culate, simple or forked, many-flowered. Calyx hispid with soft white hairs; lobes erect, linear-oblong, subacute. Corolla funnel-shaped; tube equalling the calyx, throat with 5 scales; limb rather small. Stamens inserted just below the corolla-scales; filaments long, more than twice the length of the anthers, which reach more than half-way up the corolla-lobes. Nutlets ovoid, smooth and shining, dark brown.

I describe this species with considerable hesitation, on account of its evident close relationship to *M. saxosa*, a plant which has not been seen since its first discovery by Mr. Colenso, nearly sixty-five years ago. Judging from Hooker's description, however, it differs from that plant in the much larger size, more slender habit, fewer softer hairs, more numerous and larger flowers, and in the anthers not being exserted. I have much pleasure in dedicating it to Mr. Aston, who is doing so much towards increasing our knowledge of the botany of the Tararua Range.

Art. XXIV.—*The Absorption of Moisture from the Atmosphere by Wools.*

By A. M. Wright, F.C.S.

[*Read before the Philosophical Institute of Canterbury, 1st December, 1909.*]

Wool is very hygroscopic, and may contain from 8 up to 50 per cent. of moisture, according to the conditions of the atmosphere to which it is exposed. This is an important item in the sale of wool, and hence in Great Britain and on the Continent the percentage of moisture contained in wool to be sold must be officially determined in wool-conditioning laboratories.

The legal amount of moisture allowed in most European countries is 18·25 per cent.

The purposes of this investigation were—(1) To determine under what conditions wool absorbs moisture from the atmosphere; (2) to determine what constituents present in wool enable it to absorb such relatively large amounts of moisture.

The chemical composition of wool-fibre is nitrogenous, but we must distinguish between the true wool-fibre and the incrustating and mechanically adhering matters.

Pure wool-fibre consists for the most part of keratine, the characteristic constituent of horn, feathers, &c., and is not of constant chemical composition, but varying in different qualities and kinds of wool.

The incrustating and adhering matters consist of—(*a*) Wool-fat or yolk (soluble in hot alcohol); (*b*) other fatty matter (soluble in ether); (*c*) suint, which exudes from the body of the animal with the perspiration, and is sometimes known as "wool-perspiration" (soluble in water); (*d*) adhering impurities or dirt mechanically mixed with the above or entangled among the fibres (mechanically removed after extracting the fats).

The following are the analyses of the greasy and slipe wools of various kinds used in this investigation. The methods of analyses used are those described by the author,* with an additional method to determine the water-soluble suint. Suint was determined in the portion of the sample remaining after removal of the adhering sand and dirt. After drying and weighing, the sample was placed in a soxhlet extraction-thimble and repeatedly extracted with hot water; thereafter it was dried and weighed, the difference in weight from the previous weighing being suint, and the residue pure wool-fibre.

TABLE I.—GREASY WOOL.

—	Half-bred.	Three-quarter-bred.	Leicester.	Lincoln.
Moisture	16·90	19·20	17·79	17·18
Wool-fat	16·68	12·08	8·94	5·72
Other fatty matter ..	0·42	0·74	0·91	0·96
Water-soluble suint ..	10·30	12·72	7·81	2·26
Sand, dirt, lime, &c. ..	3·62	3·94	5·10	5·32
Pure wool-fibre ..	52·08	51·32	59·45	68·56
	100·00	100·00	100·00	100·00

TABLE II.—SLIPE WOOL.

—	Half-bred.	Three-quarter-bred.	Leicester.	Lincoln.
Moisture	12·78	12·82	13·37	12·67
Wool-fat	6·49	5·76	3·53	3·47
Other fatty matter ..	2·45	2·29	1·82	2·05
Water-soluble suint ..	2·01	1·60	1·20	1·04
Sand, dirt, lime, &c. ..	2·66	3·72	4·49	3·85
Pure wool-fibre ..	73·61	73·81	75·59	76·92
	100·00	100·00	100·00	100·00

It will be seen from the above analyses that the slipe wools contain a lower percentage of moisture than the greasy wools; the cause of this difference will be explained later. It is further seen that the amounts of wool-fat and suint are considerably less in the slipe wools; this is only to be expected, for in the washing of the skins these matters are removed.

The increase in fatty matters other than wool-fat is probably due to the fat and grease on the underside of the skin adhering to the wool in rubbing against the woolly side during the process of washing.

In determining the amount of moisture absorbed by greasy and slipe wools, the wools were dried absolutely, and, after weighing, were exposed to the atmosphere of the laboratory for from twenty-four hours to 408 hours, being weighed at regular intervals; at the same time determinations of the relative humidity and the amount of moisture in grains per cubic foot present in the atmosphere were made.

* Jour. Soc. Chem. Ind., vol. xxvii, No. 3, 1909; Trans. N.Z. Inst., vol. xli, 1908.

The results obtained are presented in the following tables (the amounts of moisture absorbed by the wools are calculated to the moisture-free samples) :—

TABLE III.—GREASY WOOL.

Time, in Hours.	Moisture absorbed, per Cent.	Relative Humidity.	Grains of Water per Cubic Foot.
24	24·38	80	3·6
32	29·27	85	5·2
48	27·77	85	4·4
72	26·82	72	3·8
144	28·66	82	3·9
168	26·62	76	3·8
192	27·36	85	3·8
216	25·79	70	2·7
240	24·85	65	4·3

TABLE IV.—SLIPE WOOL.

Time, in Hours.	Moisture absorbed, per Cent.	Relative Humidity.	Grains of Water per Cubic Foot.
24	16·26	80	3·7
26	16·12	75	4·2
48	16·69	81	4·7
72	16·27	78	3·5
96	16·92	80	4·1
144	20·66	95	4·8
168	19·82	87	4·6
180	17·79	60	4·2
192	18·14	80	3·6
200	19·41	85	5·2
216	19·43	85	4·4
240	18·92	72	3·8
312	19·27	82	3·9
336	18·71	76	3·8
360	19·13	85	3·8
384	17·95	70	2·7
408	17·74	65	4·3

From the above results it is seen that the greasy wool absorbs from 24·38 to 29·27 per cent. moisture, whereas the slipe wool absorbs under the same conditions from 16·12 to 20·66 per cent. It is also seen that the amounts of moisture absorbed increase and decrease as the relative humidity rises and falls.

It is he relative humidity of the atmosphere rather than the absólute amount of moisture present which determines the amount of moisture which wool absorbs. From the above table it is seen that the amount of water per cubic foot of air bears but little direct relation to the moisture absorbed by the wool.

The amount of moisture absorbed by pure wool-fibre free from incrustations and adhering impurities was determined, and the results are shown as follows :—

TABLE V.—PURE WOOL-FIBRE.

Time, in Hours.	Moisture absorbed, per Cent.	Relative Humidity.	Grains of Water per Cubic Foot.
24	18·03	72	3·8
96	19·50	82	3·9
120	18·90	76	3·8
144	19·62	85	3·8
168	18·47	70	3·7
192	18·19	65	4·3

It is thus seen that pure wool-fibre, free from all other matters, absorbs from 18·03 to 19·62 per cent. of moisture from the atmosphere under varying degrees of humidity.

It is obvious from the above results that the pure wool-fibre cannot be the only matter in normal wool which causes the absorption of moisture, for in the greasy wool, containing from 50 to 60 per cent. of pure wool-fibre. it is found that the absorption of moisture is from 24 to 29 per cent., whereas if the pure wool-fibre were the only factor we should expect to find a moisture-absorption of but from 9 to 12 per cent.; and in slipe wool, containing from 70 to 80 per cent. pure wool-fibre, we find a moisture absorption of from 16 to 20 per cent., whereas it should be only from 14 to 15 per cent. It is thus apparent that there are other factors which determine the amount of moisture absorbed.

It is probable that the relatively high amounts of moisture absorbed by pure wool-fibre is due to the very large surface-area presented to the atmosphere in proportion to the weight of the fibre.

A number of wool-fibres, each 3 in. long, were counted and weighed, and the following results calculated: 13,100 fibres of half-bred wool, each 3 in. long, weighs 1 gram; 12,500 fibres of three-quarter-bred, each 3 in. long. weighs 1 gram; 9,100 fibres of Leicester, each 3 in. long, weighs 1 gram; 7,800 fibres of Lincoln, each 3 in. long, weighs 1 gram.

If we take the average diameter of each of the above classes of wool as given in the following table, it will be found by calculation that the surface-area of 1 gram of wool is as follows :—

	Diameter.	Surface-area of 1 Gram.
Half-bred	0·0008 in.	98 sq. in.
Three-quarter-bred	0·0010 in.	118 sq. in.
Leicester	0·0016 in.	136 sq. in.
Lincoln	0·0018 in.	132 sq. in.

It will be seen that the large surface-area is an important factor in considering the relatively large amount of moisture absorbed by the fibre.

The wool-fat was examined, and it was found capable of absorbing up to 17·2 per cent. moisture when spread thinly on a watch-glass; but even with the inclusion of this factor it is not possible to account for more than 1 or 2 per cent. of the moisture absorbed by the normal wool-fibre.

The water-soluble suint, or wool-perspiration, was examined, with the result that it was found that very large amounts of moisture were absorbed by this constituent.

TABLE VI.—WATER-SOLUBLE SUINT.

Time, in Hours.	Moisture absorbed, per Cent.	Relative Humidity.	Grains of Water per Cubic Foot.
24	60·43	76	3·8
48	66·42	85	3·8
72	65·50	70	2·7
96	63·55	65	4·3
120	64·76	72	3·4
144	66·24	80	3·8

The results presented above show that here also the moisture absorbed varies with the relative humidity.

It is at once apparent that the suint, although present in amount of only 1 or 2 per cent. in some wools, and up to 12 per cent. in others, is responsible for a relatively large amount of moisture absorbed by the normal wool-fibres.

In slipe wools this material is largely washed out during the treatment of the skins, and its presence in greasy wools accounts for the increased power of moisture-absorption shown by these wools, and is an important factor in determining the amount of moisture that can be absorbed by the wool-fibre.

In determining the absorption of moisture by slipe wools it was found that the fatty matter other than wool-fat, which is present in slipe wool to a greater amount than in greasy wools, had the power of slightly retarding the absorption of moisture. This fatty matter, as has already been pointed out, is picked up by the wool from the greasy underside of skin during the washing process.

In the following experiments the natural wool-fat was first removed by extraction with hot alcohol, and the wool, after drying and weighing, was exposed to the atmosphere, and the amount of moisture absorbed determined; thereafter the other fatty matter was extracted with ether, and, after drying and weighing, was again exposed to the atmosphere under similar conditions of relative humidity, and the moisture absorbed noted.

In all cases the wool absorbed more moisture when the foreign fatty matter was removed than in its presence. The results obtained are shown in the following table:—

TABLE VII.

Foreign Fatty Matter.	Moisture absorbed in Presence of Fatty Matter, per Cent.	Moisture absorbed in Absence of Fatty Matter, per Cent.
2·06	10·70	11·07
2·16	9·38	9·92
2·60	9·22	9·98
2·88	9·98	10·18
3·28	9·95	11·13

It is probable that the fatty matter forms a film over the surface of the wool, and, being itself impervious to moisture, thus retards to a certain extent the moisture-absorption by the fibre and the other constituents of the wool.

Another point of considerable interest in connection with the foreign fatty matter present in slipe wool is that it is an oxidizable fat, and it is probably this fat which caused the rise in temperature in certain of the bales of wool experimented upon by the Wool Fires Commission,* Nos. 6 and 12.

In this connection it is of interest to refer to the reports by Mr. R. J. Friswell and Dr. J. S. Haldane† on these experiments.

Mr. Friswell states, "Another most interesting point is the fact that the oxidation of the grease by air and moisture (to which I attributed the fires on the s.s. "Gothic") is proved by these experiments. I have extracted the grease from Nos. 6 and 12, and have found it oxidized, and rubber- or varnish-like in character." Dr. J. S. Haldane states, "The results of the tests quoted in your letter are, I think, very instructive. They seem to me to point to this: that the rise in temperature of the bales was due to some substance (probably an oil) capable of combining with oxygen at a comparatively low temperature, and so producing heat; that the amount of this substance is very small, since the process practically comes to an end after about a fortnight, and that more or less of this substance was present in all the bales tested."

This fatty matter has been found in greater or smaller amounts in all slipe wools examined, but the amount present, while it is undoubtedly capable of producing heat by oxidation in the presence of air and moisture, is relatively so small that even should oxidation take place the heat generated cannot be very great. Where the amount of foreign fatty matter is high, of course a very serious danger does exist, as, for instance, in the case of a wool containing only from 6 to 10 per cent. moisture, but from 34 to 36 per cent. foreign fatty matter of an oxidizable nature.‡

SUMMARY.

The results of this investigation show that the amount of moisture which a wool can absorb from the atmosphere depends on several factors.

1. The relative humidity of the atmosphere determines the amount of moisture which a dry wool will absorb, more moisture being absorbed during a period of high relative humidity than when the humidity is low.

2. Pure wool-fibre, of which greasy wool contains from 50 to 70 per cent., and slipe wool about 75 per cent., can absorb from 18 to 20 per cent. of its weight of moisture from the atmosphere. This amount is not sufficient to account for all the moisture absorbed by the dry normal wool-fibre.

3. Natural wool-fat, present in greasy wool in amounts up to nearly 17 per cent., and in slipe wool to about 6½ per cent., is capable of absorbing about 17 per cent. of its weight of atmospheric moisture.

4. Suint, or wool-perspiration, can absorb from 60 to 67 per cent. of its weight of moisture when exposed to the atmosphere, this matter being very hygroscopic, and is present in greasy wools in amounts up to nearly 13 per cent., and in slipe wools to about 2 per cent.

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* Rept. Comm. on Fires on Wool-ships, Exhibit 40, p. lxxxvii.

† Supp. Rept. Comm. on Fires on Wool-ships, p. 6.

‡ Rept. Comm. on Fires on Wool-ships, p. lxxxv; Journ. Soc. Chem. Ind., vol. xxvii, No. 13.

5. Fatty matter other than natural wool-fat, present in slipe wools to an amount of from two to six times that found in greasy wools, and picked up by the wool from the greasy underside of the skins during the washing process, has a retarding effect on the amount of moisture absorbed.

By thoroughly washing wool, as in the case of slipe wools, not only are the incrustating and adhering matters washed out, and so a less weight of the product obtained, but a further deduction in weight has to be allowed for, because the wool is incapable of absorbing the same amount of moisture from the atmosphere which it could absorb in a greasy state, before the natural fat and suint were partially removed. The amount of moisture which slipe wool can absorb from the atmosphere does not reach the legal standard of 18·25 per cent. allowed.

For permission to publish these results the author desires to thank the Christchurch Meat Company (Limited), in whose chemical laboratory at Islington most of the work in connection with this investigation was carried out.

Art. XXV.—*The Formaldehyde Method for the Estimation of Nitrogen in Organic Substances.*

By A. M. Wright, F.C.S.

[*Read before the Philosophical Institute of Canterbury, 1st December,* 1909.]

The reaction between ammonia and formaldehyde, whereby hexamethylenetetramine is formed, has been used for some time as a means of estimating formaldehyde, but the reaction has only recently been utilised for the estimation of ammonia.

Bennett* has shown that the reaction can be made use of for the estimation of nitrogen in certain organic substances after digestion with sulphuric acid according to the well-known Kjeldahl method. He applied the method particularly to the determination of nitrogen in leather-factory control, and has shown that accurate results can be obtained for nitrogen in leather and tannery lime liquors.

The substance under examination is digested with sulphuric acid and sulphate of potash until the liquor is clear; the excess of acid is neutralised with sodium-hydrate solution, using phenolphthalein as the indicator; a neutral solution of formaldehyde is added, liberating the sulphuric acid present in combination with ammonia; hexamethylenetetramine is formed, which is neutral to phenolphthalein; the liberated acid is titrated with decinormal alkali-solution until the pink colour returns.

It is not so much claimed that this method effects a saving of time, but rather that no special apparatus is required for carrying out the determination, the whole operation being conducted in one flask.

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* Journ. Soc. Chem. Ind., vol. xxviii, 1909, pp. 291, 292.