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ART. XXII.—*Who was the Inventor of Rag-paper?*

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I PROPOSE, in this paper, to review briefly the present state of the question, and of the answer thereto. Within the last twenty years a great advance has been made with regard to it; and we owe this advance almost entirely to the researches of two savants, Hofraths Dr. J. Wiesner and Dr. J. Karabacek, both Professors in the University of Vienna. In the following review I shall state the results of those researches, together with such conclusions as appear to me legitimately deducible from them.

In 1877–8 a great find of ancient manuscripts was made in Egypt, at el-Faiyūm, in the ruins of the ancient Arsinoë (Crocodilopolis). Another find was made in el-Ushmūnein (Hermopolis), and a third in Ikhmīn. Most of the manuscripts of these finds ultimately (1884) came into the possession of H.I.H. Archduke Rainer of Austria; and they now form the famous collection known by his name. That collection contains upwards of 100,000 documents in ten languages, extending in their dates over a period of 2,700 years, from the fourteenth century B.C. to the fourteenth century A.D. Most of the manuscripts are written on papyrus, and some are on parchment; but the material of a large portion is paper. It is the latter, the paper manuscripts, with which we are here concerned.

The examination and classification of this mass of manuscripts were entrusted to Professor Karabacek, who in 1894

published an excellent "Guide to the Collection."[1] He called to his assistance a number of experts to deal with the various points of interest that presented themselves in the course of the examination. Their results were published from time to time in a series of learned dissertations.[2] The microscopical examination of the paper of the manuscripts was entrusted to Professor J. Wiesner, while the historical and antiquarian enquiry was undertaken by Professor Karabacek himself.[3] The results of their researches are such as to revolutionize some of the hitherto most unquestioned opinions regarding the material and the history of paper.

Hitherto the following points were accepted as established facts: (1) that the method of making paper from rags was only discovered in the thirteenth century, previous to that date all paper being made of raw cotton fibre; (2) that the art of making this raw cotton paper was learned by the Arabs from the Chinese in 704 A.D., when the former conquered Samarkand. The former of these supposed facts has been demolished by Professor Wiesner, and the latter has been subverted, or at least considerably modified, by Professor Karabacek.

In the two dissertations above cited, Professor Wiesner shows, as the result of a most laborious and minute investigation, by means of the microscope and chemical processes, of papers dating from the eighth century to modern times, that cotton fibre in its raw form has never, at any time, been used in the preparation of paper.[4] On the other hand, he

[1] *Führer durch die Ausstellung, mit 20 Tafeln und 20 Textbildern;* Wien, 1894.

[2] *Mittheilungen aus der Sammlung der Papyrus Erzherzog Rainer.* 5 vols. 1886–1892.

[3] Reports of Professor Wiesner: *Mikroscopische Untersuchung der Papiere von El-Faijûm*, in vol. i, p. 45; and *Die Faijûmer und Uschmuneiner Papiere, eine naturwissenschaftliche, mit Rücksicht auf die Erkennung alter und moderner Papiere und auf die Entwicklung der Papierbereitung durchgeführte Untersuchung*, in vol. ii, pp. 179–260. Reports of Professor Karabacek: *Das Arabische Papier, eine historisch-antiquarische Untersuchung*, in vol. ii, pp. 87–178; and *Neue Quellen zur Papiergeschichte*, in vol. iii, pp. 75–123.

[4] Cotton fibre, in textile form, that is, extracted from cotton rags, indeed, Professor Wiesner found to be used, but in European manuscripts, and only in comparatively modern times.

has found that all the papers of the collection are made of rags. Moreover, practically all these rags have been found to be linen. Occasionally, indeed, a few fibres of cotton rags have been found mixed up with the mass of linen textile fibres; but this only shows that in the selection of the rag material for the paper manufacture, no very great care was exercised, so that occasionally a few cotton rags were allowed to pass in the mass of linen rags, when they were put into the vat to be turned into pulp.

Further, Professor Wiesner found that all the papers of the Erzherzog Rainer Collection were sized with starch-paste, as well as loaded with starch-flour. The object of sizing, at that time as in the present day, was to render the paper capable of being written on, and that of loading, to improve its quality. It was also found that the sheets of paper had been made in moulds with network bottoms, similar to the modern wire-moulds.

The earliest dated papers that Professor Wiesner examined were a letter of 874 A.D., a contract of 900 A.D., and a receipt of 909 A.D., all three written in Arabic. But there were also two letters which, though not dated, could with good reason be assigned to the year 791 or 792 A.D. It is thus shown that in the ninth and tenth centuries, and probably as early as the end of the eighth century, the Arabs were acquainted with the art of making paper from linen rags in network moulds, and of sizing and loading it with starch, that is, in fact, substantially with the whole method of paper-making as practised in Europe till the invention of paper-machines in modern times.

This being so, the puzzling question arises, how it ever came to pass that the legend of the raw cotton paper arose. It is all the more puzzling, as Professor Karabacek also shows that the Arabic tradition lends it no support whatever: the home of the legend is limited to Europe, where it strangely persisted until these latter-day investigations.

To this question Professor Karabacek gives what seems to be a very sufficient reply. He suggests, in effect, that the legend owes its origin to a misunderstanding. One of

the common mediæval names of paper is *charta bombycina*, or as it is also sometimes spelled, *bambycina*. Another well-known name of it is *charta damascena*. The latter name it received from Damascus, the place of its origin. Similarly paper made in Bambyce was called *charta bambycina*; but in later times this fact was forgotten, and seeing that the word *bombyx* was used as a name for cotton, and that by its colour and texture the paper which was commonly in use suggested that material to the eye and the touch of the observer, the idea arose that the paper was made of cotton, and agreeably therewith the name began to be spelled *bombycina*. The legend of the cotton paper, therefore, arose from a misunderstanding such as is not uncommon with regard to articles of merchandise. A name originally indicative of an article's locality of origin comes to be understood solely as indicating its material. Examples are satin and muslin, which are corruptions respectively of the Chinese Tsen-thung and the Arabic Mausil. These are names of localities; but that fact is entirely forgotten in the modern use of the terms satin and muslin, which now only indicate certain materials.

Bambyce is the Latin form of Mabaq, the old name of the town of Hierapolis, in Coelesyria, the capital of the Euphratian province of Constantine the Great. It lay close to the right bank of the Euphrates. In ancient times it possessed a flourishing industry of textile fabrics, especially of silks. The *vestes bombycinae*, or 'silken clothes (of Assyria),' were famous in antiquity. In its district the culture of the silkworm was carried on extensively, whence the silkworm and its product, silk, probably by a similar misunderstanding, received their Greek name of *bombyx*. Later on, the meaning of that name was more generalized, and came to mean 'cotton,' and thus by another misunderstanding, as has been shown, it gave rise to the legend of the cotton-paper. In course of time, owing specially to its being a frontier fortress between the warring Byzantine and Arabic empires, Bambyce declined, and Damascus took its place, in industrial celebrity. The paper of Damascus

ousted the paper of Bambyce; and though the name of bambycine paper continued to pass current by the side of that of damascene, its meaning, as indicative of a locality, was entirely forgotten, and it was taken to indicate merely the material of which damascene paper was made.

This explanation of the origin of the legend of cotton-paper, though otherwise very taking, has one difficulty. For the present, there is no direct evidence that paper manufacture was in any special way one of the industries of Bambyce. There is every reason to believe that paper-making was carried on, more or less, in all the more important towns of the Arab empire. That Bambyce was no exception to the rule is shown by the fact, brought to notice by Professor Karabacek, that the Ducal library in Gotha possesses a manuscript which states itself to be written in 601 Hijrah (1204 A.D.), in Mambij (Bambyce), by a certain *warrāq*, or 'paper-man,' that is, a person whose profession included both the making of paper (*warq*) and the copying on paper. This shows that Bambyce was a place in which paper-makers lived; but it is hardly sufficient to show that it was a place of paper manufacture in any special sense. Evidence, however, to this effect may yet be found. In the meantime, the microscopical and botanical investigations of Professor Wiesner have proved beyond doubt that, however the legend of cotton-paper may have arisen, paper made of raw cotton fibre has never existed. Seeing that even modern paper manufacture, with all its improved appliances, abstains from the use of raw cotton, as being a too impracticable material, it is indeed difficult to understand how it could have been used by the ancient paper-makers with their primitive methods.

We have seen that the Arabs knew the art of making paper from linen rags in the eighth century A.D. It is well known and generally admitted that they learned the art from the Chinese. The question is, what is the exact date of their learning it. The date hitherto accepted has been the year 704 A.D., in which year Samarkand is said to have been conquered by the Arabs, and the art of

paper-making taught them by Chinese prisoners captured on that occasion. This, as Professor Karabacek shows, is a complete fiction, based on a misunderstanding and confusion, originally due to Michele Casiri, of two entirely disconnected Arabic notices. No Arab historian places any, even temporary, occupation of Samarkand in the year 704. On the contrary, in that year Samarkand was in the undisturbed possession of the Turki ruler of Sogdiana. The first so-called 'conquest' took place in 676 A.D., but it was a farce. The Arabs were permitted to march in by one gate and out by another. Though nominally conquered, the city remained closed to the Arabs. Its real conquest only took place in 712 A.D. by the celebrated Qutaiba. Later on, a war broke out between the Turki chiefs of Ferghana and Tashkend. The former appealed to China for help; this was sent, and with it Tashkend was subdued, which thereupon acknowledged Chinese supremacy. This result did not suit the neighbouring Arabs of Samarkand. Abu Muslim, the Abbaside governor of Khorasan, sent his lieutenant Ziyād ibn Ṣālih against the two Turki chiefs. A battle ensued at Aṭlah, on the Tharāz river, north-east of Tashkend, and the 'unbelievers' were utterly defeated and pursued to the Chinese frontier. Among the prisoners taken on this occasion and carried back to Samarkand, there were some Chinese who by profession were paper-makers. It was from these that the Arabs learned the art of paper-making. All this happened in the month of July of the year 751 A.D. This is the account of the events as related in Arabic chronicles; but, as has been shown by Professor Fr. Hirth,[1] it is fully confirmed by the Chinese chronicles of the Thang dynasty, down to the very date of the battle. There can be no doubt, therefore, that it was in 751 (not in 704) that the art of paper-making was introduced among the Arabs in Samarkand.

The question now arises, what kind of paper was it that those Chinese captives were able to make, and the making

[1] *Die Erfindung des Papiers in China*, p. 270, in his *Chinesische Studien* (Munich, 1890).

of which they introduced in Samarkand. Was it rag-paper, or any other? The Arab chroniclers say that it was 'grasses and plants' from which they made their paper. This does not seem to indicate that they used worked-up or woven fibres. It seems evident that what they used was raw fibre, and that their paper was not rag-paper in the ordinary sense. Professor Karabacek tries to reinforce this conclusion by another argument, drawn from the word *kāg̲had̲h* (or, as pronounced in India, *kāg̲haz̤*), by which paper came to be known among the Arabs. Papyrus, which they first used, was called *qarṭās*; but when paper was introduced among them it was distinguished as *kāg̲had̲h*. Now *kāg̲had̲h* is not Arabic, but is said to be a loan-word from the Persian. But Professor Hirth has proved (*l.c.*, p. 269) that it is really a Persian loan-word from the Chinese. He has found in a Bukhariote-Chinese Dictionary the statement that *kāg̲had̲h* is the same as the Chinese *kok-dz'*, which latter word, Professor Hirth says, means 'paper made of the bark of the mulberry-tree' (*Broussonetia papyrifera*, Vent.). From this Professor Karabacek draws the two conclusions, (1) that the material intended by the expression 'grasses and plants' was (chiefly, if not entirely) the bark of the mulberry-tree, and (2) that the name *kāg̲had̲h* originated on that occasion, in 751, when paper manufacture was introduced in Samarkand by the Chinese prisoners. The paper, he argues, which was thus introduced among them, the Persian-speaking population naturally called by the Chinese name *kok-dz'*, or, as they pronounced it, *kāg̲had̲h*. A serious difficulty, however, disclosed itself at once. The paper mulberry tree does not grow in Western Turkestan; and, considering the hostile relations of the Arabs to the Chinese, there were obvious difficulties in the way of procuring the needful supply of the material from China. The people of Samarkand were, of necessity, forced to cast about for a substitute. Western Turkestan was a country with an extensive cultivation of cotton; and it is not impossible that the Samarkandis may, in the first instance, have had recourse to the use of raw

cotton fibre; but whether or not they did so (there is no evidence whatsoever on the subject), the experiment must have shown at once the utter unsuitability of that material. At any rate, Professor Wiesner's researches have proved that, as a fact, raw cotton fibre has never formed the basis of paper. On the other hand, they have shown that linen rags invariably were the material from which the paper of Samarkand was made. It is evident, therefore, that linen rags were the substitute which the Samarkand paper-makers adopted to supply the want of the bark of the mulberry-tree. The query, however, still remains, what was it that suggested this substitute to the Arabs, or, as we should rather say, to the people of Samarkand? For there is no obvious connection between mulberry bark and linen rags. This query, apparently, did not suggest itself to Professor Karabacek; in any case, it is neither stated nor answered by him.

As to the name *kāghadh*, it appears to be assumed by Professor Karabacek that it originated in or about the year 751, at the time when the Arabs commenced their paper manufacture in Samarkand. It is an assumption, which may be true, but it has not yet been proved. Indeed, some facts are mentioned by Professor Karabacek himself which rather make against it. Nor do the general probabilities seem to be in favour of it. It is well known that a fairly active trade intercourse existed between China and the western Persian-speaking countries of Asia. It can hardly be doubted that Chinese paper would form one of the articles of trade, or at least reach those countries in connection with their trade transactions with China. As a fact, Professor Karabacek notes several cases of Chinese paper being known to the Arabs at a much earlier date than 751 A.D. According to him, the earliest mention of paper as an import from China to Samarkand refers to the year 30 H. or 650–1 A.D. Again, the second Khalif 'Omar is said to have been the first who used paper for writing in Mecca. This can only have been Chinese paper, and the date is 88 H. or 707 A.D. The Chinese paper, which thus came into Persian-speaking

countries and fell into Arab hands, must have been known among them by some name, and it is quite possible that that name was *kāghadh*, the Persian corruption of the Chinese *kok-dz'*. It is evident, then, that the origin of the name may very well be of a much earlier date than 751 A.D. The Arabs knew of Chinese paper; they probably knew it by its Persian name *kāghadh*, and the practical usefulness of it they, no doubt, fully appreciated. When, then, on the capture of the Chinese professional paper-makers in 751, the chance presented itself of introducing the art of making it into their country of Samarkand, it cannot surprise that, practical people as they were, they at once proceeded to profit by it. When once produced within their own borders, the article, of course, became much more common among them, and its name *kāghadh* proportionally more familiar. This, in any case, is a natural explanation of all the facts of the case; and the opposite theory that the name *kāghadh* only originated in 751, at the time of the introduction of the art of paper-making in Samarkand, can only be admitted on proof of it being given.

The argument from the word *kāghadh*, then, seems to me to fail as an evidence to show what the 'grasses and plants' were from which, as the Arab historians tell us, the Chinese captives in 751 A.D. made their paper. What the word undoubtedly does show is that the Chinese paper, which in the course of trade reached the western countries, and from which the Persian, and subsequently Arabic, term *kāghadh* originated, was *kok-dz'*, or 'paper made of the mulberry bark.' But the origin of the word is probably of a much earlier date than 751 A.D., and the word itself proves nothing regarding the identity of the 'grasses and plants' of 751 A.D. For the Chinese, as is well known, made paper of a variety of raw fibres; and those 'grasses and plants' may very well have been other fibres than those of the mulberry-tree.

At this point come in those new discoveries of ancient paper which have recently been made in Eastern Turkestan. The earliest Arab, or rather Samarkandi, paper which Professor Wiesner has examined dates from about 791–2;

and this, as he found, was made entirely of rags, that is, of worked-up or woven fibres. Of raw fibres he discovered no trace in it. On the other hand, as we now know, thanks to Professor Karabacek's researches, the Arabs learned the art of paper-making in 751 A.D. There is here a gap of about forty years; within that interval the Arabs must have passed from the use of 'grasses and plants' to that of rags. If we had any Samarkandi paper, made in 751 or in some year near to that date, which could be examined by Professor Wiesner's methods, the identity of the 'grasses and plants' could be at once and indubitably established. Or, failing Samarkandi paper, if we had Chinese paper of that precise date, the identity of the 'grasses and plants' which the captive Chinese paper-makers used could also be established. Now it so happens that Chinese papers of that precise date are included among the discoveries in Eastern Turkestan. These discoveries have been described in my Report as well as in Dr. Stein's Preliminary Report.[1] Among the manuscripts dug out from the sand-buried site of Dandan Uiliq, there are, in addition to many others which are not dated, five Chinese documents dated in the years 768, 786 (my Report, p. 23), 781, 782, and 787 (Dr. Stein's Report, pp. 39, 40). All these manuscripts fall into the interval in question, 751–792 A.D.; and they should show what materials were used at that time by the Chinese paper-makers in the countries adjoining Western Turkestan. Accordingly specimens of these papers, together with specimens of most of the other manuscripts discovered in Eastern Turkestan, were submitted by me for examination to Professor Wiesner. His results have been published by him in a report submitted to the Imperial Academy of Sciences of Vienna.[2] They show that the

[1] My *Report on the British Collection of Antiquities from Central Asia* has been published as part ii, extra number 1 of the Journal of the Asiatic Society of Bengal, vol. lxx, 1901. Dr. Stein's *Preliminary Report on a Journey of Archæological and Topographical Exploration in Chinese Turkestan*; London, 1901.

[2] *Microscopische Untersuchung Alter Ost-Turkestanischer Papiere*, in vol. lxxii of the Denkschriften der Mathematisch-Naturwissenschaftlichen Classe of the Academy. This report refers to the papers comprising my collection described in my Report. Professor Wiesner's report on Dr. Stein's papers has not yet

Chinese paper of that period in Eastern Turkestan was made of a mixed material, viz., of a mixture of certain raw fibres with rags. The raw fibres proved to be (speaking roughly[1]) those of mulberry, laurel, and China-grass; and the rags were of flax, hemp, or China-grass. Moreover, it was found that the main constituent of the paper were raw fibres, while the rags served as surrogates. We can now see what those 'grasses and plants' must have been of which the Chinese captives taught the Samarkandis to make paper. They were the fibres of China-grass and of the bark of mulberry and laurel trees. But there is another point which we also learn, that these 'grasses and plants' did not form the sole material of that early Arab, or Samarkandi, paper, but that more or less of macerated rags and ropes (linen, hempen, or others) was mixed with it. That these surrogates are not named by the Arab historians in their vague statement of the paper material is, in the circumstances, not more than might be expected. But they form the missing link between the Chinese and the Arab paper. They explain how it was that the sole use of rags in paper manufacture suggested itself to the Arabs. Originally, as taught by their Chinese instructors, they used a mixture of macerated raw fibres and rags. Gradually, as the raw fibre, especially that of the mulberry-tree, gave out, they increased the substitution of rag-fibres; and as they must have soon discovered that this substitution answered very well, they finally ended by limiting themselves entirely to the use of woven or worked-up fibres, contained in rags, ropes, nets, and such like material, mostly linen, which could be obtained by them in large quantities.[2] This, as I take it, is the real origin of the so-called rag-paper. To the Arabs, or rather Samarkandis,

been published; but the Professor has informed me privately that the results of the examination of these papers confirm in all respects those of the examination of my papers.

[1] A more accurate statement will be found below, p. 687, in the translation of Professor Wiesner's *Summary*.

[2] The Arabs wore linen clothes. With the growth of the paper industry a large trade sprang up in linen rags; and in Egypt the cemeteries began to be ransacked and the mummies despoiled of their linen coverings.

belongs the credit, not of discovering the use of rags or worked-up fibres, but (what certainly is of sufficiently great importance) of limiting themselves to it entirely; that is to say, they have the credit of the invention of *pure* rag-paper.

In passing, it may be noted that Professor Wiesner's researches further show that the processes of 'sizing' and possibly 'loading' also were already known to the Chinese makers of Eastern Turkestani paper. These processes were not discovered by the Arabs, or Samarkandis, but taken over by them from their Chinese instructors.

The above suggested evolution of the art of paper-making is altogether supported by the Chinese tradition on the materials used by them in their paper manufacture.[1] That tradition, as Professor Fr. Hirth tells us (*l.c.*, pp. 259–271),[2] says that Ts'ai Lun, about 105 A.D., discovered the method of making paper from the bark of trees, hemp, rags, and fishing-nets. Here we have a distinct statement of two classes of material, which, as a fact, Professor Wiesner has discovered to be really the constituents of Chinese paper in the eighth century A.D., namely, the raw fibres of 'bark and hemp' and the worked-up fibres of 'rags and fishing-nets.' I believe the statement of the Chinese tradition has usually been understood to indicate three alternative materials of paper, namely, that paper was made either of bark, or of hemp, or of rags and fishing-nets; but Professor Wiesner's researches show that the tradition is speaking rather of a mixture of materials: bark, hemp, and rags were mixed to form the pulp of the paper. The tradition does not refer to any pure rag-paper, but only to mixed rag-paper, similar to that discovered in Eastern Turkestan. From

[1] I may here mention a curious evidence of the trustworthiness of Chinese tradition. Among other things used in Chinese paper-making, it names lichen. This apparently is a most unsuitable substance, and the statement of its use has been looked upon with great distrust. But Professor Wiesner has discovered that, as a fact, lichen was used in the manufacture of some of the ancient Eastern Turkestani paper, which he examined, for the purpose of sizing it.

[2] The subject of the invention and development of paper-making by the Chinese, however, deserves a thorough re-examination by Chinese scholars in the light of Professor Wiesner's recent researches.

Professor Wiesner's researches we may also conclude what the 'bark and hemp' were. In 'bark,' no doubt, was included the inner bark or bast of the mulberry and laurel trees, and 'hemp' included flax and China-grass. Again, 'rags and fishing-nets' included material made of flax, hemp, and China-grass.

Though it is quite evident that anciently paper was made in China from a mixture of materials, it is quite intelligible that the constituents of the mixture and their relative amount in the mixture may have varied in different provinces of the Chinese empire. Accordingly, as Professor Giles informs me in a letter (dated 6th November, 1899), it is said that "in Ssŭch'uan hemp was used for making paper, in Fuhkien bamboo, in the North mulberry-bark, in Kiangsu rattan, on the sea-coast lichen, in Shehkiang husk of grain, in Central China silk, and in Hupeh *Broussonetia papyrifera*, Vent." [1] This, no doubt, does not mean that in the provinces named paper was made entirely from the particular substances allotted to them, for it is very improbable that, e.g., from lichen by itself any paper could be prepared. What is meant is evidently that those substances formed the principal or a peculiar constituent of the paper-pulp in their respective provinces. Now the point to be noted in the allotment of the articles is that mulberry-bark is attributed to the 'North' of China. It is Northern China, especially its north-western province, Kansu, which directly adjoins Eastern Turkestan, and it is through the latter country that the two famous trade-routes passed which connected China with the 'western countries' of Asia. It would primarily be paper made in Northern China—that is, mulberry-paper—which would be carried in the course of trade to Eastern Turkestan, and thence to the western countries. Mulberry-paper, as we know from Professor Hirth's researches, was called *kok-dz'*; and thus we see how it came to pass that in the Persian-speaking western countries, and thence among the Arabs, Chinese paper came to be known as *kāghadh*. This also

[1] Quoted from the *Pên-tsao-kang-mu* or Materia Medica.

serves to explain the circumstance that in the ancient Chinese paper discovered in Eastern Turkestan the raw fibre of the mulberry-tree has been found to form such a prominent constituent of its mixed material. The Chinese paper used in Eastern Turkestan would be paper made in Northern China, or, if made in Eastern Turkestan itself, would be made according to the fashion of Northern China, that is, it would be—as, in fact, it was found to be—in the main a mulberry-paper. In connection herewith, as a corroborative circumstance, it may be noted that in the Report of the Yarkand Mission[1] mulberry is enumerated among the 'common trees' of Eastern Turkestan.

It is a curious circumstance that, in the allotment passage above quoted, the China-grass (Ramie, *Boehmeria nivea*) should not be mentioned at all, while Professor Wiesner's investigations show that it was such an important constituent in the ancient Chinese paper of Eastern Turkestan. Possibly that extract, as given in Professor Giles' letter to me, may be not complete, or its enumeration of substances is not intended to be exhaustive; I am not in a position to verify the point. But the fact, as disclosed by the Eastern Turkestani papers, would seem to be that the fibres of both mulberry-bark and China-grass were common materials used in the paper manufacture of Northern China.

Thus far we have seen that the art of making paper from a mixed stuff consisting of raw fibres and textile fibres (as present in rags, nets, and the like), including the processes of sizing and possibly of loading, was already known to the Chinese in the eighth and preceding centuries. From them the people of Samarkand learned it through Chinese captives, carried there by the Arabs in 751 A.D. Owing to the failure of the raw fibres, the Samarkandis took to making paper solely from textile fibres. They thus became the inventors of what is commonly understood by 'rag-paper,' that is, paper made solely of rags. The rags used in the early

[1] *Report of a Mission to Yarkand in* 1873, *under the Command of Sir T. D. Forsyth, K.C.S.I., C.B.* Calcutta, 1875. See p. 75.

paper of Samarkand appear to have been exclusively linen. In any case, cotton, whether raw or woven, was never used either by the Chinese or the Arabs.

In addition to the difference of mixed and pure rag-paper, the Arab (or Samarkand) paper differed from the Chinese also in the manipulation of its material. Originally the Chinese used the method of 'stamping,' or pounding, the fibres in a stone mortar.[1] This rude process necessarily resulted in an excessive destruction of the fibrous tissue, and from the half-stuff thus obtained only an inferior kind of paper could be made, which would 'run' and could only be inscribed with a viscid ink. Later on, in the case of raw fibres, chemical processes of maceration were adopted for their extraction, and thus much better preserved fibrous tissue was obtained, capable of yielding an improved kind of paper. In the case of textile fibres, however, it appears the old rude method of stamping was retained. All this is clearly shown by Professor Wiesner's investigations. In the oldest papers of the fourth and fifth centuries he found the raw fibres, of which alone those papers were made, exhibiting every mark of having been obtained by stamping. In the subsequent centuries, when mixed papers already make their appearance, the raw fibres were often found so well preserved as to show that they were obtained by some chemical process of maceration, while the textile fibres still exhibited the marks of the primitive stamping process. On the other hand, in the Arab, or Samarkandi, paper of the Archduke Rainer Collection, which Professor Wiesner had previously investigated, he only found the textile fibres of rags; and these were so well preserved as to show that they were extracted by some chemical process. The conclusion, then, which may be drawn is that the Arabs extended the chemical process, which their Chinese instructors had only used with raw, but not with textile, fibres, also to the

[1] The mortar used by Ts'ai Lun (105 A.D.), the inventor of vegetable fibre paper, is said to have been still preserved as a curiosity in the time of the Thang Dynasty (618–907 A.D.). See Hirth, *l.c.*, p. 627.

extraction of the latter. The consequence was that they not only invented the pure rag-paper, but also improved the quality of their rag-paper.

This improvement had particular reference to the fitness of the paper for being written on. Half-stuff made of rudely stamped fibres (raw or textile) was only capable of producing paper which would 'run,' and could only be inscribed (or rather painted on) with some thick, or viscid, ink. On the other hand, fibres extracted by chemical process have a greater tendency to 'bind,' and thus produce paper much more susceptible of being inscribed with ordinary ink. This being so, the Chinese early cast about to discover means by which they could render their paper made of rudely stamped fibres susceptible of writing. One of the earliest methods, as Professor Wiesner's researches have shown, was to cover the surface of the paper with a thin coating of gypsum. The next was to render the body of the paper itself impermeable to a liquid by 'sizing,' or gluing, its half-stuff with starch. Sometimes, as Professor Wiesner has found, lichen was substituted for starch. A third method, apparently also used sometimes, was to 'load' the paper with starch-flour (especially of rice). The method of sizing with starch, however, was the usual and favourite one. It was the method which Professor Wiesner found used in the dated Chinese document of the year 768 A.D., above referred to. The same method he also found invariably used in the Arab, or Samarkandi, paper of the Archduke Rainer Collection. It is thus evident that the Arabs learned this method from their Chinese instructors, but in their hands it ensued in a further improvement of the paper, because the sizing with starch tended to reinforce the 'binding' property of their half-stuff, which it already possessed from being made of chemically macerated rags.

To sum up, the Arab paper possessed three advantages over the older Chinese paper: (1) it was made entirely of (linen) rags, the fibres of which rags (2) were extracted by chemical processes; (3) it was made susceptible of writing with ordinary ink by sizing it with starch glue. It is the

preparation of paper by this improved method which must be credited to the Arabs, or, as we should say properly, to the paper-makers of Samarkand, whoever they were.

Regarding the further history of the Samarkandi rag-paper, Professor Karabacek has shown that its spread beyond the country of its origin (Transoxania) into the rest of the Arab empire began in the year 794–5, when Ja'far, the Barmecide Wazīr of the Abbaside emperor Hārūnu-r-Rashīd, established the second paper factory in Baghdad. Thence the art quickly spread over the whole of the Abbaside empire, and factories arose in Persia, Arabia, Egypt, Syria, North Africa, and Spain. In the middle of the tenth century, paper had already become so common that it entirely displaced the use of papyrus. In 1035, we are told, it was such a common article in Egypt that the grocers of Cairo were in the habit of wrapping in it the goods which they sold to their customers. Each factory had its speciality. That of Damascus attained a particular celebrity, and it was principally from that place that paper, under the name of *charta damascena*, was imported into Europe. If Lichtenberg, whom Professor Karabacek quotes,[1] can be trusted, it was in the year 940 A.D. that rag-paper was introduced into China. This, of course, can only mean rag-paper in the sense of paper made entirely of rags, that is, Samarkandi or Arab paper. But the introduction of this paper, if it did take place, does not appear to have gained any permanent footing in China, for, as I understand, rag-paper (in the explained sense) is not made there even in the present day. On the other hand, rag-paper, in the sense of mixed rag-paper, as we have seen, was known to the Chinese from the very beginning of its invention by Ts'ai Lun, early in the second century A.D. Though even this does not seem to have been the beginning of the making of 'paper' in its proper sense. For 'paper' proper is a species of 'felting,' and is made on the same principle as ordinary felt: it is,

[1] From Lichtenberg's *Vermischte Schriften*, v, 508–510; in Karabacek, *l.c.*, p. 117. I am not in a position to verify the reference.

accordingly, an altogether different article from papyrus and parchment, which are made by quite different methods. Now the main point of Ts'ai Lun's invention was that he substituted vegetable fibres (of grasses, barks, rags, etc.) in the place of animal. He was, therefore, not the inventor of paper, but only of vegetable fibre paper. Before his invention, as early as the second century B.C. according to Professor Hirth (*l.c.*, p. 264), felt-like paper was made by the Chinese from 'silk-waste.' This silk-waste (*hsü*) appears to have included both raw and woven silk; and thus even this early silk-paper of the Chinese may be said to have been mixed rag-paper.

Finally, the art of preparing felt (as distinguished from spun or woven cloth) from the wool of their herds, for use as clothing or tent-covers, seems to have been known from immemorial times as a national industry among the nomad tribes of Central Asia. Hence it appears probable[1] that it was the felt of those nomads that suggested to the Chinese the idea of making felt-like paper from the silk of their own country. Previous to the invention of (felt-like) paper the Chinese are said in their own records (Hirth, *l.c.*, pp. 262, 266) to have used wooden splints, or slips of bamboo, for the purpose of writing. In this respect the Chinese records are fully confirmed by the recent explorations of Dr. Stein in Eastern Turkestan. In the oldest settlements on the Niya River site[2] Dr. Stein discovered numerous wooden tablets and splints, inscribed with Kharoṣṭhī and Chinese letters, but no paper of any kind. The occurrence of Kharoṣṭhī writing on them proves their great age; and that their date may possibly go back to as early as the second century B.C. is indicated by the Chinese statement about the invention of silk-paper at the end of that century. The latter statement thus in its turn serves to define more accurately the possible date of the Niya documents.

[1] See Dr. G. Jacob, in *Oestliche Culturelemente im Abendland*, p. 16.
[2] See Dr. Stein's *Preliminary Report of Archæological and Topographical Exploration in Eastern Turkestan*, pp. 43 ff.

In conclusion, I may add a translation of the summary of the principal results of Professor Wiesner's examination of the ancient papers discovered in Eastern Turkestan (*l.c.*, pp. 631, 632). It runs as follows:—

"Taking into account the dates assigned to the papers on palæographic grounds, the following conclusions may be drawn from the examination of their material:—

"(1) The oldest of the Eastern Turkestani papers, dating from the fourth and fifth centuries A.D., are made of a mixture of raw fibres of the bast of various dicotyledonous plants. From these fibres the half-stuff for the paper was made by means of a rude mechanical process.

"(2) Similar papers, made of a mixture of raw fibres, are also found belonging to the fifth, sixth, and seventh centuries. But in this period there also occur papers which are made of a mixture of rudely pounded rags and of raw fibres extracted by maceration.

"(3) In the same period papers make their appearance in which special methods are used to render them capable of being written on; viz., coating with gypsum, and sizing with starch or with a gelatine extracted from lichen.

"(4) In the seventh and eighth centuries both kinds of papers are of equal frequency: those made of the raw fibre of various dicotyledonous plants and those made of a mixture of rags and raw fibres. In this period the method of extracting the raw fibre is found to improve from a rude stamping to maceration; but that of preparing the rags remains a rude stamping, and in the half-stuff thus produced from rags it is easy to distinguish the raw fibre from the crushed and broken fibre of the rags.

"(5) The old Eastern Turkestani (Chinese) paper can be distinguished from the old Arab paper not only by the raw fibres which accompany the rag-fibres, but also by the far-reaching destruction of the latter.

"(6) The previous researches of Professor Karabacek and the author had shown that the invention of rag-paper was not made in Europe by Germans or Italians about the turn

of the fourteenth century, but that the Arabs knew its preparation as early as the end of the eighth century.

"The present researches now further show that the beginnings of the preparation of rag-paper can be traced to the Chinese in the fifth or fourth centuries, or even earlier.

"The Chinese method of preparing rag-paper never progressed beyond its initial low stage. It was the Arabs who, having been initiated into the art by the Chinese, improved the method of preparing it, and carried it to that state of perfection in which it was received from them by the civilized peoples of Europe in the mediæval age.

"(7) The author has shown that the process of sizing the paper with starch in order to improve it was already known to the Arabs in the eighth century. In the fourteenth century the knowledge of it was lost, animal glue being substituted in the place of starch; till finally in the nineteenth century, along with the introduction of paper-machines, the old process was resuscitated. But the invention of it was due to the Chinese. The oldest Eastern Turkestani paper which is sized with starch belongs to the eighth century.

"(8) The Chinese were not only the inventors of (felted) paper and the initiators of rag-paper — though in the preparation of the latter they made use of rags only as a surrogate by the side of raw fibres—but they must also be credited with being the forerunners of the modern method of preparing 'cellulose paper.' For their very ancient practice of extracting the fibre from the bark and other parts of plants by means of maceration is in principle identical with the modern method of extracting 'cellulose' by means of certain chemical processes.

"(9) The exact identification of the plants from which the fibres were obtained was beset with great difficulties, owing to the fact that all the fibres of the ancient papers under investigation are derived from the inner bark of dicotyledonous plants; and, as a rule, all 'accessory guiding indications' which might have helped to identify the

particular dicotyledon were absent. Subject to these limitations, it was possible to prove the presence among the rag-fibres of those of *Boehmeria*, flax and hemp, and among the raw fibres of the bast-cells of *Boehmeria*, *Moraceæ*, and *Thymelaceæ*. There were, however, a few kinds of bast-fibre which it was altogether impossible to identify."

P.S.—Since the above article has been in print, I have come to know a paper on the same subject by Dr. R. Garnett, published in the January Number, 1903, of the *Library*, pp. 1–10. It gives an excellent summary of the researches of Professors Karabacek and Wiesner, noticing some interesting particulars which, from the point of view of my article, were immaterial, and consequently omitted by me. On one point, however—very material to my argument—I see that Dr. Garnet offers a different suggestion. That point refers to the question, how the Samarkandis came to substitute linen rags for the raw fibres which had been used by the Chinese: see *ante*, pp. 669, 670, 673, 676. On p. 5 of his article, Dr. Garnett says: "The Arabs and their assistants [in default of the raw fibres used by the Chinese] resorted to flax, which grows abundantly in Khorasan, and made their paper from the fibres of the plant, and afterwards from rags, supplemented, as the demand increased, with any vegetable fibre capable of serving the purpose." Again, on p. 10, "It may be doubted whether the higher credit be due to the ingenious man who first thought of the flax of Khorasan as a substitute for the Chinese material, or to him who augmented this source of supply by recourse to rags."

I do not know of any evidence showing that flax ever grew abundantly in Khorasan. At the present day, certainly, it does not grow so there; cotton does. In the *Encyclopædia Britannica* articles on Western Turkestan, Khorasan, Samarkand, etc., flax is not mentioned at all among the crops of the country. I doubt whether it was different in the eighth century; whether, indeed, flax was grown at all at that time. But whether, or not, the Samarkandis resorted,

at first, to the substitution of the raw fibre of flax, or cotton, or some other plant, and only *afterwards* to rags, Professor Wiesner's investigations certainly suggest, if they do not prove, that it was the fact of the Chinese using rags as a *surrogate* which suggested to the Samarkandis the use of them as the *sole* material in their paper manufacture.

As to Dr. Garnett's remark about the [linen] rags being supplemented with any vegetable fibre capable of serving the purpose, I suppose he refers to hemp. But, in any case, it was the worked-up fibre of hemp (as contained in rags, ropes, etc.), not the raw fibre; for Professor Wiesner's investigations have shown that Samarkand paper contains no raw fibres at all, but only fibres of rags (whether linen or hempen).