Microscopic Detection of Cellulose Fibres And Their Variations on Composition of Printing Papers (Indian) as an Aid to Crime Detection

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The study of fibre composition is highly significant in document examination. Fibre species and their structural variations afford useful clues in detection of crime. Some glittering cases are referred to pointing out forensic importance. Sample of printing papers are collected from paper mills of India. To identify fibres, the quantum of paper to be examined which need only be very less. They are subjected to physical testing methods, instant and conventional for complete defibration. The fibres are suitably stained with Herzberg and Graff 'C'. Cellulose fibres belonging to a number of speeies (rag, bamboo etc.) have been detected specially with regard to their variations in morphological appearance. These variations are established in microscopic examination. They are readily traced with camera lucida and photographed. Additional informations are furnished. by colour reactions to Cellulose fibre as subsidiary test for identification.

The study of fibres is very important in paper examination and the difference in paper which ls favourable to identification is the type of raw material employed in paper industry (Kirk, 1953). The raw material composing of cellulose pulp has been the basic material for paper manufacture. Rags of cotton (*Gossypium* sp.) and linen (*Linum* sp) are greatly preferred in the manufacturing process because of the property of fibrillations (Grant, 1958). Jute (*Corchorus* Sp.) and hemp (*Cannabis* Sp.) are obtained from cordage and rope which yields a paper of high strength. Bamboo (*Bambusa* Sp.) and sabai grass (*Eulaliopsis* Sp) are of much use in India (Grant,1937,West. 1938). These non-woody fibres provide useful supplements and would be of special value as source of cellulose.

Fibre species and their variations afford useful information in detection of crime. Expertised opinion is often sought in cases of forgery. counterfeiting, felonious use of certificate, security, contracts, will, stamp or documents (Browning, 1969). While dealing with a forgery case, we may wish to know if a disputed document is written on a certain type of paper or it may be necessary to compare the paper of one document with the paper of another. Such examinations involve a knowledge of paper making and of chemical reagents (Gross *et al.* 1950). Paper fibre analysis is undertaken in setting up specifications on a given grade of paper and checking on whetner the specification has been met (Casey, 1952). Incriminating pamphlets in clandestine printing throwing personalities into disrepute required identiflcation for the detection of the source or country or origin of paper. An analysis of paper fibre proves of immense value in such cases. Sometimes the age of the document can be fixed if any item of fibre which would be absent from the corresponding data of paper manutac-

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ture of a certain country. A more concrete example is given how examination of paper fibre helps in detection of crime. Several copies of Tennyson's 'Morte-D-Arthur' dated 1842 were suspected for publications at later dates. The copies were examined and found to contain esparto grass as one of the fibre compositions. The question arose how esparto grass crept in the volume of 1842 when record indicated the same was introduced in paper industry in 1861 (Soc. Art. 1898). Much credit goes to Cartar and Pollard (1934) for pioneering work in the field of dating documents and books. Lucas (1948) examined paper fibres of a number of old Arabic documents mostly title deeds of lands and found out the relative truth of the documents as claimed by fraudulent successors. Thus detection of fibre of printing papers by microscopical analysis is of great value.

Materials

Samples of printing papers were collected from paper mills of India (vide Table I). The descriptions in the table are followed in the line as stated by Dawe (1953).

Physical testing methods

1. This is an instant method. The side of the paper was wetted and fibres were dragged away on to glass slides by a needle. A drop of 40–50% glycerine water was added and examined under microscope. In another slide, a drop of distilled water was added. The ffbres were teased apart. The slide was warmed until the fibres just dried. Whole mount was ready for staining.

2. The next method is of conventional. Papers were torn into small pieces, kept in a test tube, boiled in a 1% sodium hydroxide solution (aqueous) for 15–20

Table I Printing Papers

No. of Sample	Description/ quality	Size in inches	Sheets to Ream	Weight in lbs	Watermark Brand	Supplied by
(1)	(2)	(3)	(4)	(5)	(6)	(7)
	PRINTING					
1.	S/c white	20×30	500	24	Sun	Shree Gopal Paper Mills Ltd., India.
2.	Cream laid	13½×16½	480	8	,,	,,
3.	Light green	26×40	500	40	,,	,,
4.	Blue	18×22	500	14	,,	,,
5.	Green	18×22	500	14	,,	,,
6.	Pink	18×22	500	14	,,	,,
7.	Light blue	26×40	500	40	,,	,,
8.	Yellow	26×40	500	40	,,	,,
9.	Canary	18×22	500	14	,,	,,
10.	S/c white	17×20	500	24	Tiger	Balmer Lawrie & Co. Ltd., Calcutta.
11.	Azure laid	17×20	500	24	,,	,,
12.	Pink	17×20	500	14	,,	,,
13.	Cream laid Tiger	13½×16½	480	8	,,	,,
14.	White	20×26	500	24	,,	,,
15.	Green	18×22	500	14	,,	,,
16.	Canary	18×22	500	14	,,	,,
17.	Blue	18×22	500	14	,,	,,
18.	White	16×26	500	14½		
19.	Cream laid	16⅓×26½	500	15		Andhra Paper Mills, Rajahmundry, India.
20.	Pink	17½×22⅓	500	14		,,
21.	Orange	17½×22½	500	14		,,
22.	Green	17½ × 22½	500	14		,,
23.	Yellow	16½ × 26½	480	15		,,
24.	Orange light	17½×22½	500	14		,,
25.	Cream laid	17×27	500	18		Sirpur Paper Mills Ltd., India.
26.	Green	18×23	480	14		,,
27.	Yellow	18×23	480	14		,,
28.	Pink	18×23	480	14		,,
29.	Blue	18×23	480	14		,,
30.	White	0×203	500	28	Elephant	The Titaghur Paper Mills Co. Lid., Calcutta.

minutes till the bond between fibres were weakened. The supernatant liquid was decanted and the sample was reqeatedly washed with distilled water, neutralised with 0.05 N hydrochloric acid and washed again with distilled water. The whole material was converted into pulp. A small amount of the same was rolled between the fingers to form pellets, keft in a test tube and shaken with little quantity of distilled water till defibred. Distilled water was later added to obtain a fibre concentration of 0.05 to 0.1% (I S.I., 1966).

Staining

Basic constituent of paper was found to be cellulose (Mosher and Bracewell, 1946). The various fibres give the results in the colouring reagents (Pitt, 1939; Bhattacharyya *et al.* 1975) The simplest and most effective stains are Herzberg and Graff 'C'.

1. Herzberg stain (Heyn, 1954) Zinc chloride saturated solution 25 ml, potassium iodide 5.5 gms, iodine 0.25 gms, and distilled water 12 5 ml.

2. Graff 'C' stain (Graff, 1942) Aluminium chloride solution 20 ml, calcium chloride solution 10 ml, Zinc chloride solution 10 ml, iodine solution 12.5 ml.

One or two drops of paper fibre suspension (0.05–0.1%). was taken on a glass slide, residual water was evaporated on hot-plate at 40°–50°C, fibres were stained for 5–10 mins, in separate slides with Herzberg as well as Graff 'C' stain, covered with cover glass and examined under the microscope. Fibres were identified and traced with camera lucida. Colour reactions to different fibres were also noted.

Result (morphology of fibres).

Rag fibres (Photo A)

Fibres are torn (figs. 1,3,4); invaginated at one end (fig. 6) and rounded at others (figs. 2,5); fibres with fibrillations, flat and twisted (figs 3,4).

Bamboo fibres (Photo B)

Fibres are moderately thick walled with tapering ends, lumen wide, small pits (fig. 7); fibres show somewhat buckled area with transverse markings (fig. 8); pith cells abundant (figs. 12, 13, 14, 15, 16, 17); vessel elements generally broad with numerous simple perforations (figs. 10, 11); epidermal cell rare (Fig. 9).

Sabai Grass (Photo C)

Fibres are remarkably straight with broad and thick lumen (Figs. 18, 19, 20); some with tapering ends (fig. 18); parenchyma cell present (fig. 25); vessel elements fairly long and narrow in width with simple perforations (figs. 23, 24); epidermal cells are numerous with characteristic toothed margins (figs. 21, 22); spicules scarcely present (figs. 26, 27).

Result (colour reactions to fibres)

Table II–Reagent and Result

Fibres	Herzberg	Graff 'C'
1. Cotton, Linen	Straw-berry Rag colour	Rose
2. Bamboo	Blue	Grey
3. Sabai	Blue-black	Steel-grey

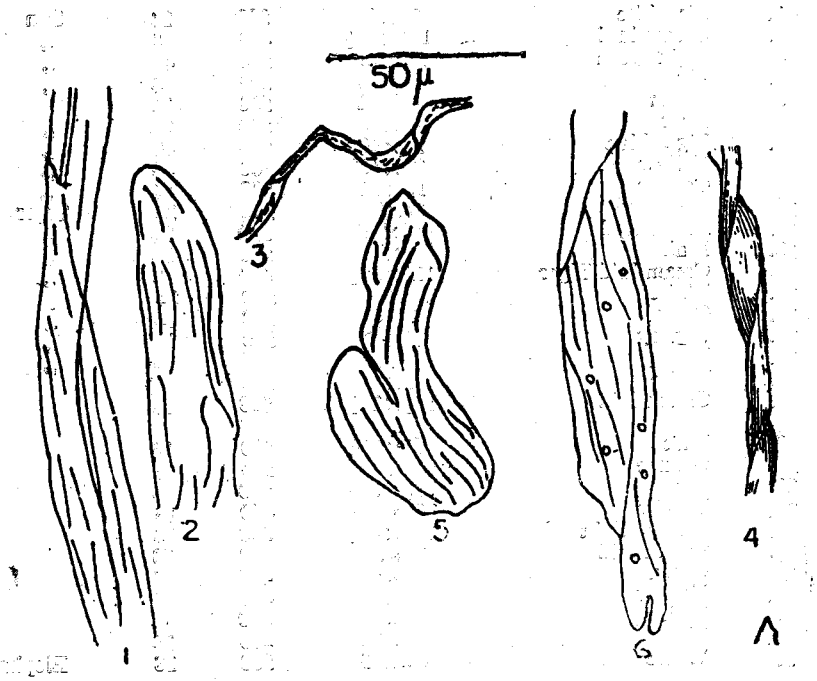
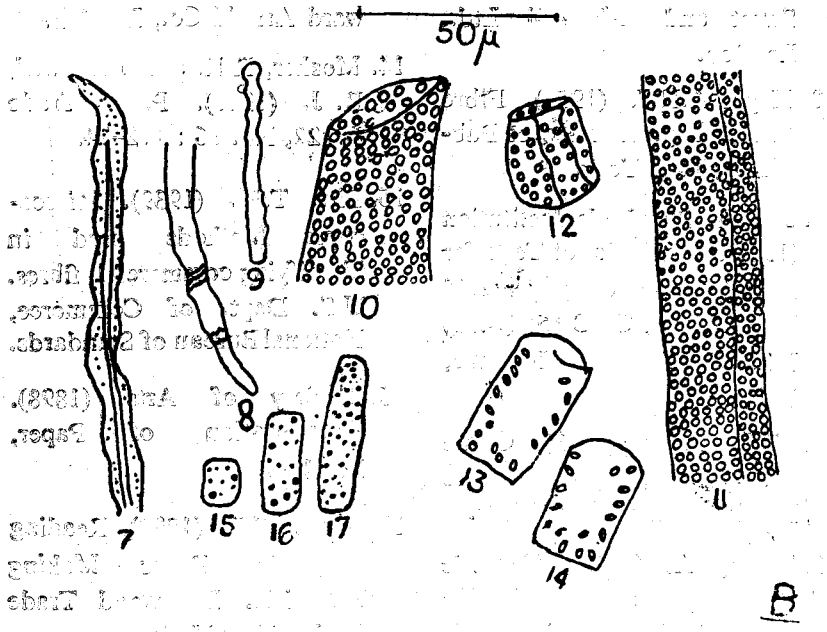


Photo A—Rag fibres—Figs. 1 to 6



Photo—B Bamboo fibres–Figs. 7 to 17

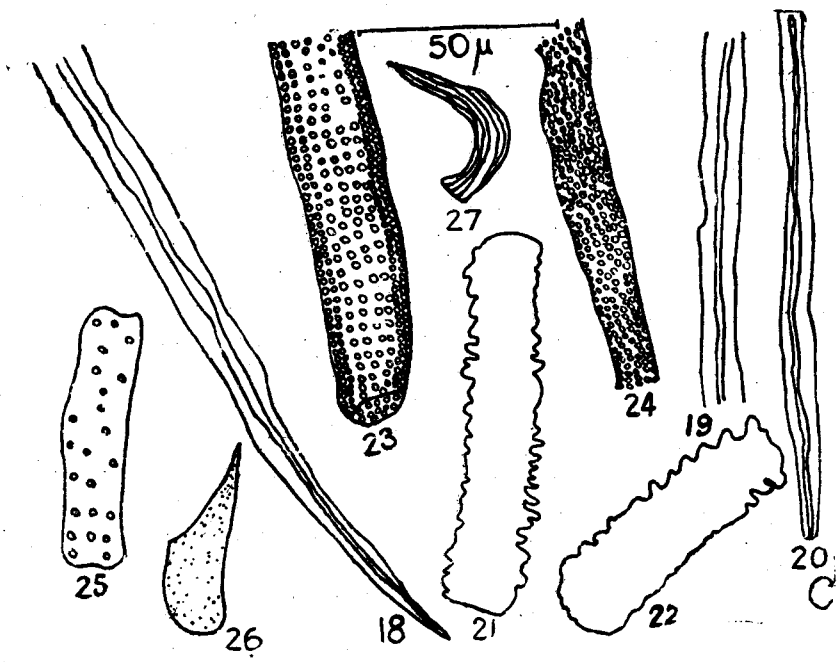


Photo C—Sabai grass—Figs. 18 to 27

To sum up : The determination of the nature of the fibre e. g. rag, bamboo and sabai is made by means of microscope after the paper has been prepared suitably. Microscopic characters are found to vary. Identification of each fibre type and its variation is made. The different fibres are also identified by their colour when treated with certain reagents. The methods are simple and are adopted in laboratory technique for detection. The quantum of paper to be examined which need only be very less. Camera lucida drawing reveals a picture of variations of fibres showing relative value of shape and size. The study here on samples may not be exhaustive, but is sufficiently representative to serve as a nucleus for identification chart.

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