

XXIII.—*Dendritic Spots on Paper.*

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MINUTE markings of a more or less dendritic or plumose character have long been noticed upon certain specimens of paper, but until the present

they seem to have been examined only by a few botanists and microscopical observers, and they, apparently, have not arrived at any very definite or satisfactory conclusion as to the nature of such dendritic markings.

Agardh and Lyngbye named the spots "*Conferva dendritica*," and Schumacher placed them amongst the fungi under the name of "*Dematium olivaceum*."

From their resemblance, when viewed under the microscope, to the well known dendritic markings found on many rocks and fossils, I was induced to make a chemical examination of them, but was much hindered in my endeavours to do so by the great difficulty experienced in finding sufficient material to work upon with any satisfaction; and the small quantity eventually obtained was by no means in a convenient form, since the dendrites are so thoroughly incorporated with the structure of the paper in which they are found.

Since I found it impossible to procure the dendritic markings in sufficient quantity to enable me to make a thorough chemical analysis by the wet way, I had to content myself with a careful blowpipe examination, supplemented by such special tests as could be applied.

The ash yielded by the spots tinges the outer blowpipe flame with the well-known green imparted to it by copper compounds, and on moistening with hydrochloric acid, the peculiar and unmistakable vivid blue colour due to cupric chloride is at once obtained.

In the borax-bead the reactions are also those of copper, viz., a green bead when hot, changing to blue on cooling.

When several spots are treated in a small test-tube with a little strong ammonia-solution the liquid becomes of a blue colour.

The copper is evidently in combination with sulphur, for on placing a spot on a bright surface of silver, and moistening with hydrochloric acid, a dark stain is produced; this is also the case when several are fused with sodic carbonate, and the resulting bead is placed on such silver surface; sodic sulphide is formed, and this reacts with the silver to form a black stain of argentic sulphide. And, in addition, when they are treated with hydrochloric acid and pure zinc free from sulphur, sulphuretted hydrogen is evolved, which blackens paper moistened with solution of plumbic acetate.

The generation of sulphuretted hydrogen is, of course, favoured by the presence of the nascent hydrogen; this influence of nascent hydrogen is well shown when copper pyrites is treated with hydrochloric acid and zinc, when the pyrites dissolves rapidly, with copious evolution of sulphuretted hydrogen; before the zinc is added, the pyrites dissolves but slowly, even with concentrated acid.

The spots are soluble in solution of ammonia, the liquid acquiring a blue tinge.

Since it was found impossible to separate the material of the spots entirely from that of the paper, but only partially, comparatively large portions of the same paper were submitted to the like treatment, but neither copper nor sulphur was found. Most papers, however, contain sulphuric acid in combination: hence the presence of sulphur in the spots cannot be made out by dissolving them in nitric acid, and then testing for sulphuric acid.

These dendritic markings usually appear to pass through the substance of the paper, and are then found developed on both sides of it; when this is the case, both sides are seldom equally well developed.

In the centre, from which the dendritic branchings radiate, there is commonly a dense nucleus of a much darker colour, which, when rubbed with a hard and smooth body, becomes more or less burnished, and in a few cases after burnishing, the nucleus has presented a bright metallic surface as of copper or brass.

From the foregoing I trust that I have made it quite clear that in chemical composition these dendritic growths do not bear any resemblance to anything of a vegetable nature, and their origin is, I think, made quite plain by the specimen which accompanies this paper; in the centre is observed a minute particle of a yellow metal, from which incipient dendritic ramifications are seen to proceed; such particles appear to have been detached from the paper-making or finishing machinery, and have combined with sulphur, and perhaps with oxygen also, and crystallised out, that is if they be regarded as true crystallisations.

Other markings, known as iron-mould, also having a more or less arborescent outline, are found in paper, especially in old books; these have had their origin in small particles of iron which have become oxidised. This form is not so common now, owing to the improvement made in paper manufacture, such particles being now removed from the pulp by means of magnets; still they are occasionally found, and if the oxidation has not proceeded too far, a microscopic fragment of iron may be found acting as nucleus; this can be detached by means of a needle, or other sharp-pointed instrument, and picked up by a magnet, to which it at once flies. Such a particle answers to all iron tests.

The formation of both kinds of dendrites is greatly favoured by the presence of moisture.

In addition to these two dendritic growths, of undoubted inorganic origin, there are others found upon paper which are of a truly vegetable nature, but they cannot well be mistaken one for the other.

I much regret that it was impossible to make a quantitative determination of their composition.

It should be mentioned that I published a preliminary note upon this subject in "Science Gossip" for April, 1869, but since that time I have had further opportunities of finishing this little investigation.