MISPLACED PLANT MICROFOSSILS

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ABSTRACT.—In macerations of the Yorkshire Jurassic rocks for microfossils, extraneous organic remains are frequent. Some represent fragments of Carboniferous coal transported and dropped by man, but these are rare. Others represent fragments of recent and quarternary vegetation and intruding fungus hyphae and these are almost invariable in material from outcrops. Various unfossiliferous rocks and artificial stones were macerated to assess the risk of contamination by pollen which was found to be very variable, but on an average a sample of five or ten grams of exposed but well washed rocks may be expected to yield one or more pollen grains.

WHILE searching for Jurassic microfossils I have rejected many small remains which I thought extraneous ; I daresay others have done the same, but it naturally goes unreported. It has annoyed me so much that I decided, for a change, to stop taking precautions against contamination but to seek it deliberately, and to make the results more sure by looking in rocks without genuine plant microfossils.

In my work on the Yorkshire Middle Jurassic and in my earlier work on the Greenland Lower Jurassic I have macerated many kinds of rock, but they were always from outcrops and therefore subject to contamination. Rocks in sea beaches acquire many marine organisms, but none that cause difficulty; it is the fragments of land plants and animals in rocks from quarries, cliffs and streams that have been troublesome.

I may distinguish three categories of contamination. First, there are derived fossils ; small pieces of fossil plants, or spores eroded out of older plant beds and then redeposited in a new plant bed. Secondly, there are fragments of older plant-bearing rock (in practice Carboniferous Coal) which have been transported by man and then find their way by accident into the younger rocks which are to be macerated. Thirdly, there are recent and subfossil remains which have fallen into rock crevices with any organisms which penetrate the rock actively and live their lives there.

In my normal work I have chiefly studied large microfossils (leaf cuticles and megaspores), and have therefore used larger bulks of rocks (up to one kilogram) than those who are looking for small spores. Then, too, I have macerated a good many samples (1500 from Yorkshire) and these factors together have almost ensured that accidents would be met.

1. DERIVED FOSSILS

True derived fossils can be dismissed briefly as they are in no sense misplaced, but they complicate the recognition of misplaced fossils. I have found them to be almost universally present in the sediments of both these deltas and they occur even in localities like the Gristhorpe Bed which are celebrated for their undamaged specimens. They are, however, all contemporary and represent plants preserved in alluvial mud banks a little way up river. These derived fossils tend to be generalized but the proper fossils of a plant bed are often of one or a few species and peculiar to it. This may have an advantage in making it easier to recognize the age of a bed by its microflora but it is in general stultifying. For instance, the pollen and small seeds associated with a leaf are found to be merely those of all beds of this age.

I almost expected to find Carboniferous spores in the Yorkshire Jurassic because it is likely enough that the sediment is derived from Carboniferous shales and sandstone. I thought I found them in six localities but I now believe that all these were probably mistakes, and I have reached the conclusion that all the real derived fossils are contemporary or at most represent a slightly older stage of the Jurassic. The evidence for this statement is not given or discussed here.

2. MISPLACED FOSSILS

Six macerations have yielded Coal Measure megaspores, that is one in 250. (I did not search for microspores in these macerations.) Three of the six gave plenty of Jurassic cuticles and spores and a single coal measure megaspore, and repeated efforts have so far given no more. It so happens that all three localities are slightly suspect—one is an old quarry, another a stream section in a village and another a stream section near a farm road. Carboniferous coal has been used in houses in N. Yorkshire for a century and bits of it are widespread wherever there are roads or houses or rubbish. I have watched bits fall from carts and become powdered by the wheels and a very tiny crumb could give a spore and could blow about and get washed into exposed shale : but this suggested origin for these isolated spores is not open to test.

The other three localities yielded abundant Carboniferous megaspores, mostly *T. brasserti* and *T. horridus*. One locality was a quarry where Jurassic coal was weathering out of the vertical face. Lumps were picked up and macerated and gave nothing but Carboniferous spores. Here, I imagine that the Jurassic coal was lignitic and without spores and a single fragment of fossiliferous Carboniferous coal, brought in by someone to cook a meal had been included. I cannot prove this but it is true that remains of coal fires together with household rubbish are to be met in disused quarries.

Rock from another locality, a coaly shale exposed in a stream gave numerous *T. brasserti* spores, but a second sample collected for confirmation gave none. However, I then found a cinder path higher up the bank and I feel sure that a crumb of unburnt coal had rolled down and stopped by the Jurassic shale outcrop.

The third locality was from a stream section in a desolate moor, far from a house or path and should have been satisfactory. However, on a second visit I just could not find any outcrop, perhaps the stream had changed its course or perhaps (and I think this is more likely) I had made some mistake. It is an unsatisfactory and unconfirmable record and to be disregarded.

There is always a risk of picking up a particle of Carboniferous coal in Britain. It happens that none of my macerations from sea beaches have yet given Carboniferous plants, but one is sure to do so eventually as tiny coal pebbles, probably from shipping and wrecks are to be found on the beaches.

3. RECENT CONTAMINANTS

Rocks from sea beaches nearly always yield fragments of algae and small arthropods, particularly mites, which crawl into cracks. The mites have tough enough shells to withstand acid maceration. Rocks exposed on land have more complicated contaminants. There are active invaders ; tree roots which penetrate for many feet along joints and bedding planes and, dying, leave their toughest layers of exodermis or cork. There are numerous small soil insects and mites which live in tiny cracks, and many of them withstand some maceration. Then there is often a great deal of fungus mycelium which permeates compact limestone or silica sandstone. This mycelium will dissolve on maceration with $HNO_3 + KClO_3$ followed by ammonia, but if the maceration is fairly light some persists, and in particular spore-like bodies. Occasionally there are blue-green algae; their sheaths are sometimes nearly as resistant as cuticle.

In more variety there are fragments which have entered rock crevices passively; tiny bits of recent leaves, fragments of insects and also leaves, stems and pollen from the Quarternary peat. These are often poorly preserved, and are hard to distinguish from true fossils and therefore insidious. Very often there are charred fragments of plants, relics of a heath or forest fire.

Finally, there are fragments, especially spores, from dust acquired during journey and up to the time of maceration. It is impossible to exclude dust when large samples of rock are being used. One learns to recognize the cuticles of many of the common recent species.

This sort of contamination was assessed by macerating samplesof unfossiliferous rock which had been subjected to weathering for a few years. The rocks were scrubbed under a tap, but not otherwise cleaned and then macerated in appropriate acids (HCl, HF, $HNO_3 + KClO_3$, and finally NH_4 OH) and the organic remains were examined at different stages. Many samples were used, ranging from natural marine rocks, limestones, sandstones and cherts from various parts of Britain to brick and iron furnace slag. I took clean-looking pieces where there was clearly no chance of finding large microfossils and searched principally for spores and pollen. The samples used were small, about 5 grams.

Over half these samples gave no spores at all on complete maceration (but nearly all before oxidation yielded fungus). Those yielding spores gave usually one or two recent pollen grains (*Betula* was recognized), but the richest, a bit of Stonesfield Slate (Marine Jurassic) from the quarry tip gave about thirty *Pinus sylvestris* pollen grains per gram, some of them obviously recent but others so delapidated that they looked like ill-preserved fossil ones. A few samples gave one or two specks of carbon which showed plant structure, these may have penetrated the surface as dust. Samples from Museums gave vegetable fibres which were almost certainly from dust. Several samples were unsuccessful because they were full of oily or bituminous matter or carbon derived from it, which had at least as great powers of resistance to maceration as had the pollen cuticles.

DUST

The risk of contamination of the bags in which rock is transported and of the macerations themselves by dust containing pollen and spores is always present, though it can be reduced by precautions. The proportion of such grains in laboratory and outdoor dust varies enormously from day to day; I therefore examined accumluations over long periods, namely, laboratory shelf dust (8 months), dust from a roof space (about 40 years) and dust washed from a roof gutter (about 2 years). All were rich in finely divided carbon which could not be removed by maceration and made it impossible to concentrate the pollen to any great extent. The laboratory shelf dust contained enormous numbers of plant fibres and the rainwater gutter dust, or mud, contained great numbers of carbon rods and hollow carbon spheres, both probably from coal smoke. The highest concentration was in the shelf dust which has about 100 pollen grains per gram; there may have been others which had been destroyed by the rather drastic maceration. This figure is at best an average, certainly on particular days vastly more pollen than this blows around. A final point may be relevant; I examined the dregs of a bottle of hydrofluoric acid and there was a *Corylus*-like pollen grain.

CONCLUSION

Apart from true derived microfossils there is always a risk that extraneous organic particles will occur in macerations of rocks from outcrops. These particles may masquerade as fossils. This risk is at its greatest in a rock with few genuine microfossils and which is almost completely soluble so that extraneous matter is concentrated millions of times. No doubt the risk can be minimized by precautions, samples of rock can be taken which look clean and macerations can be covered against dust, but I maintain that the risk cannot be entirely eliminated. It behoves one, therefore, to beware in dealing with plant microfossils. The risk of contamination with transported coal must now be growing in all parts of the world ; it is, however, still a small risk in non-industrial areas and can be effectively checked by repeating the maceration. The risk of contamination by recent spores is, however, universal, at least under British conditions, and where one is dealing with rubbly shales and clays which cannot be effectively cleaned it is a grave risk. Much can be done as a check by knowing the recent plant remains and pollen, but this clearly has limitations. It is only when dealing with coals and so on with a large number of fossil spores that one can feel secure that a grain that resembles a recent species is in fact a true fossil.

In writing this short paper I wish to state explicitly that I make no criticism of the work of others, nor have I attempted any assessment of contamination under conditions other than those of England.