Experiments on the dyeing properties of lichens / by W. Lauder Lindsay.

EXPERIMENTS

ON THE

DYEING PROPERTIES OF LICHENS.

BY

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I beg to present to the Society the tabulated results of between 500 and 600 experiments made two or three years ago, the chief object of which was the endeavour to call attention to the fact that we possess in our own island lichens capable of furnishing dyes nearly, if not quite, equal in beauty to orchil, cudbear, and litmus. I have so fully occupied the time of the Society on former occasions with detailed views on this subject, and with various papers on general points in the natural history of the lichens, that on the present occasion I confine myself to a few facts explanatory of the tables:—

I. Certain genera and species of lichens, which are abundant in Scotland, and could be collected with comparative facility, and at a very moderate expense, might be tried with advantage, on the large scale, as substitutes for the foreign lichens used in the manufacture of orchil, cudbear, and litmus. I have already indicated a favourable result in investi-

* This paper is partly a brief resumé or abstract of a series of communications to the Botanical Society of Edinburgh, made on various occasions during the years 1852, 1853, & 1854.

gating native lichens on the small scale; but it remains for the manufacturer to test the permanence and utility of colours which may merely look brilliant without having any fixity.

II. This subject is worthy of being followed out by the manufacturer on the one hand, and the chemist on the other,—

a. On account of scientific interest,—the field being comparatively new and open, and at the same time most promising of good results.

b. Were it only with the view of further developing the economic resources of our own country.

c. Because the speculation (*i.e.*, the substitution of home for foreign dye-lichens), promises to be remunerative, as the *roccellas* have frequently reached the high price of £1000 per ton in the London market.

III. The collection and transport of lichens for the purpose of examining their colorific powers is very easy, viz.:—

a. By simple desiccation and packing.

b. By drying and pulverizing.

c. By precipitating the colorific principles from a lime solution or a decoction by acetic or muriatic acid.

IV. The colour of the thallus and that obtained by the action of Stenhouse's or Helot's tests on solutions of the lichen-colorific-principles do not always correspond in tint; more frequently the reverse obtains; hence it is impossible from the colour or other external character of the thallus of a lichen to predicate the nature of the reaction of its alcoholic solution with chloride of lime, or the tint it will yield on ammoniacal maceration.

V. The lichens richest in colorific principles, capable of yielding valuable colouring matters, are crustaceous and foliaceous species of a pale or whitish colour—whose alcoholic or aqueous infusion is nearly devoid of colour—which grow on rocks or stones, and in mountainous countries, or on sea-coasts.

VI. The lichens most devoid of the same principles are species having a showy foliaceous thallus—attaining a considerable size—whose alcoholic and aqueous solutions are generally of the same colour with the thallus—and which grow on trees and in woods.

VII. The colours educible from lichens are liable to be materially affected, both as to quantity and quality, according to—

a. Age of the specimen operated on, *i. e.*, length of period that has elapsed since collection and desiccation.

b. The geologic or other nature of its habitat.

c. The nature of its basis of support—whether moist or dry—rock, stone, tree, or earth, &c.

d. The amount of exposure to sun-light and atmospheric oxygen.

e. Amount of moisture in the air.

f. Temperature of the locality.

g. Elevation above the sea.

h. Season and vicissitudes of the weather.

i. Longitude and latitude in the two hemispheres.

k. Decomposition of organic bodies in vicinity.

VIII. Westring's triple division of lichens according to the fixability or permanence of the colours they yield with or without mordants, &c.; and his quadruple division, according as these colours are extractable by cold, lukewarm, hot, or boiling water, aided or not by various accessories, are inconsistent and unnatural, and therefore not to be commended or followed.

IX. Westring's test of colorific power is inferior to Helot's or Stenhouse's; but all are frequently fallacious, and are far from being applicable in all cases. It is probable that different alkalies and reagents are suitable in different cases for the elimination of colouring matters.

X. The same circumstances, which modify the development of these colours on the small scale, cause material alterations in the results of manufacture. The result, however, is not always proportionate to the nature and amount of the modifying cause, insignificant circumstances frequently giving rise to most important and opposite changes.

XI. Speaking generally, the same process is equally applicable to the evolution of the red colouring matters of all lichens; but it is equally true that slight modifications of the process may cause a great variety in the degree or tint in any given species.

XII. The chief tint educible from lichens, which can be of any permanent utility in the arts, is *red* *brown* is also useful in a minor degree.

XIII. Chloride of lime and aqua-ammoniæ are only suit-

able for the development of a *red* colour—or more strictly of colorific and colourless principles capable of conversion into red colouring matters.

XIV. Chloride of lime is not uniformly to be relied on as a lichen colorimeter; for Table xii. shows—

a. That the alcoholic solution of certain species may strike no blood-red colour with that reagent, and still yield beautiful red and purple colours on ammoniacal maceration; and

b. Table xiii. shows that though the alcoholic solution of some species do strike this colour (blood-red), it does not follow that ammoniacal maceration produces the same or a similar colour, or any colour at all.

XV. Simple maceration in a weak solution of ammonia, aided by a moderate heat and moisture, is the surest and simplest means of evolving the red colouring matters of the lichens.

XVI. Alcohol is an excellent solvent of the colorific principles of the plants, presenting them in a form readily acted on by chemical substances. Its use on the small scale is exceedingly convenient. The reaction of ammonia on a boiled alcoholic solution, allowed to stand for three days, is generally the same in tint, though not in degree, as on an aqueous solution exposed to the air for very long periods (1 to 12 months); but in some cases they differ essentially.—*Vide* Table xiv.

This difference is probably, in part, attributable to the small quantity of materials operated on, and the short period of maceration in the former case, and to the larger quantity of materials and the abundant exposure to atmospheric oxygen in the latter.

XVII. The non-evolution of colour in many cases may arise from—

a. Alcohol or water not being the best or proper solvent menstruum of the colorific principles in any particular instance.

b. Ammoniacal maceration not being the proper means of converting the colorific into coloured substances.

c. The plant not containing colorific principles having

the same chemical composition as orcine, &c., or showing similar reactions with chloride of lime and ammonia.

XVIII. If we accept, meanwhile, Stenhouse's and Helot's tests as sufficiently accurate indicators of colorific value, we should arrange the lichen genera, which contain species yielding colouring matters—according to their value—as follows :—

1. Roccella,	5. Urceolaria,	9. Ramalina,
2. Lecanora,	6. Parmelia,	10. Lecidea,
3. Umbilicaria,	7. Evernia,	11. Isidium,
4. Gyrophora,	8. Borrera,	12. Sphærophoron,

species of which yield fine *red* colouring matters ; and

1. Parmelia,	5. Solorina,	9. Lecidea,
2. Sticta,	6. Scyphophorus,	10. Peltidea,
3. Cetraria,	7. Stereocaulon,	11. Collema,
4. Nephroma,	8. Borrera,	

some of which furnish good *brown* colours.

XIX. Among the general results of my experiments it appeared that of 540 specimens examined,

22 Gave rich purple or red colours to ammonia alone, (*i.e.*, by simple maceration).

8 Gave rich brown colours to ammonia alone.

93 Alcoholic solutions gave rich purples or red on the addition of ammonia.

81 Alcoholic solutions gave well-marked brown on the addition of ammonia.

127 Alcoholic solutions gave well-marked orange on the addition of ammonia.

42 Alcoholic solutions gave well-marked greenish-yellow on the addition of ammonia.

79 Alcoholic solutions struck a deep blood-red with solution of chloride of lime.

XX. The whole subject of the intimate chemistry of the lichen colouring matters is in a very unsatisfactory condition, demanding reinvestigation ; and I therefore repeat, that the branch of the Natural History of the Lichens, to which, in this and previous papers, I have endeavoured to draw scientific attention, will form a worthy object of research to the botanist and chemist, and possibly a remunerative one to the wholesale manufacturer.

[If commanders and masters of ships were aware of the value of these plants, which cover many a rocky coast and barren island, they might, with a slight expenditure of time and labour, bring home with them such a quantity of these insignificant looking plants as would realize considerable sums, to the direct advantage of themselves and the ship-owners ; and consequently to the advantage of the state. It is with the view of inciting those to whom the opportunity may offer, of gathering a valuable article of commerce, the value of which they would little suspect from its external aspect, and inducing the owners of vessels to direct the attention of their officers to this subject, that I subjoin some simple methods (says Dr Lindsay) of detecting the various Lichens.]

TABLE I.

Showing the Number of Species *of each Genus, with the* varieties *and duplicate* specimens *thereof, experimented upon.*

Name of Genus.	No. of species.	No. of varieties.	Duplicate specimens.*	Total specimens examined.
Alectoria,	3	4	1	8
Bæomyces,	2	...	1	3
Borrera,	6	2	6	14
Cetraria,	5	4	6	15
Cladonia,	10	12	6	28
Collema,	12	1	8	21
Cornicularia,	6	2	4	12
Endocarpon,	5	5	1	11
Evernia,	2	1	3	6
Gyrophora,	10	1	16	27
Isidium,	3	...	3	6
Lecanora,	32	8	9	49
Lecidea,	38	8	12	58
Lepraria,	2	1	1	4
Nephroma,	3	2	...	5
Parmelia,	36	28	27	91
Peltidea,	6	2	5	13
Pertusaria,	2	...	4	6
Placodium,	4	...	...	4
Psora,	3	...	...	3
Ramalina,	6	4	15	25
Roccella,	3	...	10	13
Scyphophorus,	12	8	13	33
Solorina,	2	...	3	5
Sphærophoron,	1	1	5	7
Spiloma,	1	...	...	1
Squamaria,	9	1	5	15
Stereocaulon,	6	1	...	7
Sticta,	5	...	6	11
Thelotrema,	1	...	...	1
Umbilicaria,	1	...	2	3
Urceolaria,	5	8	4	17
Usnea,	3	5	8	16
Variolaria,	1	...	...	1
Verrucaria,	1	...	...	1
Totals,	247	109	184	540

* Specimens of the same species or variety, collected in different countries, different habitats in the same country, or at different seasons of the year.

TABLE

Showing the effects of various Solvents and Reagents

Name of Solvent or Reagent.	Period of Maceration.	Roccella tinctoria.	
		Thin variety from Lima.	Thickest variety from Lima.
I. WATER—common spring—cold	14 days	Very pale sherry*	Dirty brownish-red
... at temperature of 80°	10 days	Light claret	Light Claret
... ... 120°	14 days	...	Deeper claret
... Boiling	½ hour	Dirty brownish-red	Dirty claret colour
... Distilled—cold	10 days	Pale sherry	Pale sherry colour
II. ALCOHOL [Spirits of wine].	10 days	Unaltered	Unaltered
III. ALKALIES—			
Ammonia			
Liquor—strong	3 days	Lt. crimson-purple	Rich crimson-purple
— dilute	10 days	Deep crimson-purple	Rich deep purple
Carbonate—solution, 2 grs.†	14 days	...	...
Muriate—solution, 2 grs. } — cold }	14 days	Pale brownish-red	Pale sherry
— sol. at temp. of 80°	7 days	Deeper brownish-red	Light claret
POTASH			
Aq. potassæ—			
— strong	3 days	Light claret	Deep claret
— dilute	10 days	...	...
Acetate, 2 grs.	14 days	Pale sherry	Very light claret
Bitartrate, 3 grs.	14 days	Very pale sherry	Pale sherry
Carbonate, 2 grs.	14 days	Brownish-red	Deep claret
Iodide of potassium, 2 grs.	14 days	Very light red	Light brownish-red
Nitrate, 5 grs.	14 days	Pale brownish-red	Brownish-red
Prussiate, 2 grs.	14 days	Unaltered	Unaltered
Sulphate, 2 grs.	14 days	Nearly unaltered	Nearly unaltered
SODA—			
Bicarbonate, 2 grs.	14 days	Light brownish-red	Deep sherry
Biborate (borax), 2 grs.	14 days	...	...
Carbonate, 4 grs.	14 days	Cherry red	Deep claret
Chloride of sodium, 5 grs.	14 days	Pale sherry	Pale sherry
Phosphate, 2 grs.	14 days	Pale sherry	Light brownish-red
ALKALINE EARTHS—			
Baryta—nitrate, 2 grs.	14 days	Very light br.-red	...
Lime, 2 grs., milk of— } cold }	14 days	Light sherry	Light purple-red
— boiling	1 hour	Dirty sherry	Deep purple-red
— at temp. of 80°	7 days	...	Rich purple-red
Chloride of calcium, 2 grs.	14 days	Light brownish-red	Light brownish-red

* I have been somewhat embarrassed in the naming of these colours. I endeavoured to arrange very different from that in common use.

† The number of grains appended to this and other salts signifies the proportion in which they

III.

on the evolution of the Colouring Matters of Lichens.

Roccella tinctoria. From Cape De Verde Islands.	Roccella fuciformis from the Canaries, &c.	Lecanora tartarea from Perthshire.	Parmelia parietina from Grange, Edinburgh.
Pale brownish-red	Light brownish-red	Pale sherry	Pale straw-colour
Dirty brownish-red	Dark brownish-red	Dirty sherry	Dirty greenish-yellow
...	...	...	...
Dirty sherry colour	...	...	...
Light brownish-red	Light sherry	Light brownish-red	Straw-yellow
Unaltered	Unaltered	Dirty reddish-brown	Pale yellow
Pale crimson-purple	Light brownish-red	Rich deep purple	Dirty greenish-yellow
Rich purple	Dark purple-red	...	...
...	...	...	...
Light sherry	Light brownish-red	Pale sherry	Pale greenish-yellow
Deep claret	Deeper brownish-red	Rich sherry	...
Light brownish-red	Pale sherry	Purple-red	Dirty greenish-yellow
Deeper brownish-red	Brownish-red	Rich purple	...
Light brownish-red	Light brownish-red	Deep claret	Pale straw-colour
...	...	Deep sherry colour	...
Purplish-red	Deep claret	Rich purple	...
Brownish-red	Pale sherry	Deep claret	...
Light sherry	Light brownish-red	...	...
Unaltered	Unaltered	Light claret	...
Nearly unaltered	Nearly unaltered	Sherry colour	...
Pale sherry	Light brownish-red	Purple-red	...
...	...	Deep brownish-red	...
Rich brownish-red	Deep brownish-red	Purple-red	...
Very lt. brownish-red	Very lt. brownish-red	Pale sherry	...
...	...	Light brownish-red	...
...	...	Sherry colour	...
Light brownish-red	Pale sherry	Light purple-red	...
Deeper brownish-red		...	...
...	Fine claret	Deep purple-red	...
Light brownish-red	Brownish-red	Light sherry	...

them according to the tables in "Syme's Nomenclature of Colours." His nomenclature, however, is

were used to each fluid ounce of water.

Name of Solvent or Reagent.	Period of Maceration.	Roccella tinctoria.	
		Thin variety from Lima.	Thickest variety from Lima.
Lime—Sulphate, 5 grs.	14 days	Nearly unchanged	Light brownish-red
Magnesia—			
Sulphate, 5 grs.	14 days	Light brownish-red	...
Earths Proper—			
Alumina—			
Alum, 5 grs.	14 days	Colourless	Light brownish-red
Combinations of			
Lime and sal-ammoniac, 1 g.			
Macerated cold	14 days	Light orange-red	Light claret
— warm	4 days	Deep orange-red	Deep claret
Common salt and nitre, 2 g.			
macerated cold	14 days	Deep sherry	Purple-red
macerated warm	4 days	Fine claret	Deep red
Carbonate of soda & nitre, 3 g.			
— cold	14 days	Deep claret	Deep claret
— warm	4 days	...	Deep purple-red
IV. Metals, and their salts—			
Iron—perchloride, solution	7 days	Unaltered	Unaltered
— sulphate, 1 gr.	7 days	Unaltered	...
Arsenious acid, 1 gr.	7 days	Brownish-red	Brownish-red
Copper—sulphate, 1 gr.	7 days	Unaltered	Unaltered
Lead—acetate, 2 grs.	7 days	Nearly unaltered	Brownish-red
Zinc—sulphate, 2 grs.	7 days	...	Unaltered
V. Acids—			
Acetic—common vinegar	14 days	Unaltered	Unaltered
— strong vinegar	14 days	...	...
— pyroligneous acid	14 days	. .	...
Nitric—strong	1 day	Colourless	Colourless
— dilute	14 days	...	...
— — cold		...	...
— — warm	14 days	...	...
Muriatic—strong	1 day	Colourless	Colourless
— dilute		...	...
— — cold	14 days	...	...
— — warm	14 days	...	...
Oxalic, 1 gr.	14 days	...	...
Sulphuric—strong	1 day	...	...
— dilute		...	...
— — cold	14 days	...	...
— — warm	14 days	...	...
Tartaric, 2 grs.	14 days	Brownish-red	

Vide Explanation, p. 22.

Roccella tinctoria. From Cape De Verde Islands.	Roccella fuciformis from the Canaries, &c.	Lecanora tartarea from Perthshire.	Parmelia parietina fr Grange, Edinburgh
Nearly unaltered	Palest sherry	Pale sherry colour	Unchanged
...	...	...	Colourless
Nearly unchanged	...	...	Nearly colourless
Brownish-red	Light orange-red	Purplish-red	Pale straw-colour
Purplish-red	Purple-red	Deep red	...
Claret	Light claret	...	Dirty straw-colour
Deep claret	Deep claret	...	...
Deep sherry	...	...	Dirty lt. greenish-y
...	...	...	...
Unaltered	Unaltered	Unchanged	Unchanged
...	...	Unaltered	...
Nearly unchanged	...	Dark claret	...
Unaltered	...	Unaltered	...
Nearly unaltered	...	Dirty brownish-red	Dirty brownish-red
...	...	Nearly unchanged	...
Unaltered	...	Colourless	Colourless
...	...	...	...
...	...	...	...
Colourless	Colourless	...	...
...	...	...	...
...	...	...	...
...	...	...	...
Colourless	Colourless	...	...
...	...	...	...
...	...	...	...
...	...	...	...
...	...	Deep claret	...
...	...	Colourless	...
...	...	...	...
...	...	...	...
...	...	...	...
...	...	Very pale sherry	...

Table III.

Showing the Species and Varieties the Alcoholic Solution of which gives a* red† *reaction with Solution of Chloride of Lime.*‡

Name of Lichen.	Fugitive.	Light tint.	Deep tint.
Borrera furfuracea,		Brown.	
Cornicularia aculeata ?	Cherry.		
Endocarpon Hedwigii,			
Evernia Prunastri,	Blood.		
Gyrophora deusta,	...		
erosa,		Cherry.	
murina, 3 specimens from Switzerland, Norway, and Scotland,	Cherry.	Cherry.	Blood.
hirsuta, 3 specimens from Switzerland and France,		—	Cherry.
hyperborea, 2 specimens from Do.		—	—
pellita, 3 specimens from Scotland and France,	Cherry.	—	Cherry.
polyphylla, 4 specimens from England, France, and Switzerland,	—	—	—
proboscidea, 3 specimens from Norway, France, and Scotland,		—	Blood.
vellea,	Cherry.	—	
Lecanora cœnisia,	—		
glaucoma,	—		
parella var. albo-flavescens,		Cherry.	Cherry.
tartarea, 3 specimens from Scotland, France, and Switzerland,		Pink.	Blood.
Lecidea atro-pruinosa, var. microphylla,	Cherry.		

* This merely means the result of boiling the comminuted lichen in weak spirit. It may be considered a solution of the colorific principles of the plant, as most of these are soluble in alcohol.

† This term includes light and dark shades of—

a. yellowish or orange red.

b. brownish-red, such as sherry and claret colours.

c. cherry, blood, or pinkish red.

The above list includes the greater number of the species useful as dye-agents. Most of them will be found to yield on ammoniacal maceration, rich red or purple tints, but not uniformly. (*Vide* Table xiii.)

‡ A solution of common bleaching powder. The active ingredient is probably the hypochlorite of lime it contains; so that, so far as concerns its use as a colorific test, this solution may be considered one of hypochlorite of lime.

Name of Lichen.	Fugitive.	Light tint.	Deep tint.
Lecidea conglomerata,	Cherry.		
dubia,		Cherry.	
fumosa,	...		
gelatinosa,	...		
impressa,			Blood.
incana,	Cherry.		
lurida,	Brown.		
speirea,			Blood.
quadricolor,	Cherry.		
Parmelia aleurites,	Brown.		
fahlunensis var. vulgaris,	Pink.	Cherry.	Claret.
olivacea var. corticola glabra,			Blood.
conspurcata,			—
omphalodes,		Orange	Brown.
perlata, 2 spec. from Scotland and the Canary Islands,	Pink.	Cherry.	Blood.
pulverulenta,		—	—
quercifolia var. munda,		—	
fuliginosa,		—	
stellaris,		Brown.	
tiliacea,		Cherry.	
Roccella fuciformis, 5 spec. from So. America,		Pink.	Purple.
Montagnei,		—	
tinctoria, 7 spec. from Africa, South America, and the Canary and Cape de Verde Islands,		—	—
Squamaria affinis,	Brown.		
Umbilicaria pustulata, 3 spec. from Scotland, Norway, and France,		Cherry.	Purple.
Urceolaria bryophila,	Pink.		
calcarea,		Cherry.	Blood.
scruposa, 3 spec. from France, England, and Scotland,		—	—
var. cretacea,	Cherry.		
arenaria,	—		
verrucosa,	—		
mutabilis,	—		

TABLE

Showing the effects or reaction of Solution of Chloride of Lime and tint on the

NAME OF GENUS.	Reaction of Chloride of Lime. Green-yellow deepened.		Bleached.		Brown or Brown-yellow Tint.	
	No. of Species.	Per Centage.*	No.	P. c.	No.	P. c.
Alectoria, .	3	45·0	...	...	...	...
Bæomyces, .	...	...	...	...	...	...
Borrera, .	2	14·3	4	36·1	...	...
Cetraria, .	5	33·5	3	20·0	...	...
Cladonia, .	5	18·0	...	...	...	...
Collema, .	...	...	5	25·3	...	...
Cornicularia, .	2	16·6	...	...	...	...
Endocarpon, .	...	..	...	...	...	...
Evernia, .	5	90·0	...	...	...	...
Gyrophora, .	...	...	...	...	...	...
Isidium, .	2	33·5	...	...	...	...
Lecanora, .	8	16·8	8	16·6	1	2·2
Lecidea, .	5	8·5	7	12·4	1	1·7
Lepraria, .	...	...	1	25·	...	...
Nephroma, .	1	20·0	1	20·	...	...
Parmelia, .	17	21·3	9	10·1	2	2·6
Peltidea, .	1	8·9	4	33·1	1	7·8
Pertusaria, .	1	16·6	1	16·6	...	...
Placodium, .	1	25·0	1	25·	...	...
Psora, .	...	...	...	...	1	33·3
Ramalina, .	5	20·0	1	4·	2	8·4
Roccella, .	...	...	...	...	...	...
Scyphophorus	12	32·2	1	3·1	1	3·4
Solorina, .	1	20·0	1	20·	...	...
Sphærophoron,	2	34·3	...	...	...	...
Spiloma, .	...	...	1	100·	...	...
Squamaria, .	5	33·6	4	23·1	...	...
Stereocaulon .	1	14·3	...	...	...	...
Sticta, .	1	9·1	3	35·1	...	...
Thelotrema .	...	...	...	...	...	...
Umbilicaria, .	...	...	..	...	...	...
Urceolaria,	...	...	1	5·8	...	...
Usnea, .	6	30·0	1	5·2	..	...
Variolaria, .	...	...	...	...	...	...
Verrucaria, .	...	...	...	...	...	...

These results may be considered negative so far as regards the object of my of conversion, by chemical means, into useful colouring matters.

* The percentage is only to be accepted as a very rough indication, and number of *specimens* (not species) operated on, there is only an approximation

IV.

of Aqua Ammoniæ—other than the development of a Red or Purple Lichen Genera.

Re-action of Ammonia.						Chloride of Lime.	
Ill-marked.		Dull Orange.		Greenish-yellow.		No Change.	
No.	P. c.	No.	P. c.	No.	P. c.	No.	P. c.
3	35·	1	12·4	3	40·4	5	86·
...	...	3	100·	...	...	3	100·
2	14·5	2	14·6	5	34·1	7	50·
2	14·8	4	24·6	9	60·	7	54·5
3	11·1	12	44·5	11	43·8	26	96·
2	10·9	1	4.8	17	71·3	17	90·5
5	40·	1	8·4	6	50·	9	88·6
5	45·	...	...	8	80·4	11	100·
1	16·6	2	33·5	3	50·	...	...
10	40·3	2	7·9	...	...	4	18·5
2	33·5	3	50·	...	...	4	90·2
5	10·	9	19·8	17	30·6	21	56·5
8	14·8	17	30·4	11	20·6	28	51·6
...	...	...	...	3	90·0	2	50·
...	...	1	20·	3	85·1	3	76·8
15	16·6	19	19·1	35	30·5	43	58·6
5	43·3	1	7·8	5	44·6	5	43·8
1	16·6	2	33·5	3	50·1	4	88·6
...	...	...	...	3	89·2	2	50·
1	33·4	1	33·5	2	92·4	2	68·9
2	8·6	3	12·4	17	56.6	14	43·4
9	70·	...	...	...	...	...	...
7	24·	17	50·	6	20·4	21	78·6
2	44·3	...	...	1	20·	3	26·8
...	...	1	14·6	...	...	5	100·
1	100·	..	...	...	...	...	...
1	6·8	3	20·	5	33·5	5	33·5
...	...	1	14·6	4	80·7	6	93·2
2	21·	6	44·5	1	9·1	7	89·6
1	100·	...	...	1	100·	1	100·
...	...	1	33·5	...	...	...	...
1	5·8	6	32.6	3	17·6	6	31·6
...	...	1	6·4	9	90·3	8	50·
...	...	1	100·	...	..	1	100·
1	100·	...	...	...	...	1	100·

experiments, viz., the detection of species possessing colorific principles, capable

not to be relied on as accurate; for, having been calculated from the total to the truth.

Table V.

Showing the Species the Alcoholic Solutions of which give, on maceration in dilute aqua ammoniæ, *various shades of* red *or* purple.*

Name of Lichen.	Red.		Purple.	
	Light.	Dark.	Light.	Dark.
Borrera Ashneh,	Cherry.		—	
chrysophthalma, 3 specimens from Zante, France, and Switzerland,	Pink.	Pink.	—	
Cetraria islandica,	Brown.	Brown.		
Gyrophora hirsuta, 3 specimens,		Cherry.		
pellita,		—	—	
polyphylla, 2 specimens,		—	—	
proboscidea,		—		
Isidium coccodes,	Cherry.			
Lecanora albella,	—			
atra,		Blood.		
callopisma,	—			
lutescens,	—			
oreina,		Blood.		
radiosa, v. inflata,		—		
speirea,		—		
sophodes,	Cherry.			
tartarea,	—		—	—
ventosa, 2 specimens,		Blood.	—	—
Villarsii,		—		
Lecidea aurea,	Cherry.			
commutata,	—			
coronata,	—			
erythrella, v. fusco—				
virens,			—	
icmadophila, 2 specimens,	Brown.			
sanguinaria,				—
speirea,		Blood.		
uliginosa,		—		
Wahlenbergii,	Cherry.			

* Alcohol appears to be an excellent solvent of the active colorific principles of the plants, presenting them in a condition to be readily acted on by ammonia or other reagents.

The results of the reaction of ammonia on the alcoholic solution, is generally similar to the effect of simple ammoniacal maceration, so that this mode of applying Helot's test is a very convenient and elegant one. There is sometimes, however, a considerable difference between the effects of ammonia on the alcoholic and aqueous solution. (*Vide* Table xiv.)

Name of Lichen.	Red. Light.	Red. Dark.	Purple. Light.	Purple. Dark.
Nephroma resupinata,	—			
Parmelia aleurites,		Cherry.		
Borreri,		Blood.		
caperata,		Brown.		
v. membranosa,		—		
conspersa, 3 specimens,		Cherry.		
encausta,		—		
omphalodes, 2 specimens,		Brown.		
ostreata,	Cherry.			
parietina, 2 specimens,	Pink.			
perlata, 3 specimens,		Blood.	—	—
saxatilis, 2 specimens,		Brown.		
v. furfuracea, 2 specimens,		—		
v. leucorrhœa,		—		
Peltidea aphthosa,	Brown.			
polydactyla,		Brown.		
Pertusaria communis,	Cherry.			
Ramalina fraxinea,	—		—	—
farinacea,	—		—	
Roccella tinctoria, 2 specimens,	Cherry.	Blood.	—	—
Scyphophorus bellidiflorus,		Brown.		
cervicornis,		—		
cocciferus,		—		
deformis,		—		
digitatus,		—		
filiformis,	Brown.			
Solorina crocea, 2 specimens,		Brown.		
Sphærophoron coralloides, 2 specimens,	Cherry.			
v. fragilis,	—			
v. cæspitosum,	—			
Squamaria candelaria, 3 specimens,	Pink.			
miniata, 2 specimens,	—			
Stereocaulon botryosum,	Brown.	Brown.		
Sticta pulmonaria,		Brown.		
scrobiculata, 2 specimens,		—		
Umbilicaria pustulata,		Blood.	—	—
Urceolaria cinerea,		—	—	
scruposa,		—	—	—
v. ocellata,		—	—	—
Usnea barbata,		Brown.		
v. articulata, 2 specimens,		—		
Cladonia bacillaris,	Cherry.			
Collema nigrescens,		Brown.		

Table VI.

Showing the Species, the Alcoholic Infusions of which give, on maceration in dilute aqua ammoniæ, *various shades of* orange.*

Name of Lichen.	Yellow tint predominant.	Red tint predominant.
Bæomyces roseus,	Light.	
rufus, 2 specimens from France and Switzerland,		Deep.
Borrera furfuracea, 2 specimens,	Deep.	
Cetraria islandica, 3 specimens from Norway, England, and France,		—
Cladonia degenerans,	—	
v. alabra,		—
furcata, 2 specimens from France and Switzerland,	—	—
v. racemosa, 2 specimens,		—
rangiferina, v. vulgaris,		—
sylvestris,	—	
uncialis,	—	
incana, v. polydactyla,	—	
vermicularis, v. subulifera,		—
Collema marginale,		—
Cornicularia pubescens,	—	
Evernia Prunastri, 2 specimens,	—	
Gyrophora cylindrica,		—
murina,		—
hyperborea,	—	—
Isidium coccodes,	—	
coralloides, 2 specimens from England and France,	—	
Lecanora cænisia,		—
hæmatomma,		—
parella,	—	
v. pallida corticola,	—	
v. albo—flavescens,	—	
speirea,	—	
tartarea,	—	
v. rupestris,		—
Turneri,	—	

* Though this tint is greatly inferior in richness or usefulness to the red and purple, many of the above species yield very good dye agents. The orange is, in many cases, capable of conversion into red and purple by chemical means.

Name of Lichen.	Yellow tint predominant.	Red tint predominant.
Lecidea atro-pruinosa, v. anthracina,	—	
candida,		—
conglomerata, 2 specimens,	—	
dubia,	—	
flavo-virens, v. fusco-virens,	—	
gelatinosa,	—	
granulosa,		—
impressa,	—	
lapicida,	—	
lurida,		—
nigrita,	—	
sabuletorum, v. fusco-cinerea,		—
squalida,	—	
speirea,	—	
quadricolor,		—
vernalis,	—	
Nephroma parilis,		—
Parmelia aleurites,		—
caperata,		—
cæsia,		—
diatrypa,		—
fahlunensis, v. vulgaris minor,	—	
glomulifera,		—
olivacea,	—	
ostreata,		—
physodes,		—
v. vittata, 2 specimens,		—
perlata,		—
quercifolia, v. munda,		—
v. fuliginosa,		—
rupestris, v. flaccida,		—
saxatilis,		—
stellaris,		—
stygia,		—
v. pulverulenta,	—	
tiliacea,	—	
Peltidea canina,	—	
Pertusaria communis,		—
fallax,	—	
Psora decipiens,		—
Ramalina fraxinea, 2 specimens,		—
scopulorum,		—
Roccella fuciformis, 6 specimens,		—
Montagnei,		—

Name of Lichen.	Yellow tint predominant.	Red tint predominant.
Scyphophorus cervicornis, 3 specimens from England, Scotland, & France,	—	—
cocciferus, 3 specimens,		—
gracilis, 3 spec. from France, England, & Scotland,	—	
v. abortiva,		—
chordalis,	—	
polyceras,	—	
pyxidatus, 3 specimens,		—
v. communis,	—	
neglecta,	—	
sparassus,	—	
Sphærophoron coralloides,		—
Squamaria cæsia,	—	
clementi,	—	
lanuginosa, 2 specimens,		—
Stereocaulon paschale,	—	
Sticta fuliginosa, 2 specimens,		—
pulmonaria, 2 specimens,		—
scrobiculata,		—
sylvatica,		—
Umbilicaria pustulata,	—	
Urceolaria calcarea,		—
foveolaris,	—	
scruposa, 3 specimens,		—
Usnea barbata, v. articulata,	—	
Variolaria faginea,		—

Table VII.

Showing the Species, the Alcoholic infusions of which give, on maceration in dilute aqua ammoniæ, *various shades of* brown.*

Name of Lichen.	Yellow tint predominant.	Red tint predominant.	Pure Brown
Alectoria jubata,	—		
Borrera furfuracea,		—	
tenella,	—		

* Few of the species yielding good brown dyes are capable also of giving red or purple ones. But this colour is a very durable, and, therefore, useful one; it is extensively employed among the peasantry in this and other countries. The processes for developing it are much more simple; but the lichens yielding brown dyes alone have never been articles of commerce.

Name of Lichen.	Yellow tint predominant.	Red tint predominant.	Pure Brown.
Cetraria islandica,		—	—
nivalis,	—		
Cladonia bacillaris,		–	
cænotæa,	—		
uncialis,	—		
Collema crispum	—		
nigrescens,		–	
saturninum,	—		
Cornicularia aculeata,	—		
bicolor,	—		
lanata,	—		
ochroleuca,	—		
tristis,	—		
Endocarpon fluviatile,	—		
Hedwigii,	—		
miniatum,	—		
Evernia divaricata,	—	—	
Gyrophora cylindrica,	—		
deusta,		—	
erosa,		—	
murina,		—	
hyperborea,		—	
pellita,		—	
polyphylla,		—	
proboscidea,		—	
vellea,		—	
Isidium coralloides,		—	
lutescens,	—		
Lecanora badia,	—		
callopisma,		—	
circinnata,	—		
chlorophana,	—		
epigæa,	—		
parella, v. pallida,		—	
murorum,	—		
Lecidea atro-brunnea,	—		
atro-pruinosa,	—		
cæruleo-nigrescens,	—		
fumosa,		—	
incana,	—		
pannæola,	—		
armeniaca,		—	
Parmelia centrifuga,		—	
crassa,		—	

Name of Lichen.	Yellow tint predominant.	Red tint predominant.	Pure Brown.
Parmelia cycloselis,	—		
cæsia,	—		
fahlunensis,		—	—
Lamarckii,		—	
multifida,	—		
olivacea,		—	—
omphalodes,		—	—
perlata,		—	
pulverulenta,		—	
rupestris,		—	
stygia,		—	—
Peltidea canina,	—	—	—
aphthosa,	—		
horizontalis,	—		
Pertusaria communis,	—		
Psora testudinea,	—		
Ramalina pollinaria,		—	
scopulorum,		—	
Roccella fuciformis,		—	
Montagnei,		—	
tinctoria,		—	
Scyphophorus alcicornis,	—		
digitatus,	—	—	
fimbriatus,	—		
gracilis,	—		
pyxidatus,	—	—	—
gracilis,	—		
Solorina saccata,		—	
Spiloma gregarium,	—		
Squamaria candelaria,	—		
Sticta crocata,		—	
scrobiculata,		—	
Thelotrema lepadinum,	—		
Urceolaria scruposa,		—	
barbata,		—	
Verrucaria leucocephala,	—		

Table VIII.

Ammonia produces, in the alcoholic infusion of the following species, deep and rich tints.

Name of Lichen.	Colour produced.
Bæomyces rufus,	Orange-red
Borrera Ashneh,	Purple ,,
chrysophthalmos,	Crimson ,,
furfuracea,	Orange
tenella,	Greenish-yel
Cetraria glauca v. fallax,	...
islandica,	Brown-red
juniperina,	Gamboge-yel
Cladonia amaurocrea,	Green-yellow
degenerans v. glabra,	Orange-red
furcata v. fruticosa,	Green-yellow
racemosa,	Orange-red
subulata,	Green-yellow
rangiferina v. sylvestris,	Orange
uncialis,	...
incana v. polydactyla,	...
vermicularis v. subulata,	...
Collema marginale,	...
nigrescens,	Green-yellow
—	Brown-red
saturninum,	Green-yellow
Cornicularia ochroleuca,	...
Evernia prunastri,	Orange
Gyrophora cylindrica,	Ochre-yellow
murina,	Orange
hirsuta,	Blood-red
polyphylla,	Brown-red
Isidium corallinum,	Orange-red
Lecanora atra,	Blood-red
hæmatomma,	Orange
glaucoma,	Gamboge-yel
lutescens,	Orange-red
oreina,	Brown-red
Lecanora radiosa v. inflata,	...
speirea,	Blood-red
subfusca,	Green-yellow
tartarea,	Crimson-red
Turneri,	Orange
varia,	...
ventosa,	Blood-red
Villarsii,	Brown-red
Lecidea armeniaca,	Brown-yel
aurea,	Orange-red
dubia,	Orange
elata,	Green-yellow
flavo-virens v. vulgaris,	...
geographica,	...
icmadophila,	Brown-red
impressa,	Orange
lapicida,	...
lurida,	Orange-red
sanguinaria,	Purple-red
speirea,	Blood-red
quadricolor,	Orange
uliginosa,	Brown-red
vernalis,	Orange
Lepraria æruginosa v. latebrarum,	Green-yellow
flava,	...
Nephroma parilis,	Orange-red
resupinata,	Blood-red
Parmelia aleurites,	Orange
Borreri,	Crimson-red
caperata,	Blood-red
conspersa,	...
conoplea,	Green-yellow

Name of Lichen.	Colour produced.
Parmelia cæsia,	Orange-red
diatrypa,	Orange
encausta,	Brown-red
fahlunensis v. vulgaris,	Orange
glomulifera,	Orange-red
omphalodes,	Brown-red
physodes,	Orange-red
perlata,	Blood-red
pulverulenta,	Green-yellow
quercifolia,	Orange
saxatilis,	Blood-red
speciosa,	Green-yellow
stellaris,	Orange-red
stygia v. latior,	Green-yellow
stygia v. pulvinulenta,	Orange
tiliacea,	...
Peltidea aphthosa,	Brown-red
canina,	Orange
Pertusaria communis,	Orange-red
fallax,	Green-yellow
Psora cæruleo-nigricans,	...
Ramalina farinacea,	Orange-red
fraxinea,	Green-yellow
polymorpha,	Green-yellow
pollinaria,	...
scopulorum,	Orange
Roccella tinctoria,	Blood-red
fuciformis,	...
Montagnei,	...

Name of Lichen.	Colour produced.
Scyphophorus bellidiflorus	Blood-red
cervicornis,	Crimson-red
deformis,	Blood-red
digitatus,	Orange-red
endivæfolius,	Green-yellow
gracilis,	Orange
pyxidatus,	...
sparassus,	Orange
Solorina crocea,	Blood-red
Sphærophoron coralloides,	Orange-red
Squamaria cæsia,	Orange
Clementi,	...
lanuginosa,	Orange-red
Stereocaulon alpinum,	Green-yellow
botryosum,	Orange-red
paschale	Orange
pileatum	Green-yellow
tomentosum,	...
Sticta fuliginosa,	Orange
pulmonaria,	Brown-red
scrobiculata,	...
sylvatica,	...
Umbilicaria pustulata,	Orange-red
Urceolaria calcarea,	...
cinerea v. alba,	Blood-red
scruposa,	..
Usnea barbata v. articulata,	...
florida,	Sulphur-yell.
plicata,	Green-yellow

TABLE IX.

Showing the percentage of species* *the alcoholic solution of which gives distinct colour-reactions with a solution of* chloride of lime.

Name of Lichen.	Shades of Blood-red.	Shades of Crimson.	Brownish-red.
Alectoria,	...	...	...
Bæomyces,	...	...	...
Borrera,	...	...	7·1
Cetraria,	...	...	...
Cladonia,	...	...	...
Collema,	...	...	...
Cornicularia,	8·3	...	...
Endocarpon,	9·0	...	...
Evernia,	16·6	...	...
Gyrophora,	79·6	...	...
Isidium,	...	...	...
Lecanora,	12·5	2·2	...
Lecidea,	16·4	...	1·8
Lepraria,	...	...	...
Nephroma,	...	...	...
Parmelia,	12·0	2·6	3·5
Peltidea,	...	...	...
Pertusaria,	...	...	...
Placodium,	...	...	...
Psora,	...	...	...
Ramalina,	...	...	...
Roccella,	...	100·0	...
Scyphophorus,	...	...	..
Solorina,	...	...	...
Sphærophoron,	...	...	...
Spiloma,	...	...	...
Squamaria,	...	...	6·6
Stereocaulon,	...	...	...
Sticta,	...	...	...
Thelotrema,	...	...	...
Umbilicaria,	...	100·0	...
Urceolaria,	50·0	5·8	...
Usnea,	...	...	...
Variolaria,	...	...	..
Verrucaria,	...	...	...

* Or more properly *specimens*, including as it does both varieties and duplicate individual species.

Vide Tables iii. and iv.

Table X.

Showing the percentage of species *the alcoholic solution of which gives, with dilute* aqua ammoniæ, *distinct colour-reactions.*

Name of Genus.	Purple.	Red.	Crimson.	Brownish Red.	Orange.	Brown.	Greenish Yellow.
Alectoria,	...	...	...	...	...	12·6	...
Bæomyces,	...	...	...	...	40·2	...	...
Borrera,	14·6	14·6	15·0	...	14·6	14·6	14·6
Cetraria,	...	...	...	6·8	20·	15·1	14·9
Cladonia,	...	3·5	...	...	58·8	11·1	14·4
Collema,	...	...	...	3·5	4·9	14·6	10·4
Cornicularia,	...	...	...	...	8·4	42·1	8·6
Endocarpon,	...	...	...	...	...	28·6	...
Evernia,	...	...	...	...	33·4	16·4	...
Gyrophora,	7·8	20·0	...	...	11·1	33·4	...
Isidium,	...	16·6	...	...	50·	33·6	...
Lecanora,	2·8	22·2	...	...	22·3	14·6	8·6
Lecidea,	1·6	15·0	...	...	23·4	12·6	7·8
Lepraria,	...	...	...	...	...	...	50.
Nephroma,	...	25·0	...	...	20·	...	...
Parmelia,	5·0	25·0	2·0	6·0	24·6	14·6	6·4
Peltidea,	...	...	...	16·5	8·1	24·6	...
Pertusaria,	...	16·6	...	...	33·2	16·6	33·4
Placodium,	...	...	...	...	...	...	...
Psora,	...	...	...	...	33·4	33·6	33·5
Ramalina,	2·0	6·4	...	...	12·6	8·4	12·6
Roccella,	8·0	8·6	...	...	56·8	26·2	...
Scyphophorus,	...	...	...	20.0	50·6	20·	3·2
Solorina,	...	...	...	48·0	...	20·	...
Spærophoron,	...	40·0	...	...	14·6	...	...
Spiloma,	...	...	...	...	...	100·	...
Squamaria,	...	...	33·5	...	24·5	6·4	14·6
Stereocaulon,	...	...	...	16·6	14·7	...	40·8
Sticta,	...	...	...	30·5	48·6	20·2	...
Thelotrema,	...	...	...	...	...	100·	...
Umbilicaria,	15·0	15·0	...	...	33·6	...	...
Urceolaria,	8·6	8·0	...	...	32·8	12·4	...
Usnea,	...	...	...	20·0	7·2	...	12·6
Variolaria,	...	...	...	...	100·	...	...
Verrucaria,	...	...	...	...	...	100·	...

Vide Tables viii., xiv., xv., xii,. v., vi., and vii.

Table XI.

Showing the percentage of species *which give distinct colours on simple maceration in dilute* aqua ammoniæ.

	Purple.	Red.	Brown.	Green-Yellow.
Alectoria,	..	...	...	...
Bæomyces,	...	...	...	...
Borrera,	7·6	...	...	7·6
Cetraria,	...	...	13·8	...
Cladonia,	...	...	...	...
Collema,	...	...	...	...
Cornicularia,	...	...	...	...
Endocarpon,	...	...	...	...
Evernia,	...	16.6	...	...
Gyrophora,	8·10	...	...	...
Isidium,	...	16·4	...	...
Lecanora,	2·1	4·3	...	...
Lecidea,	...	...	...	...
Lepraria,	...	...	...	80·1
Nephroma,	...	...	...	...
Parmelia,	2·9	3.8	...	...
Peltidea,	...	...	...	...
Pertusaria,	...	...	...	...
Placodium,	...	...	...	...
Psora,	...	...	...	...
Ramalina,	...	12·6	...	...
Roccella,	25·1	...	...	...
Scyphophorus,	...	...	...	...
Solorina,	...	...	...	...
Sphærophoron,	...	...	...	...
Spiloma,	...	..	..	...
Squamaria,	...	...	...	...
Stereocaulon,	...	...	...	...
Sticta,	...	...	9·1	9·2
Thelotrema,	...	...	...	...
Umbilicaria,	33·4	...	...	...
Urceolaria,	...	...	...	...
Usnea,	...	...	...	...
Variolaria,	...	...	...	...
Verrucaria,	...	...	...	...

This Table does not indicate truly the percentage of species yielding fine tints by ammoniacal maceration, in consequence of very few specimens having been operated on. It only shows roughly the genera furnishing useful species.

Vide Tables xvii. and xiv.

Table XII.

List of species whose alcoholic infusion strikes no red colour with solution of chloride of lime, but which yield, nevertheless, fine red or purple tints on ammoniacal maceration.

Bæomyces rupestris
ericetorum
byssoides
roseus
Borrera Ashneh
chrysophthalmos
furfuracea
Cladonia bellidiflora
cocciferus
cornucupioides
digitata
degenerans
deformis
filiformis
furcata
gracilis
fruticosa
pyxidata
rangiferina
vermicularis
Cetraria Islandica
Isidium corallinum
coccodes
Lecanora ventosa
Lecidea sanguinaria
commutata
gelatinosa
Parmelia caperata
centrifuga
conspersa
elegans v. miniata
diatrypa
Parmelia Borreri
acetabulum
fuliginosa
saxatilis
stygia
stellaris
rupestris
omphalodes
physodes
lanuginosa
pulchella
pallida v. albella
encausta
glomulifera
Peltidea sylvatica
resupinata
Ramalina fraxinea
fastigiata
Stereocaulon botryosum
Sticta pulmonaria
scrobiculata
sylvatica
Solorina crocea
Sphærophoron coralloides
fragile
Pertusaria communis
Usnea ceratina
barbata
Urceolaria cinerea
Nephroma parilis
Variolaria communis

This shows the inapplicability of the chloride of lime (Stenhouse's) test in all cases, for many of the above are excellent dye-lichens. It therefore cannot safely or uniformly be relied on as a calorimeter; this may arise from the absence of certain conditions necessary for the development of its reaction with orsellic acid, &c.

Table XIII.

Showing a number of species whose alcoholic infusion does not yield with ammonia the kind or intensity of tint, which we should à priori *expect from the blood-red tint struck by solution of chloride of lime.*

Name of Lichen	Action of Chloride of Lime on alcoholic infusion.	Action of Ammonia on alcoholic infusion.
Borrera furfuracea	Blood-red	Greenish-brown
Gyrophora heteroidea	...	Reddish-brown
hyperborea	...	Orange-yellow
spadochroa	...	Brownish-yellow
proboscidea	...	...
erosa	...	...
pellita	...	...
Lecanora parella	...	Orange-yellow
Lepraria incana	Cherry-red	Reddish-yellow
Parmelia dubia	Blood-red	Greenish-yellow
rimosa v. sordida	...	Orange-yellow
tiliacea	...	...
olivacea	...	Greenish-yellow
fahlunensis	...	Brownish-yellow
rubiginosa	...	Greenish-yellow
Ramalina fraxinea var.	Brownish-red	Brownish-yellow
— —	...	Orange
Roccella tinctoria & var., 3 specimens	Blood-red	Orange-red
fuciformis, 5 specimens	...	...
Montagnei	...	...
Umbilicaria ænea	...	Brownish-yellow
Urceolaria scruposa	...	Greenish-yellow

This table also shows the fallacy of Stenhouse's test, in certain cases, for here it leads us to form anticipations which are not realized. It is not, however, necessary—it may be a mere coincidence—that the development of a red colour by this test, and by Helot's (ammonia) test usually coexist, so that from the presence of the one reaction we are justified in expecting that of the other. Of the precise chemical nature of these reactions we know little or nothing.

Table XIV.

Showing a few instances of the different action of ammonia on the alcoholic and aqueous infusion, and of the value of prolonged exposure, &c., in the evolution of colouring matter.

Name of Lichen.	Effects of Ammonia on Alcoholic Infusion.	Effects of simple Ammoniacal Maceration.
Borrera ciliaris	Greenish-yellow	Brownish-yellow
furfuracea	Orange-yellow	Purple
pulverulenta	Greenish-yellow	...
Cladonia coccifera	Orange-red	Brownish-red
Evernia prunastri	Orange-yellow	Purple
Gyrophora murina	Orange-red	...
pellita	Brownish-yellow	Purple-red
proboscidea	...	...
Isidium corallinum	Orange-red	...
Lecanora Parella	Orange-yellow	Purple
tartarea	...	...
Parmelia parietina	Crimson	Greenish-brown
perlata	Orange-red	Purple
physodes	Greenish-yellow	Brownish-red
Peltidea canina	...	Brownish-yellow
Ramalina fraxinea	Orange-yellow	Purple
farinacea	...	...
scopulorum	...	Brownish-red
Stereocaulon paschale	...	...
Umbilicaria pustulata	Orange-red	Purple

In the majority of the above, prolonged exposure of the alcoholic decoction, after the addition of ammonia, to the air, along with the maintenance of a suitable temperature, &c., would yield colours similar in tint, if not in degree, to those produced by simple lengthened maceration in dilute aqua ammoniæ.

Table XV.

The alcoholic infusion of the following species gives a beautiful bright greenish-yellow tint on the addition of ammonia.

Borrera flavicans
tenella
Cetraria glauca v. fallax
juniperina
Cladonia amaurocræa
furcata v. fruticosa
v. rangiformis
v. subulata
Collema nigrescens
saturninum
Cornicularia ochroleuca
Lecanora atra
glauca
subfusca
varia
Lecidea dubia

Lecidea elata
flavo-virens
geographica
Lepraria æruginosa v. latebrarum
chlorina
Parmelia conoplea
cæsia
physodes
pulverulenta
speciosa
stellaris
Pertusaria communis
fallax
Psora cæruleo-nigricans
Ramalina fraxinea
polymorpha
pollinaria
Scyphophorus endivæfolius
Squamaria Clementi
crassa
Stereocaulon alpinum
pileatum
tomentosum
v. majus
Usnea florida
plicata

In many, if not most of the above, the colour is due to the chlorophyll contained in the thalline gonidia.

Table XVI.

The following were subjected in quantity to ammoniacal maceration, and yielded very poor tints.

Name of Lichen.	Colour produced.
Alectoria jubata	Brown-yellow
Borrera ciliaris	...
tenella	Brown
Cetraria nivalis	Brown-yellow
Cladonia rangiferina	...
Gyrophora cylindrica	Brown-red
pellita	...
Lecidea icmadophila	Red-brown
Parmelia parietina	Green-yellow
Peltidea canina	Brown-yellow
Scyphophorus cocciferus	Brown-red
pyxidatus	...
Sphærophoron compressum	...
coralloides	...
v. fragile	...
Stereocaulon paschale	Brown-yellow
tomentosum	...
Usnea plicata	...

In the above, nearly the same colour was developed by simple maceration in water or by boiling, and depends on the cell-contents of the cortical layer of the thallus of the plants. The colouring matters, which exist ready formed in the thallus, bear no resemblance to the colorific colourless principles which are capable, under certain chemical reactions, of yielding coloured substances.

Table XVII.

The following were subjected in quantity to simple ammoniacal maceration, and yielded rich tints.

Name of Lichen.	Colour produced.	Name of Lichen.	Colour produced.
Borrera flavicans,	Green-yellow	Parmelia perlata,	Purple-red
furfuracea,	Purple-red	pulverulenta,	...
Cetraria glauca,	Red-brown	saxatilis,	Brown-red
islandica,	...	Ramalina farinacea,	Purple-red
Evernia prunastri,	Purple-red	fraxinea,	...
Gyrophora murina,	...	scopulorum,	Cherry-red
proboscidea,	...	Roccella fuciformis,	Purple-red
Isidium corallinum,	Cherry-red	Montagnei,	...
Lecanora parella,	...	tinctoria,	...
tartarea,	Purple-red	Sticta flava,	Green-yellow
ventosa,	Blood-red	pulmonaria,	Brown-yell
Parmelia omphalodes,	Brown-red	Umbilicaria pustulata,	Purple-red
physodes,	...		

Table XVIII.

In the following species, which are, or have been, used in commerce as dye-lichens, the colorific material is detectable by reagents.

Evernia prunastri.
Gyrophora deusta.
murina.
Isidium corallinum.
Lecanora atra.
hæmatomma.
parella.
tartarea.
Parmelia caperata.
conspersa.
encausta.
perlata.
saxatilis.
Ramalina farinacea.
scopulorum.
Roccella fuciformis.
Montagnei.
tinctoria.
Solorina crocea.
Umbilicaria pustulata.
Urceolaria calcarea.
cinerea.
scruposa.
Usnea barbata.

Table XIX.

*Showing the colour of the alcoholic infusion of various species.**

Name of Genus.	Colourless.		Greenish-yellow.		Brownish-yellow.		Brown.		Red.	
		P. c.		P. c.		P. c.		P. c.		P. c.
Alectoria,	2	25·	4	50·	1	12·6				
Bæomyces,	1	33·6	2	61·1						
Borrera,	2	14·6	11	70·5	...	...	1	7·6		
Cetraria,	5	33·6	8	42·6	1	6·4				
Cladonia,	25	82·1	5	13·6	1	3·8				
Collema,	12	48·3	9	30·2	...	...				
Cornicularia,	11	90·	...	...	...	...	1	8·4		
Endocarpon,	8	80·	4	20·						
Evernia,	3	50·0	3	50·						
Gyrophora,	9	33·5	6	26·2	6	26·1				
Isidium,	5	84·5	1	10·6						
Lecanora,	18	28·5	16	33·2	3	6·3				
Lecidea,	22	25·6	21	26·7	2	3·6	3	5·6	1	1·6
Leprariа	2	50·	1	25·	...	...				
Nephroma,	1	20·	2	48·1						
Parmelia,	31	32·	49	39·6	5	5·6	1	1·6	1	1·8
Peltidea,	...	...	9	70·4	2	10·7	1	8·	2	10·2
Pertusaria,	2	50·	4	50·						
Placodium,	1	33·5	3	60·						
Psora,	2	69·1	1	13·6						
Ramalina,	11	46·1	12	52·3						
Roccella,	3	26·1	8	60·						
Scyphophorus,	11	33·1	19	58·3	2	6·4		...	1	3·2
Solorina,	...	...	...	...	3	30·7	...	...	2	58·6
Sphærophoron,	1	14·6	...	...	2	34·4	1	14·6	1	14·4
Spiloma,										
Squamaria,	3	20·1	12	68·1	1	6·7			1	6·4
Stereocaulon,	3	46·1	4	50·2						
Sticta,	1	9·	7	78·						
Thelotrema,	1	100·								
Umbilicaria,	...	...	...	...	2	90·1				
Urceolaria,	10	60·1	5	30·4	2	8·6				
Usnea,	1	6·5	13	89·1						
Variolaria,	1	50·	...	...	...	...	1	50·		
Verrucaria,	...	...	1	100·						

* In most cases depending on the Chlorophylle-contents of the Gonidia, or on the ready formed colouring matters contained in the cortical layer of the thallus of the plants.

TABLE

Showing the effect of age, exposure to light and moisture, nature in modifying or altering the tint or degree of colour educible.

Name of Lichen.	Date when collected.	Nature of habitat.	Country where collected.
Collemanigrescens	1820	Rocks	Scotland
———	1842	—	Switzerland
Evernia prunastri,	1852	Trees	England
———	1813	,,	France
Gyrophora deusta,	1826	Alpine rocks	Switzerland
———	1810	,,	France
Lecanora atra,	1852	Trees	England
———	1840	Alpine rocks	Switzerland
parella v. albo flav.	...	Trees	,,
v. pallida	...	Rocks	,,
tartarea	1810	,,	France
———	1828	,,	Switzerland
Lecidea speirea,	1840	,,	,,
———	...	,,	,,
atro-pruinosa,	1843	Granitic rocks	,,
———	1828	Calcareous ,,	,,
coronata,	...	,,	,,
———	1820	Earth	France
lurida,	...	Alpine rocks	—
———	1828	Calcareous ,,	—
sanguinaria,	1833	Rocks	Switzerland
———	1826	Trees	France
Nephroma resupinata,	1812	,,	—
v. helvetica,	1836	—	Switzerland
Parmelia aleurites,	1843	Rocks	—
———	1823	Trees	France
caperata,	1812	—	—
———	1840	Rocks	Switzerland
fahl.,v. vulg. maj.	1840	Micaceous rocks	Switzerland
———	1813	Rocks	France
olivacea cort. glabra,	1840	Trees	Switzerland
———	1810	—	Scotland
omphalodes,	1810	Rocks	—
v. panniformis,	1852	—	—
perlata,	1812	Trees	France
———	1851	Rocks	Canary islands
———	1840	Trees	Switzerland
stellaris,	1811	—	France
v. tenella,	1840	—	Switzerland

XX.

of habitat, climate, heat and cold, elevation above the sea, &c., from lichens.

	Reaction.
Alcoholic solution gives	brownish-red with ammonia.
...	greenish-yellow. ,,
...	blood-red with chloride of lime.
...	greenish yellow. ,,
...	blood-red. ,,
...	no reaction. ,,
...	blood-red with ammonia.
...	greenish-yellow. ,,
...	blood-red with chloride of lime.
...	greenish-yellow. ,,
...	crimson red with ammonia.
...	orange-yellow. ,,
...	blood red with chloride of lime.
...	no reaction. ,,
...	cherry red. ,,
...	no reaction. ,,
...	orange red with ammonia.
...	greenish-yellow. ,,
...	blood-red with chloride of lime.
...	no reaction. ,,
...	purple-red with ammonia.
...	greenish-yellow. ,,
...	blood-red. ,,
...	greenish-yellow. ,,
...	brownish-red. ,,
...	greenish-yellow. ,,
...	blood-red. ,,
...	greenish-yellow. ,,
...	blood-red with chloride of lime.
...	no reaction. ,,
...	blood-red. ,,
...	no reaction. ,,
...	brownish-yellow with ammonia.
...	blood-red. ,,
...	no reaction with chloride of lime.
...	blood-red. ,,
...	greenish-yellow. ,,
...	brownish-red. ,,
...	no reaction. ,,

TABLE XX.—

Name of Lichen.	Date when collected.	Nature of habitat.	Country where collected.
Ramalina farinacea	1843	Trees	France
———	1813	—	—
fraxinea,	1852	—	Scotland
———	1851	—	—
Sphærophoron coralloides,	1852	Rocks	Norway
———	1812	Trees	France
———	1830	Rocks	Scotland
Umbilicaria pustulata	1828	,,	France
———	1850	—	Norway
Urceolaria calcarea,	1810	—	Scotland
———	1852		England
cinerea v. vulg.	1826	—	France
v. alba	,,	—	—
scruposa v. ocellata	1843	—	—
———	1852	—	England
Usnea barbata,	1815	—	France
v. alpest. dasop.	1840	Trees	Switzerland
v. camp. cerat.	1840	—	—

TABLE XXI.

The following species are said to be, or to have been, used in dyeing; but they have not, in my hands, yielded reactions indicative of useful dye agents.

Alectoria jubata. — No change of colour was produced by chloride of lime; the colour of the alcoholic solution and the effect of ammoniacal maceration, even for the lengthened period of a year, was a light brownish-yellow.

sarmentosa. — The colour of the alcoholic solution, and the reaction of chloride of lime and ammonia, was a greenish-yellow.

Lecidea geographica — Yielded the same results.

Lepraria chlorina, Usnea florida, plicata, — Also yielded similar results; with the exception that chloride of lime bleached the alcoholic solution of the former, and made no change in that of the two latter species.

Continued.

	Reaction.
Alcoholic solution gives	tile-red with ammonia.
...	greenish-yellow. ,,
...	tile-red. ,,
...	straw colour. ,,
...	crimson-red. ,,
...	greenish-yellow. ,,
...	brownish-red. ,,
...	orange. ,,
...	brownish-red. ,,
...	blood-red with chloride of lime.
...	no reaction. ,,
...	straw colour with ammonia.
...	blood-red. ,,
...	no reaction with chloride of lime.
...	blood-red. ,,
...	blood-red with ammonia.
...	greenish-yellow. ,,
...	brownish-yellow. ,,

Table XXII.

In the following species, which are used, or said to be used, in some countries for dyeing green, the colouring matter exists ready formed in, and gives the predominant tint to, the thallus of the plant.

Borrera flavicans.
Cetraria juniperina.
Parmelia parietina.
Squamaria candelaria.
Lecidea geographica.
Lepraria chlorina.
Usnea florida.
plicata.

Table XXIII.

In the following species, which are said to be used in various countries for dyeing brown, the colouring matter also exists ready formed in, and gives the predominant tint to, the thallus of the plant.

Cetraria islandica.
Gyrophora cylindrica.
Parmelia omphalodes.
Parmelia physodes.
Sticta pulmonaria.
scrobiculata.

Table XXIV.

The following lichen-genera, on account of the exceedingly minute size and delicate consistence of their thalli, from the position, nature, and colour of their apothecia, &c., have been entirely excluded from my experiments, and are not at all likely ever to furnish species useful as dye agents.

Calicium.
Arthonia.
Biatora.
Chiodecton.
Glyphis.
Graphis.
Pyrenula.
Pycnothelia.
Opegrapha.
Verrucaria.
Thelotrema.

For similar reasons, only a few species of the following genera were subjected to experiment; the results yielded are equally unfavourable.

Bæomyces.
Endocarpon.
Pertusaria.
Lepraria.
Spiloma.
Variolaria.
Psora.
Squamaria.
Placodium.

Most of the angiocarpous lichens have thus been excluded from the experiment, and promise to be utterly valueless as dye agents; and inter alia,

Chiodecton.
Cliostomum.
Endocarpon.
Gyalecta.
Pertusaria.
Pyrenothea.
Sagedia.
Segestrella.
Sphærophoron.
Strigula.
Thelotrema.
Verrucaria.

List of Tables.

I. Number of specimens experimented on.
II. Effects of reagents in evolving colour.
III., IV., IX., XII., XIII. } Reactions of chloride of lime on alcoholic solution.
IV., V., VI., VII., VIII., X., XII., XIII., XIV., XV. } Reactions of ammonia on alcoholic solution.
XI., XIV., XVI., XVII. } Effects of simple ammoniacal maceration.
XIX. Colour of alcoholic infusion.
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XVIII. XXI. Detectability of colorific properties by reagents.
XXII. XXIII. Green and brown dye-lichens.
XXIV. Genera not operated on.

Explanation of Table II.

This table serves fully to illustrate—

I. The negative action of all acids in evolving the colorific principles of lichens, or converting them into coloured substances.

II. The powerful action of certain alkalies and alkaline salts, especially ammonia and its compounds, in the production of colour-production and metamorphosis.

III. The influence of heat, moisture, exposure to atmospheric oxygen, &c., in assisting the development of the lichen colouring matters.

a. Several other species were operated on; various other combinations of the alkalies and alkaline earths, &c., and other reagents were used; the experiments were conducted in the greatest possible variety, as regards the amount of heat and exposure to the air, the length of the maceration, the strength and degree of dilution of the reagents, &c.; but the results, though differing sometimes slightly, or in some insignificant features, were essentially the same.

b. The period of maceration varied from a few hours to as many weeks or months; the shortest was half an hour, the longest period a year. Beyond a certain point, prolonged maceration did not appear materially to affect the nature or degree of tint; nay, in some cases, the colour was greatly deteriorated or destroyed. In some species, the colouring matters were rapidly produced; in others, again, very slowly; in the former case, therefore, a short, while, in the latter, a long period of maceration was necessary.

c. The same remarks apply to the degree of heat applied; up to a certain point, it is an important auxiliary, but beyond this it becomes very deleterious.

d. During the course of the experiments, some of the solutions very rapidly became mouldy, while others stood for nine months or a year with little or no appearance of mould of any kind. It is foreign to my present subject here to specify the instances in which this phenomena did or did not occur; the results possess interest merely as showing the effects of certain chemical reagents in promoting, retarding, or destroying the development and growth of fungi.

e. In some of the solutions, a flocculent, or granulo-flocculent precipitate was thrown down. Of the nature of this, in most cases, I am unable to speak, the question being a purely chemical one; but, in some instances, it undoubtedly consists of the colorific principle of the plant.

f. After the exhaustion of the red colouring matter of *Lecanora tartarea* and the *Roccellas* by ammonia, they yielded very rich crimson tints to alcohol; and similar, though less brilliant, colours to solutions of carbonate of potash and carbonate of soda, &c.

g. In some cases, the full colour was evolved only on second maceration, or after the application of a series of reagents.

h. In the case of solutions of salts used as macerants, the quantity or proportion of grains to the ℥i of water is given.

TIGHT GUT