

MICRO-STRUCTURE OF SOME INDIAN FUSAINS.

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The writer of this paper collected several samples of fusain from different coal seams and he is engaged in the physical and chemical study of them. The present paper records only a part of the work and deals with the micro-structure of the following specimens:—

- (i) Fusain from Hurra coalfield, Rajmahal Hills.
- (ii) „ „ Jilbari coalfield, Rajmahal Hills.
- (iii) „ „ XIV seam, Jharia coalfield, Ekra colliery.
- (iv) „ „ Borachak seam, Raniganj coalfield.
- (v) „ „ Borodhemo seam, Raniganj coalfield.
- (vi) „ „ Salt Range coal (Ara), Punjab (kindly supplied by Dr. Fox).
- (vii) „ „ Talchir coalfield, Talchir colliery.

Regarding the occurrence and distribution of fusain in the coal substance it may be mentioned that they occur in greater abundance in the Talchir and Rajmahal Hill coals than in the other coals of the series under discussion. The Talchir and Rajmahal Hill coals are full of fusain patches which occur in a large number of thin layers. When the coal specimen is split open, the surface is generally scattered over with small and thin fusain patches. In the Jilbari and Talchir samples, besides fusain which occurs in a large quantity, dull coal or durain is present in a large amount and vitrain or bright coal occurs in subordinate amount. In the case of Jharia and Raniganj coals fusain occurs in a small amount and in very thin layers. It is very conspicuous by its softness, fibrous texture and the beautiful silky lustre on the fibrous strands. As fusain has little cohesive power the coal splits readily along planes where it occurs. The fusain is never found to occur in great thickness and is usually less than 2 mm. thick whereas vitrain 2 or 3 inches thick and durain several inches thick have been noticed in some of the Gondwana coals. The fusain is readily separated from the rest of the coal by scraping with a knife when the long fibrous strands and small sharp-pointed irregular splintery fragments fall freely from the coal specimens. The Tertiary coal of the Salt Range contains only a few specks of fusain which is generally sharp-pointed, brittle and dark brownish in colour and is fairly hard at the same time.

The microscopic investigation of the small samples of fusain reveals little of the structure because they are opaque. Hence it is necessary to treat the material in some way to facilitate microscopic examination.

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The simple treatment of the fusain specimens with acids as suggested by Stopes and Wheeler¹ was carried out in the author's laboratory. Concentrated nitric acid together with a few drops of hydrochloric acid was added to each of the fusain specimens and left for a week. The acid solutions were then neutralised by potassium hydroxide solution and after the process of neutralisation sufficient water was added to each of the specimens. After the above treatment it was found that fusain in all cases forms no froth and no true solution resulted. In the case of the Jharia and Raniganj specimens the water was more or less clear and colourless. In the case of Talchir and Rajmahal specimens the solution was straw coloured. The particles of debris were very heavy and numerous and settled very quickly in the test tubes. It may be pointed out that, unlike fusain, vitrain goes completely in solution which becomes deep tea coloured. When the debris settled some of it was taken out, dried and the fragments were examined and were found to be composed of fibrous strands and angular fragments of different sizes. All of them were almost always black and opaque but a few of the fragments and fibres were of a light brown and yellow colour showing some cellular structure. Some of these were transparent or semi-transparent and many of the black and opaque splintery fragments showed rows of bordered pits in them.

APPEARANCE OF UNTREATED FUSAIN UNDER MICROSCOPE IN TRANSMITTED LIGHT.

The powder and fibres were examined under the microscope. They were found to be almost black, opaque and sometimes show a scanty cellular structure. The cell walls are sometimes seen to be thickened and empty and at other times filled with some colourless to light coloured foreign material showing double refraction. The substance appears to be silica. Certain thin portions of the fibres and fragments of the fusain were found to be slightly transparent giving rise to a yellowish brown colour. They sometimes beautifully preserve layers of bordered pits. One or two rows were quite common but three or four rows were also noticed in some cases. Mr. A. K. Banerji's work may be mentioned in this connection (*Rec. G. S. I.*, Vol. 66, Pt. 3).

TREATED COAL: MACERATION.

With a view to get better results, the fusain specimens were subjected to maceration treatment by a saturated solution of potassium chlorate and concentrated nitric acid (Schulze solution). In some cases with the above treatment the solution was of a pale yellow colour which gave the indication that the coal was highly resistant to the reagent. In order to overcome this difficulty, concentrated sulphuric acid was added to the solution which was boiled for some time, thereby making the reacting solution completely efficacious. Heating was not carried too far so that the coal itself did not become swollen and charred. The fusain specimens were allowed to remain in the solution

¹ Fuel Bulletin, No. 1, pp. 25-27.

for a week or two and when the solution was coloured brown the fusain pieces were taken out and washed repeatedly with water in order to get rid of any adhering acids. After this treatment the fusain particles were mounted on the slide and were examined under the microscope. By the above treatment all the fusain particles did not become transparent or semi-transparent but some of the pieces acquired a slight transparency and could be studied under the microscope. The cellular woody structure is not quite common in all the fusain particles. But a large number of the Gondwana specimens contained specially thickened cells and tracheids with several vertical rows of bordered pits (uni-seriate, bi-seriate, poly-seriate). One or two rows were quite common whereas three or four rows were found to be present in some of the fragments. The pits could be well seen and were of different shape and size. In some cases the pits were rounded and circular whereas in other fragments the pits were elliptical and long and narrow and arranged in two rows situated alternately. The description of the pits is given below:—

The xylem is composed of tracheids with bordered pits. The pits are round or oval and are arranged on the surface wall in one, two or three vertical rows. In some cases two rings of bordered pits and the common wall between adjacent pits are clearly discernible. The uni-seriate tracheids are on an average 40μ ($1\mu = .001$ mm.) across and the pits (outer ring) 10μ in diameter (magnification 800 times). The evidence clearly points to the conclusion that it is a gymnospermous wood.

It may be mentioned that the Gondwana fusains have a very large number of fragments containing such characteristic bordered pits.

When the Salt Range fusain was similarly treated and examined under the microscope it was found that the majority of the fragments remained black and opaque. Some of the fragments were however of a semi-transparent and of a yellowish brown colour but did not show much woody structure in them. On the other hand, only a very small number of pieces revealed some structure. The few fragments of a yellowish brown colour contained tracheids with uni-seriate bordered pits. The cavities were of very small dimension and of rounded nature. These pits did not show the characteristic features in the same way as in the case of the Gondwana fusains. A few fragments also contain simple pits. Several fragments of wood which are more in number than those just mentioned were found to be present in transverse section showing the water-conducting cavities of different sizes arranged in a more or less regular manner. Evidently these are not bordered pits. The bigger cavities are arranged in one row succeeded by another of much smaller cavities, possibly protoxylem and metaxylem, suggesting a dicotyledon. Many pieces of fusain have well-shaped curved boundaries showing that the pieces have broken along the water cavities. The intervening spaces however remained absolutely black and opaque under the microscope without showing any woody cellular structure. The regular arrangement of the cavities shows that they are fragments of angiospermous wood (dicot). There are also many fragments

in which the vessels are scattered in an irregular manner suggesting monocot. The microscopic study thus tends to prove that the Salt Range Tertiary (Eocene) coal is composed of very small amounts of gymnospermous and of more profuse angiospermous wood both dicot and monocot. The Gondwana fusains under discussion however have been derived from the degradation of a rich gymnospermous flora.

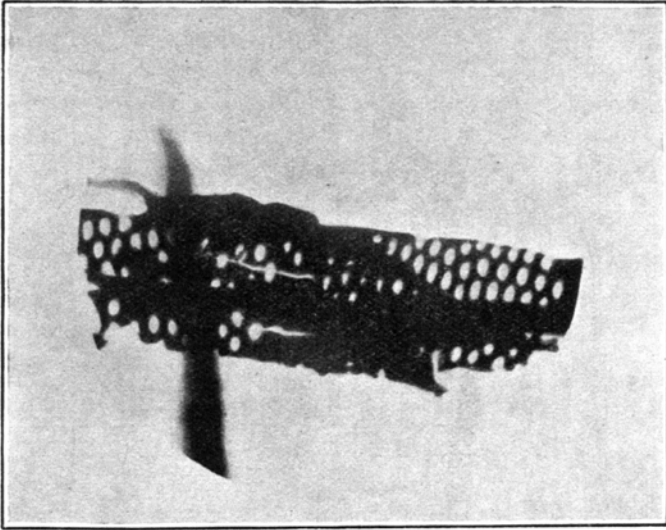


FIG. 1.—Talcbir Fusain showing bordered pits in tracheids;
Transmitted light. $\times 300$. (Micro-photo.)

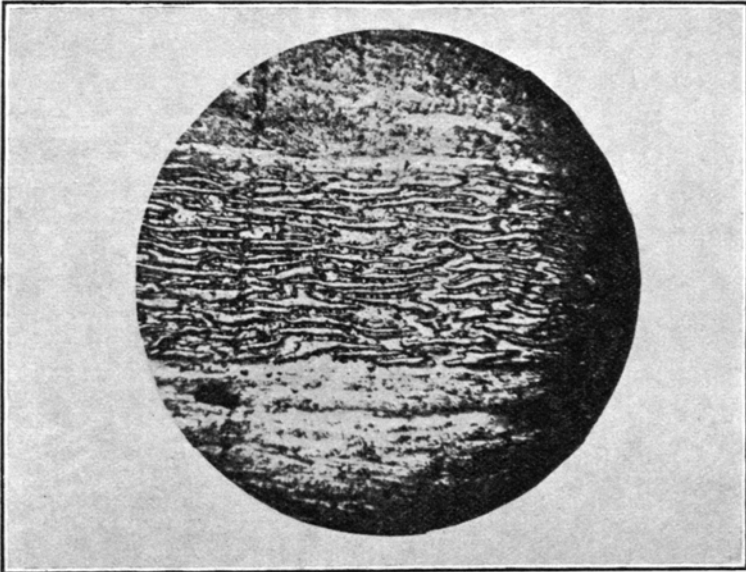


FIG. 2.—Borachak Fusain. $\times 60$. Reflected light (micro-photo).

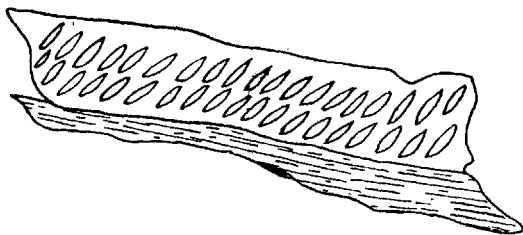


FIG. 3.—Camera lucida drawing. Hurra Fusain showing bordered pits. $\times 600$.

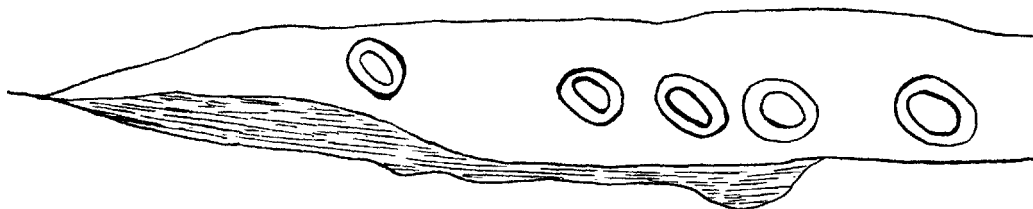


FIG. 4.—Camera lucida drawing. Borachak fusain tracheid showing bordered pits. $\times 800$.

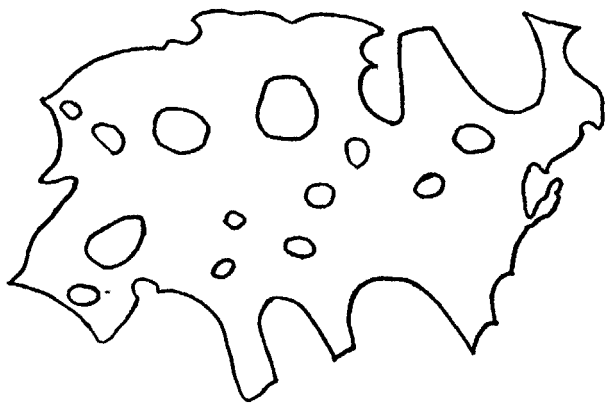


FIG. 5.—Camera lucida drawing. Ara fusain showing vessels. $\times 800$.

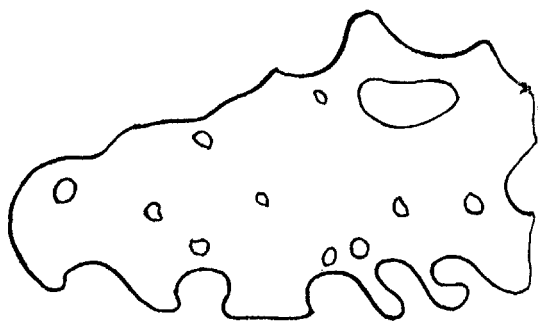


FIG. 6.—Camera lucida drawing. Ara Fusain showing vessels. $\times 800$.

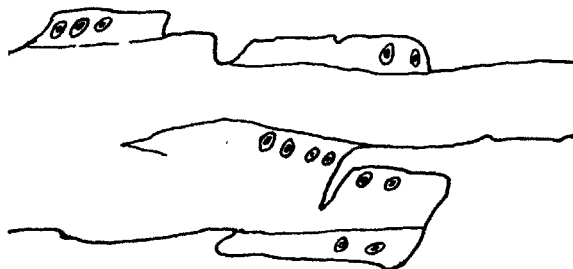


FIG. 7.—Camera lucida drawing. Ara Fusain showing tracheids with b. pits. $\times 600$.