FOSSIL COLLECTING AND SITE CONSERVATION IN BRITAIN: ARE THEY RECONCILABLE?

by DAVID B. NORMAN

ABSTRACT. Collecting fossils for scientific study or as a pastime activity can be a very enjoyable and rewarding experience. However, the motives for collecting fossils, which can range from pure scientific research through hobby collections to commercial enterprise, can present the genuine scientist, hobbyist/collector or legislator with a variety of challenging and conflicting points of view. Imposing legislation which will allow collection through a permit system is appropriate only in a restricted number of cases and is generally regarded as unwieldy, open to abuse and expensive to implement, and may in the longer term damage the scientific value of most sites. However, adopting a totally *laissez-faire* approach to all sites runs the risk of complete loss of fossil localities through over-collection and destruction of specimens. Options for dealing with this paradoxical situation are discussed and some recommendations proposed.

THE history of fossil collecting is one that can be traced some considerable distance into antiquity (Wendt 1968; Rudwick 1976; Dong 1988), but it only assumed high importance in the latter part of the eighteenth and early in the nineteenth century, following the work of Alexandre Brongniart and Baron Georges Cuvier (Rudwick 1976). Such awakenings of interest in the scientific value of fossils favoured fossil collectors, whose skills in finding fossils became sought after by people wishing to develop their own collections and by local and national museums who were anxious to augment their collections for the purposes of display and scientific study.

The Mary Annings (mother and daughter), who opened the very first fossil shop in Britain at Lyme Regis, Dorset, in the early years of the nineteenth century, were very early examples of skilled collectors who made a living out of the desire among relatively wealthy patrons (including the British Museum) for well-preserved fossils; these they were able to collect from the richly fossiliferous clays and limestones exposed along the coastline between Lyme Regis and Charmouth. Many extremely important palaeontological discoveries made by the Annings were bought for private collections or by local and national museums (Rolfe *et al.* 1988). This example is not an isolated one. A contemporary of the Annings, Thomas Hawkins, amassed a very fine collection of large marine reptile skeletons from the same area of Dorset; another, Dr Gideon Mantell, developed a large private museum of fossils from the Sussex area, and was extremely active as a trader of fossils with collectors in other parts of Britain, Europe and the United States. This tradition of collecting and selling and, in some cases, donating fossils to museums (either directly or as bequests) has been maintained, with varying degrees of intensity, down through the years to the present day and has been one of the principal means by which museums have been able to acquire important national and international collections representative of our fossil heritage.

PERCEPTIONS RELATING TO FOSSIL COLLECTORS

Over the past twelve years the subject of fossil collecting and, in particular, the role of commercial and non-commercial fossil collectors has been the subject of lively and, in some cases, acrimonious debate. There have been many claims that geological sites were being destroyed by indiscriminate hammering or over-collection. This culminated in a meeting in London in 1987 on 'The use and conservation of palaeontological sites', organized by the Palaeontological Association and sponsored by the Geological Society, the Geological Curators' Group and the Nature Conservancy

[Palaeontology, Vol. 35, Part 2, 1992, pp. 247–256.]

Council (Crowther and Wimbledon 1988). Contrary to expectations, the meeting, at which representatives from all relevant interest groups were present, reached a very broad consensus view on the subject: that *responsible* collecting should be recognized as essential to the geological use and longer-term conservation of most sites (Besterman 1988; Taylor 1988; Knell 1991). Such views have been emphasized recently (Norman and Wimbledon 1988; Norman *et al.* 1990*a*) culminating in a general policy statement (Norman *et al.* 1990*b*) concerning the use and conservation of palaeontological Sites of Special Scientific Interest (SSSI).

Sites designated as SSSI are those which have been selected and legally notified as such. To satisfy the legal requirements, documents have to be submitted to the owners/occupiers of the land where the sites have been identified, the relevant local authorities and Government Departments, by the statutory conservation organisations: the Nature Conservancy Council for England (NCCE), the Countryside Council for Wales (CCW), and the Nature Conservancy Council for Scotland (NCCS). The terms of such notifications are contained within two Acts of Parliament: the *National Parks and Access to the Countryside Act 1949* and the *Wildlife and Countryside Act 1981*; these ensure that SSSI are: (i) given clear geographical locations; (ii) supported by statements of their scientific importance; and (iii) safeguarded by a list of Potentially Damaging Operations (PDOs).

PDOs, introduced by the 1981 Act, provide a most important mechanism for consultation between owners or occupiers and the statutory authorities because they list the types of activity that are thought to be liable to cause damage to the scientific value of the site. Before such activities can be sanctioned negotiations have to be opened with the conservation authorities. A negotiated agreement results in the issuing of a PDO consent form, disagreements are eventually resolved through a Court of Public Inquiry which makes recommendations to the Secretary of State for the Environment who publishes a judgement (*determination*) in due course.

It is clear that palaeontology, and to some extent stratigraphy, is crucially dependent upon collected material, though it should be added that collection is not the absolute be-all and end-all that it used to be. Taphonomic studies which can lead to an understanding of the environment of deposition of fossils require fossils *in situ* rather than *ex situ*, at least in the first instance. Despite such caveats there is no doubt that the scientific disciplines themselves would not now exist in their present form if collecting had not occurred, and they could not develop further without new discoveries. Equally, the areas of land which have been identified as palaeontological and stratigraphical SSSI by the Geological Conservation Review (GCR) could not have been so identified and given a measure of legal protection from the depredations of developers and planners, had not well-documented collections of fossils been made in the past. Between 1977 and 1991 the GCR was funded by the Nature Conservancy Council (the predecessor of NCCE, CCW and NCCS) to survey and select a comprehensive network of earth science SSSI.

So, the obvious question: if there is widespread recognition of the value of responsible fossil collecting for the use, maintenance and conservation of geological sites within the broad geological community, why should the subject be one which is still at the centre of heated debate? The reason seems to me to be a curious and rather intractable mixture of genuine and intense local concern over the fate of particular favourite sites and their fossils (particularly if these are rare or exceptionally well-preserved), coupled with a fear that the large-scale irresponsible fossil collecting associated with unfettered commercial demands will result in disaster: sites would be pillaged in a mad scramble to obtain a few 'prize' specimens, to be sold for high prices, leaving only rubble and scree behind. Added to this there is the quite widespread belief that most sites can be 'worked out' by a short period of intense fossil collecting.

All three of these factors seem to underlie, to varying degrees, the reactions of many who object to fossil collecting. The importance of each of these factors will tend to vary depending on the type of site at which such events may be occurring. However, there is no doubting the passion with which such views can be held, particularly when the after-effects of such destructive excavations are to hand. In nearly all cases it appears to be the collector with commercial aims who has borne the brunt of criticism in the past. Unpalatable though the thought is, I strongly suspect that the 'commercial collector' is simply the easiest target for criticism because his/her motive for collecting can be

claimed to be straightforward avarice. I do not intend entirely to absolve commercial/professional fossil collectors, who have in some instances caused appreciable degradation of sites. However, as several authors have stated in the past, it is not only commercial collectors who can cause apparent devastation; badly supervised parties of school children, college or university students on field courses are also capable of quite extensive hammering at sites, even if not on the scale of some commercial operations.

THREATS TO PALAEONTOLOGICAL SITES

Fossil collecting is clearly a threat to fossil sites. However, as a result of the 1987 meeting on palaeontological site use and conservation, it has become accepted generally that it is not the only serious threat. There are four principal categories of threat to such sites: burial, quarrying, misguided conservation and collecting (Black 1988; Taylor 1988).

Burial

One of the primary causes of site loss in the UK is through burial by various means. Burial or general inaccessibility of sites generally takes place through the activities of local authority planners and developers.

At inland sites, in-filling of quarries as part of a waste-disposal strategy is one of the most obvious examples of direct burial. Pre-existing restoration plans for quarry sites can also result in infilling, battering, grading and planting of vegetation on fossiliferous rock faces. (Recent examples include Boon's Quarry SSSI, Webster's Clay Pit SSSI and Clockhouse Quarry SSSI.)

At coastal locations, sea defence and coast protection measures frequently result in schemes which involve the construction of wave-return walls, gabion barrages or rock armour berms in front of eroding cliffs; these are also frequently linked to selective mechanical grading at the top of the cliff and various drainage schemes as part of cliff stabilization measures. Alternatively the cliff may simply be battered with reinforced concrete. The net effect of these actions is either direct, to obscure the cliff section with an impenetrable layer of concrete, or, more indirectly, to reduce erosion at the base of the cliff and promote grading and stabilization of the cliff, culminating in vegetation growth on the previously clear and accessible cliff section (for example at Barton, which is part of the Milford-Highcliff SSSI).

Quarrying

Active commercial quarrying, if located at fossiliferous sites, is a very obvious form of threat. Quarrying removes important fossil specimens as a physical by-product of mining. This threat is most real when excavation is done by remote-controlled heavy machinery, which it is in the vast majority of cases; then important material is inevitably lost. In some cases, localized loss may not be critical, because the beds are laterally extensive and will occur at faces exposed at various locations throughout the quarry and may be left accessible once commercial quarrying has ceased. However, in the case of impersistent beds (channel-fills, fissure-fills, etc.), the entire scientific interest may be lost very rapidly. Equally, if the fossiliferous beds are steeply inclined, quarrying may remove all lateral exposures and leave the scientifically important beds completely inaccessible in the floor of the quarry.

There is also a positive side to quarrying by commercial companies: the very fact of quarrying in the first place made possible many extremely important fossil discoveries. Thus in many instances active quarrying, like natural erosion, is extremely valuable because it constantly serves to renew exposures and makes available previously inaccessible sections of the geological column. Provided that responsible collectors can gain occasional access to new exposures, quarrying can be highly beneficial to palaeontological research.

In a small number of cases commercial quarrying may still depend upon more traditional skills and a less intensive use of heavy equipment. Here it may be possible to establish a code of practice with the quarry owners to (try to) ensure the recovery of a percentage of the fossils that might

otherwise be lost by quarrying (a recent example of this being a code of practice document which has been proposed for Grinshill Quarry, Shropshire). However, such arrangements obviously depend very much on the attitude of the quarry management and the cooperation of the quarrymen.

Misguided conservation schemes

Though rare, there might well be occasions when teams of conservationists could become involved in sites combining biological and geological interests. In such instances there could be a conflict between the interests of the biologists, who might for example be interested in restoring a specific habitat and species mix in an abandoned quarry. Such a scheme might require the infilling and grading of geologically important areas and would thus be inimical to the geological interest of the site. I am not aware of any examples of such a conflict of interests on SSSIs to date.

Equally serious and damaging for geological sites is what might be called the 'civic tidiness effect', which can result in attempts being made to clear what might appear to local council officers to be 'untidy' areas of abandoned quarries (piles of scree, etc.), all of which may be of inestimable value to the practising geologist. This approach is also applied to coastal areas, as in the 'tidying' of a major part of the shoreline at the palaeobotanical site known as Lake (Ham Common SSSI), using gabion blocks, and the grading of the coastal cliff exposures at Bournemouth cliffs, part of Poole Bay SSSI.

Collecting

While responsible collecting is not normally threatening to the scientific interest of the majority of palaeontological and stratigraphical sites, there is a type of site which can be considered vulnerable to collectors, if they act irresponsibly (Norman *et al.* 1990*b*). These are the sites at which fossils are highly localized, such as the examples cited earlier. Classic examples of these are fossiliferous sedimentary infills in fissured limestone; those found in Somerset and South Wales fall into this category. Others can be highly localized beds, such as the famous Granton Shrimp Bed locality in southern Scotland (Taylor 1988).

However, it should be emphasized that these are the exceptions within the full range of palaeontological sites in Britain (Wimbledon 1988), if the SSSI coverage is a fair reflection of the total site coverage, and such special sites deserve special consideration and protection, since they represent a unique and uniquely vulnerable aspect of Britain's natural heritage.

REALITIES AND SOLUTIONS

General statement

Given the generally agreed understanding that responsible collecting is an integral and necessary part of the conservation strategy for any palaeontological site, it must be inappropriate to pursue aims which would end in the hindering of access to the majority of fossil sites. The science of palaeontology will be unable to grow and develop in the absence of source material, and our network of palaeontological sites provides the vital resource for the great part of such activity. Further, in the wider context, it would be unwise to ignore or actively discourage visits to such sites by the general public, whose sympathy and understanding are needed if, in the longer term, our scientific concerns over the heritage value of such sites are to prevail in the political arena.

Consequential loss

If fossils may be removed from sites by responsible means, then it must be accepted that, with the passage of time, the fossil resource at any site will be depleted. This must be considered an acceptable loss, an inevitable consequence of the nature of scientific investigation at palaeontological sites, and indeed many other types of geological site, since their study is in essence field-based. Provided that the more important discoveries made at these sites are properly documented and find their way into museum collections, the scientific knowledge base gains from the loss of the site

resource. Irresponsible collecting resulting in a lack of documentary information for the locality constitutes absolute 'loss', no matter how beautiful the specimen.

Management of loss

Management of the rate and type of loss of material from sites in the British Isles must ultimately depend upon the establishment of widely accepted codes of practice relating to the removal of specimens. The word 'responsible' has been used on a number of occasions in this article, and in several others in recent years, in relation to fossil collecting. It is absolutely vital that a responsible attitude to the collecting of fossils is nurtured in the geological community (in its widest possible sense), simply because we are all dealing with a generally large but nevertheless finite component of our natural heritage. With this idea of responsibility for our natural heritage in mind I would like to offer some recommendations which, if widely adopted, would enable site users to make the most of palaeontological sites in a way that is pragmatic and caters for their various needs. I do this by recognizing that palaeontological sites do not all share the same characteristics. Some are more, and some much less, sensitive to collecting.

Vulnerable versus specimen-rich palaeontological sites

Vulnerable sites. From the point of view of a management strategy for all fossil sites, it is useful to identify those sites which are most vulnerable to collecting pressure. Such sites, as discussed earlier, are relatively few in number and small in geographical extent, when compared to the totality of fossil sites, but by definition contain a rare and limited resource.

In these circumstances it should be regarded as a priority to operate a permit system, in order to ensure that collecting is scientifically justifiable and that suitable repositories will be found for the storage and curation of the specimens, so that they may be studied freely by the geological community at large.

Specimen-rich sites. Many palaeontological sites would appear to have an extensive, though clearly not infinite, fossil resource. In these cases the priority for resource management must be seen in terms of 'husbandry', with a strong emphasis on open access and responsible collecting so that they are used as effectively as is practicable. Within this category of site a clear distinction should be drawn between high erosion and low erosion sites, and it should be recognized that differences in emphasis will be needed in their management, to ensure their long-term viability.

1. High erosion specimen-rich sites. Particularly in areas where there are rapidly eroding sea-cliffs, or in sites which are actively worked quarries (provided permission to collect can be obtained from the quarry firm), the collection of fossils should be regarded as a high priority. High rates of erosion or commercial excavation will inevitably result in high rates of loss of newly exposed fossils, so the more specimens that are collected, and the more regularly these sites are patrolled, the more likely the scientific community is to benefit from at least a percentage of new discoveries. (Examples include regular patrolling of the Oxford Clay brick pits by staff of Peterborough Museum which has resulted in some spectacular discoveries of marine reptiles in recent months. Among natural high erosion sites, museum, amateur and commercial collectors have made some spectacular discoveries in recent years on the southern coast of the Isle of Wight and the coastal cliffs in west Dorset.)

2. Low erosion specimen-rich sites. Inland sites do not generally suffer the high rates of erosion common to many coastal areas or actively worked quarries. In the absence of this 'scouring/refreshing' effect, fossiliferous beds can rapidly be rendered inaccessible, 'worked out' (and exceedingly dangerous) as they disappear beneath a massive overburden. The renowned 'slot' at Ludford Corner was a classic example of this effect though this has since been cut back and made accessible through NCC funding (Rowlands 1989). At such sites, fossil collecting should be done with consideration to the extent of the resource and its accessibility. Agencies such as the newly established Nature Conservancy Council for England, The Countryside Council for Wales and the Nature Conservancy Council for Scotland are empowered to monitor such sites and also administer

funds which may be granted for site clearance and restoration work in order to ensure that such sites remain viable as collecting and study resources.

Principal users of palaeontological sites

Given these distinctions between types of site and the degree and style of collecting that they allow, it is also appropriate to consider the types of 'user'. I distinguish five principal types of users of palaeontological sites: professional/commercial collectors, research scientists, amateurs/hobbyists, student groups, primary and secondary school parties. These are not absolutely clear-cut groups since individuals can be members of several categories simultaneously, or indeed of all if seen from the perspective of a lifetime's work for some individuals.

Commercial collectors. As has been emphasized on a number of occasions (see Taylor 1988; Knell 1991), these users of palaeontological sites have, in most cases, a vested interest in them and the commercial management of the resource, since it can form the basis for their livelihood. Occasionally their excavation techniques are 'responsible', and detailed notes are taken of the location and stratigraphical horizon from which the specimen was collected. The reason for this is two-fold: they realize the scientific value of such information and also its value for identification and ultimately for notional valuation, if intended for sale.

In recent years these collectors have been responsible for several important discoveries of fossils, particularly of large fossil vertebrates; this reflects the fact that large vertebrate fossils can attract high prices in the market place, and that these people are prepared to devote considerable time to developing their skills as collectors. As a consequence commercial collectors are very much in the vanguard of the collecting fraternity. At a time when university, college and museum funds for travel and research are extremely limited, the work of these collectors can be extremely valuable to the science as a whole and should be encouraged, provided that collecting is done responsibly and that research scientists gain access to the material.

The destination of fossils collected depends upon who is prepared to pay. Conflicts or differences of opinion between collectors, museums and academic research workers arise largely because of the mismatch between the commercial aspirations of professional collectors, the perceptions of academic research workers of the value to science of specimens and the limitations on funds faced by museum curators (Rolfe *et al.* 1988).

The ideal result for the scientist is that the specimens should be adequately curated and available for study in a recognized institution – no matter in which country that might be.

The museum curator will stress either the importance of having representatives of the local fossil flora or fauna, or alternatively that their collection provides a national or international overview of a particular palaeontological theme. The nature of the specimen will dictate the preferred approach.

In the case of amateurs and the general public, their concern is more one of the ethics of removal of national natural heritage items by such commercial collectors and their offer for sale on the open market.

Research scientists. With their knowledge and field experience, research scientists can be as competent at finding fossils as professional collectors; they simply lack the time and financial support to enable them to indulge in extended fossil prospecting trips. They too are committed to responsible collecting, since they value the resource they are using. Without it they cannot fulfil their research plans; equally important, without adequate locality and stratigraphic information a new specimen may be rendered virtually worthless from a scientific point of view.

The ideal ultimate destination of such collections is a well-curated museum where the natural heritage may be preserved for posterity.

Student groups. Fieldwork by university and college students at palaeontological sites frequently involves collecting from fossiliferous horizons. Such activities can involve the removal of large quantities of duplicates from sites. The vast majority of these will be lost at a later date, even though

specimens may have extensive field notes attached. This exploitation and subsequent loss, though perhaps understandable in general terms, can pose a considerable threat to some sites.

While it is undoubtedly essential for fieldwork exercises, such as collecting, to be undertaken by all students of the geological sciences, it is seen as increasingly important that students, and particularly their teachers, should take a much more responsible attitude to the resources of sites and the heritage value of material collected (Knell 1991). Conservation and husbandry of finite resources such as this need to become increasingly a part of the undergraduate curriculum nationally.

Non-commercial collectors, amateurs/hobbyists. As a leisure activity, fossil hunting can be fun, healthy and rewarding and is popular with young and old alike. For the palaeontological research community at large this presents a marvellous opportunity, because amateurs and hobbyists will frequently pass specimens on to museums for identification (for example Mr Bill Walker's discovery of the new dinosaur *Baryonyx walkeri* which was donated to the Natural History Museum).

The primary concern for the curator and research worker, with this sort of activity, is that specimens may be collected without vital locality and horizon information. Education over the matter of specimen collecting, in the form of leaflets, meetings at local clubs and societies and professionally led field trips (such as those organized by the Geologists' Association), can help in this respect.

Primary and secondary school groups. Of increasing importance as a result of the appearance in Britain's schools of the new Government-inspired teaching initiative, the National Curriculum, is the requirement for school children to pay visits to and make collections from geological sites. The potential impact of this type of activity on the fossil resource at many sites is enormous, and is the source of some anxiety within the geological community.

Clearly there is a very great need to establish widely accepted codes of practice among the school teaching profession, concerning the use of sites and the removal of specimens by children during such visits. The problem in this respect is that relatively few of the teachers leading such groups will have a background in geology.

Owners/occupiers. Last, but not least, the users of palaeontological sites must consider the rights of the owners of such sites. As Taylor and Harte (1988) have shown, fossils are regarded as 'minerals' for the purposes of the Law. As a consequence they belong to the person holding the mineral rights to the land – usually the site owner or occupier. For fossils to be collected legally, permission should be sought from the owner of the land prior to collections being made, and title (ownership) may then pass legally to the finder of the fossils, provided this is with the agreement of the owner, and provided that this does not contravene one of the PDOs if this happens to be an SSSI. If fossils are removed from land without permission then this constitutes theft of property, unless of course the material is lying around loose in spoil heaps and trespass is not the means of access (this latter proviso does not apply in Scotland where even apparently abandoned material is owned and remains subject to owner's rights).

In some situations, title to, or ownership of, fossils has been deliberately abandoned by the legal owner as a matter of policy. Along the coast between Lyme Regis and Charmouth in Dorset, the local authority and National Trust, who between them own the coast, have decided to permit fossil collecting as part of a strategy to encourage tourists to the area.

THE FATE OF COLLECTED SPECIMENS

Another source of anxiety and comment within museums relates to the activity of commercial fossil collectors and the loss into private hands of specimens that might otherwise go to scientific collections. In reality this has always happened and will continue, since it is physically impossible to police all sites at all times. In individual cases this may rightly be deplored; however, in many

cases specimens of great scientific importance do eventually end up in national or regional museum collections owing to the responsible actions of these collectors and the relationships that many have established with their own local museums. In some cases it is probably true to say that the scientific value of a specimen may far outweigh its aesthetic appeal (a component of its commercial value) and it will not, as a consequence, attract a high market price, unless museums themselves compete for a specimen and in so doing drive up its price!

Unless scientists are empowered to do all collecting at all times on all sites, a situation which is plainly inconceivable, it is futile to try and prohibit non-scientific collecting of whatever type. The entire community (researchers, curators, collectors) must work collaboratively, obviously within the parameters set by their own professions, in order to ensure that collecting is done responsibly (as befits any element of our national heritage) and that the most scientifically valuable specimens are not lost to science in the long term. Such an approach requires considerable effort and understanding on all sides. Nevertheless, it has been the guiding principle since the time of the earliest collectors.

CONCLUSIONS

In most circumstances the collection of fossils from palaeontological sites is to be encouraged, since this activity will, in the long term, promote the science of palaeontology.

There are a small number of instances where the collection of fossils needs to be regulated and monitored, simply because the fossil resources at some sites are limited and their scientific and heritage value is high. These can be considered to be vulnerable sites.

Strategies relating to the management of the palaeontological resource at specimen-rich fossil sites will vary depending on the degree to which the site is subject to erosional (natural or man-induced) forces.

Collecting practice must be encouraged to be of a uniformly high standard through education and example, as befits specimens that are a component of our natural heritage. And there must be encouragement of attitudes which will foster a willingness to ensure that the scientifically most important specimens are not lost to science in the long term.

The price of fossils, established through commercialized fossil collecting, will continue to cause consternation so long as museums and universities are underfunded (and low priority is given to the acquisition of new fossils): a situation that is unlikely to change in the foreseeable future. Undesirable though it may be to put a monetary value upon any aspect of our natural heritage, it has been argued that there are merits in doing so for fossils. The value may be arbitrary, in most instances, but it may provide a way of raising political awareness among policy makers about an otherwise totally underestimated part of our national heritage.

Acknowledgements. I would like to thank a number of colleagues who have read and commented on earlier drafts of this article, but among them I should like to single out for special thanks Michael Taylor (Leicestershire Museums) and Peter Doyle (Thames Polytechnic), as well as Colin Prosser, Kevin Page and Stefa Kaznowska, all of the Nature Conservancy Council for England.

REFERENCES

BESTERMAN, T. P. 1988. The meaning and purpose of palaeontological site conservation. 9–19. *In* CROWTHER, P. R. and WIMBLEDON, W. A. (eds). The use and conservation of palaeontological sites. *Special Papers in Palaeontology*, **40**, 1–200.

BLACK, G. P. 1988. Geological conservation: a review of past problems and future promise. 105–111. *In* CROWTHER, P. R. and WIMBLEDON, W. A. (eds). The use and conservation of palaeontological sites. *Special Papers in Palaeontology*, **40**, 1–200.

CROWTHER, P. R. and WIMBLEDON, W. A. (eds). 1988. The use and conservation of palaeontological sites. *Special Papers in Palaeontology*, **40**, 1–200.

DONG, Z.-M. 1988. *Dinosaurs from China*. China Ocean Press, Beijing/British Museum (Natural History), London, 114 pp.

KNELL, S. 1991. The local geologist. 3. The responsible collector. *Geology Today*, **7**, 106–110.

NORMAN, D. B. and WIMBLEDON, W. A. 1988. Palaeontology in the NCC. *Geology Today*, **4**, 194–196.

—— DOYLE, P., PROSSER, C. D., DAVEY, N. D. W. and CAMPBELL, S. 1990*a*. Comments on C. W. Wright's 'Ideas in palaeontology: prejudice and judgement'. *Proceedings of the Geologists' Association*, **101**, 91–93.

—— WIMBLEDON, W. A., DOYLE, P., PROSSER, C. D. and PAGE, K. N. 1990*b*. [NCC policy on fossil collecting]. *Geologists' Association Circular*, **883**, 19–21.

ROLFE, W. D. I., MILNER, A. C. and HAY, F. G. 1988. The price of fossils. 139–171. *In* CROWTHER, P. R. and WIMBLEDON, W. A. (eds). The use and conservation of palaeontological sites. *Special Papers in Palaeontology*, **40**, 1–200.

ROWLANDS, M. A. 1989. Teme Bank SSSI, Shropshire. *Earth Science Conservation*, **26**, 23.

RUDWICK, M. J. S. 1976. *The meaning of fossils: episodes in the history of palaeontology*. 2nd edition. Science and History Books, New York, 287 pp.

TAYLOR, M. A. 1988. Palaeontological site conservation and the professional collector. 123–134. *In* CROWTHER, P. R. and WIMBLEDON, W. A. (eds). The use and conservation of palaeontological sites. *Special Papers in Palaeontology*, **40**, 1–200.

—— and HARTE, J. D. C. 1988. Palaeontological site conservation and the Law in Britain. 21–39. *In* CROWTHER, P. R. and WIMBLEDON, W. A. (eds). The use and conservation of palaeontological sites. *Special Papers in Palaeontology*, **40**, 1–200.

WENDT, H. 1968. *Before the deluge*. Victor Gollancz, London, 419 pp.

WIMBLEDON, W. A. 1988. Palaeontological site conservation: facts, form, function and efficacy. 41–56. *In* CROWTHER, P. R. and WIMBLEDON, W. A. (eds). The use and conservation of palaeontological sites. *Special Papers in Palaeontology*, **40**, 1–200.

DAVID B. NORMAN

Science Directorate
Nature Conservancy Council for England
Peterborough PE1 1UA, UK

Present address:
Sedgwick Museum
Downing Street
Cambridge CB2 3EQ, UK

Typescript received 4 July 1991
Revised typescript received 20 September 1991

APPENDIX

In general terms fossil collecting *per se* cannot, in most circumstances, be considered to be an undesirable activity, whether it is for scientific, educational or commercial purposes. It cannot be stated often enough that, without the activity of collecting, the sciences of stratigraphy and palaeontology would suffer and museums would lose a source of material for display or educational purposes.

There are, however, circumstances, ranging from inappropriate style of collecting (irresponsible use of portable power tools and heavy machinery, unjustifiable large-scale removal of specimens, lack of adequate recording of locality and horizon information with specimens) to the exploitation of vulnerable sites (collecting indiscriminately from isolated sites where the fossils are of extreme rarity), that are both undesirable (for the longer-term viability of sites as a scientific resource) and betray a disregard for the value of the National Natural Heritage (NNH) that is utterly deplorable.

Given these considerations, a general policy statement with regard to fossils and fossil collecting on SSSI has been issued (Norman *et al.* 1990*b*). An abridged version of this statement, which formed part of a longer statement relating to a specific incident of fossil collecting, is given below:

'The value of palaeontological and biostratigraphical SSSI rests ultimately upon their associated fossils, the sedimentary environment and stratigraphic context. In order for the scientific merit of such an SSSI to have been established, collecting and subsequent scientific study must have occurred. If palaeontological sites are to continue to have scientific relevance (rather than becoming simply a collection of historically interesting locations), further collecting of specimens and their study *must* be ensured.

Given that responsible collecting is a scientifically desirable activity, attention must then be given to the manner in which this is done, and the reasons for it being done.

The *manner* which must be encouraged does not really need to be explained to the audience reading this letter, but is clearly one by which adequate geological records of collections are made for future comparative research purposes (*A code for geological fieldwork*, Geologists' Association, 1975).

The *reasons* for such collecting on SSSI should ideally be scientifically justifiable (part of an individual or group research project, whose aims have been evaluated) and should eventually result in the placement of a proportion of the material (that which is of prime scientific importance, or is published) in a recognised institution (museum) where it can be conserved for posterity and made accessible to others. This "ideal" may not however be practicable in all circumstances. A minority of SSSI may require restrictions on collecting because of the rarity of particular fossils and/or the finite nature of the deposits. At the other end of the spectrum of site quality, SSSI subject to high rates of natural erosion (soft coastal cliffs for example) or high rates of artificial attrition (active working quarries which are known to yield important fossils) may require active promotion of responsible collecting as a means of ensuring that a percentage of the recoverable National Natural Heritage (NNH) is taken before it is lost either through erosion or mechanical destruction.'