth of the River Ogmore to the Taafe.'.

Subsequently, De la Beche (1846, p. 246, fig. 26) compared the basal Jurassic beds above the unconformity in Glamorgan with similar rocks in the English Mendip Hills, where he described the Bajocian shoreline conglomerate as a 'beach-like accumulation'. His illustrations of Jurassic borings in the Carboniferous substrate are the first of their kind in the geological literature. The small borings (1846, fig. 43) are easily referable to *Trypanites*. The shell of a bivalve in a larger boring (1846, fig. 44) is unmistakably *Gastrochaenolites*, a boring by *Lithophaga*. *Trypanites* and *Lithophaga* borings occur at Southerndown (Fletcher 1988, p. 4) as well as in the Mendip Hills.

Less than twenty years after publication of De la Beche's far-ranging report, heated debate broke out regarding the age, geographical setting, and depositional environment of the Sutton Stone. Some aspects of this debate have filtered down to the present day.

Hodges (1986, p. 239) concluded that the Sutton Stone and overlying Southerndown beds of Tawney (1866) should be abandoned as distinct stratigraphical units with independent characteristics, because of their great 'vertical changes in both lithology and colour' and the fact that they cannot be separated palaeontologically. Fletcher *et al.* (1986), on the other hand, considered these units to be suitable lithofacies for distinct nomenclature. Ager (1986) followed Hodges' recommendation in assigning the Sutton Stone and overlying Southerndown Beds to the Sutton Formation.

Age of the Sutton Stone

Tawney (1986, p. 75) divided the stratigraphical sequence above the unconformity (approximately 30 m thick) into the 'Sutton series' and the overlying 'Southerndown series'. Contrary to De la Beche (1846), the 1·2 m thick basal conglomerate was included by Tawney (1866, p. 73) as part of the 12 m thick Sutton series. Tawney followed Jones and Tomes (1865) in assigning the beds to the Rhaetian on the basis the supposed range of the bivalve '*Ostrea interstriata*' from the Sutton Stone. This species may now be referred to *Atreta intusstriata* (Emmerich); it is present in both the Upper Triassic and Lower Lias (Lower Jurassic) of Europe (Hodges 1991).

Tawney (1866, p. 81) was the first to describe ammonites from the Sutton Stone on the coast, among them a species he named *Ammonites suttonensis*. Specimens were recovered at a level about 6 m above the base of the unconformity, both at Sutton quarry and Trwyn-y-Witch (Text-fig. 1). Tawney's species is allied with *Caloceras johnstoni* signifying the upper subzone of the *Psiloceras planorbis* Zone (Hodges 1986). The ammonite *Schlotheimia* cf. *thalassica* was later recorded (Trueman 1922) at a horizon about 3 m above the base of the unconformity at Pant-y-Slade. This nominal species is now considered to be a synonym of *S. angulata*, representing the youngest ammonite zone in the Late Hettangian (Hodges 1986). These and other ammonites collected by Hodges (1986) derive from the Sutton Stone near Ogmore, but from horizons well above the basal conglomerate. No ammonites have ever been recovered from the basal conglomerate of the Sutton Stone, but Hodges (1986, p. 239) surmised that the base of the section at Pant-y-Slade was almost certainly in the *planorbis* Zone, possibly extending down into the Upper Rhaetian.

In the first description of corals from the Sutton Stone, Duncan (1866, p. 90) maintained that the Welsh corals had 'nothing in common with any species from Liassic strata', but Bristow (1867) maintained that the age was Early Jurassic, based on the occurrence of '*Ostrea liassica*' and other bivalves. Later, Duncan (1867) recanted his earlier interpretation, though Tomes (1884) still attempted to salvage his argument for a Rhaetian age. All subsequent references to the basal conglomerate of the Sutton Stone assume it is Lower Jurassic in position, except for the possibility (Francis 1959; Hodges 1986) that the base of the section may extend down into the Upper Rhaetian.

Observations on palaeoecology

Records show that Charles Moore led a field trip to Southerndown in 1866 for the members of the Bath Natural History Club, who collected corals and bivalves from the conglomerate above the unconformity (Winwood 1867). Correspondence with Moore, quoted in Jones and Tomes (1865, p. 191), shows that oysters were found 'attached to Carboniferous Limestone pebbles'. Moore (1877) was also the first to verify that Mesozoic organisms encrusted the Carboniferous Limestone in the Vale of Glamorgan.

The presence of limpets (Tawney 1866, p. 88; Huddleston and Wilson 1892; Strahan and Cantrill 1904) and the top shell, *Trochus*, have also been debated; these are both forms typical of modern intertidal rocky shores.

Although it could be considered that most massive coral species can show an encrusting habit (B. R. Rosen, pers. comm. 1995), this was long a subject for debate. Duncan (1866, 1867) and Moore (1877) recorded numerous corals from the Sutton Stone. Tomes (1884) reported that the coral *Elysastraea fischeri* (this species is now referred to the genus *Heterastraea*) was the only coral (out of 42 species) to encrust clasts of Carboniferous Limestone, and he stated specifically that he had 'not in a single instance met with the *Elysastraea* growing on the floor of Mountain Limestone beneath the Sutton Stone'. Nonetheless, this observation was used to suggest the former existence of coral islands (Tomes 1884, p. 362). Subsequently, Duncan (1886) confirmed the encrusting nature of some corals within the Sutton Stone. In particular, he noted that '*Astrocoenia parasitica* encrusts foreign bodies' (Duncan 1886, p. 105). Reviewing all the evidence available, Arkell (1933, p. 126) concluded that true coral reefs had never formed on Jurassic shores in the Vale of Glamorgan. However, Cox and Trueman (1936, p. 57), considered that a 'distinct coral reef was built' around a small island near Wick.

Jurassic palaeogeography

Trueman (1920, 1922, fig. 67B) recognized a chain of small islands, and mapped shorelines in the vicinity of Dunraven, Wick, and Cowbridge. The high percentage of calcareous material in the

Sutton Stone was taken as evidence that very little sediment found its way into the coastal deposits, except for that derived directly from the carbonate basement rocks. Geological cross-sections through the islands (Trueman 1922, fig. 68; Wilson *et al.* 1990, fig. 9) suggest that the islands were drowned soon after the end of the Hettangian.

The islands were called St David's Archipelago by Ager (1974, 1986) and their interpretation by Bradshaw *et al.* (1992, p. 109) as islands off the Welsh Landmass is essentially the same as suggested by Trueman (1922). Discovery of marine Jurassic beds in the Irish Sea, however, has greatly reduced the size of the postulated land areas in Wales.

Curiously, recent work lacks any reference to palaeolatitudes. An Early Jurassic (Hettangian) reconstruction of global coastlines by Smith *et al.* (1994, p. 51) indicates a position slightly above 30° N latitude for this part of the British Isles.

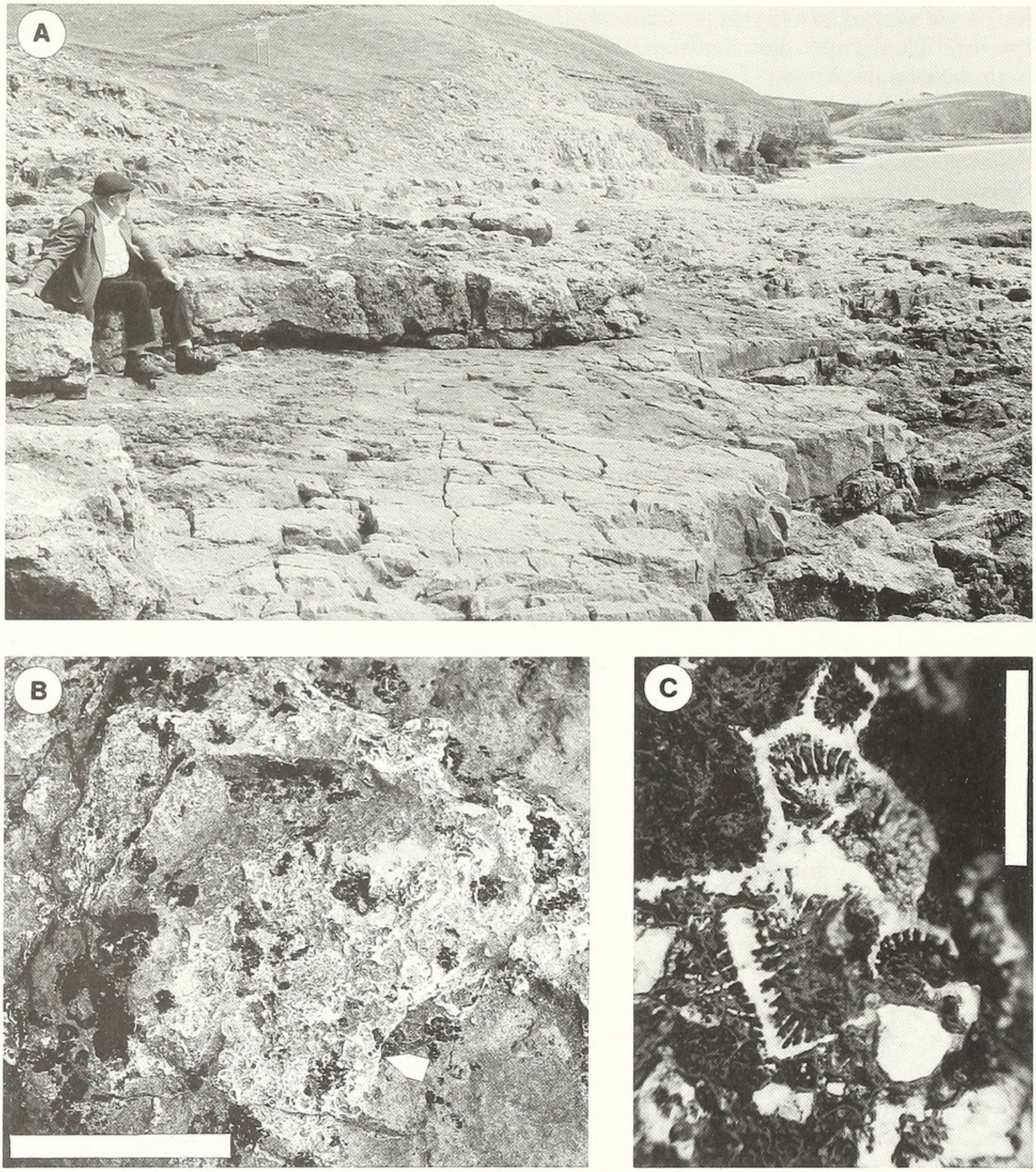
Depositional setting of the Sutton Stone

The most recent controversy to emerge is without doubt the depositional setting of the Sutton Stone. Ager (1986, p. 35) concluded that it is a debris-flow deposit resulting from a major tropical storm or hurricane which happened 'one Tuesday afternoon'. This notion was based on the argument that the Sutton Stone is a matrix-supported conglomerate with pebbles that float in a fine-grained matrix (see Ager 1993, fig. 9.4). The sort of shingle at Dungeness which was appealed to by De la Beche (1846) as a useful model for the Jurassic basal conglomerate, consists of clast-supported pebbles (see also Ager 1993, fig. 9.3).

Fletcher *et al.* (1986, p. 383) pointed out that a variety of breccias, conglomerates, and skeletal grainstones occurred at different levels and thus the Sutton Stone could not represent a single depositional event. An alternative model was subsequently elaborated (Fletcher 1988, p. 9) in which a suite of different rock fabrics could be produced as a result of cliff collapse and retreat at the back of a wave-cut platform. The origin of some Jurassic features and fabrics at Southerndown were likened to processes on modern carbonate shores, as observed in Puerto Rico (Kaye 1959). Fletcher (1988) concluded that the sculpturing of the Jurassic platform and rocky shoreline at Southerndown took place during still-stands in sea level under conditions of a 2 m tidal range. Under this model, derivation of the Sutton Stone conglomerate by means of day-by-day cliff collapse was also influenced by storm events.

VESTIGES OF ECOLOGICAL TIME

Uniformitarian and catastropic outlooks are popularly portrayed as at variance with one another in assessing the development of the stratigraphical record (Ager 1993). Unconformities and the basal conglomerates typically associated with the transgression of ancient rocky shorelines provide one setting where both outlooks must be accommodated. On one hand, the erosion of an unconformity surface entails day-by-day processes of sedimentary abrasion and hydraulic forcing in the surf zone. The remains of organisms dwelling on ancient rocky shores generally include encrusting, boring, and clinging forms adapted to a high-energy environment, but conveniently preserved *in situ*. Such remains may be found attached to the unconformity surface, itself, or to the clasts which comprise the basal conglomerate. These fossils, as well as erosional surfaces, such as wave-cut platforms and seastacks, represent vestiges of ecological time retained in the stratigraphical record. On the other hand, the shingle fronting a rocky shoreline may be regarded as a deposit most effectively shaped and transported by violent storms. Many authors would agree with Ager (1993) that rocky-shore deposits and their biotas rarely enter the stratigraphical record because of their propensity to be completely eroded away (see review in Hayes *et al.* 1993). Our examination of the unconformity at Southerndown was prompted by the expectation of finding small events on an ecological time scale preserved in the rock record.



TEXT-FIG. 2. Encrusting corals on the unconformity surface near the bottom of Pant-y-Slade (Platform A). A, general view of the exposure, showing the Jurassic Sutton Stone sitting unconformably on the Carboniferous High Tor Limestone. B, slightly raised, but badly weathered, Jurassic coral colony attached to the surface of the Carboniferous limestone; scale bar represents 60 mm; corallum rests below seated figure's left foot in the Text-figure 2A. C, enlargement of individual corallites attributed to *Heterastraea* sp. from the colony shown in Text-fig. 2B; scale bar represents 10 mm; OUM J.55601.

New discoveries on the unconformity surface

Near Pant-y-Slade (SS 871741), a thorough search for encrusting organisms now confirms the presence of encrusting corals and bivalves, as well as the annelid boring, *Trypanites*, on the surface

TABLE 1. The Jurassic rocky-shore fauna of the Vale of Glamorgan.

Life style	Platform attachment	Clast attachment	References
Encrusting forms			
Corals			
Heterastraea sp.	×	×	Tomes (1884); this report
Allocoeniopsis gibbosa	×	×	Duncan (1886); this report
Bivalve			
Liostrea sp.	×	×	Jones and Tomes (1865); Moore (1877); this report
Boring forms			
Bivalve (*Lithophaga*)			
Gastrochaenolites	×	×	Fletcher (1988)
Annelid			
Trypanites sp.	×	×	Fletcher (1988); this report
Clinging forms			
Gastropods			
Patella suttonensis			Tawney (1866)
'*Trochus*'			Strahan and Cantrill (1904)

of the Carboniferous Limestone (Text-figs 1–2; Table 1). This search was made on a narrow exposure surface (130 m long but only a few metres wide) of Platform A (Fletcher 1988, p. 3).

Several badly weathered disc-shaped objects are present (Text-fig. 2A). Unlike all the Carboniferous corals observed, they are not planed flat, but are raised above the surface. They are also distinguishable from Carboniferous rugosans (particularly the common genus *Lithostrotion*) by the absence of regularly alternating major and minor septa, the absence of a well-defined outer ring of dissepiments, and septa with irregular, rather than smooth and straight, margins (B. R. Rosen, pers. comm. 1995).

A closer view of one example (Text-fig. 2B) shows an elliptical disc no more than 140 mm in diameter. At higher magnification (Text-fig. 2C), a few corallites are still visible on the surface of the disc, all less than 10 mm across. The open pattern of the corallites, with their clear septal divisions, indicates that the discs are colonial corals preserved in life position. This encrusting form has been identified as *Heterastraea* (B. R. Rosen, pers. comm. 1992). Specimens similar in growth were referred to as '*Elysastraea fischeri*' by Tomes (1884), who noted their clast-encrusting habit.

Other Jurassic examples of encrusting corals, attributed to *Allocoeniopsis gibbosa* (B. R. Rosen, pers. comm. 1992), were discovered on the Carboniferous pavement approximately 70 m northwest of the *Heterastraea* colonies. Again, this observation supports Duncan (1886), who recorded the clast-encrusting habit of a species he identified as '*Astrocoenia parasitica*'. An example of the pavement-encrusting *Allocoeniopsis gibbosa* (Text-fig. 3A) shows good preservation of corallites facing upward in growth position. The margins of the corallum, however, have been worn away.

The discovery of Jurassic corals encrusting the Carboniferous substrate corroborates the original argument by Tomes (1884) that life must have flourished on the unconformity surface before deposition of the Sutton Stone. As the species on the substrate are the same as encrusting species within the Sutton Stone, however, the difference in geological time may not be very significant.

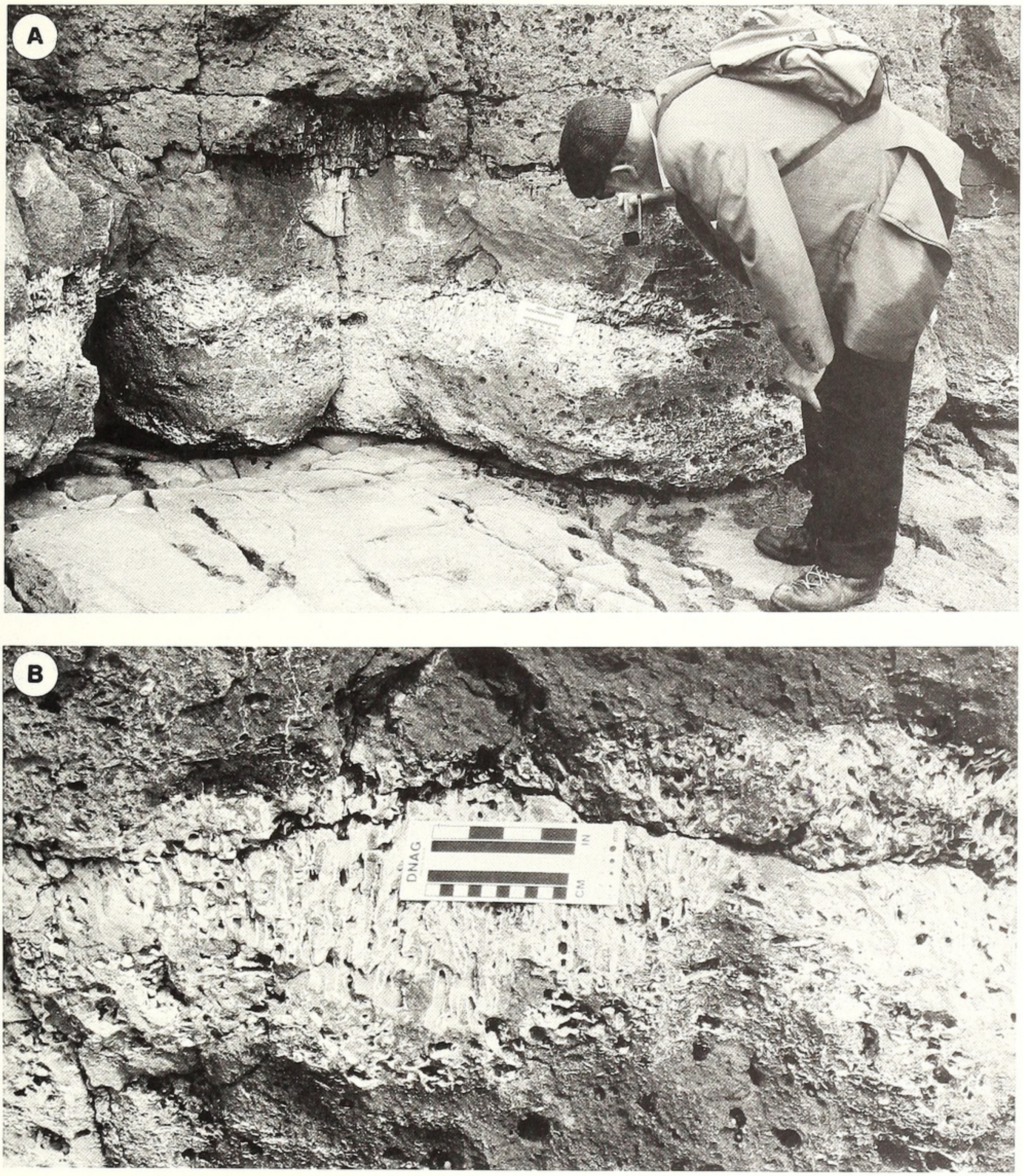
Verification and correction of prior observations

Moore (1877) was the first to record oyster encrustations on the Carboniferous unconformity at Southerndown, but none has been illustrated previously. An attached valve of an oyster (Text-fig. 3B) occurs on the Carboniferous pavement approximately 60 m northwest of the *Heterastraea*

TEXT-FIG. 3. Fossils and physical features on the unconformity surface near the bottom of Pant-y-Slade (Platform A). A, portion of the corallum belonging to *Allocoeniopsis gibbosa* (Duncan) attached to the Carboniferous High Tor Limestone; scale bar represents 10 mm; OUM J.55602. B, attached valve of an unidentified oyster on the same surface; scale bar represents 10 mm. C, tidal rills eroded in the Carboniferous substrate.

colonies. A single valve of *Pecten suttonensis* was also found resting directly on the unconformity surface close to the *Heterastraea* colonies. This species, however, is not considered to have lived attached to the pavement. At a distance 15 to 27 m southeast from the *Heterastraea* colonies, the Carboniferous pavement is bored extensively by *Trypanites*.

To the southeast of Pant-y-Slade on Platform A, the Carboniferous surface exhibits the distinctive tidal rills (Text-fig. 3C), which were first described as channels and ridges by Fletcher



TEXT-FIG. 4. Serpulid colonies in growth position (above Platform B). A, several colonies 300 mm above the Carboniferous substrate. B, enlargement of previous view; scale is 100 mm long.

(1988). The low-sided channels are approximately 1 m wide and 300 mm deep, displaying a consistent orientation. The rills are exhumed from beneath the overlying Sutton Stone.

Only a few metres farther to the south-east, Platform A drops off vertically about 1·5 m to Platform B (Fletcher 1988). It was on this smaller platform that Cope (1971, p. 118) first recorded the occurrence of 'masses of serpulid tubes.' These features were also noted by Ager (1986, p. 30) as preserved in life position within the Sutton Stone, although he gave the mistaken impression that their colonies rest directly on the Carboniferous Limestone. We observed seven serpulid colonies in the lower part of the Sutton Stone conglomerate above Platform B (Text-fig. 4A–B), spread out over a lateral distance of 2·5 m. On average, each colonial mass is 300 mm in diameter and about 200 mm in height. Six colonies are preserved in life position 300 mm above the unconformity; one occurs only 150 mm above the unconformity surface.

Ager (1986) maintained that these colonies represent the only fossils to be found in growth position in the Sutton Stone of Southerndown. On Platform A, close to the locality with the *Heterastraea* colonies, we observed numerous colonies of cerioid corals in life position within the Sutton Stone at a horizon about 0·5 m above the unconformity surface. On average, these dome-shaped colonies are about 30 to 40 mm in height and 150 mm in diameter, spaced at intervals of approximately 250 mm on a bedding plane. These corals occur at a separate level at least 17·5 mm above the level of the serpulid colonies on Platform B. These occurrences contradict the conclusion by Ager (1986) that the local Sutton Stone is a single, chaotic debris-flow deposit.

Summary of fossil data

The diversity of the Jurassic rocky-shore community at Southerndown is summarized in Table 1. Seven species are preserved *in situ* on the unconformity surface, *in situ* on clasts in the basal conglomerate, or loose within the Sutton Stone. Due to their encrusting, boring, or clinging habits, these species may be considered fixed elements of the Jurassic rocky-shore community. Other species may belong to this community, but it is difficult to prove their remains were not transported landward from a more offshore setting.

DISCUSSION

Examples of rocky-shore, intertidal platforms preserved in the geological record are few in number (Johnson 1992). The oldest known possible example is the Precambrian unconformity between the Torridon and Stoer groups in north-west Scotland (Lawson 1976), with exhumed surfaces including a stepped topography with small runnels and channels. Cherns (1982) described tidal erosion surfaces in the Silurian Eke Formation on Gotland, Sweden. These included solution basins comparable with features forming today in coastal karst terrains. Stromatolitic mats developed in some of these basins, and abutted directly against confining side walls. In Israel, Cretaceous disconformity surfaces with *in situ* bivalve borings, which have been partially abraded away, are described by Lewy (1985) as having formed in an intertidal setting. Pliocene and modern abrasian platforms with tidal rills eroded in a contiguous Upper Cretaceous shaley substrate are described by Ledesma-Vazquez and Johnson (1994) from Baja California, Mexico. Like the Israeli disconformities, these intertidal surfaces are bored extensively by bivalves.

In terms of its palaeolatitude, physical topography and range of fossils, a good analogue of the Jurassic platform at Southerndown is the well preserved Pleistocene platform on the shores of Western Australia (Johnson *et al.* 1995). This abrasion platform at the mouth of the Greenough River near Geraldton, exhibits well developed tidal rills eroded in a sandstone substrate. The channel surfaces are uncolonized but the ridge tops are extensively covered by red coralline algae and other encrusters, including oysters, two kinds of serpulid worms, and a scleractinian cup coral. At a slightly higher elevation devoid of tidal channels, the same disconformity surface was colonized by boring barnacles. Gastropods, dominated by robust turbinate shells, were mobile intertidal dwellers on this surface. The entire surface was taken over by a fringing coral reef under transgressive conditions. This Pleistocene disconformity surface has a rocky-shore fauna of at least seven common species. By comparison, the Jurassic rocky shore at Southerndown has an equal number of closely associated species. The main difference between the two systems is that the Jurassic platform seems to lack any encrustations of coralline red algae. Borings on the Pleistocene surface appear to be limited by the success of the coralline red algae as an encrusting cover.

Palmer (1979, p. 214) confirms the occurrence of the long-ranging rhodophyte, *Solenopora* *jurassica* in Middle Jurassic rocks of England, but the crustose coralline algae, including widely cited forms such as *Lithothamnium*, did not evolve until Late Jurassic time (Wray 1977).

In terms of size, the largest encrusters on the Jurassic unconformity at Southerndown are the colonial corals, here identified as *Heterastraea* sp. and *Allocoeniopsis gibbosa*. Very few examples are known of fossil corals attached directly to non-organic surfaces. The oldest record is from the Upper Ordovician of Hudson Bay, where *Favosites* sp. occurs encrusted on quartzite boulders (Johnson and Baarli 1987) in a rocky-shore setting. Webb (1993) has documented encrustations of another tabulate coral, *Michelinia scopulosa*, on a Carboniferous unconformity in Arkansas. Lower Pennsylvanian corals sit on a karst surface eroded in the Upper Mississippian Pitkin Limestone. An unidentified scleractinian coral is shown by Lescinsky *et al.* (1991, figs 4D–F) to encrust andesite boulders in a rocky-shore setting of Late Cretaceous age in Baja California, Mexico. Octocoral encrusters on gneiss boulders are reported from a rocky-shore setting in the Upper Cretaceous of Bohemia (Zitt and Nekvasilova 1993). The only other coral documented as living as an encruster on an abrasion platform is the scleractinian cup coral, *Rhizotrochus tuberculatus*, reported as the first fossil occurrence from the Upper Pleistocene of Western Australia (Johnson *et al.* 1995). In checking information on corals encrusting non-organic surfaces compiled by Johnson (1992) and Wilson and Palmer (1992), it is evident that the Southerndown locality records one of the earliest instances of scleractinian corals in this habit.

The Cretaceous rocky-shore locality in Baja California also has yielded examples of the pecten, *Lyriochlamys* sp., preserved in life position wedged among boulders (Lescinsky *et al.* 1991, fig. 4A). It is possible that some of the Jurassic pterioid bivalves at Southerndown, such as '*Pecten suttonensis*' or '*Lima gigantea*' may have adopted the same life style. This will be difficult to prove, however, given the nature of floating clasts in the Sutton Stone and parts of the underlying Southerndown Beds.

CONCLUSIONS

Important observations on the palaeoecology of encrusting oysters and corals in the Sutton Stone of Southerndown were recorded by 19th century paleontologists such as Moore (1877), Tomes (1884), and Duncan (1886). Trueman (1922) placed the unconformity on which the Sutton Stone rests into a much broader context with his seminal description of Early Jurassic islands eroded from Carboniferous carbonates. To this most historic example of an ancient rocky shoreline, we add the first recognition of corals encrusting directly on the unconformity surface and preserved in growth position. The age of the corals *Heterastraea* sp. and *Allocoeniopsis gibbosa* found in this condition, conform with the known Lower Jurassic distribution elsewhere in the British Isles (Negus 1991).

As a time-transgressive facies representing a 'littoral' setting, use of the term Sutton Stone appears to be fully justified as applied particularly to the basal conglomerate resting discontinuously on the unconformity surface. The nature of the eroded platform surface underlying the Sutton Stone and its surprisingly diverse fauna of encrusting, boring, and clinging organisms clearly confirm vestiges of ecological time in the development of this Jurassic rocky shoreline, as suggested by Fletcher (1988). The same argument may be applied to fossil encrustations on clasts and to the preservation in growth position of large coral and serpulid colonies within the Sutton Stone. The mass-flow deposit envisioned by Ager (1986) should not be attributed to a single storm event. Careful reinvestigation of the Southerndown locality indicates that other ancient rocky-shore localities reported in the literature may be expected to yield additional information of palaeoecological value.

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