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USEFUL KNOWLEDGE;

OR, A

FAMILIAR ACCOUNT

OF THE

VARIOUS PRODUCTIONS OF NATURE,

MINERAL, VEGETABLE, AND ANIMAL.

VOL. I.

LONDON:
GILBERT & RIVINGTON, PRINTERS,
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USEFUL KNOWLEDGE;

OR, A

FAMILIAR ACCOUNT

OF THE

VARIOUS PRODUCTIONS OF NATURE,

Mineral, Vegetable, and Animal,

(SYSTEMATICALLY ARRANGED)

WHICH ARE CHIEFLY EMPLOYED FOR THE USE OF MAN.

ILLUSTRATED WITH PLATES AND 150 WOOD-CUTS, AND INTENDED AS A WORK BOTH OF INSTRUCTION AND REFERENCE.

BY THE REV.

WILLIAM BINGLEY, M.A. F.L.S.

LATE OF PETERHOUSE, CAMBRIDGE, AND AUTHOR OF ANIMAL BIOGRAPHY.

SIXTH EDITION,

REVISED, ENLARGED, AND ALTERED TO THE EXISTING STATE OF SCIENCE, BY

DANIEL COOPER,

AUTHOR OF "FLORA METROPOLITANA;" ASSOCIATE OF THE LINNÆAN SOCIETY; LATE AN ASSISTANT IN THE ZOOLOGICAL DEPARTMENT OF THE BRITISH MUSEUM, AND LECTURER ON BOTANY AT THE THEAT ANATOMY AND MEDICINE, BOROUGH, ETC. ETC.

IN TWO VOLUMES.

VOL. I.

MINERALOGY, GEOLOGY, AND IN-GROWING PLANTS.

LONDON:

PRINTED FOR J. G. F. & J. RIVINGTON; LONGMAN & CO.; HARVEY & DARTON; BALDWIN & CRADOCK; WHITTAKER & CO.; SIMPKIN MARSHALL, & CO.; & C. DOLMAN.

1842.

TO

JAMES FORBES YOUNG, ESQ. M.D.

OF KENNINGTON, SURREY,

THIS REVISED AND ENLARGED EDITION OF THE WORK

IS MOST RESPECTFULLY DEDICATED,

AS A HUMBLE THOUGH SINCERE RETURN

FOR INNUMERABLE KINDNESSES RECEIVED AT HIS HANDS,

AND

IN CONSIDERATION ALSO FOR HIS WORTH AS A FRIEND,

BY HIS FORMER PUPIL

AND ATTACHED FRIEND,

THE EDITOR.

PREFACE

TO THE SIXTH EDITION.

It has been aptly said by Tillotson, "He who does not know that which is of use and necessity for him to know, is but an ignorant man, whatever he may know beside."—Setting out then in a measure with this maxim, the present Editor has endeavoured (following in the steps of the Author and former Editors) to include in the Sciences treated of in the succeeding pages, such general remarks connected with the various branches, as will give the reader, desirous of making himself acquainted with any particular article furnished by either of the three kingdoms of Nature, and made use of in the Arts, Manufactures, or Domestic Economy, a store of useful and correct information, reduced, it is anticipated, to the comprehension of the most simple understanding.

On comparing the present with the last edition of this work, a considerable change will be noticed, particularly as regards the arrangements followed in the sciences of Botany and Zoology; a necessary consequence resulting from the progress of each branch of science within the last ten years.

In the first part, viz. the "MINERALOGY and GEOLOGY," but little change could be satisfactorily made in the limited space allotted, except that which the following pages testify, as these two sciences are so intimately connected, that, popularly speaking, it becomes difficult to separate the one from the other in an elementary treatise

In the second Part, viz. the "VEGETABLES," a comple[te] revision will be found both in the classification and detai[ls] of structure. In the Introduction to this Part the Edit[or] has given a hasty glance at the principles of the Structur[e] and Physiology of Plants, and has re-arranged the whol[e] from the Linnæan system, to that given by Dr. Lindley i[n] his "Natural Arrangement of Plants," 2nd edition.

The third or "ZOOLOGICAL" part has, like the last, been altogether remodelled, and the acknowledged system of Cuvier substituted for that of Linnæus, hitherto used.

As this work is solely intended as a book of reference, to make it to the full extent available for this purpose, the reader would do well to give a hasty glance at the copious index to each division given at the end of the Second Volume.

The illustrations throughout have been faithfully copied from works of standard merit by Mr. Joseph Dinkel, and may therefore, one and all, be relied on.

Chatham, Kent,
March 1, 1842.

EXPLANATION OF THE PLATES

TO THE PART

VEGETABLES.

To the Binder.—The plates are to be placed at the end of vol. i.

PLATE I.

FIG.
1. Olive.
2. Ginger plant.
3. Black pepper.
4. Cardamom plant.
5. Sugar cane.
6. Saffron.

FIG.
7. Scammony plant.
8. Jalap plant.
9. Coffee-tree.
10. Peruvian-bark tree.
11. Tobacco plant.
12. Annual capsicum.

PLATE II.

13. Wheat.
14. Oats.
15. Barley.
16. Rye.
17. Vernal grass.
18. Cotton grass.
19. Bull-rush.
20. Meadow fox-tail grass.
21. Cat's-tail grass.
22. Fiorin, or Orcheston long grass.
23. Canary grass.
24. Purple melic grass.

PLATE III.

25. Meadow soft grass.
26. Reed meadow grass.
27. Smooth-stalked meadow grass.
28. Annual meadow grass.
29. Crested dog's-tail grass.
30. Hard fescue grass.
31. Flote fescue grass.
32. Sheep's fescue grass.
33. Common reed.
34. Sea matweed.
35. Rye, or Ray grass.
36. Coutch, or Squitch grass.

PLATE IV.

FIG.
37. Flax.
38. Socotrine Aloe.
39. Rice.
40. Cinnamon-tree.
41. Camphor-tree.
42. Cashew Nut-tree.

FIG.
43. Logwood-tree.
44. Mahogany-tree.
45. All-spice, or Pimento-tree
46. Almond-tree.
47. Pomegranate.
48. Caper plant.

PLATE V.

49. Tea-tree.
50. Clove-tree.
51. Tamarind-tree.
52. Cotton-plant.
53. Cowhage-plant.
54. Chocolate-tree.
55. Orange-tree.
56. Lemon-tree.
57. Bread-fruit-tree.
58. Maize, or Indian corn.
59. Cucumber.
60. Indian rubber-tree.

PLATE VI.

61. Common elm.
62. Broad-leaved elm.
63. Alder.
64. Beech-tree.
65. Sweet chestnut.
66. Horse chestnut.
67. Hazel.
68. Oak.
69. Walnut-tree.
70. Sycamore.
71. Plane-tree.
72. Mulberry-tree.

PLATE VII.

73. Hornbeam.
74. White poplar.
75. Black poplar.
76. Flowering ash.
77. Lignum-vitæ tree.
78. Quassia-tree.
79. Ash-tree.
80. Nutmeg-tree.
81. Hop-plant.
82. Hemp.
83. Fig-tree.
84. Morell.

MINERALS.

Warm Spring of Solfatara, near Naples.
(Page 152, Vol. I.)

PART I.

USEFUL KNOWLEDGE.

MINERALOGY AND GEOLOGY.

INTRODUCTION.

1. MINERALS are natural bodies destitute of organization and life. MINERALOGY is that branch of natural science which treats of the properties and relations of such bodies[1].

MINERAL DEPOSITS.

2. If we penetrate beneath the surface of the earth, we observe there a very remarkable arrangement. Instead of a generally uniform appearance, as we see on the surface, we pass through divers substances, as clay, gravel, sand, and numerous others, deposited in *beds* or *strata* of various thickness, from a few inches to a great many feet (Fig. 1).

Fig. 1.

These lie, for the most part, nearly horizontal: but in some instances, particularly in mountainous countries, they take different degrees of inclination; and, in places where the country

[1] It has been thought advisable to combine under one head Mineralogy and Geology, as it is difficult to draw, at the present day, a definite line of demarcation between these two comprehensive sciences. Although they will be found, to a certain extent, combined, the reader is referred to the works of Lyell, Phillips, Mantell, and Pye Smith, for a more extended account of the particular science, "Geology."

consists of gently sloping hills and vales, the beds have a waving or bending form (Fig. 2). The strata of which the earth is composed, as deep as the curiosity or the necessities of mankind have explored them, satisfactorily demonstrate the wisdom which has been displayed in the arrangement of materials requisite for the use of men and animals.

Fig. 2.

The first layer is frequently a rich black mould (ALLUVIAL SOIL) formed almost wholly of animal and vegetable remains, and termed *humus*. This (together with the carbonic acid in the atmosphere) is supposed to yield sustenance to the vegetable productions, and thereby becomes the actual, though not the immediate, support of the whole animal creation.—Beneath this is often found a thick bed of clay, with which bricks, tiles, various kinds of pottery, and innumerable other articles for the comfort of social life are made.—Next are deposited vast beds of gravel, that are of use in numerous points of view.—Underneath this are the infinitely varying strata of chalk, green sand, sandstone, limestone, &c. (see Table, p. 14.) which not only serve for the construction of buildings, and for other important purposes, but also frequently surround mines which contain the valuable metals.—Beneath the slaty stratum (the new red sandstone formation) are usually discovered those immense beds of coal so requisite for the comfort, and, in some situations, even for the existence of man; to say nothing of the important uses of coal in times like the present, for the working of machinery.

These strata, it is true, are not always found together, nor are they always discovered in the same order; but the statement will suffice to show the general nature of their arrangement.

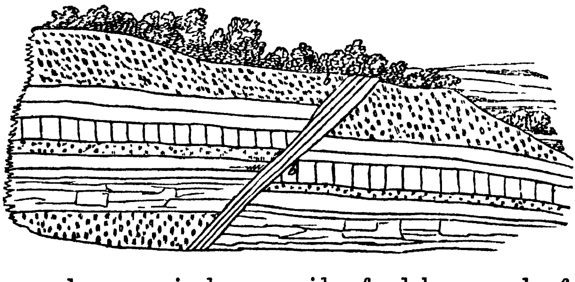
3. Minerals are sometimes observed in detached *masses* of various sizes, and situated at various depths in the earth.

4. They are also found in a kind of natural clefts which

cross the regular mineral beds or strata in different directions (Fig. 1, *a*). When these contain metallic ores, they are styled *veins;* but when they contain only stony or earthy matters, the miners call them *dykes.* They vary much both in magnitude and length. Six thousand feet are considered an unusual length for veins, though, in some instances, veins have been traced upwards of four miles. Few veins extend more than 1200 feet below the surface of the mountains in which they are situated. They are usually much inclined; but they sometimes descend in a direction parallel with the beds of rock in which they occur.

5. At the places where dykes or veins pass through the earth, they occasionally disjoint the strata in a very singular manner (Fig. 3). Some of the coal strata, for instance, are

Fig. 3.



thrown down or raised on one side of a dyke upwards of a hundred yards; and the miner, after penetrating through this dyke, instead of finding the same coal again, meets on the opposite side with beds of stone or clay. Hence he is frequently at a loss how to proceed in searching for the coal of which he is in pursuit; and hence it is that to such dykes the peculiar name of *faults* has sometimes been given.

6. In England the *metallic ores* are generally found in veins that form a considerable angle with the regular strata. This in Cornwall is uniformly the case. And it is remarkable, concerning the veins of tin and copper of that county, that they run in a direction nearly east and west; whilst the dykes, or veins of other substances, run for the most part north and south.

7. The thickness of veins, and the quantity and quality of the ores they contain, differ in every mine. Some are

only a few inches wide, whilst others extend to the width of several feet. The vein at Dalcooth mine, in Cornwall, varies from two or three to forty feet and upwards; and in some parts it contracts so as to be little more than six inches across.

8. In Cornwall the first traces of tin and copper are usually found at the surface of the ground, and thence to the depth of 80 or 100 feet beneath; and it is said that no miner has ever yet seen the bottom of a vein, although several have been wrought to the depth of more than 1000 feet. The veins of these metals have, in some instances, been worked to the length of three or four miles.

9. It is frequently observed that metallic veins are separated from the substances they intersect by a thin wall, or lining, of minerals different from these substances, and also by a layer of clay on each side of the vein. It is also remarked that the same substance which forms the outer coat of the vein is often intermixed with the ore, or forms layers alternately with it. This has usually the denomination of *matrix* or *gangue*.

10. There are few mines of any considerable depth that would not be flooded with *water* from internal springs, were not means adopted for drawing off this fluid. The steam engines that are employed for this purpose in some of the Cornish mines are so powerful as to discharge incessantly, both by night and day, a quantity of water, equal to at least 1000 gallons, or near twenty hogsheads, every minute.

SYSTEMATIC ARRANGEMENT OF MINERALS.

11. To a superficial observer, perhaps nothing would appear more easy than to describe a mineral. This, however, is by no means the case. The same general appearance sometimes prevails in substances that are very different from each other; and the same stone, in its different states, is often extremely varied in its appearance. To these difficulties it must be added, that the combinations of mineral substances are multiplied to a great extent. A little application, however, particularly if the student be possessed of a collection of arranged and named specimens, which he will have no difficulty in procuring at a reasonable

price, will enable him to overcome all the obstacles that otherwise might impede his progress in beginning to acquire a knowledge of this interesting science[1].

Berzelius[2] states, that since chemistry has participated in the classification of minerals, and consequently the exclusive observation of their external characters, called physical, is no longer admitted in the determination of species; the chemical method has met with a difficulty, in the property that certain oxides possess of replacing each other without any alteration resulting to the crystalline form, so that when these same oxides form colourless compounds of a specific gravity nearly equal, one does not perceive any difference in the crystal—it is necessary to discover it by chemical analysis. Therefore the schools of Werner and Haüy, notwithstanding their definition of what constitutes species in minerals, have placed under one and the same species crystals of different composition; and to evade this difficulty Haüy was obliged to have recourse to the admission of accidental mixture, which had been drawn into the form peculiar to a species by the force of crystallization of its constituent parts; but when the results of chemical analyses made with great precision, and by perfect methods, began to throw doubts on the principle of the school of Haüy, viz. *that two bodies of different composition can never have the same crystalline form, unless it does not belong to the limited forms*, the question was all at once decided by a discovery, as opportune as unexpected, that of M. Mitscherlich, according to whom, *bodies composed of different elements, but of atoms in equal numbers, and combined in the same manner, take the same crystalline form.*

According to the same eminent philosopher, the *genus* of a mineral is determined by its chemical formulæ and

[1] Such collections are supplied by Mr. Tennant, No. 149, Strand, London. His terms for collections, containing from 100 to 200 specimens, are five guineas; from 200 to 300 specimens, ten guineas; and from 300 to 400 specimens, fifteen guineas. For collections containing from 350 to 400 specimens, more select, and comprising a better suite of precious stones, he charges from twenty to thirty guineas; and for larger collections, from fifty to one hundred guineas. At the particular request of the Editor, Mr. Tennant has arranged a few collections of minerals, and numbered them in such a manner as to correspond with, and illustrate the present volume.

[2] Annales de Chimie et de Physique, Vol. xxxi.

geometric figure; and the species by the elements of which it is composed.

The system adopted in our national collection, the British Museum, is that detailed by Berzelius, in which the classification of minerals is determined after their most electronegative element[1].

12. The most simple and natural division of minerals is into four classes, of, 1. STONES; 2. SALTS; 3. COMBUSTIBLES; and, 4. METALS; and the following table, which has chiefly been arranged from the system of Werner, the well-known German mineralogist, will exhibit a tolerably correct outline of the classification of these substances. To reduce the whole within the compass of a single page, many of the families, however, have necessarily been omitted.

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[1] It is not advisable, in a purely popular work, to alter the entire arrangement and remodel the few scattered species mentioned in the succeeding pages; were it done, the number of minerals are not sufficient to convey even a general idea of the classification which Berzelius would follow. Under these circumstances, then, the arrangement which has been adopted in the preceding editions will be followed, as being more simple, and therefore more readily remembered and understood.

				Genus	PRINCIPAL SPECIES.
MINERALS.	I. STONES	I. EARTHY	Scratch glass....	Diamond ..	*Diamond.*
				Zircon	*Jargon.*
				Ruby....	*Oriental sapphire.*
					Oriental ruby.
					Emery.
				Schorl ..	*Topaz.*
					Emerald.
				Garnet....	*Precious garnet.*
				Quartz ..	*Crystal.*
					Flint.
					Agate.
					Opal.
			Will not scratch glass....	Clay	*Pure clay.*
				Clay slate..	*Roofing slate.*
				Mica......	*Muscovy glass.*
				Soapstone..	*Fullers' earth.*
				Talc	*Talc.*
					Asbestos.
		II. SALINE		Lime....	*Limestone.*
					Phosphate of lime.
					Fluor spar.
					Alabaster.
				Barytes.	
				Strontian.	
	II. SALTS			Alumina ..	*Alum.*
				Magnesia..	*Epsom salt.*
				Soda....	*Common salt.*
					Borax.
				Potash....	*Nitre.*
				Ammonia..	*Sal-ammoniac.*
	III. COMBUSTIBLES			Sulphur...	*Sulphur.*
				Bitumen .	*Naphtha.*
					Coal.
					Jet.
				Graphite ..	*Black-lead.*
				Resin	*Amber.*
	IV. METALS	I. MALLEABLE ...		Platina....	*Platina.*
				Gold......	*Gold.*
				Mercury...	*Mercury.*
				Silver	*Silver.*
				Copper....	*Copper.*
				Iron......	*Iron.*
				Tin........	*Tin.*
				Lead	*Lead.*
				Nickel.....	*Nickel.*
				Zinc......	*Zinc.*
		II. BRITTLE		Arsenic ...	*Arsenic.*
				Bismuth...	*Bismuth.*
				Cobalt	*Cobalt.*
				Manganese.	*Manganese.*
				&c. &c.	

13. To complete a general view of the different productions of the mineral kingdom, it is requisite to subjoin a tabular arrangement of the various kinds of *rocks*, formed chiefly according to their mineralogical characters.

			SPECIES.
ROCKS.	I. PRIMARY		1. Granite.
			2. Gneiss.
			3. Mica slate.
			4. Clay slate.
			5. Primary limestone.
			6. Primary trap.
			7. Serpentine.
			8. Porphyry.
			9. Sienite.
			10. Topaz rock.
			11. Quartz rock.
			12. Primary flinty slate,
			13. Primary gypsum.
			14. White stone.
	II. SECONDARY	I. TRANSITION ROCKS...	1. Transition limestone.
			2. Transition trap.
			3. Grauwacke.
			4. Transition flinty slate.
			5. Transition gypsum.
		II. FLOETZ ROCKS...	1. Old red sandstone.
			2. Floetz limestone.
			3. Floetz gypsum.
			4. Second, or variegated sandstone.
			5. Second floetz gypsum.
			6. Shell limestone.
			7. Third sandstone.
			8. Rock salt.
			9. Chalk.
			10. Floetz trap.
			11. Coal.
			12. Newest floetz trap.
	III. ALLUVIAL		1. Peat.
			2. Sand and gravel.
			3. Loam.
			4. Bog iron ore.
			5. Calcareous tufa, &c.
	IV. VOLCANIC	PSEUDO-VOLCANIC ROCKS	1. Burnt clay.
			2. Porcelain jasper.
			3. Earth slag.
			4. Columnar clay ironstone.
			5. Polishing slate.
		II. TRUE VOLCANIC ROCKS..	1. Stones and ashes.
			2. Lava.
			3. Matter of muddy eruptions.

(13 *a*) The following is a chronological arrangement of the strata in Great Britain, chiefly condensed from the works of Dr. Pye Smith and Dr. Mantell.

CHRONOLOGICAL ARRANGEMENT OF THE STRATA,

Commencing with the uppermost, or newest Deposits.

FOSSILIFEROUS STRATA.

(Having fossils or organic remains.)

TERTIARY SYSTEM.

I. Modern and ancient Alluvium.—This comprises the modern and ancient superficial deposits.—The *modern* are characterized by the remains of man, and contemporaneous animals and plants: the *ancient* by an immense proportion of large Mammalia and Carnivora, of species and genera both recent and extinct.

II. Tertiary System.—An extensive system, comprising groups of *marine* and *lacustrine* deposits, characterized by the remains of animals and vegetables, the greater portion of which are extinct. Volcanoes of great extent were in activity during this period. Under this head Mr. Lyell and others enumerate the *Pleistocene, Pliocene, Miocene, and Eocene formations.* These several terms express

1. Pleistocene......... more recent formation.
2. Pliocene........... recent do.
3. Miocene........... less recent.
4. Eocene............. or the *dawn* of the existing state of the animate creation.

Total thickness 2,000 feet.

SECONDARY FORMATIONS.

III. The Chalk, or Cretaceous System.—A *marine* formation, comprising beds of limestone, sandstone, marl, and clays, abounding in remains of Infusoria, Zoophytes, Mollusca, Cephalopoda, Echinodermata, Fishes, &c.; drifted wood and marine plants; with Crocodiles, Turtles, and extinct Reptiles.

It is divided into

		LOCALITY.
1. Chalk, with flints (upper).. / —— without flints (lower)	Thickness 600 feet.	Flamborough Head to Spilsby; North of Norfolk, through Cambridge, Herts, Berks, Wilts, to S. Dorset, Hants, Sussex, Surrey, and Kent.
2. Green sand (upper) .... / Gault, bluish clay .... / Green sand (lower)	500 feet.	Kent, Sussex, Isle of Wight.

The Wealden.—A *freshwater* formation, evidently
ta[1] of some ancient river; characterized by an
ce of the remains of enormous and peculiar rep-
mely, the Iguanadon, Hylæosaurus, Megalosaurus, Plesiosaurus, Crocodile, &c.; of terrestrial plants, freshwater mollusca, and *birds*.

It comprehends the

Weald clay / Hastings sand / Purbeck stone	900 feet.	Sussex, and spreading into Kent and Hants.

V. The Oolite.—A *marine* formation of vast extent, consisting of limestones and clays, abounding in marine Shells, Corals, Fishes, and Reptiles, both terrestrial and marine; land plants of peculiar species, and the remains of *two or more genera of* Mammalia.

It is divided into

Oolite (upper) / Portland stone / Kimmeridge clay	A narrow waving course, from North of Lynn to Portland.
Oolite (middle) / Coralline sandstone / Oxford clay / Forest marble / Bradford clay	In Northampton, Bedford, Bucks, Oxford, Berks, Wilts, and Dorsetshire.
Oolite (great) / Fullers' earth, &c.	Waving through Yorkshire, Lincoln, Northampton, Gloucester, Wilts, Dorset, Somerset,—and Surrey?
Oolite (lower.)	

Thickness of the whole, 2,000 feet.

VI. The Lias.—A series of clays, shale, and lime-

[1] *Delta*, alluvial land formed by a river at its mouth.

stones, with marine Shells, Cephalopods, Crinoidea and Fishes. Reptiles, particularly of two extinct genera, the *Plesiosaurus* and *Ichthyosaurus*, in immense numbers. Drifted wood and plants.

Thickness, 200 feet.	Waving from Tees-mouth through Notts, Lincoln, Leicester, Northampton, &c. to Dorset.

VII. THE SALIFEROUS, OR NEW RED SANDSTONE SYSTEM.—Comprising marls, sandstones, and conglomerates, frequently of a red colour, with Shells, Corals, and Plants; Fishes and Reptiles. This series forms the grand depository of rock salt. The term PŒICILITIC is also used to signify this group.

New Red sandstone Rock salt Variegated marble Magnesian limestone and Conglomerate	Thickness 900 feet.	Cumberland, Westmorland, and Durham. Yorkshire, Notts, Leicester, and Lancashire. Cheshire, Staffordshire, and Warwick.

VIII. THE CARBONIFEROUS, OR COAL SYSTEM.—Shales, ironstones, millstone grit, freshwater limestone, and immense beds of coal. This system is characterized by innumerable remains of land and aquatic Plants of a tropical character, and belonging to extinct species and genera; with Fishes, Reptiles, and Insects.

It is subdivided into

1. Coal, shale, and sandstone, in alternating layers, forming vast concave patches, like a series of irregularly-shaped dishes.	Thickness 3,000 feet.	Parts of South Scotland, counties of England, some of the midland counties, South Wales.
2. Millstone grit	700 feet.	Northern counties, and Derby, Nottingham, &c.
3. Mountain limestone, with some beds of shale, sandstones, and inferior coal.	1,000 feet.	Northumberland, Durham, Yorkshire, Derby, Monmouth, Glamorgan, and Pembroke.

IX. THE OLD RED SANDSTONE SYSTEM.—Consisting of various strata of conglomerate, sandstone, marl, and limestone; the prevailing colour of a chocolate red; contains Shells, Corals, and Fishes, many of which are peculiar.

Red and brown sandstones, tile-stones and marls, with equivalent limestones in Devonshire; whence the system is now called Devonian.	Thickness 10,000 ft.	Scotland, Salop, Hereford, Monmouth, South Wales, Somerset, Devon.

X. THE SILURIAN SYSTEM [1].—Composed of *marine* limestones, shales, sandstones, and calcareous flags; abounding in Shells, many of new forms; and swarming with Corals, Crinoidea, and Trilobites.

This system is thus divided:

Ludlow, upper rocks, Sandstone and limestone. ———, lower. Wenlock and Dudley, Sandstones and limestones. Horderley and May Hill, Flagstones, sandstones, and limestones. Biulth, Caradoc, and Llandeilo, Flags, sandstone, & limest. Longmynd, and Gwastaden rocks, Silicious, very hard and quartzy; slates.	Thickness 70,000 ft. and probably much more.	A district varying in breadth, and undulating southerly and westerly from the vale of Llangollen, through portions of Montgomery, Salop, Stafford (an upheaved insulated tract from Dudley to Beacon Hill), Worcester, Gloucester, Hereford, Monmouth, Radnor, Brecon, Caermarthen, Pembroke.

XI. THE CAMBRIAN OR GRAUWACKE SYSTEM—Consists

---

[1] Mr. Murchison has adopted the term "Silurian" in the place of *Transition* (which embraced the whole of the Carboniferous series), as it is separated by the old red sandstone formation, and more particularly to be distinguished and characterized by its fossil treasures. The new term adopted by Mr. M. being derived from an ancient people in Britain, called SILURES, who having Caractacus for their leader, bravely withstood the Romans, and upon whose dominions the strata comprised in this system belonged. Owing to the extended range of these rocks from the Caradoc Hills, and Wrekin, Salop, to the west coast of Pembrokeshire (nearly 120 miles), Mr. M. divided the groups into two series:

Upper Silurian, synonymous with Caradoc.
Lower Silurian, ——————— Llandeilo.

principally of a largely developed series of slate rocks and conglomerates, containing Shells and Corals.

Slate rocks of Plynlymmon, Snowdonia, &c. with dark limestones and sandstones, both fine and conglomerate.	Thickness 50,000 ft. or more.	Merionethshire, Caernarvonshire, and other parts of North Wales; and in Cornwall.

METAMORPHIC ROCKS,

(Destitute of organic remains.)

STRATIFIED.

XII. The Cumbrian.—Vast rocks of slates, purple, green, &c., with very hard and fine sandstones, sometimes conglomerate; the lowest group of slates soft.

More than 10,000 ft. thick	Westmorland, Cumberland, and a large breadth of South Scotland, from the Lammermuir Hills to coast of Wigtownshire.

XIII. The Mica Schist System.—Sedimentary rocks altered by high temperature; mica slate, quartz rock, crystalline limestone, gneiss, and hornblende schist, &c., exhibiting no trace of organic remains.

Hard rock, consisting of mica and quartz interlaminated.	Thickness many thousand feet.	Scotland, S.W. from Stonehaven. becoming very broad across Perthshire and Argyleshire to the Mull of Cantire, and the islands of Isla, Jura, &c.

XIV. The Gneiss System.—Formed of gneiss, sienite, and quartz rock, alternating with clay slate, mica schist, &c.

Gneiss consists of the component parts of granite (quartz, felspar, and mica) finely grained and laminated, so as to present the idea of being the product of granite, abraded, worn, and then deposited from the water, and acted upon by the heat below.	Many thousand feet.	Ben Lomond.

UNSTRATIFIED.

XV. Granite.—In amorphous masses and veins; porphyry, serpentine, trap, &c.

Composed of mica, felspar, and quartz.	Many thousand feet thick.	Principally in the North of Britain.

(13 *b*) Imaginary plan of the section of a basin in Great Britain, illustrative of the different terms ordinarily employed.

(*** The arrangement adopted at p. 9 is here followed.)

Fossiliferous Strata.
ORGANIC REMAINS.

I. MODERN AND ANCIENT ALLUVIUM.	
II. TERTIARY, 2,000 ft.	1. Pleistocene.
	2. Pliocene.
	3. Miocene.
	4. Eocene.
III. SECONDARY CHALK, or CRETACEOUS SYSTEM, 1,100 ft.	I. Chalk (with flints) upper.
	Chalk (without flints) lower.
	II. Green sand (upper).
	Gault.
	Green sand (lower).
IV. THE WEALD, 900 ft.	Weald Clay.
	Hastings sand.
	Purbeck.
V. OOLITE, 2,000 ft.	Upper Oolite—Portland Stone. Kimmeridge Clay.
	Middle Oolite.—Coralline sandstone. Oxford clay. Forest marble. Bradford clay.
	Great Oolite.—Fullers' earth, &c.
	Lower Oolite.
VI. LIAS, 200 ft.	Lias.
VII. NEW RED SANDSTONE, 900 ft.	Rock salt.
	Variegated marl.
	Magnesian limestone.
	Conglomerate.
VIII. COAL SYSTEM, 4,700 ft.	Shale, Sandstone } alternating.
	Millstone grit.
	Mountain limestone, &c.

IX. OLD RED SANDSTONE, 10,000 ft.	Conglomerate. Sandstone. Marl. Limestone.
X. SILURIAN, 70,000 ft.	Marine limestones. Shales. Sandstones. Calcareous flags.
XI. GRAUWACKE, 50,000 ft.	Slate rocks. Conglomerates.
Metamorphic Rocks. No organic remains. I. STRATIFIED. XII. CUMBRIAN, 10,000 ft.	Slates. Hard and fine sandstone. Conglomerate. Soft slates.
XIII. MICA SCHIST, Many thousand feet.	Hard rock. { Mica, Quartz } interlaminated.
XIV. GNEISS, Many thousand feet.	{ Gneiss, Sienite, Quartz } alternately with { Clay slate, Mica schist, &c. }
II. UNSTRATIFIED. XV. GRANITE, Many thousand feet.	{ Porphyry, Serpentine, Trap, &c. } intermixed.

OF DETERMINING MINERALS.

14. For the purpose of ascertaining the names and characters of minerals, attention must be paid to their *form*, *surface*, *lustre*, *fracture*, or the appearance of their internal surface when broken; *structure*, *transparency*, *streak*, or the mark left when scratched by any hard body; *stain*, or trace left when rubbed upon paper; *cohesion*, whether solid, friable, or fluid; *hardness*, or the resistance which they oppose when scratched; *tenacity*, or the resistance which they oppose to the stroke of a hammer; *flexibility*, or their property of bending without breaking; *feel*, or the sensation communicated by their surfaces when handled; *smell*, *taste*, *adherence to the tongue*, *sound*, *specific gravity*, or weight in comparison with that of water; *colour* and *electricity*.

To ascertain the *chemical properties* of minerals, one of the most important instruments is the blow-pipe. This is a tube which terminates in a cavity as small as a fine wire, and through which the air is forced, and made to play upon the flame of a candle or lamp. The flame is thus concentrated, and directed against small particles of the mineral to be examined, which is placed upon a bit of charcoal, or in a spoon of platina or silver. The air is forced into the blow-pipe by the mouth of the person using it, or by bellows attached to it for that purpose. Under this operation we have an opportunity of trying the action of other bodies upon minerals at a very high temperature; and the properties which these experiments bring into view enable us, in many cases, to ascertain not only the nature, but even the component parts of minerals.

ON CRYSTALS.

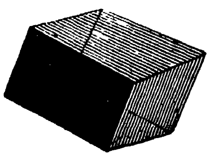
15. By the term *crystal* is meant certain definite and symmetrical forms, minerals and their compounds assume, and which are either transparent, semitransparent, or opaque. Crystallographers divide crystals into two divisions, which are either *primary* or *secondary*.

A *primary* form, says Mr. Brooke, is that parent or derivative form, from which all the secondary forms of the mineral species to which it belongs may be conceived to be derived; and

Secondary forms consist of all those varieties belonging to each species of mineral, which differ from the primary form.

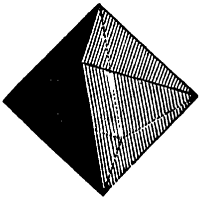
Of the former (*primary*), six forms are usually enumerated; of the latter (*secondary*), of carbonate of lime alone many hundreds occur; and by the operation only of a few laws, many more might be developed.

The following are the principal forms alluded to in the subsequent pages, illustrated by the cuts which are annexed.

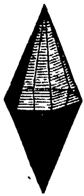


1. *Rhombohedron*, or *rhomboid*, is composed of six equal and similar rhombic faces, parallel two and two.

2. *Pyramid*; by this term is meant two equal pyramids applied base to base. Three kinds are enumerated.

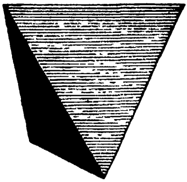


a. The *four-sided*, constituting octahedrons, is contained under eight equilateral triangles.

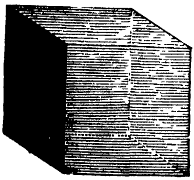


b. The *six-sided*, constituting a pyramidal dodecahedron.

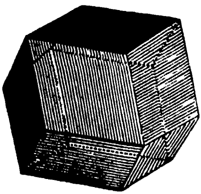
c. The *eight-sided*, constituting a crystal with sixteen triangular faces.



3. The *tetrahedron* is a figure composed of four equilateral triangles.

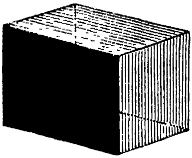


4. The *hexahedron* or *cube* is a figure (like a die) presenting six squares.

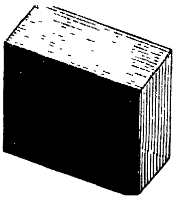


5. The *dodecahedron* is contained under twelve equal and similar faces—the figure of which determines the kind of dodecahedron.

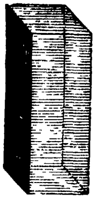
6. The *icosatetrahedron* is a solid, bounded by twenty-four faces; the figure of which faces determines the kinds.



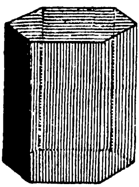
7. The *prism* is a solid figure having any number of sides with parallel edges, and its two ends parallel. The annexed diagram represents a *right rhombic prism*.



a. Doubly oblique prism is represented in the annexed figure.



b. The *four-sided prism.*



c. The *six-sided prism.*

8. The *tetracontra octahedron*, having forty-eight equal and similar faces, as in the diamond, which is considered to be an octahedron, on each face of which a low six-sided pyramid is raised.

SIMPLE MINERAL SUBSTANCES.

16. As a necessary introduction to the study of minerals,

it is requisite to describe, in a brief manner, such simple substances as form their constituent parts. Few of these, it is true, are to be found in a separate, uncombined state; yet that they do exist, and that they are to be obtained from the minerals with which they are united, we have the proof of every day's experience.

UNCONFINABLE SUBSTANCES.

17. There are some kind of unconfinable bodies, the existence even of which is manifested only by their contact with other bodies, or becoming separated from them. They are of a nature too subtile to be collected or confined in our vessels for the purpose of examination, and the investigation of their properties has consequently been attended with peculiar difficulty. Those at present known are *caloric*, *light*, *electricity*, and *magnetism*; but of these the first only is immediately connected with the subjects of our present investigation.

18. *Caloric.*—Every one is acquainted with the different sensations of heat and cold. That which produces on our bodies the sensation of *heat* has the name of *caloric*; heat being only an effect, of which caloric is the cause. This is extended in a greater or less degree through the whole extent of space, and penetrates into the interior of even the most solid bodies: in so doing it expands the particles of which they are composed, augments their bulk, and diminishes their solidity. The sun appears to be the principal source from which the earth is supplied with this powerful, exciting, and necessary element. The rays of the sun are composed of both heat and light; these become separated from each other when they reach the earth. There are, however, many other sources of *heat* besides that emitted from the sun. Mechanical and chemical action is a too frequent cause of the evolution of *caloric*; combustion, or the union in a rapid manner of a combustible body with oxygen gas, by which both light and heat are evolved, is another common source of heat; the heat given off from animals, and that from electricity, must also be recorded. The absence of caloric in any substance occasions the sensation called *cold*.

If the world were deprived of caloric, every organized being, whether animal or vegetable, would from that moment cease to exist. It is the cause of all fluidity: to it many of the productions of the earth have been most essentially indebted, even for their form and structure; and in no respect do the power and goodness of the Almighty appear more conspicuous than in the creation, dispersion, and continuance, of this most subtile and astonishing body.

19. All the various substances with which we are acquainted must be considered either as solid or fluid. Every substance is called a *solid*, in which the parts are so united or connected that it requires an external force to separate them. A *fluid*, on the contrary, is a body, the parts of which are so loosely connected, that they not only yield easily to any force impressed upon them, but also move freely amongst themselves: every fluid is a combination of caloric with some other substance.

20. Fluids are of two kinds: one of these, called *liquids*, has, when at rest, a smooth and distinct surface, and is distinguishable both by the sight and touch; the other, denominated *gas*, or *gaseous fluids*, has the appearance of air, and is not perceptible either to the sight or touch, except under certain circumstances; and except, also, chlorine (29). The latter is principally oxygen (21), azote or nitrogen, and hydrogen (45). We shall at present have occasion to speak only of the first.

GASEOUS FLUIDS.

21. *Oxygen*, like caloric, is a fluid never found in an uncombined state, and is devoid of taste, smell, and colour. When desired for chemical purposes, it is readily procured by heating the oxides of metals in an iron bottle, thereby driving off part of the oxygen; and also by submitting chlorate of potassa to a red heat. When in combination with metals or metalloids, it forms alkalies, oxides, earths, and acids. It forms 20 or 21 per cent. by volume, or nearly 23 per cent. by weight, of the air that we breathe, and of the water (which is calculated to cover about three fourths of the earth's surface) it forms eight-ninths of its weight, and about one-third of the crust of the earth, inasmuch as the principal substances, carbonate of lime, alumina, and silica, of which it is formed, have been proved by the chemist to

be constituted of nearly one-half oxygen; but it approaches nearest to a state of purity in combination with caloric (18), when it has the name of *oxygen gas.* It was formerly called *vital air*, because no breathing animal can live for a moment in any air or gas which has not in it a mixture of oxygen; every kind of combustible burns with great splendour in it, and without it ceases to burn. Dr. Priestley, however, who discovered it in 1774, gave it the name of *dephlogisticated air.* It has of late been much used for the purposes of illumination in the form of the Bude light of Mr. Gurney, and as a substitute, when mixed with twice its bulk of hydrogen and the flame projected on quick-lime, for the sun in microscopic exhibitions [1] as first applied by Mr. J. T. Cooper, and for lighthouses by Mr. Drummond. It unites with a number of substances, changing even the hardest of them in nature, as the diamond; this is effected in the course of a few minutes, and by heating it to redness previously to immersing it into this gas, it becomes converted into a gaseous compound called *carbonic acid;* its property of destroying the surfaces of many of the metals (when combined with them), and of reducing them to a state different altogether from that they originally possessed (as the rust on iron when exposed to water and air, &c.), is familiar to the common observer. If these *oxides*, for such they are termed, are deprived of their oxygen, the metals return to their former state. This is not, however, the case with the diamond; as that mineral is composed exclusively of pure *carbon*, chemical analysis can only restore carbon in the form of *charcoal*, and this of the purest kind; by the chemical action which takes place, the cohesion of the particles becomes irreparably destroyed, to be restored only in a very different state of aggregation (viz. charcoal) to that they originally possessed.

Even in the laboratory of nature (the atmosphere), oxygen constituting so large a portion of water and air, works its changes on the surfaces of the hardest rocks, reducing them to powder, thereby rendering such apparently little available materials fit for soils of no mean value.

100 cubical inches of this gas weigh nearly 35 grains; its specific weight is 1.111; its atomic number is 8.

[1] For a detailed account of which consult the Microscopic Journal, vol. i. p. 2.

ACIDS.

22. It is one of the most remarkable properties of oxygen to impart to most of those bodies called *acids* their peculiar character of acidity, and from this property it received its name, derived from the Greek "to produce acid." Oxygen does not itself possess the properties of an acid, nor is it an essential ingredient in all acids, though it is the acidifying principle in the greater number of them.

23. *Acid* is a word originally synonymous with sour. It has, however, been gradually extended in its signification, and now comprehends all substances possessed of the properties of exciting upon the tongue the sensation called sour; of changing the blue colours of vegetables to red; of uniting with water in almost any proportion; of combining with alkalies (42), metallic oxides, and earths, and of forming with them certain compounds called *salts*.

24. *Sulphuric acid*, or *oil of vitriol*, as it is commonly called, is a liquid of a somewhat oily consistence, transparent and colourless as water, formed by a combination of three equivalents of oxygen (21) with one of sulphur (46). It is highly corrosive, and one of the most destructive of the mineral acids, destroying animal and vegetable substances rapidly, with usually a deposit of charcoal. Its boiling point is 620° Fahr. This acid is occasionally found in nature in a free state, more especially in volcanic regions, probably the result of the combustion of sulphur. Dr. T. Thomson states that there is an earth so strongly impregnated with it, that it is used by the natives as an acidulous seasoner of food. Humboldt records another instance of a river taking its name from the acid nature of the water, Rio Vinagre, (Vinegar river) which takes its course from

Cascade de Vinaigre.

the volcano of Puracé, in Colombia, to Popayan. This water contains in addition a little hydrochloric acid. It unites with earths (31), alkalies (42), or metals, and forms, with them, several well-known salts, which have the name of *sulphates*. Thus alabaster (192) and Epsom salts (199) are respectively formed by a union of sulphuric acid with lime and magnesia, and are denominated by chemists sulphate of lime and sulphate of magnesia. In like manner, blue vitriol (209) is sulphate of copper; green vitriol (208), sulphate of iron; and white vitriol (210), sulphate of zinc.

25. *Phosphoric acid* is produced by a combination of oxygen (21) with phosphorus (47) either by burning phosphorus in a vessel with oxygen, or by acting on bones by sulphuric acid (24); and, when obtained in a state of purity, is not a fluid, but a white and flaky substance (*pyro-phosphoric acid*), but when exposed to moisture is converted into *phosphoric*. This acid, when combined with mineral productions, forms those salts which have the name of *phosphates*. It is composed of five equivalents of oxygen, and two of phosphorus.

26. *Carbonic acid* is a compound of two equivalents of oxygen (21) and one of carbon, or pure charcoal (48): in a state of gas it forms about 1000th part of atmospheric air. It is also emitted in great abundance from wine, beer, and other liquors in a state of fermentation, to which they owe their briskness, and is sometimes found in the lowest parts of mines, where it is known to the miners by the name of *choke damp*, from the circumstance of its immediately extinguishing flame, and suffocating all animals that are immersed in it. This gas, which was formerly called by chemists *fixed air*, is inodorous, and rather more than $1\frac{1}{2}$ times the weight of common air. In combination with lime it forms chalk, marble, and limestone; and it constitutes part of several other mineral substances, which are thence denominated *carbonates*. When this gas escapes from fluids in abundance, it is the cause of effervescence. Almost every other acid can displace it when in combination with alkalies, &c. It is the food of plants: plants possess the power, principally in the leaves, of decomposing carbonic acid gas, by which the carbon becomes deposited, under the stimulus of light only, augmenting their

structure and giving them their green color, while the oxygen is liberated, in a free state, into the atmosphere.

27. *Fluoric acid*, or *hydro-fluoric acid*, is a gas of a very singular nature; it is held in combination with lime in the Derbyshire or fluor spar (194), and may be separated from it by pouring sulphuric acid, or oil of vitriol (24), upon the powdered spar, in a leaden retort, and applying to it a gentle heat. The salts formed by fluoric acid have the names of *fluates*. Of all the bodies in nature, this is the most corrosive: it has the power of eroding and dissolving glass, and on that account should be kept in metallic bottles; it is also very hurtful to animal life.

28. The *boracic* is a peculiar kind of acid, which, in combination with soda (200), forms the substance that we import from the East Indies under the name of borax (204). When extracted from borax this acid does not assume the form of a fluid, but appears in thin six-sided scales or flakes, of a white colour, which adhere slightly together, and feel somewhat greasy in handling. To the taste it is at first sour, then bitterish; and at last it leaves an agreeable sweetness on the palate. Its principal property is that of rendering very fusible bodies with which it unites.

29. *Chlorine* is a gas, called, by its discoverer Scheele, *dephlogisticated muriatic acid*, by others oxymuriatic acid. It is of a greenish yellow colour, of a pungent, disagreeable smell, and highly injurious when respired. It is a very important substance in many chemical combinations, as well as in the arts, particularly in bleaching. Combined with hydrogen it forms what is commonly called *muriatic acid* or *spirit of salt*. It combines with many bodies in a similar way to oxygen; this last body forming with them *oxides*, as *chlorine* does with them *chlorides*. With soda it forms a *chloride of sodium*, formerly called *muriate of soda* or common salt (202). For a long period, and until lately, while the basis of muriatic acid remained unknown, the combinations of that acid with many substances were called *muriates*: modern chemists call them *chlorides*. Many bodies are ignited by chlorine, and burn in it with much brilliancy, especially the metals, when reduced to a fine state of division.

Muriatic, or, as it is now more properly termed, *hydro-*

chloric acid gas, consists, therefore, of hydrogen (45) and chlorine. It is greedily absorbed by water, which takes up 480 times its bulk; thus dissolved in water it constitutes *liquid muriatic (hydrochloric) acid* or *spirit of salt.* It is, when pure, colourless, but it is generally of a yellow hue; it is considerably heavier than water, and emits peculiar and suffocating fumes. It combines with many bodies, as above stated of its base, chlorine.

30. *Nitric acid* is a compound of oxygen and nitrogen, in the proportion of twenty-five parts, by weight, of the latter to seventy-five of the former. It is one of the constituent parts of nitre, or saltpetre (206); and, in a pure state, is transparent and colourless, like water. By the action of light, however, it soon becomes yellow; and, if exposed to the air, it emits yellow fumes of nitrous gas, which even tinge the air of the same colour. To the taste it is extremely acid. It dyes the skin a yellow colour, which is very difficult to be removed, and it is so corrosive as to destroy almost every substance into which it penetrates. If poured upon oils, it sets them on fire. With various bases it forms compounds called *nitrates.* This acid, which hitherto has never otherwise been obtained than mixed with water, is chiefly known in commerce by the name of *aqua fortis* (206). It is prepared by heating strong sulphuric acid and saltpetre together, and condensing these fumes in a chamber, at the bottom of which water has been placed: it cannot be obtained without the latter precaution is attended to.

EARTHS.

31. The solid contents of the globe are composed of several elementary substances, amongst which have been enumerated no fewer than ten different kinds of earth:

1. Silex.	5. Glucine.	8. Strontian.
2. Alumine.	6. Yttria.	9. Lime.
3. Thorinum.	7. Barytes.	10. Magnesia.
4. Zircon.		

These, when freed from foreign admixture, are, for the most part, of a white colour, not soluble in water, not combustible, and do not exceed four times the weight of water.

32. The whole of these earths have, till lately, been considered simple and uncombined substances; but, by the discoveries of Sir Humphry Davy, it has been ascertained that most of them have a metallic basis, and are in fact metallic oxides, or compounds consisting of a metal united with oxygen (21). These, which have the same affinity with their respective bases as rust has to iron, are silex, lime, barytes, and alumine.

33. *Silex, siliceous earth,* or *silica,* is the basis of all substances known by the name of flint, sand, &c. quartz and silex (76). In a state of nature it has never been found pure; but, in combination with other substances, it abounds in almost every country of the globe. Common flint (90) contains ninety-seven parts in a hundred of silex: it consequently has given its name to this earth, *silex* being the Latin word for flint. When purified, it is a white powder, the particles of which are harsh to the touch, as if they consisted of very minute grains of sand. It is not quite three times as heavy as water, and has neither taste nor smell. Water will not dissolve it, nor any kind of acid, except the fluoric. Sir H. Davy has discovered it to have a metallic basis, to which he has given the name of *silicium.* The combination of *silica* with alkalies (potash or soda) forms glass; the various colours of which are produced by the oxides of different metals.

34. *Alumine* is a kind of earth, so called from its forming the basis of alum (197). It is soft, compact, and tenacious, about twice the weight of water, and, when breathed upon, has a smell which is peculiar to all clayey productions. The various kinds of pottery are composed of this substance, which is the proximate principle of most clays. In the fire it shrinks, and becomes so hard as even to yield sparks when struck against steel. It readily absorbs water, and is dissolved by most acids. Some writers state that pure alumine has been discovered in a native state near Halle, in Germany. It is found in a crystallized form, and nearly in a state of purity, in the Oriental ruby and sapphire. The name of *argil,* or clay, has sometimes been applied to it; but, in mineralogy, this name has usually been given to a mixture of alum, quartz, and other substances. Sir H. Davy has obtained from alumine a metallic basis, called *aluminium.* The contraction by heat of the earth alumina, forms the principle upon

which Wedgewood constructed his *Pyrometer* (a measurer of heat). This instrument consists of a metallic groove in which is inserted a quantity of an aluminous earth. When introduced into the fire, the degree of heat is ascertained by the quantity of water which is driven off, which is indicated by the contraction of the clay on the scale.

35. *Zircon*, when freed from those substances with which it is combined, is a white and somewhat rough powder, insipid to the taste, insoluble in water, and about four times as heavy as that fluid. It is found in the two kinds of precious stones called jargon or kircon, and in the hyacinth, and has not hitherto been applied to any useful purpose.

36. *Glucine* is an earth of a peculiar nature, which is found in the emerald, euclase, and beryl, and, when purified, forms a soft and white powder, without smell, and of a sweetish taste. To the last of these qualities it is indebted for its name, which is derived from a Greek word signifying sweet. It is somewhat unctuous to the touch, and about three times as heavy as water. The uses of this earth, whatever they may be, are not known.

37. *Yttria* is an earth which, among other particulars, differs from glucine by its weight, as it is nearly five times heavier than water. In a natural state it occurs as the basis of a black Swedish mineral, called gadolinite or yttria, found at Ytterley in Sweden. When cleansed, by chemical process, from all its impurities, it is a fine, white, and inodorous powder. Its metallic base is called *yttrium*.

38. *Barytes* is a white, porous, and very heavy earth, which can only be obtained pure by chemical process, and occurs usually in nature, in combination with either carbonic (26) or sulphuric acids (24). It is easily reduced to powder, and is soluble in all kinds of acids. To the taste it is harsh and caustic; and, if the soluble salts are taken into the stomach, they prove extremely virulent poisons. In some respects it agrees with the alkalies (42), particularly in its property of changing blue vegetable colours to green, and in corroding, like them, though with less energy, all kinds of animal substances. From these circumstances it has sometimes been denominated an alkaline earth. It has been discovered to have a metallic base, which is called *barium*.

39. *Strontian* is an earth which, like barytes, is not found otherwise than in combination with sulphuric and

carbonic acids. It occurs in various parts of the world, and, when purified, forms a porous mass of a greyish white colour, acrid taste, and somewhat alkaline nature. This earth converts vegetable blue colours to green, but does not act so strongly on animal bodies as barytes, nor is it poisonous, like that substance. This earth has the property of giving a red colour to flame, and is therefore much used in the making of red fire, and other purposes for theatrical representation. The basis of this earth, *strontium*, was discovered by Sir H. Davy.

40. *Lime*, the basis of all those substances which are denominated *calcareous*, is only to be obtained in a state of purity by artificial process. Combined with carbonic acid (26) it forms limestone (140), chalk, and marble; all of which are capable of being converted into lime by burning. Lime may also be obtained from the oyster and other shells. When pure, it is of a white colour, and is a moderately hard substance, though it is easily reducible to powder. Its taste is burning and acrid; and, like the alkalies, it changes vegetable blue colours to green. It has likewise the property of corroding and destroying animal substances. Lime, when pure, absorbs water rapidly, becomes hot, and falls into powder. Even if exposed to the open air it gradually attracts moisture, and assumes a powdery form; in this state it absorbs carbonic acid (26) from the atmosphere, and is thereby again converted into carbonate of lime (140). It is more soluble in hot than in cold water. It occurs abundantly in almost every country, but always in combination with some acid, carbonic (26), sulphuric (24), boracic (28), fluoric (27), or phosphoric (25). This substance has a metallic basis, which has been denominated *calcium* by Sir H. Davy.

41. *Magnesia* is a white earth, of a soft powdery appearance, without taste or smell, and somewhat more than twice as heavy as water. It is not found in this pure state in nature, but may be prepared from Epsom salt, which consists of magnesia in union with sulphuric acid (24). The slightly acrid taste that is perceptible in the magnesia used in medicine arises from a portion of lime which it contains. It does not dissolve in water, but is soluble in every kind of acid, and differs from the other alkaline earths, by the solubility of the sulphate. It changes delicate blue colours

to green. The common magnesia of the shops is a carbonate of magnesia; *burnt* magnesia is magnesia deprived of its carbonic acid by heat.

ALKALIES.

42. Alkalies enter into the composition of several kinds of minerals, and are known by their property of changing the colour of blue vegetable juices to green, and by a peculiarly acrid, caustic, and nauseous taste, which it is impossible to describe, but which, after it has been once experienced, will easily be recollected. Alkalies corrode and dissolve animal substances, and unite with oil and fat in such a manner as to form the well known compound called *soap*. They readily dissolve in water; and, when mixed with acids, form what have been denominated neutral salts.

43. The alkalies at present known are three in number; *potash* (205), *soda* (200), and *ammonia* (207). Of these the two former, although till lately they have been considered simple substances, have been shown by Sir H. Davy to have metallic bases, called *potassium* and *sodium;* ammonia or volatile alkali is composed of three atoms of hydrogen (45), and one of nitrogen (45).

SIMPLE COMBUSTIBLES.

44. By this term we are to understand all those substances, capable of combustion, which have not been discovered to consist of more than a single component part. The chief are the following: *hydrogen*, *sulphur*, *phosphorus*, and *carbon*.

45. *Hydrogen*, as its name imports, is a principal constituent part of water: for, singular as it may appear, that well-known fluid is formed by a combination of two kinds of air or gas, called hydrogen and oxygen (21), and in the proportion of about fifteen parts of the former, and eighty-five parts of the latter. This gas had formerly the denomination of *inflammable air*, and has long been known when combined with carbonic (48) in mines under the name of *fire-damp*. It is about fourteen times lighter than atmospheric air. When pure, it soon destroys animals, and extinguishes all such flaming substances, as are immersed in it. Mixed with atmospheric air, it explodes with great violence on the application of any ignited body.

46. *Sulphur* is a simple combustible substance, of a yellow colour; it is found pure, or native, in several parts of the world, especially near volcanoes, and is sufficiently familiar to us under the name of *brimstone* (211). When exposed to the flame of a candle or other burning body, it strongly attracts oxygen (21), and is soon converted into an acid (24). It frequently occurs in combination with mineral substances, such as arsenic, antimony, copper, and other metallic ores, from which it is separated by roasting. It is nearly twice as heavy as water, and burns when heated to about 300 degrees of Fahr. It unites with four different portions of oxygen (21), forming as many different acids.

47. *Phosphorus* is a combustible substance, which, when pure, is nearly colourless, semitransparent, and flexible. When exposed to the air under the usual temperature of our atmosphere, it is luminous in the dark, and has a smell somewhat resembling that of garlic. It is so combustible that, when melted, it should be kept under water, as it cannot be exposed to the air during this process without great risk of catching fire. This substance is not known in a native state; and the whole of what is used in chemistry and commerce is obtained by different artificial processes. In union with oxygen (21) it becomes converted into an acid, called *phosphoric acid* (25); combined with lime, it constitutes the bones of men and animals. The greater part of the phosphorus of the shops is obtained from bones.

48. *Carbon* is a name given to the pure inflammable part of charcoal. It is a simple elementary, non-metallic body. It is abundantly diffused throughout nature, for it enters into the composition of several minerals, and of all vegetable and animal bodies. The purest form under which carbon is known to exist is in the diamond (50). It may, however, be obtained sufficiently pure, for all common purposes, by burning a piece of wood, covered with sand, in a vessel called a crucible. The charcoal or carbon obtained from bones, is termed *ivory black*, or *animal charcoal;* that from coal, *coke;* and that from oils, fat, tar, turpentine, &c. *lamp black*. In combination with oxygen (21) it forms carbonic acid (26). Carbon is a chief component part of pit-coal (217), petroleum (213), and other bituminous substances.

CLASS I.—STONES.

ORDER I.—EARTHY STONES.

I. HARD : those which scratch Glass.

49. OF GEMS IN GENERAL.

Gems, or precious stones, as they are frequently called, are for the most part transparent, and have a vitreous or glassy appearance. Their different colours are commonly occasioned by metallic oxides (21) of various kinds, with which they are impregnated. Some writers have classed them by their colours, but this is a very uncertain mode, as different gems have not unfrequently the same colour; and, in many cases, the same gems are of different colours. The usual distinction of gems into Oriental and Occidental is also liable to error, as the best gems, from whatever part of the world they are brought, are always called Oriental. The most estimable of all the kinds are the diamond (50), ruby (54), emerald (67), and sapphire (53); and stones a grain in weight, and equal in quality, are valued in the following proportions :—at 8*l.* per carat for diamonds, 4*l.* for rubies, and 3*l.* for each of the others. The amethyst (79), topaz (61), and aqua-marina (61), are considered of nearly equal value with each other; and the garnet (70) is the cheapest of precious stones.

The ancients engraved upon several kinds of gems; but they appear to have been ignorant of the art of cutting the diamond, the ruby, and the sapphire, which were too hard for them to operate upon. The emerald and the noble opal (102) were too highly esteemed as precious stones to have often found their way into the hands of engravers. It has been asserted that the ancients did not use the topaz for engraving; but there is extant a beautiful *intaglio*, representing an Indian Bacchus, which is said to be a topaz. The garnet was often engraved upon; and there are many master-pieces of the art in chalcedony (91) and carnelian (93). Onyx and sardonyx (92) were employed for that species of engraving in relief called *cameos;* and in many instances it is pleasing to observe with what dexterity the ancient artists availed themselves of the different colours in the alternate zones to express the different parts and shades of their figures.

Most of the gems may be imitated by artificial preparations of glass, coloured by different metallic substances (p. 67); and it is not easy, by mere inspection, to distinguish the better kinds of factitious stones from real gems. They are, however, discoverable by a deficiency of lustre, and being so soft as, even in the most perfect kinds, to yield to the point of a steel instrument.

The cutting and polishing of gems is the work of the lapidary, and is in general thus performed:—The shape most proper to be given to any particular gem being determined on, the stone is cemented to the end of a stick, and the different *facets* are formed by a mill contrived for the purpose. This mill is a plate of copper, or an alloy of lead and tin, to which a horizontal motion is given by very simple machinery, and the surface of which is charged either with diamond powder and oil, or with fine emery and water. A thick peg of wood, called a gauge, pierced with small holes in all directions, is set upright on the lapidary's bench, close to the mill, and the process of shaping the facets thus takes place. The stone is placed on the surface of the mill, the opposite end of the stick to which it is cemented being inserted in one of the holes of the gauge. In this position it is kept steady by the workman, with his right hand, whilst with the other he puts the mill in motion. The skill of the lapidary depends on regulating the velocity of the mill, and pressing with more or less force on the stick, with an almost imperceptible tendency to one or other direction in different stages of the work, examining each facet at very short intervals, in order to give as great precision as possible to its size and form. This part of the business being completed, the cutting-mill is taken out, and replaced by one of brass, on which the polishing is performed by means of fine emery (58), tripoli, and rotten stone (119), exactly in the same manner as is practised in the first stage of the process for setting the facets.

DIAMOND.

50. *The DIAMOND, or ADAMANT of the ancients, is the most valuable of gems, and the hardest of all known bodies; when pure, it is perfectly transparent, possessing a high refractive power.*

In a rough state, diamonds have usually either the form of rounded pebbles, with a shining surface, or they are crystallized in the shape of octohedrons, or double four-sided pyramids. Though for the most part colourless, they are sometimes yellow, green, blue, blackish, or rose-coloured; of these the black and the blue are the rarest.

Diamonds were known to the Greeks, who called them *adamas* and *adamantos*, probably on account of their hardness. The best diamonds are brought from the East Indies. The principal mines are those of Raolconda and Coulour, in the province of Golconda, where they occur in alluvial soil; and that of Soumelpour, or Goual, in Bengal. An instance is recorded of their being obtained from the sand of the river Gumil, in the province of Constantine, Africa. At Raolconda they are found in the deep crevices of rocks. Persons, by means of long iron rods, with hooks at the end, draw out from these crevices the loose contents, and afterwards wash them in tubs, for the purpose of discovering the diamonds.

The first discovery of diamonds at Coulour was about two centuries ago, by a countryman, who, on digging his ground to sow millet, accidentally found one of these stones of a large size. From that period the whole adjacent plain began to be searched to the depth of from ten to fourteen feet; and the work was at one time so extensively pursued, that nearly 6,000 persons were employed in it. At Soumelpour the diamonds are found amongst the sand and gravel of the river. They have likewise been found in the coal formation of India, and in the sandstone at Panna, in Bundelkund.

Diamonds are likewise found in the island of Borneo, and in several parts of South America. The mode by which they are obtained from one of the rivers of Brazil has been described by Mr. Mawe. The current is turned, and part of the bed of the river being laid dry, the mud is taken up and washed, by negroes, in places prepared for the purpose, through which a portion only of the stream is allowed to flow. As soon as all the earthy particles have been washed away, the gravel-like matter that remains is raked together, the stones are thrown out, and what diamonds happen to be present are found amongst the refuse that is left.

To ascertain whether a stone that has been found be really a diamond, the workmen have a mode of placing it upon a hard substance, and striking it with a hammer. If it either resisted the blow or separated into layers, it was considered to be a diamond; but, in the latter case, the discovery was sometimes made at an immense expense, as, by thus diminishing the size, its value must also, of course, be greatly diminished.

Diamonds are generally exported from Madras in a rough state; and in small parcels neatly sewed in muslin, and sealed by the merchants who send them. These, we are informed by Mr. Milburne in his valuable work on oriental commerce, are, for the most part, sold in Europe by invoice, as it is called; that is, without being opened: and he says that they are always found to contain the value for which they were sold in India.

Of all transparent substances, none for brilliancy can be compared with the diamond. Its hardness is such, that no steel instrument whatever can make any impression upon it: it is, indeed, the hardest substance in nature, and is only to be cut, rubbed down, or polished, by diamond powder or dust. Notwithstanding this, at a temperature not so high as that which is required for the melting of silver, it gradually dissipates and burns, uniting with the oxygen of the atmosphere, and becoming carbonic acid gas, in a like manner to charcoal. This property was first discovered by Lavoisier. Diamonds have been shown to consist principally of carbon, or charcoal, in a pure and crystallized state. Sir D. Brewster was of opinion that the diamond is of vegetable origin. Mr. Heuland has, however, recorded an instance of its having been obtained in a primary rock.

The ancients, ignorant of the art of cutting diamonds, were contented to set them in a native state; and for this purpose they preferred such stones as had naturally a crystallized form. The four large diamonds which ornament the clasp of the imperial mantle of Charlemagne, and which are still preserved in Paris, are uncut stones of this description. The extreme hardness of the diamond baffled all attempts to polish it in such manner as to exhibit its peculiar beauty, until the year 1456, when a young man of Bruges, whose name was Louis Berquen, endeavoured to polish two diamonds by rubbing them against each other. Having succeeded in this, he next constructed a wheel, on which, by means of diamond powder and grease, he was enabled to cut and polish these gems in a manner beyond his greatest expectation. To such an extent was this discovery appreciated by Charles, Duke of Burgundy, that he handsomely rewarded Berquen for his invention. Since this period the art of polishing them has been greatly improved both by the Dutch and British jewellers.

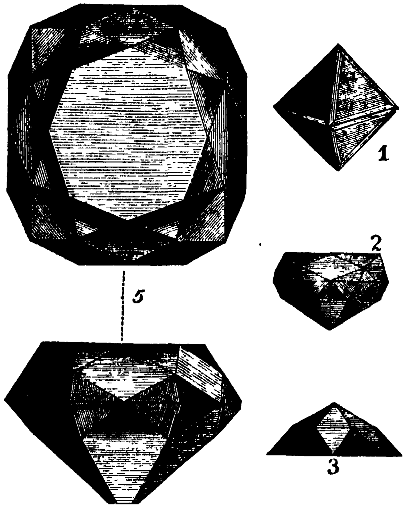
In the choosing and valuing of diamonds in a rough state, attention is paid to their colour, their being free from extraneous matter, and their shape. Those that are most perfect are crystalline, and resemble a drop of clear spring water, in the middle of which is to be perceived a strong light, that plays with great spirit on moving them about. When they have a yellowish or greenish tinge, they are considered to be bad. Many diamonds have a kind of confused structure, which lapidaries compare to knots formed in wood. These are rejected, from the impossibility of polishing them properly.

Mr. Mawe remarks that diamonds, when rubbed together, have a peculiar and scarcely to be described grating sound, which is one of their most remarkable characteristics. By this alone rough diamonds may be accurately and expeditiously distinguished from every other gem.

It is usual to cut diamonds into three principal forms, called *brilliant* (Fig. 15. 2), *rose* (Fig. 15. 3), and *table* diamonds

(Fig. 16). Brilliants are, for the most part, cut from such of the stones as have naturally a crystallized shape, and rose diamonds from the flat varieties [1]. "It is not easy," says Dr. Thomson, "to convey an idea of what is called a *brilliant*. Some conception may be formed by supposing a natural diamond to be a regular octohedron, consisting of two four-sided pyramids with square bases applied base to base (Fig. 1). Half the upper pyramid is cut off, and all the corners and edges converted into triangular faces," as shown in the annexed cut (Fig. 2). The former are so called from their great lustre, in consequence of the facets on both sides being cut. These are always set upon a black ground, whilst rose diamonds, which are much thinner, are set upon a white foil speckled with black, for the purpose of adding to their lustre.

Fig. 15.

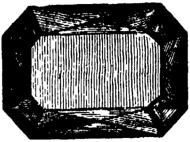


Rose-cut diamonds are nearly hemispherical, the surface of which is cut into twenty-four triangular planes. The diagram (Fig. 3) will convey a good idea of the rose-cut diamond in this form. There are seven prominent solid angles upon the hemisphere, where six of the little triangles meet; one constituting the apex, and the other six surround it at the distance of one of the triangular faces, as seen at Fig. 3. They are of course much less estimable than brilliants;

[1] In the above cut Fig. 15. 1 represents a rough diamond; 2, a profile of a brilliant cut stone; 3, a profile of a rose-cut stone; 5, plane and profile of the Pitt diamond.

so much so, indeed, that formerly many of them, brought from Holland, have been re-cut into brilliants, notwithstanding the additional expense, and the loss of size necessarily attendant on this operation.

Fig. 16.



The table diamond (as seen in the margin) is the least beautiful of any. This mode of cutting is only adopted for such stones, or rather fragments, as, with a considerable breadth, have only a very trifling depth. The diamond-cutters of England are considered to be the best in Europe, but their number is so small as to occasion many stones to be sent to Holland to be cut.

The value of diamonds is ascertained by their weight in carats; and this value increases, in a very high ratio, according to their magnitude. For instance, a diamond cut and polished, weighing one carat, will be worth about 10*l.*, whilst another of five carats will be worth 150*l.*, and of ten carats 800*l.*[1] This rule, however, can only be taken for diamonds of twenty carats and under. The larger ones, in consequence of the scarcity of purchasers, are generally disposed of at prices greatly inferior to their estimated worth. The value of some diamonds that are peculiarly perfect exceeds the above ratio; whilst for a stone that is cloudy, foul, or of bad colour, even three quarters of the estimated value will perhaps be deducted.

No diamonds are so valuable as those that are perfectly transparent, and of a snow-white colour. The green and yellow varieties are, however, much esteemed: the blue kinds were formerly more valued than at present; and the least valuable are those that have a grey or brownish tint. Black diamonds are much prized by collectors. By far the greater number of diamonds discovered are small, of bad colour, full of imperfections, and unfit for the ordinary purposes to which they are applied. These are usually reduced

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[1] A carat is equal to four jeweller's grains, seven grains of which are equal to six grains troy. To ascertain the value of wrought diamonds the weight must be doubled, about half being supposed to be lost in the working. This sum must be multiplied into itself, and the product by two. Thus to find the value of a diamond of twenty carats, $20 \times 2 = 40 \times 40 = 1600 \times 2 = 3{,}200$*l.*

to powder, and in that state are advantageously employed for cutting and polishing the more perfect kinds.

The principal use of the diamond is in jewellery. It is also used by lapidaries, for slitting hard stones, and for cutting and engraving upon other gems; by clock-makers in the finer kinds of clock-work; in the glass-trade for squaring large pieces or plates of glass, and among glaziers for cutting their glass.

One of the largest diamonds ever known (if it be such, and not a white topaz, as some people have imagined) is in the possession of the Queen of Portugal, and weighs 1,680 carats, or more than *eleven ounces*. It was found in Brazil, and sent to Lisbon in the year 1746. It is still uncut, and has been valued at 5,644,800*l*.

According to Tavernier, the French traveller, the diamond he saw in the possession of the Great Mogul, originally (that is as first obtained) weighed 900 carats, or 2769.3 grains. By cutting and polishing it was reduced in weight to 279.9 carats, or 861 grains. It is not ascertained what has become of this magnificent gem of late years: it was valued at more than 700,000*l*. sterling.

The Rajah of Mattan, in the island of Borneo, possesses a large diamond, shaped like an egg, with an indented hollow near the smaller end. It was found in that island about eighty years ago; is said to be of the finest water, and to weigh 367 carats, or more than two ounces and a quarter. Several years ago the governor of Batavia, desirous of purchasing this gem, sent a Mr. Stuvart to the Rajah, authorizing him to offer for it 150,000 dollars, two large brigs of war, with their guns and ammunition, together with a certain number of great guns, and a quantity of powder and shot. The Rajah, however, refused to deprive his family of so valuable an hereditary possession; for the Malays not only attach to it the miraculous power of curing all diseases by means of water in which it is dipped, but also believe that the fortune of the family is sustained by its continuing in their possession.

The sceptre of the Emperor of Russia is adorned with an oriental diamond about the size of a pigeon's egg, which weighs 195 carats. This diamond is said to have once been placed as the eye of an idol in Seringham, in the Carnatic. A grenadier, who had deserted from the French service in India, contrived to become one of the priests of the idol, in the hope of being able to steal this eye. He at length effected his purpose, and escaped with the diamond to Madras, where he sold it to the captain of a ship for a sum equal to 2,500*l*, of British money. It was afterwards transferred to a Jew for 18,000*l*. Coming into the hands of a Greek merchant, he offered it for sale at Amsterdam, in 1766; and the Russian Prince Orloff bought it for the Empress Catharine for about 90,000*l*. sterling, and an annuity of 4,000*l*. during the life of the person who sold it.

The *Pitt*, or *Regent diamond* (Fig. 15. 5), which lately was set in the handle of the sword of state of Buonaparte, and is now possessed by the king of France, is a brilliant, of the most beautiful kind, and weighs $136\frac{3}{4}$ carats, or $419\frac{1}{4}$ grains. It was brought from India by Thomas Pitt, Esq. governor of Fort George. It was valued in 1791 at half a million sterling. Mr. Pitt has himself stated respecting it, that in December 1701, whilst resident in Madras, several valuable stones, in a rough state, were brought to him for sale by an eminent diamond merchant. One of these, the diamond here spoken of, was so large that the merchant asked for it the sum of 85,000*l*. After much bargaining, Mr. Pitt purchased it for 20,400*l*. He afterwards sold it for 135,000*l*. to the Regent Duke of Orleans; and by him it was placed among the crown jewels of France.

The *Pigot diamond* weighs forty-seven and a half carats. This, which is an extremely fine stone, was disposed of by lottery, in 1800, for 22,000*l*.; and was in 1831 in the possession of Messrs. Rundell and Bridge, jewellers in London.

A large star, cross, and chain, worn on grand gala days by the Prince of Brazil, as sovereign of the different Portuguese orders of knighthood, are each ornamented with a great number of magnificent diamonds, set in gold. The centre diamond of the star is alone valued at 800,000*l*.

When the diamond is rubbed it will attract bits of straw, feathers, hairs, and other small objects; and if exposed to the rays of the sun, and immediately taken into a dark place, some diamonds are recorded to appear phosphorescent.

ZIRCON FAMILY.

51. *JARGON is a gem usually of a smoky yellow or brownish colour, sometimes grey, green and white, and generally semitransparent: if placed upon any object, it exhibits of it a very distinct double image.*

The primitive form of its crystal is an octohedron, but it is frequently crystallized in right-angled prisms, terminated by four-sided pyramids. Its fracture is conchoidal.

In hardness this stone does not much exceed that of the emerald: it is brittle and easily broken. The greyish-white and yellowish-white varieties of jargon are valuable chiefly on account of their resemblance to the diamond. The brightest are those possessed of a red tint. The darker coloured varieties can be deprived of their colour by heat; and in this state, though in lustre they are infinitely inferior to them, they are sometimes substituted for diamonds. Jargons are now seldom used except for the jewelling of watches and time-pieces. About a century ago they were much used in mourning ornaments, for which the dark tone of their colour, and their almost adamantine lustre, were supposed to be peculiarly appropriate. It is capable of being formed into a transparent vitrified substance by being heated with borax.

Jargon is principally brought from the island of Ceylon; where it is found in the sand of rivers; but it is occasionally found in France and Spain, and in granite rocks near Cuffel, in Dumfriesshire, Scotland. In the United States and Carinthia, &c. in gneiss—and at Expailly in Auvergne in the sand of the river.

52. *The* Hyacinth, *or* Jacinth, *is a dark orange-red variety of jargon.* It is also chiefly imported from Ceylon, where it is generally found in the sand of rivers, in irregularly round pieces, but seldom of large size without flaws.

This stone is indebted for its name to a supposed resemblance in colour to that flower which, according to the Pagan mythology, Apollo raised from the blood of his favourite youth, Hyacinthus.

When bright, and free from flaws, the hyacinth is a superb ring stone; but it is not of usual occurrence in modern jewellery.

RUBY FAMILY.

53. *The ORIENTAL SAPPHIRE is a gem of a blue colour, the shades of which vary from a full and deep tint to a nearly colourless appearance, and sometimes it is party-coloured.*

It is found crystallized in six-sided pyramids, much lengthened and joined base to base; and also in rounded or pebble-shaped fragments. It has a foliated texture, is extremely hard, and about four times as heavy as water.

We are chiefly indebted for the sapphire to the East Indies and the Island of Ceylon, where it is found amongst the sand of the rivers. When brought into Europe it is cut by means of diamond powder, and polished with emery. It is now usually set with a foil of its own colour; but it was formerly the practice, instead of foil, to place under this stone the blue part of a peacock's feather.

In hardness the sapphire ranks next to the ruby (54); and in value it is about equal to the emerald (67). A good sapphire of ten carats' weight is worth about fifty guineas. In the Museum of Natural History at Paris there is a sapphire which weighs upwards of sixty-six carats: it was placed there from the wardrobe of the crown.

We are informed by M. Hauy that sapphires are found in Bohemia and France, particularly in one part of the Ville du Puy, among the sand of a rivulet near Expailly. In the summer-time, when the rivulet is nearly dry, they are collected by persons, each of whom is furnished with a small tray and a linen bag. Wherever there are small depressions in which the water has been stationary, these persons enter them, and fill their trays with the sand. This they wash in water in such manner that the lighter particles are carried away; whilst the heavier ones of gravel, sapphire, and other articles, remain at the bottom.

Some sapphires exhibit a kind of opalescence, or whitish floating light, in their interior. Sapphires lose all their colour in the fire; and, after having been subjected to heat, they are so hard and transparent as sometimes to be sold for diamonds.

The opaque, grey brown, or red mineral called *Corundrum*, is opaque, and destitute of those characters fitting it for a place among the precious stones—its mineralogical characters are identical with the oriental sapphire, and by most authors from that circumstance is considered of that species.

54. *ORIENTAL RUBY, is a precious stone of an intense and bright red colour, occasionally varied with blue, and sometimes party-coloured.*

In the general form of its crystals it much resembles the sapphire (53).

The ruby is imported into this country from the East Indies, though seldom in a rough state, as the stones are almost always first cut by the Indians for the purpose of ascertaining their value. They are said to be found in the sand of certain streams near the town of Syrian, the capital of Pegu; and with sapphires, in the sand of rivers in Ceylon. But they are so seldom seen of large size, that a ruby above thirty-one carats' weight, of perfect colour, and without flaws, is even more estimable than a diamond of equal weight. The ruby is usually set with a foil; but if peculiarly fine it is sometimes set without bottom, that the stone may be seen through.

Tavernier, the eastern traveller, states, that in the throne of the Great Mogul he saw 108 rubies, which, on an average, weighed from 100 to 200 carats each. Among the jewels of the King of Candy, that were sold by auction in London, on the 13th of June, 1820, was a ruby which measured two inches in length, and one inch in breadth. It was, however, interesting only as a specimen for a cabinet, for it had in various directions a great number of small hair-like tubes running through it.

The hardness of this stone is such, that the ancients do not appear to have possessed the art of cutting it; and in the improvements which of late have been made by Mr. Earnshaw in the construction of time-keepers, no stones have been found sufficiently hard for jewelling the holes except the ruby and the diamond.

There are several modes of counterfeiting rubies; and some persons have succeeded so well in imitating these stones, that even the most able lapidaries, till they try the hardness, may be deceived.

55. *The* ORIENTAL AMETHYST *is an extremely rare gem, usually of a purple colour, apparently formed by a union of*

the colouring matter of the sapphire and the ruby.—This stone, if heated, loses its colour, and becomes transparent. After this process its brilliancy is such, that it is scarcely distinguishable from the diamond; and in jewellers' work it is occasionally substituted for that gem. The common amethyst (79), or that which is chiefly seen, is nothing more than a violet-coloured rock crystal (78).

56. *The* ORIENTAL TOPAZ *and* EMERALD *are each varieties of the oriental ruby, the former straw-coloured, and the latter green.*—This kind of emerald is imported from Pegu, and some other parts of the East Indies, and is an extremely rare gem.

57. ***The SPINELL or BALASS RUBY is less hard than the oriental ruby* (54) *; in the primitive form of their crystals being regular octohedrons, also dodecahedrons with rhomboidal faces; and in not being much more than three times and a half heavier than water.***

Its colour varies considerably, sometimes it is blue, green, yellow, black, and brown, and at other times it is found nearly white. The most common colour is red. Its chemical composition is alumina, with traces of oxide of iron, magnesia, and silica.

Although this kind of ruby is inferior both in lustre and colour to the oriental ruby, yet when it exceeds a certain size it is much esteemed. A spinell that weighs more than four carats is valued at half as much as a diamond of the same weight, and is not unfrequently imposed upon ignorant purchasers for the oriental species. It is easily wrought, takes a high polish, and is certainly a beautiful gem. Being too expensive for necklaces, it is usually set in rings and brooches, surrounded by brilliants.

The spinell ruby is found amongst sand, in one of the rivers of Ceylon, which flows from the high mountains, towards the middle of the island. It is also found in Brazil; and in Hungary, Bohemia, and Silesia. In Hungary and South America, it is found occasionally in primitive limestone.

The Balass ruby is so named from Balacchan, the Indian appellation of Pegu, from which country it is chiefly imported.

58. *EMERY is a very hard opaque mineral, of a blackish or blueish grey colour, which is chiefly found in shapeless masses, and mixed with other minerals. It is about four times as heavy as water. It is chemically composed of alumina, silica, and oxide of iron.*

The best emery is brought from the Levant, and chiefly from Naxos, and other islands of the Grecian Archipelago, where it occurs abundantly, in large loose masses, at the foot of primitive mountains. It is also found in some parts of Spain ; and is obtained from a few of the iron mines in our own country.

In hardness it is nearly equal to adamantine spar, and this property has rendered it an object of great request in various arts. It is employed by lapidaries in the cutting and polishing of precious stones ; by opticians, in smoothing the surface of the finer kinds of glass, preparatory to their being polished ; by cutlers, and other manufacturers of iron and steel instruments ; by masons, in the polishing of marble ; and, in their respective businesses, by locksmiths, glaziers, and numerous other artizans.

For all these purposes it is pulverized in large iron mortars, or in steel mills ; and is afterwards separated, according to the several degrees of fineness that are required, by washing it in water, and suffering the grosser particles to deposit themselves. By this operation the finer particles, which remain suspended in the water, and which are obtained by decanting the water off, and suffering it to stand for a considerable time, are separated. The particles first deposited are again ground, and again agitated in the water, to separate the finest. By these successive operations the emery is reduced to a powder so fine, that when rubbed between the fingers it communicates no sensation whatever of grittiness. In general those particles only of the emery which remain suspended in the water, after it has stood about half an hour, are used to polish metals.

59. *ADAMANTINE SPAR, or IMPERFECT CORUNDUM, is a very hard and nearly opaque stone, which varies much in colour, but is chiefly grey, with a greenish, brown or bluish tint.*

It is usually found in the form of six-sided prisms, but it some-

times occurs in shapeless masses, has a foliated texture, and is about four times as heavy as water.

The name adamantine spar was given, by the British lapidaries, to this substance, from its hardness being nearly equal to that of the diamond. It was originally discovered among the granite rocks of China; but it has since been found, and in greater purity, in Bengal and Ceylon.

In a powdered state this substance has long been used by the artists of India and China for the cutting and polishing of precious stones, and even of the diamond; but though it will in some degree operate upon that gem, it is not sufficiently hard to bring out the peculiar beauty of it in a degree at all comparable to that which is effected by the European lapidaries with diamond powder. The Chinese also use adamantine spar for polishing steel, and in the composition of the finer kinds of porcelain or earthenware. For the cutting of seals and precious stones European workmen consider it preferable to emery; but for minute engraving it is much inferior to diamond powder.

60. *CHRYSOBERYL is a gem of yellowish or brownish or asparagus green colour, harder than quartz* (76), *and sometimes transparent; but often only semitransparent, in which case it exhibits a bluish light, floating in the interior of the stone.*

It is usually found in rounded pieces, but is sometimes crystallized in compressed six-sided prisms, and in double six-sided pyramids, the primary form being a right rectangular prism. It is principally composed of alumina and glucina.

So little is this gem in request in Europe, that it is seldom to be found in the possession of jewellers; but in Brazil it is considered inferior only to the diamond. It is usually procured from South America, yet it occurs in Saxony; and, with topazes, amongst sand in the rivers of Ceylon. It is also found in Siberia, and in granite at Hoddam in Connecticut.

Such is the hardness of the chrysoberyl, that when properly polished, which is a difficult operation, it is capable of receiving a lustre nearly equal to that of the diamond. We are informed that, a few years ago, a considerable number of these gems were imported into this country from Brazil, but that the greater part of them were entirely spoiled by inferior workmen, and that the rest were so ill-cut that they remained unnoticed, and without value. The smaller stones are said to appear to most advantage in circular ear-drops; and the larger specimens form necklaces and ring stones of great beauty.

The variety which exhibits an opalescent appearance, or presents a bluish light, undulating, as it were, in the interior of the stone, and changing its situation according to the position of the observer, is chiefly valuable as an article of curiosity: the transparent kind is always preferred by the jeweller.

SCHORL FAMILY.

61. *The TOPAZ is a gem usually of a wine-yellow colour, but sometimes orange, pink, blue, and even colourless, like rock crystal; of a lamellar or foliated structure, harder than quartz, but not so hard as ruby.*

It varies considerably in its crystallization, sometimes occurring in masses, the basis of the crystal being a right rhombic prism, is three and a half times heavier than water; and when placed upon any object, shows a double image of it. It is a fluo-silicate of alumina.

The name of topaz is derived from an island in the Red Sea, where the ancients found a stone, but very different from ours, which they denominated topaz. The best topazes are of a deep colour, and are imported from Brazil; the most brilliant ones are supposed to be those of Saxony, but the latter are generally of a very pale colour. They are found only in primary rocks, generally granite. This species of gem is found in many parts of Europe, but defective in transparency, and sometimes even opaque. It occurs in large crystals, and rolled masses, in an alluvial soil (269), in the upper parts of Aberdeenshire, Scotland; and in veins, along with tin-stone, at St. Ann's, in Cornwall. Topazes more than a pound in weight have been found in Scotland. They are likewise found at Mucla, in Asia Minor, at Botany Bay, and in Germany. The Uralian and Altai mountains, and Kamtschatka yield the finest crystals.

Mr. Mawe speaks of a topaz mine at Capon, near Villa Rica, in Brazil. In two breaks or slips of the rocks, he says, there were little soft places, where the negroes found the topazes by scraping in them with pieces of iron. He himself observed at least a cart-load of inferior topazes, any number of which he might have taken away; but all that he saw were defective, and full of flaws.

These stones vary much in size; some, particularly those of Siberia, being extremely small, and others being upwards of an inch in thickness. In the Collection of Natural History at Paris there is a Brazilian topaz which weighs four ounces and a quarter. These stones are not sufficiently scarce to be in general much valued by the jeweller or lapidary. The deep yellow variety is preferred to the pale sort, although the latter is often superior to it both in size and hardness.

Figures have sometimes been engraved on the topaz; and these, when well executed, are of great value. In the National Museum at Paris there is a superb Indian Bacchus engraven on a topaz. The cabinet of the Emperor of Russia contains several fine topazes of this description.

Some of the coarse kinds of topaz are broken down, pounded, and used instead of emery for the cutting of hard minerals; and powdered topaz was formerly kept in apothecaries' shops, and sold as an antidote against madness.

When heated with borax it slowly becomes melted into a vitreous mass, the powder giving a green colour to the tincture of violets. (*Thomson.*)

It is a somewhat singular circumstance, that if the Saxon topaz be gradually exposed to a strong heat in a crucible, it will become white; and, on the contrary, that Brazilian topazes by the same process become red or pink. By exposure to a still stronger heat, the Brazilian topaz changes its colour to a violet-blue.

Jewellers usually divide topazes into the following kinds:

62. Brazilian and Saxon, already mentioned.

63. Bohemian.—These are found chiefly in the tin mines of Bohemia, are of a small size, deficient in transparency, have only grey or muddy-white colours, and are of little value.

64. Blue Topaz.—This is a large Brazilian gem, which varies in size from one or two carats to two or three ounces. A fine blue topaz, without flaw, and which weighed an ounce and a quarter, was sold for 200 guineas. It is sometimes difficult to distinguish blue topaz from an aqua-marina (68).

65. Pink Topaz.—Some beautiful rose-coloured varieties of topaz have been brought from Asia Minor, and others are found in South America; but the pink topazes in the jewellers' shops are chiefly stones of the yellow Brazilian kind, which have had their colour changed by heat.

66. The White, or Nova Mina Topaz, is a perfectly colourless and transparent variety. It generally occurs of small size, and is in considerable estimation in Brazil for ear-rings, or for being set round yellow topazes. Small stones of this description have recently been found at St. Michael's Mount, in Cornwall.

There is imported from Brazil a yellow kind of crystal (83), which is so similar in its appearance to the yellow topaz as sometimes to be imposed upon purchasers for that stone.

Dr. Thomson records a variety called *Pyrophysalite*, which occurs at Finbo, three quarters of a Swedish mile from Fahlun, embedded in gneiss. It has a white colour with a light shade of green. It is found in very large crystals, and is translucent at the edges; in one direction is foliated, and splendid; the cross fracture is uneven and glimmering: in its other properties it agrees with topaz.

67. ***The EMERALD is a well-known gem, of a pure green colour, and somewhat harder than quartz.***

Its natural form is a short six-sided prism; but it is sometimes found massive, and rounded like a pebble. It is composed of silica, alumina, and glucina.

By the ancients the emerald was a gem much in request, and particularly for engraving upon. They denominated it *smaragdus*, and are said to have procured it from Ethiopia and Egypt; but besides the true emerald, Pliny, under this title, includes green jasper (96), malachite (231), fluor spar (194), and some other green minerals. The pillars of emerald in the temple of Hercules at Tyre, mentioned by Herodotus, and the large emeralds described by Pliny as having been cut into columns and statues, cannot be referred to the true emerald.

The deepest coloured and most valuable emeralds that we are acquainted with are brought from Peru. They are found in clefts and veins of granite, and other primitive rocks; sometimes grouped with the crystals of quartz (76), felspar (110), and mica (123); and, not unfrequently, loose in the sand of rivers as in Brazil. The most ancient emerald mine is that of Manta, in Peru, but it has been some time exhausted; and most of the emeralds that are now brought to Europe are obtained from a mine situated in the valley of Tunca, between the mountains of New Grenada and Popayan, traversing according to Humboldt hornblende-slate, clay-slate, and granite. They have likewise been found in Great Britain. Mr. R. A. Barclay, in the Annals of Philosophy, records an instance of having met with them crystallized in a dark grey quartz vein traversing the granite and slate at St. Michael's Mount, Cornwall, others have been found in Scotland, Ireland, Germany, North America, and Sweden.

The emerald is one of the softest of the precious stones; and is almost exclusively indebted for its value to its charming colour. The brilliant purple of the ruby, the golden yellow of the topaz, the celestial blue of the sapphire, are all pleasing tints; but the green of the emerald is so lovely, that the eye, after glancing over all the others, finds delight in resting upon this. In value it is rated next to the ruby; and when of good colour, is set without foil and upon a black ground, like a brilliant diamond. Emeralds of inferior lustre are generally set upon a green gold foil. These gems appear to greatest advantage when table cut (Fig. p. 37), and surrounded by brilliants, the lustre of which forms an agreeable contrast with the quiet hue of the emerald. They are sometimes formed into pear-shaped ear-drops; but the most valuable stones are generally set in rings. A favourite mode of setting emeralds among the opulent inhabitants of South America, is to make them up into clusters of artificial flowers on gold stems.

The largest emerald that has been mentioned is one said to have been possessed by the inhabitants of the valley of Manta, in Peru, at the time when the Spaniards first arrived there. It is recorded to have been as big as an ostrich's egg, and to have been worshipped by the Peruvians, under the name of the Goddess, or Mother, of Emeralds. They brought smaller ones as offerings to it, which the priests distinguished by the appellation of daughters. Many fine emeralds are stated to have formerly been bequeathed to different monasteries on the Continent; but most of them are said to have been sold by the monks, and to have had their place supplied by coloured glass imitations. These stones are sometimes seen of large size, even a foot in length, but are seldom entirely free from flaws.

The emerald if heated to a certain degree assumes a blue colour; but it recovers its proper tint when cold. When the heat is carried much beyond this, it melts into an opaque coloured mass, especially if borax be added.

The precious stone called oriental emerald (56) is a green and very scarce variety of the oriental ruby.

68. *The BERYL, or AQUA MARINA, is a light or mountain green variety of the emerald, sometimes straw-coloured, bluish, yellow, or even white. Like the emerald it is composed of Silica, Alumina and Glucina.*

These stones are of such frequent occurrence, even in large pieces perfectly clear and free from flaws, they are in general so soft, and have so little the brilliancy of other gems, that they are usually considered of inferior value. The most beautiful kinds are brought from Dauria, on the frontiers of China, from Siberia, and from Brazil. They are also found in Saxony and the South of France, and are very common at Baltimore, in North America. Specimens of aqua marina have been obtained from the upper parts of Aberdeenshire, Scotland, where they sometimes occur in alluvial soil, along with rock crystal and topaz. These stones have also been found, embedded in granite, near Lough Bray, and Cronebane, in the county of Wicklow, Ireland; and also in mountain rock, in some parts of Devonshire.

They are cut by means of emery (58), and polished with tripoli (119). The darkest green specimens are set upon a somewhat steel-coloured foil; and the pale ones are either placed, like the diamond, on a black ground, or upon a silvery foil. Aqua marina is usually made into necklaces; but it is likewise employed for brooches, and not unfrequently for steel stones and intaglios. The larger ones are in much esteem among the Turks for the handles of stilettos.

69. *The TOURMALINE is a stone generally of a smoky blackish colour: sometimes, however, it is green, red, blue, or brown; and, when not very thick, it is transparent; but when black it is opaque.*

It is occasionally found in shapeless masses, but more frequently crystallized in three, six, eight, ten, or twelve-sided prisms, variously truncated or terminated; the primary form being an obtuse rhomboid, and its weight is somewhat more than three times that of water. The principal constituents of this mineral are Alumina and Silica.

This stone was first made known in Europe about the beginning of the last century, by the Dutch merchants, who brought it from the island of Ceylon, where it is principally found. When strongly heated it becomes electric; the summit of the crystal presenting the greatest number of planes becoming positive, and the other extremity illustrates the negative phenomena: such is stated on the authority of Haüy. An early writer, by whom it is mentioned, says, that " it has the property not only of attracting ashes from the warm or burning coals, but that it also repels them again, which is very amusing: for as soon as a small quantity of ashes leap upon it, and appear as if endeavouring to writhe themselves by force into the stone, they in a little time spring from it again, as if about to make a new attempt. It was on this account that the Dutch called it the ashes' drawer."

Since the above period, tourmaline has been found in Brazil; and in Norway, Germany, France, and several other parts of Europe. It generally occurs embedded in different parts of mountain rock, generally granite or quartz; it must not however be considered confined to these two minerals; it is found in connection with some others, as talc, slate, dolomite, &c.; and, in these, is rather confined to single beds of strata, than disseminated through the whole mass of the mountain A piece of tourmaline, of cylindrical form, and brownish grey colour, was some time ago discovered in the neighbourhood of Kitt-hill, near Callington, Cornwall. Black tourmaline, both in large and small crystals, is found in granite rock, in the vicinity of the Logan, or rocking stones, near Treryn, in the same county.

When laid on a table, the tourmaline appears a dark and opaque stone; but when held against the light, it has generally a pale brownish hue. It is sometimes cut, polished, and worn as a gem; but, on account of the muddiness of its colours, it is not in general much esteemed. Those persons who wear tourmalines set in rings consider them more as objects of curiosity than of elegance: they show them as small electrical instruments, which, after being heated a little while by the fire, will attract and repel light bodies.

In the superb collection of minerals of the British Museum, there is a magnificent specimen of *red tourmaline*, or *rubellite*, which has been valued at 1,000*l.* sterling. It was presented by the King of Ava to the late Colonel Symes, when on an embassy to that country, and was afterwards deposited by the latter in Mr. Greville's collection; with that collection it became the property of the British Museum.

It is capable of being fused with borax, and forms a vitrified mass.

GARNET FAMILY.

70. *The PRECIOUS, or NOBLE GARNET, is a gem of a crimson colour, which, when crystallized, has the form of a twelve-sided solid, the primary form being the rhomboidal dodecahedron. It is sufficiently hard to scratch quartz, is about four times as heavy as water, and fuses before the blow-pipe into a dark globule. It is composed of three different minerals, each in combination with silicic acid, viz. Alumina, Iron, and Lime.*

This stone is found abundantly in many mountains (particularly of primitive rock), in different parts of the world. But garnets of the hardest and best quality are brought from Bohemia, where there are regular mines of them; and a great number of persons are there employed in collecting, cutting, and boring them. The boring is performed by an instrument having a diamond at its extremity, which is rapidly turned by a bow. The work is so expeditiously performed, that an expert artist can bore 150 garnets, or he can cut and polish thirty, in a day. In Suabia there are two towns in which upwards of 140 persons are employed in these operations.

In general garnets are stones of inferior value. When compared with the ruby, those even of finest quality have a very sombre appearance. The kinds most esteemed are such as have a clear and intense red colour, or a rich violet or purplish tinge. The best garnets are cut in the manner of other precious stones, and are usually set upon a foil of the same colour. To heighten the colour and transparency of certain garnets, jewellers either form them into what are called doublets, by attaching to the lower part of the stone a thin plate of silver, or they hollow them underneath.

Crystals of garnet sometimes occur three or four inches in diameter. These are cut into small vases; which, if of good colour, and free from defects, are highly valued. Many fine engravings have been executed on garnet. One of the most beautiful that is known is a figure of the dog Sirius, formerly in the possession of Lord Duncannon.

The coarser kinds of garnet are used as emery for the polishing of other minerals; and are thus prepared. They are made red-hot, then quenched in water, reduced to powder in an iron mortar, and lastly diffused through water, poured into other vessels, and allowed to settle, in order to obtain a uniform powder. This powder is known to artists by the name of *red emery*.

It has been conjectured that our garnet is the same kind of stone which, on account of its colour, the ancients denominated *carbuncle*.

71. Common Garnet.—A very inferior variety of garnet, of a brown or greenish brown colour, is found in our own country, and particularly amongst rocks near Huntley, in Aberdeenshire, Scotland. These garnets, however, are, in general, so soft as to be of little value to the lapidary; and consequently are seldom cut or polished for ornamental purposes. But being easily fused, and abounding in iron,

they are occasionally employed as a flux in the smelting of rich iron ores: and as an addition to poor ones.

72. SYRIAN GARNETS *are distinguished by their violet or purplish tinge.* Some writers state that they have their name from the word Soranus, which signifies a red stone; and others from Sirian, a town in Pegu, where they are said to be found in great beauty.

73. PYROP GARNETS *are of a dark blood-red colour,* which, when the stones are held between the eye and the light, falls strongly into yellow: they are chiefly brought from Bohemia: are employed in almost every kind of jewellery, and generally set with a gold foil. At Waldkirch, in Suabia, there are many mills for the cutting and polishing of pyrop garnets: and numbers are occupied in manufacturing these stones.

74. VESUVIAN *is a liver-brown kind of garnet,* that was originally found among rocks ejected from Mount Vesuvius; and in the vicinity of which mountain it still occurs in considerable abundance. At Naples it is cut into stones for rings and other ornaments. Vesuvian has of late years been found in other parts of Europe; and even at Kilranelagh, and Donegal, in Ireland.

75. *CINNAMON STONE, or ESSONITE, is a mineral substance composed of the same materials as garnet, and in the same proportions. Its colour is of an orange yellow, with a tinge of red. It occurs only in granular masses, and is mostly translucent. It is about three and a half times heavier than water.*

This mineral is for the most part confined to primary rocks, occurring usually in gneiss. Ceylon and the United States are said to be its localities. It is occasionally cut as a precious stone; and when of good colour, and free from flaws, is of considerable value.

QUARTZ FAMILY.

76. *COMMON QUARTZ is a hard and foliated substance, usually of a white or grey colour, and more or less transparent. When pure it is chiefly silica.*

It is generally found in shapeless masses, which are nearly twice and a half as heavy as water, and the fracture of which is glassy.

When crystallized, it most commonly has the form of a six-sided prism, terminated by a pyramid of six sides; the primary form being a rhombohedron.

This kind of stone forms a constituent part of many mountains, and is very common in our own, as well as in most other countries, entering into sandstone, granite, gneiss, and mica slate. In granite it may be seen in a crystallized state, especially in that from Tyrol, Piedmont, and Savoy. The islands of Ceylon and Madagascar likewise afford it. It is sufficiently hard to scratch iron and steel; and it has the property, after having been several times successively made red-hot, and dipped into water, of communicating to that fluid a certain degree of acidity. It forms a transparent glass when fused with soda.

Quartz is employed, in place of sand, for making the finer kinds of glass; and also in the manufacture of porcelain. For the latter purpose great quantities are collected from the mountains of Wales, ground into powder, and in that state shipped to Liverpool, and other parts. After having been burnt and reduced to powder, it is sometimes mixed with clay, and formed into bricks for the construction of glass furnaces: these are capable of resisting the intense heat which is requisite in the fusion of glass. The most transparent specimens are from Brazil.

77. Burrstone *is a vesicular and corroded variety of quartz, which forms a most excellent and valuable kind of millstone.* It is chiefly found in France; but is so much esteemed by the English millers, that the Society of Arts, in London, for many successive years, offered a considerable reward for its discovery in Great Britain. At length a vein of burrstone was discovered in the Moel y Golfa hills, North Wales, by a Mr. Evans, who in consequence received a premium from the Society. About the same time another vein was opened near Conway; and the same Society, in 1800, gave a premium of 100*l.* to the widow and orphan children of the discoverer. Both these quarries were sufficiently convenient for water carriage; yet the demand for the Cambrian burr did not answer the expectation, and millstones of French production were still preferred to them.

The mode of splitting these stones, as it is practised in some parts of France, is singular, and affords a proof of the extraordinary power of capillary attraction. The blocks are first cut into the form of cylinders, sometimes many feet in height. To split these horizontally into millstones, circular indentations are made round them, at proper distances, according to the thickness that is to be given to the stones; wedges of willow, that have been dried in an oven, are then driven into the indentations with a mallet. When these have been sunk to a proper depth, they are moistened with water; and, after a few hours, the several stones that have been marked out are found to be perfectly separated.

78. *ROCK CRYSTAL is an extremely beautiful kind of quartz, sometimes perfectly transparent, and sometimes shaded with grey, yellow, green, brown, or red. It occurs in the form of crystals with six sides, each terminated by a six-sided prism. It is nearly pure silica.*

The name of this substance was considered by the ancients to signify ice, or water crystallized; and they imagined that crystal was produced from a congelation of water.

Its uses are numerous. It is cut ino vases, lustres, and snuff-boxes; and many kinds of toys of extremely beautiful appearance are made of it. When pure and perfectly transparent it is in much request by opticians, who make of it those glasses for spectacles which are called *pebbles*, and who use it for various kinds of optical instruments. The best crystal is imported from Brazil and Madagascar, in blocks, not unfrequently from fifty to a hundred pounds weight.

This stone is wrought in the different shapes that are required, by sawing, splitting, and grinding. The sawing is effected by an extended copper wire fixed to a bow: the wire is coated with a mixture of oil and emery, and is drawn backward and forward until the operation is performed. But as this process is a tedious one, particularly when the mass is large, a more expeditious, although less certain, method is sometimes adopted. The crystal is heated red hot, and a wet cord is drawn across, in the direction that the workman intends to split it. By the rapid cooling thus effected, in the direction of the cord, the stone easily splits by a single blow of the hammer, and generally in the direction required. The grinding is performed by means of emery: and the polishing effected by tin ashes and tripoli.

The ancients held vases that were made of this stone in great estimation, particularly when they were of large size. Of two cups which the tyrant Nero broke into pieces in a fit of despair, when informed of the revolt that caused his destruction, one was estimated to be worth more than 600*l.* of our money. The most valuable kind of crystal that was known to the ancients was obtained from the island of Cyprus; but it was often faulty in particular parts, having flaws, cracks, and blemishes. When the crystal was used for the engraving of intaglios and cameos, the artist could sometimes conceal these defects amongst the strokes of his work; but when it was to be formed into cups or vases, this could not be done, and for the latter purpose the purest pieces only could be employed.

In the counties of Cornwall and Derby, in the neighbourhood of Bristol, and amongst the mountains of North Wales, small crystals of this kind are frequently found: these are respectively called *Cornish*, *Buxton*, *Bristol*, and *Snowdon* diamonds. We are informed that the crevices of some parts of Mont Blanc and the Alps contain rock crystal in such abundance as to be perfectly bristled with it.

Some crystals contain in their substance drops of water, or other kind of fluid; and these, as curiosities, are usually sold at a rate considerably higher than others. There are in the British Museum specimens of crystal which enclose many kinds of foreign substances, such as ironstone, needle antimony, and asbestos (136).

Various means have been devised for communicating colours to rock crystal. If it be heated and plunged into a solution of indigo, or copper, it acquires a blue colour; or if into a decoction of cochineal, a red colour. A clove-brown colour may be given by exposing it to the vapour of burning wood. Artists sometimes communicate beautiful colours to rock crystals, by forming them into what are called *doublets*. Two modes of doing this are adopted. In one, a stone that is brilliant-cut at the top is hollowed underneath, filled with the colour that the stone is intended to exhibit, and then closed at the bottom by a plate of glass. If this kind of doublet be dexterously executed, the deception is not easily discovered ; for the whole mass will appear of an uniform tint. The second kind of doublet is formed by cementing a coloured plate of glass on the base of a rose or brilliant-cut crystal: by this the whole stone acquires the colour of the plate.

There are found in nature, many coloured kinds of crystal. These are often confounded with precious stones; and, as such, are made into female ornaments of different kinds. The following are the principal of them.

79. COMMON AMETHYST. — *This is a violet-coloured crystal*, which acquires considerable brilliancy in polishing, and is sometimes of sufficient size to be formed into columns more than a foot in height, and several inches in diameter. When the colour is good, and uniformly diffused, amethysts are cut into necklaces, bracelets, ear-rings, and seals ; and when less pure, they are manufactured into snuff-boxes. They are valued in proportion to the depth of their colour, and to their perfect transparency. The most favourite form in which they are made up is in necklaces ; and as it is not easy to find a number of perfect stones with precisely the same tint of colour, necklaces of this description are very valuable. The finest that is known was in the possession of her late Majesty. When the colour is not uniformly diffused, jewellers sometimes expose amethysts, for a little while, in a mixture of sand and iron-filings, to a moderate heat; and by this process, their appearance is rendered more uniform.

The amethyst being almost the only coloured stone that can be worn with mourning, it derives, from this circumstance, a considerable addition of value.

This species of gem was well known to the ancient Greeks and Romans, and was held by them in great esteem. Its name is derived from the Greek language, and implies a power of preventing intoxication; which (originating no doubt in the resemblance of its colour to that of wine, and the absurd doctrine of sympathies) it was believed by the ancients to possess. They ascribed to it many other virtues, equally surprising and equally absurd; particularly that the wearing of it would expel melancholy, procure the confidence and friendship of princes, render people happy, and even dispel storms of wind and hail. The ancients frequently engraved upon amethyst; and their favourite subject was the representation of Bacchus and his followers.

The most valuable amethysts are imported into Europe from India and Ceylon. These, although they are with truth denominated oriental, must be carefully distinguished from the true oriental amethyst (55), which is a much more valuable gem. The amethysts next in esteem are found in Brazil, and are procured in the mining districts of that country. Siberia, and various countries in Europe, especially Germany and Spain, also furnish very beautiful amethysts; and inferior stones of this description are even found in the mountainous districts of some parts both of Scotland and Ireland.

80. False Ruby *is a crystal of a red colour*, and found in Bohemia, Silesia, and Barbary.

81. False, *or* Water Sapphire *is a blue crystal*, which does not differ much in appearance from the true sapphire, but is considerably less hard. This kind is found in Bohemia, Silesia, and some parts of Switzerland, but it is not so valuable as the last.

82. False Emerald *is a green variety of crystal*, the scarcest and most valuable of all the coloured kinds. It is chiefly found in Saxony and Dauphiny.

83. Yellow, *or* Topazine Crystal *is a stone of a wine-yellow colour*. It is found in Brazil and Bohemia, but has no other alliance with the true topaz than its colour.

84. Cairn Gorum Crystals are obtained in various parts of Scotland, but particularly from a mountain of that name in the county of Aberdeen. *They are usually of a smoky yellow or brown colour*, and were in 1831 so much in request for ornamental articles of dress, that several lapidaries have been induced to settle in Aberdeen, and who were constantly employed in cutting them for seals, rings, necklaces, brooches, and other trinkets. When these crystals are of a deep and good colour, they are nearly as estimable as topazes; and, if clear and large, they are sold at a high rate. The price of inferior seal-stones varies from

ten shillings to three or four pounds each; but those of superior beauty will produce from five to ten guineas. Such specimens as have a pure and full yellow colour are often sold for topazes. When they are muddy, the lapidaries have the art of entirely dissipating the colour, and giving them a transparent lustre. This is done by means of heat, which will dissipate the colour of every species of crystal. It is sometimes termed *Indian topaz.*

85. *AVANTURINE is a quartz, generally of a reddish colour, sprinkled with yellowish shining points of mica* (123), *which are dispersed through its whole substance.*

A French artist, some years ago, having by accident, or "par aventure," suffered a quantity of brass filings to fall into a vessel of melted glass, afterwards found that it was admirably calculated for vases and different kinds of ornamental work. Hence he denominated it avanturine, a name which mineralogists have since applied to those natural objects of which this production of art was an apparent imitation.

Avanturine is found in some of the countries bordering upon the White Sea, in Spain, and some parts of France. In the late Leverian Museum there was a piece which weighed nearly five pounds, and was unique both for beauty and magnitude. It was discovered in 1788, amongst the ruins of the triumphal arch of Julius Cæsar in the valley of Suse, in Piedmont; and was purchased of the person who found it for 200 guineas. Avanturine is cut into various ornamental articles, which are sometimes sold at a very high price.

Imitations of it are very common, and are formed by the simple operation of throwing brass or copper filings into coloured glass in a state of fusion.

86. *CAT'S-EYE is a stone of a brownish grey colour, tinged with green, yellow, white, or red; semi-transparent, and reflecting from its interior a splendid white line or speck, which varies according to the direction in which the stone is held to the light.*

It is found in pieces that are rounded, massive, or blunt-edged.

These stones are considered by some writers as varieties of quartz (76), and by others as a kind of opal (102).

They are sometimes found in Hanover, but are chiefly brought from the island of Ceylon. It is usual to cut them before they are exported, and generally in a convex and oblong form, without facets, and in such manner as to bring the streak which intersects them into the centre. Among the king of Candy's jewels, which were sold by auction in London, in June 1820, was a cat's-eye of extraordinary magnitude and beauty. It was two inches in diameter, of a dark colour, and nearly hemispherical. This stone was set in gold, will small rubies round it, and was sold for more than 400*l.*

Cat's-eyes are chiefly used for setting in rings. Their size seldom exceeds that of a hazel nut; but there was one in the cabinet of the Dukes of Tuscany, which was nearly an inch in diameter. Those that are the most highly esteemed are of an olive-green, or red colour.

87. *WOODSTONE is a very hard mineral substance, supposed to have been wood petrified with a siliceous mineral called hornstone.*

It is of various colours; and has not only the external appearance, but the internal organization of wood.

This extraordinary mineral is found embedded in sandy loam, in alluvial soil (269), and occurs in various parts both of Europe and Asia. It has been found in ferruginous sand, near Woburn, in Bedfordshire, and near Nutfield, in Surrey. Immense pieces of it are discovered in some places in the original shape of the trees; trunks, branches, and roots. In the year 1752 the whole under part of the trunk of a tree, with its branches and roots, was found in a state of woodstone, near Chemnitz, in Saxony; and in the Electoral Cabinet at Dresden, there is part of the trunk of a tree, from the same place, which measures five feet in length and as many in thickness.

Woodstone is in considerable request by lapidaries. It takes a good polish, and is made into beads for necklaces, and other female ornaments. In the East Indies it is generally called *Petrified Tamarind Tree.*

88. *COMMON SAND is a granulated kind of quartz; or consists of rounded grains of small size, which have a vitreous or glassy surface. It is either derived from the detritus formed by*

the attrition of pebbles or shingles against each other, agitated by the sea, or by similar agencies acting on sandstones, thereby reducing them to a minute state of division. The brown colour of sand is due to the presence of oxide of iron. A kind of sand is not unfrequently found composed of small particles of shell.

It is usually of a white or yellowish colour; but is sometimes blue, violet, or black.

In the torrid regions of Africa and Asia there are immense tracts of desert covered only with sand, so dry and light as to be moveable before the wind, and to be formed into vast hills and boundless plains. These are incessantly changing their place, and frequently overwhelm and destroy the travellers whose necessities require them to enter these dreary realms. Even in Morayshire Mr. Ritchie describes a tract of land of ten miles in extent ("The granary of Moray") to have been covered with sand, the sand hills constantly moving their situation.

Sand has numerous uses. When mixed in due proportion with lime, it forms that hard and valuable cement called mortar. Melted with soda (200) or potash (205) it is formed into glass; white sand being used for the finer kinds, and coarse and more impure sand for bottle glass. A very pure kind of sand which is found in Alum Bay, on the west side of the Isle of Wight, and on some parts of the coasts of Norfolk, as at Lynn, is in great request by glass-makers. Sand is also employed in the manufacture of earthenware; and its utility in various branches of domestic economy, but particularly for the scouring and cleaning of kitchen utensils, is well known. In agriculture sand is used by way of manure for all clayey soils; as it renders the soil more loose and open than it would otherwise be. The best sand for this purpose is that which is washed by rains from roads or hills, or that which is taken from the beds of rivers. When sand is carried in large quantities by the wind, and accumulates in a heap or mass in one or more situations, such heaps are termed *dunes;* it has been estimated that these dunes advance at the astonishing rate of sixty or seventy feet in twelve months, overwhelming forests, villages, and cultivated land to an almost incredible extent, as recorded by Cuvier in the department of the Landes. On the Eastern shores of the Bay of Biscay it is making great inroads. These *dunes* are occasionally found of a compact state: an instance of which occurs in the North Coast of Cornwall, where according to de la Beche "the matter thrown up is formed from comminuted sea shells, and the consolidation is principally effected."

Houses have been overwhelmed, and human remains entombed, where churchyards have existed. From the drift having taken place at different times, this recent calcareous sandstone is stratified with occasionally interposed vegetable remains.

Indurated dunes occur in various parts of the world; they have been noticed by Péron in New Holland; and the rock in which the human remains of Guadaloupe have been found would appear to be similar. These latter are discovered at the Port du Moule, in an indurated beach, composed of comminuted shells and corals. The specimen of rock, in which the fossil human skeleton is embedded in the British Museum, is formed of coral and small pieces of compact limestone, and in it Mr. King observed madrepores and shells. The specimen in the Jardin du Roi at Paris, according to Cuvier, contains species of shells at the present time existing in the neighbouring seas.

There is a kind of sand which is naturally mixed with clay, and has the name of *Founders' Sand*, from its being chiefly employed in the formation of moulds to cast metals in. At Neuilly, in France, there is a bed of perfectly transparent and crystalline sand. Each grain, when examined with a magnifying glass, is seen to consist of a perfect six-sided prism, terminated by two six-sided pyramids.

The uses of the different kinds of *sandstone* will be enumerated in the account of the rocks (267, 268).

89. *LYDIAN STONE or BASANITE is a kind of flinty slate, of a greyish or velvet-black colour, not quite so hard as flint, opaque, and about twice and a half as heavy as water.*

It is usually massive, and, internally, has a glimmering appearance. It is chiefly composed of silica.

This mineral occurs in beds in primitive clay-slate (257); and is found in Bohemia in Saxony, and also in the Pentland hills near Edinburgh. It was first noticed in Lydia, whence it derived its name.

It is sometimes used as a touchstone to ascertain the purity of gold and silver. This was its use among the ancients. The metal to be examined is drawn along the stone so as to leave a mark, and its purity is judged of by the colour of the metallic streak. A good touchstone should be harder than the metals, or metallic compounds to be examined; if softer, the powder of the stone mixes with the trace of the metal and obscures it. A certain degree of roughness on the surface of the best stone is also requisite, that the metal to be tried may leave a trace or streak sufficiently distinct. It must not, however, be too rough, otherwise the particles of the metal will be hid amongst its inequalities, and no distinct traces will be formed. The touch-stone should also be of a black colour, as this tint shows the colour of the streak better than any other. Humboldt considers it not improbable that the black colour of this substance is owing to charcoal.

90. *FLINT is a peculiarly hard and compact kind of stone, generally of a smoke-grey colour, passing into greyish white, reddish, or brown. It is rather more than twice and a half as heavy as water, and when broken will split, in every direction, into pieces which have a smooth surface.*

It is very common in many parts of England, generally among chalk, arranged in a kind of strata or beds, each mass being separate and in pieces that are for the most part either rounded or tubercular. It is occasionally found in other formations. Flint in its pure state is now called SILICA.

The recent investigations of Ehrenberg show that our common flint contains the siliceous coverings of myriads of the infusory and coral animals; likewise the scales of fish and other parts of animals; while the researches of Mr. Bowerbank clearly demonstrate, that *flints* receive their forms from having once been *sponges*. The property which flint possesses of yielding sparks when struck against steel, has rendered it an article of indispensable utility in the system of modern warfare. To this substance the sportsman has been also long indebted for a means of obtaining his game. The art of cutting or rather of breaking, this stone into gun-flints is of modern date, and was for a long time kept secret. The most absurd and contradictory accounts have been given of it by various writers; and it is only of late that the true mode has been rendered public. It consists in striking the stone repeatedly with a kind of mallet, and bringing off at each stroke a splinter which is sharp at one end and thick at the other. These splinters are afterwards shaped, by placing them upon a sharp iron instrument, and then giving them repeatedly small blows with a mallet. During the whole operation the workman holds the stone in his hand, or merely supports it on his knee: and the operation is so simple that a good workman has no difficulty in making 1500 flints in a day. The manufacture of gun-flints is chiefly confined to England, and two or three departments in France. In Prussia an attempt was once made to substitute a kind of earthenware or porcelain for flint; and such was, for some time, used by the Prussian soldiers. All the kinds of flints are not equally adapted for guns: the best are the yellowish grey: the dark smoke and ash-grey varieties are also used, but they are neither so easy to be split, nor do they afford such thin fragments as the other; and owing to their greater hardness, they wear the lock sooner.

Flint, in the form of *Silex*, is found in the stems, or rather in the skin (cuticle) of many plants, especially those of the Endogenous class, (Endogenæ) such as canes, grasses, &c. and it is from this circumstance, these plants derive their durability and power of withstanding the combined actions of air and water. Nearly pure silica occurs in the joints between the leaves and the stem of a grass, known as *Tabaschir*. The editor has succeeded in obtaining the cases of silica from the Dutch rush *(Equisetum)* by means of maceration.

Occasionally on breaking a flint, a cavity is found lined with small shining crystals of quartz, the crystals assuming the usual form.

Flint is employed in the manufacture of porcelain and glass. For this purpose it is heated red hot, and in that state, is thrown into cold water. It is then of a white colour, and capable, without difficulty, of being reduced to powder, either in a mortar or by a mill. After this powder has been passed through fine sieves, some aqua fortis is poured upon it, to dissolve any particles of iron which it may have acquired in the grinding. The powder is then several times washed in hot water, and afterwards dried for use. The glass that is manufactured from this substance is perfectly transparent and faultless.

Glass is made by mixing sand, or prepared flint, with a certain proportion of soda (200) or potash (205), and exposing these substances, in a furnace, to a violent heat for thirty-six or forty-eight hours. When they are in a perfectly fluid state, part of the melted matter is taken out at the end of a long hollow tube. This is done by dipping the tube into it, and turning it about until a sufficient quantity is taken up; the workman at each turn rolling it gently upon a piece of iron, to unite it more intimately. He then blows through the tube till the melted mass at the extremity swells like a bubble, after which he rolls it again on a smooth surface to polish it, and repeats the blowing until the glass is brought as nearly to the size and form of the vessel required, as he thinks necessary.

If he be forming a common bottle, the melted matter at the end of the tube is put into a mould of the exact size and shape of the body of a bottle; and the neck is formed by drawing out the ductile glass at the upper extremity.

If he be making a vessel with a large or wide orifice, the glass, in its melted state, is opened and widened with an iron tool; after which, being again heated, it is whirled about with a circular motion, and by the centrifugal force thus produced, is extended to the size required. Should a handle, foot, or any thing of similar kind be required, that is made separately, and stuck on in its melted state.

The Falcon Glass Works, now in operation at the foot of Blackfriars' Bridge (Surrey side), is the largest in the metropolis, and is ably conducted by Mr. Apsley Pellatt. The whole process of manufacturing and finishing is there carried on, and may be seen by visitors two days in the week.

Window Glass is made in a similar manner to the above, except that the liquid mass is blown into large globes, and detached from the first iron tube by the assistance of a second person, who fixes his iron tube at the opposite side of the globe; the man who originally blew it then separates his tube from it; the mouth of the globe is gradually widened till it ultimately becomes a circular planisphere.

Large *plate glass* for looking-glasses is made by suffering the mass, in a state of complete fusion, to flow upon a casting table, with iron ledges. These confine the melted matter, and, as it cools, a metallic roller is passed over it, to reduce it to a uniform thickness.

The various tints are given to glass by the oxides of the different metals, thus:—

The yellow, by silver, either the oxide or phosphate: also by antimony and iron.

The purple, } by the black oxide of manganese.
The black, }

The blue, by cobalt.

The green, by copper, also by cobalt and yellow of antimony and lead.

The ruby, by gold, or the purple of Cassuis, and by chrome.

Glass utensils, unless very small and thin, require to be gradually cooled in an oven. This operation is called *annealing*, and is necessary in order to prevent them from cracking by change of temperature, wiping, or slight accidental scratches.

In illustration of *unannealed* glass, the "Prince Rupert drops," as they are termed, are sufficiently popular. They are formed simply by dropping melted glass into cold water. By this means the outside of the drops becomes cooled long before the internal mass; the particles are therefore in a different state of tension, and always ready when an opportunity offers, as by slightly breaking the extremity of the drop, to regain their proper dimensions, which is exemplified by their flying to pieces on the slightest alteration of their original condition.

It appears that the manufacture of glass was known very early; but glass perfectly transparent was esteemed of extremely high value. It is stated that the Emperor Nero purchased two glass cups with handles for a sum which was equivalent to 50,000*l*. of our money. The windows of some of the houses of the ancient city of Pompeii, which was buried by an eruption of Mount Vesuvius, in the year 79, were glazed, but the glass was thick, and not transparent.

By many persons flint is used as a test for ascertaining the purity of silver coins. This is done by rubbing them on the flint; and if the mark which they leave be not perfectly white, they are rejected as counterfeit.

White enamel is merely glass rendered more or less milky or opaque by the addition of *oxide of tin*; it forms the basis of many coloured enamels, which are tinged with the metallic oxides as mentioned above (*Brande*).

91. *CHALCEDONY is a species of quartz, generally of*

a whitish, bluish, or a smoky grey colour; and when broken, it appears internally dull, and somewhat splintery.

It is generally found in a massive state, is as hard as quartz, generally semi-transparent, and two and a half times heavier than water. It occurs occasionally in a crystallized state, the crystals assuming the rhombohedral form. It is composed of silica and a little water.

The name of this stone is derived from Chalcedon, in Upper Asia, whence it appears to have been originally obtained, and where it is still found in considerable abundance. Several superb specimens of chalcedony have been found in Britain, and particularly in some of the tin and copper mines of Cornwall. It occurs in several parts of Scotland; and in many of the countries of the Continent. In the Leverian Museum there was a specimen of chalcedony, which weighed more than 200 pounds. Its whole surface appeared such, that at first sight, one might imagine it to have formerly been in a liquid state: it had much the appearance that thick oil has while boiling.

Few stones are susceptible of a higher or more beautiful polish than chalcedony. Hence the different varieties of it are cut into ring and seal stones, necklaces, ear-pendants, small vases, cups, and snuff-boxes. The following are varieties of chalcedony only: onyx, carnelian, chrysoprase, heliotrope, agate.

92. ONYX is but a variety of chalcedony, generally marked alternately with stripes of white and black, or white and brown.

Its name is derived from the Greek language, and has been given on account of its resemblance in colour to the whitish band at the base of the human nail. Two varieties of onyx are met with:

1. *Sard*, of a deep brownish red, and when viewed by transmitted light of a blood-red colour.

2. *Sardonyx* is composed of alternate layers of the *sard* and milk-white chalcedony.

These kinds are highly esteemed by lapidaries, for the formation of vases, snuff-boxes, and trinkets of various kinds. Of sardonyx the ancients made those beautiful cameos, many of which still ornament our cabinets. The ingenuity they have shown in the accommodation of the natural veins and marks of the stone to the figures engraven upon them, is such as to excite, in many instances, the greatest admiration.

It is said that we are entirely ignorant of the country whence the ancient artists obtained the large specimens of sardonyx which are now found in some cabinets.

Onyx is imported from the East Indies, Siberia, Germany, and Portugal.

93. *CARNELIAN is but a variety of chalcedony, usually of a red or flesh colour; though sometimes white, orange, or yellow.*

On several of the British shores carnelians are found with other pebbles: but the most beautiful and valuable kinds are imported from the East Indies. These are sometimes so large as to measure nearly three inches in diameter. The kinds principally in request are those of a pure white, and a bright red colour; jewellers have the art of changing the colour of the yellow varieties to red, by heat. Turpin has shown that the colour depends upon the presence of some of the lower microscopic Algæ (*Protococcus Kermesinus*, &c.)

No stone is so much in request for seals as carnelian. It is likewise cut into beads for necklaces, and stones for ear-rings; into crosses, bracelets, and other trinkets, which, in India, form a considerable branch of traffic. The amount of the sale value of different kinds of carnelian goods vended by the East India Company in 1807, was 11,187*l.*: but in other years, it has not usually been so much as half that sum.

Formerly carnelians were exported from Japan to Holland; and thence were carried to Oberstein, in France, to be exchanged for the agates of that country, which were exported to China.

The carnelian was much esteemed by the ancients; and many fine engraved carnelians are preserved in different collections.

94. *CHRYSOPRASE, an extremelg hard kind of stone, of a clear and delicate apple green colour, is considered to be a variety of chalcedony. It is three and a quarter times the weight of water. It is principally composed of silica, with about one per cent. of oxide of nickel, and small traces of iron, lime, &c.*

This beautiful mineral has hitherto been found only in the vicinity of Kosemitz, and in a few other parts of Lower Silesia. It is susceptible of a high polish, and is much prized by jewellers when its colour is deep and pure. Its colour, however, is so fugitive, that if kept in a warm and dry situation, it loses the greatest part of it; and if exposed to moisture it becomes much altered. Lapidaries assert, that great care ought to be taken in the polishing of it; pretending that if, from want of sufficient moisture, or by the too rapid motion of the wheel, it be over-heated, it will become whitish or turbid.

Chrysoprase is generally cut into a convex form, or what jewellers call *en cabochon;* and is set with green taffeta beneath it, as foil. It is used for ring stones, brooches, and otner ornaments; and is found to harmonize well with diamonds and pearls. The larger and more impure masses are cut into snuff-boxes, seal-stones, and similar articles. Some of the finest specimens of chrysoprase that are known are to be seen in the cathedral church of Prague, where a small closet is inlaid with them.

Imitations of chrysoprase are sometimes imposed upon the public; but these are easily known by persons who are acquainted with the nature of precious stones.

95. *BLOODSTONE, or HELIOTROPE, is an opaque stone of the quartz family, generally of a dark green colour, with a somewhat bluish cast, and marked with blood-red spots or stripes.*

It usually occurs in masses of an irregular form; and when cut thin is sometimes translucent at the edges.

The most valuable kinds of bloodstone are imported from the East. They are not so opaque as those which are found in Germany, and are marked with more vivid spots. As bloodstone is capable of a high polish, and is even better calculated for engraving upon than carnelian (93), it is in great request for seal-stones, for the tops and bottoms of snuff-boxes, and other articles on which costly gold mountings are frequently bestowed. Its dark colour and opaque appearance prevent its being much used for beads. Great quantities of it are consumed in China as ornaments to the girdle clasps of the superior ranks of people. Absurd as it may appear, many persons entertain a notion that this stone worn in the dress will prevent bleeding at the nose. Good bloodstone and carnelian are considered to be about the same value.

There are many cameos and intaglios, both by ancients and moderns, executed in bloodstone. In the National Library at Paris, there is a fine engraved stone of this kind, representing the head of Christ whilst undergoing the punishment of scourging, and so cut that the red spots are made to represent drops of blood.

The ancients procured bloodstones chiefly from Ethiopia; but at present, the most highly esteemed varieties are brought from Bucharia, Great Tartary, and Siberia. A kind of mineral nearly resembling this is found in Rum, one of the western isles of Scotland.

The spots in bloodstone are particles of red jasper.

96. *JASPER is a species of quartz, of great hardness. It varies much in colour, being red, green, yellow, blue, olive, violet, black, and often variegated, spotted, or veined with several other colours. It is usually opaque, but is capable of receiving a polish. It is about twice and a half as heavy as water. It is composed of silica* ($14\frac{1}{2}$) *and oxide of iron* (1 *part*).

This stone is found in large aud shapeless masses, and constitutes an ingredient in mountains of various parts of the world, of the primary or transition orders.

Such is the hardness of jasper, that the savages of Canada avail themselves of it for the fabrication of the heads of javelins, and sometimes also of arrows. It is used by artists for the formation of vases, snuff-boxes, seals, and trinkets of various kinds; and formerly cups and saucers were sometimes made of it. Many beautiful antique engravings are upon jasper.

In the province of Andalusia, in Spain, there were four fine quarries of jasper. One of these was celebrated for a blood-red stone, streaked with white, exceedingly hard and very handsome, of which the beautiful columns of the tabernacle in the Escurial were made. This quarry was in the territory of Cogullus, in the archbishopric of Seville, and was purchased by the crown in 1581; but was afterwards so far neglected that even the place where it lay was not remembered. It was, however, again discovered about the end of the reign of Charles the Third, after a very expensive search made by order of the government.

Jasper occurs in the Pentland hills, near Edinburgh, and in several other parts of Scotland; in the Shetland Islands, and the Hebrides. It has been observed in most of the countries of the Continent; and is found in great abundance in Siberia.

97. RED JASPER *is an opaque red stone, which is found*

embedded in red clay-ironstone in Baden, and is cut and polished for various ornamental purposes. There are extant many fine antique engravings on red jasper.

98. EGYPTIAN PEBBLE *is a brown-coloured jasper, that is found in globular or rounded pieces.*—It is chiefly brought from Egypt; and, as it is capable of receiving a fine polish, and when polished is very beautiful, it is manufactured into several kinds of ornamental articles. From the great abundance in which it is supplied, it is, however, much less valuable than carnelian (93). The colours of the Egyptian pebble frequently assume very singular forms. There was one in the Leverian Museum which exhibited in the centre the resemblance of a pantaloon, or a man wearing a fool's cap.

99. STRIPED, *or* RIBBON JASPER, *is marked with alternate stripes of different colours, green, red, and yellow,* and is found in Siberia, Saxony, and even in the Pentland hills, near Edinburgh. It receives an excellent polish, and is frequently cut into the tops and bottoms of snuff-boxes. The red and green layers of jasper, being well defined and regular, this kind is used for several purposes of ornament, particularly for cameos.

Another variety, called AGATE JASPER, occurs occasionally, and is of a reddish white colour.

100. *AGATE is a semi-transparent stone, and composed of chalcedony and quartz, together with heliotrope, jasper, or opal: the first of this list is its principal constituent, which is capable of receiving a high and very beautiful polish.*

These stones are always found in a shapeless or massive form, and nearly of all colours, except bright red and green.

The name of agate is derived from the river Achates, in Sicily, in the vicinity of which these stones were obtained by the ancients in great abundance. They are now found in several parts of Scotland; in Iceland, Saxony, and Hungary; and they are occasionally brought into Europe from China and the East Indies.

Agates are used in several kinds of ornamental work, and particularly for necklaces and seals. They are occasionally made into cups, the handles of knives and forks, hilts of swords and hangers, and the tops and bottoms of snuff-boxes. The less ornamental kinds are manufactured into small mortars, which are employed by enamellers and others for pounding such substances as are very hard. They are also made into instruments for grinding colours, and into polishers for the glazing of linen. In the Electoral Cabinet at Dresden, and the Ducal Cabinet in Brunswick, there are several elegant vases formed of agate.

The most beautiful agates which our island produces are known by the name of *Scots pebbles*. These are found in various parts of Scotland, but principally on the sea-shore in the neighbourhood of Dunbar. *Agate pebbles* are found on several of the English shores, as those of Suffolk, Dorset, Scotland, Wales, and Ireland, and sometimes even in gravel-pits. Many of them will bear cutting and polishing as well as the best agates of foreign countries.

Agates are occasionally seen to be figured in a very singular manner; but this, in some instances at least, is suspected to be the work of art. One is mentioned in the church of St. Mark, at Venice, which had the representation of a king's head surmounted by a diadem. On another was represented a man in the attitude of running; but the most remarkable of all seems to have been one which contained a representation of the nine Muses, with Apollo in the midst of them!

It must be remarked that agate is not, as some mineralogists imagine, a simple mineral, but that it is composed of various species of the quartz family, intimately blended together. It consists chiefly of chalcedony (91), with flint, hornstone, carnelian (93), jasper (96), cacholong (105), amethyst (79), and quartz (76). Of these minerals sometimes only two, and sometimes three or more, occur in the same agate. Its varieties, consequently, are extremely numerous.

101. MOCHA STONE *is a variety of chalcedony, sometimes of a green colour, which has on its surface the resemblance of moss*, and this so nearly approaching a natural appearance, that some persons have actually supposed it to be occasioned by a condensation of moss into stone.

These stones are used for several ornamental purposes, and are not unfrequently imitated, by spreading a solution of copper in nitric acid or aqua fortis (30) over the surface of a plain agate, and then setting a small iron nail on its head in the middle. The acid unites with the iron, and deposits the copper in beautiful ramifications from the centre. The nail must then be removed, and the surface carefully washed by dipping the stone into warm water. Afterwards, on the application of a moderate heat, the copper becomes black. As, however, the deposition is merely superficial, it requires to be covered with glass, to preserve it from injury.

102. *OPALS are a semi-transparent kind of stones, which have a milky cast, aud, when held betwixt the eye and the light, exhibit a changeable appearance of colour. They occur of different shades of colour.*

They are always found in a shapeless or massive state, are brittle, and considerably less hard than most other precious stones, and about twice the weight of water. They are nearly pure silica.

The only opal mines in the world are those of Hungary. About four centuries ago opals were obtained in such abundance from these mines, that upwards of three hundred persons were employed in them. They still produce opals, some of which are so valuable as to pass, in commerce, under the appellation of *Oriental opals*, whilst others are so poor as to be of no value whatever to the jeweller. Opals are also found in other parts of Europe; and in the island of Sumatra, and several parts of the East Indies. This class of substances is usually found in Amygdaloid, and in primary veins associated with chalcedony.

Few precious stones are more beautiful than opals. Their elegant play of colours, brilliant blue, green, red, and yellow, variously modified, has procured for them a distinguished rank among gems. Notwithstanding this, they are but ill suited to the purposes of jewellery, on account of their softness, their great frangibility, and their sometimes splitting on a sudden change of temperature. They are usually set without bottoms; but sometimes with a black bottom, and sometimes with a foil of red, blue, or gold colour. Their value is such that a fine oriental opal is considered worth about twice as much as an oriental sapphire of the same size. By the Turks they are so peculiarly esteemed, that a fine opal of moderate size has sometimes been sold at the price of a diamond. The esteem in which they were held among the ancient Romans was such, that Nonius, the Roman senator, is stated to have preferred banishment to parting with a favourite opal which Mark Antony was anxious to possess.

In the abbey of St. Denys, near Paris, there was formerly a curious ancient opal which was green on the outside, and, when viewed against the light, exhibited a fine ruby colour; and in the Imperial Cabinet at Vienna there are two pieces of opal from the mines in Hungary, one of which is about five inches long, and two inches and a half broad; and the other the size and shape of a hen's egg. Both these stones exhibit a very rich and splendid play of colours.

In the purchasing of opals great caution is requisite, as fine glass pastes have, not unfrequently, been substituted for them, and sold at enormous prices.

PRECIOUS OPAL is usually of a milk-white colour, but when viewed under different circumstances it displays a variety of colours.

FIRE OPAL is that variety which exhibits, under ordinary circumstances, the red hue.

103. HYDROPHANOUS OPAL, *or* OCULUS MUNDI, *is a kind of opal, the distinguishing characteristic of which is, that it gradually becomes transparent, and exhibits a beautiful play of colour after being immersed in water.*—It is either of a whitish brown, yellowish green, milky grey, or yellow colour, and opaque; and when touched by the tongue, adheres to it.

The name of *oculus mundi* (eye of the world) has been given to these stones from an internal luminous spot, which changes its position according to the direction in which they are held to the light. The countries in which they are chiefly found are Hungary and Iceland.

They are sometimes set in rings; and the prices at which they were formerly valued were, in the highest degree, unaccountable and absurd. At present their value is considerably lower, though they are still in great request as objects of curiosity. The phenomenon of their becoming transparent in water is supposed to be occasioned by that fluid soaking through their whole substance, in the same manner as the transparency of paper is occasioned by immersing it in oil. A hydrophanous opal, weighing twenty-seven grains and a half, was kept four minutes in water, and on being taken out weighed thirty-two grains and a half, having received in this short period an augmentation of five grains, or more than one-sixth part of its whole weight. When taken from the water, these stones as they dry become again opaque.

To preserve them in beauty and perfection, care should be taken not to immerse them in any but pure water, and to take them out as soon as they have acquired their full transparency. If these precautions be neglected, the pores will soon become filled with earthy particles: the stones will cease to exhibit their peculiar property, and will ever afterwards continue opaque.

104. COMMON OPAL *is a semi-transparent kind of opal, which does not exhibit any changeable refraction of colour.* It is found in Germany, France, Italy, and other countries of the Continent, and is employed for brooches and other ornaments. A green-coloured Saxon variety is sometimes cut into ring-stones.

105. MOTHER-OF-PEARL OPAL, *or* CACHOLONG, *is a milk-white, yellowish, or greyish-white kind of opal,* which occurs in Iceland, Greenland, Spain, and the island of Elba. It is sometimes cut into a concave form, for brooches, and other female ornaments. Italian artists also use it for mosaic work.

106. WOOD OPAL *appears to be wood that by some extraordinary operation of nature has been converted into opal.* Some specimens exhibit, very beautifully, the ligneous texture. This kind of opal is chiefly cut into plates for the tops and bottoms of snuff-boxes. It is found in alluvial land in some parts of Germany and Hungary. Several years ago the trunk of a tree, penetrated with opal, and so heavy that eight oxen were requisite to draw it, was found in Hungary.

PITCHSTONE FAMILY.

107. ***OBSIDIAN is a kind of glass, generally of a blackish colour, brown at the edges, where it is thin and translucent, formed in volcanoes, from which it issues in thick streams. It is rather more than twice and a quarter heavier than water. It cannot be considered a true chemical compound.***

This substance has been used for various purposes, and, according to Pliny, was named after a Roman called Obsidius, who met with it first at Ethiopia. It is possible to cut and polish it; but its brittleness and frangibility are so great, that without much care it will fly into pieces during the working. The reflectors of telescopes were occasionally formed of it. In Mexico and Peru, obsidian is cut into mirrors; and the inhabitants of those countries used formerly to manufacture it into knives and other cutting instruments. Hernandez says that he saw more than a hundred of these knives made in an hour. Cortez, in a letter to the Emperor Charles the Fifth, relates that he saw razors that had been formed of obsidian. The natives of Easter and Ascension Islands use this substance for cutting instruments; and also for pointing their lances and spears, and, in place of flint, for striking fire with. According to the account that has been given by Pliny, the ancients sometimes formed obsidian into mirrors, and ornamental articles of different kinds. The Danish lapidaries, who obtain considerable quantities of it from Iceland, cut it into snuff-boxes, ring-stones, and ear-pendants.

Obsidian is found near Mount Hecla, and in other parts of Iceland; it is likewise met with in Abyssinia, Hungary, and the Grecian Islands. Sir George Mackenzie, during his journey through Iceland, observed an immense mass of this substance, which appeared to him to have been part of a stream that had flowed from a volcano. It is also found in Sicily, and several other islands of the Mediterranean, and in nearly all parts of the world where there are volcanoes.

108. *PUMICE STONE is an extremely light and porous mineral, of somewhat fibrous texture, and of white, grey, reddish, brown, or black colour.*

From the texture of this mineral, which is chiefly brought from the neighbourhood of volcanoes, some persons have imagined it to be asbestos decomposed by the action of fire. Its lightness is such that, placed in water, it will float.

To mechanics and other artists, pumice stone is a very useful mineral. It is employed for cleansing and smoothing the surface of wood, leather, metal, stones, glass, and other substances; and it is used by parchment-makers, curriers, and hat-makers. Hence it forms a considerable article of trade, and is exported from the Lipari Islands, in great quantities, to the different countries of Europe. Sailors in the Mediterranean rub their beards off with pumice, instead of shaving. It probably forms an ingredient in the *axyrite*, or shaving-stone, of late so much advertized, but, like all impositions attempted to be practised on the public, has proved a downright failure. On account of its porosity, it is used in Teneriffe as a filtering stone. In Italy it is ground and used instead of sand, in the making of mortar. Pumice occurs in Ireland, along with obsidian (107); and it abounds in several islands of the Grecian Archipelago.

AZURE STONE FAMILY.

109. *LAPIS LAZULI, AZURE STONE, or LAZULITE, is a mineral of an azure blue colour in various shades, and generally accompanied with white or clouded spots, and also with pyrites (236), which have the appearance of golden veins or spots. Its texture is earthy, and fracture uneven: sometimes it is found crystallized, the primary form of the crystal being a regular rhombic prism. It is opaque, or nearly so, and in some parts is sufficiently hard to strike fire with steel. It is rather more than three times as heavy as water. It is a compound of alumina and magnesia in combination with phosphoric acid.*

About sixty years ago this stone was an article much in fashion for various ornamental parts of dress. Being capable of a very high polish, it was cut into beads, stones for rings, bracelets, and necklaces. It was also cut into ornamental vases, small statues, and the tops and bottoms of snuff-boxes; but of late it has been almost wholly out of use for these purposes. Before the French revolution it was imported, to considerable extent, into that country from the Persian Gulf, for the inlaying of richly-decorated altars; and its value was appreciated according to the proportion of its yellow spots or veins: these by many persons were erroneously considered to be of gold.

The most important purpose to which lapis lazuli is now applied is in the manufacturing of the beautiful and brilliant blue colour, so much esteemed by painters, called *ultramarine*. For the making of this, such pieces are selected as contain the greatest proportion of blue substance, and consequently the least yellow or white. These are burned or calcined, reduced to a fine powder, made into a paste with wax, linseed oil, and resinous matters of different kinds, and afterwards separated by washing. The powder that is left in this operation, which requires much time and great attention to perform, is ultramarine.

There are few colours so little susceptible of change from the effects of time as ultramarine: the consequence of this has been, that, as several of the ancient painters introduced it for the representation of blue drapery, their pictures in many instances are now devoid of harmony, as this colour alone has stood, whilst all the others have changed.

Lapis lazuli is principally brought from Persia, Natolia, and China; but it is also found in Siberia and Tartary. In Europe it has been discovered near Werfen in Salzburg, in the valleys called Schlamming and Radelgraben, in thin veins, traversing clayslate, and among the ruins of Rome.

A coarse imitation of it is sometimes made by throwing copper filings into blue enamel whilst in a melted state.

FELSPAR FAMILY.

110. *COMMON FELSPAR is a hard kind of stone which varies much in colour, being flesh red, bluish grey, yellowish white, milk white, or brownish yellow, and occasionally green.*

It is found in a massive state, disseminated or crystallized in four, six, and ten-sided prisms, the primary form being a double oblique prism. It is about twice and a half the weight of water. It is composed of silica, alumina, and potash. Will strike fire with steel, and is sometimes opaque and coloured, sometimes transparent and whitish.

The name of felspar is derived from the German language, and signifies *spar of the fields*. It is a very common substance, and constitutes a principal part of many of the highest mountains of the world, when in combination with mica and quartz in the form of granite. When exposed to weather, it gradually acquires an earthy appearance, and at length passes into porcelain clay (118).

Felspar is of great use in the manufacture of the finer kinds of earthenware. Of the two substances which chiefly compose the porcelain of China, one called *petuntz* is a whitish laminar kind of felspar. This mineral is used in the celebrated porcelain that is manufactured at Sèvres, near Paris, for the purpose of giving to it a white and transparent appearance. Previously to being used, it is pulverized, made into a paste, and suffered to dry. It is sometimes applied to the surface of ornamental vases in the form of enamel.

111. AMAZON STONE *is a green variety of felspar*, which is found in small rolled pieces on the bank of the river of Amazons, in South America, whence it has its name. It is susceptible of a beautiful polish, and is often cut into ring-stones, brooches, and the tops of snuff-boxes. Lapidaries consider it to be the most estimable when accompanied by mica, which gives it a kind of speckled perlaceous appearance.

112. *MOONSTONE, or ADULARIA, is the purest kind of felspar that is known; and is considered to have the same relation to common felspar that rock crystal has to common quartz. Its colour is white, sometimes with a shade of yellow, red, or green.*

The translucent varieties of this stone, when viewed in a certain direction, sometimes exhibit a pearly and silvery play of colour. These are valued by jewellers, who cut them into a semi-globular form, and sell them under the name of moonstone. Those specimens are considered most estimable which, when cut in a very low oval, present the silvery spot in the centre of the stone. They are generally used for rings and brooches; and when set round with diamonds, their pearly lustre exhibits a striking and agreeable contrast with the brilliancy of that gem.

Adularia is said to have been first discovered by an Italian mineralogist, near Mount St. Gothard, in Switzerland. He named it Adularia felspar, in the belief that the mountain on which he had found it was named Adula. This, however, was not the case; for Mount Adula is at some distance from St. Gothard, in the Grisons. This mineral has since been found in the granite of the island of Arran, in France and Germany. The finest specimens are brought from Ceylon.

113. *LABRADOR FELSPAR is a very beautiful stone, of a smoky grey colour, intermingled with veins and shades of blue, green, and golden yellow, exhibiting a brilliant play of colours, according to the position with respect to the light in which it is held.*

The original discovery of this singular mineral was by the Moravian missionaries, on the island of St. Paul, near the coast of Labrador; but it has since been found in various parts of Norway and Siberia. Persons who have passed in boats along the rivers of Labrador, have described the extremely brilliant and beautiful appearance which the rocks of this substance frequently exhibit in shallow places, at the bottom of the water. The visitors of the late Leverian Museum will, no doubt, recollect a remarkably fine mass of Labrador felspar, the surface of which was polished, and exhibited some of the most splendid and beautiful colours that can be imagined. It was considered to have been the most capital specimen that was ever brought to England.

This mineral, on account of its hardness, its brilliancy, and its capability of receiving a high polish, is in considerable estimation among lapidaries for different kinds of ornamental work, particularly for the tops and bottoms of snuff-boxes, for brooches, and necklaces.

Glassy Felspar or *Ryacolite*, is a very common ingredient in lava, and received its name from the strong vitreous lustre by which it is characterized. The lava of Vesuvius contains abundance of it, and also the lava of the Laucher Sea. It is found also in many other localities, as the pitch-stone porphyry in the islands of Arran and Rum. Its colour is greyish, white, or grey; it is always crystallized; the form of the crystal, together with the weight, being that of the felspar. (*Thomson.*)

II. SOFT STONES: those which will not scratch Glass.

114. CLAY FAMILY.

Clay is a mixture of alumina (33) and silex (38), and is too well known to require much description.

It is opaque, has an earthy texture, is about twice as heavy as water, when moistened is very ductile, adheres slightly to the tongue; and with its peculiar smell (called clayey) every one is acquainted.

115. *COMMON CLAY, or POTTERS' CLAY, which is found in nearly every country of the world, is sometimes white, has a blue or yellowish tinge, or is brown or reddish.*

It is the peculiar quality of this substance to become so hard by heat that it will even strike fire with steel. The ductility of clay, and its property of thus hardening in the fire, have rendered it an article of indispensable utility to mankind in all civilized countries. It is formed into eating vessels of almost every description; plates, dishes, cups, basins, bowls, and pans for keeping provisions in. For these almost any kind of clay may be advantageously used: but it is necessary to mix it with sand, for the purpose of rendering the vessels that are made of it more firm and strong. Those that are applied to culinary, and other uses in which it is requisite for them not to be penetrable by water, are covered with a glazing. This glazing, for coarse ware, is sometimes made with lead, and sometimes by throwing a certain portion of salt into the furnace. In the formation of the better kinds of earthenware, the clay is made into a paste with water, moulded into the requisite shape upon a horizontal wheel, the inside being formed by one hand of the potter, and the outside by the other, as the wheel turns round. When the pieces have been baked, they are dipped into a glazing mixture, consisting of white lead, ground flints, and water, and are exposed a second time to the fire. The different colours of earthenware are obtained by means of various kinds of metallic oxides (21).

The coarser kinds of clay are manufactured into *bricks* for the building of houses, and *tiles* for the covering and paving of them. These are formed in moulds of the requisite shape, afterwards dried for some time in the sun, and finally piled in kilns, and there baked to a proper degree of hardness. The earth for bricks ought to be sufficiently fine, free from pebbles, and not too sandy, which would render them heavy and brittle; nor ought it to be entirely free from sand, as this would make them crack in drying.

Clay is a substance of inestimable value for forming the bottoms of ponds, and the bottoms and sides of canals and reservoirs, to prevent the water from draining away. It also composes, in a great measure, those tenacious earths called arable soils. What is peculiarly denominated clay land is known by its holding water, and not soon drying when wetted. Such land requires much labour from the husbandman, before it can be sufficiently pulverized, or brought to a fit state for being productive of corn or grass.

116. Pipe Clay *is a fine and white variety of common clay.* It is very plastic, adheres strongly to the tongue; and in a strong heat is hardened, and rendered perfectly white.

It is of this clay that tobacco pipes are made, by the simple process of casting them in moulds, forming a hole through the stems by means of a wire, generally dipping the small end into some glazing material, and then baking them. Pipe clay is also formed into oblong pieces, dried, and employed for cleaning white woollen cloths, and for various purposes of domestic utility. It is likewise the basis of the yellow, or what is called *Queen's ware* pottery. This is glazed in a manner somewhat different from that of common pottery. The glazing mixture consists of a certain proportion of carbonate of lead (239), ground flint, and flint glass, worked with water to the thickness of cream. The ware, before it is glazed, is baked, and thus acquires the property of strongly imbibing moisture. It is then dipped into the above composition; exposed a second time to the fire, by which the glaze it has imbibed is melted. A thin glossy coat is thus formed upon its surface, which is more or less yellow, according to the greater or less proportion of lead that has been used.

Spanish White is a pure clay.

117. *LOAM is a yellowish or brownish kind of clay, sometimes containing a considerable proportion of sand. It occurs in immense beds, and is found in almost every part of the world.*

This substance, when mixed with straw or hair, to prevent it from cracking, is extensively used for the building of what are called mud cottages or houses. These are generally reared on a foundation of stone, or brickwork, to secure them from injury by the moisture of the earth. It is said to be the most advantageous practice to form the loam into bricks, and to dry these in the shade, and afterwards in the sun. The use of such bricks is of great antiquity. We are informed that the ancient city of Damascus, and even the walls of Babylon, were constructed of bricks made of loam.

118. *PORCELAIN CLAY is generally of a white or of a reddish white colour, sometimes inclining to yellowish or grey. When dry, it absorbs moisture rapidly; and it becomes very tenacious when kneaded.*

It is known from the other clays by the fineness of its particles, its soiling the fingers much when handled, and its fine but meagre feel.

The usual distinction betwixt earthenware and porcelain, or china, is, that the former is opaque, and the latter semitransparent. Porcelain is also considerably heavier than common earthenware. In the manufacture of porcelain the clay is sometimes used alone, and sometimes intermixed with other earths, or with felspar (110). The earliest manufacture of porcelain is supposed to have been that in China and Japan. The quantity produced in China must formerly have been extremely great; as not only a considerable portion of the eastern parts of the world, but almost the whole of Europe, was supplied with it. In a single province it is said that nearly a million of persons were at one time employed in this manufacture.

The manufactory at Sevres, in France, has long been celebrated both for the excellence and elegance of its porcelain. There are well-known manufactories of porcelain at Meissen in Saxony, at Berlin, and in Austria; but none of these are at present superior to our own, in Worcestershire and Staffordshire.

Porcelain clay occurs chiefly in countries which abound with granite (251) and gneiss (255). It is found in small quantity in Cornwall, and other granite districts of England, as well as in those of Scotland and Ireland. But the most valuable kinds of this clay are found in China and Japan.

The mineral is not used in the state in which it is found in the earth; but is previously washed several times to free it from impurities. After the process of washing, only about fifteen parts of pure clay remain; this is the *kaolin* of the Chinese. To form the composition of the porcelain, this clay is mixed, in certain proportions, with quartz (76), flint, gypsum (192), steatite (124), or other substances; and the mixture is sifted several times through hair sieves. It is afterwards moistened with rain water, and, in the form of a paste, is put into covered casks. Here a fermentation soon takes place, which changes its smell, colour, and consistence. Its colour passes from white into dark grey; and the matter becomes both tougher and more soft than before. The peculiar mode of preparing this mixture, and the art of rightly managing it, are secrets in most porcelain manufactories.

The next operation consists in giving to the paste thus formed the requisite shape of the vessels. This is done first by kneading it with the hands; and then by taking up certain portions of it, and turning it on a lathe, in the manner of common pottery (115), but with more care.

The third operation is the baking or firing. This is done in furnaces of a particular construction, and generally lasts from thirty-six to forty-eight hours. The state of the baking is shown by proof pieces, as they are called, which are placed in convenient situations, and can be drawn out, from time to time, for examination. The porcelain in this state, is named *biscuit porcelain;* and figures, and such other porcelain articles as are neither to be painted nor exposed to water are in the state of biscuit.

A fourth operation is covering the surface of the biscuit with a varnish or enamel. This is composed of pure white quartz (76), white porcelain, and calcined crystals of gypsum (192); and sometimes principally of felspar (110). These substances are carefully ground, then diffused through water, and formed into a paste. When used, the paste is diluted in water, so as to give it considerable fluidity; and the pieces of biscuit porcelain are separately plunged into it, in such manner as to cover their whole surface. These are then exposed to a heat sufficient to melt the enamel or covering: and in this state they constitute white porcelain.

If the porcelain is to be painted, it must again be exposed to heat in the furnace. The colours used for the painting of it are all derived from metals; and many of them, though dull when applied, acquire considerable lustre by the action of the fire. The colours are always mixed with some kind of flux, such as a mixture of glass (204), borax (206), and nitre, melted together, and afterwards ground.

Gum or oil of lavender is used for mixing up the colours. When the painting is finished, the pieces are exposed to a heat sufficient to melt the flux, and thus fix the colour.

119. *TRIPOLI is a kind of clay of a yellowish grey, brown, or white colour, sometimes striped or spotted, and of an earthy texture.*

It feels harsh and dry to the touch; is soft, scarcely adheres to the tongue, and will not take a polish from the nail.

This substance obtained its name from having formerly been imported into Europe from Tripoli, on the north coast of Africa. It is, however, now found in several parts of Germany, and a granulated kind has been discovered in England.

The recent discoveries of Ehrenberg show that Tripoli is composed almost exclusively of the siliceous cases of fossil infusory animalcules.

Tripoli is used for the polishing of metals and stones. For this purpose, it is mixed with sulphur, in the proportion of two parts of tripoli to one of sulphur. These are well rubbed together on a marble slab, and are applied to the stone or metal with a piece of leather.

When tripoli is combined with red ironstone, it is used for the polishing of optical glasses. It is sometimes made into moulds, in which small metallic or glass figures and medallions are cast; and a kind of tripoli is found near Burgos, in Spain, which is used as an ingredient in the manufacture of porcelain.

In Derbyshire, Staffordshire, and other coal counties, is dug a kind of tripoli which has the name of *rotten stone.* This consists of alumina, silica, carbonate of lime, and a small portion of iron. It is generally of a dull brown colour. It is used for most of the same purposes as tripoli.

CLAY-SLATE FAMILY.

120. *CLAY-SLATE, or ROOFING SLATE, is a kind of stone of a foliated texture, and of a greyish, black, brown, green, or bluish colour.*

It breaks into splinters, does not adhere to the tongue, yields generally a clear sound when struck, and is nearly thrice as heavy as water.

Vast and extensive beds of slate occur in different parts of the world; and this mineral sometimes constitutes even a principal portion of mountains. In our own country there are many important quarries of it, particularly in Westmorland, Yorkshire, Wales, Derbyshire, and Cornwall.

The uses of slate are numerous and important; but its principal use is for the roofing of houses. For this purpose it is split into thin plates or laminæ. These are fastened to the rafters by pegs driven through them; and are made to lap over each other at the edges, in such a manner as to exclude the rain and other moisture. The kinds which are preferred for this purpose are such as have the smoothest surface, and split into the thinnest plates. It is requisite that slates should be damp when they are split, otherwise this cannot be done without difficulty. Hence it is generally customary to split the masses as soon as possible after they have been separated from the rock.

Slate should not be porous. If it be so, rain and snow water will pass through it, and destroy the wood-work of the house on which it is placed. Porous slate is also liable to have moss and lichens grow upon and cover it. These plants retain moisture long, and keep the surface, and even the interior of the slate, moist; so that, during the winter season, by the freezing of the moisture, the slate is apt to split and fall into pieces. To ascertain whether the slate be of requisite compactness, it should be completely dried, then weighed, and afterwards soaked for some time in water. When taken out it is to be wiped with a cloth, and again weighed. If it have not acquired any considerable increase of weight, it is a proof of its being sufficiently compact. If, on the contrary, it have absorbed much of the water, and have become considerably heavier by the immersion, it is shown to be of a porous texture. Slates that are brittle are bad. If they emit a tolerably clear sound, when struck with a hammer, it is considered a proof that they are not too brittle: if, on the contrary, the sound be dull, they are soft and shattery. A good slate ought also to resist the action of a considerable degree of heat.

The slates that are principally used in London are brought from North Wales, from quarries that are worked near Bangor. There are also extensive slate quarries near Kendal, in Westmoreland; and the Kendal slates, which are of a bluish green colour, are more highly esteemed than those from Wales. They are not of large size, but they possess great durability, and give a peculiarly neat appearance to the roofs on which they are placed. The slate quarries near Easdale, in Scotland, are so extensive as to furnish annually more than 5,000,000 in number, and to give employment to upwards of 300 men.

French slates were much used in London about seventy years ago; but they have been found too small, thin, and light, to resist the winds and storms of this changeable climate.

Dark-coloured, compact, and solid slates are manufactured into *writing slates*, or *table slates*, as they are sometimes called. In the preparation of these, the slate, after it is split of a proper thickness, is smoothed with an iron instrument. It is then ground with sandstone, and slightly polished with tripoli (119), and, lastly rubbed with charcoal powder. It is cut into the requisite shape, set in a wooden frame, and is then ready for use.

For writing on these slates, pencils are used which are also made of slate. These, which are called *slate pencils*, are made of a particular kind of slate, that, on splitting, falls into long splintery fragments. It is necessary that the pencils should be considerably softer than the slate to be written upon, so that they may leave a whitish streak on its surface, without scratching it. Such is the shivery nature of the slate of which they are made, that, if it be exposed for some time to the action of the sun or frost, it is rendered useless. Hence, workmen are careful to cover it up and sprinkle it with water, as soon as it is taken from the quarry, and to preserve it in damp cellars. The pieces are afterwards split by a particular instrument, and then wrought into the requisite shape.

In some of the quarries in Derbyshire and Wales the slate is so thick as to admit of being split into large and tabular pieces. These are used for gravestones, and for slabs for dairies and cellars. Paving stones and mile-stones are also formed of them; and vessels for the salting of meat, and setting of milk in dairies. For the latter use slate is particularly well adapted, on account of its resistance of greasy or oily substances. But this property renders it unfit for any purpose for which it is requisite to be painted; as, the oil not entering the stone, the paint soon peels off, and leaves the stone as black as it was at first. Cut into narrow strips, slate has also been applied, in the neighbourhood of Bangor, North Wales, for the formation of fences. Tanks and vessels made of slate are now much used in the manufacture of soda-water.

When sufficiently solid for the purpose, slate is cut into inkstands, and turned into vases, and fancy articles of various kinds. And a singular circumstance has been remarked, that, if a window or door be suddenly opened, in an apartment where the workmen are turning these, they will sometimes fly in pieces; though after the work is finished, they may be exposed to the usual changes of temperature without injury.

Pounded slate is advantageously used for cleaning iron and other works in metal. When well ground, and mixed with a certain proportion of loam, slate is made into moulds for the casting of metals in; and when burned and coarsely ground, is used instead of sand in the making of a solid and impermeable mortar or cement, for the parts of buildings that are covered with water.

121. *BLACK CHALK, or DRAWING SLATE, is an earthy substance, of a slaty texture; generally of a greyish, sometimes a bluish black colour.*

It is soft and smooth to the touch, and in handling stains the fingers.

To crayon painters, and other artists, black chalk is a very useful article. Considerable quantities of it are imported from France, Spain, and Italy; it is found also in the isle of Isla, in the Hebrides. The best is brought from Italy. This is more free from gritty particles, more firm and compact in its texture, and in its touch much smoother than the chalk of any other country. It consists of silex, alumina, carbon, and oxide of iron. When prepared for use, it is cut into square pieces, which are sometimes enclosed in wooden cases, like black lead pencils. These pencils are said to become dry, hard, and unfit for use by long keeping. To preserve them in greatest perfection, they should be kept in a moist place. Some artists prefer pencils that are made of the chalk finely ground, mixed with a certain proportion of gum water, and cast in moulds. Care should be taken not to put too much gum, as the pencils will not, in such case, leave any mark on the paper.

Drawing slate is sometimes used as a black colour for painting. For this purpose it is pounded or ground, and then mixed with oil or size, according to the kind of work for which it is required. When black chalk is strongly heated, it loses its colour, and assumes that of a reddish

122. *HONE, or WHET SLATE, is a well-known kind of stone, of a somewhat slaty texture, and generally of a dull white, or greenish grey colour. Its surface is smooth, and feels unctuous to the touch.*

These stones, when properly cut and smoothed, are of indispensable utility to carpenters, cutlers, and others, for sharpening their cutting instruments. Those of the finest grain are used for lancets, penknives, and razors. For this purpose their surface, when used, is covered with a small quantity of oil; by which, after a while, they are rendered considerably harder than they were at first. They ought to be kept in damp and cool places; for, if much exposed to the sun, they become too hard and dry for many purposes to which they are applied.

There is a vulgar and erroneous notion that hones are holly wood, which, by lying in petrifying water, have been thereby converted into stone. The greater number of them have a fine and a coarse side. From the circumstance of their having been originally brought into this country from Turkey and the Levant, they are sometimes called *Turkey stones*. They are now found in Saxony and Bohemia, in North Wales, and near Drogheda, in Ireland.

The powder of whet slate is sometimes used, instead of emery, for the cutting and polishing of Metals.

MICA FAMILY.

123. *COMMON MICA, GLIMMER, or MUSCOVY GLASS, is a mineral substance of a foliated texture, which is capable of being divided into extremely thin leaves that have a sensible elasticity, and are transparent.*

The colour of mica is greenish, sometimes nearly black, reddish, brown, yellow, or silvery white, with occasionally a metallic lustre on the surface. Mica is so soft, as easily to be scratched; and, when divided across the plates, seems rather to tear than break. The primary form of the crystal, when it occurs crystallized, is an *oblique rhomboidal prism. It is composed principally of silica and alumina, with small proportions of oxide of iron and potash.*

This is one of the most abundant mineral substances that is known. It not only occurs in a massive and crystallized state, but it enters into the composition of many rocks, as granite, gneiss, and mica slate; is found filling up their fissures, or crystallized in the cavities of the veins which traverse them. In some countries, as in Siberia, it is an article of commerce, and is obtained from mines like other minerals. From these it is extracted by hammers and chisels. It is then washed, to free it from the impurities which adhere to it; split into thin leaves or pieces; and assorted into different kinds, according to their goodness, purity, and size. We are informed by the Abbé Haüy, that plates of mica, a yard or more in width, have been obtained from the mines in some parts of Russia.

Thin plates of mica are adopted, in many parts of Siberia and Muscovy, to supply the place of glass for windows. In the shipping of Russia it is considered preferable to glass, as the concussion produced by the firing of the guns does not shatter it. It is employed instead of window glass in Peru and New Spain; also in Pennsylvania; and in this country in manufactories. Mr. John Crosley employed it effectually for the glazing of greenhouses. Mica may be advantageously substituted for horn in lanterns, as it is not only more transparent, but it is not susceptible of injury from the flame of the candle. It has, however, the inconvenience of soon becoming dirty; and of having its transparency destroyed by long exposure to the air. Mica is much used for enclosing objects that are intended to be viewed by microscopes; it is not so good as thin glass, as from its softness it soon becomes scratched.

So plentiful is this substance in Bengal, that, for the value of five shillings, as much of it may be purchased as will yield a dozen panes, each measuring about twelve inches in length and nine in breadth, and so clear as to allow of ordinary objects being seen through them at the distance of twenty or thirty yards.

Mica, when powdered, is sold by stationers on the Continent, in place of sand, for absorbing ink in writing, but it does not dry sufficiently quick to be of much use in this respect. In Russia it is employed in different kinds of inlaid work. It is sometimes powdered, and intermixed with the glaze in particular kinds of earthenware. The heat which melts the glaze has no effect on the mica: hence it appears, dispersed throughout the glaze, like plates or scales of silver or gold. Some artists use it in making artificial avanturines (85).

It must be observed that the best mica is of a pure pearl colour; and, when split into leaves, presents a smooth surface.

The Black Mica, Peach-blossom coloured Mica, and Lepidolites, from Rosna, in Moravia, are mere large foliated varieties of common mica, such as that from Zinnwald, in Bohemia, and Altenberg.

SOAPSTONE FAMILY.

124. *STEATITE (in part), or SOAPSTONE, is a soft and unctuous substance, which has much the appearance of soap; and is generally of a white or grey colour, intermixed with greenish or yellowish shades.*

It is somewhat more than twice as heavy as water; and is distinguished from indurated talc (135) *by not splitting, like that substance, into slaty fragments. It is about twice and a half as heavy as water. It is principally composed of silica and magnesia, with alumina, water, &c.*

In the counties of Devon and Cornwall, and the islands in the vicinity of the Lizard Point, this mineral is found in considerable abundance. It possesses many of the same properties as fullers' earth, and is, like that substance, employed in the scouring of woollen cloths. When mixed with water it may be formed into a paste; and, in this state, it is easily worked, like clay, for the manufacture of earthenware. In the porcelain manufactory at Worcester, according to Klaproth, considerable quantities of steatite were employed. Dr. Thomson states that it is used in the manufacture of porcelain at Swansea. According to Dr. Shaw, the Arabs use it in their baths, instead of soap, to soften the skin.

As it becomes hard in the fire, and does not alter its shape, this substance has been successfully adopted for imitations of engraved gems. The subjects are engraved upon it with great ease in its natural state; it is then exposed to a strong heat; afterwards polished, and then coloured by means of certain metallic solutions.

We are informed by travellers, that some of the savage tribes eat steatite, either alone, or mixed with their food, to allay hunger. The inhabitants of New Caledonia eat considerable quantities of it. Humboldt, the South American traveller, assures us that the Otomacks, a savage race of people, who live on the banks of the Orinoco, are almost wholly supported, during three months of the year, by eating a species of steatite, or potters' clay, which they first slightly bake, and then moisten with water. M. Golberry says that the negroes, near the mouth of the Senegal, mix their rice with a white kind of steatite, and eat it without inconvenience.

In some parts of Spain a variety of steatite is found, which is used by artists under the name of *Spanish chalk*. When slightly burned, this mineral is sometimes used as the basis of *rouge*.

125. FIGURE STONE *is a kind of steatite, which has, internally, a glimmering and resinous lustre, and a slaty or splintery fracture.*

From its softness, and yet solidity of texture, this mineral can easily be fashioned into various shapes, even with a knife. Hence in China, where it frequently occurs, it is cut into grotesque figures of various kinds, which the French call *magots de la Chine*, into cups, vases, pagodas, snuff-boxes, and other articles.

126. ***MEERSCHAUM, or SEA-FROTH, is a singular kind of mineral, of a yellowish or greyish white colour, sometimes so light as to float in water; when fresh dug it has nearly the consistence of wax.***

If exposed to a strong heat, it becomes so hard as to yield sparks with steel.

The principal use to which meerschaum, or *Keffekil*, is applied, is in the formation of the bowls or heads of tobacco-pipes used by the Turks, and the quantity consumed for this purpose is very great. It is found in a fissure of grey, calcareous earth, about six feet wide, near Konie, in Natolia, where upwards of six hundred men are employed in the digging and preparation of it; and the sale of it supports a monastery of dervises established at that place. It is also found at Valecas, in Spain. The workmen assert that it grows again in the fissure, and puffs itself up like froth. It is prepared for use by being first agitated with water in great reservoirs, then allowed to remain at rest for some time. The mixture soon passes into a kind of fermentation, and a disagreeable odour, resembling that of rotten eggs, is exhaled. As soon as this smell ceases, the mass is further diluted with water, which, after a while, is poured off. Fresh water is repeatedly added, until the mass is sufficiently washed and purified. The meerschaum, in this state, is dried to a certain degree. It is then pressed into a brass mould, and some days afterwards is hollowed out so as to form the head of the pipe. It is subsequently dried in the shade, and lastly is baked. In this state the pipe heads are brought to Constantinople, where they are subjected to further processes. They are first boiled in milk, and next in linseed oil and wax; and when perfectly cool, are polished with rushes and leather. The boiling in oil and wax renders them capable of receiving a higher polish than could otherwise be given. When thus impregnated, they also acquire, by use, various shades of red and brown, which are thought to add considerably to their beauty. In Turkey, and even in Germany, meerschaum pipes that have been much used are more valued than those newly made, and this solely on account of the colouring they possess. Indeed there are people in those countries whose only employment consists in smoking tobacco pipes, until they acquire the favourite tints of colour. By long use the heads become black: but if boiled in milk and soap, they are soon rendered white again.

It is asserted that the Turks spread meerschaum on bread, and eat it as a medicine; and that they cover with it the heads and eyes of dead bodies, previously to interment. As it lathers with water like soap, it is used by the Turkish women for washing their hair; and as it absorbs oily matters, it is occasionally used, as fullers' earth is with us, for the cleansing and scouring of cloth.

We are informed by Pliny, that a kind of bricks were made by the ancients, so light that, when dried, they would float in water. He describes them to have been formed of a spongy kind of earth, and to have had some resemblance to pumice stone, which he says might perhaps be applied to the same purposes as these bricks, if it could be obtained and wrought in sufficient quantity. Bricks of a similar description have lately been made of a mineral substance found near Sienna, in Italy, and which is supposed to be meerschaum.

A kind of meerschaum has lately been discovered, in veins, in the serpentine (132) of Cornwall.

127. *BOLE is an earthy mineral, of a yellowish or reddish brown colour, soft, and somewhat unctuous to the touch, and generally found in a massive state.*

It exhibits internally a glimmering lustre; and when put into water, immediately absorbs it, and breaks down into small pieces with a crackling noise. This mineral is further distinguished by its fracture being conchoidal, or appearing somewhat like the impression of a shell; and by its adhering strongly to the tongue.

Although bole is at present little used except as a basis of tooth powder, and a coarse kind of paint, it was formerly considered an important article in medicine, and used as an astringent. We are informed that tobacco pipes are sometimes made of this mineral; and that it is employed as an ingredient in the glaze of some kinds of earthen ware.

It is chiefly imported from the Levant; though it has also been found in considerable beds in Silesia and Saxony, in Italy and in Ireland, in the cliffs of the Giant's Causeway.

128. *LEMNIAN EARTH, or SEALED EARTH, is a kind of bole of a yellowish grey, or yellowish white colour, sometimes marbled with rust-like spots.*

It is distinguished from bole by being dry, and not unctuous to the touch, dull internally, adhering slightly to the tongue, and its fracture being earthy.

With the ancients this mineral was considered an almost invaluable medicine. They procured it chiefly from Armenia, and the island of Lemnos, in the Grecian Archipelago. The Lemnian bole was held so sacred that it was dug in the presence of the priests of Venus, and, after having been mixed by them with goats' blood, was moulded into cakes, which were impressed with the figure of a goat to authenticate them. This done, it was administered as a consecrated remedy; and even so lately as the sixteenth century, the vein of bole in Lemnos was annually opened on the sixth of August, and, after certain prayers by the priests, so much of the earth was taken out as was thought sufficient for the consumption of the ensuing year. The entrance was then closed, and the severest punishments were denounced against any one who should open it without permission. A portion of the earth was sent to Constantinople, where it was made into small cakes, and sealed by the ministers of the Emperor; the remainder was prepared in the island, and was impressed with the seal of the Governor. Not many years ago, it was customary with certain empirics on the Continent, to sell this substance in sealed packets, as a nostrum of great value, and particularly as possessing astringent properties of a very extraordinary nature.

129. *FULLERS' EARTH is a well-known mineral, generally of a greenish colour, more or less mixed with brown, grey, or yellow: of a soft and almost friable texture, and somewhat unctuous to the touch, adhering slightly to the tongue.*

When put into water it immediately absorbs it, and breaks down into a fine pulp. It is a compound of silica, alumina, and water; and is nearly twice and a half as heavy as water.

This earth is valuable for its property of taking grease out of woollen and other cloths, which, on a large scale, is effected by the operation called *fulling*, whence its name has been derived. This operation, which is performed by a kind of water-mill, called a *fulling-mill*, is particularly necessary with respect to new cloths, to extract from them the grease and oil that have been used in their preparation.

Fullers' earth was formerly considered an article of such importance in England, that its exportation was prohibited under severe penalties. It was then employed for most of those purposes for which soap has since been so extensively applied. In the dressing of cloth it is now so indispensable, that foreigners, although they can procure the wool, are never able, without fullers' earth, to reach the perfection of the English cloths: and, in this country, incalculable quantities of it are consumed. As an article of domestic utility, it might be much more frequently used than it is, as a substitute for soap, in the cleaning and scouring of wooden floors and wainscots.

There are extensive beds of fullers' earth in several of the counties of England, occurring in the green sand and oolitic formations. London is principally supplied from those of Kent, Sussex, and Surrey. At Wavedon, near Woburn, in Bedfordshire, a peculiarly fine kind is dug up from pits at the depth of ten or twelve feet below the surface of the ground; and no country in the world is known to produce fullers' earth of quality so excellent as that obtained in England.

TALC FAMILY.

130. *JADE, or NEPHRITE, is a very hard and tough species of stone, of a greenish or olive colour, somewhat unctuous to the touch, and looking as if it had imbibed oil.*

It is found massive, in blunt-edged or rounded pieces; is rather more than twice and a half the weight of water, and is principally composed of silica and magnesia.

Nothing has so much tended to make this stone known, as a superstitious notion that a piece of it suspended to the neck will dissolve stones in the kidneys. Hence has been attained its appellation of nephrite, or divine stone; and hence have originated all those numerous amulets in the form of oval plates, hearts, fishes, birds, &c. pierced with holes for ribbons to pass through, which are seen in collections of the curious. Some of the Indian nations made talismans of jade.

From the roughness and tenacity of this stone, in addition to its hardness, it is very difficult to be cut and polished; and even the best polish which it is capable of taking is so imperfect, that a person ignorant of its nature might consider it to be merely smoothed and rubbed with oil. The ancient artists executed in it many beautiful and delicate figures; and it is impossible not to admire the industry and perseverance by which they produced even chains, and other hollow kinds of work, in jade.

The Turks cut it into handles for sabres and daggers, and into several kinds of vessels, to which they attach great value. In the mineral gallery of the British Museum, there is a very valuable mass of this mineral, modelled into the form of a tortoise.

Jade occurs in granite (251) and gneiss (255) in Switzerland; but the most beautiful specimens of this mineral are brought from Persia, Egypt, and Siberia. It has been found in South America.

131. AXESTONE *is a kind of jade, but differs from it in having a slaty texture ; and in being less transparent and less tough.* This stone is found in China, New Zealand, and on the banks of the river of Amazons, in America: and it is said that several of the tribes of American Indians form of it the axes which they use in place of iron. To explain how these people have been enabled to work a substance so rebellious as this is even to the file, and to other instruments of steel (of which they know not the use), it has been presumed that, when the stone is first taken from the earth, it is considerably less hard than when, by drying, its humidity is evaporated: that in this state they work it, and subsequently harden it, in some peculiar manner, by exposure to heat.

132. *SERPENTINE is a stone which, when polished, has a near resemblance to marble, is of a dark green colour, or reddish ; variously streaked, and spotted with lighter green, red, brown, and yellow.*

It is found in beds, and in a massive state ; is translucent at the edges ; and, when pounded, the powder feels soapy to the touch. It is principally composed of silica and magnesia tinged with oxide of iron, and is rather more than twice and a half the weight of water.

There are few stones likely to prove more valuable in ornamental architecture, both for beauty and durability, than this. It admits of an excellent polish, which is not easily injured by the effects of air or water. It is also too hard to suffer the same inconveniences of being scratched or broken as marble; and its colours are stated to be indestructible. And such is the size of many of the blocks of serpentine, that columns of almost any dimensions may be wrought out of them.

The serpentine obtained from the Island of Anglesea, is lately known by the name of *Mona marble*. The prevailing colours of this stone are red and green. It is manufactured into chimney pieces, slabs, columns, and other articles ; and its great beauty, and its excellence, in many respects, over the generality of marbles, recommend it strongly to the public notice.

The chief places in which serpentine has hitherto been found are near Bareuth, and Zöblitz, in Saxony ; in some districts of Cornwall; about six miles west of the Parys copper mine, in the island of Anglesea; at Porsoy, in Banffshire, and other parts of Scotland; and at Cloghan Lee, in the county of Donegal, Ireland.

At Zöblitz there are some extensive manufactories, in which serpentine is made into vessels and ornaments of various shapes, that are carried for sale over nearly all parts of Germany. Several hundred persons are there employed in the working of this stone.

The name of serpentine is derived from some of the varieties appearing coloured and spotted like a serpent's skin. This stone, when found intermixed with primitive limestone, or crystalline white marble, differs in no respect from the celebrated *verde antico* marble (148).

Garnets, magnetic ironstone, asbestos, &c. are occasionally found imbedded in serpentine.

133. *POTSTONE, or LAPIS OLLARIS, is a greenish grey stone, unctuous to the touch, and so soft when first taken from the quarry as to yield to the pressure of the nail, yet not easily broken.*

It is found in a massive state.

In consequence of the softness and tenacity of this stone, it can be turned upon a lathe, and otherwise cut and wrought with great ease. Hence, in Egypt, Lombardy, Norway, and other countries where it is found, it is formed into various kinds of culinary vessels and lamps, which harden in drying, and are capable of withstanding the strongest action of fire. Vessels of this description were known to the ancients; and are particularly mentioned by Pliny, who speaks of some that were highly wrought being very valuable.

Potstone is used in some countries for the lining of stoves, furnaces, and ovens; and it is so durable as to have, in some instances, stood unimpaired for several hundred years.

On the banks of the Lake Como there were some extensive quarries of potstone, which had been worked from the beginning of the Christian era. These quarries, however, fell in, on the 25th of August, 1618, and destroyed the neighbouring town of Pleurs; which had previously obtained by means of them an annual revenue of about sixty thousand ducats.

134. *COMMON, or VENETIAN TALC, is an earthy stone, capable of being divided into plates or leaves, which are soft and unctuous to the touch, somewhat transparent, and usually of a greenish silvery white colour.*

It leaves a white trace when rubbed upon any object.

Mica and talc have a near resemblance to each other; but the plates of the former, when bent, are elastic, while those of the latter are not.

Venetian talc is very abundant in the Tyrol and the Valteline. In a state of powder it renders the skin soft and shining; a property which appears to have suggested the idea of employing it as the basis of the cosmetic named *rouge*. This is prepared by rubbing together, in a warm mortar, certain proportions of carmine, or extract of the flowers of *Carthamus tinctorius*, with finely powdered talc, and a certain portion of oil of benzoin.

The Romans prepared a beautiful blue or purple colour, by combining pounded talc with the colouring fluid of some particular kinds of testaceous animals, that are found among the submarine rocks of the coasts of the Mediterranean. According to Tavernier, the French traveller, the Persians whiten the walls of their houses and gardens with lime, and then powder them with a silvery white kind of talc, which, he says, gives to them a very beautiful appearance. Talc is now used by the Chinese, and was formerly used by the Europeans, in medicine.

135. *INDURATED TALC, or FRENCH CHALK, is a heavy mineral, of a close texture, and generally of a greenish colour; unctuous to the touch, and having a somewhat slaty fracture.*

It is found in a massive state; and leaves a white trace when rubbed upon any object.

This is a well-known substance, which is in great request by carpenters, tailors, hat-makers, and others, as the lines that are drawn with it are not so easily effaced as those that are made with chalk, and particularly as they remain unaltered even under water. If lines be traced with it on glass, they remain invisible, or at least are scarcely perceptible by the naked eye, till breathed upon. This, it has been conjectured, in part depends on the comparative softness of the substance with which the impression is made; the condensation of the breath taking place more readily on the glass than on the talc that covers it, and the impression of the talc becoming more apparent by the contrast.

Indurated talc, when reduced to powder, is frequently employed for the purpose of removing stains, occasioned by grease, from silk and cloth. This it does effectually, and, in general, without injuring even the most delicate colour. Like potstone, it is sometimes manufactured into culinary vessels.

This mineral is found in several parts of the continent of Europe; and in Cornwall, Scotland, and the Shetland Islands.

136. *ASBESTOS is a greenish or silvery white mineral, of a fibrous texture, which is found in many mountainous countries of the Continent, in the island of Anglesea, and in Scotland. It occurs in shapeless masses, and varies much both in weight and hardness.*

The name of asbestos is derived from the Greek language, and signifies that which is inconsumable. This mineral, and particularly a silky variety of it, in long slender filaments, called *amianthus*, was well known to the ancients. They made it into an incombustible kind of cloth, in which they burned the bodies of their dead, and by which means they were enabled to collect and preserve the ashes without mixture. In the manufacture of this article they were not able to weave the asbestos alone, but in the loom were obliged to join with it linen or woollen threads, which were afterwards burned away.

Incombustible cloth was purchased by the Romans at an enormous expense. Sir J. E. Smith, when at Rome, saw a winding sheet of amianthus in the Museum of the Vatican. It was coarsely spun, but as soft and pliant as silk. The person who attended him set fire to one corner of it; and the same part burned repeatedly with great rapidity and brightness, without being at all injured. This interesting relic was discovered, in the year 1702, in a funeral urn, and contained burned bones, together with a quantity of ashes. It was nine Roman palms long, and about seven in width, and had been deposited in the Library of the Vatican by order of Pope Clement the Eleventh.

Cloth made of amianthus, when greased, or otherwise contaminated with dirt, may be cleansed by throwing it into a bright fire. In this process the stains are burned out, and the cloth is restored to a dazzling white colour. Pliny informs us, that he had himself seen table-cloths, towels, and napkins of amianthus, taken from the table of a great feast, thrown into the fire, and burned before the company; and by this operation, he says, they became better cleansed than if they had been washed.

The inhabitants of some parts of Siberia manufacture gloves, caps, and purses of amianthus; and in the Pyrenees it is wrought into girdles, ribbons, and other articles. The finest girdles are made by weaving the most beautiful and silky filaments with silver wire. These are much prized by the women, not only on account of their beauty, but from certain mysterious properties they are supposed to possess.

The shorter fibres of amianthus have sometimes been manufactured into paper, but this is too hard for use. It has, indeed, been proposed to preserve valuable documents from fire, by writing them on paper made of amianthus. Such a plan might deserve consideration, if we possessed fire-proof ink; but until this be obtained, the fire-proof paper will be of little use.

When several of the long fibres of this mineral are placed together, they may be formed into wicks for lamps; and it has been asserted that such wicks are incombustible. Kircher, the German philosopher, had a wick made of amianthus which burned for two years without injury, and was at last destroyed by accident. It is said that the inhabitants of Greenland make use of amianthus for the wicks of their lamps.

This substance, although it will long continue unaltered in considerable heat, yet if the heat be much increased, it ceases to withstand it, and is melted into a dense kind of scoria. In the island of Corsica, asbestos is advantageously employed in the manufacture of pottery. Being reduced into fine filaments, it is kneaded with clay; and vessels made of this mixture are said to be lighter, less brittle, and more capable of sustaining sudden alterations of heat and cold than common earthenware.

Asbestos is occasionally found of a blue and yellow colour, in South Africa, constituting what is termed *Krokydalite:*

there are many other varieties known by the names of *mountain wood, mountain cork, schiller asbest, nectic asbest,* &c.

CHRYSOLITE FAMILY.

137. *CHRYSOLITE, or PERIDOT, is a soft gem, usually of a yellowish green colour, though sometimes it is grass green, or bluish green, but with a tinge of brown.*

It is generally found in fragments and rounded pieces, and rarely crystallized. In the latter case its regular form is an eight, ten, or twelve-sided prism. It is a silicate of magnesia, with a little iron.

Though scarcely harder than glass, and consequently inferior to most other gems in lustre, these stones are not unfrequently used in jewellery, particularly for necklaces and ornaments for the hair; and when well matched in colour, and properly polished, their effect is very good. They are, however, too soft for ring-stones; for, by wearing, they soon become dull on the surface. But it is said that their lustre may, in some degree, be restored by immersing them in olive oil.

Chrysolite is imported from the Levant, and is said to be found in Upper Egypt, and on the shores of the Red Sea.

Olivine is a purer state of chrysolite, and when the protoxide of iron enters into its composition in excess, it forms the mineral known as *Hyalosiderite.*

BASALT FAMILY.

138. *BASALT is a greyish black and coarse grained stone, which is usually found either in globular distinct pieces or in groups of large columns, each of which has from three to eight sides, and is divided horizontally into numerous stones, that very exactly lie upon or fit into each other. Its principal ingredient is hornblende, or augite; and is, therefore, very variable in its composition. Silica, alumina, and lime, form the basis of this mineral.*

The most remarkable assemblages of basaltic columns that are known are those called the *Giants' Causeway*, on the coast of Antrim, in Ireland, and the *Cave of Fingal*, in the island of Staffa, one of the Hebrides, or Western islands of Scotland. It also occurs at Hasenberg in Saxony.

The former, which is believed by the common people to have been an artificial production, the vast labour of giants who formerly inhabited the country, consists of an irregular group of many thousand jointed pillars. Most of these are of considerable height; are in general five-sided, fifteen or sixteen inches in diameter, and each perfectly distinct from top to bottom, though so closely and compactly arranged that it is scarcely possible to introduce any thing betwixt them. This assemblage of columns extends into the sea to a distance unknown, and along a tract of the sea coast of nearly six miles.

The Cave of Fingal is accessible only by sea, and is formed by ranges of massive basaltic columns, fifty feet and upwards in height. The stone of which these columns are formed very much resembles that of the Giants' Causeway.

In several parts of the world are large masses of basalt, composing entire insulated mountains of a somewhat conical form. They are considered by some writers as volcanic productions, but the proofs of this are by no means satisfactory.

Amongst the uses to which basalt has been applied, two of the most important are as materials of an excellent and durable kind for building and paving. When burned and pulverized, these stones impart to mortar with which they are mixed the property of hardening under water. They easily melt, without any addition, into an opaque and black glass; and from them, under a certain modification, bottles of an olive-green colour, and of extreme lightness, but great strength and solidity, have been formed. Some of the kinds have been advantageously employed as millstones. Basalt is occasionally used by artists for touch or teststones, to ascertain the purity of gold and silver; and gold-beaters and book-binders, on the Continent, usually make their anvils or beating blocks of it.

Basalt, though harder, more brittle, or less pleasing in its colours than marble, was in considerable esteem among the sculptors of antiquity, on account of its great durability. Many fine works were consequently executed by them in this stone. Pliny, who has described several, states that the columns of it were sometimes so large as to admit of several figures being wrought out of them. The Emperor Vespasian had an entire statue, accompanied by the figures of sixteen children, cut out of a single column of basalt; this statue he placed in the Temple of Peace, and dedicated it to the Nile. The famous statue of Minerva, at Thebes, is described by travellers to have been formed of basalt. Antiquities of basalt are always in a much better state of preservation than those of marble. Even such as are dug out of the earth still retain their original polish; and the finest touches of the chisel upon them are still unimpaired.

ORDER II.—SALINE STONES.

139. LIME, OR CALCAREOUS FAMILY.

LIME, after it has been freed from extraneous matters by burning, is a mineral of a whitish colour, and of a pungent, acrid, and caustic taste. It has the property of changing vegetable blue colours to green, of corroding and destroying animal substances; and absorbing water and carbonic acid from the atmosphere. Water holds twice as much lime in solution at 32° *Fahr. than it does at* 212°, *the boiling point of water. It is about twice and one-third the weight of water.*

This mineral is found in nearly every country of the globe: but, in a native state, has hitherto not been discovered except in combination with some acid [1]. The process of purifying lime, or of depriving it of the acid with which it is combined, is by burning. This is done in a large kind of furnace, called a *kiln*, where the limestone and fuel are heaped in alternate layers. After it has gone through this process it is called *quicklime*, and has the above-mentioned appearance and qualities.

The purest lime is to be obtained from the white Carrara marble. The ancients were acquainted with the mode of obtaining quicklime; it was used in medicine by Hippocrates.

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[1] With *carbonic acid* (26) it forms common limestone, marble chalk, and some other substances; with *sulphuric acid* (24) it constitutes alabaster, or gypsum; and with *fluoric acid* (27) it becomes that beautiful production, the Derbyshire spar.—All these, having lime for their bases, are denominated CALCAREOUS SUBSTANCES.

The uses of lime are numerous and important. The principal of these is in the formation of *mortar*, or cement for buildings. For this purpose it is first *slaked*, by having water poured upon it: a violent heat is thereby excited, and the lime falls into powder: it is then formed into a paste by working it with water and sand, or ashes, &c. This mixture when dry, becomes extremely solid, hard and durable. Various examples might be mentioned of buildings nearly two thousand years old, where the lime is, at this day, as hard as the stones which it cements together. Lime is also used largely in agriculture as a manure. It is employed in the refining of sugar, in the manufacture of soap, in the melting of iron, and by tanners, in a state of solution, for dissolving the gelatinous parts of skins, and removing the hair from them. The manufacturers of glue mix it with that article, for the purpose of adding to its strength, and preventing its becoming flexible by the absorption of moisture. This mineral, if well dried, pounded, and mingled with gunpowder, in the proportion of one pound to two, is of great utility in the rending of stones and rocks: the mixture, it is said, will cause an explosion equal in force to three pounds' weight of gunpowder. Lime, if swallowed or inhaled, is a virulent poison. Hence persons employed in lime-works are subject to very distressing complaints; and hence, if bread be adulterated with lime, it is extremely injurious. Notwithstanding this pernicious quality, lime is of considerable use in medicine. It is chiefly given in a state of solution in water, called *lime water*.

It is found in the three kingdoms of nature, animal, vegetable, and mineral. In the first it is very abundant, and, combined with carbonic (26) and phosphoric (25) acids, forms the basis of the bones. In vegetables, it is found in combination with the vegetable and mineral acids.

The superb basin of Lampi, one of the principal reservoirs which furnish the canal of Languedoc with water, was, some years ago, found to leak at the junction of the stones. The engineer who had the direction of the works caused lime to be slacked in the water. This, passing through the apertures betwixt the stones, formed a crust, or very white covering, over its whole surface, of so hard and durable a nature, that it now constitutes one solid and undivided substance, which the water cannot penetrate.

CARBONATE OF LIME.

140. *COMMON LIMESTONE is a variety of carbonate of lime, or of lime in combination with carbonic acid* (26), *which is harder and heavier than chalk, usually of a greyish or blue colour, and is always found in a massive state.*

Vast mountains of limestone occur in several countries of the globe; but no where is it more abundant than in some parts of England and Wales. It forms, in particular, nearly the whole mountainous districts of Derbyshire and Shropshire; and encloses, in its substance, numerous veins of lead ore, calamine, and other important mineral productions, together with the remains of fossil infusory animalculæ, and shells.

Its uses have been already described (139).

141. *CHALK is a white or yellowish earthy limestone, or carbonate of lime, forming the uppermost of the secondary series of strata.*

It is found abundantly in many of the southern counties of England, and is usually procured from large open places, called chalk-pits, by digging. In some parts of Kent, however, the workmen save themselves, in this respect, much trouble. They undermine the sides of hills to a certain depth, then dig a trench at the top as far distant from the edge as the mining extends at the bottom. This trench they fill with water, which soaks through during the night, and the whole mass is thereby loosened, and falls down before morning.

The harder and more compact kinds of chalk are cut into blocks, and used as building stones. When burned and mixed with sand, &c. chalk becomes mortar: nearly all the houses in London are cemented with chalk mortar. The lime obtained from blue limestone and greystone is, however, generally considered to make better mortar than that obtained from chalk. The former is also used as lime in agriculture. As it readily imbibes water, it is used by starch-makers, chemists, and others, to dry precipitates upon. With isinglass or the white of eggs it forms a valuable lute or cement. By artists it is in request for the construction of moulds to cast metals in; and by carpenters and others as a material to mark with. Chalk is one of the most useful absorbents employed in medicine: it likewise gives name to officinal mixtures.

When pounded and cleared from gritty particles, it has the name of *whiting*. In this state it is used for the cleaning and polishing of metallic and glass utensils; for whitening the ceilings of rooms, and numerous other purposes. *Vienna white*, which is used by artists, is perfectly purified chalk.

In No. 56 of the Inventors' Advocate, the following notice of the animalcular constitution of chalk is recorded: Professor Ehrenberg in 1836 announced, that in examining chalk and other calcareous rocks, he had discovered the characteristic fact, that the smallest grains of chalk appeared to consist of regular elliptical particles, possessing a crystalline aspect. Since that period he has ascertained, that the chalk of Puskarész, in the east of Prussia, and that of the island of Rugen, of Schonen, Denmark, Gravesend, Brighton, Ireland, Mendon near Paris, Girgenti in Sicily, presents two different structures: the one inorganic, distinguished by its regular elliptical structure and granular slaty disposition, and the other organic, consisting of microscopical shells. By mixing Canada balsam, by the assistance of heat, with the dry chalk, in a fine state of division, Ehrenberg found that the chalk contained an immense number of microscopical animalculæ, hitherto unknown, varying in size from one twenty-fourth to one hundred and eighty-eighth part of a line (the line being one-twelfth of an inch). Of the well preserved minute shells, there are contained in one-fourth part of a cubic line, or in one-twelfth of a grain of chalk, frequently 150 to 200 in number, equal to 600; 800 in each cubic line, or 1800; 2400 in each grain, and from 1.036.000 to 1.382.000 in each cubic inch; and hence in one pound of chalk the number far exceeds ten millions (Microscopic Journal, vol. i. p. 85.)

142. *MARBLE is a compact and close-grained kind of limestone, so hard as to admit of being polished. It is this quality which principally distinguishes it from other calcareous substances. It is, of course, a carbonate of lime.*

Although nearly all the numerous kinds of marble may be burned, and thus converted into quick-lime, their use in ornamental architecture, &c. is so important as, in general, to prevent their application to the inferior purpose of mortar. Marble has been known from a very early period. The book of Esther, in the Old Testament, describes the palace of Ahasuerus to have had "pillars of marble," and the pavement of "red, and blue, and white, and black marble."

It would be impossible, in an elementary work like the present, to describe, or even to enumerate, all the different kinds of marble which were known to the ancients, or are known to the moderns. But it is, perhaps, requisite that an account should be given of some of the most important of them.

GREEK MARBLES.—143. PENTELIC MARBLE *is of a beautiful white colour, and nearly resembles the Parian marble* (145) of the Italians; but it is in coarser granulations. Sometimes it is splintery. It was obtained from quarries on Mount Pentelicus, near Athens, and was generally preferred, by the Grecian artists, to Parian marble. The Pantheon was built entirely of Pentelic marble; and many of the Athenian statues, and works carried on near Athens during the administration of Pericles, were executed in it. Dr. Clarke, however, has observed, that while the works wrought of Parian marble remain perfect to the present time, those of Pentelic marble have been decomposed by the atmosphere, and sometimes exhibit a surface as rude and earthy as common limestone. There are numerous examples of Pentelic marble in those works of Phidias which form the Elgin collection in the British Museum.

144. GREEK WHITE MARBLE.—*The Marmo Græco, of Italian artists, is of a snow-white colour, in fine granulations;* and somewhat harder, and consequently capable of a higher polish, than most other white marbles. It is found near the river Coralus, in Phrygia.

145. PARIAN MARBLE *is of a snow-white colour, inclining to yellowish white.* It is obtained from quarries in the island of Paros, is finely granular, and, when polished, has somewhat of a waxy appearance. Parian marble hardens by exposure to the air, and is one of the most permanent kinds that is known. Varro and Pliny each state that it was named *lychnites*, by the ancients, from a Greek word,

signifying a lamp, because it was generally hewn in quarries by the light of lamps. The finest Grecian sculpture that has been preserved to the present time is of Parian marble. The principal statues of it now extant are the Medicean Venus, the Diana Venatrix, and Venus leaving the Bath. It is also Parian marble on which the celebrated tables at Oxford are inscribed.

ITALIAN MARBLES.—146. Carrara Marble, the purest of all the kinds with which we are acquainted, is to this day obtained from quarries near the town of Carrara. *It is of a brilliant white colour, has a granular texture; and, when broken, sparkles like sugar.* This marble, which is almost the only one in use by modern sculptors, was also quarried and wrought by the ancients.

It is susceptible of a high polish, and is applicable to every species of sculpture, except when, as is too often the case, dark veins intrude, and spoil the beauty of the work. In the centre of the blocks a beautiful kind of rock crystals, called *Carrara diamonds*, are sometimes found. It forms the purest lime when burnt.

During the late war with France, the exportation of statuary marble from the countries under the dominion of Buonaparte was prohibited; and, at one time, it became so scarce in England, as to be sold at the rate of more than seven guineas per cubic foot. The block of marble for the statue of his late Majesty (Geo. III.) in the great Council Chamber at Guildhall, London, was stated by the public prints to have cost twelve hundred guineas.

147. Luni Marble *is a snow-white, compact, and finely granular variety,* which was obtained by the ancients from quarries on the coast of Tuscany. It was preferred by the Grecian sculptors, both to the Parian and Pentelic marbles; and it is usually supposed that the Belvidere Apollo, as well as the Antinous of the Capitol, was wrought out of this marble. There is now found at Luni a white marble, variegated with red spots and dots.

148. Green antique Marble, or Verde antique *of the Italians, is a mixture of white marble and green serpentine* (132). This is believed to have been obtained from some part of Italy, but the quarries are not now known.

149. SIENNA MARBLE *is of a close texture, and a yellowish colour, disposed in large irregular spots, surrounded with veins of bluish red, passing sometimes into purple.* It is not uncommon in the vicinity of Sienna, and is in great request, throughout Europe, for chimney-pieces and ornamental furniture.

150. BROCATELLO MARBLE is somewhat like the last; but is also irregularly marked with various shades of red, and, in some parts, with white.

151. MANDELATO MARBLE *is of a light red colour, with yellowish white spots.* It is found at Lugezzana, in the Veronese. Another variety, bearing the same name, occurs at Preosa.

152. VERDE DI PRATO MARBLE *is a green marble, marked with darker green spots,* which is found near the town of Prato in Tuscany.

153. LAGO MAGGIORE MARBLE *is a beautiful kind, white, with black spots and dots.* It has been employed for decorating the interior of many churches in the Milanese.

154. BRETONICO MARBLE.—This beautiful marble, which is found near the village of Bretonico, in the Veronese, *is varied with yellow, grey, and rose colour.*

FRENCH MARBLES.—155. Many valuable kinds of marble are obtained from different parts of the French territory.

156. CAMPAN MARBLE.—Three kinds of marble are known by this name, all of them procured from immense quarries at Campan, near Bagnere, in the Pyrenees. The first, called *Green Campan,* is of a pale sea-green colour, and exhibits, on its surface, lines of much deeper green, forming a kind of net-work. The second, called *Isabel Campan,* is of a delicate rose colour, with undulating green veins. The third variety, the *Red Campan,* is of a deep red colour, with veins of still deeper red. The green variegations in this stone are formed by a talcy mineral, intermixed with the lime-stone.—The Campan marble is well adapted for slabs, tables, chimney-pieces, and other orna-

mental purposes in the interior of buildings; but, if exposed to the weather, the talcose substances perish, and leave hollow spaces, which render its surface rough and uneven.

157. GRIOTTE MARBLE *is of a deep brown colour, with blood-red oval spots, formed by shells.* Its name has been obtained from its brownish colour, being similar to that of the cherries that are called by the French *griotte.* This marble has, of late, been much used in the decoration of public monuments, and in splendid furniture, in France. Some of the ornaments of the Triumphal Arch of the Carousel are made of it. The department of Herault is the part of France from which it is obtained. It sometimes contains large white veins, which destroy the harmony of the other tints.

158. MARQUESE MARBLE.—This, which is obtained from quarries, near the village of Marquese, between Calais and Boulogne, is marked with *different shades and variegations of white and brown.* Of this marble Buonaparte commenced a magnificent column on the heights near the sea, at Boulogne, to commemorate his victories: since his death it has been finished.

159. SARENCOLIN MARBLE *is distinguished by exhibiting large zones, and angular spots of a yellow or a blood-red colour.* It is found at Sarencolin, in the High Pyrenees.

160. ST. BEAUME, or LANGUEDOC MARBLE, *is of a light red colour, marked with white and grey zones, formed by madrepores.* The eight columns which adorn the Triumphal Arch in the Carousel at Paris, are of this marble. It is obtained from quarries at St. Beaume, in the department of Aude.

161. BRECCIA MARBLE OF THE PYRENEES.—One kind of this marble contains black, grey, and red, middle-sized spots in a brownish red ground. It admits of a good polish. Another kind has an orange-yellow-coloured ground, containing small fragments of snow-white colour. Both these are found in the Pyrenees.

SPANISH MARBLES.—162. Few countries are more productive of marble than Spain; and in few countries are the public monuments and buildings more profusely decorated with marble. The vault of the theatre of Toledo is supported by 350 marble columns; and an ancient mosque at Cordova is ornamented with 1200 columns, most of which are of Spanish marble. The palace and church of the Escurial, and many of the churches in Madrid, are decorated with marbles of the most beautiful description.

163. WHITE SPANISH MARBLE.—Near Cordova, at Felabres, three leagues from Almeria, in Grenada, and in some other parts of Spain, white marble is obtained, which is susceptible of a good polish, and is well adapted to the general purposes of sculpture.

164. SEVILLE MARBLE *is a beautiful red variety, with shining red and white spots and veins.* In the vicinity of TORTOSA is found a kind of marble which has a *violet ground, spotted with bright yellow;* and near GRENADA a marble of a *green colour,* which somewhat resembles the celebrated verde antique (149).

165. SPANISH BRECCIA.—There are several beautiful varieties of breccia in Spain. At Riela, in Arragon, there is one composed of angular portions or fragments of black marble, embedded in a reddish yellow base. The breccia marble of Old Castile is of a bright red colour, dotted with yellow and black, and encloses fragments of pale yellow, brick-red, deep brown, and blackish grey colour.

GERMAN MARBLES.—166. Germany abounds in marbles, and affords many kinds which are remarkable both for beauty and singularity. Of these the kind best known is,

167. LUMACHELLI MARBLE.—*This exhibits beautiful iridescent colours, which are sometimes prismatic internally, but more commonly of various shades of red or orange;* whence it has also obtained the name of *fire marble.* Few kinds of marble are more generally admired than this. It has a dark ground, and is marked throughout with the appearance of small whitish shells, which in certain parts refract the most beautiful and brilliant colours. This marble is cut into the tops and bottoms of snuff-boxes, and several other ornamental articles. It is found in veins at Bleyberg, in Carinthia.

168. Many beautiful kinds of marble are obtained from the island of SICILY, particularly one called *Sicilian jasper*, which is red, with stripes like ribbons, white, red, and sometimes green. SWITZERLAND abounds in marbles; PORTUGAL, SWEDEN, and NORWAY, afford few. In the RUSSIAN EMPIRE many have been noticed, particularly among the Uralian mountains. The late Empress Catharine caused an immense palace to be built for her favourite Orloff, which is entirely coated, both inside and outside, with marble. She built the church of Isaac with marbles of different kinds, on a vast space, near the statue of Peter the Great, in Petersburgh. We are at present very imperfectly acquainted with the marbles of ASIA. Dr. Shaw mentions a red marble obtained from Mount Sinai; and Mr. Morier, in his journey through Persia, speaks of a beautiful translucent kind, which he calls *marble of Tabriz*, and the colours of which are light green, with veins sometimes of red, sometimes of blue. He says it is cut into large slabs, some of which he describes to have measured nine feet in length, and five feet in breadth.—Little has been published of the marbles of AFRICA.—In the United States of AMERICA many kinds of marble have been discovered, some of which have been wrought and polished.

169. Few countries produce a greater variety of excellent marbles than the BRITISH ISLANDS. Although these marbles are seldom noticed much beyond the limits of the districts in which they occur, many of them are admirably adapted for ornamental purposes; particularly for slabs and chimney-pieces. It is much to be regretted that we should send to foreign countries for stones which, in many instances at least, could certainly be as well supplied from our own. The following is an enumeration of a few of the most important kinds.

ENGLISH MARBLES.—170. PETWORTH MARBLE, when cut into slabs, is equal both in beauty and quality to many of the marbles imported from the Continent. The Earl of Egremont had at Petworth several chimney-pieces formed of it. Much of this marble was used in the cathedral church of Canterbury. The pillars, monuments, vaults, pavement, and other parts of that venerable structure, have been formed of it. The archbishop's chair is an entire piece of Petworth marble. This marble is found in greatest perfection upon an estate which formerly belonged to the Earl of Egremont, at Kirdford. It lies at the distance of from ten to twenty feet under the surface of the ground, and in strata nine or ten inches in thickness. Petworth marble is also an excellent stone for walls; and for paving it cannot be excelled. When burnt it also constitutes a valuable manure, superior, as some farmers imagine, even to chalk.

171. Purbeck Marble is obtained from the island of Purbeck, in Dorsetshire. *It is of a dark colour, and contains numerous small round shells*, which, when it is cut and polished, mark it with roundish variegations of brown, dark green, and grey. This marble was formerly more used than it is at present. Several of the small columns, and many of the monuments, in the churches of Dorsetshire, and the adjacent counties, are formed of it. But it is not so durable as many other kinds. Wherever it is long exposed to the weather, the surface cracks, splits off, and becomes defaced.

172. Babbicombe Marble is one of the most beautiful kinds that is found in any country. *It varies in colour from light brown to deep red;* large slabs of it have been obtained that are elegantly and diversely marked, some in streaks, others in spots, and others in different coloured shades.

This kind is quarried at Babbicombe, in Torbay, Devonshire, and is extensively manufactured into chimney-pieces in the West of England. An attempt was made some years since to introduce it into London; but from its not being the production of a foreign country this has failed of success.

173. Derbyshire Marble.—There are, in Derbyshire, several kinds of marble, most of which contain an abundance of fossil shells, and other remains of marine animals. At Wetton, near Ashbourne, a beautiful kind is obtained, of a greyish black colour, which contains a vast number of whitish and very minute shells. This has the name of *bird's-eye marble.* Near Monyash a beautiful variety is found, of a cheerful colour, inclining to brown red, and full of large marine figures in all directions; these, when the marble is cut, appear white, and afford a pleasing contrast.

174. Kendal Marble.—Some varieties of black, grey, and brown marble, are wrought near Kendal, in Westmoreland. These somewhat resemble the Derbyshire marbles; and like them are manufactured into chimney-pieces and ornamental slabs for houses. Several of the slabs are found to contain corallines, and the remains of other marine animals, which vary their appearance in a very pleasing manner.

The Mona Marble is a species of serpentine intermixed with white limestone: it has been already described (132).

SCOTTISH MARBLES.—Scotland affords many valuable and beautiful varieties of marble.

175. Tirie Marble.—Few of the British kinds of marble have been more admired than that obtained from Tirie, one of the Western Islands of Scotland. *It is of a reddish, sometimes a delicate rose-coloured tint, and sometimes white; and is always intermixed with other minerals which add to its beauty.* The most common of these is of a black colour, and called horneblende; the others are pale green sahlite, blackish brown mica (123), and green chlorite. In some varieties the hornblende is more abundant than the marble.

176. Assynt Marble.—At Assynt, in Sutherland, *a white marble* has been discovered, which is perfectly solid and pure, and entirely free from blemishes or stains. Blocks or slabs of it may be cut of almost any size that can be required. This marble acquires a smooth surface, but remains of a dead hue; whence, of course, its uses as an ornamental marble are much circumscribed.

177. Isle of Sky Marble.—There is found in the Isle of Sky a marble of a pure white colour, which appears capable of yielding large and valuable blocks. Its fracture is granular and splintery, and its texture fine. It is harder, heavier, and more compact than the marble of Carrara (146); and is apparently well fitted for all the purposes of sculpture. But it has the defect of being very unequally hard. While some parts of the stone are nearly as easy to work as that of Carrara, other parts are so hard as to add a charge of near fifty per cent. to the cost of the working.

178. Sutherland Marble.—Some beautiful specimens of marble of a dark brown colour, veined with whitish, light red, or light brown, are found in the county of Sutherland; which have a close texture, are susceptible of a beautiful polish, and are capable of being wrought into extremely beautiful slabs for chimney-pieces and other ornamental purposes.

179. Glen Tilt Marble *is of a white or grey colour, and veined or spotted with yellow or green; some specimens are nearly white.* The granulations are peculiarly large; and in its aspect and composition the Glen Tilt has great general resemblance to the Pentelic marble (143). This marble attracted the notice of the Duke of Athol, through the suggestion of Dr. Macculloch; and chimney-pieces of it have been made. It is obtained from a valley of the same name in the county of Perth.

180. Blairgowrie Marble.—A few miles from Blairgowrie, in Perthshire, there is an excellent granulated broad-bedded marble, *of a sugar-loaf texture, and as white as the finest statuary marble.* It may be easily raised in blocks and in slabs of great size, perfectly free from blemishes. This marble is supposed to be well adapted for ornamental architecture, but its large sparry texture renders it unfit for the sculptor.

181. Glenavon Marble *is of a white colour, with large granular concretions*, somewhat like spangles, and as large as the scales of fishes. This is a valuable kind; but its situation in the forest of Glenavon, on the property of the Duke of Gordon, is remote and difficult of access.

182. Balliculish Marble.—On the north side of the ferry of Balliculish, in Lochaber, there is a rock of marble of a beautiful *ash grey colour*, and of a fine, regular, and uniform grain, which is capable of being wrought into blocks or slabs of any size, and is susceptible of a fine polish. This marble is finely sprinkled throughout with grains and specks of pyrites (236), and with grains and specks of a beautiful lead ore, which to the eye appears to be rich in silver. If used for ornamental purposes, it would be a bright and beautiful metallic marble.

183. Blairmachyldach Marble.—In the bed of a

river, at the farm of Blairmachyldach, about three miles south of Fort William, is a singular marble, consisting of *a black ground, flowered with white.* It is of a fine close grain, but not very hard. The flowering in it is light, and beautiful, like fine needle-work, or rather resembling the frosty fret-work upon glass windows in a winter morning.

The cutting and polishing of marble appear to have been performed by the ancients nearly in the same manner as it is with us. In polishing, the first substance employed is a sharp, coarse-grained sand. Afterwards a finer sand is used, then emery (58) in different degrees of fineness. These are followed by a red powder called tripoli (119); and the last polish is given with putty.

184. *BLACK MARBLE is a species of limestone, of a uniform black colour, and easily distinguishable by an excessively disagreeable smell, which is emitted on rubbing two pieces together, or striking it with a hammer. It is a carbonate of lime.*

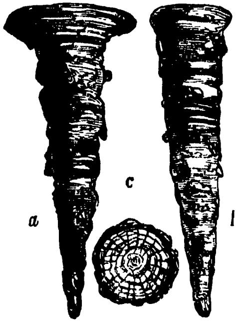
Few minerals are susceptible of a more beautiful polish than this. It is consequently much used for chimney-pieces, small columns, vases, and other ornamental work. There are two quarries of black marble near Bakewell in Derbyshire; and it was manufactured to a considerable extent by Messrs. Brown and Co. at Derby, who fixed up in their ware-rooms a large slab of it as a looking-glass. Black marble is also obtained from various places in Somersetshire.

By the ancients it was much prized. Marcus Scaurus is said to have ornamented his palace with columns of black marble, each thirty-eight feet high; and many of the monuments of ancient Persepolis were executed in it. M. D'Avejan, Bishop of Alais, used a kind of black marble for paving the apartments of his palace; but the friction and heat rendered it so fetid that his successors were compelled to substitute another species of stone in its place.—The pavements, however, of many churches, and of the porticos of several galleries, on the Continent, are of black marble.

185. *CALCAREOUS ALABASTER is a species of limestone of a somewhat whitish or yellowish colour, translucent, and internally splendent or shining.*

It is nearly a pure carbonate of lime; and occurs in masses, hanging, like immense icicles, from the roofs of limestone caverns, and also coating the sides of such caverns.

The formation of this substance is deserving of notice. The water which oozes through the crevices of lime-stone rocks becomes strongly impregnated with minute particles of lime. This water, when it has reached the roof or side of a cavern, is generally suspended, for a considerable time, before a drop of sufficient size is formed to fall by its own weight. In the interval which thus elapses, some of the particles of lime are separated from the water, owing to the escape of the carbonic acid (26), and adhere to the roof.



Stalactite.

In this manner successive particles are separated, and are attached to each other, until what is called a *stalactite*, having somewhat the appearance of an icicle, is formed. (Fig. *a. b.*) These stalactites are sometimes solid, having a lamellar structure; sometimes of a fibrous texture, radiating from the centre to the circumference, as may be observed when they are broken (*c*): having the appearance of fossilized wood; they are sometimes hollow. If the water collects and drops too rapidly to allow time for the formation of a stalactite, it falls upon the floor, and there forms an irregular lump of alabaster, which has the name of *stalagmite*. In some caverns, the separation of the calcareous matter takes place both at the roof and on the floor; and, in course of time, the substance upon each increasing, they meet, and form pillars, sometimes of great magnitude.

Caverns of this kind occur in almost every country. Those of Derbyshire are well known; but the most celebrated stalactitic cave in the world is that of Antiparos, in the Grecian Archipelago.

The kind of limestone formed in the above manner is what the ancients generally denominated *alabaster*. It was employed by them for the same purposes as marble, was cut into tables, columns, vases, and sometimes even into statues. They also used it in the manufactures of vases or boxes for containing unguents. It is supposed to have been a vessel formed of this stone that is mentioned in the Gospel of St. Matthew, where it is said there came unto our Saviour, " a woman having an alabaster box of precious ointment." In the National Museum at Paris there is a colossal figure of an Egyptian deity, which is cut in a kind of alabaster brought from the mountains between the Nile and the Red Sea.

186. *TUFA, or INCRUSTING CARBONATE of LIME, is a calcareous substance deposited by such water as is impregnated with lime.*

It clothes with a stony coat the smaller branches of trees, leaves, moss, plants, and other substances; and thus preserves them from decay, by protecting them from the action of the atmosphere.

Most of the substances termed by the common people *petrifactions* belong to this kind of lime. They are, however, merely covered with, and by no means converted into stone.

The dropping well at Knaresborough, in Yorkshire, is particularly celebrated for them. An overhanging rock, several yards in depth, has been gradually formed of the calcareous matter which the water holds in solution; and from this rock it incessantly drops into the basin below. The persons who have the care of the place constantly keep these petrified articles for sale. Even old wigs and hair brooms are subjected to the powers of the water, to furnish subjects of attraction to the visitors. There are other springs of this description in Oxfordshire and Somersetshire, and particularly at Matlock, in Derbyshire. We are informed that at Dalton, on the south side of Mendip, the workmen not unfrequently discover large pieces of oak enveloped in blocks of stone which are four or five tons in weight.

Blocks of tufa are, in some countries, cut and used for building stones; and this substance, when burned, becomes an excellent lime. Pieces of it are sometimes hollowed, and used as filtering stones.

In the British Museum there is a human skull completely incrusted with stone, which was found in the river Tiber.

The warm baths of Hungary are often so thickly coated at the sides and bottom with tufa, that, during certain intervals, it actually fills up the tubes and canals through which they are supplied. The *rock in tea-kettles* is a somewhat similar deposit from water in boiling.

187. ***PORTLAND STONE, BATH STONE, KETTON STONE, are different kinds of limestone; and of a texture so hard and compact as to be used in building.***

They have their names from the places where they are respectively found, in Portland Island, near Bath, and at Ketton, in the county of Rutland.

Of Ketton stone several of the colleges in Cambridge are built. Its grain has a singular resemblance to the petrified roe of a fish, whence also it is sometimes called *roestone.* Some of the bridges, St. Paul's Cathedral, the Monument, and many of the public buildings of a late date in London, are constructed of Portland stone.

Some of these kinds of stone, when first dug out of the quarry, are so soft that they are readily worked into any form which use or ornament may require. This is owing to the moisture with which they are naturally impregnated; but when they once become hardened, by exposure to the sun and air, they are extremely firm and solid. On the contrary, other kinds of limestone that are used for buildings imbibe and retain the moisture of the atmosphere, in consequence of which they burst or are crumbled by frost.

We are informed that Portland stone was first used in London in the reign of James the First, that monarch, by the advice of his architects, having employed it in the construction of the banquetting house at Whitehall. After the great fire in London, it was brought into general use by Sir Christopher Wren.

188. ***MARL is a combination of clay, silex*** (76), ***and lime; and is denominated calcareous, argillaceous, or siliceous, as the lime, clay, or silex, is most abundant.***

The calcareous part of marl is frequently composed of shells, whence it sometimes has the name of *shell marl;* and where these are predominant it affords an excellent manure for sandy, dry, gravelly, or light lands. Marl likewise produces very beneficial effects on mossy and clayey soils; and these effects, where it has been properly applied, have been observable for twelve or fourteen years. Some kinds of marl that contain but a small portion of lime have been successfully used in the manufacture of earthen-ware.

When it is of a hard nature, it is known as *indurated marl.* This mineral is usually found at the depth of from five to nine feet beneath the surface of the ground, and deposited between beds of clay and sand. It is dug out with spades; and, in the digging of it, in Ireland, the workmen not unfrequently meet with the horns of deer and other curious fossils.

The usual mode by which persons, generally unacquainted with minerals, distinguish this from other clayey substances, is to break a small piece of dry marl into a glass of vinegar. If it be marl it will immediately dissolve with considerable effervescence; and the briskness of the effervescence will be in proportion to the quantity of lime which it contains.

189. *FLORENCE MARBLE is a kind of indurated or hardened marl, and is remarkable for presenting, when polished, the appearance of ruined edifices or rocks.*

This kind of marble is never used in architecture. Little slabs of it are cut for mosaic work, and to be framed like pictures; and the latter, when of considerable dimensions, are sometimes purchased at a high price. If held at a distance from the eye, an inexperienced observer might mistake a slab of Florence marble for a drawing in bistre. Here, observes a French writer, we remark a shattered Gothic castle, there the mouldering fragments of a cathedral; in one part ruined walls, and in another shattered bastions and towers. But when we approach the picture the illusion vanishes, and those imaginary figures, which at a distance appeared to be so correctly drawn, become changed into irregular spots, lines, and shades, which present nothing distinct to the view.

190. COTHAM MARBLE, which when cut and polished also exhibits the appearance of a landscape, is a kind of compact marl. It has its name from being found at Cotham, near Bristol.

191. *LIAS, or CALP, is a kind of limestone of a bluish black or greyish blue colour, and composed chiefly of lime, silex* (76), *clay, and oxide of iron* (21,) *and carbonic acid* (26.)

This stone, when burned, forms a cement which has the property of setting very strongly under water. It is also now much employed in a manner which merits particular notice, for the multiplying of copies of drawings, penmanship, &c. A drawing is made either on the stone by means of a greasy ink or chalk, or on prepared paper with a similar kind of ink. A slab of lias, about an inch thick, is in the latter case slightly heated; the drawing is placed upon it, and both are passed through a rolling press. The paper is afterwards wetted, and washed from the stone; but the ink, being of a gummy, greasy, or glutinous quality, becomes in part absorbed by the stone, and remains. The stone is then ready for the printer. Previously to taking off each impression, the stone is wetted with a sponge, and fresh ink, of the same nature as that with which the drawing is made, is put on with a ball similar to that used by letter-press printers. This is prevented, by the water, from adhering to any part except to the ink that had been absorbed by the stone, from the paper on which the drawing was originally made. Paper is then placed on the stone, both are passed through a rolling press as before, and a perfect impression of the drawing is made upon the paper. This art is called *Lithography*. It has been practised in Europe with great success. It is said that copies of military drawings and orders were, to a very large amount, multiplied by this means at the head-quarters of the armies employed during the last war on the Continent.

An artificial composition is sometimes used instead of lias.

Considerable quarries of this stone are wrought in Germany. It is also found at Leixlip, near Dublin; in beds at Aberthaw, in Glamorganshire; in Dorsetshire; and near Bath; and also at Wilmcots, in Warwickshire, stone for lithography may be obtained, equal, it is said, to any of the German stones.

SULPHATE OF LIME.

192. *ALABASTER, or GYPSUM, is a sulphate of lime (24), which has a shivery and glittering texture; and is of a white colour, tinged with grey or red, and sometimes striped, veined, or spotted. When crystallized, the primitive form of its crystals is a regular four-sided prism.*

Being considerably softer than marble, this mineral is not capable of receiving a good polish. From this circumstance it is, however, the more easily worked. It is manufactured into chimney-pieces, columns, busts, ornamental vases, and lamps; the latter of which transmit a soft and pleasing light. Such is sometimes the transparency of alabaster, that it has been employed for windows; and at Florence there is now a church which receives its light through the medium of this substance.

The ancients, though acquainted with the art of making glass, had not attained the knowledge of reducing it into thin transparent plates; and frequently employed alabaster for windows. Of this stone the Temple of Fortune, which was built by order of the Emperor Nero, was erected. It had no windows whatever, and received only a soft kind of light through its walls; appearing rather as if the light issued from the interior, than that it was admitted from without.

The hot springs of St. Philip, which supply the baths of Tuscany, are so strongly impregnated with alabaster, that artists take advantage of this to obtain impressions of bas-reliefs, by merely exposing their moulds to a current of the water until they become filled with the earthy deposit. These impressions, when taken out, are found to be as hard as marble, and are very beautiful. There are in the British Museum some casts of medals formed from the water of these springs.

When alabaster is deprived of its water of crystallization by heat, it falls into a soft white powder, which on being mixed with water in due proportion, absorbs it so rapidly, that if it be formed into a paste, it dries and becomes hard in a few minutes. In this state it is called *plaster of Paris;* and is employed for the making of statues, casts, and other ornamental work, which though of a beautiful white colour, are very brittle. When mixed with coloured gummy or glutinous substances and sand, it yields plasters of different hues, and has the name of *stucco;* and in this state is used for lining the walls and ceilings of rooms. This plaster is much in request in the northern counties of England, for the floors of dairies, store-rooms, granaries, and other apartments; and when properly formed it constitutes a very smooth and durable flooring.

The fine white varieties of gypsum are used as an ingredient in the composition of earthenware and porcelain; and the glaze or enamel with which porcelain is covered, has the purest gypsum for one of its ingredients. Of late years this mineral has been advantageously employed as a manure for fertilizing some soils.

Gypsum is found in Cheshire, Derbyshire, and on the shores of the Bristol Channel, as well as in several parts of the Continent: it occurs in vast quantity near Paris, and on this account the white powder known as *plaster of Paris* receives its name. That which is imported into this country from Italy and Spain is considered the best.

193. Fibrous Gypsum.—There is a variety of gypsum which has a somewhat fibrous appearance, and which, when cut in a convex form and polished, reflects a light not much unlike that of the cat's eye (86). Hence it is sometimes sold to ignorant persons for that stone. It has also been imposed upon purchasers for the gem called moonstone (113). Fibrous gypsum is cut into ear-pendants, crosses, beads for necklaces, and other female ornaments; but its softness is such as to allow of its being easily injured both by dirt and friction. It is likewise known by the name of *Satin spar.*

FLUATE OF LIME.

194. *FLUOR SPAR, or DERBYSHIRE SPAR, is a mineral composed of lime and fluoric acid* (27).

It sometimes occurs in a massive, and sometimes in a crystallized state, the primitive form of its crystals being a regular octahedron. Its colour is usually bluish, purple, green, yellow, whitish, or a mixture of some of these, and occasionally transparent and colourless. It is rather more than three times the weight of water.

When heated this substance cracks, and shines brightly in the dark. But if kept hot for some time, it ceases to be luminous, and this property cannot be restored to it. If also two pieces be rubbed strongly together, they become luminous in the dark.

When heat is applied it fuses into a kind of enamel, and if the heat is continued until the whole of the fluoric acid is expelled, the residuum assumes a cauliflower appearance.

From this spar are made several kinds of ornamental vases of considerable size, columns, and toys, which, from being extremely varied in their colours and appearance, and admitting of a high polish, are very beautiful. When a piece of fluor spar is to be wrought into a vase, or any similar article, it is first carved with a mallet and chisel into a somewhat spherical form. It is then fixed to a turner's lathe, and with great care is formed into the shape that is required. When this is complete, it has to be polished, which is done first with gritstone and pumice (108), and lastly with emery (58) and putty. The lathes formerly in use were worked by the foot; but those now adopted are worked by machinery, the advantage of the more steady motion of which has been, that ornaments of much more delicate form can now be obtained than before. The manufacture of articles from fluor spar gives employment to a great number of industrious families in Derbyshire. This mineral occurs in several parts of that county, where it has the name of *Blue John*, and where it is obtained from caverns at a considerable depth beneath the surface of the earth. It is also found in various countries both of the European and American continents. It is usually found associated with lead, particularly the sulphuret or *galena*, and is very plentiful in Derbyshire, some parts of Cornwall; Saxony, &c. It is rarely met with in rocks or beds.

The acid produced from fluor spar is called *fluoric acid* (27), and has the peculiar property of dissolving glass and flint, and consequently cannot be kept in glass bottles. Artists, by means of fluoric acid, are enabled to etch on glass, in the same manner as with aqua fortis they do on copper. The process is sufficiently simple. The glass is first a little heated for the purpose of covering it thinly over with wax; then with a needle, or other fine point, the drawing is to be made by cutting through the wax to the surface of the glass. The edges are next to have a little wall of wax raised upon them. This done, the glass must be placed in a horizontal position, and sifted over with fluor spar finely pounded; and lastly, a mixture of one part of sulphuric acid (24) with two or three parts of water is to be poured gently upon it. The acid will be prevented from running off by the wax; and in the course of a little while, if these be cleared away, the glass will be found corroded in all the lines along which the needle passed.

The mode of obtaining fluoric acid for chemical purposes is by pouring sulphuric acid upon the powdered spar in a leaden retort, and applying to it a gentle heat. This acid should be used with great caution; for when applied to the skin it instantly disorganizes it, and produces very painful sores.

195. BARYTES FAMILY.

These minerals are sometimes called *ponderous earths*, and have their name from a Greek word signifying *heavy*. They comprehend all the combinations of barytes with acids.

When purified they form a greyish-white porous substance, which is easily reducible to powder; it has no perceptible smell, but has a harsh and more burning taste than lime, and changes the blues of vegetable colours to green.

Although barytes is one of the most useful chemical tests that we are acquainted with, it is not much employed in the arts, because, when purified, it is found too expensive. It is capable of being made into a very tenacious cement; and painters use a preparation that is made from it as a white colour which will not change. This is sold in the shops under the name of "Hume's permanent white." Barytes taken into the stomach proves a virulent poison; yet a preparation of it is used in medicine, *the Chloride of Barium*, and particularly for the removal of scrofulous complaints. It was first used by Dr. Crawford, in 1790. When finely pounded and mixed with oatmeal, *carbonate of barytes* has been found an efficacious poison for rats. Owing to the insolubility of the latter preparation it is not employed in medicine.

It occurs abundantly in Lancashire, Cumberland, and Sweden; and is known among mineralogists as *Witherite*, owing to its having been first described, and its properties pointed out by Dr. Withering. The form of its crystal is a six-sided prism terminated by six-sided pyramids. It is found in large quantities at Anglesark, in Lancashire, in Siberia, Styria, Sicily, and Hungary, &c. It is more than four and a quarter times heavier than water.

196. *SULPHATE of BARYTES is a mineral formed by the combination of sulphuric acid* (24) *with barytes.*

It sometimes occurs in a state of powder, of a snow white colour, sometimes variously tinged, frequently in shapeless masses, and often crystallized, the primitive form of its crystals being a right rhombic prism. It is not soluble in any other than sulphuric acid, and is nearly four and a half times the weight of water.

With us sulphate of barytes is of no use in the arts. The Chinese, however, employ it as an ingredient in the composition of porcelain; and it is said to form a good manure for clover fields. It is found in various parts of England, and on the continent.

The Bologna Phosphorus, *or* Bononian Stone, *a very remarkable kind of barytes, has its name from being found near Bologna, in Italy.* This substance, when detached, is usually observed in roundish, flat, kidney-shaped pieces, from about the size of a walnut to that of an orange, which have a shining and somewhat fibrous texture within.

When the outer coat of this stone is washed away by heavy rains, it has sometimes the appearance of burnished silver. An Italian shoemaker, in the year 1630, deceived by this appearance, carried home several pieces, hoping, by means of fire, to extract silver from them. But at the same time that he was disappointed in this expectation, he was surprised by a very unlooked-for phenomenon. All the pieces which he had thus attempted to melt, when they were afterwards exposed to the light, became themselves luminous. It is the singular property of the Bologna phosphorus, after it has undergone calcination in a particular manner, to become capable of imbibing so much light on exposure for a little while to the light of the sun, or even to the flame of a candle, that it will afterwards shine in the dark for an interval of from eight to fifteen minutes, like a glowing coal, but without any sensible heat. The light which it emits is sufficient to read by, provided the letters be placed near it. If well prepared, the stone will retain this extraordinary property for five or six years.

The preparation of it is thus conducted. Pieces of sulphate of barytes are made red hot, for a few minutes, in a covered crucible placed in the middle of a fire, and then left to cool. When cool they are pounded in a stone mortar, and sifted. The powder thus formed is made into a paste with a little gum arabic, and divided into long cakes, or cylinders, each about a quarter of an inch thick. These pieces are dried by a moderate heat, and then by degrees are exposed to a more violent heat, with charcoal, in a wind furnace. As soon as the coals of the furnace are half consumed, it must be filled a second time, and the phosphorus must be left undisturbed. When the coals are quite consumed, the ashes must be carefully blown off with a pair of bellows, and the phosphorus will be found at the bottom of the grate.

CLASS II.—SALTS.

ORDER I.—EARTHY SALTS.

ALUMINE FAMILY.

197. *ALUM is a substance of a crystalline, greyish white colour, more or less transparent, the crystal assuming the octahedron form. When purified, it consists of slender, irregular, hair-shaped fibres, and has a sweetish, astringent taste. It is composed of the earth called alumine* (34), *potash, and sulphuric acid.*

The alum of commerce is an artificial production from the different kinds of stones which contain it, although it is sometimes found ready formed, as in the vicinity of Naples, where it effloresces from the earth. That called *Roman alum*, from its being procured from the neighbourhood of Rome, is usually considered preferable to the other sorts; but good alum of our own manufacture is equal to it in quality. The Levant, or *Roche alum*, is said to have had its name from the village of Rocca, the present Edessa, in Syria.

There is a famous alum mine at Tolfa, near Civita

Vecchia, in Italy. The alum is obtained from this mine nearly in a pure state; and it is so extremely hard that it can only be wrought by means of pickaxes and gunpowder. At Solfatara, near Naples, and in other volcanic countries, an abundance of alum is found, in a state of efflorescence from the lava.

The alum of our own country is manufactured from a kind of bituminous shale and slate clay, which is found at Hurlett, near Paisley, and near Whitby, in Yorkshire. This manufactory was first established about the conclusion of the sixteenth century, by Sir Thomas Chaloner, who is supposed to have obtained his knowledge of the process from the alum works which had then lately been introduced into Germany and Spain. The rock of *alum slate*, or *stone*, near Whitby, affords an abundant supply of alum. The workmen tear open the rock; after which the different fragments are loosened, in the form of slaty leaves or plates, that are of a dark grey colour. To obtain the alum, a bed of faggots is formed from ten to twelve feet in depth. By the side of this a scaffold is erected, which enables the workmen to form a pile of mineral about fifty feet long and forty feet high. While this pile is forming the faggots are lighted. By the gradual operation of the heat a calcination takes place, in consequence of which the alum is afterwards rendered capable of being more easily separated than it otherwise would be from the stone in which it was contained, and from other extraneous matters that are combined with it. After this the mineral is washed in shallow vessels, so arranged that the water may be poured from one into the other. By this process the alum becomes suspended in the water, while all the earthy particles subside to the bottom. To this solution concentrated, is added a sub-carbonate of potash, or some other material containing potash. It is now boiled in large leaden caldrons, fixed on cast iron bars, over a furnace. As soon as the contents of the caldrons are brought to a proper state, they are drawn off into casks, where the alum concretes into a mass. The hoops are then taken off, and the alum is broken and left to dry; after which it is packed in casks for sale.

According to Mr. Pereira, the largest alum manufactory in Great Britain is at Hurlett, near Paisley. Here the aluminous schist lies between the coal and limestone.

Alum is an article of indispensable importance to dyers, from its property of fixing the colours in such manner that they cannot afterwards be washed out; it is usually called for this purpose, a *mordant.* By tanners it is in great request for giving firmness to the skins after they have been rendered flaccid in the lime-pits. It is employed in the manufacture of paper, and by engravers, and other artists. In the making of candles, alum is added to the tallow, to render it glossy, and to give it greater firmness and consistence; and likewise fraudulently by bakers. It has a tendency to retard ignition. Paper soaked in alum water does not easily take fire, and is thereby better fitted for the preservation of gunpowder. Such paper is likewise used in the whitening of silver, and the silvering of brass. It has been recommended that ladies' muslin dresses should be dipped in a solution of this substance, for the purpose of rendering them less liable to catch fire. A solution of alum also retards the putrefaction of animal substances, and affords useful, as well as economical, means of preserving natural productions that are imported from foreign countries. Alum is frequently mixed with paste, to prevent its losing its tenacity by the absorption of moisture. It is asserted that bakers occasionally use it as an ingredient in bread, and that its presence may be discovered by thrusting a heated knife into a loaf before it is cold: if free from alum, scarcely any alteration will be visible on the blade, but if the contrary, the surface, when cool, will appear slightly covered with an incrustation of alum. A very important purpose to which alum may be applied is in the purifying and sweetening of water that has become fetid and unfit for use; from five to ten grains of burnt alum, and double or treble that quantity of pounded charcoal, will correct the fetor of a gallon of water. Printers' cushions, and the blocks used for the printing of calicos, are rubbed with burnt alum to remove any greasiness, which otherwise would prevent the ink or colour from sticking. This substance is also occasionally employed by surgeons to stop the bleeding of small vessels, to corrode fungous or proud flesh, and for other purposes in medicine. It is useful as an astringent and styptic, and given to stop bleeding internally with much advantage.

The alum of commerce usually contains a small proportion of the sulphate of iron, varying from five to seven parts in a thousand. The redness of the *Roman alum* depends on the presence of this oxide of iron.

By calcination with sugar or other carbonaceous substance, a spontaneous combustible material is formed, known as *Homberg's pyrophorus.*

198. MAGNESIA FAMILY.

This is a family of minerals which comprehends all the combinations of magnesia with acids.

When freed from extraneous matters, magnesia is a powdery white substance.

It is found in combination with acids in both the organized and inorganized kingdoms of nature. It is obtained by heating the subcarbonate red hot until the whole of the carbonic acid is expelled.

Magnesia is used medicinally as an antacid and laxative for children and adults; it is a very serviceable medicine to the former.

199. *EPSOM SALTS, or SULPHATE of MAGNESIA, consists of magnesia in combination with sulphuric acid* (24), *generally crystallizing in octahedric fibres. A fine variety of salt is found native at Calatayud in Arragon. The* haar salt *(capillary or hair salt) of Idria, and the stalactic cobalt vitriol from Herrengrund in Hungary, are both only sulphate of magnesia, the latter being coloured red by the existence of oxide of cobalt.*

It is said that Epsom salts have been found in the Alps, and in Switzerland, under a powdery form, and sometimes even in masses, or a state of incrustation, on stones and rocks. They are, however, chiefly found dissolved in mineral waters, and particularly in those at Epsom in Surrey, and Seidlitz in Bohemia. Their taste is bitter and unpleasant. So little are the crystals affected by exposure to air, that the Abbe Haüy kept some by him for more than twelve years without any sensible alteration.

These salts are much used in medicine, and are chiefly obtained from the *dolomite* or magnesian limestone, composed of carbonate of lime and carbonate of magnesia; it is obtained from Yorkshire, Nottinghamshire, &c. and is used as a building stone. Dilute sulphuric acid is added to this stone in powder, setting free the carbonic acid, and uniting with the lime and magnesia form a sulphate of those bases; the latter is, by the process of crystallization, separated from the lime, and obtained pure; but more frequently, and in much greater abundance, from the *mother-water*, or *bittern*, left after the making of common salt from sea water, by evaporation.

The Kilburn, Epsom, Seidlitz, Beulah, and the Cheltenham (pure saline) depend upon the presence of the sulphate of magnesia for their purging saline qualities.

The *magnesia* of the shops is prepared by dissolving Epsom salts in water, and adding to the solution half their weight of carbonate of potash (205). The substance that sinks to the bottom is a carbonate of magnesia; and this, washed with a sufficient quantity of water and dried, is a light, soft, and white powder, of an insipid taste. It is the common magnesia of the shops.

Magnesia is used in medicine, both as a carbonate and also when calcined or burnt. It is also employed in some chemical processes; and was in considerable request in the manufacture of enamel and porcelain. If putrid water be agitated with a small quantity of magnesia, it loses a considerable portion of its bad taste and smell.

200. SODA FAMILY.

Soda, like potash (205), is an extremely caustic alkali (42). It has a greyish white colour, and agrees exactly with potash (205) in taste, smell, and corrosive quality, but it is not so heavy.

In a mineral state soda has hitherto been found only in combination with some acid.

Common salt (202) is a compound of soda with muriatic acid, or rather with chlorine (29).

The soda of commerce is obtained from sea-water, and from the ashes of different kinds of plants that grow on the sea-shores, but particularly from that called *Salsola soda*, which is found in great abundance on the coasts of the southern parts of Europe, and from which it has its name. It is sometimes called *barilla*, from the Salsola soda being so denominated in Spain. Barilla is an impure carbonate of soda.

This alkali is of essential use in the arts. When melted with flint or sand, it forms glass, and answers much better for this purpose than potash. In conjunction with oil and lime, it is employed in the manufacture of soap; and it is used as a substitute for soap in the cleaning and bleaching of linen, flannels, and worsted goods. If a weak solution of soda be poured into foul bottles, or casks in which wine has long been kept, it will cleanse them. It may also be successfully used for the cleansing of vessels in which milk has become acid. Saddles, bridles, or boot tops, may be effectually cleaned by means of this liquor, and restored nearly to their original colour and appearance.

The art of *soap-boiling* may easily be illustrated by the following experiment. Take a piece of quick-lime, slake it gradually by sprinkling on it a sufficient quantity of water. When it is completely slaked add to it about twenty times its weight of water. To this mixture add two parts, by weight, of common subcarbonate of soda, previously dissolved in a sufficient quantity of water. Boil the whole for about half an hour; strain it through a cloth, and boil it till so much of the water is evaporated that a phial that will contain an ounce of water will hold one ounce, seven pennyweights and a half, of this ley. Then mix in an earthenware pipkin or basin, one part of the ley, with two parts of olive oil. Place the mixture in a gentle heat, capable only of making the liquor simmer, and allow it to simmer, stirring the liquor continually, with a wooden stick, till, by letting a few drops of it fall on a plate, the soap will be found to coagulate, and the water become speedily separated from it; after which, pour out the contents into a cup, and suffer it to cool. Soap may also be prepared without heat. If one part of the ley be mixed with two parts of olive oil, in a glass or stone-ware vessel, and the mixture be stirred, from time to time, with a wooden spoon or spatula, it will become thick and white; in seven or eight days afterwards the combination will be completed, and a white and firm soap will be obtained.

White soap is formed of ingredients similar to those that have just been mentioned. *Yellow soap* is made with tallow or fish oil, resin, and soda. Soap may be formed by boiling shreds of woollen cloth with ley, till the whole has acquired a certain consistence. This kind of soap has been made, and applied with success, in several manufactories in

France. The combination of oil and other ingredients with potash (205), instead of soda, affords what is called *soft soap.*

201. *NATRON, or CARBONATE of SODA, is a salt which consists of soda* (200) *in combination with carbonic acid* (26). *It is massive, of a greyish colour, soluble in water, and has a disagreeable alkaline taste.*

This salt is found in Egypt, on the surface of the earth, and particularly near the margins of certain lakes called natron lakes. In the summer season the water of these lakes is evaporated by the heat of the sun, leaving a bed of natron generally about two feet in thickness. This is broken with wedges and hammers; and packed up for sale in the European markets. The waters of some of the lakes contain both common salt and natron; and these, on evaporation, crystallize in successive beds. Natron is found in considerable quantity under the form of an efflorescence, on the surface of the earth, in the plains of Debrezin in Hungary, and Montenuovo near Naples. It is likewise found in the ashes of most vegetables, but particularly in those of *Salsola*, *Salicornia*, and *Chenopodium*, constituting the article known in commerce as *barilla.* The quantity of barilla imported in 1827 was 326,239 cwt., and in 1837 it was only 16,760 cwt. This diminution of late years is to be accounted for from the fact, that the greater part of the carbonate of soda is prepared from the sulphate of soda instead of the barilla.

Carbonate of soda was formerly obtained in some quantities from *kelp*, which is the ashes of sea weeds. In the Orkneys, according to Dr. Greville, 20,000 persons were occupied in collecting the sea weed and burning it for kelp. About twenty-four tons of sea weed produce about one ton of kelp. It only contains about five per cent. of the carbonate of soda, which was crystallized from the other ingredients, while the *barilla* yields (depending on the plants from which it is made) fifteen, twenty-five, forty, and even fifty-five per cent. It is procured from this latter substance by the addition of water, evaporation, filtration, and crystallization.

Large quantities of this salt are sometimes imported into England, by the East India Company's ships, from China and other parts of the East. It is employed at the present day, for various purposes, in the manufacture of soap, for the washing of linen, &c. Glass-makers mix it with sand for the formation of glass. It is advantageously administered as a medicine. The ancients sometimes employed a mixture of natron for soaking their seed corn, under an impression, that, when afterwards committed to the earth, it would thereby be rendered more fertile. The ancient Egyptians are said to have made great use of natron for the preservation of dead bodies, by macerating them in it for several months previously to their being embalmed.

202. *COMMON SALT, or MURIATE of SODA, though found in some countries in a solid and massive state, is for the most part an artificial preparation from sea-water, and from the water of salt lakes and brine springs. It consist of soda* (200) *in combination with hydro-chloric or muriatic acid* (29). *It crystallizes in cubes, though usually in four sided pyramids, and occasionally in regular octahedrons.*

Few productions, either natural or artificial, are in so much request as common salt. It is used by the inhabitants of nearly all countries, for correcting the insipidity of food. When applied in small quantities, it accelerates the putrid fermentation; and, in this case, is considered to aid digestion, by promoting the decomposition of the aliments. In larger quantity it has a contrary effect, and tends to preserve organic substances from corruption. Salt is used for glazing the surface of coarse earthenware; and is employed in several processes of dyeing.

When this substance is dug out of the earth it has the appellation of *rock salt:* and immense masses of it are found in different countries of the world. The most considerable, as well as the most celebrated *salt mines*, with which we are acquainted, are those about five miles from Cracow, in Poland; and it is supposed that they contain more salt than would be sufficient to supply the wants of the whole world for several thousand years. On descending to the bottom of these mines, a stranger is astonished to find a kind of subterraneous republic, consisting of many families, who have their own peculiar laws and polity. Here are likewise public roads, and carriages, horses being employed to draw the salt to the mouths of the mine, where it is taken up by engines. The horses, when once they are down, never more see the light of day; and many of the people seem buried alive in this immense abyss. Some are born there, and never stir out; others, however, have occasional opportunities of breathing the fresh air in the fields, and enjoying the light of the sun. The subterraneous passages or galleries are very spacious; and, in many of them, chapels are hewn out of the salt. In these are set up crucifixes, and the images of saints, before which lights are kept continually burning. In some parts of the mine huge columns of salt are left standing to support the rock. Its windings are so numerous and intricate, that workmen have frequently lost their way: the lights they carried have been burned out, and they have perished before they could be found. The salt is taken from these mines in blocks so large as, sometimes, to measure nine feet in length, four feet in width, and two or three feet in thickness. In the year 1780, the greatest depth to which the workmen had penetrated was about 320 yards; and the mass of salt was considered to be in some places more than 240 yards thick, and to extend at least three leagues.

The natives of the village of Kattra Bundelkland in India obtain salt from the soil by lixiviation.

Near the town of Cardona, about fifty miles northwest of Barcelona, in Spain, there is a mountain of salt, without cleft or crevice, 500 feet high, and nearly three miles in circumference. In the province of Lahore, in Hindostan, travellers have described a mountain of the same mineral, not inferior to this in magnitude; and the elevated regions of Peru afford rock salt at the height of 7000 feet above the level of the sea.

According to De la Beche salt has not hitherto been found in the oldest stratified rocks, but is met with in all the more recent formations.

At Northwich and Nantwich, in the county of Chester, there are salt mines of great depth and extent. These are frequently visited by travellers, and are found amply to repay the trouble and inconvenience of descending into them. There are two principal beds of this substance, separated from each other by a bed of clay about ten feet in thickness; the upper one is about thirty feet below the surface, and the beds vary from five to 150 feet thick.

This was originally discovered about a century and a half ago, in searching for coal. The lower bed has been examined to the depth of many yards, without coming to the bottom; and it is about the centre of this bed that the purest salt has been discovered. The average depth of the cavity formed by the workmen along the vein of salt in the different mines, is supposed to be about sixteen feet. In some of the mines, where pillars six or eight yards square are left to support the roof, the appearance of the cavity is singularly beautiful: and the effect is greatly increased when the mine is illuminated by numerous candles fixed to the side of the rock. The scene so formed would almost seem to realize the notion of the magic palaces of Eastern poets. Some of the mines are worked in aisles or streets. The methods employed in working out the salt offer nothing worthy of notice. Large masses are separated from the body of the rock, by blasting with gunpowder; and are afterwards broken down with pickaxes, hammers, and other instruments. The number of mines in the vicinity of Northwich in 1830 was eleven or twelve, from which on an average, 50,000 or 60,000 tons of salt were raised per annum. The greater part of this quantity was exported to Ireland and the Baltic; and the remainder was employed in Cheshire, and the adjacent counties.

Salt is also made from *brine springs* in Cheshire, Cumberland, Staffordshire, and Worcestershire: but much of what is used in England is obtained from sea water, and has the name of *sea salt.* The mode of manufacturing it is very simple. The water is first pumped into shallow reservoirs of earth, called salt pans, or salterns. In these it remains exposed to the sun until a certain proportion of the water is evaporated, so as to leave it about seven times stronger than in its original state. It is then conducted by another pump into flat iron pans, eight or nine feet square, and as many inches deep. These being placed over a hot fire, the liquor or brine is boiled until nearly all the remaining particles of water have passed off by evaporation, and nothing is left in the pans but salt. This is thrown together into proper vessels, for a few days, to drain, after which it is fit for use.

In some countries the whole evaporation is performed by the heat of the sun; and, in extreme northern climates, where the sun would not have sufficient power for the operation, a very different process is adopted. The water is suffered to freeze in the salterns, and that portion of it that continues uncongealed is so strongly saturated that it requires only a moderate heat to evaporate the remainder of the water, and to crystallize the salt.

Bay salt is that which is produced from the evaporation of sea-water by the heat of the sun only. The bay salt sold in England is generally, however, nothing more than a coarse grained salt, obtained from rock salt by solution and crystallization.

The inhabitants of Cardona, in Spain, make of the rock salt in their neighbourhood various transparent articles, which they vend at a cheap rate. These, which consist of small altars, figures of saints, crosses, chandeliers, salt-cellars, &c. are as clear as crystal, and, to appearance, as lasting. They are chiefly purchased by strangers, as curiosities, and are distributed over various parts of Spain and the south of France.

The decomposition of salt furnishes the *muriatic* or *hydrochloric acid* (29), or *spirit of salt* of commerce. This liquid, which is much used in the arts, and is in great request by chemists, was formerly prepared, for common purposes, by mixing one part of common salt with seven or eight parts of clay, and distilling the mixture; it is now procured by distilling common salt and sulphuric acid (24), and receiving the product in a vessel kept cold to condense the vapours.

It has been discovered that muriatic acid, in a state of gas, is an excellent means of correcting putrid exhalations. In the year 1773, the cathedral church of Dijon was so much infected by the corruption of bodies which had been interred within its walls, that it was entirely deserted. The professor of chemistry at Dijon having being applied to for assistance, placed, on a few burning coals, in the middle of the church, a glass vessel containing six pounds of common salt. Upon this he poured two pounds of sulphuric acid (24), precipitately withdrew, and shut all the doors. The gas soon filled the whole cathedral. After twelve hours the doors were thrown open, and a current of air was made to pass through to remove the gas, which had entirely destroyed every putrid odour.

The following has been recommended as an eligible mode of fumigating rooms for the prevention of infectious disorders. Take six drachms of powdered nitre (206), and six drachms of sulphuric acid (oil of vitriol); and mix them in a tea-cup, by adding to the nitre one drachm at a time of the oil. During the preparation the cup must be placed on a piece of heated iron, and the mixture stirred with a tobacco pipe or piece of glass. As soon as the fumes arise, the cup must be moved about to different parts of the room or house that is to be fumigated.

In the year 1836 or 1837 Mr. J. T. Cooper was applied to, to remove the smell of paint in one of the Halls in the City of London, after it had been beautified, which was effectually accomplished in a few hours by a process nearly analogous to that just described, and which it would have been altogether impossible to have effected by the ordinary means in time for the festivities.

203. *GLAUBER'S SALT, or SULPHATE of SODA, consists of soda* (200) *in combination with sulphuric acid* (24). *It occurs in an efflorescent or powdery state, on the borders of salt lakes; or, more commonly, in a state of solution, in certain mineral waters. It is commonly a production of art. The ordinary form of the crystals of this substance is the right rhombic prism.*

This salt, which was originally discovered in 1658 by a German chemist, whose name was Glauber, has a nauseously bitter and saline taste. It is found, in an efflorescent state, on meadow ground at Eger, in Bohemia; and on the walls of old galleries in mines, at Grenoble, in France. It is also abundant in the ashes of some kinds of vegetables, especially of sea-weeds; and is also found in many of the fluid secretions of animals. The waters of the Mediterranean yield a great proportion of it; the Glauber's salt used for commercial purposes is chiefly prepared from sea-water, or by decomposing common salt, in order to procure muriatic acid (29). It may also be obtained by adding common salt to sulphuric acid (24).

This process is carried on to a great extent at the present day, owing to the great demand for sulphate of soda for the manufacture of the carbonate.

The use of this salt in medicine as a common purgative is well known; and in some countries, it is employed as a substitute for soda (200), in the manufacture of white glass. It ought to be kept in well-corked bottles, as otherwise the crystals soon fall into powder (effloresce).

The following is a pleasing experiment, which shows a singular and almost instantaneous crystallization of Glauber's salt. Dissolve this salt by adding portions of it gradually to water kept boiling until the water will dissolve no more. Pour the solution, whilst boiling, into common medicine phials previously warmed, and immediately cork them. Set the phials in a quiet place without shaking them. The solution, when cool, will remain perfectly fluid till the cork is taken out; but the moment this is done, and the air is admitted, it will begin to crystallize on its upper surface, in fine satin-like crystals, which will shoot downward, like a dense white cloud. In this act so much heat becomes evolved as to make the phial feel sensibly warm to the hand. When the crystallization is complete, the whole mass generally becomes so solid, that, on inverting the bottle, not a drop of it will fall out. If the crystallization should not immediately ensue on opening the phial, this may instantly be effected by dropping into it a minute crystal of the same salt. The experiment may be exhibited any number of times afterwards, by merely placing the phial in boiling water, till the salt it contains be again completely liquified; and letting it stand, as before, to cool.

This salt was formerly called *natron vitriolatum.*

204. *BORAX is a salt composed of two equivalents of boracic acid* (28) *and soda* (200), *and is imported chiefly from the East Indies, in the form of a brownish grey, impure, shapeless salt, of a sweetish taste; or in detached prismatic crystals, each about an inch in length. Its proper designation is* a Biborate of Soda. *The primary form of the crystals is the oblique rhombic prism.*

Although borax has long been known as an article of traffic, there is scarcely any production with the origin of which we have been, till lately, less acquainted. It is found in a native, though impure state, in mountain lakes, situated about fifteen days' journey from the capital of Thibet in the East Indies. These lakes are so encompassed with hills as to have no stream either falling into them or flowing from them. The water is salt to the taste, and contains both borax and common salt; and the edges and shallow parts are covered with a stratum of this substance, which is dug up in considerable masses for exportation. It has here the name of *tinkal*, and is usually brought into Europe enveloped in a kind of fatty substance. Boracic acid is found in Italy, and especially in some of the lakes of Tuscany. Borax in another form is imported from China. The mode of refining it was for a long time kept, by the Dutch and Venetians, amongst those secrets which a want of sufficient research alone prevented from being generally known. To rid the tinkal of the *fatty* or *greasy* matter, which Vauquelin saponified by the addition of soda, some calcine it; others employ an alkaline solution; after this process is completed, it is dissolved in water and crystallized, and is then known as *purified borax*.

The uses of borax are numerous. It is employed as a flux for metals, being found to produce a more perfectly limpid fusion than any other substance. For the same reason it is made an ingredient in the finest kinds of glass, and particularly in some of the coloured glass pastes which are manufactured in imitation of gems. But its chief use is to jewellers and goldsmiths, to facilitate the soldering of gold and silver. Borax is also used in medicine; mixed with honey it forms an excellent application in ulcers and aphthous sores of the mouth and lips. It is likewise used as a cosmetic when in solution with rose water.

205. POTASH FAMILY.

Potash is an alkali (42), of a white colour, and of a smell somewhat resembling that which is perceived during the slaking of quick-lime (137). It is extremely corrosive, and remarkably acrid to the taste.

In a mineral state it is found only in combination with nitric acid (30).

The *Potashes* of commerce, as well as *Pearlashes,* consist of a carbonate of potash more or less pure.

Potash, or Kali as it was formerly called, principally exists under the form of a salt, obtained from inland vegetables; and is procured by burning them, afterwards repeatedly washing the ashes with water, and then filtering and evaporating these to dryness. It is also found in the mineral kingdom united with various acids, and forms an ingredient in many rocks. The appellation of potash was given to this salt from its having formerly been prepared in large iron pots: the reddish tinge it usually possesses is owing to the presence of a little oxide of iron.

In many parts of this country, where the water is hard and wood is burned as fuel, it is a common practice to collect the *wood-ashes* by means of a kind of coarse sieve under the grates. These ashes, when added to the hard water, *soften* it, as it is termed, thus rendering it fit for those domestic purposes to which it formerly could not be advantageously appropriated.

The uses to which it is applied are numerous. In chemistry it is employed for a variety of purposes; and also in many arts and manufactures, in scouring, washing, bleaching, dyeing, glass-making, and several others. Its corrosive property is such that it is often used by surgeons in a caustic state to open abscesses, and to destroy useless or hurtful excrescences.

Potashes are prepared in this country, but the best are brought from the United States of America, Russia, and North America.

206. *ARGOL, CREAM of TARTAR, is a white crystallized salt, without smell, taste, acidulous and gritty, composed of two equivalents of tartaric acid and one of potass. The primary form of the crystal is a right rhombic prism.*

Cream of Tartar is a salt abundantly used in medicine and the arts. It is obtained usually from the *Crude Tartar* or *Argol*, which is the salt obtained from the wine casks, after the fermentation is completed. It occurs in the grape, tamarind, &c. held in solution in mucilage and sugar; when however these substances become converted into alcohol by the process of fermentation, the alcohol is no longer capable of holding it in solution, and it is then deposited in the casks. This crude substance or Argol is collected, dissolved in boiling water, and the colour removed by charcoal, and allowed to evaporate; the crystals are deposited as the liquor cools. It is occasionally very much coloured, depending upon whether it has been obtained from a red or white wine ; a little tartrate of lime generally is found united with it. In its pure state it is imported in considerable quantities from Trieste, and from France.

This salt is much used in medicine as a purgative, especially combined with Scammony or Jalap. It enters into the composition of the well known cooling drink, in fevers, &c. Imperial (when dissolved in water with sugar and oil of lemons). By heat it swells up and is converted into *black flux*, which is a compound of carbonate of potass and charcoal ; heated with nitre, it forms what is termed *white flux*, or carbonate of potash.

207. *NITRE, SALTPETRE, or NITRATE of POTASH, is a salt which consists of potash in combination with nitric acid* (30)

Its colour is whitish and semi-transparent ; it does not liquefy by the action of the air. It is usually observed in the form of fine capillary crystals, though it is sometimes found in a massive state. When pure, it usually crystallizes into six-sided prisms which have a rectangular base. Its primitive form is the right rhombic prism. It is denominated by chemists Nitrate of Potash. *When exposed to considerable heat it decrepitates and melts, and may be cast into moulds ; in this state it is called* Sal Prunella.

Nitre is found incrusted on the surface of the earth, in some parts of Europe, India, Africa, Egypt, and Spain, and in such abundance as to admit of being swept off, at certain seasons of the year, twice or three times a week. In our own country it not unfrequently occurs in a state of white efflorescence, on old plaster walls that are sheltered from rain. Nitre is also produced in stables and cart-houses, from the mixture of animal and vegetable substances in a state of putrescence.

Many kinds of plants, which grow in soils favourable to the production of it, contain nitre : this is particularly the case with pellitory, borage, the large sunflower, and avens.

Immense quantities of nitre are annually required for the purposes of war. From its constituting one of the most important substances in the composition of gunpowder, it has been found necessary to adopt artificial modes of procuring it. In several districts of the East

Indies there are places called saltpetre grounds. From these, large quantities of the earth are dug, and put into cavities through which water is passed. This brings away with it the salt which the earth contains, and which is afterwards separated from the water by boiling. The East India Company, for more than a century past, has been under engagements to import into this country, and supply the Board of Ordnance, for her Majesty's service, with 500 tons of nitre annually, at given rates and prices in times of peace and war.

The most productive district in India for this article is that of Tirhût, in Bengal.

In France, &c. this article is artificially obtained in what are called *nitrières*, or nitre beds. These consist of the refuse of animal and vegetable substances, which undergo putrefaction, mixed with calcareous and other earths; and the nitre is obtained from them by water, as above-mentioned. In Sweden it is a law, that every person possessing land must furnish a certain quantity of nitre, which they prepare artificially. According to Dumas, in Prussia *nitre-walls* are employed instead of nitre-beds, thus economizing the land, and exposing a large surface to the air. The principal requisites for the formation of nitre are said to be lime, animal and vegetable matters, heat, and an open but not too free communication with dry atmospheric air.

It is imported into this country principally from Calcutta and Madras, in cloth bags containing from 150 to 175 lbs. each, and is known in the market either as crude, single, or double refined nitre.

The discovery of *gunpowder* has completely changed the modern art of war. The earliest notice that has occurred respecting the use of this article in Europe is, that it was employed in the wars of Germany somewhat before the year 1373. It is said, however, to have been known in China long anterior to that period. Its component parts are nitre, charcoal, and sulphur, in the proportion of seventy-six, fifteen, and nine parts in every hundred. These ingredients are first reduced to a fine powder separately, and then mixed with water, so as to form a thick paste. After this has dried a little it is placed upon a kind of sieve full of small holes, through which it is forced. By this process it is divided into grains, the size of which depend of course upon the size of the holes through which it has been squeezed. It afterwards undergoes some other operations before it is ready for use.

Nitre is frequently administered in medicine; it is also used very extensively in different arts. A mixture of equal parts of nitre and tartar, burned together in a crucible, forms what is called *white flux*, which is used for melting and reducing different kinds of metallic substances. And a mixture of one part of nitre and two parts of tartar burned in the same manner forms what is called *black flux*. Nitre possesses antiseptic qualities in a considerable degree, whence it is much used, in conjunction with common salt and bay salt, for the preserving of animal food from putrefaction.

Aquafortis, or *nitric acid* (30) as it is denominated by chemists, is prepared from this mineral. The mode of obtaining it in large manufactories is by distilling in an iron retort, two parts by weight of nitre with one of strong sulphuric acid: this forms the *nitrous acid*, or the *fuming nitric acid*, to rid it of the fumes, and convert it into the *nitric acid*, it is afterwards subjected to distillation in glass retorts on a sand bath, and the vapour condensed in water. The uses of aqua-fortis are various and important. All kinds of metals, except gold and platina, are capable of being dissolved in it. Hence, among other uses, it is employed by dyers for dissolving tin, and forming with madder a scarlet colour; and by hatters for dissolving mercury (228) for some processes in the preparation of hats. Jewellers use it for several purposes.

AMMONIA FAMILY.

207. *SAL-AMMONIAC, or HYDRO-CHLORATE of AMMONIA, is a salt consisting of ammonia and hydro-chloric acid* (22). *It is occasionally found in a state of powder, sometimes in a massive form, and sometimes in very irregularly shaped crystals, the primitive form of which is an octohedron* (Fig. 5). *It is, however, more frequently an artificial production from the soot of burnt animal matter.*

The name of sal-ammoniac was given to this substance from its having been found by the ancients in great abundance amongst sand near the temple of Jupiter Ammon, in

Africa. It is at present found in Persia ; and, accompanying sulphur, amongst volcanic matter near Mount Vesuvius.

This salt was formerly imported from Egypt in the form of conical loaves, or of round cakes, which were convex on one side and concave on the other; but it is now made in Europe, by burning at the same time soot, bones, oil, and salt. The deposit formed by the vapour consists of sal-ammoniac, in conjunction with other substances, which are separated from it by a subsequent process. There is a large manufactory of this substance in London, the materials used being bones, which are subjected to destructive distillation, after having been boiled to rid them of the fatty matter. To the liquor obtained, and called *bone spirit*, sulphuric acid is added, which unites with the ammonia, and is afterwards sublimed with common salt, when the sal-ammoniac (after numerous chemical decompositions during the process) is obtained pure. Another source of this substance is the ammoniacal liquor found in the condensers and refrigerators of gas works, which is now sold to the manufacturers. When good it is white, transparent, and dry within ; and externally of a yellowish grey, or blackish colour.

Sal-ammoniac is applied to many useful purposes. Occasionally it is used in medicine. A considerable portion of it is consumed by dyers, to give brightness to some of their colours. It is also employed in the assay of metals, to discover the presence of iron; and having the property of rendering lead brittle, is sometimes used in the manufacture of shot. By coppersmiths and tinners it is used for cleansing the surface of the metals which they are about to cover with tin. In certain manufactories sal-ammoniac is mixed with tobacco, to give that article, or the snuff that is made from it, additional stimulant properties. Sal-ammoniac dissolved in nitric acid (30) forms the fluid named *aqua-regia*, or *nitro-muriatic acid*, which dissolves gold.

ORDER II.—METALLIC SALTS.

SALTS OF IRON.

208. *GREEN VITRIOL, or GREEN COPPERAS, is a salt usually obtained by a decomposition of pyrites* (236) *by the moisture of the atmosphere. It is also called* Sulphate of Iron, *it consisting of iron and sulphuric acid.*

Its colour is bright green, and its taste very astringent; a solution of it in water dropped on oak bark instantly produces a black spot.

Although green copperas is occasionally found in grottoes, caverns, the galleries of mines, and other places, yet being much in request by dyers, tanners, and the manufacturers of ink, it is artificially prepared from pyrites. This mineral being moistened and exposed to the air, a crust is formed upon it, which is afterwards dissolved in water, and from this the crystals of the vitriol are obtained by evaporation.

The principal use of green vitriol is in dyeing woollen articles, hats, and other manufactures, black. It is the basis of ink, and is used in the manufacture of Prussian blue. If it be reduced to powder by the action of fire in a crucible, and mixed with powdered galls, it forms a dry portable ink. Sulphuric acid (24) may be obtained from this kind of vitriol by distillation. The residue, after the process is completed, is used as a red paint; and when washed is employed for the polishing of steel.

This salt is also very abundantly employed by publicans and beer-sellers to give the necessary *head* to the London porter (and for which it is, as obtained direct from the large breweries of the metropolis, so justly celebrated). The publicans, or retailers of beer, are in the habit of making two butts of beer into three, by the addition of *one butt of water;* but porter so adulterated will not *froth* or *head* unless an ounce or two of this salt be mixed with the three butts; and the test employed by excisemen for the detection of this adulteration, is the *Ferro-prussiate of potass,* which on being added throws down the *Prussian blue.* Other materials, of a much more deleterious nature, are added, to give the beer the requisite stupifying and colouring qualities.

SALTS OF COPPER.

209. *BLUE VITRIOL, BLUE COPPERAS, or SULPHATE of COPPER, is a blue salt formed by a combination of copper with sulphuric acid* (24). *It crystallizes in rhomboidal prisms.*

This substance, though sometimes found in a state of concretion, or in the form of powder disseminated over the surface of stones that have been in contact with water impregnated with it, is more frequently an artificial preparation obtained from evaporating the water which runs through copper mines. In the mines of Neussol, in Hungary, at the depth of 380 feet beneath the surface of the ground, are several vats, placed at different distances, for the purpose of collecting the water impregnated with copper, and which flows into them through a kind of gallery above. From this water the blue vitriol is afterwards separated by evaporation. A process somewhat similar is pursued in our own country.

It is obtained from the sulphuret of copper in this country, by exposure to heat, air, and water. Cornwall is the principal locality for this mineral.

In the principal blue vitriol manufactories established in France, the operation is thus carried on. Pieces of copper are first dipped into water, and their surface, while wet, is covered with a stratum of powdered sulphur. The copper thus prepared is put into an oven, and heated to redness. After some time it is taken out, and while hot is plunged into a vessel filled with water. These operations are repeated several times till the whole of the copper is dissolved, and the water becomes loaded with the vitriol. Thus saturated, the water is placed over a fire till all the fluid particles are dissipated, and the vitriol alone is left.

Blue vitriol is used by artists and manufacturers in various ways. It is employed in dyeing; and enters into the composition of black colours, to which it gives depth and solidity. Blue feathers are stained by plunging them into a hot solution of it. The beautiful grass-green colour of the shops, called *mineral green*, is made from blue vitriol; and fowling-pieces and tea-urns are browned by washing them with a preparation of it.

It was used by Hippocrates as an application for healing ulcers, for which purpose it is much employed even at the present day.

It is used in medicine, and possesses astringent, tonic, and emetic properties. As an emetic, in doses of from five to ten grains, it is serviceable in cases of poisoning, especially by narcotics, as it acts speedily, and leaves no depressing or nauseating effects after its administration.

SALTS OF ZINC.

210. *WHITE VITRIOL, WHITE COPPERAS, or SULPHATE of ZINC, is a whitish, yellowish, or greenish white crystallized salt, formed by a combination of zinc* (241) *with sulphuric acid* (24), *the primary form of the crystals being the right rhombic prism.*

Although the white vitriol that is used in commerce is chiefly an artificial preparation, this salt sometimes occurs in a natural state, in mineral repositories that contain blende (241); it appears to be formed by a decomposition of that ore. It is found at Holywell, in Flintshire, in some parts of Cornwall; and at Rammelsberg, near Goslar, in the Hartz.

When white vitriol is artificially prepared, the blende is roasted, and thrown while red hot into a vessel filled with water, in which it is allowed to remain about eighteen hours. This process is repeated several times; and after the solution has become clear, it is removed into leaden vessels, and the water is evaporated by means of heat. On cooling it crystallizes. After this the crystals are melted in a copper vessel, and the surface of the solution is skimmed with a hair sieve. It is then poured into a wooden vessel, and stirred till it becomes cool, and acquires a sufficient degree of consistence, when it is formed into loaves for sale. In this state it has the appearance and colour of refined sugar. White vitriol is chiefly manufactured in Germany.

It is however very readily prepared by the action of dilute sulphuric acid on metallic zinc, in the well-known process of obtaining hydrogen gas.

As a medicine the sulphate of zinc ranks high; it is tonic, astringent, and emetic. As an emetic in cases of poisoning, in doses of half a dram to one dram, it is very valuable, as it acts promptly, and performs the requisite end without debilitating the patient. In cases of poisoning by narcotic drugs it is inferior to none.

It is employed in great quantities by varnishers, to make their oil varnishes dry more readily than they otherwise would. White vitriol is also used by painters as a drier. A fine white colour, called *zinc-white*, which is more durable than white lead, is also prepared from it. Dyers use a considerable quantity of white vitriol to render deeper the colours produced by madder, cochineal, and other substances.

CLASS III.—COMBUSTIBLES.

SULPHUR FAMILY.

211. *COMMON SULPHUR, or BRIMSTONE, is a yellow, dry, and brittle substance, which in burning yields a suffocating fume: the smell of this (under the denomination of* sulphureous acid) *is well known.*

Sulphur is found in a pure or native state in nearly all volcanic countries: it is about twice as heavy as water; and is sometimes crystallized in the form of octohedrons, whose bases are rhombs. It exists abundantly in a state of combination with several metallic substances, and is also found in putrid animal remains, and in some vegetables, especially mustard, garlic, &c.

In Italy and Sicily large tracts of country occur yielding sulphur. The county of Wicklow, Ireland, promises to supply a very large quantity of sulphur, judging from reports which have recently been made on the quantity which has been discovered; and it is generally admitted that sufficient will be found in that locality to supply the English market, even should the King of the Sicilies still maintain the duty of 4*l.* 10*s.* per ton for the sulphur exported from his dominions, which is not very likely to be the case while Russia, France, and America, are ready to comply with his demands.

Some of the sulphur which is used in commerce is obtained by the process of roasting copper, and other ores, previously to their being smelted. It passes off in the form of vapour, and on being received into chambers constructed for the purpose, is there deposited in a powdery state. It is afterwards melted in large pans, and cast in wooden moulds, to make the hard, or *roll brimstone*. Nearly all the sulphur used in France comes from the Solfatara of Italy, a half extinct volcano near Naples (Fig. 18). This volcanic country every where exhibits indications of the agency of subterraneous fires. Nearly the whole ground is bare and white; and in every part is warmer than the atmosphere during the greatest heat of summer. A sulphureous vapour is constantly emitted from the earth, and sulphur is condensed in various parts, and in great abundance. This is collected, packed in casks, and exported to Marseilles, where it undergoes certain preparations that are necessary towards purifying and rendering it fit for sale. *Flowers of sulphur* are usually obtained by subjecting crude brimstone to heat in iron pots; the flowers rise to the neck of the pot, which communicates with a large room called a kiln, and are thrown by the force of the heât over the floor of the kiln; the impurities of the sulphur being left behind in the pot; this, when washed with water, constitutes the *washed sulphur*.

Fig. 18.

Warm Spring of Solfatara *.

* The above section is an imaginary representation of the earth below the volcano; *a* and *c* are the upper and lower portions of solid rock: *b*, a cavern, containing boiling water *d*: the evolution of the steam in the confined space *b* exerts a pressure on the surface of the water, and forces it up the channel, where it finds its exit at the mouth of the volcano.

A considerable quantity of sulphur is employed in the composition of gunpowder (206). Its readiness in taking fire is the reason of its being employed in the making of matches. Sulphur gives a blue colour to artificial fireworks. Its vapour is used for the whitening of silk and wool, which process has been known from the time of Moses; and also for the bleaching of straw used for making hats and bonnets, the straw being previously exposed to steam.

Modellers employ sulphur to make moulds for various kinds of casts; and artists are enabled, by means of it, to take sharp and beautiful impressions of medals and engraved stones. The mode of doing this is very simple. The sulphur is put into an earthen vessel called a crucible, and placed on a hot fire. It soon melts; and if kept some time over the fire becomes thick and dark-coloured. When poured into water in this state it is as soft as wax. It may now be easily worked between the fingers into any given form; and if pressed upon a seal or engraved stone, will be found to retain a perfect impression of it. It is this property of sulphur which Mr. Tassie, of Leicester-fields, London, some years since availed himself of, to furnish extremely elegant impressions of many antique gems.

Melted sulphur is much used to take casts of coins, and is considered far superior to plaster of Paris, owing to the impressions being much sharper.

Sulphur was much used by the ancients in medicine; and it is now occasionally administered both as an external and internal remedy. The compounds formed from it are employed to considerable extent in various processes of dyeing and calico printing. Many of the mineral waters, those, for instance, of Harrowgate (299) and Moffat (300), are indebted to sulphur for their most valuable qualities.

This substance has the property of becoming electric by rubbing. On exposure to a gentle heat it melts; but if the heat be increased it is converted into vapour. When ignited, and the combustion is slow, it burns with a suffocating and acid fume and blue flame; but when the combustion is quick it burns with a white and vivid flame. If exposed to a sudden, though gentle heat, by holding it, for instance, in the hand when that is warm, it will sometimes break in pieces with a crackling noise.

It is a remarkable circumstance, that if a bar of iron be heated to a perfect whiteness, and then touched with a roll of sulphur, the two bodies combine and drop down together in a fluid state, forming what is called *sulphuret of iron*, a compound of the same nature as iron pyrites (236). A piece of iron rolled out very thin may be apparently melted in the hand, by putting it, when heated to whiteness, upon a thick piece of solid sulphur. It is, however, necessary that this experiment be performed with great care, and under a chimney, or in a place where there is a current of air to carry off the suffocating vapour.

Useful as sulphur is, in various ways, its most important application is in the production of *sulphuric acid*, or *oil of vitriol* (24). One mode in which this acid is obtained for the purposes of commerce, is by burning a mixture of sulphur and nitre (206) in large chambers lined with lead. In this process the nitre supplies a considerable portion of oxygen (21) to the sulphur, and the air of the atmosphere furnishes the rest. Thus a substance which, in a natural state, is one of the mildest that we are acquainted with, is by this operation converted into a corrosive and dangerous, though useful, fluid. Its taste is strongly acid; and when applied to animal or vegetable substances it soon corrodes, and destroys their texture.

Fig. 19.

Cascade de Vinaigre.

Sulphuric acid is found combined with hydrochloric acid in the river which descends from the volcano of Purace, in Colombia, to Popayan, and receives its name of "Cascade de Vinaigre," from the acid taste of its waters: such is the statement given by Humboldt.

The properties of sulphuric acid have rendered it extremely valuable for numerous purposes, both in the arts and in the laboratory. It has been long employed by chemists as one of their most useful and frequent agents.

The fluid that is put into the bottles for procuring *instantaneous light* is no other than sulphuric acid; and it is poured among filaments of asbestos (which it will not corrode), for the same purpose as ink is sometimes poured upon cotton. The matches are slips of wood dipped in a mixture of equal weights of sugar or charcoal powder, and what the chemists call chlorate of potash. These are to be rubbed together in a mortar, but with great care, as by strong friction the mixture is apt to explode. To obtain a light nothing further is requisite than to dip a match thus formed into a bottle containing the acid.

BITUMEN FAMILY[1].

212. *NAPHTHA is a slightly transparent, yellow, bituminous fluid, of a strong penetrating odour, somewhat greasy to the touch, and so light as to float even on spirit of wine.*

By exposure to the air, the consistence of naphtha is increased, and it passes into petroleum (213).

There are copious springs of naphtha at Baku, on the shore of the Caspian Sea; and also in some parts of Italy, particularly at Monte-Chiaro, near Piacenza. At Pitchford, in Shropshire, extensive strata or beds of sandstone are saturated with this mineral fluid, which is obtained from the stone by distillation, and sold as a remedy against sprains and rheumatism.

By the Persians and Russians naphtha is used internally as a cordial. On the shores of the Caspian it is burned in lamps instead of oil; and in some parts of Italy it is employed in the lighting of churches and streets. When mixed with certain vegetable oils it forms an excellent varnish.

It is the property of naphtha to take fire on the approach of a light, and to burn with great readiness and a white flame, leaving scarcely any residuum. The town of Broseley, in Shropshire, was formerly celebrated for a *burning spring*, which was first discovered in the month of June,

[1] The species of this family are composed almost exclusively of carbon and hydrogen.

1711. Its original issuing from the ground was announced by a terrible noise in the night, which awakened several persons who lived near the spot. Some of these on going out to ascertain the cause of the alarm, perceived, about two hundred yards from the river Severn, an extraordinary shaking of the earth, and a little bubbling of water through the grass. On digging round the spot, the water sprang up to a great height, and a candle which one of them held in his hand set it on fire. This circumstance excited great curiosity; and many persons from different parts of the adjacent country came to visit what was called the "burning well." To prevent this spring from being destroyed, an iron cistern was placed upon it, with a small hole in the cover, through which the water might be viewed. When a lighted candle was put into this hole the water immediately took fire, darting and flashing in a violent manner, much in the same way as spirits do in a lamp, but with greater agitation. It would sometimes burn for forty-eight hours successively, and without any sensible diminution; and a tea-kettle full of water, by being placed upon the hole, has been made to boil in nine minutes. In 1747, this spring had been lost for many years; but another was shortly afterwards discovered, the issuing of which was announced by a rumbling noise under ground, similar to that which had been formerly heard. This, however, also disappeared in the year 1756, by the sinking of a coal-pit in the neighbourhood.

According to Berzelius, both this and the following are supposed to be produced by the decomposition of organic (vegetable) matter, for they are always found in Neptunian rocks, and they appear sometimes to be one of the products of the decomposition of coal (*Pereira*).

213. *PETROLEUM, or MINERAL or ROCK OIL, is a fluid bitumen, of somewhat greater consistency than naphtha: of a black, reddish brown, or sometimes dingy green colour, and leaves, after burning, a residuum like coal.*

By exposure to the air it assumes the consistence of tar, and is then called Mineral Tar (214).

This substance exudes spontaneously from the earth, or from clefts of rocks, and is found in nearly all countries, particularly in the East Indies, Italy, France, Spain, Germany, and England. In the neighbourhood of Rangoon, in Pegu, there are several hundred wells of petroleum. These are of a square form, of considerable depth, and each lined with cassia-wood staves. The oil is drawn from them pure, and in a liquid state, and is conveyed thence in small jars. The whole annual produce of this district, 520 wells, is estimated at more than 400,000 hogsheads.

At Colebrook Dale, in Derbyshire, there is a spring of petroleum. This was discovered at the depth of about thirty yards beneath the surface of the earth, in digging an archway for the conveying of coals from a very deep pit. The petroleum was at first found to ooze from between the crannies of the rock, but it soon afterwards poured forth in a considerable stream. The utility of this fluid having been made known, large iron pipes were formed from the spring into pits sunk for the purpose of receiving it From these pits it is conveyed into immense caldrons, where it is boiled until it attains the consistency of pitch. Since the first discovery of this substance, three different springs of it have broken out. One of these is near the celebrated iron bridge ; and the fluid that issues from it is almost pellucid, but, at the same time, is thicker than treacle.

St. Catherine's well near Edinburgh, also yields this substance; and the name given to it of *Oleum Gabianum*, is from the circumstance of its having been discovered at the village of Gabian in Languedoc, France.

Petroleum easily takes fire, and, in burning, yields a strong, sharp, and somewhat unpleasant odour; and a thick and disagreeable smoke. In cold weather it congeals in the open air.

In Pegu, and other parts of the East, petroleum is used in place of oil for lamps. Boiled with a species of resin, it is employed for painting the timber of houses, and covering the bottoms of boats and other vessels. In the latter respect it is considered to be particularly efficacious, by protecting the timber from the attacks of marine worms. It is also used by the inhabitants of eastern countries as a lotion in cutaneous eruptions, and as an embrocation in bruises and rheumatic affections. The ancient Egyptians used it in the embalming of dead bodies. In some countries lumps of earth are soaked with petroleum, and are employed as fuel.

It is used in medicine in this country, externally in skin diseases, chronic rheumatism, and internally for the expulsion of worms and other diseases.

214. *MINERAL TAR, or BARBADOES TAR, is a fluid kind of bitumen, somewhat thicker than petroleum, and nearly of the consistence of common tar. It is viscid, of a black, brownish black, or reddish colour.*

In burning its smell is disagreeable, but less pungent than that of most other kinds of bitumen. Its weight is somewhat greater than that of water.

In Barbadoes and Trinidad, where this substance is principally found, it is applied to many of the purposes for which the preceding species is used; but its principal repute has been obtained from its being thought useful in disorders of the breast and lungs, though this application of it is considered very improper.

215. *ELASTIC BITUMEN, or MINERAL CAOUTCHOUC, has a strong resemblance to Indian rubber. In some instances it is elastic, and so soft as to adhere to the fingers, and in others brittle, and so hard as nearly to resemble asphalt* (216).

Its colour is yellowish, reddish brown, or blackish. One kind of this mineral, when fresh cut, nearly resembles fine cork, both in texture and colour. The English variety is about the weight of water, while the French is somewhat lighter.

This extraordinary substance, which will expunge the marks of black lead in the same manner as Indian rubber, was first noticed by Dr. Lister, about the year 1673, in cavities of the lead mine of Odin, near Castletown, in Derbyshire. Since 1816, it has been discovered in a coal mine at Montrelais, about 230 feet below the surface; it has likewise been stated to have been found in the island of Zante, and also at Neufchatel. Elastic bitumen appears to be a peculiar modification of petroleum, in its passage to asphalt: and probably owes its elasticity to its cellular texture, and to the moisture with which it is combined. It burns with a yellow flame.

216. *ASPHALT, ASPHALTUM, or SOLID BITUMEN, is a brittle substance, of a black or brownish black colour, and of consistence somewhat harder than pitch.*

It has nearly the same weight as water, is smooth to the touch, does not stain the fingers, and has little or no smell unless it be rubbed or heated. When heated it melts, swells, and inflames; and, if pure, burns without leaving any ashes.

It is soluble in naphtha, and in the volatile and fixed oils, perfectly pure and colourless; naphtha may be obtained from it by distillation.

The ancients were well acquainted with this substance, which is nothing more than mineral tar (214) in an indurated or hardened state. It is found on the surface of volcanic productions, and floats, in solid pieces, and in considerable abundance, on the Asphaltic Lake, in Syria, which has thence received its name. This lake is also called the Dead Sea, from a notion that the odour arising from the asphalt destroys even birds which fly over it: Maundrell, however, states that this is not true, as he saw several birds fly about and over it, without experiencing the slightest injury.

The celebrated Greek fire was formed of the asphalt obtained from a very thick bed in Albania. Asphalt is also found near ancient Babylon; and there is reason to suppose that the mortar so celebrated amongst the ancients, and with which the walls of Babylon and of the Temple of Solomon were cemented, was nothing more than a preparation of asphalt. We are informed by Herodotus, that a composition of heated bitumen, mixed with the tops of reeds, was used by the ancients as a cement. This account is confirmed by modern travellers, who assert that the remains of buildings have been discovered in which bitumen was formerly thus employed. It is presumed to be the same substance which, in our translation of the Old Testament, is called pitch, and which was used by Noah, as an exterior and interior coating of the ark; by the mother of Moses as a coating for the little vessel in which he was exposed; and on various other occasions.

As an article of modern utility, it is to be remarked that the Arabians dissolve asphalt in oil, and, with the mixture, smear their horse harness, to preserve it from the effects of weather, and the attacks of insects. In a state of solution it is applied, in several eastern countries, as a covering for timber and the bottoms of ships. It is occasionally used in the cleaning and healing of ulcers, and other sores. In France it is manufactured into a substance which is in considerable request for greasing the wheels of carriages. It is used by the makers of watch-dials, who mix it with lamp black and oil of turpentine; but its chief use is as an ingredient in certain varnishes, and particularly in the varnish used by copper-plate engravers. It is frequently adulterated by a mixture with common pitch; but this is easily discovered by the smell.

Besides the countries and places already mentioned, asphalt is found in several parts of America, in the island of Trinidad, in the province of Neufchatel, aud many parts of the continent of Europe, as at Alsace and Osthofen near Mayence; that obtained from the latter place, is considered most pure; it exudes from the cliffs, and is abundantly used by shoemakers under the name of *heel-ball.*

217. COAL FAMILY.

The component parts of coal are principally carbon or charcoal (48), *and bitumen* (216).

Some kinds of coal are laminar, and others compact. They in general burn freely, with a bituminous odour, and leave a considerable residuum.

This invaluable mineral is found in beds, or strata, frequently betwixt clay slate and sandstone, and seldom betwixt those of limestone. It chiefly occurs in the northern hemisphere, particularly in countries which lie nearly in the same latitudes with Great Britain; in Siberia, Germany, Sweden, France, Canada, and Newfoundland; and in some of the northern parts of China. It is stated to be abundant in New Holland. Dr. F. Krauss of Stuttgard met with it in great abundance during his recent travels in South Africa, specimens of which were exhibited on his return to this country. No fewer than seventy different kinds of coals are brought to the London market, the value and prices of which greatly differ. Of these the coals called *Walls-end,* from the name of the pit, near Newcastle, whence they are obtained, usually bear the highest price.

218. *COMMON COAL, or PIT COAL, is of a black colour, and has generally a slaty structure and foliated texture.*

When handled it stains the fingers; and when burnt it cakes more or less during combustion. Its component parts are usually charcoal (48) *and bitumen* (216), *with a small portion of clay, and sometimes with pyrites, or sulphuret of iron* (236). *What is called slaty coal contains a greater portion of clay than other kinds.*

Some foreign writers have ascribed the great wealth possessed by this country to the coals which are here found in such abundance, and which facilitate, in a very essential degree, nearly all its manufactures, and consequently are a means of promoting its commerce to an extent which is possessed by few other countries. All our great manufacturing towns, Birmingham, Sheffield, Leeds, Glasgow, &c., are situated either in the midst of coal districts, or in places to which coals are conveyed, with little expense, by canal carriage.

Coals are principally obtained from the neighbourhood of Newcastle-upon-Tyne, Sunderland, Derby, and Stafford. Glamorgan likewise furnishes a considerable supply of coal: it having been estimated that the coal fields of South Wales extend over 1200 square miles; and those of Northumberland and Durham 732 square miles. The particular places whence they are obtained have the name of *collieries*, and the mines from which they are dug are called *pits*. The deepest of these are in Northumberland, and are worked at more than 900 feet below the surface of the earth. At Newcastle there is a coal-pit nearly 800 feet in depth, and which, at that depth, is wrought five miles horizontally, quite across, and beneath the bed of the river Tyne, and under the adjacent part of the county of Durham. At Whitehaven the mines are of great depth, and are extended even under the sea, to places where there is above them sufficient depth of water for ships of great burthen, and in which the miners are able sometimes to hear the roaring of the water. On the contrary, in some parts of Durham the coal lies so near the surface of the earth that the wheels of carriages lay it open, and in such quantity as to be sufficient for the use of the neighbourhood.

The beds of coal are of various thicknesses, from a few inches to several feet; and in some places, it is found advantageous to work them at a very great depth, although their thickness does not exceed four or five feet. The thickest bed of English coal, of any extent, is that of the main coal in the mines of Bilston and Dudley, Staffordshire, which measures from thirty to forty feet. In many places there are several beds above, and parallel to, each other, separated by strata of slate, sandstone, and other minerals. Coal is never found in chalk, and very rarely in limestone.

At Whitehaven, the principal entrance to the coal-mine, both for men and horses, is by an opening at the bottom of a hill, through a long passage hewn in a rock. This, by a steep descent, leads to the lowest bed of coal. The greatest part of the descent is through spacious galleries, which intersect other galleries, all the coal having been cut away, except large pillars, which, in deep parts of the mine, are three yards high, and about twelve yards square at the base, such great strength being there required to support the ponderous roof.

There are three distinct and parallel strata of coal, which lie at a considerable distance above each other, and which have a communication by pits that are sunk between them. These strata are not always regularly continued in the same plane. The miners occasionally meet with veins of hard rock, which interrupt their further progress, and at such places, the earth on one side of the vein appears to have sunk down, while that on the opposite side has its ancient situation. These breaks the miners called *dykes* (4) see Fig. 3. When they come to one of them, their first care is to discover whether the coal, in the part adjoining, be higher or lower than that in which they have been working; or, to use their own terms, whether it be cast down or cast up. For this purpose they examine attentively the mineral strata on the opposite side, to see how far they correspond with those which they have already passed through. If the coal be cast down, they sink a pit to it: but if it be cast up, the discovery of it is often attended with great labour and expense.

In general the entrance to coal mines is by perpendicular shafts, and the coal and workmen are drawn up by machinery. As the mines frequently extend to great distances horizontally, beneath the surface of the earth, peculiar care is necessary to keep them continually ventilated with currents of fresh air, for the purpose, not only of affording to the workmen a constant supply of that vital fluid, but also to expel from the mines certain noxious exhalations which are sometimes produced in them.

One of these, denominated *fire damp*, is occasioned by the extrication of carburetted hydrogen gas (45). This gas, when mixed with the common air of the atmosphere, explodes, with great violence, on the approach of a lighted candle, or any other flame; and has, at different times, occasioned the loss of many valuable lives. It is a singular circumstance, that although it is immediately set on fire by a flame, yet it cannot be kindled by red hot iron, nor by sparks produced from the collision of flint and steel. Hence a machine called a *steel mill* was contrived, to produce, by collision with flints, a sufficient light for the miners to carry on their work in places where the flame of a candle would produce explosions. But the *safety lamp*, invented by the late Sir Humphry Davy, has nearly, if not entirely, superseded the steel mill. This lamp is enclosed in a wire gauze cylinder, the interstices of which are so extremely small, as, while it permits the light to escape, to prevent the surrounding gas from communicating with the lamp so as to explode.

Carbonic acid gas (26), is another injurious exhalation in coal mines, and is called *choke damp.* It is the property of inflammable air to rise to the upper parts; but this, on account of its weight, occupies principally the lower parts of mines, and occasions death by suffocation, though it is by no means so fatal as the former. In some mines a prevention of injury arising from each of these gases is attained, by ascertaining the particular crevices in the coal from which they issue, confining them at those places within a narrow space, and, if possible, conveying them out of the mines, through long pipes, into the open air.

Another danger attending coal mines is inundation. Many mines have been destroyed by the flooding of water, which springs up within them. The modes by which this was formerly extracted were extremely laborious, and, in numerous instances, entirely inefficacious. By means, however, of the steam engines now in use, the quantity of water raised from mines is perfectly astonishing. Four engines at one of the collieries at Whitehaven some years since, discharged more than twenty hogsheads per minute, or upwards of 30,000 hogsheads in every twenty-four hours.

The coal trade, which at present affords so important a nursery for our seamen, and, in numerous other respects, yields advantages of the most beneficial description to this country, was entirely unknown a few centuries ago. Coal was not generally adopted as fuel until the beginning of the reign of Charles I. It was, however, noticed in documents anterior to the reign of Henry III.; for that monarch, in the year 1234, renewed a charter, granted by his father, to the inhabitants of Newcastle, by which they were permitted to dig coal upon payment of 100*l.* per annum. Coal had been introduced into London before 1306; for in that year, the use of it as fuel was prohibited, from the supposed tendency of its smoke to corrupt the air. About the beginning of the sixteenth century the best coal was sold in London at the rate of 4*s.* 1*d.* per chaldron, and at Newcastle for no more than 2*s.* 6*d.* During the ensuing century, however, it was received into such general use, that, in 1648, on a scarcity of coal in London, many of the poor are said to have died from want of fuel. Mr. Taylor states, that the quantity annually shipped from Northumberland and Durham averages three millions three hundred tons; he has also affirmed that no less than fifteen millions of tons must be annually consumed as fuel in Great Britain. The whole quantity of coals imported into London, on an average of four years, ending in March, 1815, amounted to 1,170,000 chaldrons per annum; in 1827 it was 1,558,810 chaldrons: and in 1832 it amounted to 2,149,520 tons, brought by 7528 vessels.

Some writers have imagined coal to be the remains of antediluvian timber, which floated upon the waters of the deluge until several strata of mineral substances had been formed: others conceive it to have been antediluvian peat bog. It is now, however, universally admitted that coal is nothing more than vegetable matter, which must have flourished when this climate must have been at a considerably higher temperature than at the present time; and which vegetables must have been washed down by rivers probably in the form of forests, and deposited together with sandstone, clay, limestone, &c. in the situations where we now find coal. The question then arises, from whence did this mass of vegetable matter come?—was it supplied by forests in any part of our own island?—or was it obtained from land now beneath the sea, in the Northern and Western oceans? It is called *pit coal*, from the circumstance only of its being obtained from mines or pits; and, in London, for no better reason than its having been conveyed thither by sea, it has the name of *sea coal.*

Its uses as fuel are too extensively known to need here any observations. By the distillation of coal an inflammable gas is produced (*carburetted hydrogen*), which has of late been generally introduced for the lighting of manufactories, and the principal streets and shops of the metropolis. This gas is conveyed by pipes, from the reservoir in which it is collected, to great distances; and the light which it yields is peculiarly brilliant and beautiful. It was at the foundry belonging to Messrs. Boulton and Watt, at Birmingham, that the first display of *gas lights* was made, in the year 1802, on the occasion of the rejoicings for peace. In 1805 the cotton mills of Messrs. Phillips and Lee, at Manchester, were lighted with gas. In the beginning of 1816 it was estimated that, at the three gas-light stations, in Peter-street, Westminster, Worship-street, and Norton Folgate, London, twenty-five chaldrons of coals were used daily; and that these were sufficient to supply with gas 125,000 large lamps.

The following data are furnished by Mr. George Lowe, engineer to the Chartered gas company, Brick-lane.

At the Westminster gas works $125\frac{1}{2}$ tons of coals are daily used for the production of coal gas.

The Chartered gas company consume about one-fifth of the coal used by the whole of the gas works in London.

A ton of coal makes between nine and ten thousand feet of gas, and a saleable chaldron of coke. The same quantity loses in the act of carbonizing (if weighed hot) about 30 parts out of 100; so that the 70 is the quantity of coke left in the retort. Of the 30 parts, 15 are gas, 5 tar, 5 water, and 5 are consumed by purification.

In the Chartered works, about one million and a quarter feet of gas are daily made, and, during the Christmas week of 1840, Mr. Lowe states that no less than $12\frac{1}{2}$ millions of feet of gas were made by all the works in London. The following account is extracted from the "Inventor's Advocate," vol. iii. p. 191. "For lighting London and its suburbs with gas, there are 18 public gas-works; 12 public gas-work companies; 2,800,000*l.* capital employed in works, pipes, tanks, gas-holders, and apparatus; 450,000*l.* yearly revenue derived; 180,000 tons of coals used in the year for making gas; 1,400,000,000 cubic feet of gas made in the year; 134,000 private burners supplied; 30,400 public or street consumers; about 2,650 of these are in the city of London; 380 lamplighters employed; 176 gas holders, several of them are double ones, capable of storing 5,500,000 cubic feet; 890 tons of coals used in the retorts, in the shortest day, in twenty-four hours; 7,120,000 cubic feet of gas used in the longest night, say the 24th of December; about 2,500 persons employed in the metropolis alone, in this branch of manufacture; between 1822 and 1827 the consumption was nearly doubled; and between 1827 and 1837 it was again nearly doubled."

With respect to the illuminating power of ordinary coal gas, it is estimated that five feet are equal to twelve mould candles; of six to the pound weight.

The average quantity of coal imported in London for the production of gas, amounts to about 250 thousand tons annually? The Chartered gas company in 1841, guaranteed to accept 60 thousand tons, for their three works, viz. the Westminster, Brick-lane, and the Curtain-road.

The production of the *gas light* is easily effected in miniature, by putting common coal, pounded small, into the bowl of a tobacco pipe, and closely covering this with clay made into a stiff paste with water. The bowl of the pipe being placed in the fire, and there heated gradually, in a few minutes a stream of gas will issue from the end of the pipe. This may be set on fire with a piece of paper, and will burn with a bright flame. When the gas is no longer disengaged, there will be found in the bowl of the pipe the remains of the coal in the form of coke.

Soot is produced from the smoke of burnt coal, wood, &c., and is used as a manure for cold, moist, and clayey meadows and pastures: pounded coal has been applied to the same purpose in some parts of the Continent. By a process called charring, coal is divested of its humid, acid, and bituminous particles, and is converted into a kind of cinder called *coke*. This is employed in cases where intense heat is requisite, as for the smelting of iron ore; and likewise where acid and bituminous particles of coal would be detrimental, as in the drying of malt.

Culm is a species of coal used chiefly for burning lime. It contains much earthy matter, will not kindle in an ordinary fire-place, but produces considerable heat and flame in a furnace, where a strong current of air is introduced. It is found in various parts of Wales and in Ireland.

219. *CANNEL COAL is of a black colour, with little lustre, is not laminar, but breaks in any direction, like pitch, and does not stain the fingers. It burns with a clear flame resembling a candle. It is rather heavier than water.*

This highly inflammable kind of coal is found abundantly in the neighbourhood of Wigan, in Lancashire, where there is an entire stratum of it about four feet in thickness. It is also found near Whitehaven, in some of the pits at Newcastle, and in some parts of Scotland. Doubts have been entertained respecting the name of this coal; but when it is recollected that in Lancashire, whence it is chiefly brought, the word candle is usually pronounced with the omission of the letter *d*, and that, in many instances, the coal is used by the poor as a substitute for candles, these will be immediately removed. In Scotland it has the name of *parrot coal.*

No kind of coal takes fire so readily, nor burns with so cheerful and brilliant a flame as this : and its not soiling the fingers, like pit coal, renders the use of it peculiarly pleasant; but it does not cake, and soons burns away. When first kindled, it crackles and splinters very much; and on this account would be dangerous, were it not easily prevented from so doing by being previously immersed for a little while in water. Cannel coal has much the appearance of jet; the latter substance being only a variety of this coal. It admits of being turned in a lathe, and takes a good polish; and snuff-boxes and trinkets made of it have in many instances been sold as jet (222). Of all kinds of coal that are used for gas-lighting, none are said to be so useful as this. It yields a larger quantity of gas than the ordinary coal, is much purer, and is generally kept at gas works, in case of any sudden call for the purposes of illumination. It usually contains about eleven per cent. of earthy matter.

220. *STONE COAL, KILKENNY COAL, WELSH COAL, or GLANCE COAL, is of a dark iron-black colour, with a metallic lustre and foliated texture; and consists almost entirely of charcoal.*

Unlike most other kinds of coal, this occurs both in stratified masses, and in lumps, nested in clay. It is found in several countries of the Continent, in Wales, Scotland, and near Kilkenny in Ireland.

When laid on burning coals, it becomes red hot, emits a blue lambent flame in the same manner as charcoal; and is, at length, slowly consumed, leaving behind a portion of red ashes. No smoke nor soot is produced from this coal; but, on the contrary, it whitens the places where the fume is condensed; and the effluvia which it gives out are extremely suffocating.

This coal is chiefly used in the drying of malt.

221. *BOVEY COAL, BROWN COAL, or BITUMINOUS WOOD, is of a brown colour, and in shape exactly resembles the*

stems and branches of trees, but is usually compressed. It is soft, somewhat flexible, and so light as nearly to float when thrown into water.

The greatest abundance of this coal occurs at Bovey, near Exeter, from which place it derives its name. The lowest stratum is worked at the depth of seventy-five feet beneath the surface of the earth. It is also found in Scotland, Ireland, and Germany.

As fuel, the Bovey coal is used only by the poorest classes of the community, as, notwithstanding its burning with a clear flame, it emits a sweetish but extremely disagreeable sulphureous gas, which is injurious to the health of the inhabitants. It is principally used for the burning of lime, and for the first baking of earthenware.

222. *JET, or PITCH COAL, is a variety of cannel coal, and is a solid, black, and opaque mineral, harder than coal, and found in detached masses from an inch to seven or eight feet in length, having a fine or regular structure, and a grain resembling that of wood.*

It differs from cannel coal (219), *by its superior hardness. Jet cannot without difficulty be scratched with a knife, whilst cannel coal may be marked by the simple pressure of the nail.*

The name of jet has been derived from Gages, a river of Lycia, whence the ancients are said to have obtained this substance. It is frequently cast on shore on the eastern coasts of England, together with pieces of amber and curious pebbles, particularly near Lowestoft in Suffolk, and in some parts of Yorkshire, where many persons employ their leisure in searching for it, and forming it into various kinds of trinkets. Jet is found in several countries of the Continent.

It is stated that in the district of Aude, in France, there are more than 1,000 persons constantly employed in the fabrication of jet into rosaries, buttons, ear-rings, necklaces, bracelets, snuff-boxes, and trinkets of different kinds. Nearly fifty tons weight of it are annually used for this purpose; and articles to the value of 18,000 livres are said to be sold in Spain alone. In Prussia the amber diggers call it *black amber*, because it is found accompanying that substance; and because, like amber, it is faintly electric, or attracts feathers and other light objects when rubbed.

They manufacture it into various ornamental articles, and sell these to ignorant persons, as black amber, at a great price.

In different parts of the globe the trunks of trees, which have been long buried, have passed into the state of jet; and in almost all these trees may be traced the distinctive characters of the species to which they belong. They are more or less brittle, more or less unctuous, according to the species, the degree of alteration, and the nature of the soil. All of them have a smooth and glassy fracture, but all are not adapted for the tool of the workman. When, for instance, the texture of the tree presents only a mass of dry fibres, the jet obtained is dry and brittle; and cannot be used in the forming of trinkets. But, if the texture be unctuous, the fibre acquires a considerable degree of softness, is susceptible of being properly wrought, and receives a perfect and beautiful polish.

A fictitious kind of jet is made of glass; and several varieties of mineral pitch and cannel coal are imposed upon ignorant purchasers for jet.

When jet is once set on fire it burns with a green flame, and continues to burn for a considerable time, exhaling a strong bituminous smell. If the heat be rendered greater it melts.

MOUNTAIN *or* MINERAL TALLOW *is of a white colour, tasteless, and soft like spermaceti. It melts at about* 118°, *and boils at* 200°.

It is incapable of being converted into soap, and does not combine with soda. It is lighter than water.

The discovery of this substance is due to some peasants in Finland, in the year 1736. Argylshire has yielded specimens of this substance, and Hermann detected it in the waters of a fountain near Strasburg. Dr. Thomson considers that the hatchettine of Conybeare is but a variety of this substance. It was discovered by the latter in the ironstone of Merthyr Tydvil, South Wales, in 1826. It differs from the mountain tallow in having a greenish yellow hue, in being less firm, and not so opaque as that substance.

BLACK LEAD, PLUMBAGO, or GRAPHITE, consists essentially of carbon* (48), *mixed with iron, &c., and used to be considered a carburet of iron.

It is of a dark iron grey colour, with a strong metallic lustre,

and so soft that it is easily scratched with a knife. To the touch it is soft and greasy; and, when handled, it stains the fingers. In weight it is about twice and a quarter as heavy as water.

The name of black lead has very improperly been given to this substance from its appearance only, as it has no alliance whatever with lead. It is usually found in kidney-shaped lumps of various sizes, and occurs in several countries of Europe, but no where of such excellent quality as in Borrowdale, Cumberland, where it has the name of *wadd;* the vein of black lead lies between strata of slate, and is from eight to nine feet thick. This mine is not opened more than once every three or four years, the quantity thus obtained being found fully sufficient for the demand. Two other mines of black lead only occur in Britain, and are in Ayrshire, Scotland.

According to Mr. Pereira there is a monthly sale of this article by auction, in London, at a public house in Essex-street, Strand, on the first Monday in every month. The best kind usually selling for two guineas or more the pound.

Hamburgh and Ceylon afford the very common kinds; that which is unfit for making pencils and the finer purposes to which it is employed, is made into crucibles and blacklead for polishing grates.

Artists in water-colours, if deprived of this mineral, would find great difficulty in making their sketches; as the marks that are erroneously made with it are more easily expunged than those of almost any other substance. Hundreds of thousands of pencils are every year formed of black lead. For this purpose the mineral is sawed into slender square pieces. These are fixed into grooves, of the same shape, cut in cedar, or some other soft wood: another piece of wood is then glued upon this, and the whole is worked into a circular form. The finer kinds of black lead are prepared for use by being boiled in oil before they are cut. The coarser kinds, and the refuse of the sawings, are melted with sulphur, and then cast into coarser pencils for carpenters. These may, in general, be easily distinguished by their sulphureous smell. The pencils that are manufactured in England are more esteemed on the Continent than any others.

Powdered black lead is employed for numerous purposes.

It is used for giving a bright gloss to cast-iron grates and stoves, and defending them from rust, and from the action of fire. It may also be advantageously applied to the inner surface of wooden screws, to packing presses, the axles of various sorts of machines, to slides, and other wood-work, which are subject to friction. In this respect it is far superior either to grease or soap. The makers of razor-strops occasionally employ black lead in the composition which they spread upon leather for the sharpening of razors; and on the Continent it is sometimes used for blackening the hair. A coarser kind of black lead is used for making the vessels that are used by chemists, called crucibles.

The metal *molybdenum* was formerly confounded with black lead.

RESIN FAMILY.

224. *AMBER is a substance usually of a golden yellow colour, semi-transparent, and of a shining and somewhat resinous lustre It melts at* 541° *Fahr. It is occasionally seen of a yellowish white colour, and nearly opaque. It is rather heavier than water; and is chemically composed of carbon, hydrogen, and oxygen.*

The origin of amber is unknown. From the ants and other insects which it frequently contains, there can be no doubt that it has once been in a fluid state; and some writers have thought that it is a resinous juice, gradually modified by the action of sulphuric acid (24); but this is entirely conjecture. The ancients called it *electron*.

Amber is usually found in rounded and detached pieces, on the south coast of the Baltic, cast on shore between Memel and Königsberg, on the eastern shores of England, and in small quantity on those of Sicily and the Adriatic; and a substance greatly resembling it is occasionally found in gravel-pits near London. The principal mines of amber at present known are in Prussia. These are worked in the usual way, by shafts and galleries, to the depth of about 100 feet. The amber is imbedded in a stratum of fossil wood, and occurs in rounded pieces, from a few grains to three and even five pounds in weight. It has been found similarly situated in Greenland and China. The largest piece of amber ever known to be discovered in a detached state was found near the surface of the ground, in Lithuania, about twelve miles from the Baltic Sea. It weighed more than eighteen pounds, and was deposited in the cabinet of the King of Prussia at Berlin. Some years since a mass of amber, weighing thirteen pounds, was also found in Prussia. For this piece 5000 dollars are said to have been offered; but the Armenian merchants assert, that it might have been sold in Constantinople for more than 30,000 dollars.

Anterior to the discovery or general dispersion of precious stones from India, amber was considered of great value as a jewel, and was employed in all kinds of ornamental dresses. The ancient Romans were so partial to this substance, that Pliny, reprobating the great demand for it, says, the Roman females would give larger sums for a puppet or figure in amber, resembling a man or woman, however small its size, than they would for the finest man or the most valiant soldier. Under the Emperor Nero, persons were sent to Rome for the purpose of collecting and purchasing amber; and so much of it was at length obtained, that it was used for ornamenting the nets and cordage employed in the theatres for preventing the wild animals from approaching the populace there assembled. It was likewise used to ornament the armour, the biers, and funeral apparatus of such persons as were killed.

Amber was known to Thales of Miletus, who lived 600 years before Christ. It is chiefly in request by Greek and Armenian merchants, but it is uncertain where they dispose of it. Some persons conjecture that it is purchased by pilgrims previously to their journey to Mecca; and that, on their arrival in that place, they burn it in honour of Mahomet.

The kind most in esteem is of a bright golden yellow colour. This is occasionally manufactured into snuff-boxes, small vases, necklaces, bracelets, cane-heads, and other ornamental articles, many of which are purchased by the Turks, Russians, and Poles; but the general demand for them has of late very much decreased. Some years ago the German artists paid great attention to this substance; and many experiments were made, for the purpose of discovering means of removing its defects and improving its beauty. It is said that they possessed the art of liquefying it to such a degree, that it could be run into moulds without injuring its beauty; and that specimens of this liquefied amber are preserved in the Electoral Cabinet at Dresden. There are still manufactories of amber at Stolpen, Konigsberg, Dantzic, and Lubeck.

Amber, when wrought into ornaments, is first split on a leaden plate, and then turned on a particular kind of whetstone. The polishing of it is performed with chalk and water, or chalk and oil; and the work is finished by rubbing the whole with clean flannel. Without great attention it becomes very hot, and either flies into pieces, or takes fire during the operation.

After having been roasted or melted, amber is readily soluble in oil, and in this state constitutes the basis of several kinds of varnish. It was formerly much used in medicine, but in this respect it is now almost wholly neglected. Some persons, however, have still an absurd notion, that a collar or necklace of amber, tied round an infant's neck, will enable it to cut its teeth in safety. Oil of amber combined with liquid ammonia constitutes a white soapy liquor, called *eau-de-luce*.

It has already been mentioned, that insects are occasionally found in amber: these are generally in a very perfect state, and consist of flies, small moths, &c. Dr. Kastner records an instance of a piece of amber containing a frog. Grains of sand, pieces of iron pyrites, and the leaves of plants, are also sometimes found in it. Insects, sand, and other substances, are likewise remarked in a species of gum, called *gum animi*, which in colour, appearance, and qualities, so nearly resembles amber, that it is almost impossible to distinguish the two substances from each other. Large productions, which were formerly supposed to have been made of amber, such as a column ten feet high in the Florentine Museum, are now usually considered to have been formed of this gum; and many of the large beads of what are sold as amber necklaces are made of it.

It is frequently adulterated with the resins *copal* and *animi*; and was formerly much employed as a remedial agent, being considered antispasmodic and stimulant.

If a piece of amber be burned in the air, it emits a white smoke, and a somewhat agreeable, though sickly odour, and leaves behind a black and shining coal-like substance. When rubbed it becomes negatively electric, and has the property of attracting light bodies; hence one of the ancient Greek philosophers (Thales of Miletus) attributed to it a certain kind of life. From the name of *electron*, which was given to it by them in consequence of this property, we derive our word electricity.

CLASS IV.—METALLIC SUBSTANCES.

225. OF METALS IN GENERAL.

Metals, in a perfect state, are easily distinguished from other minerals, by a peculiar brilliancy which pervades their whole substance, and which has the name of metallic lustre; *by their complete opacity, and their great weight in proportion to that of other mineral substances.*

All the metals are simple substances.

When taken from the earth they are found in one or other of the four following states:—1. *In a native or metallic state.* 2. *Combined with sulphur.* 3. *In a state of oxide* (21). 4. *Combined with some acid.*

Metals, when found in a state of combination with other substances, have the name of *ores*. They are in general deposited in veins (4), of various thickness, and at various depths in the earth. The mode of obtaining them is to penetrate from the surface of the earth to the vein, and there to follow it, in whatever direction it may lie. The hollow places thus formed are called *mines*, and the men employed in them are denominated *miners*. When the veins are at a great depth, or extend to any considerable distance beneath the surface of the earth, it is necessary, at intervals, to make openings, or *shafts*, to the surface, for the admission and circulation of the air; and also to draw off the water which collects at the bottom, by drains, pumps, hydraulic belts, or steam-engines, as the situation or circumstances require.

After the metallic ores are drawn from the mine, they in general go through several processes before they are in a state fit for use. Some of them are first washed in running water, to clear them from earthy particles. They are then piled with combustible substances, and burnt or roasted, for the purpose of ridding them of the sulphur or arsenic with which they may happen to be combined, and which rises from them in a state of fume or smoke. Thus, having been freed from impurities, they undergo the operation of melting, in furnaces constructed according to the nature of the respective metals, or the uses to which they are to be subsequently applied.

The knowledge of metals is a subject of great importance to mankind. Their use in trade is so frequent, and in the arts so various and so interesting, that few objects can be more worthy of attention than these.

ORDER I.—MALLEABLE METALS,

OR, SUCH AS ARE CAPABLE OF BEING FLATTENED OR ELONGATED BY THE HAMMER, WITHOUT TEARING OR BREAKING.

226. *PLATINA, or PLATINUM, the most ponderous of all the metals, in its native state, is invariably in combination with other metals. When purified it is more than twenty-one times heavier than water, and is also one of the hardest and most difficult to be melted; of a white colour, but darker and not so bright as silver; and is generally found in small blunted and angular grains or scales in the sands of some of the rivers in South America. It has also been found in Russia. It was first known as a metal in* 1741.

In the year 1827, a fine specimen of native platina was found in the Ural mountains, not far distant from the Demidoff mines, which weighed rather more than nine and a half pounds avoirdupois; it was sixteen times heavier than water.

If platina could be obtained in sufficient quantity, it would perhaps be the most valuable of all metals. The important uses to which it is applicable may easily be imagined when we state that it is nearly as hard as iron, and that the most intense fire and most powerful acids have scarcely any effect upon it. Platina is not fusible by the heat of a forge, but requires either the concentrated rays of the sun in a burning mirror, the galvanic electricity, or a flame produced by the agency of oxygen gases and hydrogen.

It is admirably adapted for the uses of the philosophical chemist: although vessels made of it must always be found expensive, from its being necessary to solder them with gold; and although it has the disadvantage of being subject to corrosion by the application or use of caustic alkalies, vessels made of it are not liable to be broken, and are as indestructible as those made of gold. When properly refined, its colour is somewhat betwixt that of silver and iron. Not being liable to tarnish like silver, platina is manufactured into several kinds of trinkets.

Its ductility is so great that it may be rolled into plates or drawn into wire; and platina wire, for strength and tenacity, is considered much preferable to that either of gold or silver of equal thickness. Platina used to be made into mirrors for reflecting telescopes, into mathematical instruments, pendulums, and clockwork; particularly where it is requisite that the construction of these should be more than usually correct, as platina is not only free from liability to rust, but is likewise subject to very little dilatation by heat. It is sometimes beaten into leaves and applied to porcelain, in the same manner as leaf gold; and its oxide (21) is used in enamel painting, and might be used with great advantage in the painting and ornamenting of porcelain.

The peculiar property possessed by platinum, of remaining at a red heat in an atmosphere of hydrogen, coal gas, &c. has rendered this metal of the greatest importance of late years. The Davy's Lamp, so indispensable to the safety of the miners (especially those working in coal pits), owes its efficiency to the property it possesses of glowing in an explosive mixture (while the lamp itself is extinguished), and affording sufficient light to enable the miner to pursue his work with safety to himself and others in the pit, and at the same time pointing out to him (when the metal glows) that he is working in an unsafe or explosive atmosphere.

Platina was for many years after its discovery a very intractable metal. Dr. Wollaston invented a method of rendering it easily malleable; this method is described in the *Philosophical Transactions* for 1829.

227. *GOLD is a metal distinguished by its yellow colour; by its being softer than silver, but considerably harder than tin; sometimes nearly pure, but usually combined with silver and other metals, and being more easily melted than copper.*

It is always found in the metallic state, in various states, massive, in grains, small scales, and capillary, or in small branches. It cannot be dissolved in any acid except that called aqua regia (207), *and is more than nineteen times heavier than water.*

The countries of hot climates are those chiefly in which gold is discovered. It abounds in the sands of many African rivers, and is very common in several districts both of South America and India. The gold mines of Lima and Peru have had great celebrity; but since the commotions in the Spanish colonies, the working of them has been much neglected. It is from Brazil that the greatest part of the gold which is seen in commerce is brought. The annual produce of the various gold mines in America has been estimated at nearly 9,500,000*l.* sterling.

In the year 1834, the quantity of gold and silver exported from China, amounted to 1,197,735*l.* sterling.

The principal gold mines in Europe are those of Hungary, and next to them those of Saltsburg. Spain is probably very rich in gold. Considerable mines were worked there in former times, particularly in the province of Asturias; but after the discovery of America these were given up or lost. Gold has been found in Sweden and Norway, and also in several parts of Ireland, but particularly in the county of Wicklow.—Among the sands of a mountain stream in Wicklow, and among the sand of the valley on each side, lumps of gold are occasionally found. Pieces have been discovered which weighed twenty-two ounces, but they are generally much smaller, viz. from two or three ounces to a few grains. It has been said that lumps of gold, of large size, were formerly used as weights in some of the common shops, and that others have been placed to keep open the doors of cottages and houses in some parts of Ireland, the owners not knowing what they were. Gold is also occasionally found in Cornwall, and some other counties of England. Wherever it occurs, it is commonly observed in a state of alloy with copper or silver, and in the form of grains, plates, or small crystals.

The knowledge of this metal was known to the ancients, upwards of 3,500 years ago, and there is but little doubt but that it was the first known to man.

Gold was formerly obtained in Scotland. It is asserted, that at the marriage of James V. there were covered dishes filled with coins made of Scottish gold, and that a portion of these was presented to each of the guests by way of dessert. Very extensive operations for the discovery of gold were carried on during the reign of Queen Elizabeth, at Leadhills, in Lanarkshire, under the direction of an Englishman whose name was Bulmer. The trenches, the heaps of soil that were turned up, and other marks of these operations, are yet visible near the road between Leadhills and Elvanfoot. It is said that three hundred men were then employed; and that, in the course of a few years, a quantity of gold was collected equal in value to 100,000*l.* sterling. Not many years ago similar operations were commenced under the superintendence of a celebrated manager of the Scottish lead mines. The gold was found immediately under the vegetable soil; and the method of obtaining it was to direct a small stream of water so as to carry the soil along with it to basins or hollow places, where the water might deposit the matters carried down by the force of its current. The matter thus deposited was repeatedly washed, till the whole of the earthy substances were carried off. The gold, being heaviest, sunk to the bottom, and remained behind. The soil is said still to furnish gold; but the produce would by no means be equal to the expense of collecting it. Grains of this metal have been sometimes found, after great floods, among the sand of brooks in different parts of Scotland.

The mode of extracting gold from its ore is by reducing it into a fine powder, and mixing this powder with quicksilver (228). The latter has the quality of uniting with itself every particle of the precious metal, but being incapable of union with the other substances, extracts it even from the largest portions of earth. The quicksilver which has absorbed the gold is then separated by means of heat; it flies off in vapour, and leaves the other metal in the vessel used for the operation.

Gold has been known and in request from the very earliest ages of the world. By the assent of civilized nations it has become the representative of wealth under the form of money; and it is now an universal circulating medium for the purchase of all kinds of commodities. It has been chosen to occupy this important place on account of its scarcity, its weight, and other valuable properties.

As gold is not liable to tarnish or rust, it is frequently employed for ornaments of dress. But beyond its use in the coinage, its most important uses are for goldsmiths' work, in jewellery, and for gilding. In each of these its standard or purity is different. That denominated *coinage*, or *sterling gold*, consists of an alloy of about twenty-two parts of gold with two parts of copper; whilst gold of the *new standard*, of which gold plate, watch-cases, and many other articles are made, consists of only eighteen parts of gold, and six parts of copper. Each of these is stamped at Goldsmiths' Hall; the former with a lion, a leopard's head (the mark of the goldsmiths' company), a letter denoting the year, the queen's head, and the manufacturer's initials; the latter is stamped with the queen's head, letter for the year, a crown, the number 18 to designate its quality, and the manufacturer's initials. The coinage gold of Portugal and America is of the same standard as our own; that of France is somewhat inferior; and Spanish gold is inferior to the French. The Dutch ducats and some of the Moorish coins are of gold unalloyed. *Trinket gold*, which is unstamped, is in general much less pure than any of the above; and the *pale gold* which is used by jewellers is an alloy of gold with silver.

The ductility and tenacity of this metal, particularly when alloyed with copper, are extremely remarkable, and are fully proved by the great extent to which a very small quantity of it may be beaten into leaves, or drawn into wire. Leaves of gold may be beaten so thin that a single grain may be made into fifty-six leaves, each an inch square. These leaves are only $\frac{1}{282000}$ of an inch thick; and the gold leaf which is used to cover silver wire is but the twelfth part of that thickness. An ounce of gold upon silver wire is capable of being extended more than 1,300 miles in length: and sixteen ounces of gold, which, in the form of a cube, would not measure more than an inch and a quarter on each side, will completely gild a silver wire in length sufficient to compass the whole earth like a hoop.

Gold is beaten into leaves upon a smooth block of marble, fitted into the middle of a wooden frame about two feet square, in such manner that the surfaces of the marble and of the frame are exactly level. On three of the sides there is a high ledge; and the front, which is open, has a flap of leather attached to it, which the man who beats the gold uses as an apron for preserving the fragments that fall off. In this process there are three kinds of animal membranes used, some of which are laid between the leaves to prevent their uniting together, and others over them to defend them from being injured by the hammer. The exterior cover is of parchment. For interlaying with the gold the smoothest and closest vellum that can be procured is first used; and when the gold becomes thinner, this is exchanged for much finer skin, made of the entrails of oxen, prepared for this express purpose, and hence called *gold-beater's skin.* After the leaf has been beaten to a sufficient degree of thinness, it is taken up by a cane instrument, and thrown flat upon a leathern cushion, where it is cut to a proper size with a square frame of cane, or wood edged with cane. These pieces are then fitted into books of twenty-five leaves each, the paper of which has been well smoothed, and rubbed with red bole (127), to prevent them from sticking. The leaves are about three inches square, and the gold of each book weighs somewhat more than four grains and a half.

It was anciently the custom to beat gold into thin plates, and to gild the walls of apartments, the surfaces of dishes, drinking utensils, and other articles, by covering them with such. But this was not only an expensive, but must have been a most clumsy mode of ornament. The present modes of gilding are very different. When wood is to be gilded, the surface is first smeared with an adhesive kind of oil, or with a kind of glue called size; and the gold leaf above mentioned is then spread upon it by a tuft of cotton or other soft substance.

The *gilding of iron or copper* is performed by cleaning and polishing its surface, and then heating it till it has a blue colour. When this has been done, a layer of gold leaf is put on, slightly burnished down, and exposed to a gentle fire. It is usual, in common work, to place three such layers, or four at the most, each consisting of a single leaf. The heating is repeated at each layer, and last of all the work is burnished. For gilding in *or molu*, as it is denominated by the French, an amalgam consisting of ten parts of mercury and one part of gold is used. This is spread upon the metal, and is afterwards exposed to the action of a fire sufficiently strong to volatilize the mercury and leave the gold behind. The gilding in *or molu* is much more solid and permanent than that by the former method.

When gilding is pale and dirty, it may be revived by means of what is called *gilding wax*, a composition of yellow wax, bole (127), verdigris (230), and alum.

A very beautiful gilding upon metals, and particularly upon silver, is effected by soaking clean linen rags in a solution of gold made by aqua regia (207). The rags are dried and burnt; and the ashes are carefully preserved. These ashes are used by taking a sound cork, moistening it with a little water, dipping it into the ashes, and then rubbing strongly a portion of them on the surface of the silver, which should be perfectly clean and bright. By this simple and economical process, it will be covered with an extremely thin coating of gold, the colour and brilliancy of which may be heightened by burnishing. The ornaments upon snuff-boxes, fans, and various kinds of trinkets, are merely thin plates of silver, gilded in this manner.

The Messrs. Elkington of Birmingham, have very recently taken out a patent for a very simple and ready mode of gilding, applicable to the gilding of all kinds of Birmingham wares. In the 63rd number of the Inventor's Advocate, p. 228, an abstract of the specification will be found. The methods employed for coating or plating metals with gold by this process, are, first, by the use of metallic or oxide of gold, dissolved in prussiate of potass, or any other soluble prussiate, or any analogous salt; secondly, by combining the use of the above with the application of a galvanic current. To two pounds of prussiate of potass, dissolved in one gallon of water, add two ounces of oxide of gold, or metallic gold, in fine division; boil them for half an hour: and, for a thin coating, let the metal be simply immersed; for a thicker coating, let it afterwards be exposed to the action of a galvanic current, either by contact with a bar of zinc, or other electro-positive metal, or by two cylinders closed at the bottom, the outer one glazed, the inner one of unglazed earthenware; let the space between them be filled with a solution of common salt; into this a cylinder of zinc is placed with a copper wire soldered to it, so as to bend over and dip into the inner vessel, which contains a solution of silver, and in which the articles to be coated are placed, one part being in contact with the copper wire. Another method is to substitute for the above solution, a solution of silver, reduced by an acid to a "neutral salt," and then acted upon as before, by the galvanic current.

The *edges of tea-cups*, and other similar articles, may be gilded, though not in a very durable manner, by applying a thin coat of amber varnish (224), and then placing leaf-gold upon it. When the varnish is dry, the gold is to be burnished.

Gold, in a state of solution, is sometimes used for staining marble, ivory, ornamental feathers, and other articles, a purple-red colour, which cannot be effaced. By chemical processes an oxide (21) is obtained from this metal, which is employed for giving those beautiful shades of lilac, rose colour, red, and purple, which we observe in glass and porcelain.

A *gold powder for painting* may be made by uniting one part of gold with eight parts of mercury (228), and afterwards driving off the latter by heat.

The article denominated *gold wire* is generally silver wire gilded, very little wire being made entirely of gold. *Gold thread* consists of flatted silver gilt wire, laid over a thread of yellow silk, by twisting it in a machine with iron bobbins. It is of this, and not of gold, that the article called *gold lace* is made. The Chinese, instead of flatted wire, use slips of gilt paper, which they interweave in their stuffs, and twist upon silk threads.

228. ***MERCURY, in its native state, is called QUICK-***

SILVER, and is found in small globules of a shining, silvery appearance, scattered through different kinds of stones, clay, and ores; in this state it is termed native or virgin mercury. It is nearly fourteen times heavier than water.

The principal ore of mercury, and that from which the metal is chiefly obtained, is cinnabar. *This is of a red colour, and consists of mercury mineralized with sulphur. It is sometimes found in a massive state, sometimes in grains, and sometimes crystallized; and chiefly among rocks of the coal formation.*

The most productive mines of cinnabar are in the palatinate of Germany, at Idria, in Carniola, and at Almaden in Spain. The latter belong to the Spanish crown, and situated in the province of La Mancha, were offered a few years since as the best and only security which the Madrid government could offer to the Messrs. Rothschilds for advances of money, and to whom their produce is even at the present day to a certain extent mortgaged; thus accounting for the increase in price of this article within the last two years. These mines were known to Theophrastus, who lived 288 years before Christ, and who speaks of their produce together with Vitruvius. Another quicksilver mine was discovered in 1755, at Almadenejos, or Little Almaden, which in one year has yielded 12,000 quintals*, although the average quantity is about 3,000. The Spanish mines usually afford about 20,000 quintals annually. Those of Idria are supposed to be more valuable than any of the others. Their first discovery, which was somewhat more than three hundred years ago, was made in a very extraordinary manner. This part of the country was then much inhabited by coopers; and one of the men, on retiring from work in the evening, placed a new tub under a dropping spring, to try if it would hold water; and, when he came in the morning, he found it so heavy that he could scarcely move it. Examining into the cause of this extraordinary circumstance, the man observed that it was owing to a shining and ponderous fluid which was at the bottom. The affair was noised abroad, and a society of persons was formed to search further, and discover the mine

* A quintal is 100 lbs.

from which this quicksilver had flowed. Such was their success, that the reigning Duke of Austria paid them a compensation for the discovery, and took the mine into his own possession. The greatest perpendicular depth of this mine is now more than 830 feet. It is descended by buckets, or by ladders placed obliquely in a zigzag direction. In some parts of the mine the pure metal flows in small streams, so that in six hours a man has been known to collect more than thirty-six pounds weight of it. In other parts of the mine it is found in a multitude of little drops, either in ores or in clay.

The Idrian mines yield about 164 tons of quicksilver annually, much of which is used in the country, where they pack it in leather bags. That which is not made use of in the country is sent to China in iron bottles, weighing when filled from sixty-five lbs. to a hundred weight each.

It has been asserted that, several years ago, in digging out clay for the foundation of a house opposite to the King's Arms' inn, in the street called Hyde-hill, in Berwick-upon-Tweed, a quantity of native mercury was discovered. The clay, when dug out, lay for some time in the place to which it was conveyed; and the mercury was observed to exude from the small fissures or cracks that were formed as it dried. It is said that, several years afterwards, in making some alteration in the yard of the same house, the workmen penetrated into the same bed of clay; and that it then appeared to be impregnated with native mercury, which exuded in small globules.

Mercury is sometimes imported into Europe from Peru, and from the East Indies.

According to Humboldt, the quantity annually consumed in Mexico is 734 tons, and the whole of South America 1250 tons, valued at 250,000*l.* sterling. The price of quicksilver, in 1839 was 3*s.* 10*d.* per pound, and in 1829 1*s.* 10*d.* In 1830, 2,007,068 pounds were imported, and it has been fluctuating much from that time.

The following Table will show the imports in the several years.

	Bottles.		Bottles.
In 1828	3,700	In 1834	9,667
1829	9,500	1835	26,572
1830	25,622	1836	25,577
1831	4,681	1837	25,896
1832	10,075	1838	19,001
1833	20,946	1839	30,150

The modes of extracting it from *cinnabar*, or sulphuret of mercury, are various; some mix this ore either with quicklime, or with half its weight of iron filings, and distil it in a stoneware retort. By this process the sulphur combines with the iron, and the mercury, in a state of purity, passes into the receiver.

The ore is roasted at Almaden, by which process the sulphur is burnt out.

When pure or native mercury occurs in mixture with other substances, these are stamped or ground into a coarse powder. Water is poured upon them; they are briskly stirred until the water becomes thick and turbid, and then are left to settle. This operation is repeated till the water runs off perfectly clear. The substance at the bottom, which is principally mercury, is then put into large iron retorts, and the metal is obtained, free from all extraneous matter, by distillation.

It is the singular property of this metal, which has no other alliance whatever with silver than its appearance, to be capable of division, by the least effort, into an indefinite number of particles, each of which assumes a spherical form; and to be always in a fluid state at the common temperature of our atmosphere. Even during the most intense frost, it still retains its fluidity. By the effect, however, of extreme cold artificially produced, 38½ degrees Fahr. below zero, mercury becomes a solid metal, and in this state it crystallizes in needle-shaped and regular octahedrons, and may then be beaten with a hammer and extended without breaking; but care must be taken that it does not touch the fingers, as it would blister them and cause unpleasant sores, in the same manner as any burning substance, viz. by the sudden abstraction of nervous power, by which the blood vessels are deprived of the capability of contracting.

Mercury has been known from the remotest ages; Aristotle states that Dædalus was acquainted with it, who is supposed to have existed 1300 years before Christ. It was employed by the ancients in gilding, and in the operations of separating gold and silver from their ores, in the same manner as at present. Being the heaviest of all fluids of which we have any knowledge, and not congealing in the temperature of our climate, it has been preferred, before all others, for barometers, as a measure of the weight of the atmosphere. And, as heat dilates mercury similarly to other fluids, it is likewise made into thermometers. Mercury has been used in medicine in its pure metallic state, to expel worms from the alimentary canal.

The combinations of mercury with other metals are termed *amalgams.* That of mercury and gold is formed so readily, that if gold be dipped into mercury, its surface immediately becomes as white as silver. An amalgam of mercury and gold is employed for the gilding, and of mercury and silver for the silvering of metals.

Mercury and tin combined together form the substance that is used for the *silvering of looking-glasses.* The process is as follows: A quantity of tin-foil equal in size to the glass, is evenly placed on a flat stone or table; and mercury, in which some tin has been dissolved, is poured upon it, and spread with a feather or bunch of cloth until its union has covered every part. A plate of glass is then cautiously slided upon it from one end to the other, in such manner that part of the redundant mercury is driven off, or swept away before its edge. The remainder is now united to the tin. The glass is then loaded with weights all over, so as to press out still more of the mercury. By inclining the table this remaining mercury becomes discharged; and in a few hours the rest of the tin-foil and mercury adhere so firmly to the glass, that the weight may be removed without any danger of its falling. About two ounces of mercury are requisite for covering, in this manner, three square feet of glass.

By means of mercury a *fulminating powder* is made, which, when struck with a hammer, or anvil, or flat iron, such as is used by laundresses, explodes with a stunning and disagreeable report, and with such force as to indent both the anvil and the hammer. Four or five grains are as much of this powder as ought to be used for such experiments. Its force is much greater than that of gunpowder, but does not extend so far. Hence it is a substance which might be rendered of great use in the blasting of rocks.

Corrosive sublimate, or *Bichloride of mercury*, is an extremely poisonous preparation. Among other uses, it is employed by dyers as a mordant to fix their colours; and of late by Mr. Kyan as a supposed preservative to timber, &c. from the effects of insects, fungi, and other destructive causes. As much as fifty-two tons weight of quicksilver are annually converted into corrosive sublimate by Kyan's Antidry-rot Company; and to prevent the injurious effects arising from the slow absorption of this poison into the system of those workmen engaged in working the patent, they retain a plate of silver in their mouths during their work, to arrest its action by amalgamation. From certain proportions of corrosive sublimate and mercury rubbed together until they are perfectly incorporated, and then *thrice* sublimed, is formed *calomel*, or *Chloride of mercury*; a salt which of late years has been extensively and most usefully employed in medicine.

A valuable red colour or pigment called *vermilion*, or *artificial cinnabar*, which was as well known to the ancients as it is to the moderns, is usually formed of three parts of mercury and one of sulphur, melted together, heated to redness, and then sublimed out of contact of the air. The manufacture of vermilion was long kept a secret by the Dutch; and it is stated that, before the late war, nearly 50,000 pounds weight of it were annually made, in three furnaces, by four workmen, near Amsterdam. Native cinnabar is sometimes used for the same purpose; but the artificial kind is preferred on account of the purity and brightness of its colour.

229. *SILVER, when pure, is a white, brilliant, sonorous, and ductile metal, somewhat more than ten times heavier than water. It melts at a bright red heat.*

It is found in different states. Of these the principal is denominated Native Silver, *from its being nearly in a state of purity. Native silver sometimes occurs in small lumps, sometimes crystallized (having the cubic or regular octohedral form), and sometimes in leaves, threads, or wire. In many instances the latter are so connected with each other as to resemble the branches of trees, in which case the ore is called* dendritic. *There are also several* ores of silver, *in which this metal is combined with lead, antimony, arsenic, sulphur, and other substances.*

The silver that is produced from the mines of Potosi, in South America, is of the dendritic kind, and is considered by the Spaniards as the purest that is known. A range of mountains near Potosi, about twenty miles in circumference, is said to be perforated by more than 300 shafts, or openings of mines, and to produce in the whole from 30,000 to 40,000 dollars' worth of ore per week. The annual produce of the silver mines in America has been estimated at near 2,400,000*l.* sterling.

Silver is also found in several parts of Europe; and some years ago there were mines of this metal worked to a great extent at Konigsburg, in Norway. These were discovered in 1623, and they were found so profitable, that in 1751 forty-one shafts and twelve veins were wrought there; and 3,500 officers, artificers, and labourers, were employed. The perpendicular depth of the principal shaft was more than 750 feet. Specimens of native silver are not uncommon among some of the copper-mines of Cornwall; and many years ago a vein of silver ore was, for a short time, wrought with considerable advantage in the parish of Alva, Stirlingshire, Scotland; it is said that from 40,000*l.* to 50,000*l.* worth of silver was obtained from it before the repository was exhausted. We are informed that a mass of capillary native silver was found, in veins traversing the blue-coloured limestone of Isla, one of the Western Islands of Scotland. Great quantities of silver are extracted from lead. There was lately melted in one refining-house in London 50,000*l.* worth of this metal, from lead of the Beeralston mines in Devonshire.

Different methods are employed in different countries to extract silver from its ore. In Mexico and Peru the mineral is pounded, roasted, washed, and then mixed with mercury in vessels filled with water; a mill being employed for the more perfectly agitating and mingling them. By this process the silver combines with the mercury. The alloy thus obtained, after undergoing some further processes, is submitted to the action of heat, by which the mercury passes off in a state of vapour, leaving the silver behind. The silver is then melted and cast into bars or ingots. In other countries, after the earthy matters are cleared from the silver ore by pounding and washing, the remainder is melted with lead: which by a subsequent process is separated, and leaves the silver alone and pure.

Mrs. Trollope gives the following account of the extraction of silver from ore by amalgamation, at a mine near Huelgoat, in Brittany:—" This takes place every morning of the year, at six o'clock, except on Easter Sunday. When the red earth which contains the silver, and lies above the lead ore for the most part, is raised out of the mine, it is first pounded and washed, by which a large portion of the earth is separated from it. The metalliferous part is then reduced to a sort of paste. It is then placed in six large rotatory barrels, together with a certain quantity of mercury, and a mixture of salt and vitriol, which assists the process of amalgamation, and plenty of water. The barrels are then kept revolving by a water-power for twenty-four hours, at the end of which time the mercury has drawn to itself all the silver away from the earth. The water and earth are then drawn off, and the united mercury and silver remain at the bottom of the barrels. This is then pumped into an hydraulic press, which separates the mercury from the silver by forcing the united mass with great power into a cylinder, one end of which is stopped with a piece of the best and closest grained ash wood that can be procured. This sort of bung is about ten inches in diameter, and two or three inches thick. The action of the press forces the mercury to pass through the pores of this, while the silver remains in a solid state behind. Some little mercury, however, still remains attached to it, which is afterwards caused to pass off by evaporation at a very high temperature.—The silver mine of Huelgoat yields 1,000,000 kilogrammes of mineral for the smelting-house, of which 715,000 kilogrammes are lead, and 733 kilogrammes of silver. All the smelting is carried on at Poullavuen, not far distant from Huelgoat."

This metal ranks next in value to gold. Like gold, it is coined into money, and is manufactured into various kinds of utensils, such as goblets, vases, spoons, and dishes, which have the general appellation of *silver plate*. For all these purposes it is alloyed with copper, which does not affect its whiteness, and is not easily detected, unless it be in too great proportion: the intention of this is to render it harder than it would otherwise be, and thereby the better to adapt it to receive fine and sharp impressions on being cast. Our *standard silver* is composed of somewhat more than twelve and a quarter parts of pure metal and one part copper; and the metal of this standard is used both for silver plate and in the coinage. The mark or stamp which is given to it at Goldsmiths' Hall is similar to that which has been explained for sterling gold.

After platina (226) and gold (227), silver is considered the most unchangeable of all metals. The air does not easily act upon its surface in such manner as to injure it; but when long exposed to the atmosphere, especially in frequented or smoky places, it acquires a covering or rust of a dark brown colour, which on examination is found to be what chemists denominate *sulphuret of silver*. The fumes of sulphur and other inflammable substances blacken silver. Various powders have been contrived with a view to restore to plate its original lustre; but these should be used with caution, as some of them are very injurious.

Silver is nearly as ductile as gold. It may be beaten into leaves so thin that a single grain in weight will cover a space of more than fifty-one inches; and it may be drawn into wire much finer than a human hair, indeed so fine that a single grain of silver has, in this form, been extended nearly to the length of 400 feet. It is this wire gilded that has the name of gold wire; and what is denominated *gold lace* (227) is but flatted silver thread gilt, twisted round silk, and woven.

The *plating* of copper with silver is a very useful operation, and is thus performed. Plates of silver are bound with iron wire upon small ingots of copper. The quantity generally allowed is one ounce of silver to twelve ounces of copper. The surface of the plate of silver is made not quite so large as that of the copper; and upon the edges of the copper, which are not covered by the silver, a little borax (204) is put. By exposing the whole to a strong heat, the borax melts; and in melting contributes to fuse that part of the silver to which it is contiguous, and to attach it in that state to the copper. The ingot, with its silver plate, is then rolled between steel rollers moved by machinery, till it is of a proper thickness. It is afterwards cut into such sizes and to such shapes as may be required for use. An ounce of silver is thus often rolled out into a surface of three square feet, having its thickness upon the copper not more than the three-thousandth part of an inch. Hence we ought not to be surprised at the silver being soon worn from the sharp edges of plated goods. To prevent this it is customary, with the best articles, to have all the edges and the parts liable to be worn, formed, to a considerable thickness, of silver.

What is called *French plate* is made by heating copper, or more frequently brass, to a certain degree, then applying leaf-silver to the surface, and strongly rubbing it with a burnisher. The durability of this plating depends, of course, on the number of leaves which are applied on a given surface. For ornaments that are not much used ten leaves may be sufficient; but a hundred will not last long, if the metal be exposed to frequent handling or washing.

Besides the above, there are various modes of *silvering* metal articles, or, as it is called, *washing* them with silver. All these are performed by different chemical preparations of this metal.

Mr. R. E. Elkington, of Birmingham, has lately obtained a patent for coating copper or its alloys with silver, by the process of fusing silver upon the surface of the metal, whereby the coating of silver is alloyed or united with the surface of the coated metal; and also by the use of oxide of silver dissolved in prussiate of potass, soda, or any other analogous salt, or in pure ammonia; and by the use of the above, in connection with a galvanic current; and lastly, by the use of a solution of silver in an acid, so as to constitute a neutral salt, in connection with a galvanic current, as described page 181. (See *Inventor's Advocate*, vol. iii. p. 228.)

The article denominated *shell-silver*, used by painters, is prepared by carefully grinding silver-leaf, with a little honey or gum water, upon a slab, or in a mortar, and separating the honey or gum by means of water. When this is washed away, the silver may be put on paper, or kept in shells, for use. When it is to be used it must again be mixed with gum water.

The application of silver-leaf for the silvering of paper or wood is similar to that of gold-leaf (227).

Silver dissolved in nitric acid (30), yields crystals which, afterwards melted in crucibles, form that grey mass usually called *lunar caustic*, and by chemists *nitrate of silver*. This preparation is of considerable use in surgical cases, being employed to keep down fungous or proud flesh in wounds and ulcers, and also for the consuming of warts, small wens, and other excrescences upon the skin. It is likewise, though a most violent medicine, sometimes given internally: but in very small doses, to persons subject to epileptic fits. The liquid in which the silver is dissolved becomes excessively caustic. It gives to the skin, the hair, and almost all animal substances, an indelible black colour. Hence it is often used as a specific for dyeing the human hair. No person, however, would employ it for this purpose who is acquainted with its injurious qualities, not only to the hair itself, but also to the skin, if permitted to come in contact with it.

The article called *indelible*, or *permanent marking ink*, for marking linen, and other wearing apparel, is formed by dissolving, in a glass mortar, two drachms of nitrate of silver in six drachms of pure water, and then adding to them two drachms, by measure, of thick gum water. This is the ink for writing on the linen.—In another vessel dissolve half an ounce of salt of tartar, or of the subcarbonate of soda of commerce, in four ounces of water; and add to the solution half an ounce, by measure, of thick gum water. This forms the preparatory liquor. With this the linen is to be thoroughly wetted at the part intended to be marked. The linen is to be dried, and then to be written upon by a clean quill pen dipped in the marking ink. The letters will at first be pale, but by exposure to light and heat they will soon become black; and be so permanently fixed that no washing nor bleaching can efface them.

The *Photogenic*, or *Photographic* Art, as introduced by Mr. Talbot, and which created so much sensation for a time among scientific men in 1838, is dependent for its action on exactly the same circumstances, and in a degree under the same influences, to the process just described in marking linen by the nitrate of silver. In the *Photogenic* process, paper is coated with a very uniform layer of *chloride of silver*, which, like the nitrate, is sensitive to the action of light. When an object, as a fern for instance, is placed on this paper, and pressed close to it by being inserted between two plates of glass, the whole of the prepared paper exposed to the light will be rendered black, or, in other words, will be decomposed, while that portion covered with the object will not be acted upon. To render this impression permanent the whole paper is immersed in a preparation of hyposulphite of soda, or a strong solution of common salt. The uniform covering of chloride of silver is thus effected. Sheets of proper paper are first soaked, for some few hours, in a solution of common salt; these are then hung up to dry: when quite dry they are slowly passed through a solution of nitrate of silver, and likewise hung up to dry in a *dark* place. When dry it must be kept from the action of light, and constitutes the *Photogenic* paper. This process has, however, given way to the more beautiful and delicate manipulation for which M. Daguerre, of Paris, has justly received a yearly emolument from the French government, termed the *Daguerreotype*. By this process portraits, views from nature, &c. may be most correctly obtained. It was first secured by letters patent in this country, by Messrs. Newton and Berry, of Chancery-lane. It was subsequently purchased by Mr. Beard, the proprietor of the process for obtaining *Photigraphic* Portraits, who grants licences to work it.

There is a very extraordinary compound of silver called *fulminating silver*, which explodes without heat, and with even the slightest degree of friction. Of this compound little *fulminating balls* have been made. These are globules of thin glass, each somewhat larger than a pea, and containing a grain or two of fulminating silver. After the silver is put in, it is secured by a piece of soft paper pasted over the ball so as completely to cover it. These balls explode by merely crushing them under the heel of the shoe. What are called *fulminating bombs* are similar balls, but of the size of hazel nuts. No one should attempt to explode these by crushing them with the shoe, as their explosive effect is so violent as sometimes to prove injurious.

Fulminating silver requires the utmost care. It should never be put into phials, nor should it be in any way handled so as to produce much friction. It is the most dangerous preparation that is known. The mere touch of a hard substance will sometimes explode it: and its very

3. Drop upon a clean plate of copper a small quantity of solution of lunar caustic, or nitrate of silver. In a short time a metallic vegetation will be perceptible, branching out in pleasing forms, and in various directions.

230. *COPPER is a red or orange coloured metal, rather less than nine times heavier than water. It is the most sonorous of all metals, and, except iron, the most elastic. It melts at a cherry red or dull white heat,* viz. 1996 *degrees Fahr. according to Daniel.*

It is found under a great variety of forms, sometimes in masses of pure metal, sometimes crystallized in cubes or regular octohedrons; most frequently it is in combination with other substances, particularly sulphur.

There are valuable copper mines in every quarter of the world: and the use of copper is probably of greater antiquity than that of any other metal. Its name (*cuprum*) is derived from the Greek word κύπρος, signifying Cyprus, from which island it was first obtained. It is mentioned in the Old Testament; and, at a very early period, domestic utensils and instruments of war were made of bronze, or a compound of copper and tin. Even during the Trojan war, as we learn from Homer, the combatants had no other armour than what was made of bronze. The Greek and Roman sculptors are said to have executed fine works of art in porphyry, granite, and other hard minerals by means of copper instruments; whence historians have been induced to believe that the ancients possessed the secret of rendering this metal as hard as steel: some of them even imagined that they had the means of converting it into steel.

Copper is very abundant in several parts of Great Britain, particularly in the island of Anglesea. The copper mines of Anglesea are situated on the top of a mountain, and form an enormous cavity more than five hundred yards long, a hundred yards broad, and a hundred yards deep. The ore is got from the mine by pickaxes, and blasting with gunpowder. It is then broken with hammers into small pieces, an operation which is chiefly performed by women and children. After this, it is piled into kilns of great length, and each about six feet high; from the upper parts of which flues are attached that communicate with what are called sulphur chambers. The kilns are closely covered; and fires are lighted in different parts, that the ore may undergo the process of roasting. The whole mass gradually kindles, and the sulphur which is combined with the ore, is expelled in fumes, by the heat, and is conveyed, through the flues, to the sulphur chamber. This process occupies from three to ten months, according to the size of the kilns; and, during that period, the sulphur chamber is cleared four or five times. When the operation is complete, or the ore is freed from the sulphur, it is taken to places denominated slaking pits. It is subsequently conveyed to the smelting houses, where, by intense heat, the pure metal is drawn off in a fluid state.

As the water which passes through several parts of the Parys mine, is strongly impregnated with sulphate of copper (269), or copper held in solution by sulphuric acid (24), the proprietors turn the course of this water through certain large and shallow pits, which they have formed for the purpose, and in each of which they place a quantity of iron. A decomposition here takes place: the iron is corroded, and, at length, entirely dissolved, and the copper, in the form of a brown mud, falls to the bottom. One ton weight of iron, thus immersed, will produce nearly two tons of copper mud, each of which, when melted, will yield sixteen hundred weight of metal. This mode of obtaining copper is said to have been an accidental discovery, from one of the workmen, several years ago, having left a shovel in the water, which, when afterwards taken out, appeared changed into copper.

The magnitude of the above mentioned copper works may readily be conceived, when it is stated that the beds of ore were, in some places, more than sixty feet in depth: and that the proprietors employed more than one thousand workmen: and that they shipped, on the average, from the adjacent port of Amlwch, upwards of 20,000 tons of copper annually.

There is at Ecton, in Staffordshire, a copper mine, which is now worked at the depth of 1416 feet below the surface of the ground. This is the deepest mine in England.

According to Mr. J. H. Vivian, copper is refined or toughened by melting it and stirring the mass with a birch-pole.

Cornwall, however, is stated to yield the largest quantity of this metal than any other county; in 1832, 11,947 tons were carried to Swansea to be smelted with North Wales coal, which is said to have produced 1320 tons of copper in addition.

In 1832 the county of Devon yielded but 247 tons; Anglesey 783; Staffordshire 152; making in all 14,449 tons, the price of which is £90 per ton, making £1,300,416.

Copper has been found in a native state at Redruth in Cornwall, at which place it is not uncommon. America, Germany, Norway, and Spain also afford it in this state.

The uses of copper are numerous and important. When rolled into sheets, betwixt large iron cylinders, it is employed for the covering of houses, sheathing the bottoms of ships, and other purposes. As a covering for houses, copper is lighter than slate. The coppering of ships tends to facilitate their progress through the water, by presenting a smoother surface than that of wood, and not permitting shell animals to fasten to it to that extent as they do to wood. It likewise preserves the bottoms of the ships from being punctured by marine worms; and consequently secures to them a longer duration than they would otherwise have. Plates, or flat pieces of copper, are used by artists for engraving pictures upon, either by cutting them with a sharp steel instrument, or corroding them with aqua fortis (206), in lines drawn by a needle through a thin coat of wax spread upon their surface, termed etching.

Copper is manufactured into various kinds of cooking utensils. Great care, however, ought to be taken that acid liquors, or even water intended for drinking, or to be mixed with food, be not suffered to stand long in such vessels, otherwise they will dissolve so much of the metal as to give them disagreeable and even poisonous qualities. Yet it is remarkable that, while acid liquors are kept boiling, they do not seem to dissolve any of the metal. Hence it is that confectioners, by skilful management, prepare the most acid syrups in copper vessels, without their receiving any unpleasant taste or injurious quality from the metal. All vessels formed of this metal, which are employed in cookery, ought to have their inner surface covered with a coat of tin (238).

As copper does not, like iron, strike fire by collision, it has on this, as well as on some other accounts, been substituted for iron in the machinery which is employed in gunpowder mills. It is also made into water pipes, and sometimes into sash frames. Under the hammer it is capable of being beaten into thin leaves like gold. Copper wire is much employed by bell-hangers and other artizans. The filings of this metal are used for giving a green colour to some kinds of artificial fireworks.

Copper has been found in the ashes of many plants, especially hemlock, rhatany, flax, nux vomica, &c.: and it has been detected in the blood of animals by Sarzeau.

Several preparations of copper are employed in medicine, some of them internally, and others externally; but most of the former are violently emetic.

Verdigris is a rust or oxide (21) of copper, usually prepared from that metal by corroding it with vinegar. There is a large manufactory of verdigris at Montpellier in France. The workmen place alternate strata of copper plates and husks of grapes, the latter of which speedily become acid and corrode the metal. The verdigris, thus formed, is scraped off as it collects on the surface; it is afterwards dried, and put into bags or casks for sale. A manufactory of verdigris has been established at Deptford, near London.

A solution of this substance in distilled vinegar affords permanent crystals, which are improperly called *distilled verdigris*, and are made into a green paint. Verdigris is principally consumed by dyers in combination with logwood, for striking a black colour. It is a virulent poison.

Oxide of copper is employed for giving a beautiful green colour to porcelain. It also imparts the same colour to glass, and hence is frequently employed for the formation of artificial emeralds.

Alloys of Copper.

Of all metals that are known, copper is the most susceptible of alloy. The most frequent and useful of these alloys are made with copper and zinc, in different proportions.

Brass is an alloy composed of three parts of copper, and about a fourth part of zinc (241). It is a beautiful, useful, and well known yellow metal. Not being so apt to tarnish and rust as copper, and being in other respects better adapted for the purpose than that metal, it is much used for clock-work, and for mathematical and astronomical instruments. It is more ductile than either copper or iron; and hence is peculiarly fitted to be made into wire, for the strings of musical instruments, and other purposes. For the manufacture of pins brass wire is used in very great quantity. In the year 1824 a large pin manufactory was established by Mr. Wright in the vicinity of Wellclose-square, London, and which, when at full work, was stated to be able to supply pins for the whole of the United Kingdom, being about 16,000,000 pins daily. Although sieves are woven with brass wire, after the manner of cambric weaving, yet it is of such extreme fineness that similar ones could not possibly be made with copper wire. Brass wire, flatted and gilded, is sometimes made into lace for this purpose. Brass unites great beauty of colour to a high degree of ductility, and is used chiefly for escapement wheels, and other nicer parts of watch-making. For work, in which there is no friction, it is necessary to cover brass with a kind of varnish or *lacquer*, to improve its colour, and prevent it from being tarnished by exposure to the atmosphere: for this purpose it is washed over with a solution of *argol.*

Brass alloyed with tin forms *gun metal*, and a kind of *bell metal*; and, with lead, it is known as COCK-METAL, which is of a softer character than the others.

Brass is instantaneously cleaned if immersed in nitric acid.

The tools used for burnishing this metal are made of bloodstone.

Prince's Metal, or *Pinchbeck*, is an alloy, containing three parts of zinc (241) and four of copper. This metal has nearly the same colour as gold, and was formerly much in use for the manufacture of ornamental articles of different kinds.

Dutch Gold or *Dutch Metal* is formed by the cementation of copper-plates with calamine (241), hammered out into leaves. This article is chiefly manufactured in Holland and Germany, and has about five times the thickness of gold leaf.

Bronze and *the metal of which cannons are made*, consist of from six to twelve parts of tin (238) combined with one hundred parts of copper. By this union a metal is produced more easy to cast, running freely into the moulds, and less likely to rust, two important items in a manufacturing point of view. This alloy is brittle, heavier than copper, and of a yellow colour. Before the method of working iron was brought to perfection, it was used by the ancients for the manufacture of sharp-pointed instruments; it is supposed to have been the *æs* or brass of the Romans.

The bronze used by the ancient Egyptians was composed of one-third copper and two-thirds brass; and, on the authority of Pliny, the Grecian bronze possessed, in addition, one-tenth of lead and one-twentieth of silver.

Bell Metal, or the metal of which bells are formed, is usually composed of three parts of copper and one of tin. Its colour is greyish white; it is very hard, sonorous, and elastic.

Bronze and bell metal are not, however, always made of copper and tin only. They frequently have other admixtures, consisting of lead, zinc, or arsenic. Bell-makers sometimes abuse the vulgar credulity by pretending that they add a certain quantity of silver to the alloy, for the purpose of rendering the bells more melodious; but they are better acquainted with their business than to employ so valuable a metal in the operation.

White Copper is an alloy composed of equal parts of copper and arsenic (242). The metal produced by this mixture is of a whitish colour, but with a coppery tinge. It is freed from the latter by being melted several times; and, by this process, is at last rendered as white as silver. White copper is very brittle; but, if the arsenic be evaporated by heat, it resumes its ductility, and still preserves its white colour. When the operation is well performed, it is easy, at the first glance, to mistake white copper for silver; but the difference may immediately be ascertained from the properties inherent to the two metals.

White copper is employed in the manufacture of many kinds of trinkets; and of a great number of domestic utensils; such as tea-pots, coffee-pots, and candlesticks.

231. *MALACHITE, or Mountain Green, is a solid green copper ore, the surface of which has frequently a bubbled appearance, and the interior is marked with numerous irregular zones, and layers of different shades of green. It is nearly four times as heavy as water, and is so soft as to be easily scratched by a knife. Its chemical composition is carbonic acid, oxide of copper and water, forming a hydrous dicarbonate of copper.*

In its appearance, malachite somewhat resembles green jaspar; but it is by no means so hard. It is, however, capable of being cut and polished as a gem, and is manufactured into various kinds of trinkets, which were formerly much in request for necklaces, brooches, and bracelets. It is also cut into slabs, and mounted into snuff-boxes. Such is the size of which it is sometimes found, that M. Patrin saw, at Petersburgh, a plate of malachite thirty-two inches long and seventeen inches broad, which was valued at 20,000 livres; but the finest specimens in Europe are some slabs that are adapted as the tops of tables, sideboards, &c. at Trianon, in the Park of Versailles: the largest of these are nearly four feet in length and two feet wide. They may indeed have been formed by various pieces joined together; but, if so, the joints are so completely concealed as not to be discoverable even by the closest examination. Malachite is sometimes employed for the engraving of cameos, but is seldom cut in intaglio. Smaller pieces of this substance, that are used for trinkets, are about the same value as carnelian. Independently of its use, in the above respects, and also as an ore of copper, malachite, when pure, is ground into powder, and employed as a green pigment.

The Vosges Mountains in Lorraine, certain copper mines of Saxony, and Chessy in France, are celebrated for producing very fine specimens of malachite. This beautiful mineral is also found in small quantity in the copper mines of Cornwall and Wales.

232. *TURQUOISE. The beautiful light blue substances that are called turquoises were formerly considered as the bones or teeth of animals, impregnated with a blue oxide* (21) *of copper; but they are sometimes found in nodules which are certainly not of an osseous nature.*

Turquoises are frequently set in rings, necklaces, brooches, and other female ornaments. In Persia they are very common; and, amongst the Turks, are held in such estimation that persons of rank almost constantly wear them in some part of their dress, as ringstones, and to adorn the handles of stilettos. They are imported into England from Russia, stuck with pitch upon the ends of straws; because if mixed together in parcels, the purchaser would not easily be able, in turning them over, to observe their colour, and ascertain their value.

In the turquoise there is nothing that can recommend it to notice except the agreeable softness of its colour, which is particularly distinguishable by candlelight; this alone has rendered it so fashionable as an ornament in female dress, for rings, ear-drops, and brooches, that the demand for it is at present greater than the supply. Imitations of turquoise are easily made in paste, and not unfrequently imposed upon the ignorant purchaser; but in these, though the colour is correctly given, there is a glassy lustre much higher than that of the real stone.

Of late years a spurious kind of turquoise has also found its way into Europe, which is much softer than the genuine kind, has more of a green than a blue cast, and is by no means capable of so good a polish.

233. *IRON is a well-known metal, of a livid greyish colour, hard and elastic, and capable of receiving a high polish. Its weight is nearly eight times as great as that of water. It requires an intense white heat to melt it.*

It is seldom found in a truly native state, but occurs abundantly in almost every country of the world, in a state of oxide (21) *and mineralized with sulphuric* (24), *carbonic* (26), *and other acids.*

Iron is found in plants, in several kinds of coloured stones, and even in the blood of animals.

Of all the metals there is none which is so useful, or so copiously and variously dispersed as iron. Its uses were ascertained at a very early period of the world. Moses speaks of furnaces for iron, and of the ores from which it was extracted, and tells us that swords, knives, axes, and instruments for cutting stones, were, in his time, all made of this metal.

The most considerable iron mines at present existing are those in Great Britain and France. According to Sir John Guest's report it appears: "That in 1740 almost all the iron in this country was made from charcoal, and the make was 17,350 tons. In 1788, in consequence of the introduction of the new process for making iron with pit-coal, the quantity increased to 68,300 tons; about which time Mr. Watt brought his improvements to bear upon the iron trade, by the introduction of steam engines for blowing the furnaces, after which time there was a still more rapid increase. In 1796 the quantity produced was 125,000 tons. In the next ten years, down to 1806 the quantity was increased to 258,000 tons. In 1823 the quantity produced was 452,000 tons. The quantity in 1825 was 581,000 tons (this was all pig-iron). In 1828 the quantity was 703,000 tons. From that time to 1831 it became stationary; it rather diminished in 1830 in consequence of the distress which prevailed in the country at that time; from which time the increase has been far more rapid. In 1835 it was estimated at about a million of tons; in 1836 it was estimated at 1,200,000 tons; and the estimate made by a very intelligent person (who went round the works in 1839) was 1,512,000 tons, and which is rather on the increase. A very large proportion of the increase of late years has been produced by the introduction of hot air in the blast furnace."

After iron ore is dug out of the earth, it is crushed or broken into small pieces, by machinery. It is next washed, to detach the grosser particles of earth which adhere to it. This operation ended, it is roasted in kilns, formed for the purpose, by which the sulphur, and some other substances that are capable of being separated by heat, are detached. It is then thrown into a furnace, mixed with a certain portion of limestone and charcoal, to be melted. Near the bottom of the furnaee there is a tap-hole, through which the liquid metal is discharged into furrows made in a bed of sand. The larger masses, or those which flow into the main furrow, are called *sows;* the smaller ones are denominated *pigs* of iron; and the general name of the metal in this state is *cast iron.*

With us iron is employed in three states, namely cast iron, wrought iron, and steel.

Cast iron is distinguishable, by being, in general, so hard as to resist both the hammer and the file, being extremely brittle, and for the most part, of a dark grey or blackish colour.

A great number of useful and important articles are formed of cast iron, such as grates, chimney backs, pots, boilers, pipes, and cannon shot. These are made by pouring the liquid metal into moulds that are shaped for the purpose in sifted sand. Even roofs of houses and bridges are now made of cast iron.

Wrought iron. The process of converting cast iron into wrought or malleable iron, is called *blooming.* The cast iron is thrown into the furnace, and kept melted by the flame of combustibles which is made to play upon its surface. Here it is suffered to continue for about two hours, a workman constantly stirring it, until, notwithstanding the continuance of the heat, it gradually acquires consistency, and congeals. It is then taken out, while hot, and violently beaten with a large hammer worked by machinery. In this state it is formed into bars for sale.

The value of iron is beyond all estimate, and infinitely greater than even that of gold. By means of this metal the earth has been cultivated and subdued. Without it houses, cities, and ships, could not have been built; and few arts could have been practised. It forms also the machinery by which the most useful and important mechanical powers are generated and applied.

Steel is usually made by a process called *cementation.* This consists in keeping bars of iron in contact with powdered charcoal, during a state of ignition, for several hours, in earthern troughs, or crucibles, the openings of which are stopped up with clay. Steel, if heated to redness, and suffered to cool slowly, becomes soft; but if plunged, whilst hot, into cold water, it acquires extreme hardness. It may be rendered so hard as even to scratch glass; and at the same time, it becomes more brittle and elastic than it was before. Although thus hardened, it may have its softness and ductility restored by being again heated, and suffered to cool slowly. A piece of polished steel, in heating, assumes first a straw-yellow colour, then a lighter yellow, next becomes purple, then violet, then red, next deep blue, and, last of all, bright blue. At this period it becomes red hot, the colours disappear, and metallic scales are formed upon, and encrust its surface. All these different shades of colour indicate the different tempers that the steel acquires by the increase of heat, from that which renders it proper for files, to that which fits it for the manufacture of watch springs. Mr. Stoddart some years since availed himself of this property to give to surgical and other cutting instruments, those degrees of temper which their various uses require.

The kind of steel which has been most celebrated in this country is that imported from Syria under the name of *Damascus steel.* Germany is also noted for its steel. The best steel manufactured in Britain is known by the name of *cast steel,* and the making of it, although it was long kept a profound secret, is now discovered to be a simple process. It consists merely of fusing it with carbonate of lime (140), or in what is called cementation, with charcoal powder, in a peculiar kind of furnace. The iron produced in Sweden is considered superior to that of any other country in Europe for the manufacture of steel.

A very superior kind of steel is about to be introduced by Mr. Johnson, which is termed *Indian steel*, and far surpasses that ordinarily used for the manufacture of razors, and other cutting instruments.

All kinds of edge tools, where excellence is required, are made of steel, and a steel instrument may be immediately known from an iron one, by letting fall upon it a drop of nitric acid or aqua fortis (206), somewhat diluted with water. If it be steel, this will occasion a black spot; but if it be iron, it will not have this effect. Steel is attracted by the magnet, and is capable of receiving a permanent *magnetic property*, which has led to the discovery of the mariner's compass. Had iron been productive of no other advantages to mankind than this, it would on this account alone have been entitled to their greatest attention.

Steel is much used in the more delicate manufactures; *steel pens* are said to be made at the rate of forty millions a month in Gloucestershire. *Needles* "were first made in England, in the reign of Mary, by a Spanish negro, who would not impart the secret, which died with him, and was not recovered until the reign of Elizabeth, when the English were taught the art by a German."

Iron, when exposed to the moisture of the atmosphere, becomes gradually covered with a brown, or yellowish substance, known by the name of *rust*, which, is suffered to continue without interruption, will corrode the entire substance of the iron. The rust or oxide of iron (21) is a substance in considerable request by calico printers for a dye. *Iron moulds* are spots on linen occasioned by its exposure to iron in damp situations; these are removeable only by the application of an acid (oxalic).

There are various modes of *preserving iron and steel* from rust. The following is recommended by an eminent French chemist as one of the best. Mix copal varnish, made greasy with oil, with about four-fifths of the best spirit of turpentine. Apply this by means of a sponge, over the whole surface, and allow it to dry. This varnish may be successfully used for all the metals; and particularly for the preservation of such philosophical instruments as, by being brought into contact with water, are liable to lose their splendour, and become tarnished.

The various preparations of iron are much used in medicine; its general property when internally administered being that of giving tone to the muscular and nervous system. Iron was used in medicine upwards of 3200 years ago. By the Alchymists it was denominated *Mars*, and was represented by the symbol.

The combination of iron with sulphuric acid, and its uses as *Green Vitriol*, are mentioned at 208.

234. *METEORIC STONES are a species of iron ore, which have at different times been known to fall from the atmosphere.*

They have been seen only in shapeless masses, of from a few ounces to several hundred pounds in weight. Their texture is granular. They are covered externally with a thin blackish crust, and are internally of an ashy grey colour, mixed with shining minute particles. All meteoric stones consist of iron and a portion of nickel.

There is sufficient evidence to show that solid masses of stone have been observed to fall from the air at a period considerably anterior to the Christian era. Notwithstanding this, so very extraordinary was the phenomenon, that until the year 1802, it was generally regarded by philosophers as a vulgar error. Mr. Howard, in that year submitted to the Royal Society a paper which contained an accurate examination of the testimonies connected with events of this kind; and described a minute analysis of several of the substances which had been said to have fallen in different parts of the globe. The result of this examination was, that all these stony bodies differ completely from every other known stone; that they all resemble each other, and are all composed of the same ingredients.

The greatest number of the stones which have fallen from the air have been preceded by the appearance of luminous bodies or meteors. These meteors have burst with an explosion, and then the shower of stones has fallen to the earth. Sometimes the stones have continued luminous until they sunk into the earth, but most commonly their luminousness disappeared at the time of the explosion. Their motion through the air is surprisingly rapid, in a direction nearly horizontal; but they seem to approach the earth before they explode. In their flight they have frequently been heard to yield a loud whizzing sound. They are hot when they first reach the earth, and exhibit, on their surface, visible marks of fusion.

A general tradition has prevailed in almost all ages, and amongst all people, of the fall of solid bodies from the atmosphere, under various denominations, but, with us, more particularly, under that of *thunderbolts*. In barbarous and uncivilized countries, these have usually been ascribed to the miraculous judgment of the Deity, and they may be considered as the true origin of the worship of stones. The image of Diana, mentioned in the Acts of the Apostles, as believed by the Ephesians to have fallen down from Jupiter, and the Palladium or sacred statue of Minerva, which also is said to have fallen from Heaven, and to have been preserved in Troy, as a treasure, on the safety of which that of the city depended, had each, no doubt, this origin. The Psalmist evidently alludes to the falling of meteoric stones, when, speaking of the Almighty, he says, " He made darkness his secret place: his pavilion round about him with dark water, and thick clouds to cover him. At the brightness of his presence his clouds removed; hail-stones and coals of fire. The Lord also thundered out of heaven, and the Highest gave his thunder, hail-stones and coals of fire."

Among numerous other instances of these stones, it is recorded that on the seventh of November, 1492, betwixt eleven and twelve o'clock at noon, a dreadful clap of thunder was heard at Ensisheim, a considerable town in Alsace, and that a huge stone was seen to fall on a field lately sown with wheat. On several of the neighbours going to the place, the hole it had formed was found to be about three feet in depth, and the stone when dug out, weighed two hundred and sixty pounds. It was preserved in the cathedral of Ensisheim until the beginning of the French Revolution, when it was conveyed to the public library at Colmar. There are in the British Museum two small pieces of this stone, and fragments of several other meteoric stones which have fallen in different parts of the world.

In the British Museum specimens may also be seen of the following:—one of the many stones which fell, July 3d, 1753, at Plaun, in the circle of Bechin, Bohemia, and which contain a great proportion of attractable iron;—specimens of those that were seen to fall at Roquefort and at Juliac, in the Landes of Gascony, July 24th, 1790;—one of a dozen stones of various weights and dimensions that fell at Sienna, in Tuscany, Jan. 16th, 1794;—fragments of the meteoric stone, weighing 56 pounds, which fell near Wold Cottage, in Yorkshire, Dec. 13th, 1795;—fragment of a stone of twenty pounds, which fell in the commune of Sales, near Villefranche, in the department of the Rhône, March 12th, 1798;—specimens of stone fallen near the city of Benares, in the East Indies, Dec. 19th, 1798;—entire and broken specimens of the meteoric stones of which a shower descended at Aigle, in the department of the Orne, April 26th, 1803;—fragment of that of Smolensk, June 27th, 1807;—fragment of one of those that were seen to fall at Weston, in Connecticut, Dec. 14th, 1807;—two meteoric stones with shining black surfaces, fallen May 22d, 1808, at Stannern, in Moravia;—two fragments of the Tipperary meteorite which fell in August, 1810: it contains quartz globules of a green colour, owing to oxide of nickel;—a fragment of that of Berlanguillas, in Catalonia, July 8th, 1811;—a fragment of one, weighing 66 pounds, which fell August 5th, 1812, near Chantonnay, in the Vendée;—fragment of the meteoric stone which fell at Adare, in the country of Limerick, Ireland, in 1813;—fragment of one of those which fell Sept. 5th, 1814, at Agen, in the Pyrenees, and another of that which descended at Juvénas (Ardêche), on June 15th, 1821;—a portion of the meteorite which fell at Nanjenoy in Maryland, February 10th, 1825;—three entire stones, and a fragment of those that were seen to fall, Oct. 13th, 1838;—at Old Bokkeveld at the Cape of Good Hope (See Philosoph. Trans. for 1839).

Two stones fell near Verona in Italy, in the year 1672, one of which weighed three hundred, and the other two hundred pounds.

Mr. Sowerby, the publisher of English Botany, and of several other highly estimable works, possessed a meteoric stone which fell near Wold Newton in Yorkshire, in the afternoon of the thirteenth of December, 1795, and weighed fifty-six pounds. Whilst this stone was in motion through the air, several persons perceived a body passing along the clouds, although they were unable to ascertain what it was. It passed over several different villages, and was also accurately and distinctly heard. The day was foggy; and though there was some thunder and lightning at a distance, it was not until the stone fell that an explosion took place, which alarmed all the adjacent country, and created, distinctly, a sensation that something very extraordinary had happened. A shepherd belonging to Captain Topham was within a hundred and fifty yards of the place where it fell; George Sawden, a carpenter, within sixty yards; and John Shepley, one of Captain Topham's farming servants, was so near that he was forcibly struck by some of the mud and earth that were raised by the stone dashing into the ground. In its fall the stone excavated a place nineteen inches in depth (seven inches of which were in a solid rock of limestone), and somewhat more than three feet in diameter, fixing itself so firmly that some labour was required to dig it out.

Another stone of considerable size fell in Scotland on the fifth of April, 1704. A misty commotion was observed in the atmosphere, and nearly at the time of the stone falling, a report was heard as loud as if three or four cannon had been fired at a little distance. The report was succeeded by a violent rushing or whizzing noise; and almost immediately afterwards the stone fell into a drain, in the presence of two men and two boys, splashing the water to a distance of twenty feet around. The stone, when dug out, was found to have sunk about eighteen inches into the earth.

On the fifth of November, 1814, about half-past four o'clock in the afternoon, a dreadful peal of thunder was heard in the Doab in Persia, and was immediately succeeded by a shower of large stones, many of them from twenty-six to thirty pounds weight each. Several inhabitants of the adjacent country were present at the time, and not fewer than nineteen of the stones were collected.

On the eleventh of December, 1836, about half-past eleven o'clock P.M. with a clear sky, and S.W. wind, a fire-ball of uncommon size and brilliancy appeared over the village of Macao, at the entrance of the river Assu, in Brazil; it immediately burst with a loud crackling noise, and a shower of stones fell within a circle of ten leagues. They fell through several houses, and buried themselves some feet deep in the sand. The weight of those picked up varied from one pound to eighty pounds.—*(Poggendorf's Annals.)*

Professor Pallas, many years ago, discovered lying on the surface of a hill in Siberia, a mass of native iron, which weighed 1680 pounds. It was considered by the natives as a holy relic, and was believed by them to have fallen from heaven. M. de Bougainville, the French circumnavigator, discovered on the banks of the river La Plata, in South America, an enormous mass of native iron, which he calculated to have weighed about 100,000 pounds. And a mass of native iron, appearing in every respect to have been of meteoric origin, was some years ago discovered in the district of St. Jago del Estro, in South America. It was in the middle of a great plain, and had no rock nor mountain near it, and was calculated to have weighed about thirty tons.

The origin of meteoric stones is involved in great obscurity. Some writers have imagined that they might be projected from distant volcanoes; others, that they may have been detached from rocks, and had their substance considerably changed by a concurrence of natural causes: others, that they may have been generated in the air by a combination of mineral substances; and others, that they may have been projected from the moon. The latter was the opinion of La Place the astronomer, who says that a mass, if thrown by a volcano from the moon, with the velocity of about a mile and a half per second, it will thence be projected beyond the sphere of the moon's attraction, and into the confines of that of the earth; the consequence of which will be, that the mass must presently fall to the earth, and become a part of it.

235. *LOADSTONE, or MAGNETIC IRONSTONE, is a compact blackish kind of iron ore, which is possessed of the power of attracting iron, as well as every substance which contains ferruginous particles. It is betwixt four and five times as heavy as water.*

This mineral is found in masses of different form and size in most of the iron mines of Europe and America; and when submitted to the furnace it yields a considerable proportion of metal. It makes excellent bar iron, but very indifferent cast iron. In Sweden, and particularly at Roslager, magnetic iron stone is found quite pure, and the iron that is wrought from it is imported in considerable quantities into Great Britain, for the purpose of being manufactured into steel.

The appellation of load, or leading stone, has been given to this kind of iron from its magnetic virtues: for it is not only endowed with the property of attracting iron, but also of pointing itself, and even enabling a needle touched with it to point, towards the poles of the world. We are, however, entirely ignorant of the cause of this very extraordinary property.

Artificial magnets, constructed of steel, not only possess all the essential virtues of the genuine loadstone, but even in a much higher degree. The natural magnet is consequently now little esteemed, except as an object of curiosity.

236. *PYRITES, or MARCASITE, is a mineral substance, formed by a combination of iron with sulphur.*

It is usually of a bronze, yellow, or brownish colour, very various in form, being massive, globular, club-shaped, oval, or crystallized; and so hard as to strike fire with flint.

Few minerals are more common than this, as it occurs, in some state or other, in almost every rock and vein. It is often found among coal; and when heated decrepitates with a loud unpleasant noise and sulphureous smell. To the decomposition of this mineral it is that the hot temperature of almost all the mineral waters may be ascribed.

The name of pyrites, which in the Greek language signifies *firestone*, has been obtained by this mineral from its property of striking sparks from steel. It was formerly used for fire-arms, as we now use flints. In commerce it was known by the name of marcasite. Some years ago it was much used, particularly in France, for the making of buttons and buckles; it was cut and polished by lapidaries for trinkets, particularly for the rims and hands of watches, and various kinds of female ornaments. If skilfully cut in the form of small rose diamonds, although an opaque substance, it has somewhat the appearance of a diamond. In the tombs of the Peruvian princes, with whom a considerable portion of their valuables was always interred, there have been found polished plates of marcasite; which appear to have served them as mirrors.

This mineral is never worked as an ore of iron; and it is principally valued on account of the sulphur which can be obtained from it by means of heat; and the green vitriol, or copperas (208), which it affords by exposure to the air. Sulphuric acid has been made in some quantity from it.

Ignorant persons frequently mistake iron pyrites for gold; but it is easily distinguished from that precious metal by its brittleness. It breaks when hammered, whereas gold is malleable, or may be extended by hammering: it also strikes fire with steel, which gold will not.

237. *RED OCHRE, REDDLE, or RED CHALK, is an iron ore of a blood-red colour, which is sometimes found in powder, and sometimes in a hardened state. It has an earthy texture, and stains the fingers when handled.*

The principal use of red chalk is for drawing: the coarser kinds are employed by carpenters and other mechanics, and the finer kinds by painters. For the latter purpose it should be free from grit, and not too hard. In order to free it from imperfections, and render it better for use, it is sometimes pounded, washed, mixed with gum, and cast into moulds of convenient shape and size.

Under the name of reddle, this substance is much used for the marking of sheep; and (when mixed with oil) for the painting of pales, gates, and the wood-work of out-buildings.

Another kind of iron ore, or rather a compound of the ores of iron and manganese, is called *umber*. This mineral, which is of a brown colour, is found in beds in the island of Cyprus, and is used as a kind of paint both in a raw state and burnt.

238. *TIN is a white metal, somewhat like silver in appearance, but is considerably lighter, and makes a crepitating or cracking noise when bent. It is very soft and ductile, has but little elasticity, and is peculiar to the mineral kingdom.*

This metal is always found either in a state of oxide (21), *or in combination with sulphur and copper; and is about seven times as heavy as water. It melts at* 442° *Fahr. and is volatile at a white heat.*

The principal tin mines which are known to us are those of Cornwall, Devonshire, Germany, the island of Banca, and peninsula of Malacca, in India, and Chili and Mexico in America. Of these the most celebrated are the mines of Cornwall, which are known to have been worked before the commencement of the Christian era. Diodorus Siculus, who wrote forty years before the birth of Christ, gives an account of these mines, and says that their produce was conveyed to Gaul, and thence to different parts of Italy. This species of metal was used in the time of Moses, and is mentioned in the writings of Homer.

Tin is found in veins or beds, but chiefly in veins, running through granite and other rocks. In some of the valleys and low grounds of Cornwall, the tin ore is found in rounded grains and masses. In these situations small grains of gold are sometimes found with it. To separate the tin from earthy and other matters with which it is intermixed, streams of water are passed over them; and these deposits have the name of *stream-works.*

When the tin ore has been dug from the earth, or has been collected at these stream-works, it is thrown into heaps, and broken to pieces. After this it is washed, and subsequently roasted in an intense heat, for the purpose of dissipating some of the substances with which it is combined. It is lastly melted in a furnace, and thereby reduced to a metallic state, and let fall from a height, by which it splits into a number of irregular prisms, somewhat like a basalt pillar. This is called *grain-tin. Mine-tin* (another variety of *tin-stone*) is ground, washed, roasted, and afterwards smelted with Welsh culm and limestone, by which *block-tin* is procured, the finest kind of which is called *refined-tin. (Mr. J. Taylor.)* The metal is then poured into quadrangular moulds of stone, each containing about 320 pounds weight. These have the denomination of *block-tin,* and are stamped by officers of the Duke of Cornwall with the impression of a lion, the arms of that duchy. This is rendered a necessary operation before the tin can be offered for sale; and on stamping it pays a duty of four shillings per hundred weight to the Prince of Wales, as Duke of Cornwall, who thence derives a very considerable income.

The produce of the mines in 1830 was 30,425 cwt., but in 1831 fell to 21,762 cwt. In 1827 it reached as high as 49,474 cwt. The *cwt.* may be valued at 3*l.* 16*s.*, which in the first year made the total value about 115,000*l.*; in the second year 82,520*l.*—(See *Murray, Encyc. Geogr.* p. 369.)

The article usually called *tin,* or *tin-plate,* of which saucepans, boilers, drinking vessels, and other utensils of domestic economy are made, consists only of thin iron plate coated with tin. It is thus formed: the iron plates are immersed in water rendered slightly acid by spirit of salt (muriatic acid, 202) or sulphuric acid (211); after which, to clean them completely, they are scoured quite bright. These plates are then each dipped into a vessel filled with melted tin, the surface of which is covered with suet, pitch, or resin, to prevent the formation of dross upon it. The tin not only covers the surface of the iron, but penetrates it, giving to its whole substance a white colour. This process is chiefly conducted in Glamorganshire.

In a manner similar to this, stirrups, buckles, bridlebits, and other articles, are tinned.

Iron is usually tinned before, but copper always after it has been formed into utensils. The object to be attained by the tinning of copper is to prevent the vessels made of that metal from being corroded, and to preserve the food prepared in them from being mixed with any particles of that poisonous substance called verdigris, which is formed by such corrosion. In the tinning of copper vessels, their interior surface is first scraped very clean with an iron instrument, and then rubbed over with sal-ammoniac (207), for the purpose of more completely cleansing them, and also of preventing the formation of verdigris from the copper during the operation. The vessel is then heated, and a little pitch is thrown into it. While quite hot a piece of tin is applied to the copper, and this instantly uniting with it, soon clothes the whole surface with tin.

This metal, when amalgamated with mercury, is used for the silvering of looking glasses (228). When tin is melted in an open vessel, its surface is soon found to be covered with a grey powder, which is an oxide (21) of the metal, and is generally called *dross*. If the heat be continued, the colour of this powder becomes yellow. In this state it is known by the name of *tin-putty*, and is employed in polishing glass, steel, and other hard substances. When the heat is very violent, the metal takes fire, and is converted into a fine white oxide, which is used to render glass opaque, for the forming of enamel. Oxide of tin dissolved in acids (hydrochloric, &c.) is also an important article to dyers. It is employed by them in large quantities to give brightness to such colours as are used in forming scarlets and other reds, and to precipitate the colouring matter of other dyes.

Tin is an essential ingredient in *bell-metal*, *bronze*, *pewter*, and various other compounds. It may be combined with lead, in any proportion, by fusion; and this alloy is harder and possesses much more tenacity than tin. The hardest alloy is a composition of three parts of tin and one of lead. The presence of the tin destroys, in a great measure, the noxious qualities of the lead. It is customary to tin copper vessels with this mixture, and it has been ascertained that such vessels are in no respects injurious.

There are three kinds of *pewter* in common use. These are called *plate*, *trifle*, and *ley pewter*. The first, which is made into plates and dishes, is formed of tin, with a small proportion of lead and antimony (245). The second, or *trifle pewter*, which is made in somewhat different proportions, is used for the quart and pint pots of the publicans; and the *ley pewter*, which is formed of three parts of tin and one of lead, is manufactured into wine and spirit measures.

Britannia metal, an article much used of late as a substitute for silver in the manufacture of teapots, spoons, &c. is composed of the following metals: to $3\frac{1}{2}$ cwt. of best block tin, when melted and raised to a red heat in a cast-iron pot, add 28 lbs. of martial regulus of antimony, 8 lbs. of copper, and 8 lbs of brass, taking the precaution to keep the whole stirring until the whole of the materials be added to the melted tin.

Tin may be beaten into leaves or plates that are much thinner than paper. But when it is thus worked several leaves must be joined together. They then support each other, and yield to the hammer without tearing. These leaves are used for the silvering of glass globes, and the plating of other metals. Those that are used for the silvering of looking-glasses are much thicker. The article called *tin-foil* is an alloy consisting generally of two parts of tin and one of lead, and capable of being beaten to less than the thousandth part of an inch in thickness.

Tin, when reduced to a fine powder, by shaking it when melted in a box which has been previously rubbed on the inside with chalk, has been very successfully used as a *ver-*

mifuge, especially in tape-worm. It is generally given mixed with treacle.

It was called *Jove*, or *Jupiter*, by the chymists of old.

239. *LEAD is a heavy metal, of a pale and livid grey colour when broken, not sonorous when pure, very flexible, and so soft that it may be marked with the nail. It stains paper or the fingers of a bluish colour, and is rather more than eleven times and a quarter heavier than water. It melts at* 612° *Fahr.*

The most common state in which lead is found is in combination with sulphur and a small portion of silver. This ore is known by the name of Galena, *and is frequently in the form of blackish cubical crystals. Lead is also found in union with arsenic* (242) *and many acids.*

Great Britain possesses the most important lead-mines in the world; those that are best known are in the counties of Flint, Derby, Northumberland, and Cumberland. Those of Derbyshire are supposed to have been worked even in the time of the Romans.

It is calculated that these mines afford 16,000 tons annually of lead, which at 20*l.* per ton would yield 320,000*l.* But little is comparatively imported from foreign countries, owing to the quantity annually produced by our own mines.

Lead mines are entered sometimes by perpendicular shafts, and sometimes (when in the sides of hills) by levels. In some of the Derbyshire mines, where the depth of the veins will admit of it, the men work at different heights, of from four to six feet above each other, along what are called stoops: the uppermost men being two or three yards before those next in succession, and thus forming a kind of steps. The implements used are picks, hammers, and strong iron wedges; and the rocks are also frequently loosened by means of gunpowder.

When the ore is brought out of the mine, it is sorted and washed to free it from dirt and rubbish. After this it is spread on a board; the best pieces are picked out and separated; and those containing ore mixed with spar (194) or other substances, are placed separate, to be broken and again picked. After the ore, by picking and washing, has been sufficiently cleansed from extraneous matters, it is roasted in a kind of kiln to free it from the sulphur that is combined with it. The next process is to mix it with a certain quantity of coke, charcoal, or peat, and submit it to the smelting furnace. In this furnace there are tap-holes, which when the lead is melted, are opened, and the metal, in a fluid state, runs into a large iron pan. The dross which floats on its surface is now skimmed off; and the metal is taken out by ladles, and poured into cast iron moulds with round ends. The lead thus formed is ready for use, and has the name of *pig-lead.* According to their size, the pieces that are thus cast have the appellation of *pigs* and *half-pigs.*

The following method of obtaining the lead from the earth in Britanny, is given by Mrs. Trollope :—" This is performed by about one hundred women, in an immensely long barn-like building. An equal number of long sloping tables are ranged side by side, at intervals of about two feet, throughout the whole length of the building. They may be about seven feet long by three feet broad. A stream of water runs along the tops of these tables, which can be turned on to each, or stopped, at the discretion of the woman who works at it. The matter that first comes from the mine is first pounded to dust, and is then brought in small boxes, holding about half a bushel each, carried on poles like a sedan-chair, by two girls, and thrown on the upper end of the table. It is then the business of the women to let the water on in small quantities, and by means of a sort of rake, and a brush made of broom twigs, thoroughly wash the mineral matter, till by degrees the earthy particles pass off with the water, and the grains of nearly pure lead remain, blue and shining, upon the table. These women receive nine sous a day for twelve hours work. The miners gain from nineteen to twenty sous a day, of the same number of hours."

Lead is mentioned in the Sacred Writings; and is described by Homer as in common use at the period of the Trojan war. The ancients seem to have considered it as nearly allied to tin. The Romans employed it to sheathe the bottoms of their ships, fastening it to the planks and timbers by nails made of bronze.

When first melted, lead is bright, but it soon tarnishes by exposure to the air. It melts at a temperature very low in comparison with most other metals; and when a strong heat is applied, it boils and evaporates.

Lead is much employed in the useful arts. When rolled between iron cylinders to a requisite state of thinness and uniformity, it is used for the covering of houses and churches, notwithstanding the danger, in case of fire, to persons within, who are exposed to a shower of burning metal; sheet zinc, and even iron, has in a great measure superseded its use for those purposes. It is cast into pipes, cisterns, and reservoirs for water, as well as into large boilers for chemical purpose. But all culinary or domestic vessels made of lead, particularly if intended for the keeping of acid liquors, should be carefully avoided, as the surface of the lead is thereby corroded, and the liquid contained in them is rendered poisonous. Hence arises that dreadful complaint, too well known where cyder is kept in leaden cisterns, called the *Devonshire colic;* hence also the injury which sometimes follows from the use of lead in the glazing of coarse earthenware.

It is a fact not generally known, that the purer the water, the greater is its action on this metal, and vice versa; and consequently, if the water-companies supplied *distilled water*, instead of the ordinary impure *river water*, and the same means were adopted to convey it from the works, &c.; such as leaden pipes, cisterns, and the like, the results would prove awfully mortal; as the water would become so impregnated with poison as to work direful effects on the constitution.

Great quantities of lead are used for the making of *shot*. For this purpose the metal is alloyed with arsenic (242), to render it more brittle, and to render the grains more round and perfect than they otherwise would be. Shot is formed by dropping the melted alloy into water, through an iron or copper frame, perforated with round holes, according to the size required. For the smallest shot the elevation is about ten feet above the water; and for the largest about a hundred and fifty feet.

An alloy of lead and tin, in the proportion of two parts of lead and one of tin, forms the *solder* which is used by plumbers. The *types* that are used by printers for very large characters are sometimes composed of an alloy of lead and copper. Lead is also used, with tin, in the manufacture of *pewter*.

Lead is represented by the symbol of *Saturn* by the alchymists.

Oxides of Lead.

The different oxides (21) of lead are easily soluble in expressed oils, and consequently are of great use to painters. Of these the following are the most important:—

White Lead, Ceruse, or *Carbonate of Lead.*—White lead ore is met with either in a crystallized or solid state in England and Scotland. It is made (according to the old process) by suspending thin plates of lead over vinegar, evaporated by the heat given off by the fermentation of dung or tanner's bark: by this means the vapour which rises from the acid is made to play about the plates, which causes them to become at length entirely corroded and converted into a heavy white powder. The manufacture of white lead is a most unhealthy trade, and is confined to a few persons, who have large conveniences for the purpose. An ordinary factory contains about fifteen or sixteen stacks, each stack containing 12,000 pans, and fifty tons of lead. About 16,000 tons of white lead are annually manufactured by this old process. This substance, when mixed with oil, is used as a paint for numerous purposes. The fumes that are emitted from white paint are extremely noxious. Persons who breathe them are frequently seized with pains, and experience symptoms not much unlike those that precede palsy: the danger which attends the inhabiting of apartments recently painted is well known. The odour of vinegar will correct the pernicious effect of these exhalations, by acting as a solvent, and combining with and precipitating them. White lead is also obtained in considerable abundance, by precipitating the subsalts by means of carbonic acid. By the patent of Messrs. Button and Dyer, the *subnitrate of lead* is used, and the quantity manufactured by this means, is about six tons daily, or about forty tons per week. We are informed that white lead, dangerous as it is, was in great request among the Roman ladies as a cosmetic. It is sometimes used as an external application for ulcers and other kinds of sores.

Massicot is a slight oxide of lead, of a yellow colour, used for painting, and prepared from the dross or pellicle that is formed by the melting of lead.

Red lead, or *minium,* is an oxide of lead, and made, by a tedious and troublesome process, from massicot. For this purpose the massicot is ground to a fine powder, put into a furnace, and constantly stirred, whilst the flame of the burning coals plays against its surface for about forty-eight hours, when it is converted into a red powder, which is the article under consideration. It is subsequently passed through very fine iron sieves. The use of red lead as a pigment is well known; but as it is liable to turn black, vermilion is generally preferred to it. It is sometimes employed in medicine as an external application for abating inflammations, for cleansing and healing ulcers, and the like ; and is used in the manufacture of glass.

Litharge is another oxide of lead. This is prepared by exposing lead to a brisk fire and air for a certain length of time. Litharge is used by potters for the glazing of earthenware, but vessels that are glazed with it are thereby rendered unwholesome. It is also employed in the composition of the finer kinds of glass, for the purpose not only of giving them greater transparency, but also of rendering them capable of sustaining sudden changes from heat to cold, and of giving to them a susceptibility of being cut without breaking. It, however, adds considerably to the weight of the glass. It is also used by painters as a drier. Mixed with lime in the equal proportions, or three parts litharge, and two of lime, forms the compound called *Orfila's hair-dye.* A paste is made of it, and applied to the hair for about five hours, covering the part either with oiled silk, or a cabbage leaf. It dyes the hair brown or black, and renders it dry and crisp.

Litharge plaster, or *diachylon plaster*, as it is more frequently called, is prepared by boiling eight pints of olive oil with five pounds of litharge in powder, adding water to moderate the heat, and constantly stirring the mixture till they are duly incorporated. This plaster is applied in excoriations of the skin, slight wounds, and other sores.

Litharge is also boiled with vinegar, to make the preparation called *Goulard*, or *Goulard's Extract:* it is a liquid acetate of lead.

Sugar of lead is a lead combined with the acetic acid, consequently an acetate of lead. It is usually observed in the form of small slender crystals, which have a glossy appearance like satin. This substance is employed, in considerable quantity, by dyers and calico printers; and by painters as a drier. Although in itself a most virulent poison, it is often added by unprincipled dealers to wines which are acid, in order to correct their acidity. Such frauds, however, are easily detected by preparations or tests, which are sold by chemists for that purpose. Perhaps the best and simplest test is Harrowgate water, containing sulphuretted hydrogen; a little of this poured into the suspected compound will discover the presence of lead by giving to the fluid a dark brown or blackish tinge.

The following is a pleasing experiment. Dissolve an ounce of sugar of lead in about a quart of distilled water; filter the solution through a piece of blotting paper, and put it into a glass decanter, suspending in it a piece of zinc by a brass wire. A decomposition will take place; the lead will be set at liberty, and will attach itself to the zinc, forming in the liquid a sort of metallic tree.

It has been stated that silver is usually a component part of lead ore. To disengage this, where the quantity is sufficient to repay the expense, the lead, after it has been smelted, is subjected to the action of what is called a refining furnace. A continued blast of fresh air is thrown upon its surface by means of large bellows, while the lead is kept in a state as intensely hot as possible. This by degrees converts the lead into a yellow scaly oxide or dross. The oxide, thus formed, is driven off from the melted metal as it rises, and the silver is left alone at the bottom, in a metallic state. After the operation is complete, the oxide is fused with charcoal, and again reduced to metallic lead.

We must not omit to mention that, in some of the mines of Derbyshire, there is a singular variety of lead ore called *slickenside*. This is a kind of galena, which presents to the eye a smooth and bright surface, appearing as if it were plated. Sometimes it forms the sides of cavities; and it has the extraordinary property, when merely pierced with the miner's tool, of rending with great violence, and exploding with a crackling noise. Some miners, fearless of danger, venture to scratch it with their tools; and, on coming again to the spot, they often find that, during their absence, the *slickenside* has exploded, and fallen off in considerable quantity. Sometimes, however, they suffer for their imprudence. Mr. Mawe, in his account of the Mineralogy of Derbyshire, says, that he has seen a man come out of a mine cut violently, as if he had been stabbed about the neck and in other parts of the body, in consequence of the explosion of *slickenside* which he had pierced. The cause of this extraordinary phenomenon has not been explained.

240. *NICKEL, when pure, is a fine white metal, somewhat resembling silver in appearance, but it is attracted by the magnet, and has itself the property of attracting iron.*

It is ductile and malleable, difficult of fusion, and about nine times heavier than water. This metal is always mixed with arsenic (242) *and iron.*

Nickel is found in Cornwall, and in some other counties of England; in Germany, Sweden, France, Spain, and several parts of Asia. The Chinese employ it in making white copper; and in conjunction with copper and zinc, they manufacture it into various kinds of children's toys. Nickel gives a certain degree of whiteness to iron. It is used, with advantage, by some of the Birmingham manufacturers, in combination with that metal, and by others in combination with brass, forming the article now in so much use as a substitute for silver, and called *german silver*, which in a few words is nothing more than *brass* whitened with *nickel*. If it were possible to discover an easy method of working nickel, there can be little doubt but it would be found a very valuable metal for surgical instruments, for compass needles, and other articles, as it is not, like iron, liable to rust. When nickel is freely suspended, it points to the north and south, in precisely the same manner as the common magnetic needle.

Oxide of nickel is used for giving colours to enamels and porcelain. In different mixtures it produces brown, red, and grass-green tints.

241. *ZINC, or SPELTER, as it is sometimes called, is a bluish white metal, formed in thin plates adhering together, sometimes crystallized. It has a very perceptible taste, is about seven times heavier than water, rather harder than silver, and possesses but a small degree of malleability and ductility, except under certain circumstances. It melts at about* 680°*: is ductile and malleable at*

a temperature of from 210° *to* 300, *when it may be hammered into sheet zinc. The form of the crystals is the four-sided needles and prisms.*

This metal is never found in a pure state; and the principal ores from which it is procured are known by the names of Calamine *and* Blende. *Of these the former is an oxide* (21) *of zinc combined with carbonic acid* (26), *and the latter is a combination of zinc with sulphur* (24).

The ores of zinc are very abundant in many countries. It was formerly stated, that nearly the whole of Flintshire in North Wales abounded with calamine; and that, so entirely ignorant were the inhabitants of its use, that even after the middle of the eighteenth century, they mended their roads with it. These roads, however, have since been turned up in many places, and the materials have been converted to more valuable purposes. Derbyshire affords a great quantity of the ores of zinc, particularly calamine. This is found at various depths, generally in beds of yellow, or reddish brown clay, and usually near some vein of lead ore. Calamine was obtained also in abundance on the Mendip Hills in Somersetshire. The only zinc works now existing in England, are at Maestag, near Margam, in Glamorganshire. The zinc used in this country is chiefly imported from Silesia in plates and ingots.

The mode of extracting zinc from its ore is by distillation; and this is accomplished by roasting the sulphuret, carbonate, &c. The process adopted, in some parts of Saxony, is equally simple and ingenious. An inclined stone is placed near the anterior part of a furnace, in which the ore of lead containing zinc is fused. A great part of the zinc condenses upon this stone, and flows, in drops or globules, into a quantity of charcoal placed at the bottom to receive it. These globules are afterwards again melted, to run the metal into a mass.

When exposed to the air, the surface of zinc is soon tarnished (oxidised), but it scarcely undergoes any other change. It has a certain degree of ductility. When heated a little above 218° of Fahrenheit, it is malleable; and, when annealed, may be passed through rollers, and formed into thin sheets or leaves. Although, previously to being thus heated, it is brittle, on now cooling, it continues soft, flexible, and ductile. The inconvenience arising from the brittleness of the zinc being removed, this metal is applicable to many useful purposes. It may even be drawn into wire, but the tenacity of this is not great: a piece of zinc wire, one tenth of an inch in diameter, will sustain only a weight of twenty-six pounds without breaking. It has been proposed to substitute zinc in the place of tin for the lining of copper vessels; but it has not hitherto been ascertained whether this can be done with effect, and without injury. Prizes were offered to a considerable extent, in France, for the ascertainment of this fact some years since. In China, zinc is employed as a current coin of the country; and for this purpose it is used in the utmost purity. The Chinese also, as well as the artists of our own country, employ it to a great extent in various alloys. It is used in the manufacture of *brass*, *pinchbeck* or *prince's metal*, and *bronze*, all of which consist of this metal in combination with different proportions of copper (230). *Tutenag* is a well known white metal, made principally of zinc, and used for forming candlesticks and other articles. When tutenag is well manufactured, it is of a good colour, and not more disposed to tarnish than silver. Zinc is one of the metals employed to form the galvanic or voltaic apparatus; and its filings are mixed with gunpowder, to produce those brilliant stars and spangles which are seen in the best kinds of artificial fire-works. Preparations of zinc are occasionally used in medicine as astringents, tonics, and emetics, &c. If a thin plate of zinc be applied to the upper surface of the tongue, and a shilling to the lower surface, and both metals, after a little while, be brought into contact, a very peculiar taste will, at that instant, be perceived. The same sensation will be perceived, though in a weaker degree, if the silver be placed at the top and the zinc at the bottom. In this experiment a simple galvanic circle is produced.

If a silver probe be introduced high up one of the nostrils, and be brought into contact with a piece of zinc placed on the tongue, a sensation not unlike that of a strong flash of light will be produced in the corresponding eye. A similar perception will result, both at the moment of contact and that of separation, if one of the metals be applied as high as possible between the gums and upper lip, and the other in a similar situation with the under lip, or even under the tongue.

A white oxide (21) prepared from zinc, was, some years ago, proposed as a substitute for white lead in house painting. This oxide is not dangerous in its application; and does not become yellow when mixed with oil. But these advantages are counterbalanced by some defects, which have hitherto caused it to be rejected. It is lighter than white lead; does not cover the surface so equally, nor so well; and is of considerably higher price. The oxide of zinc is used in medicine.

A preparation of zinc is used in the patent process of Sir William Burnett, for preserving timber, sail cloth, &c. from the ravages of dry rot, &c. It is anticipated it will supersede Kyan's patent.

Calamine.—The principal use of calamine, or the native carbonate of zinc, is in the manufacture of brass (230). It is found in various counties in England, and also on the continent. It is about four and a half times the weight of water. After the calamine is dug, it is reduced to pieces not in general larger than a nut. It is then roasted for five or six hours, in what is called a reverberating furnace. The large pieces are separated, and the small ones are passed through a sieve. It is washed; and, when dry, is ground in a mill. In this state it is sold. The principal demand for it in this country is at Birmingham, for the different brass founderies in that town. It is also employed in the making of brass at Bristol.

The use of calamine in the composition of brass was known at a very early period. It is mentioned by Aristotle, who also makes a distinction between the compound resulting from the mixture of copper and calamine or brass, and that resulting from the mixture of copper and tin or bronze.

It is used in medicine to form the *calamine cerate*, and as a powder for children. Internally administered, its effects are somewhat of the same character as the oxide.

Sulphate of Zinc, or White Vitriol, occurs native in the Hartz Mountains, at Holywell in Flintshire, &c.

It is abundantly used in medicine as an astringent, tonic, &c.; but for this purpose zinc is dissolved in sulphuric acid and evaporated, when the crystals are deposited.

ORDER II.—BRITTLE METALS,

OR SUCH AS ARE NOT CAPABLE OF BEING FLATTENED OR ELONGATED BY THE HAMMER WITHOUT TEARING OR BREAKING.

242. *ARSENIC* (NATIVE) *is a metal of a steel blue colour, and considerable brilliancy; it is remarkably brittle, is the softest of all known metals, and is somewhat more than five and a half times heavier than water. It readily fuses; and in close vessels may be distilled at* 360°. *This metal and all its compounds are virulent poisons. Its vapour has a very strong smell resembling garlic, and when heated to redness burns with a bluish flame.*

It is found nearly pure, and in considerable abundance, in different parts of Germany; usually occurring in masses of various shapes, and in combination with a small portion of iron, gold, or silver.

The arsenic sold in the shops, and too well known for its poisonous qualities, is an oxide, or rather an acid, of this metal artificially prepared.

In some mines on the Continent arsenic is very abundant, and is found extremely injurious to the workmen. Being very volatile, its fumes affect and destroy the lungs, and occasion death in a short time to many of them. One of its ores, *arsenical pyrites*, is found abundantly in Cornwall and Devonshire, accompanying ores of copper and tin; and, in combination with other metals, it occurs, in a greater or less proportion, in almost all mines.

Arsenic is occasionally used in the arts. It is employed in various metallic combinations where a white colour is required, and particularly for the whitening or bleaching of copper, which is thereby also rendered capable of taking a fine polish; hence its use in many of the compositions for the mirrors of reflecting telescopes, and for other optical instruments. The manufacturers of glass frequently employ the oxides of arsenic in the fabrication of that article. Arsenic is used in the processes of dyeing and calico printing; and for the imparting of different artificial shades and colours to furs. It is also used in the manufacture of small shot, from its rendering the lead more brittle, and better capable of being formed into grains, than it would be without such admixture.

The *white arsenic* (arsenious acid) of commerce is prepared to a great extent in Bohemia and Saxony, by roasting arsenical cobalt ores in reverberatory furnaces, and the vapours are condensed in a long chimney or large chamber, and afterwards submitted to a second sublimation.

Of all substances with which we are acquainted, this is perhaps the most deadly. If only a few grains of it be taken into the stomach, it proves fatal; and it has sometimes proved the more injurious from its deceitful appearance, in which it somewhat resembles salt or white sugar: it is, nevertheless, *much heavier* than either salt or sugar. Carelessly left in places open to the access of children, arsenic has not unfrequently been mistaken by them for sugar, and has been attended with the most dreadful consequences. If thrown on heated coals, however, it is immediately known, by the smell of garlic, and the white fumes which it gives out. The best remedies for this poison are warm water with sugar, in large quantities, to excite vomiting: lime-water, soap and water, pearl-ash and water, mucilaginous drinks should be afterwards administered.

Notwithstanding its deleterious qualities, arsenic is occasionally used in medicine, though in extremely small doses; and it has, in particular, been found efficacious in many cases of intermittent fever, and skin diseases.

It is employed as a poison for rats and mice; and, diluted with water, it attracts and poisons flies, whence it is sometimes called by the French, *poudre à mouches.* There cannot, however, be too great caution used either in the preparation, or in the application, of this fatal poison.

243. *YELLOW ORPIMENT is a mineral substance of a lemon colour, which consists of arsenic in combination with sulphur; and in the proportion of about fifty-seven parts of the former, and forty-three of the latter.*

It is about thrice as heavy as water; and is found both in a massive and crystallized state; the primary form of the crystals is a right rhombic prism.

The orpiment of commerce is an artificial production, and is chiefly imported from different parts of the Levant.

The Turks, and other Orientals, use it in the depilatories which serve to render bald the top of the head. A very beautiful but fugitive pigment, called *King's yellow*, is also prepared from sulphur and arsenic: and other preparations of orpiment are occasionally used by painters, and also by dyers and calico printers. The whole of these, however, are extremely poisonous.

Orpiment is found in a natural state, along with copper and other ores, in Natolia, Servia, Hungary, Turkey, and some other countries.

244. *REALGAR, or RED ORPIMENT, is a mineral substance of a red or orange colour, which consists of arsenic in combination with sulphur; and in the proportion of seventy-five parts of the former, and twenty-five of the latter.*

It is somewhat more than three times as heavy as water; and occurs sometimes in a crystallized, and sometimes in a massive or disseminated state. When fused by the action of the blowpipe, the flame is coloured blue.

This production, which, by ignorant persons, is not unfrequently mistaken for red lead, is in considerable request by painters, dyers, and calico printers. In China it is manufactured into small pagodas and other ornaments. The Chinese form it into medical cups, and use lemon juice, which has stood for some hours in them, as a cathartic. Realgar is poisonous, but by no means so much so as arsenic (242).

It is found in Sicily, Hungary, and various parts of Germany; and is very common in several districts of China. It is also artificially prepared.

245. *ANTIMONY is a metal of a brilliant and slightly bluish white colour, destitute of ductility, and rather less than seven times heavier than water. It melts at* 800°.

Its texture is laminated, the plates crossing each other in almost every different direction. It is as hard as silver, and so brittle that it may easily be reduced to powder in a mortar. Native antimony occasionally occurs in a crystallized state.

In the state of Connecticut, North America, it is said that antimony, in a pure metallic form, is found in such abundance, that, in some places, large masses of it may be seen lying on the surface of the ground. The principal supply of antimony in Europe is from an ore which is found in Hungary, Norway, Cornwall, and Borneo, called *sesqui-sulphuret of antimony*. The old process of bringing it into a state for use was very simple. The *black* mineral was put into pots, each of which had a hole in the bottom, and which was placed on another pot bedded in the earth. The upper pots, which were filled with the mineral, were heated. As soon as the antimony fused it flowed into the lower pots, while the substances with which it was combined, remained in the upper ones. The antimony fixes, and forms cakes of the shape of the pots which receive it. In this state the metal presents, in its fracture, a surface thick-set, with long needle-shaped crystals, which, lying by the side of each other, compose, as it were, the whole of the mass. It is afterwards re-melted and cast into cakes for sale. The above process is now but little used: the plan adopted at La Vendée is, simply placing the ore on the bed of a reverberatory furnace, with a means for it to be conveyed as soon as melted into vessels away from the heat. The antimony usually found in the shops is a sesqui-sulphuret of that metal.

This metal, in a pure state, or alloyed only with a very small portion of silver and iron, is found in veins of mountains in some parts of France, Sweden, and Germany, occurring in massive and kidney-shaped lumps of a white colour.

The only mine of antimony in Britain, which is of any importance, is at Glendinning in Dumfriesshire. It was discovered in 1760, in searching for lead ore, but was not regularly worked till 1763. In the first five years about a hundred tons' weight of antimony were obtained from it. This, at £84 per ton, produced the sum of £8400. The undertaking was afterwards relinquished. The vein of ore is only from eight inches to a foot and a half in thickness.

Antimony was known to the ancients. The earliest account we have of it is in the Sacred Writings. The passage in the Second Book of Kings [1], which states that, on the approach of Jehu to the city of Jezreel, "Jezebel painted her face," implies in the original that she stained her eyes and eyebrows with antimony, for the purpose of making

[1] Ch. ix. v. 30. See also Ezek. ch. xxiii. v. 40.

them look black and large, a custom which at that period was prevalent in several of the Eastern countries. Antimony was likewise considered by the ancients a remedy against inflammations of the eyes.

This metal is the basis of many of the officinal preparations which are now in use; and it was the basis of many others which were formerly used, but are now discontinued. No mineral substance has so much attracted the attention, or so much divided the opinion of physicians as antimony. One party extolled it as an infallible specific for almost every disease; whilst another described it as a virulent poison, which ought to be expunged from the list of medicines. It was on this metal that the alchymists of the middle ages principally founded their hope of discovering the philosophers' stone; and by a kind of good fortune, of which we can cite but few examples, it has happened that, in pursuing a chimera, they hit upon a succession of important realities. To the unremitted perseverance with which they tormented this metal, if we may so express it, the art of healing has been most essentially indebted.

The first rational account of the properties of antimony was given, about the end of the seventeenth century, by a French chemist, whose name was Lemeri. Its great importance in medicine will be seen by an enumeration of some of the most valuable preparations of it which are still in use.

Antimonial Wine was formerly prepared from antimony and white Lisbon wine. The London College has now, however, omitted the wine, and orders water and spirits of wine in its stead. It is employed as an emetic and alterative.

Emetic Tartar, or *Antimony Tartrate of Potass*, which is much more employed in this country than all the other antimonial preparations put together, is formed by boiling the sesqui-oxide of antimony with cream of tartar, with a certain proportion of water; it is to be then filtered, and suffered to crystallize.

Butter of Antimony, or *Chloride of Antimony*, is a combination of antimony with chlorine. It is generally employed as a caustic.

Glass of Antimony is of a reddish brown colour; it is occasionally used in medicine, but more frequently in colouring the imitations of yellow diamond, Oriental, Brazil, and Saxon topaz, hyacinth, emerald, and beryl.

James's Powder, or *Antimonial Powder*, is a well-known useful medicine, composed of phosphate of lime and antimony.

An alloy consisting of sixteen parts of lead and one part of antimony constitutes the metal of which *printers' types* are formed. This alloy does not differ from lead, except in being considerably harder and more tenacious. The plates on which music is engraved are formed of a mixture of tin and antimony; and the oxides of antimony are used for the colouring of glass.

246. *BISMUTH is a reddish white metal, harder than silver, and composed of broad brilliant plates adhering together, and crystallizes either in octohedrons or cubes.*

It is nearly ten times heavier than water, and is so brittle as readily to break under the hammer. It fuses at 476°, or even in the flame of a wax candle, and long before it becomes red hot, and has the singular property of expanding as it cools: it is readily volatilized in close vessels.

The ores of bismuth chiefly occur in Sweden, Norway, Germany, France, and England. This metal appears to have been known to the ancients. It was confounded by them with tin; and even in our own manufactories it is known to the workmen by the name of *tin-glass.*

It is not of much use in the arts; but its fusibility renders the working of it very simple and easy. It is employed in the composition of some of the soft kinds of solder; and is also used for giving hardness to tin and other metals. Amalgamated with mercury it renders that metal less fluid; and the addition of it to mercury and tin is found useful in the foliating or silvering of looking-glasses. Some manufacturers use it in the composition of pewter; but it is said that this ought not to be done, particularly for the formation of vessels intended to contain food, as bismuth partakes of the noxious properties of lead, and sometimes contains even arsenic. It is also occasionally employed in the fabrication of printers' types.

A very singular metal *(fusible)* is formed by melting together eight parts of bismuth, five of lead, and three of tin. Tea-spoons formed of this metal surprise all who are unacquainted with their nature: they have somewhat the appearance of common spoons, but they melt as soon as they are put into boiling water.

Bismuth reduced to powder, mixed with the white of eggs and applied to wood, gives it, when gradually dried and rubbed with a polisher, the appearance of being silvered. If this metal be dissolved in aqua fortis (30), and water be poured into the solution, a white powder precipitates, which is an oxide of bismuth, and which, after being well washed, is used as a pigment, under the name of *pearl-white* (trisnitrate of bismuth). From its beautiful appearance, this powder is sometimes employed by ladies for painting their skin; a practice which cannot be too much condemned, both on account of the danger with which it is attended, and from its soon injuring both the texture and natural colour of the skin. It has the further disadvantage of turning black when touched by the fumes of fetid and other substances; and ladies who have used this cosmetic, and have afterwards bathed in the Harrowgate waters, have come from the bath a perfectly tawny colour. It was probably the oxide of bismuth which the Roman ladies used for whitening their skin; for Martial, in speaking of a lady who made too free a use of cosmetics, describes her as afraid even of the sun. The oxide of bismuth is used in the composition of most of the pomades employed in France for painting the face. The trisnitrate of bismuth has lately been employed in medicine as a remedy against spasmodic affections of the stomach, waterbrash, &c.

The following is a pleasing experiment, illustrative of metallic crystallization. Melt a ladleful of bismuth, and allow it to cool slowly and quietly till a thin crust is formed on the surface: then, with a pointed iron, make two small opposite apertures through the crust: and through one of these quickly pour out the fluid portion, as carefully and with as little motion of the mass as possible. The air having entered by the other aperture, there will appear, on removing the upper crust by means of a chisel, when the vessel has become cold, a cup-shaped concavity, studded with very brilliant crystals, and more or less regular according to the quantity of metal employed, the tranquillity and slowness with which it has cooled, and the dexterity with which the fluid portion of the mass was poured off before it became solid. The same effect may be produced by melting bismuth in a crucible which has a hole in the bottom, lightly closed by an iron rod or stopper; this is to be drawn out when the mass begins to congeal. By so doing the upper portion, which is fluid, is made to run off, and a cake studded with crystals will be left.

247. *COBALT is a metal of a grey colour, with a shade of red, brittle, somewhat harder than silver, nearly eight times as heavy as water, is attracted by the magnet, and is itself capable of being rendered permanently magnetical. It is difficultly melted.*

The ores of cobalt are not numerous, and are for the most part combinations of this substance with other metals, or of its oxides (24) *with arsenic, or with sulphur.*

The name of this metal implies an evil being (*Kobald*, German for goblin), and is said to have been given on account of the vapour of arsenic, which issues from it, tormenting the miners, and making them believe that they are afflicted by wicked spirits. Hence it was once customary in Germany to introduce into the church service a prayer that God would preserve miners and their works from *Kobalds* and *spirits*.

Cobalt is found in several parts of Europe, but most plentifully in the southern borders of France, and in Saxony; and the cobalt ores of Hesse, although they were formerly used for no other purpose than the mending of roads, were stated in 1830 to yield a clear profit of nearly 15,000*l.* a year. Some parts of our own country yield this substance in considerable abundance, particularly the Mendip hills, in Somersetshire, and a mine near Penzance, in Cornwall.

After the ore is taken from the earth, it is broken into pieces about the size of a hen's egg, and the stony parts are picked out. The sorted mineral is then pounded in mills, and sifted through brass-wire sieves. The lighter particles are next carried off by water. After undergoing some other preparations to rid it of the impurities and foreign matters with which it is connected, it appears in the form of a dark grey oxide. The working of the cobalt ores in Germany is considered so injurious, on account of the arsenic with which they are combined, that much of the labour is performed by criminals, who are condemned to it for the commission of crimes which, by the laws of the country, have deserved the punishment of death.

As a metal, cobalt was unknown till the year 1733, when it was discovered by a celebrated Swedish chemist, whose name was Brandt. In its metallic state it is not employed in the useful arts; but in a state of oxide it is found extremely valuable in the colouring of porcelain, in painting, enamelling, and for other purposes. Cobalt and ultramarine form the most permanent blue colours with which we are acquainted. The old painters generally used them for the representation of the sky and of blue drapery, and this is the reason why these parts in some old pictures have been found so much more durable than any others.

A solution of the oxide of cobalt in muriatic acid (29), and afterwards diluted till nearly the whole of its colour disappears, forms one of the most beautiful *sympathetic inks* with which we are acquainted. If a landscape be drawn with Indian ink, and afterwards the foliage be washed over with this solution, it will have no peculiar appearance; but on holding the paper near the fire, the part representing the vegetation will gradually assume a green tint, which will subside on removing the paper into a cool situation.

Zaffre is an oxide of cobalt, mixed with about three times its own weight of calcined and pounded flint. It has been chiefly imported into this country from Saxony and Bohemia, but it is now also manufactured from cobalt dug from mines in the Mendip Hills and in Cornwall. In Staffordshire there are several persons who carry on a considerable trade in preparing this colour for the earthenware manufacturers of that county.

This substance is extremely valuable for the colouring of porcelain and glass; as it resists, without change, the effects of the most intense heat. Hence also it is advantageously used for giving various shades of blue to enamels, and to glass manufactured in imitation of lapis lazuli, turquoise, sapphire, and various precious stones. So intense is the colour imparted by it, that a single grain of zaffre will give a full blue tint to 240 grains of glass.

Smalt is a kind of glass, of a dark blue colour, formed by melting zaffre with three parts of sand and one of potash; when this substance is ground to a coarse powder, it has the name of *strewing-smalt*, and is much used by sign painters, as an ornamental filling up of the vacant space betwixt the letters of signs. In Germany it is frequently employed instead of sand, for the purpose of drying ink after writing. The same substance reduced to a perfectly fine or impalpable powder, is the article which is sold under the name of *powder-blue*, and which is not only used by laundresses and others in the getting up of linen, but also as the basis of several kinds of paint; and by the manufacturers of writing and printing papers, to give a blue tinge to those articles.

248. *MANGANESE, in the state that we usually see it, is a black oxide (peroxide). In its metallic state it is bluish white, very brittle, and difficult of fusion. It is eight times as heavy as water.*

Mines of manganese have long been worked in several parts of Great Britain, but particularly in the counties of Devon, Aberdeen, and Somerset. Near Exeter and in the Mendip Hills this mineral is found in great abundance. After the ore has been extracted from the mine, it is reduced to small pieces, washed and ground to an impalpable powder, in which state it is sent to market.

It is employed for various useful purposes. In the manufacture of the finer kinds of glass it is used in a double capacity, both as a colouring material and as a destroyer of colour. As a colouring ingredient, the imitators of several precious stones are indebted to it for the red and purple tints which they give to the oriental ruby, the balais ruby, and the amethyst.

The violet colour given to porcelain is obtained from manganese. This substance is also used for the glazing of black earthenware, as a paint, and an ingredient in printers' ink. As a discharger of colour it is applied in small quantities, and, by the oxygen which it gives out, it is said completely to destroy any tinge left in the glass by the presence of iron, and some other colouring matters. This property has obtained for it the appellation of the *soap of glass.*

It is from manganese that most of the oxygen gas (21) used by chemists is obtained. By the application of a red heat, this is yielded in such abundance, that an ounce of the oxide of this metal will yield about two quarts of gas. The consumption of manganese has, of late years, become very considerable by the discovery of chlorine (29), which is now extensively used in the bleaching of linen and cotton, this gas being obtained by the distillation of the oxide of manganese with muriatic acid (29). It has been used in medicine, but is now nearly obsolete.

COMPOUND MINERALS,

OR

ROCKS.

249. There exist considerable masses of minerals in a state of combination, or aggregation with each other. These constitute the rocks and soil of which the globe of the earth is composed; and the study of them is called GEOLOGY. The opinions of learned men relative to their structure, and original formation, have produced various systems denominated *theories of the earth;* but, when we consider that the greatest depth beneath the surface to which the art and industry of man have been able to penetrate, does not exceed $\frac{1}{35000}$ part of the earth's diameter, we must confess that this is very insufficient to allow of any correct opinion being thereby formed concerning the structure of the whole.

Modern geologists, for the more convenient arrangement of the compound minerals, have divided them into four classes, which they denominate *primitive rocks, secondary rocks, alluvial depositions,* and *volcanic rocks.*

I. PRIMITIVE ROCKS.

250. *These were so called from their being considered by geologists to belong to the first formed part of the globe: though this opinion has with some within the last few years become obsolete.*

Rocks of this description are of a nature extremely hard.

They are by some considered to contain no vestiges whatever of animal or organic remains; and the substances of which they are composed are crystallized. They rise through other rocks at various elevations, in every quarter of the globe; and rarely alternate with, or rest upon rocks that enclose organic remains, though they are themselves frequently covered by such, and devoid of any traces of either animal or vegetable remains.

The following are the principal kinds:

251. *GRANITE is an unstratified compound rock, composed of felspar* (110), *quartz* (76), *and mica* (123), *each in crystalline grains of various size, and promiscuously arranged; sometimes one and sometimes the other of these ingredients predominates, but generally the felspar.*

This is one of the most common and most widely extended rocks that are known: and is usually considered as the foundation on which the secondary rocks are deposited. In Cornwall it is very abundant, and veins both of copper and tin are found in it. Granite forms the summits of the highest mountains in Scotland, of the highest of the Grampian Hills, the Alps, and the Pyrenees; and indeed the loftiest parts of most of the countries of the world. The Logan, or rocking stones, in Cornwall, are immense blocks of granite [1].

The granite, according to Mr. Lyell, "was formerly supposed to be the oldest of rocks, the mineral product of a particular period or state of the earth, formed long antecedently to the introduction of organic beings in our planet. But it is now ascertained that this rock has been produced again and again, at successive eras, with the same characters, penetrating the stratified rocks in different regions, but not always associated with strata of the same age. Nor are organic remains always entirely wanting in the formations invaded by granite, although they are usually absent.

The uses of this stone are numerous and important. Millstones, steps, troughs for stamping mills, and innumerable other articles, are made of it. The streets of London

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[1] A rocking stone is also found at Perros-Guirec in Britanny upwards of 20ft long, and its weight is estimated at about one million pounds; it is supposed to be the largest in that province. *Mrs. Trollope.*

are chiefly paved with granite, and its hardness and durability render it peculiarly eligible for this use. Weather has little effect upon it. Consequently, when applied to architectural purposes, it is found infinitely preferable to Portland stone, of which nearly all the public buildings of modern date in London have been constructed, and many of which are fast going to decay. This circumstance induced the proprietors of the Waterloo Bridge to adopt granite in the construction of that edifice. Mr. Smeaton also chose it for the outer walls of the Eddystone Lighthouse.

252. Scottish Granite.—Scotland is remarkable for many kinds of granite, some of which are susceptible of an excellent polish. The greatest part of the mountain of Ben Nevis, near Fort William, is composed of a reddish granite, one of the best and most beautiful that is known. This mountain is nearly a mile in perpendicular height, and is said to contain granite enough for all the kingdoms of the earth, although they should be as partial to this stone as the ancient Egyptians were. Columns and obelisks of any size and height might be cut from it: for the rock is one uniform mass, without appearance of strata, division, or fissure of any kind. A convincing proof has been given of the strength and hardness of this granite, in a fragment of several tons' weight, which fell from nearly the top of a precipice five hundred yards in height, upon a hard and solid rock below, and yet continued entire.

253. Granite of Ingria.—A beautiful red granite is found in some parts of Russia, remarkable on account of the felspar (110) that it contains, appearing in round or oval pieces, from half an inch to two inches in diameter. This granite, when polished, exhibits shining spots of a round or oval shape, which give to it somewhat the appearance of being studded with precious stones.

The royal summer garden at Petersburg is decorated with a superb colonnade of Ingrian granite. The columns are sixty in number, and each of a single piece twenty feet high, and three feet in diameter. Many of the public buildings in Petersburg are of this granite. An immense block of it, thirty-two feet long, twenty-one feet broad, and seventeen feet high, forms the pedestal of the celebrated equestrian statue of Peter the Great, in that city.

254. GRAPHIC GRANITE.—A singular kind of granite has been discovered in the island of Corsica, and lately near Portsoy in the north of Scotland. The ground of this granite is a whitish or reddish yellow felspar, in which are embedded crystals of quartz, each from an inch to an inch and a half long, and several lines in diameter. The name of graphic granite was given to it, in consequence of an imaginary resemblance which the sections of these crystals have to Hebrew, or Arabic, and sometimes to musical characters.

GRANITE OF JERSEY.—A very superior kind of granite has been imported from Jersey, and is found admirably adapted for paving the carriage-roads in London. During the late repairs of Blackfriars' Bridge in 1840, this rock was laid down in long narrow pieces, to form the carriage-road ; its durability and superior qualities to those stones ordinarily employed, having been previously well tested.

255. *GNEISS is a stratified primary rock, consisting, like granite, of felspar* (110), *quartz* (76), *and mica* (123), *but differing from that rock in its structure, being slaty, and having rather more of the latter mineral entering into its composition.*

Mountains of gneiss are not so steep as those of granite, and their summits are usually rounded. Ben Lomond and others in Scotland, and Mount Rosa in Italy, are almost wholly of gneiss, as well as the middle part of the Pyrenees. It is not an uncommon rock, but in Britain is of less frequent occurrence than granite.

Many valuable metallic ores are found in veins of gneiss. This rock also sometimes contains crystals of garnet (70), and tourmaline (69).

256. *MICA SLATE, or MICACEOUS SCHISTUS, is a primary stratified rock of a slaty structure, consisting principally of quartz* (76) *and mica* (123).

Like gneiss, it is rich in ores. It often contains beds of magnetic ironstone (235), galena (239), copper, blende

(241), cinnabar (228), and sometimes even gold. It frequently has garnets, and sometimes tourmalines (69), interspersed in different parts of it.

Mica slate occurs in many parts of Scotland; the mountain of Schehallien, and the rocky adjacent country, are in a great degree composed of it.

257. *CLAY SLATE or SCHIST, is a stratified primary rock, generally of a dull blue colour, more or less compact, always slaty, and always stratified.*

Under the appellation of clay slate are included *roofing slate* (120), *whet slate* (122), *drawing slate* (121), and some other kinds already described.

Few rocks abound more in veins and beds of valuable metals than slate. In different countries it contains ores of tin, lead, cobalt (247), silver, and copper; and gold, and mercury (228) sometimes occur in it. The celebrated quicksilver mines of Idria (228), and the immense mass of copper at Parys mountain in the island of Anglesea (230), are in clay slate. Crystals of pyrites (236), and sometimes garnets (70), and thin layers of quartz (76), and felspar (110), are all occasionally found embedded in it.

This is a widely-extended rock; it sometimes forms whole mountains, and even chains of mountains; but these usually have a gentle acclivity. The summit of the celebrated mountain called Skiddaw in Cumberland is of clay slate.

258. *PRIMARY LIMESTONE is a simple mountain rock of a crystalline or granular structure; and generally of a white, yellowish, greenish, or reddish colour.*

To this species of rock belong many of the rich and beautiful kinds of marble already described (143, &c.) Carrara, or statuary marble (146), is a familiar instance of it. Whole mountains in Stiria, Carinthia, Carniola, and the Pyrenees, and three mountains in Switzerland, 10,000 feet in height, are of primitive limestone. The mountain of Filabres in Spain is said to consist of one block of white granular marble, 2000 feet high, and three miles in circuit; without intermixture of other earths or stones, and almost without a fissure.

Various mineral ores, in beds and veins, as lead, zinc (241), and iron, are occasionally found in this kind of rock.

259. *PRIMARY TRAP is a mountain rock composed of a black mineral called hornblende, mixed, in some varieties, with felspar* (110), *and, in others, with augite* (123).

The word *trap* is of Swedish origin, signifying a *stair;* and rocks of this formation are called trap rocks, because their strata, when exposed, usually jut out, one beneath the other, somewhat like a stair. Under this term is comprehended a series of rocks, distinguished chiefly by the hornblende which they all contain.

Rocks belonging to this formation are numerous. They occur in Scotland; and abundantly in Derbyshire and some other parts of England. In many countries they constitute considerable hills. They abound in ores.

260. *SERPENTINE is a primary rock, usually consisting of quartz* (76), *magnesia* (198), *alumine* (197), *with a portion of oxide* (21) *of iron. It is mostly unstratified.*

This rock and its various uses have been already described (132). It generally occurs in shapeless masses and beds, and seldom in distinct strata. It is found in Cornwall, the island of Anglesea, and several parts of Scotland; but it rarely forms mountains.

Ores of lead, silver, and copper, are sometimes found in serpentine.

261. *PORPHYRY is an unstratified primary rock, consisting of quartz* (76) *or felspar* (110), *or both, embedded in a solid and compact cement or ground. It is usually purple, brown, or green, and derives its name from the Greek, signifying purple, owing to one variety presenting that colour.*

The ground or basis of porphyry varies in the different kinds. In some it is claystone, in others pitchstone, hornstone, or compact felspar.

When not covered by other formations, porphyry sometimes forms single rocks. The highest points of the *Andes* consist of porphyry. It occurs in beds of considerable magnitude, but never appears in distinct and well-defined strata.

There are many beautiful and splendid works in porphyry. Obelisks, statues, and columns, wrought in it, have had great celebrity. It is susceptible of a polish as high as that of marble, but it is so hard that the expense of working it has caused it to be much neglected by the moderns. This hardness, however, renders it very durable, and also constitutes it a material of great utility for mortars, slabs for grinding colours upon, and for several other purposes.

Porphyry was much esteemed by the ancient Egyptians; and Pliny informs us that the procurator-general in Egypt, under Claudius Cæsar, brought thence for that emperor certain statues of porphyry, which he conceived to be very valuable: this act, however, was not much approved, and the example was not followed by any other Roman.

The principal quarries of porphyry are in Egypt; but this stone is also found in Italy, Germany, and various parts of the European continent. It may be traced from Norway to the borders of the Black Sea, and it has been discovered in some of the western and northern parts of Great Britain.

262. *SIENITE is an unstratified rock, composed of felspar* (110), *quartz, and hornblende, in equal proportions. Its colours are usually reddish and black.*

Some varieties of it contain quartz (76) *and mica* (123), *with but little hornblende. In these the colours are various.*

Although this is a less abundant rock than any of those that have yet been mentioned, it occurs in great abundance at Mount Mado, in the island of Jersey. There are extensive quarries of it in that mountain not only for the use of the island, but for exportation to England, and other distant countries. The cliffs for a long space, and an elevation of a hundred feet or more, consist entirely of sienite, in large masses, which are apparently uninterrupted by a single fissure. Shafts for columns of considerable length have been taken from these quarries; and were the demand sufficient to call for new openings, it is imagined that columns of twenty feet and upwards in length might be raised. The felspar is of a flesh colour, and the stone is capable of a beautiful polish.

A somewhat similar kind of sienite is found at Grande Roque, in the island of Guernsey, in large masses, which are quarried for building stones. Sienite also occurs in some parts of Scotland and Derbyshire; in Saxony, Hungary, the island of Cyprus, and Egypt. Its name has been derived from that of the city of Syene, in Upper Egypt, where it is found in great abundance.

Sienite was much used by the ancients in ornamental architecture. What was called the red granite of Egypt (for this rock has usually been considered a granite) furnished numerous magnificent obelisks and columns, of a single piece, which have been much admired in Rome and other places. The ancient artists sometimes cut this kind of stone into statues, vases, monumental and other works. The celebrated column in Egypt, upwards of ninety feet high, and known by the name of Pompey's Pillar, is formed of sienite.

In veins of this rock are found, in different countries, many kinds of metallic ores; among others, silver, iron, tin, copper, and lead.

263. *QUARTZ ROCK is a simple mountain rock, usually of a granular texture, and a whitish colour: it consists of pure silex. It sometimes contains mica, in which case it has a slaty form.*

In certain mountains of Scotland, and the Scottish islands, quartz rock is very abundant. On the Continent it appears in Saxony, Bohemia, Silesia, and several other countries. We are informed that a mountain, 350 feet high, and near 5000 feet broad and long, one of the Altaisch chain, in Siberia, consists entirely of a milk-white quartz.

The uses of quartz have been already described (76, &c.) This kind of rock does not contain metallic ores of any description.

II. SECONDARY ROCKS.

264. SECONDARY ROCKS *are composed of, or at least contain within them, the mineralized remains of organic substances.* These must necessarily have been formed at a period subsequent to the formation of those organized bodies the remains of which they enclose; and they have apparently been formed by the deposition of water. Hence it is, that, to distinguish them from rocks of the preceding class, they have received the appellation of secondary. They mostly rest upon or cover primitive mountains, and sometimes lean upon their sides or invest them.

Werner, the celebrated German mineralogist, made two divisions of secondary rocks. The first of these he denominated *transition rocks*, and stated that they are less perfectly crystallized than the primary rocks; and that they enclose the remains of marine animals, no species of which are at this time known to exist: the other division he termed *floetz*, or *flat rocks*, because they are generally disposed in horizontal or flat strata. Some of the latter contain the fossil remains of marine animals and shells, approaching in character and appearance to the kinds which are now found in the ocean; and others contain shells precisely similar to those now known to exist. These rocks usually occur at the foot of primitive mountains, or in deep valleys.

1. TRANSITION ROCKS.

265. *TRANSITION LIMESTONE is distinguished by containing marine petrifactions of corals, and other zoophytes which are supposed no longer to exist. It often contains veins of calcareous spar, and exhibits a variety of colours, which give to it a marbled appearance.*

This species of limestone occurs in immense beds, and forms a great portion of the mountainous parts of Derbyshire and Scotland; but it does not rise so high on the sides of mountains as primitive rocks (250).

It often contains veins of valuable metallic ores. When cut and polished, many of the varieties of transition limestone are beautiful marbles; some of them have been already described.

266. *GRAUWACKÉ is a transition rock, composed of pieces of quartz* (76), *flinty slate, felspar* (110), *and clay slate* (120), *cemented together by a basis of clay slate.*

It has various appearances, the pieces being sometimes as large as a hen's egg, and sometimes so small that they can scarcely be perceived by the naked eye. It is one of the lowest members of the secondary strata.

When the rocks of grauwacké are not covered by those of any other formation, they form round-backed hills, usually insulated towards the tops, and intersected by deep valleys. They are widely distributed: and are often extremely rich in ores, both in beds and veins. Almost all the mines of copper, lead, and zinc, in the Hartz, are in grauwacké; and in Transylvania this species of rock is traversed by numerous small veins of gold.

2. FLOETZ, OR FLAT ROCKS.

267. *OLD RED SANDSTONE, or MILLSTONE GRIT, is a floetz or flat rock, composed of large grains of sand or quartz* (76), *coloured by oxide* (21) *of iron, and usually cemented together by a kind of clay.*

In several parts of Derbyshire this kind of rock forms the uppermost stratum; and in some places is known to be 120 yards thick.

What are known by the name of *peak millstones* are formed of millstone grit. They are chiefly obtained from quarries near Nether Padley, in Hathersede, Derbyshire; a very inaccessible part of the country, but where the stone is of better quality than it can elsewhere be procured. These millstones are made of different dimensions, from two feet in diameter and eight inches thick, to five feet and a half in diameter and seventeen inches thick.

Some of the beds of millstone grit which have spherical stains in them, of a light red colour, are said to be infusible; and are consequently a valuable stone for lining the hearths of iron and other furnaces, where an intense heat is required. These are called *firestones*, and Roche's quarry, near Upper Town, in Ashover, Derbyshire, is famous for them.

The upper beds of this kind of rock are often thin, and capable of division, so as to make excellent *paving stones*, or *flags*. There is a particular bed of it at Stanton, in the Peak of Derbyshire, so porous that it is made into *filtering stones* for the cleansing of turbid water.

268. *THIRD SANDSTONE, GRITSTONE, or FREESTONE, is another kind of floetz or flat rock, formed of very small agglutinated particles of sand. It is opaque, usually of a whitish colour, and found in large masses, of various degrees of hardness.*

The name of *freestone* has been given to this kind of rock, from its capability of being broken or hewn, with nearly equal facility in any direction. Hence, as well as from its great durability, it is peculiarly esteemed for buildings. It is also formed into cisterns and troughs of various kinds; into pillars for supporting corn ricks; into *rolling stones;* and into *grinding stones* for cutlers, edge-tool makers, and workers in polished steel. *Paviors' flags*, or the stones used for the paving of foot-paths, yards, kitchens, and outhouses, are generally flat pieces of freestone.

Scythestones, or stones for the sharpening of scythes upon, are made of freestone. Considerable numbers of these are wrought in Derbyshire; and the dexterity that is displayed in cleaving and forming them is somewhat remarkable. The workmen use sharp-pointed picks, several very small wedges, and a hammer. A proper block of stone being selected, two or three of these small wedges are set in a row, by gentle blows of the hammer. These blows are successively repeated till the stone splits. The wedges are then set in a straight line into the face of the piece split off, and the stone is cleft again in that direction. In this manner the subdivisions are continued, until a piece remains of a size to make two scythestones, each an inch and a half square, and about twelve inches long. This the workman holds in his left hand, nearly upright; with the point of his pick he traces a deep nick down the middle of first one side and then the other; and then by a slight blow of his pick he separates it into two, so dexterously that not more than three or four in a hundred are broken in the cleaving. Such stones as are intended for round rubbers, are first reduced into an octagonal shape by the point of the pick, and then handed over to women and boys, who grind or rub them in a notch formed in a hard stone, until they are of the requisite shape. The square ones are finished by being ground on a flat stone.

Other rocks, belonging to what is called the floetz, or flat formation, have been already mentioned, under the heads of *limestone* (140), *gypsum* (192), *rock-salt* (202), *chalk* (141), and *coal* (217).

III. ALLUVIAL DEPOSITIONS.

269. *These are described to comprehend all such substances as have been formed from previously existing rocks,*

of which the materials have been worn down by long exposure to the agency of water and air, and afterwards deposited in nearly horizontal beds on the surface of the land. Alluvial deposits have been formed, and are still forming in every quarter of the globe. They occur both in mountainous regions and in flat countries, filling up the valleys or hollows in the one; and often forming vast and extended plains in the other.

They consist of *sand, gravel, loam, clay*, and other substances.

IV. VOLCANIC ROCKS.

270. *Volcanic rocks are composed of such mineral substances as have been ejected from volcanoes, or have been formed by the agency of subterraneous fires, and have undergone certain changes in such fires.*

They are of two kinds: the one called *pseudo-volcanic*, such as burnt clay, porcelain jasper, and earth-slag, which have been altered in consequence of the burning of beds of coal in their neighbourhood; and the other, called *true volcanic* minerals, such as stones, ashes, and lava, which have been thrown out of real volcanoes.

271. It will somewhat tend to illustrate the history of the mineral kingdom, to state, in conclusion, under a tabular form, the relative heights of the principal mountains, or masses of rocks, which occur in the different countries of the world; previously remarking, that the most lofty and magnificent of these, respecting which any account sufficiently authentic has hitherto been obtained, are the *Himalaya* mountains of Nepaul and Thibet, in Asia, one of the former being, it is said, 27,667, and the highest of the latter measuring at least 23,262 feet, or from four miles and a half to five miles and a quarter in perpendicular height above the level of the sea. Previously to the knowledge that has lately been attained respecting the Asiatic mountains, those of the Andes, on the continent of South America, had been considered by far the highest in the world. One of them, Chimborazo, is above 21,000 feet in height. Of the European mountains, the highest is Mont Blanc, in Switzerland, which measures 15,680 feet, or about two miles and three quarters. The loftiest summit within the British

islands is Ben Nevis, in Inverness-shire, Scotland, which does not exceed 4,380 feet, or somewhat more than three quarters of a mile; while the great pyramid of Egypt, the loftiest work of human art and industry with which we are acquainted, and which will serve as a point in the scale, measures only 477 feet.

272. It has been remarked, that the greatest altitude at which *bananas* and *palm-trees* grow in America is about 3280 feet above the level of the sea (Fig. 48): that in the torrid zone, the superior limits of *oaks* is about 10,500 feet (49), of *pines* 12,000 feet (50), and of *lichen plants* 18,225 feet (51). The American travellers, Messrs. Humboldt and Bonpland, on the twenty-third of June, 1802, ascended the mountain of Chimborazo to the height of 19,400 feet (52). The highest flight that has been remarked of the South American vulture, called the *condor*, was 21,000 feet (53). M. Lussac, on the 16th of September, 1804, ascended in a balloon from Paris, to the height of 22,900 feet. In Switzerland, the limit of perpetual snow is above the altitude of 9000 feet (54).

The highest inhabited spot on the globe (54) is said to be a *farm-house*, 13,434 feet above the level of the sea. It is situated on one of the Andes in South America, called *Antisana;* the mountain itself is 19,149 feet high.

*** *See the Plate facing the title page for the above numbers.*

			Frontispiece. Fig.	Ft. above the Sea.
British Islands.	Scotland	Ben Nevis, Inverness-shire	1	4380
		Ben Lawers, Perthshire	2	4051
	England	Skiddaw, Cumberland	3	3530
		Cross Fell, Cumberland	4	3390
		Helvellyn, Cumberland	5	3324
		Wharnside, Yorkshire	6	2480
		Ingleborough, Yorkshire	7	2380
	Wales	Snowden, Caernarvonshire	8	3568
		Cader Idris, Merionethshire	9	3550
	Ireland	Macgillicuddy's Reeks, Kerry	10	3404
		Sleibh-Dorin, Londonderry	11	3150
Continent of Europe.	France	Mont d'Or, Auvergne	12	6707
		Puy de Sausi, Auvergne	13	6700
	Pyrenees	Mont Perdu, the highest of the Pyrenees	14	11,283
		Le Pic Blanc, Spain	15	10,205
	Alps	Loucira	16	14,451
		Loupilon	17	14,144
	Switzerland	Mont Blanc, highest mountain in Europe	18	15,680
		Mont Rosa	19	15,555
		Mont St. Gothard	20	10,014
	Italy	Mont Cimone	21	6401
		Vesuvius	22	3900
	Germany	Ortler-Spitze, Tyrol	23	15,430
		Ostelle, Saltzburg	24	12,800
		Carpathian Mountains, highest summit	25	8640
		Lomnitz Peak	26	8640
	Sweden	Areskutan, Jempland	27	6180
Islands.	Teneriffe	Peak of Teneriffe	28	12,236
	Sicily	Ætna	29	10,963
	Jamaica	Blue Mountains	30	7431
	Iceland	Snæfiel	31	6860
		Hecla	32	4900
Asia.	India	Dhawalgeri in Nepaul	46	27,667
		Mountains of Thibet	47	23,262
	Turkey in Asia	Mount Lebanon, estimated at	33	9520
		Mount Ararat, estimated at	34	9500
		Mount Ida	35	4960
America.	Andes, South America.	Chimborazo, Quito	36	21,441
		Cotopaxi, Quito	37	18,880

Heights of remarkable Lakes, Cities, &c.

Alps	Lake of Lausanne	38	1230
	Lake of Lanzon, on the mountain of Olan	39	6797
Switzerland	Lake of Lucerne	40	1408
South America	City of Riobamba, Quito	41	10,880
	City of Quito	42	9356
North America	City of Mexico	43	7424
Austria	Town of Eisenerz	44	2056
Egypt	The great Pyramid	45	477

*** *See the Plate facing the title page for the above references.*

WATER IN GENERAL.

273. Water, when pure, is transparent, and without either colour, taste, or smell; it is also nearly incompressible. It is a compound body, consisting of oxygen (21) and hydrogen (45).

It is *liquid* at the common temperature of our atmosphere, assumes a solid state under the denomination of *ice* in a cold temperature (32° of Fahrenheit's thermometer); and by heat is converted into an elastic vapour called *steam*. It boils under ordinary circumstances at 212°. The weight of water is about 816 times greater than that of atmospheric air.

Water abounds in, and may be considered as, a kind of general cement to all solid bodies. It performs the most important functions both in the animal and vegetable kingdoms, and even enters largely into their composition.

A chief part of the nutrition of vegetables is the water which they absorb from the earth through the pores (*spongeoles*) of their roots. The great quantity so absorbed may readily be imagined, when it is stated that the driest and most compact kinds of wood, such as even heart of oak, when converted into charcoal, lose during the process, full three-fourths of their weight; and that the fluid which escapes is nearly pure water. This fluid is found in the driest of solid bodies, whatever be their description. A piece of hartshorn kept for forty years, and thereby become as hard and dry as metal (so that if struck against a flint it would give sparks of fire), upon being distilled, was found to yield an eighth part of its weight of water.

Every being with life in a great degree lives by it; and whatever grows, through it receives its growth; and wherever it enters it promotes and sustains life, preserving the whole of created nature in their proper classes of existence. And whether we consider it as productive of health to animals and vegetables, as requisite to the existence and beauty of the earth, or as one of the great powers by which the Almighty works in the support of the world, we cannot but admire and adore the wisdom by which it has been ordained.

In the various kinds of water, even of that which is commonly used in drinking, and for the preparation of food, there is great difference both of taste and appearance. This difference is chiefly occasioned by the foreign matters which they hold in solution or suspension. In some cases the quantity of these is so minute as to have but little influence on the taste; but in others they alter its properties altogether, and render the water noxious, or medicinal, or unfit for the preparation of food.

The *chemical examination of water*, for the purpose of ascertaining the different substances which it holds in solution, is one of the most difficult and complicated operations that is known in this branch of science; and one that exercises in a peculiar degree both the skill and industry of the operator. The difficulty arises not only from the diversity of the bodies which occur, but from the very minute quantities of some of them.

These bodies are usually discovered by an addition to the water of certain substances, the consequence of which is some change in its appearance, and this change indicates the presence or absence of the bodies suspected.

The substances thus employed are very numerous, and have the name of *tests*. The methods of ascertaining the exact proportion of each of these ingredients are much too complicated to require a place in the present work.

Water can scarcely be obtained in a state of purity except by the artificial process of distillation, although rain water, if collected in open situations (away from houses), is of the same nature as that which is distilled.

Water almost always has a portion of atmospheric air and carbonic acid gas in it; much of the air which it contains is dissipated by long boiling.

ORDER I.—COMMON WATER.

274. *RAIN WATER is considered to be next in purity to distilled water, from its having undergone a natural distillation. Its foreign contents vary according to the state of the air through which it falls. Hence, for instance, when it passes through the atmosphere of a smoky town, it becomes impure: and when collected in towns, it frequently acquires a small quantity of sulphate of lime* (192) *and calcareous matter from the mortar and plaster of the houses, and various other impurities from the lead, zinc, or copper used as coverings to buildings.*

This water is always very soft; and is consequently well calculated for the dissolving of soap in washing and other processes. It is also peculiarly adapted to the solution of alimentary or colouring matter, in the preparation of food and dyeing, and is accordingly used to great extent for these purposes. By the addition of a small quantity of a solution of barytes (195), it may be rendered sufficiently pure for all chemical uses.

If rain water be long kept, especially in hot climates, it acquires a disagreeable smell, and becomes putrid, and full of animalculæ.

275. *ICE and SNOW WATER are equal to rain water in purity; and the air having been expelled from them during the process of freezing, they are consequently devoid of air when first melted.*

Ice and snow, in their natural state, are highly important to mankind. It is a general law of nature that all bodies become more dense and heavy by exposure to cold; but the freezing of water is an exception to this law, and for a purpose of extreme benefit to mankind. By this ordination it is that ice always rises to the surface of the water, and thus preserves from the effects of the surrounding cold a vast body of heat in the fluid beneath; and is itself ready to receive its own accustomed quantity upon the first change of the atmosphere. The expansion of water in freezing is owing to its assuming a crystallized form; and this expansion is often so great that glass bottles filled with water are burst by it.

During the intense cold of winter, snow, which is of a soft and spongy texture, is considered of great utility in preventing the immediate access of the atmospheric air to the ground; it has doubtless been designed by Providence as a garment to protect the incipient vegetation at that inclement season from injury.

The inhabitants of all the extreme northern parts of the world use thawed snow for their constant beverage during winter; and the vast masses of ice which float in the polar seas afford an abundant supply of fresh water to the navigators of those dreary regions. Snow water has, however, long lain under the imputation of occasioning those extraordinary swellings in the neck, or thyroid gland, called *goître*, which deform the inhabitants of some of the alpine valleys of Switzerland; but this opinion is not supported by any well-authenticated facts. Indeed it is rendered quite improbable by the frequency of this disease in the island of Sumatra, where ice and snow are never seen; and by its being quite unknown in Chili and Thibet, though the rivers of these countries are chiefly supplied by the melting of the snows. This disease also is met with in Derbyshire, Nottinghamshire, and several other counties. It is usually considered to be owing to the action of water on peculiarities of constitution.

276. *SPRING WATER is nothing more than rain water, which having gradually filtered through the earth, collects at the ottom of declivities, and there makes its way to the surface. It sually contains sulphate of lime, which renders it hard.*

It is obvious that spring water must be nearly as various in its ntents as the substances through which it flows.

Ordinary springs pass insensibly into mineral springs, cording as their foreign contents become more abundant; it it has not unfrequently happened that waters have quired great medical reputation from their purity only. though by far the greater number of springs are cold, ne are hot, or at least are of a temperature which, at all es, exceeds that of summer heat; and this warmth is so le influenced by the state of the atmosphere, that it is rly the same both in summer and winter.

The water of almost every spring is of such a nature that vill not dissolve, but curdles, soap; and cannot be used dressing several kinds of food. Water of this description is denominated *hard*, a property owing to the great proportion of earthy salts which it holds in solution, and which at the same time are not in such abundance as to impair its taste. The most common of these salts is sulphate of lime (192), and carbonate of lime (140); when it contains only the latter, the water is rendered more soft by boiling, which expels the excess of carbonic acid (26), and thus causes much of the carbonate of lime to be precipitated. Hence originates the earthy crust or *rock* in such tea kettles as have had hard water several times boiled in them. This encrustation is very commonly met with to a considerable extent in steam-engine boilers, which is exceedingly objectionable, frequently causing the boilers to burst. In most boilers there is a hole termed the *man-hole*, through which a workman periodically enters with a hammer and hard chisel to remove this deposition. Very lately a patent has been taken out for the purpose of obviating this inconvenience, by simply inserting indigo, logwood, or other colouring matter into the water, which has the property of *glazing* the particles, and thus prevents their adhering together.

In the country, where hard water abounds and wood is used as fuel, the ashes are usually saved from the hearth for the purpose of rendering the water soft, which they effect by the alkali they contain (carbonate of potass). Common soap, in small quantities, has been recommended by Dr. Clarke for softening water.

The water of deep wells is, for the most part, much harder than that of springs which ov·rflow their channels. The sparkling liveliness of spring water is occasioned by the evolution of gas which is mixed with it; most commonly carbonic acid gas.

277. *RIVER WATER is a mixture of spring and rain water, and various impurities, which from much agitation, and by long exposure to the air in the course of its channel, becomes in general tolerably soft and free from earthy salts.*

For washing, and other purposes of domestic economy, river water, from its softness and purity, is not only preferable to spring water, but also serves for many uses to which the latter cannot be at all applied. As a beverage, however, it is in general vapid and unpleasant.

The waters of some rivers, particularly where the beds over which they flow are sandy or stony, are remarkably pure. This is the case with several of those in Switzerland, Wales, Scotland, and the northern counties of England. The river Seine has great repute in France on this account: it has been found, on accurate examination, even more pure than Bristol water.

That of the river Thames, impregnated as it is with putrid remains and the refuse matter from sewers, gas works, &c. is soft and good, when taken up at low water; and after rest and filtration is found to contain but a small proportion of any thing either noxious or unpleasant. It is preferred by mariners to most other water for sea store; but it soon becomes putrid, and undergoes a remarkable spontaneous change; for when, after having been kept a month or two, a cask is opened, a quantity of inflammable air makes its escape, and the water is black and nauseous. If in this state it be racked off into large earthen vessels (oil jars it is said are commonly used for the purpose), and exposed to the air, it gradually deposits a portion of black slimy mud, and becomes perfectly clear, sweet, and fit for use.

Charcoal exerts a specific action on water so tainted, especially *animal charcoal.* The common practice on board of ship is to introduce a piece of charred biscuit into a cask containing tainted water, which is rendered fresh in a day or two; but in this case the charcoal is of a *vegetable* nature.

278. *STAGNANT WATER* ***contains greater impurities than any other. In ponds and marshes particularly, it is filled with animals and vegetables, and their remains, which are there undergoing a gradual decomposition.***

The water of lakes is not, in general, so much contaminated as this; but from the same cause it frequently has a slimy appearance, a brownish colour, and an unpleasant taste.

From the putrefying contents of stagnant water, nutriment is afforded to various living plants and insects, which there supply the place of those that perish. Its taste is vapid, unpleasant, and wholly destitute of that agreeable freshness which is found in spring water. It is, however, generally soft, and by filtration it may be freed from many of its impurities.

The air which issues from marshes and stagnant pools is extremely noxious, and is the cause of agues and other distressing complaints, to such persons as reside in the neighbourhood of them, or are much exposed to them; and the injurious effects of such air have also been considered to extend to the internal use of these waters.

The nature of water, as food, exerts a very decided effect on the animal economy.

ORDER II.—SEA WATER.

279. *SEA WATER is a very heterogeneous compound, not only containing a considerable portion of saline substances, but holding also suspended in it an infinite number of minute animal and vegetable particles, to the gradual putrefaction of which its peculiarly nauseous and bitter taste at the surface is in some measure to be attributed.*

The average quantity of salt in sea water is estimated to amount to about one-thirtieth part of its weight. It likewise contains a certain portion of muriate of magnesia, sulphate of magnesia (199), *and a small quantity of sulphate of lime* (192). *Sea water, taken from a great depth, has not the bitterness which the water of the surface has; it is only saline.*

No natural waters, if we except certain brine springs and salt lakes, are so saline as those of the ocean; and the latter differ in this respect in different parts of the world. Between the tropics the sea is in general more salt than it is at the poles, a wise ordination to preserve it in those climates from the great tendency to putrefaction: and at a considerable depth it is always found more salt than at the surface. The water of the Baltic is much less salt than that of the Atlantic; and it is a remarkable circumstance, that its saline contents are increased by a west wind, but still more so by a gale from the north-west.

Some philosophers have endeavoured, but to little purpose, to account, from second causes, for the saltness of the ocean. Dr. Halley persuaded himself that it might have been gradually acquired, in very minute portions, by a deposit of salt washed down from the land by rivers, and that as it could not be carried off by evaporation, instead of being diminished it must be constantly increasing. But this idea of salting the sea with fresh water is, to say the least of it, somewhat absurd, more particularly as it presumes that the sea was originally unimpregnated with salt. Had this been the case, the putrefaction of the immense mass of animal and vegetable substances which it gradually contained, would probably have proved fatal to the whole of the inhabitants of the earth.

The temperature of the sea, although it must necessarily vary in the different seasons, is much more uniform than that of any inland water exposed to the atmosphere. This is in a great measure attributable to its vast body of water, and the perpetual agitation to which it is exposed.

Sea water, when congealed by frost, is found to reject all, or nearly all its saline particles; and consequently when thawed, its ice yields water so fresh that it may be drunk without unpleasantness. The freezing of sea water is not unfrequently practised in the northern parts of the world, with a view to lessen the trouble and expense of extracting salt from it for domestic and other uses (202). Salt water may likewise be rendered fresh and palatable by distillation, a mode which is now very generally practised at sea.

The sea shore has of late become so much frequented by invalids, for the purpose of bathing, that there is scarcely a fishing village on the whole extent of our coast, but which is provided with some accommodation for bathers. As a cold bath, sea water is employed with advantage in all those cases of debility for which cold bathing has in general been recommended. It is also used as an external application in tumours and some other complaints; and taken internally as a remedy in various disorders. It may not be generally known, that towels soaked in a strong solution of common salt and dried, if used to rub the body with after bathing in fresh water, renders the bath nearly as beneficial as the salt water.

It is to sea water that we are chiefly indebted for the salt which we use at table, and for all the purposes of domestic economy (202). From this water is also obtained those salts used in medicine, called Epsom salts (199).

Mr. Daniell has recently examined, at the request of the Lords of the Admiralty, sea water brought from various parts of the coast of Western Africa, with a view, if possible, to ascertain the reason of the rapid decay of the copper sheathing of ships, which in those latitudes soon becomes corroded and destroyed. The result of his researches is, that *sulphuretted hydrogen* gas is generated in those parts in considerable quantity, especially at the mouths of the rivers, by the continual action and re-action of the *sulphates* on the animal and vegetable matters in the water. The vessels recently fitted out for the Niger expedition are consequently provided with contrivances to obviate this paramount inconvenience. Mr. Daniell also conjectures that the evolution of this deleterious gas is the main cause of the fevers in those regions. The crews have also received directions for using proper ventilation, and to cause occasionally the free passage of *chlorine* gas through the various parts of the vessels. It is, indeed, delightful to see that government have made use of the recent improvements of science for preserving, to the utmost of their power, the health of those who have engaged in so laudable an enterprise.

ORDER III.—MINERAL WATERS.

From the earliest periods mineral waters have been applied either internally or externally as remedies in a whole catalogue of diseases. The followers of Æsculapius, according to Sprengel, caused temples to be raised in the vicinity of mineral and thermal waters; and Homer records both hot and cold springs.

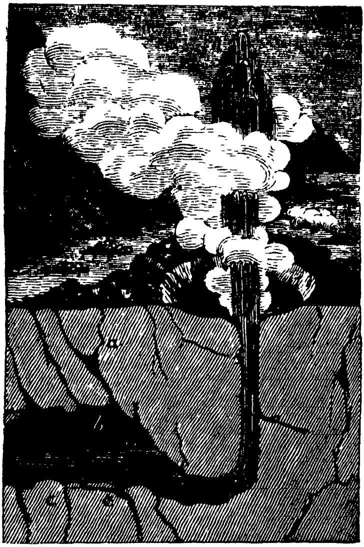
They are for the most part produced from water in the form of rain, which percolating through the different strata of the earth, imbibe a variety either of oxides of metals or salts, according to the nature of the earth through which the water passes. The hot springs and salt springs cannot, however, be altogether accounted for on the above theory; other causes must be in action in their vicinity.

With regard to hot springs, Murray[1] observes, that they are those which preserve a heat above the mean temperature of the place. Such as are merely tepid are common in most countries, especially in mines. Those having a considerably higher temperature, are less frequently met with, and mostly in volcanic districts; but some of them reach the boiling point, or are actually boiling and spouting forth

[1] Encyclopedia of Geography, p. 189.

with great violence, which indicates their having had a still higher temperature before getting vent. The most remarkable are the hot springs of Iceland, some of which are considered amongst the greatest wonders of the world. They are believed to be more abundant in Iceland than in any other country. But the interest which the number and variety of these hot springs excites in a person who never saw any thing similar, is quickly lost in the feelings which are raised on beholding the magnificent or tremendous explosions of the Geysers (Fig. 20), as they are called. Besides the principal fountains, there is a great number of boiling springs, cavities full of hot water, and several from which steam issues. There are also some places full of boiling mud, of grey and red colours. The siliceous depositions of the waters of the great Geyser have formed for it a basin of 56 feet in diameter in one direction, and 46 in the other; a projection from one side causing it to deviate from the perfect circle. In the centre of this basin is a cylindrical pit or shaft, ten feet in diameter. Through this the hot water rises gradually, filling it and the basin, after which it runs over in small quantities. At intervals of some hours, when the basin is full, explosions are heard from below, like the report of distant cannon, and at the same time a tremulous motion of the ground is felt all around the basin:

Fig. 20.



Plan of Hotwater Springs or Geysers [1].

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[1] For a description of this cut see p. 152, note.

Fig. 21.

Murray also alludes to the existence of very hot springs in the island of St. Michael (one of the African islands): they are there called the *Termas*, or warm baths, the springs supplying which are so hot as often to burn the hand which touches them. Elsewhere the *Caldeiras*, or boiling springs, rise in columns, not exceeding twelve feet in height, but of various diameters, and the burning vapours are formed into clouds, which exhibit a variety of fantastic figures and brilliant tints. It is stated that the water will boil an egg in two minutes; the atmosphere is strongly impregnated with sulphur, and suffocating vapours issue from various fissures. Not far from the *Caldeiras* is the Muddy Crater, a vast cavern filled with mineral substances in a state of constant ebullition, and making a noise greater even than the waves of the sea.

1. THE MORE SIMPLE COLD WATERS.

280. ***MALVERN WATER** is a simple cold water, perfectly bright and pellucid: it has an agreeable and somewhat pungent flavour; but in other respects it does not differ in taste from pure and good soft water.*

It contains carbonic acid (26), *and a very small portion of earth, either lime or magnesia; but the carbonic acid perhaps excepted,* *the foreign bodies are less in quantity than those even of our common spring water.*

The spring from which this water principally issues is denominated the Holy Well: and is situated high up the hill, about midway between the villages of Great and Little Malvern, in Worcestershire.

Both as an external and internal application, the waters of Malvern have been considered beneficial in many obstinate complaints. It is a singular circumstance respecting them, that, notwithstanding their apparent purity, if they be exposed to the air in an open vessel, they will soon acquire a fetid and unpleasant smell.

Malvern is principally frequented during the summer season[1].

2. THE MORE SIMPLE WARM WATERS.

281. *BRISTOL HOT-WELL WATER is pure, warm, and slightly acidulated, clear, sparkling, and agreeable to the palate, but without any very decided taste. It is also destitute of smell. When poured into a glass it sends forth numerous air bubbles. The heat of this spring is very moderate; it varies from 72° to 76° of Fahrenheit's thermometer; and this heat does not sensibly alter during summer or winter.*

The saline contents of the hot-well water are carbonic acid, muriate of magnesia, common salt, Glauber's salt, sulphate and carbonate of lime (192) *: but these are in extremely small quantity. It also contains at the rate of about thirty cubic inches of carbonic acid gas, or fixed air* (26), *in every gallon.*

This water springs from the bottom of the southern extremity of St. Vincent's rock, a lofty cliff of lime-stone situated on the north bank of the river Avon, and about a mile below the city of Bristol. And, although it is considerably higher than the river, it is so far affected by the spring tides as to become, thereby, in some degree turbid. The discharge of water amounts to about forty gallons in a minute.

There is another spring at *Clifton*, on the summit of the same hill, from the bottom of which the water of the hot-well issues. This is called the *Sion spring*, and is one or two degrees colder, but, in other respects, it very nearly resembles the water of the hot-well.

Its discovery was somewhat remarkable. A Mr. Morgan,

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[1] Adjoining to Great Malvern, and a little higher up the hill, there is a very light and pleasant *chalybeate water*.

an attorney, of Bristol, having erected a house near the spot, sunk a well for the supply of his family with water. The workmen had proceeded to the depth of nearly 240 feet without success, when they were suddenly alarmed by the gushing forth of such an abundance of water that they were compelled to retreat with precipitation. The proprietor was so far disappointed of his hopes as to find that this was a spring of warm instead of cold water. But the circumstance induced him to erect an engine to raise the water for medicinal purposes; and, since that period, a pump room and bathing houses have been prepared for the accommodation of visitors.

The water of each of these springs, besides being used medicinally in pulmonary consumptions and other complaints, is employed very extensively at table, and for all domestic purposes. It is remarkable for softness and purity; and, from its quality of continuing untainted for a great length of time, even in hot climates, is a valuable water for long voyages, and is accordingly exported in considerable quantities to distant parts.

The season of general resort to Clifton and the hot-wells is from about the middle of April to the end of October.

282. *MATLOCK WATER is a simple warm water, which, in its sensible properties, exclusive of its temperature, which is only about* 66° *of Fahrenheit, is scarcely different from good spring water. It is beautifully clear, and exhales no steam, except in very cold weather.*

The medicinal virtues of this water have chiefly been ascribed to its temperature. Its supply is very copious, and from several different sources. Though recommended in some internal complaints, it is principally employed as a bath; and, in this respect, it forms a medium betwixt the waters of Bath or Buxton and those of the generality of cold baths.

Matlock, which is a beautifully romantic village, situated in a hilly part of Derbyshire, and at the distance of 143 miles north of London, was first brought into public notice about the year 1698, shortly after which period the first bath was erected. It is chiefly frequented from the month of May to that of October; or, if the weather continue fine, till near the beginning of November.

283. *BUXTON WATER is a simple warm water, which con-*

tains so little foreign matter, as scarcely to be distinguishable from common spring water heated to the same temperature. It contains, however, a small quantity of nitrogen, carbonate and sulphate of lime, muriate of soda, and oxide of iron. It has neither smell nor taste; and though it sparkles a little in the glass, when first drawn, this is not apparently more than what is observable in the water of many common springs.

Its temperature, in the bath called the Gentleman's Bath, is invariably 82°.

Buxton has been celebrated for its warm springs nearly two centuries and a half. As early as the year 1572 a treatise on their virtues was published: this states them to have been at that time much resorted to by persons from all the adjacent counties. The water is employed both externally and internally, and to great extent. Its principal value, as a bath, arises from its very copious supply, its purity, and its high temperature. The sensation which is felt from bathing in it is considered to be such as would be experienced from any bath heated to the highest temperature which is compatible with giving some sensation of cold when the body is first plunged into it. This water is also used as an internal medicine; and is frequently used by the inhabitants as their common beverage, and for such domestic purposes as its hardness will admit.

There are several springs and several distinct baths; but the original and most ancient of them is called St. Ann's Well, and is enclosed in an elegant stone building. These waters are frequented by persons afflicted with the rheumatism, gout, diseases of the alimentary organs and kidneys, and various other complaints: the chief influx of company is during the summer and autumnal months.

The situation of Buxton is in a narrow and funnel-shaped valley, surrounded by wild, bleak, and dreary mountains, in the midst of the county of Derby, and about 160 miles north of London.

3. HOT CARBONATED CHALYBEATE WATER.

284. *BATH WATER is a hot water. When first drawn, it appears clear and colourless, nor does it afford any signs of briskness or effervescence. The temperature of the water drawn from the King's Bath, which is that usually employed for drinking, is* 116° *of Fahrenheit, and that of the Cross Bath is* 112°. *No odour whatever is perceptible from a glass of fresh water; but from a*

large body of it the nose is affected by a slight degree of pungency. When the water is hot from the pump, it fills the mouth with a strong chalybeate impression without any pungency, and accompanied with scarcely any kind of saline taste; and, what is remarkable, as soon as the water cools, the chalybeate taste is entirely lost, and nothing but an extremely slight saline sensation remains upon the palate.

The saline contents of Bath water are sulphate and carbonate of lime (192), *Glauber's salt* (203), *and common salt; together with a very small portion of oxide of iron* (21), *yet sufficient to give iron-mould stains to the linen of the bathers, and silica* (90). *The water curdles soap, and is so hard as to be unfit for many domestic purposes.*

The city of Bath has been celebrated for its hot springs even from the time of the Romans. These are of higher temperature than any others within the British dominions; and, indeed, are the only natural waters which we possess that are at all hot to the touch, the other thermal waters being of a heat below the animal temperature.

There are three principal sources of these waters, called the King's Bath, the Cross Bath, and the Hot Bath; and they differ slightly in their properties. The springs arise within a short distance of each other, at the lower part of the city, and yield so copious a supply, that all the large reservoirs used for bathing are filled every evening with water fresh from their respective fountains.

The application of the water externally is either general or local. The latter consists in pumping it for a considerable time on the part affected. This is called *dry pumping*, because in it only one part of the body is wetted, whilst the rest is kept dry; and in many cases it is found an excellent remedy.

The diseases for which these waters are resorted to are very numerous, and are amongst the most important and difficult to be cured that come under medical treatment.

4. HOT ALKALINE SULPHUREOUS WATER.

285. *AIX-LA-CHAPELLE or AKEN WATER, is an alkaline sulphureous water, much hotter than that of any of the springs in England. varying in temperature in the different baths from* 112° *to* 143°. *It has a saline, bitterish, and somewhat alkaline taste; and its smell precisely resembles, but is greatly more powerful than that of Harrowgate water* (299).

It contains a small quantity of carbonate of lime, common salt, and carbonate of soda (201), the latter of which renders it soapy to the touch. But the most striking feature in this water is the unusual quantity of sulphuretted hydrogen which it contains; and which is so extremely volatile on the application of heat, that none of it is left in the residuum after evaporation. In this water there is also a considerable portion of carbonic acid.

The city of Aix-la-Chapelle is in the circle of Westphalia, betwixt the rivers Meuse and Rhine, about seventy miles east of Brussels, and in a rich and fertile country. Its waters have been in great medical repute, and have attracted a numerous concourse of visitants for many centuries past. Their reputation was so well established, even in the time of Charlemagne, that he frequently resided at Aix; and he is said to have been so much delighted in the use of the waters, as to have sometimes even held his levee at the baths.

In this city, and in the small territory that belongs to it, there are several sources of hot water. Of these the principal spring is enclosed in a stone cistern, which is vaulted and almost conical at the top, and the parts of which are connected with the utmost care, to prevent the vapour from escaping. From this spring the water flows, in a copious stream, into several spacious and elegant baths in the different parts of the city, distinguished by the names of the Emperor's Bath, the Nobles' Bath, the Poor's Bath, and other appellations. In most of these there is every necessary apparatus for bathing by immersion, for vapour bathing, and for pumping on any particular parts of the body.

The water rises with great quickness from the springs, and sends forth bubbles of air, which burst with a slight noise when they reach the surface. It is at first perfectly colourless and pellucid, and emits a large portion of steam, and with it a strong sulphureous smell, which is perceptible at a great distance.

Its temperature is so high, that, in the large baths, it requires to stand from fifteen to eighteen hours before it is sufficiently cooled for tepid bathing; and it is one of the few natural springs which are hot enough to be employed as vapour baths without the addition of artificial heat. On standing to cool, it gradually loses its clearness, acquires a milky hue, and deposits an earthy sediment, which is entirely calcareous. At the same time it loses its offensive smell, and, when cold, has scarcely any odour.

Wherever a large quantity of this water passes hot from the spring through a confined place, the upper covering becomes encrusted with sulphur. This is particularly the case with respect to the dome of the vault that encloses the great source which supplies the Emperor's bath, and which is opened from time to time, for the purpose of having the sulphur brushed off.

From the waters of Aix-la-Chapelle, though only internally used, the body acquires a sulphureous smell; and even silver worn in the pocket becomes tarnished.

286. *BORSET WATER is of two kinds. One of these resembles the water of Aix in every respect, except as to the impregnation of sulphur, which is much weaker: its temperature is* 132°. *The other contains no sulphur: it is, however, equally alkaline, and the heat is as high as* 152°, *which much exceeds the hottest of the waters of Aix.*

Both these waters are used by fullers and cloth-workers, on account of the convenience they afford, without expense, of a sufficiency of hot and somewhat alkaline fluid, which is well adapted for the cleansing of woollen cloth.

In the latter of the above-mentioned springs a large portion of earth is suspended. This, as the water cools, is deposited, and forms hard incrustations of considerable thickness round every substance with which it comes in contact. It is not, however, on this account found less useful for the scouring of cloth, boiling of vegetables for the table, or any of those domestic purposes for which soft water is required.

In this spring there is a considerable portion of carbonic acid gas (26), which is continually escaping from the fresh water, and is in sufficient quantity to corrode, in a short time, the leaden covering that is used for the vapour baths, and any iron within its reach.

After having supplied several baths, the stream flows into a large fish pond, where it is still of blood heat. In this pond we are informed that carp and tench multiply very fast, and grow to an enormous size; but that their flesh is soft and without flavour, until they have been removed, for about six months, into a pond of cold water, where they become perfectly firm and good for the table.

In their medicinal application these waters are chiefly employed externally, and their great heat allows of every convenience for vapour, hot, warm, and tepid bathing. The village of Borset, or Bordscheit, in which they are found, is situated about a quarter of a mile south of Aix-la-Chapelle (285).

5. HOT, SALINE, HIGHLY CARBONATED CHALYBEATE WATER.

287. *THE VICHY WATERS are hot, saline, and chalybeate. They vary in some degree in the different springs, have a salt and somewhat bitter taste, and a considerable pungency of smell. They are alkaline, and about the temperature of* 120°.

There are at Vichy, a small town on the banks of the river Allier, about 180 miles south-east of Paris, no fewer than six different springs of hot water, which vary somewhat in their temperature, and in the proportion of their foreign contents. The valley in which this town is situated is highly fertile and beautiful, and abounds in vineyards and fruit-trees.

It is remarkable that sheep, cows, and other animals, crowd to drink this water with great eagerness, and even to lick the stones and sides of the channel through which it flows. Their partiality for it is so great, that at certain times they are known to swim across the river Allier in considerable numbers together, without even tasting of that water, and to proceed without interruption onward until they reach this their favourite beverage.

288. *CARLSBAD WATER is hot, saline, and chalybeate, having an unpleasant alkaline and bitter taste, though scarcely any smell. Its constant temperature is* 165°. *It contains carbonates of lime and of soda, Glauber's salt* (203), *and common salt, together with a small portion of iron and of silica; and carbonic acid gas* (26) *in considerable quantity.*

The town of Carlsbad, situated on the river Eger, in Bohemia, and its springs (which have the name of *Caroline Baths*), received their appellation from the Emperor Charles the Fourth, who is said to have himself discovered the latter, in the year 1370, whilst hunting; and since that period few waters have more engaged the attention of chemists and physicians than these. Carlsbad is now much frequented during the summer months, and has good accommodations as a watering place. Its water is remarkable for a rapid and copious deposition of calcareous earth, which takes place always on cooling, and forms a very hard and beautiful crust on the inner surface or tube of any channel through which it flows; and forms petrifaction round moss, pieces of straw, or other extraneous substances which are put into the stream, even for so short a time as twenty-four hours. All the iron which the fresh water contains is also precipitated by cooling, and rather sooner than the calcareous earth. A very fine laminated calcareous stone in variegated colours is thus formed in large masses around the channel of the stream, which when polished is almost equal in beauty to jasper.

Of the hot springs of this neighbourhood, the principal is called the *Sprudel*. It boils up with great violence, and discharges about 352 cubic feet of water hourly, through a curious natural vault or incrustation which it has gradually formed. This water supplies the greater number of the baths. The other springs are in general of much lower temperature: they do not exceed from 114° to 125°, and they differ somewhat from each other in their chemical properties. They all contain a large portion of carbonic acid gas, and this is given out in such quantity by the water, that it fills several caverns in the rocks adjoining to the springs, rendering them fatal to all animals which incautiously enter them.

The waters of Carlsbad are used for the removal of a great variety of disorders, but particularly such as are connected with indigestion. They are likewise used in obstructions of the bowels and diseases of the kidneys. About five pints, divided into fourteen portions, are on an average drunk by each individual every day.

The Sprudel spring is better than that of any mineral waters which are employed medicinally. It requires to be considerably cooled before it can either be used as a bath or drunk. Its heat is such that it is occasionally employed in place of water artificially heated, for several domestic purposes, such as the scalding of fowls and hogs, the feathers and hair of which it immediately loosens.

According to Berthollet, 13,000 tons of carbonate of soda (201), and 20,000 of the sulphate (Glauber's salt) are annually discharged from the orifices of these springs. He also states that the Donnersberg, a mountain of clinkstone of about 2,500 feet in height, the loftiest of the Bohemian Mittelgebirge, alone contains sufficient soda to supply the Carlsbad waters for more than 30,000 years.

6. SIMPLE SALINE WATERS.

289. *SEIDLITZ WATER is very salt and bitter. It contains a small portion of carbonate, and some sulphate of lime* (192), *carbonate of magnesia, muriate of magnesia, and a very great proportion of Epsom salt* (199), *to which its bitter taste and medicinal virtues are principally attributed.*

The spring for which the village of Seidlitz, in Bohemia, has long been celebrated, was for many years wholly neglected by the inhabitants, on account of the bitter and nauseous taste of its water, which rendered it unfit for nearly all domestic purposes. Its virtues as a medicine were first brought into notice about the year 1721, by Hoffman, the celebrated Prussian physician.

The *Seidlitz powders* of the shops are composed of two drams of tartarized soda, two scruples of the bicarbonate of soda, and thirty grains of powdered tartaric acid; they cannot therefore be considered analogous to the natural water from which they take their name.

290. *EPSOM WATER is saline, and partakes in some degree of the nature and qualities of Seidlitz water, but it is by no means so powerful. It is transparent and colourless; and when first taken into the mouth has scarcely any taste, but it leaves a decidedly bitter and saltish taste on the palate.*

This water contains sulphate of magnesia, or Epsom salt (199), *selenite, and a small portion of carbonate of lime.*

Although the Epsom waters, on account of their deficiency of strength, are now scarcely ever employed in medicine, yet they were among the first saline cathartic springs which were brought into use in this country. The salt to which they owe their property, and which is known throughout Europe by the name of Epsom Salt, was for many years prepared almost exclusively from them and from Seidlitz water. But the quantity which they supplied was found so very inadequate to the increasing demands for this salt in medicine, that Epsom Salt has, for some time past, been obtained from the *mother water* left on the crystallization of common salt from sea water (199).

Epsom water, if closely corked, may be kept for several months without injury; but otherwise it soon becomes putrid. The spring from which it issues is situated about half a mile from the town of Epsom, in Surrey, sixteen miles south of London.

There are in the neighbourhood of London many springs of similar quality to this of Epsom: of these the principal are at Streatham, Beulah Spa (Norwood), Acton, Kilburne, Bagnigge Wells, and formerly the Dog and Duck in St. George's Fields; but they are in general so weak as to render very large quantities of the water necessary to produce any sufficient medical effect.

7. HIGHLY CARBONATED ALKALINE WATER.

291. *SELTZER WATER is a highly carbonated alkaline water. When fresh, or well preserved, it is perfectly clear, and sparkles much when poured into a glass. It is somewhat pungent, slightly saline, and a little alkaline to the taste.*

It contains the carbonates of magnesia, of lime, and of soda (201), *and common salt; and more carbonic acid gas* (26) *than any water hitherto known. It is hard, and curdles soap.*

The spring which supplies this water is situated in Nieder Seltzer, a village in a fine woody country, within the bishopric of Treves; and there are few mineral springs which have acquired so much celebrity for medical virtues as this. The diseases for the removal of which it has been successfully applied are too numerous to be here particularized.

To the taste it is very agreeable, and when drunk in moderate quantity it exhilarates the spirits, increases the appetite, and produces no particular determination to the bowels. It is to the strong impregnation with carbonic acid, and the small proportion of soda which it contains, that its most important benefits are owing.

If it be closely corked and sealed, Seltzer water may be kept without injury, or even alteration, for a very considerable time; but if exposed to the air it soon becomes fetid. It is used as a common drink at table in many parts of Germany and Holland, and is even brought into England in stone bottles, each containing about three pints. A large quantity of Seltzer water, either genuine or artificial, is consumed in this country.

8. CHALYBEATE WATERS

292. Are such as contain a portion of iron. This is easily detected by the property which it has of striking a black colour with tincture of nutgalls.

293. *TUNBRIDGE WATER is a carbonated chalybeate, the small portion of iron which it contains being held in solution by carbonic acid* (26). *It is, however, neither brisk nor acidulous. To the taste it is simply chalybeate; and that only in a slight degree.*

Its saline contents are oxide of iron (21), *a small portion of common salt, the muriates of magnesia and lime, and sulphate and carbonate of lime* (192), *carbonic acid gas* (26), *and other gases, but these only in small quantity.*

Tunbridge Wells is a populous village, situated in a sandy but romantic valley in the county of Kent, about five miles from the town of Tunbridge, and thirty-six miles south of London. There are at this place many chalybeate springs, all of which nearly resemble each other in their chemical properties. Two of them, however, are chiefly used, each of which yields about a gallon of water in a minute.

When first taken from the stone basin into which it flows, the water is perfectly clear and bright, and exhales no particular smell. It does not sparkle in the glass, but a few bubbles slowly separate, and adhere to the sides of the vessel. When it has stood for some hours exposed to the air, it becomes turbid, and otherwise undergoes a very material change. As it does not properly curdle soap, it may be denominated a soft water.

The original discovery of this water, as to its medical properties, is usually considered to have been in the reign of James the First. The season for drinking it commences as early as March or April, and continues till November.

294. *SPA WATER, the celebrity of which has given a general appellation to most other mineral springs, is a highly carbonated*

chalybeate water, which contains a great proportion of carbonic acid (26). *It has an agreeable acidulous taste, mixed with a strong impression of chalybeate, which remains on the palate for a considerable time after it has been drunk.*

It contains oxide of iron (21), *the carbonates of magnesia, of lime, and of soda* (201), *and common salt, together with about forty-five parts in a hundred of carbonic acid gas* (26); *and is sufficiently soft to mix both with milk and soap without curdling.*

Spa is a small but celebrated town in the Netherlands. It is situated on the little river Weze, about twenty miles south-east of Liege, and seven miles south-west of Linsburg; and is surrounded by rude and uncultivated mountains, many of which are covered with wood, and others with heath or morasses. In its neighbourhood there are no fewer than sixteen mineral springs, five of which are more celebrated than the others. The most copious and the most frequented of the whole is the *Pouhon spring*, in the market-place of Spa. This is a large, slow, and deep spring, the descent to which is by several steps. In cold dry weather the water, when first taken up, appears colourless and perfectly transparent: it scarcely sparkles, but it soon covers the inside of the glass with small air-bubbles, which it also emits very copiously when shaken. During moist weather the surface of the well appears somewhat turbid; and on the approach of rain a whistling or humming noise is heard, which is called by the country people the music of the spring.

If this water be bottled, and then set in a warm place, it will generally force out the cork with a loud explosive noise. In preserving it for exportation it is consequently necessary to wire the corks firmly down. In this state, if well cemented, it may be kept perfectly good for more than two years.

It is somewhat remarkable, respecting this water, that if it be taken in a full draught, particularly in hot weather, or upon an empty stomach, it produces a swimming in the head, and a degree of intoxication, which frequently continues for half an hour or upwards, and is very similar to that which arises from the drinking of spirituous liquor, but it does not leave the same debility.

295. *PYRMONT WATER is a highly carbonated chalybeate. When recently taken from the spring, it is clear and pellucid,*

and sends forth a copious stream of bubbles for a considerable time. In this respect it far exceeds any of the mineral waters with which we are acquainted. Its taste is pleasant, being strongly acidulated, and having a pungency not unlike that of brisk Champagne wine; but it is at the same time strongly chalybeate, and a little bitterish.

It chiefly contains oxide of iron (21), *the carbonates of lime and magnesia, Epsom salt* (199), *sulphate of lime* (193), *and common salt, and a great proportion of carbonic acid. It is very hard.*

Pyrmont is a town of Westphalia, and about thirty-eight miles south-west of Hanover. It is the capital of a county, has a strong fort, and is well known on account of its mineral springs.

The water which issues from these springs constantly emits so large a quantity of carbonic acid gas, as to have a sensible pungency of smell to those who stand around, and even to make the water-servers giddy. It forms an atmosphere over the surface of the well which proves fatal to small birds, and ducks that attempt to swim across. The gas contained in the water is estimated to be nearly equal in bulk to the water. It is owing to this that Pyrmont water, if bottled and well corked, and afterwards removed into a warm place, will frequently burst the bottles.

When drawn fresh from the spring, and drunk copiously, it produces a temporary kind of intoxication. It also enlivens the spirits and increases the appetite. This water is sent in bottles, by the Weser, to Bremen, whence it is exported to various parts of the world.

296. *CHELTENHAM WATER is a saline, carbonated chalybeate, which has a slight sulphureous smell, and a brackish, somewhat bitter, and chalybeate taste, but no briskness nor pungency. It contains also a small proportion of iodine.*

Its saline contents are Glauber's salts (293), *carbonate of soda, Epsom salt, sulphate of lime, common salt, and oxide of iron, together with carbonic acid, and a trace of iodine and bromine.*

The original discovery of the mineral spring at Cheltenham was about the year 1716. The water of this spring issues slowly, and in a scanty stream of not more than thirty-five pints in an hour, from a bed of sand intermixed with blue clay. The well is sunk to the depth of six feet, and is excluded from communication with the external air. This spring is denominated the *Old Spa.*

In the year 1788, on digging a well for a private house, another spring was accidentally discovered, which is of nearly the same nature as the other, and produces a much more abundant supply of water. It is about a hundred yards distant from it, is upwards of forty feet deep, and is drawn by a pump.

When Cheltenham water is fresh drawn, it appears tolerably clear, though not perfectly transparent. After standing some time, it becomes more turbid, and air-bubbles, in small quantity, rise from it. It contains more salt than most other waters, except those of the sea and some brine springs; and by far the greatest part of the salts are of a purgative kind. The water is also a very strong chalybeate, and has a slight impregnation of sulphur. It is to Mr. John Thomas Cooper the public are indebted for the discovery of iodine and bromine in this water, though in very small quantity, and on which its remedial effects in many diseases chiefly depend.

This water cannot long be kept, nor can it be transported to any distance without being materially altered. In order, however, to reduce its valuable parts to a more convenient form, for carriage and keeping, the salts are extracted from it on the spot, by evaporation, and crystallizing the residuum. These salts are much used, in addition to the fresh water, for the purpose of increasing its operation on the bowels.

Cheltenham is a flourishing town in the county of Gloucester. It is about ninety-five miles north-west of London, situated in a sandy vale, surrounded with hills of a moderate height, and in the midst of a fertile and well cultivated country.

Leamington water has similar properties to that of Cheltenham; indeed its saline contents are even in greater quantity than that of Cheltenham.

297. *BRIGHTON CHALYBEATE WATER, when fresh, has a peculiar and faint smell not uncommon in ferruginous waters, and a strong though not unpleasant chalybeate taste.*

It contains oxide of iron, sulphate of lime (182), *common salt, muriate of magnesia, siliceous earth, and a certain portion of carbonic acid gas* (26).

Brighton is a well-known town, situated on the coast of Sussex, and about fifty-four miles south of London. The chalybeate spring is at Wick, on the declivity of a small eminence nearly a mile west of the town, and a quarter of a mile from the sea. A small but neat building has been erected immediately over the spot from which the water issues, and where it is received, a few feet under ground, into a basin of Portland stone. This reservoir contains only a few gallons of water, but it fills again almost as soon as it is emptied.

The water is so hard as instantly to curdle soap. It is considered useful in cases of debility, indigestion, and such diseases for which chalybeate and tonic remedies are required. The sea-bathing at Brighton is, in many cases, an additional and important advantage to those persons who use the chalybeate water.

The recent establishment of a German spa at Brighton, where all the important mineral waters of the continent are chemically manufactured, has been a source of fresh attraction to this fashionable watering place.

9. COLD SULPHUREOUS WATERS.

(Containing sulphuretted hydrogen gas.)

298. HEPATIC, or SULPHUREOUS WATERS, are so strongly impregnated with sulphur, united either to hydrogen (45), or to an alkali, or both, as thereby to acquire a very sensible smell or taste. They have the property of blacking silver and lead; and are immediately known by the smell, which is very fetid, and like that which arises from the scouring of a foul gun-barrel, or as some persons suppose, like the smell of rotten eggs.

The taste of these waters is peculiar, and rather sweetish. They constitute a drink which, at first, is very unpalatable, but which, by habit, is soon reconciled to the drinker. None of them will bear carriage to any distance.

The whole of the sulphureous waters of Britain are cold; some on the Continent are warm.

299. *HARROWGATE WATER is a cold sulphureous water, which has a very strong and fetid smell, like that of a damp rusty gun-barrel. To the taste it is bitter, nauseous, and strongly saline.*

Its saline contents are common salt, the muriates of lime and magnesia, the carbonates of lime and magnesia, Epsom salt (199), *carbonic acid* (26), *nitrogen, and sulphuretted hydrogen gas.*

There are at Harrowgate four distinct sulphureous springs, which appear to have their rise in a large bog, at a small distance from the wells. The water of all these springs is similar in its properties and its distinguishing characters, but as one of them is more strongly impregnated with sulphur than the others, this alone is used for drinking, whilst the other three are employed to supply the baths.

When the water of the former of these springs is first taken up, it is perfectly clear and transparent; and sends forth a few air-bubbles. Notwithstanding both its nauseous smell and taste, such is the power of habit in reconciling it to the palate, that, after a little while, nearly all persons who drink this water do it without disgust.

When exposed to the air it loses its transparency, and assumes a somewhat greenish colour: the sulphureous odour abates; and at last, the sulphur is deposited on the bottom and sides of the vessel in which it is kept.

Such is the nature of Harrowgate water, that a secret correspondence has often been carried on by means of it. A letter written with a solution of sugar of lead is illegible; but if dipped into this water the writing will not merely become visible, but in a short time will appear almost black. Sulphuretted hydrogen has the property of reviving the metallic oxides: hence also it is that ladies who have used metallic cosmetics have become of a dark tawny colour by bathing in these waters.

Harrowgate has long been celebrated for its sulphureous waters. It has also two very valuable chalybeate springs, called the *Old Spa*, and the *Tewit Well*, the water of which was formerly used internally, whilst the other water was confined to external use. But at present, the latter is employed to a very great extent as an internal medicine.

The two villages of High and Low Harrowgate are situated in a pleasant open country, in the centre of the county of York, near the town of Knaresborough, and about 212 miles north of London.

300. ***MOFFAT WATER is a cold sulphureous water, the smell of which is precisely similar to that of Harrowgate water, and the taste simply saline, and without any bitterness.***

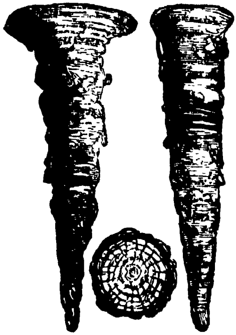
Its saline contents are common salt, together with carbonic acid gas, nitrogen, and sulphuretted hydrogen gas. It is consequently very simple in its composition.

Moffat is a village situated at the head of a valley, on the banks of the river Annan, and about fifty-six miles south west of Edinburgh. It is surrounded by hills, some of which are very lofty. This village has obtained so much celebrity on account of its waters, as to be considered the Harrowgate of North Britain. These issue from a rock which is at a little distance below a bog, whence, probably, they derive their sulphureous ingredients. The principal spring is contained within a stone building, and affords a sufficient quantity of water to supply every demand. It is drawn by a pump.

When the water is first taken from the well it appears somewhat milky and bluish. It sparkles a little; but on being exposed to the air it becomes turbid, and throws up a thin film, which, on examination, will be found pure sulphur. This change takes place even in close vessels, so that it cannot be sent to any distance with advantage.

The common people so much esteem this water, that it is said many of them drink at the rate of from six to ten quarts of it in a morning, and one instance has been stated of a person drinking thirty-two quarts of it in eight hours.

A similar spring is also in existence at Rothsay.



Stalactites.

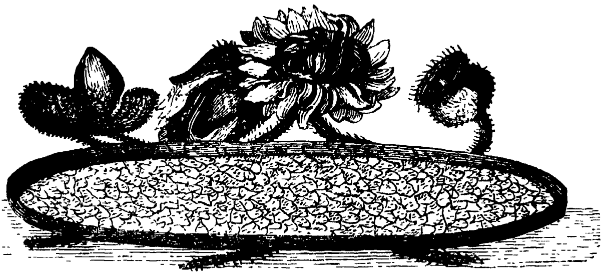
(See p. 119.)

VEGETABLES.

PART II.

VEGETABLE KINGDOM.

MOST IMPORTANT PLANTS USED AS FOOD, &c.



The VICTORIA REGINA; or, Great Flower of British Guiana.

Discovered by R. H. Schomburgh, Esq., on the river Berbice, January 1, 1837.

(Length of leaf 6 ft ; the flower 21 inches across.)

INTRODUCTION.

The RAFFLESIA ARNOLDII; or, Great Flower of Sumatra.
(Size 3 feet across.)

THE STRUCTURE AND FUNCTIONS

OF

PLANTS.

OUTLINE

OF THE

STRUCTURE AND FUNCTIONS

OF

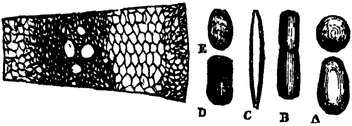
PLANTS.

301. VEGETABLES, or PLANTS, are natural bodies endowed with organization and life, but destitute of voluntary motion and sense. BOTANY is that branch of natural science which treats of their structure and functions, the systematical arrangement and denomination of their several kinds, and their peculiar properties and uses.

302. Vegetables, like other organic beings, are made up of certain ELEMENTARY parts or organs; these are for the most part *membrane* and *fibre;* the combination of these forming, 1. *Cellular tissue;* 2. *Woody fibre;* 3. *Spiral vessels;* to which some add, 4. *Ducts;* but the latter are more properly considered varieties of the Spiral vessel.

303. If the pith of Elder, or any other plant, the leaf, the flower, or the fruit, are macerated in water for a sufficient length of time, the degree of aggregation or cohesion between their particles becomes destroyed, and the vegetable fabric is resolved into its organic elementary parts. The most universal of which is the *Cellular tissue*, Fig. 22; and this is made up of cells or globules of membrane (A B C), or membrane and sometimes fibre intermixed (E D), which adhere more or less together (B), and produce

Fig. 22.

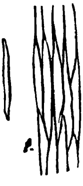


Cellular tissue.

a net-work of tissue (F), the form of the cells of which depends on the degree of compression or force which is exerted to keep them in contact. It is a point worthy of remembrance, that although to all appearance the wall which divides two contiguous cells from each other is *single*, yet it is in reality *double*, a necessary consequence of the juxtaposition of two or more cells; occasionally the neighbouring cells are not in direct contact with each other; *spaces* then exist between the walls; such spaces have received the name of *intercellular passages*, these are deserving of attention, and will be again alluded to. Further, cellular tissue is by far the most universally distributed elementary structure, as it is also the *most simple* in its nature; no plant has yet been found in which its absence could be detected, although the other remaining forms above noticed are sometimes altogether absent.

304. It is a general rule in physiology, that the more simple the tissue, the more simple are the properties of the secretions yielded by that tissue; bearing this general fact in mind, it is necessary to state, that there exist many families of plants composed almost exclusively of it, such as the mosses, lichens, sea-weeds, and the like, which are abundantly used in various parts of the world, either as food for man, or fodder for cattle. Such plants are termed *cellular*, and do not produce flowers or sexes; they are therefore termed Asexual or Flowerless Plants; their increase is effected by means of *spores* or *sporules*, developed in little cases called *thecæ*, germination taking place from any point of the spores, and not from a single point, the *embryo*, as in the Vascular or Flowering Plants.

Fig. 23.



Woody fibre.

305. *Woody fibre* is the next elementary tissue, to observe which, unstrand a piece of string, and place a single fibre beneath the microscope, when it will be found that the apparently simple filament is composed of one or more elongated tubes, tapering to each end (fusiform or spindle-shaped), the ends of which, more or less, overlap each other as at Fig. 23: by maceration, however, they may be separated into single fibres, when it will be seen under high power that they are formed of membrane, which is entire, and *not* perforated with *visible* pores. Woody fibre is developed from the sap of plants

(cambium), and mostly in the vertical direction, the cleavage of wood indicating the direction of its growth. It is one of the most important structures in vegetables, for within it the sap rises, and in its interior the proper juices are deposited; it gives support and strength to the plant, and serves very nearly the same function to it, that the bones do in the animal frame. It is familiar to the world in the articles flax, hemp, New Zealand flax, fibre of the fruit of the cocoa-nut, and a variety of other forms, and is, as it were, peculiar to VASCULAR, or Flowering Plants.

306. *Spiral vessels* are usually found intermixed with woody fibre, in the stems, leaves, roots, and other organs of plants; they are the most beautiful of all the elementary organs, and are composed of tubes of membrane tapering to each end, and around the *interior* of which, one, two, three or more delicate fibres are coiled in a very regular and beautiful manner (Fig. 24). Although these organs are usually present with the woody fibre, yet they are by no means so numerous, particular parts of the vegetable yielding them in considerable abundance, such as the tube which surrounds the pith (medullary tube), and in the rays emanating from that tube (medullary rays) towards the circumference of the stem; in the footstalks and veins of the leaves they may also be observed, which are, in fact, prolongations of the medullary rays; they have also been seen in the root, and the various parts of the flower, and in many cases where woody fibre is altogether absent. They may be seen in the footstalk of the leaf of the rose, strawberry, &c. in great abundance; also in the Agapanthus, Amaryllis, Hyacinth, and such-like plants, where, by the gentle tearing of the leaf across, at the same time exerting a little extension, they may be unrolled to some considerable length; but in this case the outer membrane becomes ruptured, and the spiral thread alone uncoils; to view them in their natural position, a thin slice of a piece of boiled Asparagus answers the purpose better than any other plant[1]. Botanists are

Fig. 24.

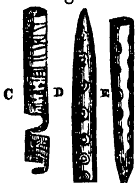
Spiral vessels.

[1] In the microscopical examination of vegetable and animal structures, it is requisite to add a few drops of clear water to the specimen, placed between two pieces of glass; this renders

not yet agreed as to the precise functions which the spiral vessels perform in the economy of the vegetable. Some affirm that they convey air at one period of the growth of the plant, containing from seven to eight per cent. more oxygen, or vital air, than is contained in the atmosphere, while at other times they convey fluids. They are like the woody fibre considered to be peculiar to VASCULAR or Flowering Plants; although spiral vessels have, in a few instances only, been observed in CELLULAR or Flowerless Plants.

307. *Ducts* are by most botanists considered as modified spiral vessels. They are composed of membranous tubes variously marked internally, either *reticulated* (Fig. 25, c), *dotted*, *annular*, &c. In some instances, as in the Fir tribe (Coniferæ), they are characteristic of the whole of the members of that family, in the form of vessels having round markings upon them (D E), as to the precise nature and structure of which much discussion has of late taken place, some physiologists contending that the *dots* are elevations, others that they are depressions, &c. Like the other forms of vascular tissue, viz. woody fibre and spiral vessels, they are considered peculiar to the VASCULAR or Flowering Plants.

Fig. 25.



Ducts.

Having now given a brief outline of the structure of the elementary tissues of plants, it is necessary to describe the various combinations of them which occur, forming what are termed the *Compound organs*.

308. *Of the Compound Organs.*—These comprise the *cuticle* or skin, and its appendages, viz. *stomata* or breathing pores, *hairs* both lymphatic and secreting, *glands*, *scurf*, *prickles*, &c. After these have been alluded to, the structure of the *root*, the *stem*, the *leaves*, *flowers*, and their *various* appendages and modifications, will be briefly described, and a general and popular outline of the Science of Botany will thus be given. Points of importance connected with the Physiology of Plants will be mentioned under each head, and a few remarks on System will conclude the Introductory matter.

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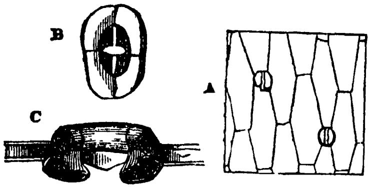
the objects much more transparent and beautiful than they would otherwise be.

309. *Cuticle or Skin.*—The vegetable, like the animal, is clothed with a cuticle or skin, the structure of which is cellular and homogeneous in its nature (Fig. 26. A). This membrane covers all parts of the plant but *two*, viz. the extreme points of the roots (spongeoles), and the uppermost parts of the central organ of the flower (stigma), a fact which is necessary to bear in mind, as it will be hereafter seen, that neither *absorption* of fluids from the earth, nor *fertilization* of the flower, could be in a measure accomplished, were these parts clothed with a membrane or skin. By the aid of a penknife, or by macerating leaves in water for a short time, the cuticle may be peeled off; this when placed under the microscope, exhibits different appearances, according to the plants under examination.

Fig. 26.



Cuticle and Stomata.

310. The oval and other shaped organs seen upon the cuticle, (Fig. 26. A.), and particularly on the under surface of leaves, are openings which have received the name of *stomata*, or breathing pores (Fig. 26. B. C.) They are more abundant in some plants than in others, and are only developed in those parts freely exposed to the air and light; they are consequently absent on the root, and in those which grow in the dark and submersed in water. In many plants they are so imperfectly formed, that their uses may be considered very restricted, or of little or no importance whatever. The *stomata* are openings into the green substance or *parenchyma* of the leaf, and other parts of that colour, such as young shoots or twigs; their situation is between two or more contiguous cells of the cuticle (A). They are mostly formed of two semilunar shaped bodies, (B.) joined together at their extremities, and making in those of an oval shape an oval ring, which expands or contracts (B.) according to the degree of dryness or moisture in the surrounding air; this ring (which is supposed to be the extremity of a spiral vessel by some) opens into a cavity in the green matter beneath, where the respiration and exhalation of the plant are in a great measure effected.

In illustration of the variable number of these organs on one square inch of surface in different plants, a few examples will here suffice; thus on the

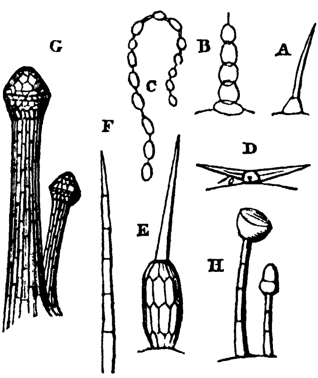
	Upper side.	Under side.
Hydrangea Quercifolia	None	160.000
Holly	———	63.600
Rumex Acetosa (Sorrel)	11.088	20.000
Crinum amabile	20.000	20.000
Mesembryanthemum	30.000	60.000
Coltsfoot	12.000	12.500

311. Seated upon the cuticle are delicate little *hairs*, assuming a variety of forms, according to the particular functions they are destined to perform. The division of the most practical importance is into *lymphatic* and *secreting hairs*.

The structure of hairs is replete with interest, each kind, especially the *secreting*, offers points in the economy of the vegetable on which they are found, of the most important character when physiologically considered.

The *lymphatic hairs* are formed of cells of cellular tissue placed end to end, and assuming a diversity of forms, as seen

Fig. 27.



Lymphatic and secreting hairs[1].

(Fig. 27. A. B. C. D. F.); their uses are supposed to be that of regulating exhalation and moisture; they are therefore more abundant on the under side of leaves (where the stomata mostly abound) than on the upper. The *secreting* are either of use for protecting the surface on which they grow, or for secreting and diffusing the many odours which belong or are peculiar to the green parts of many vegetables. The sting of the nettle (E.) affords a good example of the former kind; the hairs of this plant, when examined by a pocket lens, or microscope, will be found to have at their base a receptacle formed of many cells, which

[1] A. represents an ordinary lymphatic hair; B. that of Salvinia; C. that of Spiderwort; D. that of the Indigo, in which they lie parallel with the surface, and are fixed by the middle; F. is that of Xanthium Spinosum.

secrete an acrid juice; from the upper part of this reservoir proceeds a very fine and delicate membranous tube, perforated at its extremity: as soon as the hand touches the nettle, the sharp extremity of the tube enters a pore of the skin; and as soon as this pressure has been sufficiently exerted to cause the tube to be pressed upon the reservoir, the consequence is, that a small portion of the acrid juice is forced up the tube and enters a pore of the skin, producing the familar sensation called "stinging." Another of the many kinds of this division occurs in the sweet-briar, a representation of which is shown at G. In this example the volatile resinous principle is secreted at the top of the hairs with which the plant is covered. In fine weather, when the plant is in full vigour, the warmth of the air causes this volatile principle to be diffused, this mixing with the surrounding atmosphere, produces that fragrance so much admired, and which is a characteristic of the plant. H. represents the cup-shaped hairs of *Juglans regia*, in which the odoriferous particles are secreted.

312. *Glands* are also met with on the cuticle, and are of various kinds; when they secrete a principle, it is mostly of a resinous volatile nature.

313. *Lenticular glands*, or *lenticels*, are small oval or elongated raised glands, as in the willow, from which new roots spring when the portion of the stem on which they are developed, is so placed as to favour their development. The process of propagating vegetables by slips or layers, is in many instances altogether dependent on their presence and growth. Of all the British trees, the willow affords the best example of this mode of increase. The Banyan, or *Indian Fig-tree*, is another illustration; in this the *fulcra* or *props*, which descend to the earth and take root, arise from the lenticels.

Fig. 28.

The Banyan Tree.

314. Having now briefly considered the most important structures and organs connected with the frame-work of the *external* and *internal organs of a plant, it now remains to* describe the various organs made up of the structures above named. These are of two kinds. The NUTRITIVE or CONSERVATIVE organs, including the ROOT, STEM, LEAVES, and their appendages; and the FERTILIZING or REPRODUCTIVE organs, including the FLOWER, the FRUIT, and the SEED, with all their collateral parts.

The organs which absorb and elaborate the juices are the ROOT, the STEM, and the LEAVES.

315. It is the office of the *root* to fix the plant in the earth, and to absorb from the earth in part, the nourishment for its support. This absorption of fluid is chiefly accomplished by the extremities of the small *fibrils*, which are nothing more than the last or newest formed points, although they are by some considered as especial organs, and to which the names of *spongeoles* or *spongelets* have been given. When treating of cuticle (309.) it was stated that the spongeole was not covered with this membrane, obviously for the reason that absorption would be retarded, were they so invested.

316. Many theories have from time to time been brought forward, to endeavour to explain the mode in which the sap rises in plants; but that which has received the greatest attention of late years, and is decidedly the most scientific and capable of explanation on physiological principles, is the theory which M. Dutrochet described under the terms *Endosmose* and *Exosmose;* it runs simply thus;—when two fluids of unequal degrees of density are separated from each other by means of a membrane, either of animal or vegetable composition, the *denser* fluid has the property of attracting or drawing in the *less dense* fluid through the membrane; this constitutes his Endosmose; at the same time it is found that an interchange of the two fluids likewise takes place in the opposite direction, constituting *Exosmose*.

The application of this principle may at once be seen, when it is considered that the fluid secreted within the cells, &c. of plants, is composed of water holding in solution a variable proportion of *gum*, *starch*, or *sugar*; and consequently when pure water is presented exterior to the cells constituting the *spongeole* or absorbing organ, by virtue of *Endosmose* the *denser* fluid within the cells will draw the *less* dense through the wall or membrane of the cells, and thus the circulation will in a measure be carried on from cell to cell throughout the entire plant, at least until the two fluids become of the same specific gravity.

In order to witness the effects above described, the following simple experiment may be performed;—into a phial, the lower end of which having been previously ground off and tightly covered with fine bladder or membrane, put some syrup: place this in a vessel of clean water, and allow it to remain for a few hours, taking the precaution to observe the height of the syrup on the side of the phial. In the course of a few hours the phial will become filled, and the pure water which was in the basin, will be absorbed by virtue of the peculiar affinity existing (*Endosmose*), while it will at the same time be evident to the taste, that a portion of the syrup will have found its way into the pure water in the vessel (*Exosmose*). This action is found to take place, under certain circumstances, with a force equivalent to the pressure of *three* atmospheres.

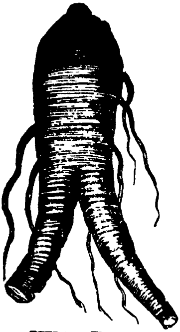
Fig. 29.

Common Ginger.

317. But to return to the root, several kinds are met with, and various names have been given to distinguish the different forms. Many of what former botanists called roots, have received the names of subterranean or underground stems, such are the *rootstock* as in the ginger, (Fig. 29.), the *rootstock* of the Iris or Orris, the *tubers* of the Potatoe, the *cormus* of the Crocus, the *bulb* of the Onion, Hyacinth, &c., the *true* roots of these plants being the fibres which proceed from the lower surface of each, as for example in the ginger (Fig. 29).

318. Under the head of *true* roots, are classed the *fibrous*, as in grasses; the *bitten* or *præmorse*, as in the primrose; the *tap*, as in the carrot; the bifurcated tap, as in the white bryony (Fig. 30.); the *solid bulb*, as in the turnip, with many others.

Fig. 30.



White Bryony.

319. The root, finally, being in many instances the reservoir of nourishment to the vegetable, in it are usually elaborated properties, either nutritious or deleterious, which are made use of at the period of development of the flower stem and the fruit; and become absorbed to carry on those functions requisite for the perfection and continuation of the species.

320. While it is the almost invariable tendency of the root to descend into the earth, avoiding air and light, the *stem*, on the contrary, takes the very opposite direction, and ascends into the air, and by its subdivisions or *branches* exposes the organs it bears, the *leaves*, to the full influence of those powerful agents. The point of separation between the root and stem is termed the *collum* or neck.

321. Stems are of several kinds. The principal division is into *true* and *false*. True stems are by far the most common, and include those of forest trees, &c. False stems are such as do not spring directly from the top of the root, but from the interior of sheathing leaves, as in the hyacinth, when it is called a *scape;* when they spring, as in the common plantain of the fields, from the axilla of leaves which arise directly from the root, they are called *radical peduncles.*

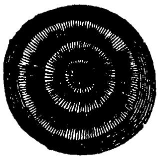
The mode of growth of stems affords excellent characters, on which modern botanists have founded a classification, viz. into Exogens, or *Outgrowing;* Endogens, or *Ingrowing;* and Acrogens, those which *grow at the tip*. To distinguish the peculiarities of each, is a matter very soon acquired, and to which a few lines will now be devoted.

322. Exogens, or *Outgrowing* stems, are so named in consequence of the newly-deposited wood being always

situated *exterior*, or *without* that which was last formed. These trees consequently increase in diameter yearly, and the newer or most external or circumferential deposit is the softer, and is the *alburnum*, white or false wood, while that wood which occupies the interior of the stem is harder in its nature, and on this account has received the name of *duramen*, or heart wood. It is in the latter kind that the juices are deposited, and is always the part used, as the Guiacum, &c. when its virtues are required by the dyer, physician, and artisan. The alburnum is mostly rejected, as being unfit for purposes to which such woods are usually applied.

If a transverse section of the oak, the beech, elm, or any other British tree, for example, be carefully examined, it will be seen that there is a number of concentric zones or circles distinct from each other, as in Fig. 31. These zones are annual growths, the line of demarcation being caused by the periodical check to vegetation which occurs in the winter and colder months of the year, after the leaves have fallen, and vitality is, as it were, dormant until the return of spring. But if such a stem be more particularly examined, no fewer than *ten* different layers or parts can be counted. Thus assuming the *pith* as the botanical centre of the stem (although not always the mathematical centre), and the cuticle covering the bark as the outermost structure met with, the intervening ones would, proceeding in that direction, be as follows :—

Fig. 31.



Section of an outgrowing Stem.

1. *Pith* or medulla, the botanical centre of the stem; mostly composed of cellular tissue.

2. *Medullary sheath* enclosing the pith; mostly composed of vascular tissue.

3. *Medullary rays* emanating from the sheath; mostly composed of vascular tissue.

4. *Duramen* or Heart-wood; the most durable, and in which the juices are deposited.

5. *Alburnum* or False-wood; usually of a white colour. This in time becomes converted into Heart-wood.

6. The *Liber*, a laminar structure, well seen in the Lace-bark tree of Jamaica.

7. The *Cortical layers;* also capable of being separated into plates, as the *bass* or *matting* of the gardens, which is obtained from the cortical layers of the lime-tree by maceration. This structure and the liber are usually so mixed together as to render, at times, their separation difficult.

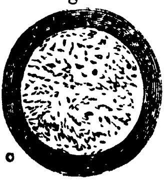
8. The *Herbaceous integument.*—This is the structure which is mostly of a green colour, and shines through the investing membrane, giving in annual stems their green hue. When it becomes very much altered in its physical properties, it is known as *cork.* It cracks when distended beyond its natural limits, and produces the fissures on trees, as the oak, elm, &c. In the birch, &c. it peels off in thin plates.

9. The *Cuticle* or skin, is the most external of all. For its structure and peculiarities see p. 289.

It must not be expected that all the above layers may be seen in any outgrowing stem; it becomes requisite to seek for such plants in which the one is developed to a greater extent than the other, to distinguish and define their limits. Thus the oak would not be selected in the place of the elder to exhibit the pith, although in its sapling state it would have been equally manifest.

Within the stem the sap rises, and within the stem it is deposited after it has been exposed to air and light, and elaborated by passing through the leaves. It rises in the alburnum or young wood, is deposited within the bark, and is horizontally diffused by the medullary rays.

Fig. 32.



Section of an Ingrowing Stem.

323. Endogens, or *ingrowing* stems, are so named from the circumstance of the newest-formed fibres of the wood being deposited *interior* or *within* those last formed. As soon as these plants acquire their proper diameter, they never increase in thickness, although the stems become more solid. Unlike the outgrowing stems, the vascular and cellular structures are here thrown together in a confused kind of mass, as seen in the representation of a

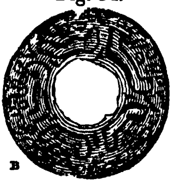
Fig. 33.

Sugar-cane.

section of a Palm, Fig. 32. In such stems the softer parts are in the centre, and the harder parts at the circumference, the opposite to what happens in outgrowing trees. A peculiarity worthy of notice here connected with Endogenous plants is, that the leaves never fall off, but die down to the stem and leave a *scar*, as in the Sugar-cane, Fig. 33, Palms, and the like. The trees belonging to this division are chiefly confined to the tropics, such as the palms, &c.

324. ACROGENS, or those stems which grow from a *point* or *tip*, include the Ferns and lower tribes generally. The *contorted* structure, peculiar to plants of this division, may be seen in sections of arborescent ferns, natives of the hotter parts of the world. Fig. 34 will convey an idea of its appearance. It may also be seen on cutting in a slanting direction the base of the stem of the common Brake Fern of the heaths and commons, when the well-known representation of the "*oak tree*" may be recognised, and will serve in illustration of this structure.

Fig. 34.



Section of an Acrogenous Stem.

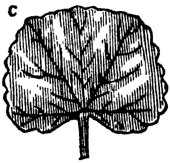
325. A *leaf* is composed of two parts, the *petiole* or foot-stalk, when present, and the *lamina* or limb. When the petiole is absent the leaf is *sessile*. The petiole is formed by a prolongation of the medullary rays or vascular tissue of the stem, and performs the office of conveying from the stem sap for elaboration. Its continuation through the limb of the leaf to the apex, constitutes the *midrib*, and its subdivisions the *veins*. In most leaves there are two distinct sets of veins, an upper and an under set, the former for conveying the sap to the surface to be exposed to air and light, and the latter to return it back into the stem after its due elaboration. The leaves are the principal respiratory

organs of plants, in them the carbonic acid gas (26) *of the* atmosphere, under the influence of light, is decomposed; the *carbon* deposited to augment its structure and substance, and the *oxygen* returned for the support of animal life. The reverse of this takes place to a moderate extent in the dark. The organs chiefly employed in this function are the stomata (310). Leaves owe their colour to the colouring matter or *chlorophylle*, secreted in the green or parenchymatous substance situated between the two layers of transparent cuticle (309).

326. Like the stem, leaves afford characters by which the three great divisions of the Vegetable Kingdom may, with a few exceptions, be recognised; thus:—

Fig. 35.

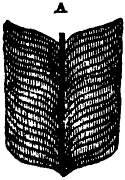
C



I. *Exogens* are recognized by their *reticulated* or *veined* leaves, which, when held against the light, have a netted appearance, as the mulberry, oak, beech, &c.

Fig. 36.

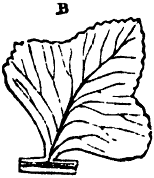
A



II. *Endogens* are particularized by the veins running in a parallel direction, either with the midrib, or at right angles to it. An exception occurs in the Wake-robin, &c.

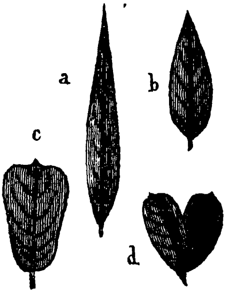
Fig. 37.

B



III. *Acrogens* are known by the subdivisions of the midrib, continually dividing in a forked or bifurcated manner; this arrangement is met with in the veins of the leaves of ferns.

Fig. 38.



Simple Leaves.

Like other parts of vegetables, leaves occur of various forms. Some are *lanceolate*, as at Fig. 38, *a*; others *ovate*, as at *d*; others *ovato-lanceolate*, as at *b*; others furnished with a little point or tip, as *c d*, and are termed *mucronate*. The most common division of leaves is into *simple* and *compound*, or *divided*; simple as in Fig. 38, and divided as in the Castor Oil Plant, Fig. 39, in which may also be seen that the margins of the leaflets are *serrated*, or toothed like a saw; and that the leaves are furnished with long petioles, while in the poppy they are *sessile* (Fig. 40), and in the grasses *sheathing*.

Fig. 39.

Castor Oil Plant.

327. The *stipules* are small leaf-like bodies, which are characteristic of many tribes of plants, such as those of the Rose, Pea, &c. They are situated at the base of the footstalk of the leaf, at its point of connection with the stem. Leaves, when united together and modified as to form and shape, produce in certain families of plants cups or *pitchers*, which are destined to perform some particular office in the economy of the individual to which they belong.

328. Having now briefly alluded to the organs of nutrition, or those intended by nature for the absorption, elaboration, and growth of the vegetable, it will be necessary to

speak, in a few words, of those organs which by their combined action perpetuate the species ; they are those of FERTILIZATION or REPRODUCTION, and have individually received the names of *bract* or scale, *calyx* or cup, *corolla* or coloured part of the flower, *stamens* or male organs, *pistils* or female organs, the *fruit*, and *seed;* the several parts of which each organ is formed will be alluded to under the description of each.

329. The *bract* or scale is situated between the last formed leaf on the stem and the flower ; in its structure and appearance it in most cases more nearly resembles the leaf than the corolla, and is easily recognized in the yellow leaf-like expansion on the flowerstalk of the limetree, &c.

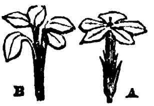
330. The *calyx* or cup (Fig. 41 A), when present, forms the outermost of the floral envelopes, and protects the corolla, which is beautifully folded in its leaf-like divisions, from the effects of the weather or intrusion of insects, before the appointed time. Its divisions are termed *sepals ;* when they are united into a tube, a *monosepalous* or single-sepalled calyx is the result; when they are distinct, a *polysepalous* or many-sepalled calyx exists. It forms the outer whorl of the *perianth.* In some cases, as for example, in the apple, the calyx remains inclosing the fruit, and is then said to be *persistent;* when on the other hand it falls off as soon as the flower is ready to expand, as in the poppy (Fig. 40) it is *caducous.* The adhesion or non-adhesion of the calyx to the fruit is a matter of some importance in classification, for when, as in the apple, medlar, &c. the calyx incloses the fruit, the fruit is said to be *inferior;* and, on the contrary, *superior,* when it is inserted beneath the ovarium, which is then said to be *free.*

Fig. 40.

The Poppy.

The *corolla* or coloured portion of the plant is popularly termed the flower; it is indeed but the inner whorl of the *perianth,* and its office is that of protecting the more delicate and essential organs or *true* flower, collectively considered, viz. the *stamens* or *pistils*. In structure the corolla is principally *cellular* (303), yet it is provided with spiral vessels (306), stomata (310), &c. to a comparatively small extent. The colour of this organ depends on the power the cells (of which it is formed) possess of secreting colouring matter (*chromule*), and which, shining through their thin transparent membranous walls, gives the colour to various flowers.

Fig. 41.

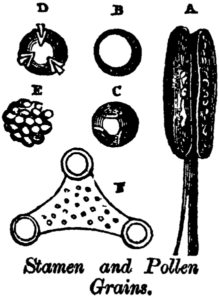


Corolla.

Like the portions of the calyx, those of the corolla have received names, viz. *petals*: when these are united into a tube a *monopetalous* corolla is formed, as seen, Fig. 41. A, and in the bell-flower, trumpet-flower, &c.; when they are not united, a *polypetalous* corolla exists as at B, as the rose, pink, &c. The normal state is that represented at B, but an union takes place of the separate portions, and produces the appearance at A. The use of the corolla, when present, is evidently for the protection of the stamens and pistils, and preventing the ingress of water, insects, &c. until those organs are in a fit and proper state to perfect the process of fertilization; as soon as that is accomplished the perianth withers away, and the fruit becomes mature. It is also of use in nourishing the stamens, and this it does by secreting a saccharine fluid at the base of the petal called *nectar*, which invites the intrusion of insects into many flowers, fertilization being in many cases effected by brushing the *pollen* (331) from the anthers (331) on the stigma (333). Odours are principally given off from the corolla, as well as other parts of the internal apparatus of the flower.

331. While the calyx and corolla are not altogether essential to the flower, the *stamens* are most decidedly so. Without them fertilization could not take place, and perfect seed could not be the result. They are well known as the thread-like bodies in the centre of the coloured portions, which surround, or are seated upon, the central organ or *pistil* (332). A stamen (Fig. 42. A) is composed of two distinct parts, the *filament* or thread, which is not essential, and the *anther*, or box, of the greatest importance; in it the *pollen*

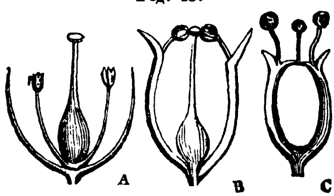
Fig. 42.



Stamen and Pollen Grains.

secreted. This box is usually divided into two separate compartments, as at A. Its interior, when mature, is filled with various shaped grains or powder (according to the plant under examination), which become dispersed by the rupture of the anther, and are distributed on the apex of the *pistil* and elsewhere. Some of these *pollen grains* are represented in Fig. 42, B. C. D. E. F. from various plants :—they will serve as an example of the very varied form of the fertilizing dust. In concluding the description of the pollen, it must be borne in mind, that when they alight on the moist apex of the pistil, they give out from any point of their surface a tube called the *pollen tube*, this will be alluded to again presently. The pollen is likewise delicately coated with a vegetable wax, and is composed of *three* tunics or coats.

Fig. 43.

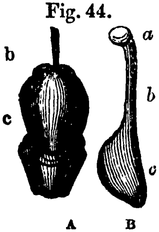


Insertion of Stamens.

The stamens are variously inserted. When they are inserted below the ovary they are said to be *Hypogynous* (Fig. 43 A); when upon the calyx, and away from the ovary, *Perigynous* (B); and when they are seated on the top of the ovary (C) *Epigynous*.

332. The *pistil* is the central organ of the flower, the lower part of which (*ovary*) ultimately becomes the *fruit*.

Fig. 44.



The Pistil.

It is composed of *three* parts, the top or *stigma* (Fig. 44, B *a*); the middle part, often absent and not essential to the pistil, the *style*, *b*; and the lower part, usually more or less expanded, called the *ovary*, *c*, which becomes the fruit, and in which the *seeds* are developed. The ovary is either formed of a single cell, as at B, *c*, or it is formed of more, as at A, c, when, if no obliteration or absorption has taken place, such a seed vessel or *pericarp* should exhibit *five* separate partitions or *dissepiments*. In the poppy capsule there are many, as seen, Fig. 45. The seed vessel sheds its seeds in a variety of ways. In the poppy, &c. for example, it *dehisces* by *pores* at the upper

Fig. 45.

Poppy Capsule.

part (Fig. 45). In the apple, plum, &c. the whole fruit decomposes before the seed can find its way to the earth: such a fruit is said to be *indehiscent.* In some, as the balsam, &c. it is shed abroad with considerable force, and in others this takes place with a loud report.

333. The *stigma* occupies the top of the pistil, and is, as mentioned (309), uncovered with cuticle. On its surface is usually found a viscid secretion, which causes the grains of pollen, that have fallen upon it, to adhere. When there, they imbibe moisture, and protrude the *pollen tubes*, mentioned at (331); these pass down the style if present, to the ovary, through the *intercellular passages*, and reach the hitherto unfertilized seed, attached by its *placenta* or thread to the interior, when fertilization is effected, and all the neighbouring organs perish as soon as this process is completed, their various offices having been duly performed. The fruit then enlarges, and the seeds and fruit become mature. The seed is composed of *integuments* or skins, of *albumen* (Fig. 47. A) in many instances, which is of various degrees of solidity, and is known as *horny*, *bony*, *fleshy*, &c.; of an *embryo* (Fig. 46. B.) or vital point, and *cotyledons* (Fig. 46. A.) or seed lobes. When two seed lobes are found, the plant is said to be *Dicotyledonous* (Fig. 46); when but a single one is present, it is then *Monocotyledonous* (Fig. 47); and when no seed-lobe can be detected, *Acotyledonous* (Fig. 48): this great group includes all those plants which do not produce regular flowers, as the mosses, lichens, sea-weeds, mushrooms, &c.

Fig. 46.

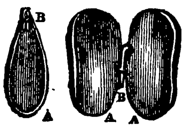


Fig. 47.

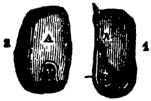


Fig. 48.

334. A general but hasty glance has now been taken of the Science of Botany, sufficient to enable the student to understand the few general principles which may hereafter follow. To enter more minutely into details would have been beyond the limits of an elementary and popular treatise like the present.

CLASSIFICATION.

THE LINNÆAN SYSTEM.

335. The Linnæan system of classification of plants is founded upon a supposition that the stamens represent the *male*, and the pistils the *female* parts of fructification. The whole vegetable creation has been distributed by Linnæus into twenty-four *classes*. These are divided into *orders*, which are subdivided into *genera* or tribes; and these genera are further divided into *species*, and the species sometimes into *varieties*.

336. Of the Classes, the discriminating characters are taken from the number, connexion, length, or situation of the *stamens* (331). In each of the first twenty classes there are stamens and pistils in the same flower; in the twenty-first class the stamens and pistils are in distinct flowers on the same plant; in the twenty-second, in distinct flowers on different plants; in the twenty-third, in the same flower and also in distinct flowers; and in the twenty-fourth class they are not at all discernible. Thus:

CLASSES.

The stamens considered according to their				CLASSES.
Number	Number only		One	1. Monandria.
			Two	2. Diandria.
			Three	3. Triandria.
			Four	4. Tetrandria.
			Five	5. Pentandria.
			Six	6. Hexandria.
			Seven	7. Heptandria.
			Eight	8. Octandria.
			Nine	9. Enneandria.
			Ten	10. Decandria.
			Twelve	11. Dodecandria.
	and their	Insertion	On the calyx: more than twelve	12. Icosandria.
			On the receptacle: more than nineteen.	13. Polyandria.
		Proportion unequal.	Four: two long and two short	14. Didynamia.
			Six: four long and two short	15. Tetradynamia.
Connexion by	Filaments united.		In one set	16. Monadelphia.
			In two sets	17. Diadelphia.
			In three or more sets	18. Polyadelphia.
	Anthers united			19. Syngenesia.
	Stamens upon the pistil			20. Gynandria.
Separation of stamens and pistils	On the same plant			21. Monœcia.
	On two plants			22. Diœcia.
	With flowers of both sexes			23. Polygamia.
Not being discernible or without flowers				24. Cryptogamia.

337. The characters of the ORDERS are most commonly taken from the number of the *pistils* (332), but sometimes from circumstances relative to the stamens, pistils, or seed. Those of the *first thirteen classes* are taken from the number of pistils; thus:

Monogynia..........	1 pistil	Heptagynia.........	7 pistils
Digynia	2 pistils	Octagynia...........	8 pistils
Trigynia.............	3 pistils	Enneagynia.........	9 pistils
Tetragynia...........	4 pistils	Decagynia...........	10 pistils
Pentagynia..........	5 pistils	Dodecagynia..about	12 pistils
Hexagynia...........	6 pistils	Polygynia........	many pistils

The orders of the fourteenth class, *Didynamia*, are taken from the situation of the seeds; and are

Gymnospermia.... seeds apparently naked.
Angiospermia...... seeds in a capsule.

The orders of the fifteenth class, *Tetradynamia*, are formed from a difference in the shape of the seed-vessel:

Siliculosa...... seeds in a short or a broad pod.
Siliquosa...... seeds in a long pod.

In the classes *Monadelphia*, *Diadelphia*, *Polyadelphia*, and *Gynandria*, the orders are taken from the number of stamens:

Pentandria........ 5 stamens.
Hexandria, &c..... 6 stamens, &c.

In the nineteenth class, *Syngenesia*, the orders are taken from the structure of the flower:

Polygamia æqualis—all the florets perfect, or with stamens and pistils.
Polygamia superflua—the florets of the centre perfect or united; those of the margin with pistils only, but all producing perfect seeds.
Polygamia frustranea—the florets of the centre perfect or united; those of the margin, in general, without either stamens or pistils.
Polygamia necessaria—the florets of the centre with stamens only; those of the margin with pistils only.
Polygamia segregata—flowers collected into heads, each with a separate involucre.

The classes *Monœcia* and *Diœcia* take their orders from the number and other peculiarities of the stamens, as these organs are not made use of to discriminate the classes, thus:

Monandria	1 stamen.
Diandria, &c..........	2 stamens, &c.
Polyandria...........	7 stamens.
Monadelphia..........	stamens united into one set.
Polyadelphia..........	stamens united into several sets.
Gynandria	stamens upon the pistil.

In the class *Polygamia* there are three orders:

Monœcia. Diœcia. Triœcia.

The twenty-fourth class, *Cryptogamia*, has five principal orders:

1. Ferns.
2. Mosses.
3. Liverworts.
4. Flags.
5. Mushrooms.

The Linnæan system is professedly artificial. Its sole aim (observes Sir J. E. Smith) is to help any one to learn the name and history of an unknown plant in the most easy and certain manner. This is done by first determining its class and order; after which its genus is to be made out, by comparing the parts of fructification with all the generic characters of that order; and finally, its species, by examining all the specific definitions of the genus.

It should be noted here, that although the general arrangement of Linnæus is yet to be found in many of our botanical books, considerable changes with regard to the genera, &c. have been made. Thus, in regard to *Ginger*, this species, *Amomum Zingiber*, is not only removed from the genus *Amomum*, but *Zingiber* is itself established into a distinct genus, with eight species, of which the *Zingiber officinale*, from which the ginger root of the shops is obtained, is one. Most of the species formerly included under *Amomum* being now placed by Roscoe under *Zingiber*.

THE NATURAL SYSTEM.

338. In considering the various plants used, either as food, medicine, &c. in the following pages, the arrangement laid down by Dr. Lindley is adopted, in accordance with the progressive state of botanical science. A complete revision will therefore be found to have taken place, when this part is compared with the former editions of the work; and which, although at first sight it may appear more abstruse than the system of Linnæus hitherto adopted, will, it is hoped, have that beneficial effect on the minds of growing botanists, for whom this work is solely intended, which can but result from the more extended and enlarged ideas of both structure, function, and properties, such a system of classification according to natural affinities will surely bring about; for as botanical science, like every other, is becoming daily of more importance, it is requisite that its principles should be correctly and in a manner expounded to the young observer, so as to enable him hereafter to make use of what little knowledge he may have in his youth acquired. With this in view it has been considered desirable (after giving in detail the system of Linnæus) to arrange the plants hereafter to be mentioned according to the Natural System of Decandolle and others; indeed, such as is given in *Dr. Lindley's Natural System of Botany, 2nd edition*, 1836, to which work the reader is referred for a detailed account of the characters of the natural orders.

It cannot be expected in a work of this description, that the details of such an extended system should be entered upon; on this account it is that the artificial analysis of the orders as given by Dr. Lindley in the work above quoted, is made use of, which will convey sufficient *general characters* of the Families, to enable the student, desirous of ascertaining to what Natural Order any plant may belong, to decide upon the same; having accomplished this object he is referred to the original work in which the *essential characters* may be found in all their detail.

From the previous observations in the Introduction it must be evident, that there exist two principal and leading divisions of the Vegetable Kingdom (which are further subdivided) distinguished one from the other, by their structure and arrangement of the elementary organs; viz.—

1. *The most complex*—VASCULAR or FLOWERING Plants; properties variable; either wholesome or poisonous	*Having one or more seed lobes.*
2. *The most simple*—CELLULAR or FLOWERLESS Plants, mostly nutritious or wholesome	*Having no seed lobes.*

*** The examples quoted at the end of the following Natural Orders are those of which a detailed account is given further on in the work.

DIVISION I. VASCULAR,

OR

FLOWERING PLANTS.

CLASS I.—EXOGENS, OR DICOTYLEDONOUS FLOWERING PLANTS.

Leaves reticulated. Stem with wood, pith, bark and medullary rays. Flowers usually with a quinary division. Seeds in a pericarp. Cotyledons two or more, opposite.

SUB-CLASS I.—POLYPETALOUS.

* POLYANDROUS—*Stamens more than twenty.*

§ *Ovary inferior, or partially so.*

† *Leaves furnished with stipules.*

1. POMEÆ.—The Apple tribe. *Medlar, Pear, Apple, Quince.*

†† *Leaves without stipules.*

2. NYMPHÆACEÆ.—The Water-lily tribe. *Victoria regina.*
3. MYRTACEÆ.—The Myrtle tribe. *Cloves, Pomegranate, Myrtle, Allspice, Cajeput, Guava.*

§§ *Ovary wholly superior.*

† *Leaves furnished with stipules.*

4. MAGNOLIACEÆ.—The Magnolia tribe. *Tulip tree.*
5. ROSACEÆ.—The Rose tribe. *The red, the dog, and hundred-leaved Roses, Raspberry, Strawberry.*
6. AMYGDALEÆ.—The Almond tribe,—*Cherry, Apricot, Plum, Sloe, Peach, Nectarine, Almond.*
7. BIXACEÆ.—The Arnatto tribe. *Arnatto.*
8. EUPHORBIACEÆ.—The Euphorbium tribe. *Boxtree, Caoutchouc, Castor-oil, Tallow-tree, Cassava.*
9. CISTACEÆ.—The Rock-rose tribe. *Ladanum.*

10. STERCULIACEÆ.—The Baobab tribe. *Chocolate, Baobab.*
11. MALVACEÆ.—The Mallow tribe. *Cotton.*
12. TILIACEÆ.—The Linden tribe. *The Lime tree.*

†† *Leaves without stipules.*

13. ANACARDIACEÆ.—The Cashew-nut tribe. *Mastic, Cashew-nut, Copal, Mangos.*
14. CAPPARIDACEÆ.—The Caper tribe. *Capers.*
15. PAPAVERACEÆ.—The Poppy tribe. *Poppy.*

** OLIGANDROUS.—*Stamens fewer than twenty.*

§ *Ovary inferior, or partially so.*

† *Leaves furnished with stipules.*

16. RHAMNACEÆ.—The Buckthorn tribe. *Buckthorn.*

†† *Leaves destitute of stipules.*

17. CUCURBITACEÆ.—The Gourd tribe. *Cucumber, Pumpkin, Bottle Gourd, Water Melon.*
18. GROSSULACEÆ.—The Currant tribe. *Red and Black Currants, Gooseberries, &c.*
19. UMBELLIFERÆ.—The Umbelliferous tribe. *Parsley, Celery, Anise, Fennel, Caraway, Parsnip, Cariander, Assafœtida, Rock Samphire, Carrot.*

§§ *Ovary wholly superior.*

† *Leaves furnished with stipules.*

20. BERBERACEÆ.—The Berberry tribe. *Berberry.*
21. LEGUMINOSÆ.—The Bean tribe. *Tamarind, Logwood, Senna, Purging Cassia, Gum Arabic, Broom, Spanish broom, Furze, Cowage, Soy, Beans, Vetches, Peas, Liquorice, Saintfoin, Red Clover, Lucern, Indigo.*
22. ZYGOPHYLLACEÆ.—The Bean-caper tribe. *Guaiacum.*
23. VITACEÆ.—The Vine tribe. *Vines.*

†† *Leaves destitute of stipules.*

24. AMYRIDACEÆ.—The Balsam tribe. *Balsam of Tolu.*
25. CRUCIFERÆ.—The Cruciferous tribe. *Sea-kale, Wood, Horse-radish, Mustard, Rape, Turnip, Cabbage.*
26. PAPAYACEÆ.—The Papaw tribe. *Papaw.*
27. RESEDACEÆ.—The Mignonette tribe. *Weld.*
28. LINACEÆ.—The Flax tribe. *Flax.*
29. SIMARUBACEÆ.—The Quassia tribe. *Quassia.*
30. RUTACEÆ.—The Rue tribe. *Rue.*
31. ACERACEÆ [1].—The Sycamore tribe. *Maple, Sugar-Maple, Sycamore.*

[1] TERNSTROMERIACEÆ.—The Tea tribe. This tribe is omitted in Dr. Lindley's Analysis.

32. ÆSCULACEÆ.—The Horse Chestnut tribe. *Horse-chestnut.*
33. ERICACEÆ.—The Heath tribe. *Heath.*
34. CEDRELACEÆ.—The Mahogany tribe. *Mahogany.*
35. AURANTIACEÆ.—The Orange tribe. *Orange, Lemon, Shaddock.*

SUB-CLASS II.—INCOMPLETÆ OR APETALOUS.

* ACHLAMYDEOUS.—*No Calyx.*

† *Leaves furnished with stipules.*

36. PLATANACEÆ.—The Plane-tree tribe. *Plane-tree.*
37. SALICACEÆ.—The Willow tribe. *Willow, Abele, Aspen, Italian Poplar, Canadian Poplar.*

†† *Leaves destitute of stipules.*

38. PIPERACEÆ.—The Pepper tribe. *Black, Long, and Betle Peppers.*

** MONOCHLAMYDEOUS.—*A Calyx present.*

§ *Ovary inferior, or partially so.*

† *Leaves furnished with stipules.*

39. CUPULIFERÆ.—The Nut tribe. *Edible Chestnut, Beech, Oak, Cork, Hazel, Hornbeam.*

†† *Leaves destitute of stipules.*

40. JUGLANDACEÆ.—The Walnut tribe. *Walnut, Hickory Nut.*
41. SANTALACEÆ.—The Sanders' Wood tribe. *Sandal-wood.*
42. CHENOPODIACEÆ.—The Goosefoot tribe. *Barilla, Beet, Mangel Wurzel.*

§§ *Ovary superior.*

† *Leaves furnished with stipules.*

43 ULMACEÆ.—The Elm tribe. *Elms.*
44. POLYGONACEÆ.—The Buck-wheat tribe. *Rhubarb, Buck-wheat.*
45. BETULACEÆ.—The Birch tribe. *Birch Alder.*
46. URTICACEÆ.—The Nettle tribe. *Hop, Hemp, Bread-fruit, Jack-fruit.*

†† *Leaves destitute of stipules.*

47. PRIMULACEÆ.—The Primrose tribe. *Cowslip.*
48. LAURACEÆ.—The Cinnamon tribe. *Cinnamon, Camphor, Sweet-bay, Alligator Pear, Sassafras.*
49. MYRISTICACEÆ.—The Nutmeg tribe. *Nutmeg.*

SUB-CLASS III.—MONOPETALÆ.

* *Ovary superior.—Flowers regular.*

50. Boraginaceæ.—The Borage tribe. *Alkanet.*
51. Convolvulaceæ.—The Bindweed tribe. *Scammony, Jalap.*
52. Ebenaceæ.—The Ebony tribe. *Ebony, Benzoin, Storax.*
53. Aquifoliaceæ.—The Holly tribe. *Holly.*
54. Oleaceæ.—The Olive tribe. *Olive, Manna, Ash.*
55. Jasminaceæ.—The Jasmine tribe. *Jasmin.*
56. Solanaceæ.—The Nightshade tribe. *Tobacco, Potatoe, Capsicum, Deadly nightshade.*
57. Gentianaceæ.—The Gentian tribe. *Buck-bean, Gentian.*
58. Apocynaceæ.—The Strychnos tribe. *Nux-vomica, Woorara.*

** *Ovary superior.—Flowers irregular.*

59. Labiatæ —The Mint tribe. *Lavender, Spear-mint, Peppermint.*
60. Verbenaceæ.—The Vervain tribe. *Teak-tree,*
61. Bignoniaceæ.—The Trumpet-flower tribe. *Calabash.*
62. Scrophulariaceæ.—The Fig-wort tribe. *Fox-glove.*

*** *Ovary inferior.*

63. Compositæ.—The Compound tribe. *Artichoke, Cardoon, Lettuce, Endive, Chamomile, Tarragon, Jerusalem Artichoke, Sunflower, Mikania Guaco.*
64. Dipsaceæ.—The Scabious tribe. *Teasel.*
65. Vaccinaceæ.—The Bilberry tribe. *Cranberry.*
66. Stellatæ.—The Madder tribe. *Madder.*
67. Caprifoliaceæ.—The Honey-suckle tribe. *Elder.*
68. Cinchonaceæ.—The Coffee tribe. *Peruvian Bark, Coffee.*

CLASS II.—GYMNOSPERMS.

Leaves with parallel or forked veins. Stem with wood, pith, bark and medullary rays. Floral envelopes absent. Seeds naked. Cotyledons, two or more, opposite.

69. Taxaceæ.—The Yew tribe. *Yew.*
70. Coniferæ.—The Fir tribe. *Juniper, Red Cedar, Scotch Fir, Weymouth Pine, Spruce Fir, Cypress.*
71. Cycadaceæ.—The Cycas tribe. *Sago.*

CLASS III.—ENDOGENS, OR MONOCOTYLEDONOUS FLOWERING PLANTS.

Leaves with parallel veins. Stem without any distinction of wood, pith, bark, and medullary rays. Flowers usually with a ternary division. Seeds in a pericarp. Cotyledons solitary, or if two, unequal and alternate with each other.

* *Flowers complete (having distinct floral envelopes).*

§ *Ovary inferior.*

† *Flowers gynandrous.*

72. ORCHIDACEÆ.—The Orchis tribe. *Salep.*
73. VANILLACEÆ.—The Vanilla tribe. *Vanilla.*

†† *Flowers not gynandrous.*

74. MARANTACEÆ.—The Arrow-root tribe. *Arrow root.*
75. ZINGIBERACEÆ [1].—The Ginger tribe. *Ginger, Turmeric.*
76. MUSACEÆ.—The Banana tribe. *Plantain and Banana.*
77. IRIDACEÆ.—The Corn-flag tribe. *Flag, Orris, Saffron.*
78. AMARYLLIDACEÆ.—The Narcissus tribe. *American Aloe.*
79. BROMELIACEÆ.—The Pine Apple tribe. *Pine Apple.*
80. JUNCACEÆ.—The Rush tribe. *Soft Rush.*
81. PALMACEÆ.—The Palm tribe. *Fan Palm, Dragon's-blood tree, Walking Cane, Cocoa-nut, Cabbage-tree Palm, Catechu, Date.*
82. DIOSCOREACEÆ.—The Yam tribe. *Yam.*

§§ *Ovary superior.*

83. LILIACEÆ.—The Lily tribe. *Asparagus, Aloes, Garlic, Leeks, Shalots, Canadian Onion, Chive, Common Onion.*
84. SMILACEÆ.—The Smilax tribe. *Sarsaparilla.*

** *Flowers incomplete (having no distinct floral envelopes, except leaves).*

§ *Flowers glumaceous.*

85. GRAMINACEÆ.—The Grass tribe. *Sugar, Bamboo, Rice, Maize, and every variety of the Cereal grains.*
86. CYPERACEÆ.—The Sedge tribe. *Papyrus.*

§§ *Flowers naked; or with a few verticillate leaves.*

† *Flowers on a spadix.*

87. ARACEÆ.—The Arum tribe. *Arum.*

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[1] Also called SCITAMINACEÆ.

88. ACORACEÆ.—The Acorus tribe. *Sweet-scented Flag.*
89. TYPHACEÆ.—The Bulrush tribe. *Bulrush.*

†† *Flowers not on a spadix.*

90. NAIADACEÆ.—The Pond-weed tribe. *Sea-wrack.*
91. PISTIACEÆ.—The Duckweed tribe. *Duckweed.*

CLASS IV.—RHIZANTHS.

Leaves, if any, scale-like. Stem, homogeneous, with scarcely any trace of a vascular system. Flowers with leaves. Seeds having no embryo, but consisting of a homogeneous sporuliferous mass.

92. RAFFLESIACEÆ.—The Rafflesia tribe. *Rafflesia Arnoldii.*

DIVISION II. CELLULAR,

OR

FLOWERLESS PLANTS.

CLASS V.—ACROGENS, OR ACOTYLEDONOUS, OR CRYPTOGAMIC PLANTS.

Sexes absent.—Sporules in lieu of perfect seeds.

§ *With a distinct axis of growth; leafy.*

93. FILICES.—The Fern tribe. *Brake.*

§§ *With a distinct axis of growth; leafless.*

94. CHARACEÆ.—The Stone-wort tribe. *Chara.*

§§§ *With no distinct axis of growth.*

95. FUNGI.—The Mushroom tribe. *Morel, Truffle, Puffball, Mushroom, Touchwood.*
96. LICHENES.—The Lichen tribe. *Crab's eye, Calcareous, Tartareous Lichens, Archell, Orchell, Iceland Liverwort.*
97. ALGÆ.—The Sea-weed or Flag tribe. *Diatoma, Conferva, Red Snow, Gory Dew, Bladder Fucus, Bladder-locks, Sweet Fucus, Dulse, Green Laver, Gulf-weed, Sea Cat-gut, Edible Birds' Nests.*

FLOWERLESS PLANTS.

ACROGENS, CRYPTOGAMIC,

OR,

ACOTYLEDONOUS PLANTS.

(Sporules.)

† Seed-lobes absent.
†† Increased by spores, or sporules.
††† Germination taking place from no fixed point.

Examples. SEA-WEEDS, LICHENS, MOSSES, FERNS, &c. &c.

Note.—For the sake of convenience in dividing the work into *two* volumes, it has been thought advisable to *reverse* the order of the foregoing system, commencing with the lowest on the list, the ALGÆ; this arrangement will allow of the better division of the vegetable kingdom, at the end of the first volume, than would otherwise be the case.

The number affixed to each order refers to its place in the general system adopted at p. 309.

Class V.

CELLULAR PLANTS.

Sexes absent. Sporules in lieu of perfect seeds.

(All the plants included under this head belong to the class Cryptogamia of Linnæus.)

NAT. ORD. 97. ALGÆ, *Linn.*—FLAGS OR SEA-WEEDS.

339. THE plants of this order are wholesome, affording a mucilaginous and nutritious substance. They are interesting from the circumstance of *Kelp* and *Iodine* being procured from them. Many serve as articles of food.

The term Alga is derived *ab algore*, signifying *coldness;* from the character of many of them (the lower kinds) resembling congelations of films or drops of water. The English term *flag* is peculiarly applicable to this extensive order, as the individuals which form it are for the most part denizens of water, either fresh or marine, usually attached to stones, &c. and are raised or depressed according to the rise or fall of the water; in other words they *flag.*

It is at this the lowest point of the vegetable kingdom, that the greatest difficulty presents in defining the exact limits of the animal and vegetable creations. In the lower animals a spontaneous division of their mass takes place, and each simple vesicle, devoid of all appearances of animal life, is capable, in the course of time, of enlarging into a being of the same character as the one from which it separated. In the lowest vegetables a similar division of their parts takes place, each "having a common origin, but an individual life."

340. *Diatoma vulgaris* is one of the lowest, and nearly related to animals of the family of *flags;* "it varies in its form, and in the mode of connection of its parts. At one period of its existence it is cylindrical, at another it is composed of quadrangular segments; sometimes connected by their sides, at others by their alternate angles. It has been observed that these segments have somewhat the forms and appearance of crystals; and Agardh has in consequence fancied they form a distinct passage from vegetables to minerals; but their active properties, and the changes they undergo at the different periods of their existence, sufficiently distinguish them" *(Pereira).*

Numerous examples might be quoted of similar vegetables; these are to be found in more extended works on the subject.

341. CONFERVÆ *are thread-like plants, composed of jointed portions, either simple or branched, and mostly of a green colour. They are inhabitants of salt or fresh water, especially in gently flowing streams or very stagnant ditches.*

The occurrence of large tracts of ground, &c. being covered with confervæ in considerable abundance, has been a subject of general interest of late, among the scientific world. At the Royal Society, and also at the Linnæan Society, masses of confervæ have been exhibited. A specimen of the satin-like mass of *C. fluviatilis* was exhibited by Mr. Yarrell, at the latter Society, which grew near Totness, Devon, in a water meadow. A spring which flows only in winter rises in the meadow, and this substance was taken from narrow gutters, from one of which, twelve inches wide, a piece was taken up which measured 79 feet in length, so firm and tough was its consistence; and another piece broke off at 39 feet. In consistence and appearance it bore considerable resemblance to a piece of cotton wadding, but of a firmer texture. A portion was carefully examined under the microscope, and was found to consist entirely of an interwoven mass of filaments of *Conferva fluviatilis.* The under surface of the mass was of a bright green colour, but the upper surface was white, from the effects of direct exposure to the air and light, which had caused the death of the plant at this part.

Its texture was such, that it might have been advantageously made use of by the poor for clothing.

342. Nostocs, Will o' the Wisps, and Flowers of Heaven, as they are popularly termed, also belong to this class.

343. Red Snow (Protococcus nivalis) *is in part considered to be one of the lowly flags. It is composed of isolated globules replete with colouring matter of a red hue, and which is found on snow in the Polar regions and Alps.*

On the return of Captain Ross from the North Pole expedition in 1819, this singular fact was made known, and specimens collected by him, and preserved in sealed bottles, were submitted to the scrutinizing attention of philosophers. It was discovered by Captain Ross on the 17th of August 1818, during his Northern expedition in Baffin's Bay, in latitude 75° 54′ North, and longitude 67° 15′ West. The late Mr. Francis Bauer, of Kew, devoted much time to its investigation, and gave an account of its structure in the 7th volume of the Journal of Science and Arts, where the following remarks will be found, in a letter addressed to Mr. Brande. Mr. Bauer states that he had not an opportunity of seeing it until 28th Feb. 1819, when a quart bottle full of the melted snow was presented to him, for the purpose of ascertaining (as far as it could be effected by microscopical observation) whether the red colouring matter was of animal or vegetable nature. Suffice it to say, that Mr. B. positively asserted it to be vegetable, and stated that it was a new species of the genus *Uredo*, termed by him *nivalis*. The generic name has, however, been changed by Agardh (who considers it an Alga) to that of *Protococcus*. Dr. Vogt, M. Agassiz, and Shuttleworth, have very recently shown that much of it is composed of the eggs of animalcules, and particularly of *Philodina roseola*[1]. The extent of country exhibiting the crimson snow was stated by Captain Ross to be eight miles; it was not confined to the surface, but extended down to the rock, a depth in some instances of ten or twelve feet. The size of each individual plant was ascertained to be the $\frac{1}{1600}$th part of an inch in diameter. Mr. Bauer is inclined also to believe that it grows on

[1] See Microscopic Journal, vol. i. 1841. p. 80. Fig.

the spot, and is not transported, as some have conceived, from distant parts.

Many other accounts are on record, of which the following are but a few.

A shower of red snow fell in Carniola, in the nights of the 5th and 6th of March, 1808.

On the same night a shower of snow of a rose colour, fell over the whole surface of Carniola, Cadore, Belluno, and Feltri, to the height of twenty centimetres. The earth was previously covered with snow of a pure white, and the coloured snow was succeded by other of a pure white also; the two kinds did not mingle together, but remained perfectly distinct, even during liquefaction. The same phenomena happened at the same time in the mountains of Valtelline, Brescia, and Tyrol. During the expedition to the frozen ocean under Baron Wrangel, both snow and ice were observed of a blue, green, and red hue.

But however singular the above account may be considered, it may be interesting to observe, that like effects are not unfrequently produced by plants of the same character, and of different colours; thus the

Blue is owing to *Byssus cobaltiginea.*
Green . . . . . . *Palmella botryoides.*
Yellow . . . . . . *Lepra candelaris.*

The sudden appearance of these minute bodies on the earth, and animalcules of a red colour in pools and ditches, giving a hue as if they were converted into blood, has on several occasions excited the attention and astonishment of country people throughout the world, and given rise to superstitions and omens without number.

344. Gory Dew (*Palmella cruenta*) is occasionally observed. Professor Burnett met with it abundantly during 1831 and 1832 at Oxford; it is often observed in damp situations, forming "broad indeterminate patches of a deep rich purple, with a shining surface, as if blood or red wine had been poured over the stone or ground. During dry weather it contracts, grows dull, and disappears; but after rain spreads anew, resumes its sanguine colour, and becomes conspicuous even to the vulgar gaze."

Its history affords (says Dr. Johnston in his Flora of Berwick upon Tweed) an easy explanation of a phenomenon considered supernatural by Monkish chroniclers, and to which Drayton in his notes to Polybion refers: "in the plain near Hastings, where the Norman William, after his victory, found King Harold slain, he built Battle Abbey, which at last (as divers other monasteries) grew to a town enough populous. Thereabout is a place, which after rain always looks red, which some have attributed to a very bloody sweat of the earth, as crying to Heaven for revenge of so great a slaughter."

These jelly-like forms of vegetables perform in the general economy of nature many important and interesting functions. Low and simple as they are in the scale of organization, they tend to purify stagnant pools, and render such situations better adapted to the life of animals, by the power they possess of abstracting from the foul water the very material for the support of such plants; and which, at the same time that it purifies the fluid, renders it more suitable to the existence of animals. Many of the smaller animals, including fish and other gill breathers, derive their nourishment by feeding on these plants; for, according to the investigations of Priestley, they are the principal means of affording vital air (oxygen) to these creatures, so necessary for the proper performance of their vital functions.

The following plants afford, when burned, two important articles of commerce, *Iodine* and *Kelp;* they serve also as excellent manure to the farmers, who usually designate them *furbelows*, or *furbelow-hangers*.

345. *BLADDER FUCUS, or SEA-WRACK,* (Fucus vesiculosus) *is a species of sea-weed, of a flat shape, with a middle rib, the edges entire, forked and sometimes tumid at the ends, and furnished with several air bladders imbedded in the substance of the plant. Several varieties.*

By far the most important application of this, one of the commonest of all our marine plants, is for the making of *kelp*, which in Scotland affords employment to many families. So lucrative and so highly esteemed is the bladder fucus, and some other plants nearly allied to it, that the natives of several parts of the Western Islands have rolled large masses of stone into the sea, with a view to promote and extend their growth, for they grow chiefly on rocks.

For the preparation of kelp these plants are dried, by exposure for some time to the sun and air. They are then burnt in a kelp furnace, which is generally a round hole dug in the earth. When the furnace is nearly filled with the remains of the burnt sea-weeds, the whole is briskly agitated with a rake or hook, till it is compacted, or becomes of a shining glutinous consistence, in appearance not unlike melted iron. It is then allowed to cool, and is afterwards placed in storehouses for exportation. In this state it is an impure kind of carbonate of soda, which is chiefly employed in the making of black bottle glass. In the Orkney Islands every consideration is sacrificed to the making of kelp, nearly 3,000 tons of which are annually sent to market and sold at Leith, Newcastle, and other places, at the rate of from seven to ten pounds sterling per ton of twenty-one hundred weight; during the war, the kelp made at the Hebrides amounted to 6,000 tons annually. The total quantitity of kelp manufactured in Scotland, and its adjacent isles, amounted formerly to 20,000 tons a year. It usually fetched 20*l.* per ton.

The inhabitants of Gothland boil this plant with coarse meal, as food for swine, hence the name of *swine-tang;* and the poorer classes of Scania thatch their cottages with it, and also employ it as fuel. In the Hebrides it is customary to dry cheese, without using any salt, by covering it with the ashes of the bladder fucus, which abound in saline particles. This and other sea-weeds serve as a winter food for cattle, which regularly frequent the shores for them at the ebb of the tide: they are also used as manure for land.

A soapy liquor found in the bladders of this plant is sometimes externally applied as a medicine for dispersing scrofulous and scorbutic swellings, by simply bruising them in the hand and rubbing them on the parts affected. When this plant is calcined or burnt in the open air, a black and saline powder is produced, which, under the name of *vegetable æthiops*, has been recommended as a dentrifice, and for other uses.

346. ***EATABLE WINGED FUCUS, or BLADDER LOCKS*** (Laminaria esculenta), ***is a simple, undivided, and sword-shaped sea-weed, which is olive-coloured, and sometimes varying from six to***

twenty feet in length. Its stem is four-cornered, runs through the whole length of the leaf, and is winged at the base.

This plant, which is very common on some of the shores of Scotland, and also on those of Cornwall, and several parts of North Wales, is a grateful food to cattle; and its stalk, when boiled and stripped of its membrane, constitutes a very favourite dish in Scotland. The proper season for gathering it is the month of September, when it is in higher perfection than at any other time of the year.

347. *SWEET FUCUS* (Laminaria saccharina) *is a simple, undivided, and sword-shaped sea-weed, without any rib, of a leathery consistence, and tawny green colour; and frequently five or six feet in length. Its stalk is round and hard.*

This plant abounds on all our sea-shores: and if slightly washed from the sea-water, and dried in the air, it becomes covered with a sweet powdery efflorescence. It is edible either in a raw state or boiled as a pot-herb. Sometimes it is hung up to serve the purpose of a hygrometer, which it does in some degree by becoming flaccid during a moist state of the atmosphere, and hard in dry weather. In Nordland it is termed Trole-tare, which means that it is only fit for the *sea-devil.* Thunberg states, that in Japan it is prepared in such a manner as to be quite esculent, and that it is customary there, when presents are made, to lay upon them a slice of this *fucus* attached to a piece of paper folded in a curious manner, and tied with threads of gold and silver.

348. *DULSE, or RED PALMATE FUCUS* (Fucus palmatus), *is a flat, membranous, and hand-shaped sea-weed, of a brownish crimson colour, smooth on both sides, and without any mid-rib.*

In the markets of Edinburgh, and other parts of Scotland, this plant, which is common on most of the British shores, is exposed for sale as an article of food. After having been washed in fresh water, it is eaten raw, by itself, in salad, or by poor people with other provisions. Sometimes it is boiled and used as a pot-herb. If gradually dried, it gives out a whitish powdery substance, which covers the whole plant, and has a sweet and agreeable taste, somewhat resembling that of violets. In this state it is frequently packed in casks for exportation. Some persons chew it as tobacco. In Scotland it is occasionally used as a medicine, and it is supposed to sweeten the breath and destroy worms.

349. *GREEN or EDIBLE LAVER* (Ulva lactuca) *is a thin, membranous, pellucid, and green vegetable substance, which is found on rocks, stones, and shells, in the sea and salt-water ditches in nearly all parts of Great Britain.*

Of late years this plant, stewed with lemon juice, has been introduced to the tables of the luxurious, as a sauce to be eaten with roast meat. Though in a recent state it has a salt and bitterish flavour, and even when thus prepared is not always relished at first, yet by habit most persons become partial to it. The laver which is consumed in London is chiefly prepared in the west of England, and packed in pots in a state ready for the table. Some persons use laver medicinally; it is esteemed wholesome for scrofulous habits; but it can scarcely be taken in sufficient quantity to do much good, without having too strong an effect on the bowels.

350. The TROPIC GRAPE of sailors (*Sargassum vulgare*) is one of the sea-weed tribe, and worthy of notice from the circumstance of its being met with floating unattached in the ocean in considerable plenty, and more particularly as it only grows within forty degrees of latitude on either side of the equator, and is usually crossed by vessels homeward bound from Monte Video or the Cape of Good Hope; it occurs in these situations in the form of two banks, which are so constant, that the Spanish pilots usually rectify their longitude from their position. "It is probable," says Burnett, "that these banks were known to the Phœnicians, who in thirty days' sail, with an easterly wind, came into what they called the 'Weedy Sea;' and to the present day, by the Spaniards and Portuguese, the chief tract is named *Mar de Zargasso*. It was the entering of such fields of Fucus as these that struck so much terror into the minds of the first discoverers of America; for sailing tardily through extensive meadows for days together, the sailors of Columbus superstitiously believed that the hinderance was designed by Heaven to stay their adventurous course; hence they wildly

urged their commander to proceed no further, declaring that through the bands thus woven by nature it would be presumptuous impiety to force a way."

351. SEA CAT-GUT (*Chorda filum*) is one of the sea-weeds possessed of a hollow stem, which enables it to float on the surface of the water, even though its point of attachment is at some considerable depth. Some species of this division have been found from 500 to 1500 feet in length.

352. EDIBLE SWALLOWS' NESTS.—This much-prized article of luxury with the Chinese, is reported to be formed by swallows, principally on the island of Java, and also on other islands of the Indian Archipelago; these birds are said to collect in their flight small portions of a species of *Gelidium* from the sea-shores, and having partially digested, eject it, and of this substance construct their nests, which are collected at much risk by the Japanese, who pack them in boxes, and send them to the Chinese markets, after having dried them in the sun. The following are the prices usually given for the three different qualities in the market at Canton:—3500 Spanish dollars the pecul, or 5*l.* 18*s.* 1½*d.* for the first kind; for the second, 2800 Spanish dollars the pecul; and for the third, 1600. They are reputed to possess aphrodisiacal properties by the Chinese.

Much diversity of opinion has recently prevailed as to the validity of the above generally-received statement; both Mr. Cuming and Mr. T. Lay, who have visited the countries where they abound, advancing theories somewhat contrary to the hitherto-received opinion, but which would occupy too much space to give in detail.

NAT. ORD. 96. LICHENES, *Juss.*—THE LICHEN TRIBE.

353. *The LICHENS, or TIME-STAINS, constitute a very numerous family of plants, which grow on the bark of trees, on rocks, stones, and other substances, and have an indistinct fructification, in scattered wart-like tubercles, or excrescences, and smooth saucers or shields, in which the seeds are imbedded.*

Some of them have a powdery appearance, and others are crustaceous, leaf-like, shrub-like, herbaceous, or gelatinous.

354. *The CALCAREOUS LICHEN* (Lichen calcareus) *consists of a white crust with black tubercles.*

This plant, which is found on lime-stone rocks in Wales, and the north of England, is used in dyeing woollen and other cloths a scarlet colour.

355. *CRAB'S-EYE LICHEN* (Lichen parellus) *is a crustaceous, whitish, and granulated vegetable substance, with cups of the same colour, which have a thick and blunt border.*

From this lichen, which is found on rocks and stones in mountainous countries, and sometimes on stones near the sea-shore, is prepared, it is said by some, the bluish pigment called *litmus*. It is chiefly collected from rocks in the north of England, packed in casks, and sent to London for sale.

356. *TARTAREOUS LICHEN* (Lichen tartareus) *is a whitish, crustaceous, vegetable production, with yellow cups or shields, which have a whitish border.*

The inhabitants of the Highlands of Scotland gather this species of lichen from the rocks, and after cleaning, and some further preparation which is kept a secret by the manufacturers, they form it into cakes. These, when dried, are pulverized, and sold, it is said, to dyers by the name of *cudbear*, which is a corruption of Cuthbert, the name of its inventor. In conjunction with alum, the powder of the tartareous lichen is used in dyeing scarlet, and also for striking a purple dye; but the colour produced by it is not very permanent.

357. *ARCHELL, or PURPLE ROCK LICHEN* (Lichen omphalodes), *is a vegetable production, of a somewhat crustaceous consistence, and leaf-like form; the segments with many lobes, and of a dark purplish brown colour, with dull purple saucers.*

This kind of lichen grows upon rocks on the high stony moors of several parts of England, Wales, and Scotland. When properly prepared, it imparts to woollen cloth a reddish brown colour, or a dull but durable crimson. If wool that has been dyed with it be dipped into a blue vat, it will acquire a beautiful purple tinge. It is sometimes used as a styptic; and was formerly applied as a remedy in inflammatory fevers and other complaints; but, in the latter respect, it is now entirely neglected.

358. *ORCHELL, or DYER'S LICHEN* (Roccella tinctoria), *is a somewhat crustaceous and shrub-like vegetable production, of nearly a cylindrical form, solid, without leaves, but little branched, and with blackish brown alternate tubercles.*

In the Canary and Cape de Verd Islands, as well as in the Grecian Archipelago, orchell is found in great abundance. It likewise grows in Guernsey and in some parts of England, and is employed by dyers chiefly for giving a bloom to other colours. This is effected by passing the dyed cloth or silk through hot water slightly impregnated with it; but the bloom thus communicated soon decays after it has been exposed to the air. When prepared in a peculiar manner, orchell yields a rich purple tincture, fugitive indeed, but very beautiful. Mixed with a solution of tin it is reputed to dye a permanent scarlet. Orchell is the substance generally used for colouring the spirits of thermometers, and it is a remarkable circumstance, that, as exposure to the air destroys its colour upon cloth, so the exclusion of the air produces, in a few years, a like effect upon the fluid in those tubes; but on breaking the tubes the colour is restored: it also affords one of the most delicate tests for detecting the presence of an acid. It has fetched £1000 per ton in times of scarcity. This plant is now generally considered as that from which *litmus* is obtained. The *tincture of turnsole* was the name given to the preparation by the Florentines.

359. *ICELAND LIVERWORT* (Lichen Islandicus) *is a leafy, membranous, vegetable production, of a brownish green colour, jagged at the edges, and fringed, having large and purplish brown saucers or shields.*

The name of this lichen is derived from that of the island in which it chiefly grows. It is, however, also found in the Highlands of Scotland, and in some of the northern parts both of England and Wales.

It abounds with nutritious mucilage; and, after having been steeped in water to extract its bitter and laxative qualities, it is sometimes used as a medicine in coughs and consumptions. One ounce of Iceland lichen, boiled in a pint of water, yields about seven ounces of mucilage. The inhabitants of Iceland prepare from it a kind of gruel, which they mix with milk. They also boil it in several waters, and then dry and make it into bread. In Germany a durable brown dye is made by means of it; and, under another mode of preparation, it imparts an excellent black tinge to white woollen yarn.

A knowledge of the several species of lichens is of essential service to the dealer in drugs, as in very many instances their presence or absence afford decided marks of distinction between many of the *true* and *false* barks.

NAT. ORD. 95. FUNGI, *Juss.*—THE MUSHROOM TRIBE.

360. *The ESCULENT MOREL* (Morchella esculenta) *is a kind of fungus with a naked and wrinkled stem, and an egg-shaped head, full of cells on its external surface. Pl. 7. fig.* 84.

As an ingredient for thickening and heightening the flavour of sauces and soups, morels, which are chiefly found in woods and hedges in a loamy soil, are in great esteem. For this purpose, after they are gathered, they are strung upon pack-thread to be dried; and, when dry, they may be kept without injury for many months.

In Germany, the persons employed in gathering morels found that they always grew most abundantly in woods that had been burnt: and, with a view of promoting their increase, they were accustomed to set fire to the woods, until this practice was prohibited by the government. Useful and palatable as these plants are, it has been ascertained, that, if gathered after having been exposed for some days to wet weather, they are extremely pernicious.

361. *The TRUFFLE* (Tuber cibarium) *is a globular, solid, and warty fungus, without root, which grows at the depth of four or five inches beneath the surface of the earth, and is from the size of a pea to that of a potatoe.*

This, one of the best of the edible funguses, is chiefly found in hilly woods and pastures, which have a sandy or clayey bottom, and occurs on the downs of Wiltshire, Hampshire, and Kent. Truffles are generally discovered by means of dogs, which are taught to hunt for them by scent; and wherever they smell one of them, they bark, and scratch it up. In Italy they are hunted, in a somewhat similar manner, by pigs.

Truffles are either served at table roasted in a fresh state like potatoes, or they are cut into slices and dried, as an ingredient for sauces and soups. Those that are most delicious are internally of a white colour, and have somewhat the odour of garlic.

In England, truffles seldom exceed the weight of four or five ounces, whilst on the Continent they are known to weigh as much as fifteen or sixteen ounces each.

362. *The PUFF-BALL* (Lycoperdon bovista) *is a round kind of fungus, which is filled with a soft whitish flesh when young, and a fine brown powder when ripe.*

The *powder* (or spores) of the puff-ball is sometimes used as a styptic to prevent the bleeding of recent wounds. This powder is extremely subtile, and is very injurious to the eyes. Instances have occurred of persons, who, having had it blown into their face, have thereby been deprived of their sight for a considerable time; and have also been affected with violent pain and inflammation.

There is a curious experiment of taking a shilling from the bottom of a vessel of water, without wetting the hand. This is said to be effected by strewing a small quantity of the dust of the puff-ball on the surface; it so strongly repels the fluid as to form a covering for the fingers, and defend them from the contact of the water.

The fumes of the puff-ball, when burnt, have a powerfully narcotic quality; and on this account they are sometimes used to take the combs from hives without destroying the bees.

363. *The COMMON MUSHROOM* (Agaricus campestris) *is a fungus consisting of a white cylindrical stalk and a convex cover of a white or brownish colour, which has beneath an irregular arrangement of gills, pinky when young, but afterwards of a dark liver colour.*

When it first appears above ground the mushroom is smooth and nearly globular, and in this state it is called a button.

In England mushrooms are in great demand for the table. They are found wild in parks, downs, and other pastures where the turf has not been ploughed for many years; the best time for gathering them is in the months of August and September.

They are eaten fresh, either stewed or broiled; and are preserved for use either by drying, by being pickled, or in powder. They are also employed in making the well-known sauce called mushroom ketchup. As an article of food, however, mushrooms are by no means wholesome, being so tough, and having so great a resemblance to soft leather as to be almost indigestible. This is particularly the case when they are of a large size.

Mushrooms may be raised artificially on beds constructed for the purpose, even in cellars and boxes: for if they have only warmth and moisture, the plants will vegetate without light; but the most proper situations for them are under sheds in the open air. The plants thus grown, however, have more toughness than such as grow wild in the fields; and in other respects are much inferior to them.

There is a kind of mushroom (*Agaricus georgii*) which is yellowish, with yellowish white gills, and when full grown is sometimes so large as to measure eighteen inches across. This is occasionally eaten, but in many instances the use of it has been attended with injurious consequences.

In Covent Garden market a tall and spongy kind of mushroom (*Agaricus procerus*), with white gills, and a large horizontal ring round the stem, is frequently exposed for sale about the month of September.

On hedge-banks, in pastures, and in what are called fairy-rings, there is a species of mushroom (*Agaricus orcades*), with brownish or watery white gills, two or four in a set, a pale brown, convex, and irregular cover, and a whitish stem. These are considered by many persons to be the *champignons* of the French cooks. They have a much higher flavour than the common mushroom; but from their leathery nature are indigestible, except in the form of powder, with sauces, or in ketchup, in all of which they are very admirable.

With respect to the plants of the mushroom tribe, it ought to be observed, that, though several of them are edible, many are extremely poisonous. Instances of the fatal effects arising from an indiscriminate eating of them are innumerable. Great caution, therefore, is requisite that such only shall be used as are ascertained to be wholesome, particularly as, in many instances, the poisonous species can scarcely be distinguished by the eye from such as are harmless. In cases of injury arising from poisonous funguses, the best remedy that can be first administered is an emetic; afterwards, as purgatives, Glauber's or Epsom salts.

364. *SPUNK, or TOUCHWOOD* (Microporus fomentarius), *is a fungus somewhat shaped like a horse's hoof, with pores on the under side, and the upper part very hard and smooth, but marked with circular bands or ridges of different colours.*

It grows horizontally on the trunks and large branches of several kinds of trees, when old and decayed.

In Germany, and in some parts of England, this fungus is used as tinder, for which, on account of its readily catching fire, it is well adapted. It is prepared by being boiled in a strong ley, dried, and again boiled in a solution of saltpetre. In Franconia, pieces of the inner substance of the spunk are beaten so as to resemble leather, and are sewed together for making garments. The inhabitants of Lapland frequently burn it about their cottages, to keep off a species of gad-fly, which is peculiarly injurious to the young rein-deer.

This fungus is often employed as a styptic for the stopping of blood. When intended for this use, the exterior hard substance is pared off, and the coat underneath is separated from the porous part, and well beaten with a hammer, until it becomes pliable. Thus prepared it is kept dry, in slices of a convenient size for use; and although it is not so much esteemed in this country as it was some years ago, many of the continental surgeons have a very high opinion of its efficacy.

365. *The ERGOT, HORNED or SPURRED RYE* (Acinula clavus) *is a diseased state of the grain of rye, by which the seed, instead of being of the usual shape, and having the ordinary appearance, becomes club-shaped and black, and is altogether altered both as to external characters and internal properties.*

Until very lately considerable doubts existed as to the nature of the *Ergot of rye*, some considering it to be the result of the puncture of an insect, similar to the formation of a gall nut; others, that it was a spontaneous growth. Fries was the first to point out its true character, viz. that it was owing to the attack of a fungus; subsequent observers, however, have clearly decided the point in dispute.

This very valuable medicine, in judicious hands, is of the utmost importance to the obstetrician. When mixed with flour and eaten as food, in the form of rye bread, it produces very alarming effects on the constitution, viz. dry gangrene, typhus fever, and general disorder of the nervous system, attended with convulsions. This disease of the grain is not confined to the *rye-grass*, but occurs in very many of the *fodder grasses.*

There are two species of the genus *Uredo*, which the farmers in different districts call smuts, brand-dews, dust-brands, scorch-blasts, brand-bladders, pepper-brand, canker-brand, burnt corn, &c. The one, *Uredo segetum*, the smut or dust-brand, attacks all the cereal grains, such as wheat, oats, barley, rye, &c.; the other, *Uredo fetida*, canker-brand, or brand-bladders, has hitherto been found on wheat alone. (*Burnett.*)

The above examples are but few of this widely-diffused and deleterious natural family; to which might be added, did space permit, observations on *Blights*, *Blasts*, *Mildews*, &c. forming no inconspicuous part of the many-varied productions even of our own country.

Nat. Ord. 94. CHARACEÆ, *Rich.*—The Stone-wort Tribe.

366. This tribe has received the name of Stone-wort, from the circumstance of the stems of various species becoming encrusted with a deposit of carbonate of lime, thrown down from the water in which they are mostly found.

" The most interesting circumstance connected with the Characeæ is, that, owing to the extreme tenuity and transparency of their teguments, aided by their sap, containing numerous small opaque masses of globuline, the motions of their fluids can be ocularly demonstrated, and by the aid of a microscope their course be satisfactorily traced. These motions have been shown in a great number of other plants; but the Characeæ are interesting, not only from being the first in which they were clearly seen, but also from the phenomenon being the most easily exhibited in them." (*Burnett.*)

The *Charas* and *Nitellas* form the two genera of the tribe, which are found in salt marshes, in fresh water, or in the sea.

In addition to their interest in a microscopic point of view, they have been noticed here principally for the purpose of carrying out the system followed at p. 314.

NAT. ORD. 93. FILICES, *Juss.*—THE FERN TRIBE.

367. *FERN or BRAKE* (Pteris Aquilina) *is a well-known cryptogamous plant, which grows wild on heaths, in woods, and in many other places.*

Though this plant is an extremely troublesome weed to the farmer, from the roots penetrating deep into the ground, it is applied to various uses in rural economy. When cut and properly dried, it serves as litter for horses and cattle; and it supplies the place of thatch for covering the roofs of cottages and stacks. Where coal is scarce it is used for the heating of ovens and burning of lime-stone.

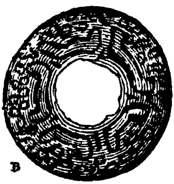
Burnett says, that from its constant profusion in every part of the country, it is not improbably the especial *Fearn* of our Saxon ancestors, from which so many places, as *Fearn*ham or Farnham, Farnhurst, Farnborough, Farnworth, Farningham, &c. have been named.

The *ashes* of fern, from their yielding a tolerably pure alkali, are frequently used by manufacturers of glass, particularly in France; and in some parts of our own country the poor people mix these ashes with water, and form them into round masses which they call *fern balls*. These are afterwards heated in a fire, and then, with water, are made into a ley for the scouring of linen. They thus furnish a cheap substitute for soap.

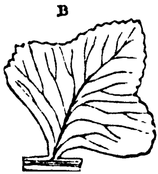
Swine are fond of the roots of fern, and will feed freely upon them. We are even informed that, with the inhabitants of Palma, one of the Canary islands, the roots, when powdered and mixed with barley meal, are sometimes made to supply the place of bread.

It has been used instead of hops in brewing, Morin having shown that it contains *tannin* and *gallic acid.*

It is deserving of remark, that, when the root of the fern is cut obliquely across, it presents a kind of figure of the Imperial or Russian eagle; from which circumstance Linnæus was induced to name it *Pteris aquilina*, or "Eagle brake;" this fact is indicative of the order to which it belongs, and which *contorted* arrangement of the tissue is one of the leading characteristics of this natural order; a representation of it is given in the cut below. The leaf exhibits the forked or bifurcated arrangement of the veins or subdivisions of the midrib, also peculiar to this order.



Contorted Structure.



Forked Veins.

FLOWERING PLANTS.

RHIZANTHS.

The RAFFLESIA ARNOLDII; or, Great Flower of Sumatra.
(Size 3 feet across.)

Example. RAFFLESIA ARNOLDII, &c.

CLASS IV.—RHIZANTHS.

Leaves, if any, scale-like. Stem homogeneous, with scarcely any trace of a vascular system. Flowers with sexes. Seeds having no embryo, but consisting of a homogeneous sporuliferous mass.— Lindley.

ORDER 92. RAFFLESIACEÆ. *Endl.*—THE RAFFLESIA TRIBE.

368. *RAFFLESIA ARNOLDII, or GREAT FLOWER of SUMATRA, is one of the most singular and interesting plants in the vegetable kingdom. Its whole substance is thick and succulent, the calyx being formed of several roundish, dark-brown, concave leaves, indefinite in number and unequal in size. The petals are five in number, of a brick-red colour, thick, and covered with protuberances of a yellowish white.*

This singular flower, which measured a full yard across, is parasitical upon the branches of trees in the island of Sumatra.

This gigantic plant (see Fig. p. 335) was discovered by Dr. Joseph Arnold, in 1818, on Sir Stamford Raffles' first journey from Bencoolen into the interior of the island of Sumatra; the drawings and specimens of which were brought to this country by Dr. Horsfield, and placed in the hands of Mr. Robert Brown, who, in the 13th vol. of the Linnæan Society's Transactions, has given the results of his researches, accompanied with illustrations by the late and justly-esteemed artist and observer, Mr. Francis Bauer. The following account of its discovery is extracted from a letter of Dr. Arnold, published in the above volume. After giving an account of the journey to Passummah, he thus proceeds:—" But here (at Pulo Lebbar, on the Manna river, two days' journey inland of Manna), I rejoice to tell you, I happened to meet with what I consider as the greatest prodigy of the vegetable world. I had ventured some way from the party, when one of the Malay servants came running to me with wonder in his eyes, and said, 'Come with me, sir, come! a flower, very large, beautiful, wonderful!' I immediately went with the man about a hundred yards in the jungle, and he pointed to a flower which was truly astonishing. My first impulse was to cut it up, and carry it to the hut. I therefore seized the Malay's parang (a sort of instrument like a woodman's chopping hook), and finding that it sprang from a small root which ran horizontally (about as large as two fingers, or a little more), I soon detached it, and removed it to our hut. A guide from the interior of the country said that such plants were rare, but he had seen several, and that the natives called them *Krúbút.*"

Sir Stamford Raffles afterwards found them to be more commonly distributed, and in some districts they are termed *Ambun-Ambun.* According to Mr. Jack, they are parasitic on the roots and stems of a ligneous species of *Cissus*, the *C. Angustifolia* of Roxburgh, and appears to take its origin in some crack or hollow of the stem. The odour of the plant, according to Dr. Arnold, is that of tainted beef, which attracts insects in great numbers, doubtless, as observed by Mr. Brown, to effect its impregnation.

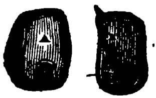
Another species of a smaller kind has received the name of *Rafflesia Horsfieldii*, in honour of Dr. Horsfield, whose researches during his sojourn in the East merit the greatest praise. Mr. Cuming has also very recently brought to this country another species from Manilla.

FLOWERING PLANTS.

ENDOGENS,

OR,

MONOCOTYLEDONOUS PLANTS.



(Seedlobe, A.)

† One seedlobe to each seed.
†† Increased by the agency of sexes.
††† Germination taking place from a fixed point, the embryo (B).

Examples. PALMS, GRASSES, SEDGES, &c. &c

CLASS III.—ENDOGENOUS PLANTS.

Leaves with parallel veins. Stem without any distinction of wood, pith, bark, and medullary rays. Flowers usually with a ternary division. Seeds in a pericarp. Cotyledons solitary, or if two, unequal and alternate with each other.

ORDER 91. PISTIACEÆ. *Rich.*—THE DUCK-WEED TRIBE.

369. The DUCK-WEED (*Lemna minor*, &c.) is introduced here principally with a view to carry out the system given at p. 309. It is too common a plant to require description; but is interesting in some particulars; for, independent of the use of this plant as food to ducks, and its giving shelter to myriads of insects, it purifies the air which arises from those stagnant pools on which it is mostly to be found; hence it is met with most abundantly in the hotter months of the year, when the putrefactive process takes place with more rapidity. Its flowers are very inconspicuous; they occur at the margins of the leaves, where, indeed, the new leaves are formed. The little pendant roots on the under surface absorb the principal part of its nourishment. Four species are met with in England. It is placed by Linnæus, in his *Sexual System*, under "Diandria Monœcia."

ORDER 90. NAIADACEÆ. *Lindl.*—THE POND-WEED TRIBE.

370. The SEA-WRACK (*Zostera marina*) is here mentioned on account of its peculiarity of flowering and perfecting its seeds under water; but as in the process of fertilization *air* is absolutely requisite, this inconspicuous inhabitant of our salt marshes is provided with a membranous air-tight kind of bag or envelope, which is impervious to water, and in which reproduction is effected without the necessity of rising to the surface, as is the case with most other aquatic vegetables, as the *Water-lilies*, *Water-crowfoot*, *Duck-weed*, *Pond-weeds*, &c. &c. This plant is very commonly used for packing, and for stuffing cottagers' cushions.

One of the most interesting examples that can be quoted of plants rising to the surface of the water to perform the function of fertilization, occurs in the *Valisneria spiralis*. This plant belongs to the Nat. Ord. *Hydrocharaceæ*, the Frog-bit tribe, and to the class *Diœcia* of Linnæus, by which is understood that the stamens and pistils are produced on different plants. As soon as the period arrives for the function to be performed, the flower bearing the stamens rises to the surface of the water by the uncoiling of a delicate spiral thread, becomes separated from the spiral, and when mature floats about on the surface until it meets with the pistil of another plant, which, unlike the stamens, does *not* separate from its spiral or thread-like coil. As soon as fertilization is accomplished, the spiral of the pistil recoils, and the fruit (pistil) is drawn down to the bottom of the waters to ripen—a good example, as above mentioned, of the presence of air to accomplish this all-important process for the continuation of the species.

ORDER 89. TYPHACEÆ. *Dec.*—THE BULRUSH TRIBE.

371. The BULRUSH (Typha latifolia) *is a plant too well known to require any description.*—*Sex. Syst.* Monœcia Triandria.

There are two kinds of *Bulrushes* met with occasionally in ponds, canals, &c. The larger kind (*T. latifolia*) is in some districts more rare than the smaller species (*T. angustifolia*). A still smaller species (*T. minor*) is said to be a native of Britain; but its claim as a native is not altogether so satisfactorily established as could be wished.

The pollen of these plants is inflammable, and is used, like the sporules of *Lycopodium*, for various purposes in theatrical representations.

ORDER 88. ACORACEÆ. *Lindl.*—THE SWEET-FLAG TRIBE.

372. The SWEET-SCENTED FLAG, is used in medicine, and is the rhizoma or *rootstock* of the *Acorus Calamus*, a plant indigenous to Britain, but by no means common. The London market is supplied from the county of Norfolk. Its native situations are moist places. The *rootstock* of this, like the *Orris root*, is the part only used. It occurs in the market in pieces of from four to five inches long, very irregular in its shape, corky or spongy in its texture, and exhibits on its upper surface the scars left by the dying down of the leaves,

while on the under small round points may be seen, which indicate the remains of the rootlets.

The poor people of Norfolk make use of the powdered rhizoma of this plant for the cure of ague and other forms of intermittent fevers. It also possesses tonic and aromatic properties, and may be given in combination with other medicines in dyspepsia, &c. Its sweet odour, which becomes manifest on passing the hand upon a leaf, is due to the presence of a volatile aromatic oil it contains. It is either given in powder or in infusion.

ORDER 87. ARACEÆ. *Schott.*—THE ARUM TRIBE.

373. *The COMMON ARUM, CUCKOO PINT, or LORDS AND LADIES* (Arum maculatum), *is a well-known indigenous perennial plant, which grows in shady hedge bottoms; and has, about the month of May, a club-shaped spike, frequently of a purple colour at the top, issuing from a green sheath (spathe) with which it is enveloped. The spathe is sometimes spotted —Sex. Syst.* Monœcia Polyandria.

The acridity of every part of this plant, whilst in a recent state, is such, that, if tasted, there is left upon the tongue a disagreeable burning and pricking sensation, which continues for a long time afterwards; and which no one, who has once felt it, will be inclined to experience a second time. If bruised and applied to the skin, a blister will shortly after be raised.

The fresh *roots*, which are whitish, and each about the size of a nutmeg, were formerly used internally in medicine as a powerful stimulant, and externally for blisters; but it is very uncertain in its operation. In some parts of France they are employed in bleaching. Their acrimony is wholly dissipated by drying; in a dried state they afford an almost tasteless farinaceous powder, which may even be made into bread. The powdered roots are converted by the French into a harmless cosmetic, called *Cyprus powder*.

In the isle of Portland, where this plant is abundant, the root is eaten by the country people; where also a starch is obtained from it and sent to London, and sold under the name of *Portland sago*. The starch is obtained in a similar manner to that which is employed in obtaining starch from potatoes; but it is not, we presume, better than other vegetable starch.

The flowers of some of the foreign species of the *arum* (particularly *A. dracunculus*) have so strong a smell, like carrion, that even flesh-flies are attracted to deposit their eggs in them: the structure of the flowers is such that, when the insects attempt to retreat, they are prevented by the reversed hairs which are there found, and are destroyed. Some of the species are considered wholesome food; among which the *Arum colocasia*, or Egyptian arum, and the *Arum trilobatum*, a native of Ceylon, may be named as edible. Several species are eaten in the West Indies and South America; the leaves being sometimes boiled, the roots either boiled or baked.

Most plants of this tribe are employed to show that, during the process of fertilization, a much greater degree of heat is evolved within the bract, spathe, or floral envelope, than under ordinary circumstances.

ORDER 86. CYPERACEÆ. *Juss.*—THE SEDGE TRIBE.

374. *The PAPYRUS is a sedge-like plant* (Cyperus papyrus, LINN., Papyrus antiquorum, LINK.) *which grows in watery places in Egypt, Syria, Sicily, and Madagascar.*

It has a three-sided stem, many feet in height, which is terminated by a bushy head, consisting of a large and compound cluster of flowers —Sex. Syst. Triandria Monogynia.

From this plant the ancients made their paper; and the process of manufacturing it is described by Pliny, the Roman naturalist, to have been very simple. The inner rind of the stem was merely cut into strips, and laid in parallel and transverse rows; and these, on being heavily pressed with weights, adhered together. The substance thus formed, though of rude texture, was capable of being written upon; and there are many manuscripts still extant on paper of this description, particularly in the British Museum. The ancients also sometimes employed the sword-shaped leaves of this plant for writing upon. With the former a kind of ink was used; but on the latter the letters were formed by a metallic pointed instrument, called by the Roman a stylus.

But the papyrus plant was not merely useful for writing upon. The inhabitants of the countries where it is found manufacture it, even to this day, into sail-cloths, mattrasses, ropes, and sometimes even into wearing apparel. When the stems are compactly woven together, and plastered externally with a kind of resinous substance, so as to prevent the admission of water, they are made into boats. These, though they resemble great baskets in appearance, are of considerable use to the inhabitants. The "ark of bulrushes daubed with slime and pitch," in which the infant Moses was placed, is supposed, by the best commentators, to have been a boat made of this plant. According to Bruce, all the boats at the present time in Abyssinia are made of papyrus.

The floral *thyrsus* which was used to adorn the temples and statues of the gods, was a representation of the tuft of the papyrus.

The papyrus requires stoves to rear it in this country, where they must be placed in water, with a bottom of rich mud.

375. *COTTON GRASS* (Eriophorum angustifolium, Pl. 2. Fig. 18).—*The seeds of this grass are encompassed with long cotton or wool-like hairs: so abundant are the plants in many tracts of marshy land, particularly in the north of England, that the ground appears almost as if covered with snow.—Sex. Syst.* Triandria Monogynia.

Poor people sometimes stuff their pillows with the down of the cotton grass; but there is a prevailing opinion that it is not wholesome to sleep on. This down is probably too brittle to be manufactured by itself into thread; yet, in combination either with wool or cotton, it may be spun into a strong and uniform yarn, from which gloves, stockings, and cloth, in small quantity, have been made. Its brittleness has been much corrected by a simple chemical process. Wicks for candles have sometimes been made of it.

376. *LAKE RUSH* (Scirpus lacustris, Pl. 2. Fig. 19).—*Of the stems of this plant the bottoms of chairs are made. Being of a soft and pliant texture, and destitute of roughness, the bulrush is also sometimes used for the stuffing of pack saddles, making of mats, and thatching of cottages. In severe seasons cattle eat it.—Sex. Syst.* Triandria Monogynia.

Order 85. GRAMINACEÆ. *Lindl.*—The Grass Tribe.

377. *SUGAR is the concrete or crystallized juice of the sugar-cane* (Saccharum officinarum, Pl 1. Fig. 5), *a plant much culti-*

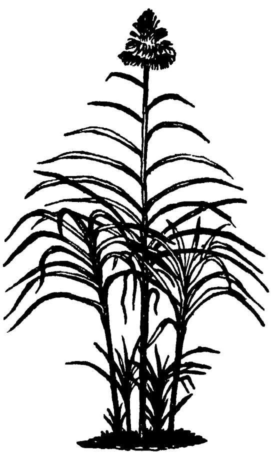
vated both in the East and West Indies, which has a jointed stem eight or nine feet high, long and flat leaves of a greenish yellow colour, and flowers in bunches.—Sex. Syst. Triandria Digynia.

Sugar, as found in commerce, is a neutral compound, consisting of acid, oil, charcoal, hydrogen, and carbonic acid gas.

The cultivation of the sugar-cane is pursued to a great extent in the islands of the West Indies, where, about three centuries ago, it was first introduced from China, or some other parts of the East, and where it flourishes with great luxuriance, particularly in moist and rich ground. The quantity annually produced in different parts of the world, in 1839 and 1840, amounted to 18,080,658 cwts., and the duty paid on that imported, in 1839, was 4,827,018*l.*

The season for planting it commences about the beginning of August. This operation is performed by laying the canes in rows, in trenches formed for the purpose. Roots issue from each joint; and in the course of nine or ten months, the stems which rise from these respective roots, and constitute the sugar crop, attain their perfect state. The saccharine juice is contained in a spongy texture, (Fig. 50. A) with which the interior of the plant is filled.

Fig. 49.



Sugar Cane.

When cut down, the canes, separated from the leaves, are divided into pieces, each about a yard in length. These are tied together in bundles, and conveyed to the sugar-mill, where they are bruised. The juice which flows from them is conducted into a large receiving vessel. The quantity of juice prepared by some of these mills is upwards of ten thousand gallons in a day.

The next operation is called clarifying. For this purpose the juice is conducted to the boiling house, where it is received into copper pans, each placed over a separate fire. A certain proportion of powdered lime is now added to it, for the purpose, it is said, of taking up any oxalic acid which the juice may happen to contain. The heat is then increased until the liquor is nearly in a boiling state. By this process the greatest part of the impurities contained in the juice rises to the surface in a scum. The purified liquor is then carefully drawn off, leaving the scum at the bottom of the pan.

From these pans it is then conveyed to the evaporating boiler, where the scum, which rises to the surface, is skimmed off as the liquor boils. After undergoing a similar process in smaller boilers, with a further mixture of lime, until it has attained a certain degree of thickness, it is transferred into a large shallow wooden vessel, where, as it cools, it assumes an imperfect crystallization, by which it is, in some degree, separated from the *molasses* or *treacle*, which is incapable of being crystallized, and which is exported to the different countries of Europe.

From the cooler the sugar is removed to the curing-house. This is a large, airy building, furnished with a capacious cistern. Over the cistern is an open frame of strong joist-work; upon which are placed several empty hogsheads, each open at the head, and having a few holes at the bottom, closed by stalks of the plantain tree thrust through them. The mass of saccharine matter is now put into these hogsheads; the molasses are separated from the sugar, by draining into the cistern, through the spongy stalks of the plantain; and the remainder, thus entirely crystallized, has the name of *muscovado* or *raw sugar*.

378. *Clayed sugar* is prepared by a process somewhat different: the sugar, when taken from the coolers, is put into conical vessels of earthenware, each having, at its bottom, a hole, about half an inch in diameter, which, at the commencement of the process, is stopped with a plug. This plug, after the sugar has become perfectly cool, is removed, and the molasses drain through the hole. When these have ceased to run, the surface of the sugar in the vessel is covered with fine clay, to a certain thickness, and water is poured upon the clay. This, oozing through it, pervades the whole mass of sugar, re-dissolves the molasses still remaining in it, with some parts of the sugar itself, carries these off through the hole at the bottom, and renders the sugar that is left much purer than that which is made the other way.

certain portion is again subjected to boiling in a more rapid manner; after which it is again transferred to coolers, and while there it is violently agitated with wooden oars till it appears thick and granulated. It is then poured into conical moulds of unglazed earthenware or iron, the points of which are perforated. Here it concretes into a hard white mass, leaving that part of the syrup, which will not crystallize, to run off through the hole in the point of the cone. The broad end of the cone is then covered with moist pipe clay, the water from which penetrates into the sugar, and displaces and carries off the impurities which, otherwise, would be retained in and discolour it. It is then carefully dried, and receives the name of *loaf* or *lump sugar.*

379. *Sugar-candy* is formed by boiling down a solution of sugar till it becomes thick; and then removing it into a very hot room, to crystallize upon sticks or strings, placed across small tubs, or other vessels. It is denominated brown or white sugar-candy, according to the quality of the sugar of which it is made.

380. *Barley sugar* is sugar boiled in barley water, but now more frequently in common water, till it is brittle. It is then rolled on a stone anointed with oil of sweet almonds, and formed into twisted sticks. To give it a colour, a small quantity of saffron is sometimes mixed with it.

When sugar was first introduced into this country, it was employed only as a medicine; but it has now become an essential article both of luxury and use. It is the basis of syrups; and is used in cooking, and in confections, preserves, sweetmeats, and liqueurs of every description. Sugar is also sometimes employed in medicine.

The juice of the sugar cane is so palatable, and at the same time so nutritive, that during the sugar harvest, every creature which partakes freely of it, whether man or animal, appears to derive health and vigour from its use. The meagre and sickly negroes exhibit at this season a surprising alteration, they now become fat and healthy. The labouring horses, oxen, and mules, being allowed, almost without restraint, to eat of the refuse plants, and of the scummings from the boiling-house, improve now infinitely more than they do at any other season of the year.

Yet it should nevertheless be observed, that sugar, to many persons labouring under *indigestion*, is particularly injurious.

381. *Rum* is a spirituous liquor distilled from molasses, the scummings of the hot cane juice from the boiling house, or raw cane liquor from canes expressed for that purpose, lees (or, as it is called in Jamaica, *dunder*), and water. The dunder answers the purpose of yeast for the fermentation. The duty paid on the importation of rum, brandy, &c., in 1839, amounted to 2,615,443*l.*

Fig. 50.

A

Sugar-cane.

Sugar-canes, as large and juicy as those of the West Indies, are cultivated in several parts of Spain, but particularly in the country betwixt Malaga and Gibraltar. They were originally introduced by the Moors, several centuries ago, and the sugar made from them is of excellent quality. There are sugar mills, in more than twelve different places, on the coast of Grenada, all of which are fully employed; in one village there are four, which cost at least 5,000*l.* sterling each. As sugar exists in considerable quantity in many other vegetables besides the sugar-cane, it is sometimes obtained from them as well as from the cane.

382. *The BAMBOO CANE* (Bambusa arundinacea) *has a hollow, round, straight, and shining stem; and sometimes grows to the length of forty feet and upwards: it has knots at the distance of ten or twelve inches from each other, with thick, rough, and hairy sheaths, alternate branches, and small, entire, and spear-shaped leaves.—Sex. Syst.* Triandria Digynia.

There is scarcely any plant so common in hot climates as this, and few are more extensively useful. It occurs within the tropical regions both of the eastern and western hemispheres, throughout the East Indies and the greater part of China, in the West Indies, and America. In England it can only be cultivated in a hot-house ; and its growth is so rapid, even there, that a strong shoot has been known to spring from the ground and attain the height of twenty feet in six weeks.

The inhabitants of many parts of India build their houses almost wholly of bamboo, and make nearly every description of furniture with it. From two pieces of bamboo, rubbed hard together, they produce fire ; this is owing to the quantity of *silex* which is deposited in the cuticle or skin of the stem. The masts of boats, boxes, baskets, and innumerable other articles are made of bamboo. The *sheaths* and *leaves* may also be manufactured into paper. The stems are frequently used as pipes for conveying water. The strongest make the poles with which slaves or servants carry those kind of litters so common in the East, called palanquins. The bamboo serves also as fences for gardens and other enclosures : and the leaves are put round some of the tea which is sent in chests from China to Europe. The Chinese make of the external *bark* of the bamboo, various kinds of cordage, which has the advantage of united lightness and durability. Some of the Malays preserve the small and *tender shoots* of bamboo in vinegar and pepper to be eaten with their food. Many of the walking canes which we see in Europe are formed of the young shoots of this plant.

The Chinese make a kind of frame-work of bamboo, by which they are enabled to float in water ; and the Chinese merchants, when going on a voyage, always provide themselves with this simple apparatus to save their lives in case of shipwreck. It is formed by placing four bamboos horizontally across each other, so as to leave, in the middle, a square place for the body ; and, when used, this frame is slipped over the head, and secured by being tied to the waist.

From the cavities at the base of the leaves of bamboo is also obtained a concrete white substance called *Tabasheer*, which has some curious properties ; it appears to be nearly, if not entirely, pure flint or silica.

383. ***RICE*** (Oryza sativa, Pl. 4. Fig. 39) ***is a well-known kind***

of grain, which is much cultivated in the East Indies, America, Spain, Italy and the south of France, in Germany, and Hungary; and which, previously to its being sold for use, is freed from a brownish husk that covers it.

The rice plant has an erect, simple, round, and jointed stem. Its leaves are narrow and pointed; and its flowers appear in a kind of bunch, at the extremity, somewhat resembling, but more compact than, an ear of oats. But there are several varieties.—Sex. Syst. Triandria Digynia.

The best rice comes from America; and it is said that the Americans were indebted for this grain to a small bag of it which was formerly given as a present from a Mr. Dubois, treasurer of the East India Company, to a Carolina merchant. In 1839, 32,926*l.* were paid as duty on this article.

Fig. 51.

Rice.

A wet and morassy soil appears in general necessary to the cultivation of rice. The parts of the farms or plantations in which it is grown are usually so situated as to admit of being flooded; and in many places, reservoirs of water are formed for this purpose. These reservoirs have sluices, by which the rice fields may be inundated at pleasure. In reaping the crop, the labourers generally work knee deep in water and mud. As the rice is cut, the sheaves are put on drays, and carried out to be spread on dry ground. The rice thus produced has the name of *marsh rice*, and is that which is chiefly imported into Europe.

In some of the mountainous parts of the East Indies rice is cultivated on the sides of hills, where it can only be watered by rain. It is sown, however, at the beginning of the rainy, aud reaped in the beginning of the dry season; so that, in fact, it has nearly all the advantages of being watered, which the marsh rice possesses. The general appellation of rice, in the East Indies, is *paddy;* but the kind just mentioned is denominated *paddy gunung*, or *mountain rice* (*Oryza mutica*), and is little known in Europe, though of late years it has been cultivated with success in Tuscany. Its grains are whiter, finer, and more palatable than those of the marsh rice.

Rice is freed from the husks in several ways. In some places it is pounded in large mortars, and afterwards winnowed. In others large cylindrical pestles are lifted by a wheel worked by oxen. The inhabitants of several parts of the East throw it into hot water, by which the grains are slightly swelled, and thus burst through the husk. In the island of Ceylon and in some parts of America it is trodden out by oxen. The Sacred and other writings inform us that this was the mode which the ancients adopted with other species of grain.

In Spain, when the rice is ripe, it is gathered into sheaves, and put into a mill, where the lower grinding stone is covered with cork; and, by this means, the grain is separated from the husk, without being bruised.

Rice is said to have been cultivated with success in some parts of Scotland; a crop of rice has been also obtained near Windsor; indeed it is not improbable, that, by degrees, this species of grain may be naturalized to our climate. It will not, however, pay for growing in this country.

No kind of grain is so generally adopted for food in hot climates as this. The inhabitants of many parts of the East subsist almost wholly upon it; and large quantities are annually imported into Europe, where it is highly esteemed for puddings and numerous culinary preparations. In a scarcity of other grain, rice may be used with considerable advantage as an ingredient in bread. For the fattening of poultry, boiled rice has also been adopted with success. It is sometimes used in medicine, and is prescribed by medical men in preference to the other cereal grains, on account of its being less laxative.

The inhabitants of the East obtain from rice a vinous liquor, which is more intoxicating than the strongest wine; and an ardent spirit, called *arrack*, is also partly made from it. The latter is chiefly manufactured at Batavia, and at

Goa on the coast of Malabar; and is said to be distilled from a mixture of the wort or infusion of rice, and of toddy, or the juice of the cocoa-nut tree, to which other ingredients, and particularly spices, are added.

There is, it is said, only one species of rice; but the varieties of it, according to the soil, climate, and culture, are very numerous.

384. *MAIZE, or INDIAN CORN* (Zea mays, Pl. 5. Fig. 58), *is a species of grain much cultivated in America and other warm climates: the grains are either of a yellow or blackish colour, somewhat shaped like flattened peas, and grow closely set round the upper part of high perpendicular stalks. There are numerous varieties of this plant, some of which have been lately cultivated in this country. Sex. Syst.* Triandria Digynia.

To the inhabitants of many warm climates the cultivation of maize is a very important pursuit.

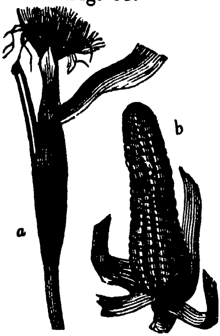
Fig. 52.

Indian Corn.

These plants are propagated by sowing the seeds in rows, in March, April, or May; they generally produce two crops in the year, and yield, according to the soil, from fifteen to forty bushels per acre. As soon as they are ripe, the ears are gathered. They are shortly afterwards threshed, and the grain, when separated, is spread out to dry in the sun; for, if it were heaped together in this state, it would ferment and grow. It formed the article known as Cobbett's Corn.

The American Indians parch this kind of corn over a fire, in such a manner as not to burn it. Afterwards they pound it, sift the meal, and preserve it for their chief food. They make it into puddings and cakes, or bread. It is also eaten by the natives of Asia. Maize is useful for poultry and cattle of every kind; and if converted into malt, a wholesome beverage may be brewed from it. Of the leafy *husk* which surrounds the ear of the maize (Fig. 53. A, B) a beautiful kind of writing paper has been manufactured at a paper-mill near Rimini in Italy; and a greyish

Fig. 53.



Indian Corn.

paper may be manufactured from the whole plant. The *stalks* are said to afford an excellent winter food for cattle. When the *young ears* are beginning to form (Fig. 53. A), they have a sweet and agreeable taste. If in this state the leaves be stripped off, and the ears be subjected to pressure, a pleasant and palatable milky juice may be obtained from them. When taken in quantity as food it occasions looseness of the bowels.

There is another species of this corn, *Zea Curagua*, or *Valparaiso Cross corn*, that is curious on account of the grains when roasted splitting into the form of a cross, and to which a sort of religious reputation is attached.

385. *OATS are the seeds or grain of an annual plant* (Avena sativa, Pl. 2. Fig. 14), *too well known, and too much cultivated throughout every part of Europe, to need any description. The country from which they were originally imported is not known.— Sex. Syst.* Triandria Digynia.

Oats are not alluded to in the Old Testament, though Theophrastus, Dioscorides, and Pliny mention them. The principal use of oats in this country is for the feeding of horses. In the northern parts of England, and in Scotland, they are applied also to the nutriment of man, though the meal is much less nutritious than wheaten flour. When simply freed from their husks they are called *groats* or *grits ;* and in this state are much used in broths, and other kind of nutriment for sick and infirm persons. More frequently, however, they are ground into *oatmeal*, which is made into cakes, biscuits, &c. The husks, infused in water, and allowed to remain till the water becomes somewhat acid, are boiled to a jelly called *sowins*. A grateful and nutritive kind of jelly, which has the name of *flummery*, is also made of oatmeal, boiled with water, and flavoured with a little orange-flower water and sugar.

Oats will thrive in almost any soil, but they are chiefly productive on land that has been newly broken up, and they are also considered most valuable and productive in cold climates; for in Italy, France, and the south of Ireland, they are not so good as in Yorkshire and Scotland. They are usually sown in February or March, and the harvest commences about August. Several kinds or varieties are cultivated in different parts of England, such as *white oats*, *black oats*, *brown* or *red oats*, *Siberian*, *Tartarian* or *reed oats*, *Friezland* or *Dutch oats*, *Poland oats*, *Georgian oats*, *potato oats*, and some others; but of these the first are considered the most valuable.

386. *WHEAT is a well known kind of corn* (Triticum vulgare, *var.* hybernum (Pl. 2. Fig. 13), *Lammas or Winter Wheat), which is cultivated in most of the civilized countries of the world, and is supposed to have been originally introduced into Europe from some part of Asia.*

The Triticum vulgare, *var.* æstivum, *Summer or Spring Wheat (so called because sown in the spring), appears to deserve more attention than has hitherto been given to it in this country. It is supposed to be a native of Baschkirs, and is much cultivated in Europe.* —*Sex. Syst.* Triandria Digynia.

The following species are likewise cultivated for their grain: Triticum turgidum (compositum), T. turgidum, T. Polonicum, T. spelta, *and* T. monococcum.

No grain is so nutritive or so valuable to the inhabitants of nearly all climates as this; and by a wonderful ordination of Providence, it is rendered capable of sustaining without injury almost the two extremes of heat and cold. Not only does it ripen in Egypt and Barbary, but it ripens equally well in Scotland, Denmark, and Sweden.

It constitutes the chief food of the British nation; and its abundance or scarcity regulates, in a great degree, the welfare and prosperity of the inhabitants. The whole annual consumption of grain, in this island, amounted, ten years ago, to nearly 25,000,000 quarters; and in London alone, to more than 1,162,100 quarters. Of this, by far the greatest proportion is wheat. The amount of Customs' duty paid on corn, in the year 1839, was 1,098,779*l.*

For the cultivation of this important grain the best lands are rich clays and heavy loam: and although light soils will produce wheat of excellent quality, yet the crops on the other soils are by far the most abundant. The best season for committing the seed to the ground is September, and the earlier in the month the better. Some farmers consider it necessary to steep the seed in brine or other pickle before it is used, to prevent it from being devoured by vermin, and render the corn less liable to disease than it would be without this process. In a good season the wheat harvest commences in August, and is finished in the course of the ensuing month. This corn is usually cut with reaping-hooks, but in some parts it is mown with scythes.

The different varieties of wheat cultivated in this country are too numerous to be particularized.

Wheat is liable to injury, not only from the attack of insects, but from several kinds of disease, the principal of which are *blight*, *mildew*, and *smut*. In the former the fibres and leaves of the plants are contracted and enfeebled, and the grain is ultimately deprived of sufficient nourishment: by mildew the straw and ear are affected: and by smut the grains, instead of containing their proper substance, become filled with a black or dark brown powder. This powder has been ascertained to be a fungus.

Mr. Edlin obtained from one pound avoirdupois of wheat, twelve ounces of starch, twelve drachms of gluten, and four drachms of sugar, the rest was bran and waste. No vegetable used for the sustenance of man contains *gluten* in so large a quantity as wheat: it is remarkable that gluten has a very near alliance to the animal substance called albumen.

387. *Starch* is a substance frequently prepared from wheat, and is obtained by the following process. The wheat is put into tubs of water, and exposed, for some days, to the heat of the sun, in order to bring on a proper degree of acetous fermentation, the water being changed twice a day. Having now become sufficiently soft, it is poured into large canvas bags or sieves, which are worked or beaten on a board over empty vessels, called *frames*, to extract the farinaceous particles, and to separate the bran. Fresh water is put to it; and after being considerably agitated, it is allowed to subside. As the sediment increases, the water, called *sours*, is gradually drained off, and at length the starch is *boxed*, where it strains through canvas. It is then deprived of its moisture, and dried by heat. During this process it splits into pieces of a somewhat square shape, though unequal in size and length. The *Poland* or *glazing*

starch, made use of by washerwomen, is coloured blue by smalt or indigo. Notwithstanding the principles of which starch is composed differ little from those which constitute sugar; and notwithstanding starch, in the *germination* of seeds and in the process of *malting*, is converted into sugar, yet no useful and economical *artificial* process has been yet invented for converting starch into sugar: many trials were some years ago made in France; and although the conversion could be effected, the process was so troublesome that it has been long since abandoned.

388. *Bran* is the husk of wheat, separated in grinding. Infusions of bran are, not unfrequently, employed both externally and internally in medicine. They are also sometimes used to cleanse the hands instead of soap. In times of scarcity, bran has been employed in the making of household bread; its effects on various constitutions do not warrant its general use, as it is very liable to bring on a relaxed state of the bowels.

389. *Wheat straw*, when cut small, has been by some considered a wholesome provender for horses and oxen, especially when mixed with green food. It is also used as litter for horses, and is employed as thatch for cottages, houses, and barns. When cut into certain lengths, bleached by means of sulphur, and split, it is plaited, and formed into hats and bonnets. This trade is now principally carried on at Luton and Hitchin in Hertfordshire. Hitchin is esteemed the largest *straw plait* market, and Luton the principal manufacturing town, the manufactories of Messrs. Vyse and Waller being the most extensive in the country. Dunstable was formerly considered as having the largest trade. Of late *straw plait* has been much imported, and on hats of chip and straw a duty of twenty shillings per dozen is levied. This amounted, in 1839, to 1,729*l.* The duty on foreign *chip* or *straw plait* is from seventeen to twenty shillings per lb., and this amounted, in 1839, to 19,637*l.*

390. A nutritive substance called *Semolina* is formed from wheat flour, granulated by a particular process. A patent was granted in the year 1780 to Mr. Jacob Levy, for a method of making it. Previously to this, semolina had been imported from Poland, under the name of *Cracow*

groats. It is supposed to be a wholesome food, but is little heard of in this country. It may be made into excellent puddings.

391. *Macaroni* is a preparation from the finest wheat flour, mixed with eggs, or other glutinous substance. It is chiefly imported from Italy, Sicily, and Germany. Its name implies *cut paste*, and it is eaten in various ways; on the continent with milk, and with us in soups and puddings, or served up in a dish with grated cheese, milk, and other ingredients.

392. *Vermicelli* is made by a mixture of flour, cheese, the yolks of eggs, sugar, and saffron. This, being reduced to a proper consistency, is formed into long slender pieces or threads, like worms, by being forced, with a piston, through a number of little holes, in the end of a pipe made for the purpose. Vermicelli was first brought from Italy; it is chiefly used in soups and other culinary preparations.

393. *BARLEY is a well known and cultivated corn* (Hordeum distichon, Pl. 2, Fig. 15), *the native country of which has not been decidedly ascertained.*

Four species, or sub-species, of barley are more or less cultivated, namely, the Hordeum distichon, *or Common barley; the* Hordeum vulgare, *or Spring barley; the* Hordeum zeocriton, *or Battledore barley; and the* Hordeum hexastichon, *or Winter barley, called in Scotland* Bear *or* Bigg: *this has six rows in the ear, the common barley has only two rows in the ear.—Sex. Syst.* Triandria Digynia.

Next to wheat, this is, in Europe, the most valuable of all the species of grain, especially for growth on light and sharp soils. The seed-time for barley usually commences about the end of March or the beginning of April, and sometimes lasts until the first week in June. Four quarters per acre are considered a fair average crop, and eight quarters a very extraordinary one.

Few instances of fecundity in corn are more remarkable than what has been related of two grains of the SIX-ROWED BARLEY which were planted in a garden: they produced 113 stalks, nearly all of which yielded ears; and these contained in the whole more than 2,500 grains.

The principal use to which barley is applied in this country is the making of *malt*, from which beer and ale are brewed. For this purpose it is first steeped in water for three or four days. It is then taken out, and suffered to lie, until it begins to germinate. As soon as the germination has approached a certain state, its further progress is prevented by drying the barley in a kiln, heated with coke, charcoal, or straw. The grain has now become mellow and sweet; and, after having been crushed in a kind of mill contrived for the purpose, its saccharine qualities are easily extracted by the heated water, in brewing. The liquor thus produced has the name of *wort;* and this, after having undergone the process of fermentation, and having received a bitter flavour by a mixture of hops, becomes ale or beer. Hence has originated the general appellation of *malt liquor.* What remains of the malt after brewing is called *grains.* These, in London, and elsewhere are employed for the feeding of horses, cows, and swine.

Besides the use of barley in brewing, there is in some countries, especially in Scotland and Germany, a great consumption of this grain, for broths, soups, and other food. For this purpose it is freed from its husks and formed into round granules, about the size of small shot, and of a pearly whiteness, which hence have the name of *pearl-barley.* All except the heart or best part of the grain is thus taken away. The barley, in this state, when boiled, forms a nutritive food; and a decoction of it, properly flavoured with acid, is much used as a beverage in acute diseases. The making of pearl barley is a German invention, but it is now prepared in this country. In Scotland the lower classes make it by means of hand-mills; this is much larger and coarser than pearl barley; it is usually called *Scotch barley.* Many persons are satisfied with merely ridding the grain of its husks by stamping it in mortars.

394. *Barley-meal* is occasionally made into bread by the poor; and it is likewise used for the fattening of poultry and swine. From *barley-straw* a yellowish coloured paper has been manufactured; the making of which was, some years ago, attempted in this country upon a large scale, but without success.

395. ***RYE*** (Secale cereale, Pl. 2. Fig. 16.) ***is a grain supposed to have been first introduced into the northern parts of Europe from***

the island of Crete, and the Caucasian Caspian Desert.—Sex. Syst. Triandria Digynia.

Rye is mentioned in several books of the Old Testament. As bread corn, sometimes alone, but more commonly mixed with wheat, rye was formerly in great request, particularly in the northern counties of England. This mixture, which is denominated *blend-corn*, or *maslin*, is at present partially used, in certain districts, not only from motives of economy, but also because the rye is supposed to render the bread more moist and palatable than it would otherwise be. It is by no means so nutritive as wheat, owing to the absence of *gluten*. It is not now so much used as it used to be. In some parts of the country rye is much used by gingerbread bakers, for the dark colour of its flour is not perceptible when mixed with treacle. This grain is frequently used for the distillation of spirits.

Rye is liable to a disease called in France *ergot*, in this country *horned* or *spurred* rye (365); when eaten in this state it is exceedingly poisonous. *Horned* rye is covered with a violet coloured skin, and becomes bent and lengthened into the form of a horn or spur. Its poisonous effects are chiefly evinced by pains in the limbs, succeeded by violet-coloured spots on the skin, blisters, and gangrenous ulcers, and dry gangrene.

Rye will ripen if sown in the spring; but it succeeds best when treated like a winter wheat. In several parts of England rye is sown either by itself, or mixed with tares, to be cut whilst green for the feeding of sheep, cows, and horses. Rye straw is used by brick-makers and collar-manufacturers, and is considered an excellent material for the thatching of cottages and barns.

396. *FODDER GRASSES.—When grasses are spoken of, they are understood to be such plants as have a round, jointed, and hollow stem, surrounded at each joint with a single leaf, long, narrow, and pointed; and the flowers of which are a kind of chaffy husk. According to this definition, wheat, barley, oats, and rye, properly belong to the grasses, although they are known by the peculiar appellation of corn, grain, or cereal grains*[1]*.—Sex. Syst. They all belong, with but one exception, to* Triandria Digynia.

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[1] The grasses are so numerous, and the describing of them in such a manner as to be understood by an inexperienced person

To the grasses it is that the face of nature is indebted for a great portion of its cheerful appearance and its beauty. They constitute the general herbage of every country, covering to an immense extent the whole surface of the ground. They are very various in their kinds, the British species alone being nearly a hundred and twenty-five in number. To many species of animals their leaves afford an indispensable article of sustenance; and their seeds supply food to birds.

397. *SWEET-SCENTED VERNAL GRASS* (*Anthoxanthum odoratum*, Pl. 2. Fig. 17).—This species is usually considered (though it perhaps ought not exclusively to be so) as that to which the hay-fields are indebted for their well-known and delightful fragrance. When partially dried, it is very odorous; and if chewed, in a recent state, its *stalks* are highly aromatic, tasting not unlike those of fresh lavender. Its odour is owing to a camphorous principle. The *root* has an odour somewhat resembling that of musk. A distilled water, which serves as a vehicle for some perfumes, is occasionally prepared from the leaves and flowers of the vernal grass. The dried flowers are employed in some parts of the Continent for imparting an agreeable flavour to snuff and tobacco.

The vernal grass is not very productive, and by some farmers it is considered not palatable for cattle. Others, however, esteem it a useful addition in their meadows: and from its being generally found in great abundance on pastures of which sheep are fond, and that afford excellent mutton, it is at least thought to be a good grass for them.

398. *MEADOW FOX-TAIL GRASS* (*Alopecurus pratensis*, Pl. 2. Fig. 20.) is a very common but valuable kind, which grows freely in moist and fertile pastures and meadows. It possesses, in a superior degree to any other grass, the three great requisites of quantity, quality, and early growth. The best hay that is brought to London is said to be from meadows where this grass abounds; in many parts adjacent

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would be attended with so much difficulty, that it has been considered more advantageous to the reader to admit, in this place, only some of the most important kinds; and merely to speak of their uses, referring to the figures for their further illustration.

Though a native and very common grass in our own country, it is doubtful whether our climate be sufficiently warm to bring it to the same perfection in which it is found in America. It has, however, been cultivated in England with considerable success; and when used for green food, for which it is particularly calculated, it may be cut two or three times in one season; but when intended for hay, it should be cut at least a week before it flowers. The name of *Timothy* was given to it because it was brought by Timothy Hanson from America.

400. *FIORIN*, or *ORCHESTON LONG GRASS* (*Agrostis stolonifera*, Pl. 2. Fig. 22), is known as a troublesome weed in moist meadows and pastures, and also in cold and stiff arable land, by the name of *Black Squitch* or *Bent grass*. It grows with such luxuriance, lying upon the ground, and taking root at the different joints, that the stems are sometimes several feet in length; and when cultivated as a crop, it has been known to produce, at two cuttings, between seven and eight tons per acre. This grass was first cultivated for hay several years ago, at Orcheston in Wiltshire. Horses, sheep, and cattle, are said to be extremely partial to it, and to prefer the hay which is made from it to any other. To be in perfection, it requires a moist climate, or a wet soil; and it will grow on cold clays that are unfitted for other grasses.

In Ireland, whose soil and climate it seems to suit better than any where else, it is called fiorin grass, and under this appellation it was first introduced to the public notice in that country, in 1810, by Dr. Richardson.

401. *The MEADOW SOFT GRASS, or YORKSHIRE WHITE GRASS* (*Holcus lanatus*, Pl. 3. Fig. 25), though it vegetates late in the season, produces an abundant crop, and flourishes well in any moist situation. Both its foliage and flowers are soft and woolly. It is chiefly calculated for the feeding of sheep, and has answered extremely well when close fed. The hay made from it is said to be very injurious to horses, and it is not much relished by cattle.

402. *CANARY GRASS* (*Phalaris Canariensis*, Pl. 2. Fig. 23).—This grass grows wild in Worcestershire, and some other parts of England. It is cultivated chiefly in the Isles of Thanet and Sheppey, for the sake of its seeds, which are extensively used as food for small birds.

403. *PURPLE MELIC GRASS* (*Melica cœrulea*, Pl. 2. Fig. 24) is found in great luxuriance on the turf moors, near Glastonbury, in Somersetshire. The people of that neighbourhood make of its stalks a neat kind of besoms, which are used as a cheap and tolerably good substitute for hair brooms. This grass occurs in the most barren, sandy, and boggy situations: but more especially about pools upon mountainous heaths.

404. *REED MEADOW GRASS* (*Poa aquatica*, Pl. 3. Fig. 26.) is one of the most useful of the British grasses, particularly if grown in wet meadows, or upon the banks of rivers or brooks. In the fenny lands of Cambridgeshire and Lincolnshire it not only affords a rich pasturage for cattle in summer, but forms also the chief part of their winter sustenance. In favourable situations it sometimes attains the height of five or six feet. When cut for hay, it is first dried, then bound up into sheaves, and formed into ricks, in which it undergoes a slight fermentation that much improves it. Cows and sheep are partial to this grass. As hay, it is a valuable food for cattle, and particularly for milch cows. It is sometimes cut thrice in one season.

405. *SMOOTH-STALKED MEADOW GRASS* (*Poa pratensis*, Pl. 3. Fig. 27) is a favourite grass for cattle; and flourishes even on the driest soils, growing wild in

meadows, on dry banks, and even on walls. In the rich meadows of Somersetshire it forms a considerable part of the herbage; and in those that have been flooded during the winter, it flourishes with such luxuriance as nearly to exclude every other grass. Notwithstanding this, it possesses the valuable property of resisting excessive drought, and is frequently green in high gravelly pastures, after almost every other grass has been withered; it flowers early, and makes an extremely valuable hay.

406. *ANNUAL MEADOW GRASS* (*Poa annua*, Pl. 3. Fig. 28).—No grass is more common than this, and none makes a finer turf. It occurs in almost every situation, by the sides of roads, on open and extensive commons; and in many parts of England there are whole meadows of it without any mixture of other grasses. In those districts of Suffolk which produce the best butter, the annual meadow grass is found in great abundance.

It is a remarkable circumstance respecting this grass, that it does not suffer injury, but that on the contrary it is improved by persons frequently walking over it.

This grass and the COMMON MEADOW GRASS, *Poa trivialis*, are almost the only grasses which will thrive in grass plats, in towns, and small confined situations.

407. *CRESTED DOG'S-TAIL GRASS* (*Cynosurus cristatus*, Pl. 3. Fig. 29) is extremely common in meadows and pastures, and constitutes a principal part of the turf, on high gravelly or chalky soils, in parks, lawns, and sheep walks; and from the close and thick turf which it makes, it affords good nourishment to cattle and deer. Parks that are famous for excellent venison contain a great proportion of this grass. In the summer time its seeds afford sustenance to pigeons and small birds.

408. *SHEEP'S FESCUE GRASS* (*Festuca ovina*, Pl. 3. Fig. 32) has great celebrity as food for horses and cattle, and in particular for sheep, which are said to prefer it to all other grasses, and to become fat upon it sooner than upon any other. Though of short growth, its leaves are numerous and succulent. The Tartars are said generally to fix their habitations during the summer, in places where there is the greatest plenty of this grass, from its yielding an abundant

supply of excellent food for their cattle. But according to Sir H. Davy it is not so nutritive as has been generally supposed. It is, however, well adapted, by its short thick foliage, for sheep, and for producing delicate mutton; it is abundant on downs. It is also an excellent grass for lawns, requires little mowing, and suffers few intruding plants. On a comparison of this grass with the *Festuca rubra*, or PURPLE FESCUE GRASS, we learn from the same authority that this last exceeds in nourishment the sheep's fescue grass, in the proportion of fourteen to eleven.

409. *HARD FESCUE GRASS* (*Festuca duriuscula*, Pl. 3. Fig. 30) is common in pastures, meadows, and waste grounds. It springs early, affords excellent food for all kinds of cattle; and in good ground yields a plentiful crop, either as grass or for hay.

410. *FLOATING FESCUE GRASS* (*Festuca fluitans*, Pl. 3. Fig. 31).—This plant, which grows almost exclusively in wet ditches and in ponds, is so favourite a food of horses and swine, that they will sometimes even endanger their lives to obtain it. It is said that a field of four acres, in Berkshire (nearly always covered with water), afforded sufficient nutriment to maintain five farm horses in good condition, from April to the end of harvest, without any other food; and that it yielded even more than they could eat. The Cottenham and Chedder cheeses are said, in a great measure, to derive their celebrity from the cows feeding on this grass.

Its seeds are small, and remarkable for their sweet flavour and nutritious qualities. They are annually collected in Poland, and are exported thence to various places, under the name of *manna seeds*. These are used in soups, gruel, and puddings, even by persons of the first rank and consequence. When ground into flour, they are convertible into bread, which is little inferior to that made of wheat. Geese are fond of the seeds, and well know where to find them. It is remarkable that these seeds have hitherto been entirely neglected in England; though without difficulty they might be obtained in sufficient quantity to prove beneficial.

411. *The COMMON REED* (*Arundo phragmites*, Pl. 3.

Fig. 33) grows in ditches, ponds, and by the sides of rivers, attaining the height of six or seven feet, and flowering about the month of July.

Reeds are frequently made into screens or fences for gardens, and they are considered particularly eligible for sheltering tender plants from injury by cold, or blighting winds. They likewise make excellent *weavers' combs;* and when nailed across a frame of wood work, are frequently employed as a foundation for plaster floors. They are sometimes made into chair bottoms; and into thatch for cottages and out-buildings; screens for brick-makers; and by the ship-builder for burning off the pitch, and for charring the bottoms of ships.

From the flowers the country people of Sweden extract a green dye, which they occasionally use for woollen cloth; and it is stated that, from the dried roots, a flour may be made, which can be converted into a wholesome and nutritive bread.

412. *SEA MATWEED* (*Arundo arenaria*, Pl. 3. Fig. 34) is a useful and common plant on most of our sandy sea shores. Its cultivation has at various times been much encouraged, and even acts of parliament have been passed for its preservation, in consequence of its spreading roots giving stability to the loose, blowing sand, and thus raising a bulwark against the encroachments of the waves. The Dutch are said to have availed themselves of the advantage of these plants in securing and rendering firm several parts of their coasts, which would otherwise have suffered much injury. The same is also the case along the shores of Norfolk and Suffolk, &c.

On the south coast of the island of Anglesea the inhabitants manufacture them into mats and ropes; and the Danes employ the fibrous roots for making whisk brushes. The roots are sometimes more than forty yards in length.

The common people of Iceland collect the seeds of the sea matweed for making bread.

413. *RYE GRASS, RAY GRASS, or RED DARNEL* (*Lolium perenne*, Pl. 3. Fig. 35), has of late years been cultivated in some countries, to considerable extent, as fodder for cattle. Its agricultural merits were first dis-

covered in Norfolk, and thence the seeds have been distributed through the greater part of the kingdom; those who purchased them little suspecting that the plant was a weed in their own fields. In dry pastures and by road sides this grass is extremely common.

When sown in high or sandy lands, either alone or with clover, it yields an earlier crop than most other grasses; and thus affords food at a season when it is sometimes difficult otherwise to be obtained. The ray grass that grows wild is stated to be much superior to that which is obtained by cultivation; and we are informed that, if sown in a rich and fertile soil, it will dwindle in a few years to a poor and insignificant grass. Several varieties of this grass are now cultivated.

It may be also mentioned here that another species of *Darnel* (*lolium temulentum*), called *white*, or *bearded darnel*, has been long known: and that its seeds, if given internally, or mixed with malt liquor, produce intoxication; and it is probable, therefore, that they have considerable medicinal power. It is considered as the only suspicious species in the Order.

414. *COUCH, or SQUITCH GRASS* (*Triticum repens*, Pl. 3. Fig. 36), is a troublesome and pernicious weed. The roots strike so deeply into the ground, and extend so widely, that the eradicating of them is frequently attended with difficulty. As the plant lies upon the ground it strikes out fibres from every joint; and so luxuriant it sometimes is, that a single joint, when transplanted, has in the course of twelve months covered a square yard of land.

The roots of couch grass are collected in large quantities at Naples, and sold in the market as food for horses. They have a sweetish taste somewhat resembling that of liquorice; and in times of scarcity, when dried and ground into meal, they have been converted into bread. They are in this country usually collected and burnt in our fields; this being the best method of getting rid of them, at the same time the ashes affording a good dressing for the land.

415. *MILLET is a small yellowish seed of a grassy plant* (Holcus sorghum), *with large and compact stalks which rise to the height of seven or eight feet, and is much cultivated in several parts of India and Africa.*

In some countries millet *seed* is ground into flour and converted into bread; but this is brown and heavy. It is, however, useful in other respects as food, and is an excellent seed for the fattening of poultry. A good vinegar has been made from it by fermentation; and on distillation it yields a strong spirit. Millet seed is imported into this country from the East Indies, for the purpose chiefly of puddings; by many persons it is preferred to rice. The *stalks* of the millet plant, if subjected to the same process that is adopted with the sugar-cane, yield a sweet juice, from which an excellent kind of sugar may be made.

Nat. Ord. 84. SMILACEÆ. *Lindl.*—The Smilax Tribe.

416. *SARSAPARILLA is procured from several species of* Smilax, *and particularly* S. officinalis, *which is a perennial plant, with an annual climbing or trailing stem, angular or prickly. The root is the part used in medicine. It is very abundant about the banks of the river Magdalena, New Granada, near Bajorque, and this kind is the Zarzaparilla of the natives.—Sex. Syst.* Diœcia Hexandria.

In the market several kinds of this root are met with, obtained from various localities. The varieties usually imported are known as the Lisbon, Jamaica, Honduras, Lima, Vera Cruz, &c.

Dr. Steggall, in his Materia Medica, gives the following account of the three principal sorts:—"*Honduras sarsaparilla* comes in bundles two or three feet long, consisting of the roots folded lengthways, and secured by some circular turns, and packed in bales weighing about one hundred pounds, imperfectly covered with skins. The roots at one extremity are collected in large numbers to a common head, to which a portion of the stem is sometimes appended.

"The *Jamaica*, or *Red sarsaparilla*, generally reputed to be the best, is not produced in Jamaica, and only got the name in consequence of that island being a channel for its exportation. A large quantity is also shipped from Vera Cruz and Tampico. The bundles are rather smaller than those of the Honduras variety, the fibres are smaller, and the bark is thinner.

"The *Brazilian*, or *Lisbon sarsaparilla*, grows in the country between the Orinoco and Rio Negro, and is conveyed to the port of Para. It is distinguished by the amylaceous character of its interior structure, and on this account has at times been supposed to be the most valuable variety."

Dried sarsaparilla root is wrinkled externally, of a grey-brown, reddish, and sometimes blackish colour, composed of a thin epidermis, a thick cortical portion, ligneous fibre, and a central pith. In its ordinary state it is almost inodorous, but in decoction acquires a very peculiar odour. It is mucilaginous and slightly bitter to the taste, and after long chewing, causes an acrid sensation in the throat. The root is considered efficacious in proportion as it possesses this acrimony, which appears to reside chiefly in the cortical part. The virtues are imparted to water, but are impaired by long boiling. Diluted alcohol is considered to be even a better menstruum than water for taking up the active matter.

This medicine has for some time ranked highly among medical practitioners, and decidedly so on account of its efficacy as a tonic, alterative, &c.

The duty levied on the importation of this drug is sixpence per pound, and the quantity on which the duty was paid in

1834	was	122,413 lbs.
1836	. . .	125,140,
1837	. . .	101,298,
1838	. . .	121,888.

In the year 1831, the importation amounted to 176,854 lbs. of which 107,410 lbs. were retained for home consumption.

Nat. Ord. 83.—LILIACEÆ. *Dec.*—The Lily Tribe.

417. *ASPARAGUS* (Asparagus officinalis) *is a well-known perennial plant, the young shoots of which are a favourite culinary vegetable. Two varieties and several sub-varieties are cultivated.—Sex Syst.* Hexandria Monogynia.

Few circumstances in the phenomena of vegetation are more remarkable than the gradual enlargement of size, and improvement of quality, which have taken place in the cultivation of asparagus. It grows wild on the pebbly beach near Weymouth, in the island of Anglesea, and in several other places in this country; but its stem, in these situations, is not usually thicker than a goose's quill, and its whole height does not exceed a few inches; whereas in gardens its stem is sometimes near three quarters of an inch thick, and its height, when at maturity, is four or five feet.

Asparagus is one of the greatest delicacies which our kitchen gardens afford, particularly from the early season at which it is produced. Even in the open ground it is in perfection for the table about the end of April; and when forced, by being planted in hot beds under glass, it may be cut much earlier. Asparagus continues in season till about the end of June.

It is usually raised from seed, in beds formed for the purpose: and the plants should remain three years in the ground before they are cut: after which, for several years, they will continue to afford a regular annual supply. During the winter they are secured from the effects of frost by the beds being covered some inches thick with straw or litter; the best covering is, however, rotten dung.

In the cutting of asparagus, the knife is passed three or four inches beneath the ground. The heads are cut by sloping the blade upward. The smallest should be suffered to grow; indeed, two or more shoots from a root should be permitted to grow up and bear seeds; as, if all the shoots of a root be cut, the root will die.

418. *ALOES are an extensive tribe of plants, some of which are not more than a few inches, whilst others are thirty feet and upwards, in height. All the leaves are fleshy, thick, and more or less spinous at the edges or extremity.*

These plants, which are chiefly inhabitants of hot climates, have flowers of a single petal, the mouth expanded, the base nectariferous, and the filaments of the stamens inserted into the receptacle.

Some of the largest kinds of aloes are of great importance to the inhabitants of countries in which they grow. Beset as the *leaves* are with strong spines, they form an impenetrable fence. The negroes of the western coast of Africa make ropes and weave nets of the fibrous part of these. The Hottentots hollow out the *stems* of one of the kinds into quivers for their arrows. In Jamaica there is a species of aloe which supplies the inhabitants with bowstrings, fishing lines, and materials from which they are able to weave stockings and hammocks. An aloe which grows in Mexico is there applied to almost every purpose of life. It serves as hedges for enclosures: its trunk supplies the place of timber for the roofs of houses, and its leaves the place of tiles. From this plant the Mexicans make thread, needles, and various articles of clothing and cordage: whilst from its juices they manufacture wine, sugar, and vinegar. Some parts of it they eat, and others they apply in medicine.

The *juice* of aloes was formerly used in Eastern countries in embalming; and, as the resinous part of this juice is not soluble in water, it is sometimes used in hot climates as a preservative to ships' bottoms against the attack of marine worms. One ounce of it mixed with turpentine, tallow, and white lead, is considered to be sufficient for covering about two superficial feet of plank; and about twelve pounds are sufficient for a vessel of fifty tons' burthen. In proof of the efficacy of this method, two planks of equal thickness, and cut from the same tree, were placed under water, one of them in its natural state, and the other smeared with the composition above described. They were suffered to continue in the water eight months: when they were taken out, the former was perforated in every part, and in a state of absolute decay, whilst the latter was as perfect as at first. In the East Indies, the juice of these plants is used as a varnish to preserve wood from the attacks of destructive insects: and skins, and even living animals, are sometimes smeared with it for the same purpose.

There is a tract of mountains, about fifty miles north of the Cape of Good Hope, which is wholly covered with aloes. Among the Mahometans, and particularly in Egypt, the aloe is a kind of symbolic plant: it is dedicated to the offices of religion; and pilgrims, on their return from Mecca, suspend it over their doors as a declaration that they have performed that holy journey.

419.* *SOCOTRINE ALOES are the dried juice of a large species of aloe* (Aloë Socotrina, Pl. 4. Fig. 38), *which grows in great abundance in the island of Socotra, near the mouth of the Red Sea, and also in South Africa.*

The leaves are sword-shaped, fleshy, smooth, full of juice of a bluish-green colour; and beset at the edges with small white marginal serratures, and covered inwardly at the point. The flower-

stems rise to the height of two, three, or more feet, are smooth, erect, and have at the top a spike of flowers of a purple or reddish colour, the stamens of which have oblong orange-coloured anthers. —*Sex. Syst.* Hexandria Monogynia.

Socotrine aloes are now imported into this country in skins, packed in chests and casks. The greater part of what is now sold as *Socotrine* aloes is brought from Bombay, and called *hepatic* aloes, from its liver colour; or a *mixture of hepatic and Cape aloes* prepared in this country, and which is perhaps equal to the best imported *Socotrine* aloes. The best kind is of a semi-transparent red colour. In 1833, from the island of Socotra eighty-three skins were exported, which is about equivalent to two tons. It is stated by Sir W. Ainslie, that most of the aloes sold as the *Socotrine* are prepared in the kingdom of Melinda.

420. *Cape aloes*, brought over in chests and skins from the Cape of Good Hope, are of a shining, brittle fracture, of a dark reddish-brown colour, a powerful smell, and a bright greenish-yellow colour when powdered. It is produced from the *Aloë spicata*, and other species.

All the above aloes have an acidulous and somewhat fragrant smell, and an intensely bitter taste.

421. *Barbadoes aloes*, *common* or *horse aloes*, are the dried juice of the *Aloë vulgaris*, cultivated in Barbadoes and Jamaica. They are usually imported in the rind of gourds, and are rarely given except to horses and cattle.

In the cultivation of aloes it is requisite that the plants should grow for two or three years before the juice is procured from them. The operation of collecting the juice is performed in different ways. Dr. Browne tells us that labourers go into the field with knives and tubs; and that cutting off the largest and most succulent leaves close to the stalk, they immediately put them into the tubs in an upright position, that the liquor may drain from the wounds. When this is nearly all discharged, they take the leaves out singly, and clear them of any juice that may adhere to them; and the liquor is then put into shallow flat-bottomed vessels, and dried gradually in the sun, until it acquires a proper thickness to be poured out or ladled into the gourds which are to contain it. An additional quantity of juice is obtained by pressing the leaves.

Hughes states that, in Barbadoes, the greenish-yellow coloured juice is boiled in a copper kettle for five hours, until it becomes thick. The way to know whether it has been sufficiently boiled is, to dip a stick in the liquor, and observe whether the aloe sticking to it, when cold, breaks short; if it does, then it is boiled to perfection, and fit to be poured into gourds or calabashes, or other vessels, for use.

In some places the plants are pulled up by the roots, and after having been carefully cleansed from earth or other impurities, they are sliced and cut in pieces into small hand-baskets or nets. In these the pieces are boiled for a little while in water, by which the juice is extracted; and successive basketfuls are boiled in the same liquor, until it becomes thick and of a dark colour. The fluid part is subsequently evaporated, and what remains is put into gourd shells for sale.

Other methods of drying the juice are to pour it into bladders left open at the top, and suspended in the sun; or to place it in broad shallow trays of wood, pewter, or tin, exposed to the sun every dry day, until the fluid parts are exhaled, and a solid extract is formed, which is then packed up for sale.

The medical properties of aloes, as a purgative and tonic, have long been known and established: their extensive application in medicine is the best proof that can be adduced of their utility. In the arts aloes are, in several respects, useful. But particularly the leaves of the Socotrine aloes afford a beautiful violet colour, which does not require the aid of any mordant to fix it; the same also is capable, it is said, of being formed into a fine transparent colour for painting in miniature. The dose as a tonic is from two grains to four: as a purgative, from five grains to eight.

422. *GARLIC* (Allium sativum) *is a plant with a bulbous root, of an irregular form, and composed of many smaller bulbs, called cloves, which are included within a white skin.*

The stem leaves are flat and narrow; the upper part of the stem bears also small bulbs, and the stamens are three-pointed.—Sex. Syst. Hexandria Monogynia.

In its native climate, the south of Europe, *garlic* is said to have considerably less acrimony than in this country; it is, therefore, much used, both as a seasoning and as food. The lower classes of French, Spaniards, and Portuguese, consume great quantities of it. The Jews also eat of it to excess. With us it is used for culinary and other domestic purposes, and also as a medicine. It has an acrid taste, which depends on the presence of an essential oil, and a highly offensive smell. It is an irritant when externally applied.

The medical properties of garlic are various. In dropsical complaints, asthmas, agues, and worms, it is said to have been successfully used. Some instances have occurred, in deafness, of the beneficial effects of wrapping a clove (of which five or six usually occur in a plant) of garlic in muslin and putting it into the ear. It may be taken in substance, or made into pills, or the juice may be given mixed with sugar. The powerful properties of garlic depend chiefly on an *essential oil*, which blisters the skin when applied to it, and which is so heavy as to sink in water. The virtues of this pungent vegetable may be also readily extracted by spirit of wine, water, and acetic acid. A syrup is also made from it. Boiling water after some time renders it inert.

The juice of garlic is said to be the best and strongest cement that can be adopted for broken glass and china, leaving little or no mark, if used with care. Snails, worms, and the grubs, or larvæ of insects, as well as moles, and other vermin, may also be driven away by placing preparations of garlic in or near their haunts.

This plant grows wild in Sicily and the south of France. Several species of garlic, particularly *Allium vineale*, or *crow garlic*, is found in our own pastures.

423. *LEEKS* (Allium porrum) *are biennial plants, which belong to the garlic tribe, and are known by their leaves growing out on each side, somewhat in the shape of a fan. Three varieties occur.—Sex. Syst.* Hexandria Monogynia.

Leeks are much esteemed for culinary uses, in soups, broth, and for boiling as greens with meat. The blanched stalk for such purpose is most esteemed. The bulb is used in medicine as a diuretic.

They are considered the badge of the Welsh nation, and representations of them are frequently worn by persons of that country on the day of their patron saint, St. David. The origin of this custom was an occurrence during the Welsh wars, in which a party of Welshmen, wanting a mark of distinction, and shortly afterwards passing through a field or garden of leeks, seized and stuck the plants in their caps, and under this signal were victorious.

Leeks are natives of Switzerland, although now generally cultivated all over Europe. They were introduced here, it is said, in 1562; but this does not seem consistent with the *Welsh wars.*

424. *SHALOT* (Allium Ascalonicum) *is a kind of garlic, the bulbous roots of which are oblong, irregular, and seldom of large size.*

The stem is naked and round; the leaves are somewhat awl-shaped; the head of flowers is globular; and the stamens are three-pointed.—Sex. Syst. Hexandria Monogynia.

The uses of shalot, or echalotte, as it is denominated by the French, are almost wholly confined to cookery. It has a strong, but rather pleasant smell, on which account it is generally preferred to onions. It is employed for the seasoning of soups, gravy, hashes, pickles, and for numerous other purposes.

This plant grows wild in Palestine, near *Ascalon,* whence its specific name.

425. *The CANADIAN ONION* (Allium Canadense) *is remarkable for producing a bulb or onion at the top of the stalk.*

The stem is naked and round; and the leaves are flat and narrow.—Sex. Syst. Hexandria Monogynia.

These onions are well deserving of attention, both as objects of curiosity, from producing their bulb at the upper extremity of the stalk, and also for their use. When pickled, they are generally thought superior in flavour to the common onion.

They were originally imported from Canada; are perennial, and are propagated by planting the bulbs in the spring or autumn. Either the bulbs of the root or those on the stalk will grow.

426. *CHIVES* (Allium schœnoprasum) *are the smallest of the garlic tribe, seldom rising more than a few inches above the ground, and the bulbs not being larger than peas.*

The stem is naked, as long as the leaves; and the leaves are round, and somewhat awl-shaped.—Sex. Syst. Hexandria Monogynia.

Chives are natives of this country as well as of several other parts of Europe; and are so hardy, and at the same time so useful, that they merit a place in every garden: yet, in the northern counties of England and in Scotland, they are only occasionally to be seen. The leaves, which are small and are the principal parts that are used, appear early in the spring. They are employed in salads, and for numerous culinary purposes; and often at a season when other plants of the same tribe cannot be procured.

427. *The COMMON ONION* (Allium cepa), *a biennial plant, is known by its round and hollow leaves, and its smelling pipy stalk, which is considerably thicker in the middle than either at the top or bottom. Upwards of twenty varieties are cultivated.—Sex. Syst.* Hexandria Monogynia.

The name of onion is derived from the Latin word *unio*, which properly signifies a bulb that does not throw out offsets. Onions are propagated by seeds which are sown in spring; and the bulbs or roots arrive at perfection in the autumn. The whole plant, when young, is eaten as salad. Onions generally cease to grow towards the middle of August, the stalks and leaves at that time shrinking and turning brown. Shortly after this they must be drawn out of the earth; the tops and blades must be cut off; and the roots dried, either in a warm place, or by exposure to the sun. Onions are supposed to be natives of Spain; but their native place, and the time of their introduction into this country, are not correctly known.

428. *Spanish onions* are of a large size, and flattened shape; and *Portugal onions* are large, handsome bulbs, of a roundish form.

By the common people onions are frequently eaten raw with their food. This has particularly been the case, and from time immemorial, with the inhabitants of Egypt. Persons whose digestion is good can eat onions with impunity; but the dyspeptic should avoid them, as they produce much inconvenience. Onions have so much acrimony as generally to affect the breath for many hours: but when boiled or roasted, this is in a great measure dissipated, and they then exhibit some sweetness, with a considerable portion of mucilaginous matter. They are of great use in several culinary preparations, but particularly in soup and pickles. They are employed in medicine chiefly as poultices for swellings; and have been recommended by some persons, to be rubbed on bald parts of the head, to promote the growth of the hair.

NAT. ORD. 82. DIOSCOREACEÆ. *Lindl.*—THE YAM TRIBE.

429. *YAMS are an American and West Indian root of a very irregular shape, which possess properties somewhat similar to those of the potato, but they are less mealy, and, in a raw state, are very viscous.*

The plant (Dioscorea sativa) *which produces these roots has heart-shaped leaves, and a stem that creeps along the ground like ivy.—Sex. Syst.* Hexandria Trigynia.

In some of the rich lands of South America, yams are said to grow to the weight of fifty or sixty pounds each; and are so productive that an acre of ground planted with them has been known to produce roots to the weight of from 20,000 to 30,000 pounds. Yams are propagated by setting the eyes, in the same manner as we plant potatoes; in six or eight months they arrive at maturity.

When they are dug out of the ground, they are, for a little while, exposed to the sun to dry; and if, after this, they be packed in casks full of dry sand, they may be preserved, without injury, for many months. They are consequently often used as sea-store for vessels about to sail on long voyages, and are frequently brought to England. Several attempts have been made to cultivate yams in this island; and these have been attended with a certain degree of success in the counties of Mid-Lothian, Perth, and Stirling, in Scotland, where they are used for the feeding of cattle. There are two kinds, one red, and the other white. The former of these contains a more nutritive food than the latter, though their flavour is much less excellent.

With the negroes, in the West Indian islands, the yam is a very important article of food. When roasted, it is so wholesome and nutritive, that it is preferred by them even to bread. Like potatoes, yams may be converted into bread, by mixture with a portion of wheat or barley flour. They are sometimes made into soup, puddings, and other useful dishes.

NAT. ORD. 81. PALMACEÆ. *Lindley.*—THE PALM TRIBE.

430. *The FAN PALM is a very remarkable tree* (Corypha umbraculifera) *that grows in the East Indies, but particularly in Malabar, and the island of Ceylon; its leaves, eight or ten in number, rise out of the summit of the trunk, are winged and somewhat fan-shaped, and have their segments connected by a thread or fibre. It is called in Malabar* Codda-pana.—*Sex. Syst.* Hexandria Trigynia.

The stem of the fan palm is straight, cylindrical, smooth, and as tall as a ship's mast. Its *leaves* are upwards of six yards in length, and four yards wide; and form altogether a head of twelve or thirteen yards in diameter. These leaves, which, when dry, fold up somewhat like a fan, are used for the covering of huts and cottages; and not unfrequently by soldiers, instead of canvass, for the construction of tents. One of them is sufficiently large to shelter twenty persons from the rays of the sun. They are also a kind of natural paper, on which the inhabitants write with an iron style. Most of the books shown in Europe for those of Egyptian papyrus are formed of parts of these leaves.—The soft part of the trunk is formed into cakes, and constitutes a species of bread, very serviceable to the inhabitants in times of scarcity. The *juice* of some parts of the tree is used as an emetic.

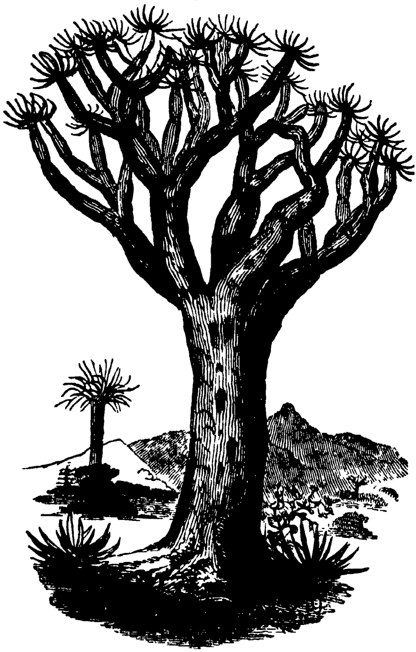
The fan palms are said not to bear fruit until the last year of their life, when they produce a large quantity of *berries.* These are each about the size of a large chesnut, smooth, green, and fleshy; but are not known to be of any use.

431. *The ROTANG or DRAGON'S BLOOD TREE, is a species of cane* (Calamus rotang) *which grows to the length of more than a hundred feet, is about as thick as a man's arm, and is closely beset with erect prickles.*

This cane has, at the top, a tuft of leaves which are several feet in length, and alternately winged, and of which the leaflets are sword-shaped, and armed with sharp spines.—Sex. Syst. Hexandria Monogynia.

In consequence of its great length and slender form, the rotang tree (which is usually found in woods near rivers, and in morassy places) does not grow entirely upright; but, after having attained the height of five or six yards, it depends for support upon other trees, which it sometimes overruns, in nearly a horizontal direction, to the extent of sixty or eighty feet. The flowers are produced in upright spikes that separate into long spreading branches, and are succeeded by a red and somewhat egg-shaped fruit, which to the taste is pleasantly acid. Some of the drug called *Dragon's Blood* is obtained, it is said, from this fruit and from other palms of the genus *Calamus*. Another kind is yielded by the *Dracæna Draco*[1], Fig. 54. When this substance is tolerably pure, it breaks smooth, and appears internally of a dark red colour; melts readily, and easily catches fire. Its principal uses are as a colouring material, and for tooth powders; its medicinal powers are of no importance; it was formerly considered an astringent.

Fig. 54.



Dracæna Draco.

The *stem* of the rotang furnishes the inhabitants of the countries where it grows with shafts for pikes or spears; and the inner part of the young *shoots* is boiled or roasted for food.

[1] This tree belongs to the Natural Order *Liliaceæ*. It is a native of the East Indies and the Canary Isles. There is one in Orotava celebrated for its size and age. According to Humboldt, next to the Baobab trees (*Adansonia digitata*) it is considered one of the oldest inhabitants of the earth.

432. *The COMMON WALKING CANES* (Calamus scipionum) *have a smooth and glossy stem, usually marked with dark spots; and the knots or joints are sometimes three or four feet asunder.—Sex. Syst.* Hexandria Monogynia.

These canes grow, very abundantly, in Sumatra and other Eastern islands, as well as on the continent of India, whence they appear to have been originally exported to Europe by the Dutch. There is a considerable trade in them to China. The long spaces between the knots, their shining surface, and lightness, have rendered them preferable to most other articles for walking canes.

433. *The RATTAN, or TRUE CANE* (Calamus verus), *is remarkable for growing to the great length of a hundred feet and upwards, and at the same time, not being thicker than a man's finger.—Sex. Syst.* Hexandria Monogynia.

A considerable trade in rattans is carried on from several of the islands of the East to China, which is the principal market for them. These canes are extremely tough and flexible, of a yellowish brown colour, and when cut into thongs, are sometimes used to make cables and other ropes. Our cane-bottomed chairs are made of split rattans, the outer surface of which is always kept uppermost. For this work the canes are chosen by their great length, pale yellow colour, and bright gloss. They are purchased in bundles, each of which contains a hundred canes, neatly tied in the middle, and the ends bent together. When perfectly dry, they are so hard as to yield sparks of fire when struck against each other. The word rattan, in the Malay language, signifies a staff or walking stick.

434. *The COCOA-NUT is a fruit produced in nearly all hot climates; of an oval shape, from three or four, to six or eight inches in length, covered with a fibrous husk, and lined internally with a white, firm, and fleshy kernel.*

The tree (Cocos nucifera) *which produces the cocoa-nut is a kind of palm, from forty to sixty feet high. It has, on its summit only, a kind of leaves, which appear almost like immense feathers, each fourteen or fifteen feet long, three feet broad, and winged. Of these the upper ones are erect, the middle ones horizontal, and the lower ones drooping. The trunk is straight, naked, and marked with the scars of the fallen leaves. The nuts hang down from the* *summit of the tree, in clusters of a dozen or more together.—Sex. Syst.* Hexandria Trigynia.

The external rind of the cocoa-nut has a smooth surface, and is of a somewhat triangular shape. This encloses an extremely fibrous substance of considerable thickness, which immediately surrounds the nut. The latter has a thick and hard shell, with three holes at the base, each closed by a black membrane. The kernel lines the shell; and is sometimes nearly an inch in thickness, and encloses a considerable quantity of liquid, of a whitish colour, which has the name of *milk*.

Food, clothing, and the means of shelter and protection, are all afforded by the cocoa-nut tree. The soft part (albumen) of the *nuts*, which somewhat resemble the filbert in taste, but are of much firmer consistence, are used as food in various modes of dressing, and sometimes are cut into pieces and dried. They yield an oil, which, in some countries, is the only oil used at table: when fresh, it is equal in quality to that of almonds. It, however, soon becomes rancid, and, in this state, is principally used by painters. The Indians obtain an oil from cocoa-nuts, either by pressure or steeping the soft part in water till they putrefy, and then boiling the pulp, when the oil rises to the surface, and is skimmed off. This oil is used for a variety of purposes. The *milk*, which somewhat resembles the kernel in flavour, is an exceedingly cool and agreeable beverage.

Cocoa-nut trees flourish best in a sandy soil, and first produce fruit when six or seven years old; after which each tree yields from fifty to a hundred nuts annually.

The fibrous *husks* which envelope the cocoa-nuts, after they have been soaked for some time in water, and freed from other substances with which they are intermixed, are spun into long yarns, woven into sail-cloth, twisted into ropes and cables, even for large vessels, and the *fibre* is advantageously employed for the stuffing of mattresses, &c. The cordage thus manufactured is valuable in several respects, but particularly from its floating in water. The woody *shells* of the nut are so hard as to be capable of receiving a high polish; they are formed into drinking cups, and other domestic utensils, which are sometimes expensively mounted in silver.

On the summit of the cocoa-nut tree the tender *leaves*, at their first springing up, are folded over each other, so as somewhat to resemble a cabbage. These are occasionally eaten in place of culinary greens, and are a very delicious food; but, as they can only be obtained by the destruction of the tree that produces them, and which dies in consequence of their being removed, they are considered too expensive an article for frequent use. The larger leaves are employed for the thatching of buildings, and are wrought into baskets, brooms, mats, sacks, hammocks, and many other useful articles.

The *trunks* are made into boats, and sometimes constitute timber for the construction of houses; they form also excellent gutters for the conveyance of water. If, whilst growing, the body of the tree be bored, a white and sweetish liquor exudes from the wound, which has the name of *toddy*, a favourite beverage in many countries where the trees abound. When fresh it is very sweet; in a few hours it becomes somewhat acid, and, in this state, is peculiarly agreeable; but in the space of twenty-four hours, it is complete vinegar. By distillation this liquor yields an ardent spirit, which is sometimes called *rack* or *arrack;* and is more esteemed than that obtained by distillation from rice or sugar, and merely fermented and flavoured with the cocoa-nut juice. If boiled with quick-lime, it thickens into a syrup, which is used by confectioners in the East Indies, though it is much inferior to syrup produced from the sugar-cane.

435. *The CABBAGE-TREE* (Areca oleracea) *is an American species of palm, which grows to the height of a hundred feet and upwards, and is destitute of leaves until within a few feet of the summit. The leaves, sometimes nearly twenty feet long, are winged, and the leaflets are entire.—Sex. Syst.* Hexandria Trigynia.

Such is the general elegance of this tree that it is frequently denominated the queen of the woods. Its *fruit*, which grows in bunches from the top, is an oblong and obtuse kind of berry, of a blueish purple colour, and about the size of an olive. The sheaths of the flowers, and the floral leaves, when first developed, are folded round each other, enclosed in a thin green, and spongy bark, eight or nine inches in circumference, and constitute the part which is denominated the *cabbage*. This is white, and when boiled is esteemed a great luxury. It is also eaten raw as a salad, and fried with butter; its taste is said to resemble that of an artichoke. This part is likewise frequently made into a pickle with vinegar and spices.

We are informed that the cabbage-tree was first introduced into Jamaica by Admiral Knowles, when governor of that island; and that it has since been cultivated there with great attention. But it is chiefly planted for its beauty, being considered too valuable to be often cut down for the small portion of food which it thus affords, however delicious that may be.

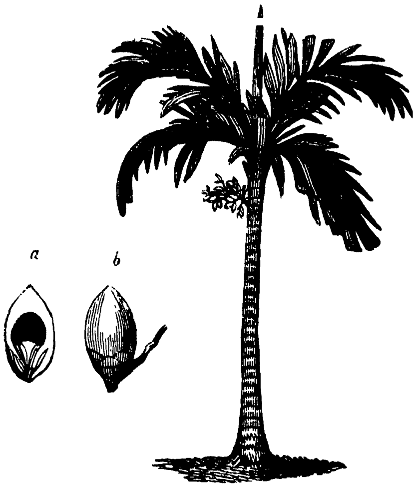
In the *leaves* of this tree there is a thread-like substance, which is sometimes spun, like hemp, and made into different kinds of cordage. The sockets or grooves formed by the broad part of the footstalks of the leaves are used by the negroes as cradles for their children; and on the inner sides of the very young footstalks there are tender pellicles, which when dried may be converted into paper. The *trunks*, when cleared of the pith, serve as water pipes and gutters. Of the *pith*, or, rather, soft centre, a kind of sago is made; in this, after the trees are felled, there is bred a large species of caterpillar, which the inhabitants of some of the West Indian islands eat as a great delicacy.

436. *The CATECHU, ARECA, or BETEL-NUT TREE* (Areca Catechu, Fig. 55), *is a species of palm which grows in the East Indies, and is more particularly cultivated in Asia.*

It is generally from thirty to forty feet high, and its trunk is six or eight inches in diameter. The leaves, which grow on the summit, are winged, having the leaflets folded back; and the fruit is a pulpy berry with a thin skin, containing a nut about an inch in length, and of a rounded conical form.—Sex. Syst. Hexandria Trigynia.

The *kernel* of the areca-nut (Fig. 55), which is covered by a thin, smooth, and yellowish shell, is somewhat like a nutmeg, but contains in the centre a white, soft, greyish, and almost liquid substance, which becomes hard as the nut ripens (*a*). This fruit is in general use by the Indians, who cut it into slices, mix it with other substances, wrap it in the leaves of betel, and chew it much in the same manner

Fig. 55.



The Areca, or Betel-nut Tree.

as the common people of our country chew tobacco. The consumption of these nuts in India is almost beyond calculation. They are an article of considerable trade from port to port; and also from India to China. The Areca-nut charcoal is much used as a dentrifice in this country.

The drug called *catechu*, formerly *terra japonica*, was supposed to be an extract prepared from the above nuts; but it is now ascertained to be obtained from the wood of a species of *Acacia*. The *Palm catechu* is obtained from the seeds, and is an astringent extract.

437. *The DATE is a fruit shaped somewhat like a large acorn, and covered externally with a yellowish membrane or skin, which contains a fine, soft, and sweetish pulp, and in the centre an oblong, hard stone, with a longitudinal furrow.*

The tree (Phœnix dactylifera, *or* Date Palm (Fig 56), *which produces this fruit, grows chiefly in most of the northern parts of Africa and the Levant, is forty feet and upwards in height, has an upright stem, marked through its whole length with protuberances, and terminated at the summit with a cluster of winged leaves or branches, each eight or nine feet in length.—Sex. Syst.* Hexandria Monogynia.

The cultivation of the date is attentively pursued on the African coast of the Mediterranean; in several parts of Persia, Arabia, and even in Spain. The latter country, however, is not sufficiently warm to ripen the fruit in perfection, without the constant labour of the cultivator. He is obliged to ascend the trees, from time to time, to examine the flowers and turn them towards the sun.

Among the Africans, Egyptians, and Arabs, the date constitutes a principal article of food, and as such it is considered both wholesome and nutritive. Its name is a word formed of *dacte* or *dactylus*, implying a finger, from an imaginary resemblance which this fruit has to the end of the finger. Although dates in general are of a yellowish colour, some are black, some white, and others brown: some also are sweet, and others bitter. The best are called *royal dates*, and are imported into this country from Tunis.

Each tree produces ten or twelve bunches of fruit, in a *spathe* or sheath, as at Fig. 56, which when gathered are hung up in a dry place, until so much of their moisture is evaporated as to allow of their being packed in boxes for exportation.

Fig. 56.

The Date Palm.

Nearly all the parts of the date-tree are useful. The *wood*, though of a spongy texture, is employed for the beams and rafters of houses, and for implements of husbandry, which are said to be very durable. The *pith* of the young trees is eaten, as well as the young and tender *leaves*. From the old leaves and their stalks the women and children of Valencia make mats, baskets, and other utensils; and from the filamentous parts, ropes and different kinds of cordage are manufactured. A considerable traffic is carried on in these leaves, which, under the name of *palms*, are sent to Italy to be used in the grand religious ceremonies of Palm Sunday. In Persia an ardent spirit is distilled from the fruit; and in many places the *stones* are ground to make oil, and the paste that is left is given as food to cattle and sheep.

Several other members of the Palm family afford articles much in demand; thus—" Palm oil is imported from the western coast of Africa, principally from Guinea, where it is procured by expression from the fruit of the *Elais quin-*

censis. It has a solid consistence, a rich orange-yellow colour, a sweetish taste, and an agreeable odour, somewhat similar to that of the rhizome of the Florentine orris. By exposure to light it is bleached. It consists of *Stearin* 61 parts, and *Olein* 69 parts, besides *colouring* and *odorous matters*. The Africans use it as butter. It is emollient and demulcent like other fixed oils, but is rarely employed in medicine. By the public it is occasionally employed by way of friction in bruises, sprains, &c. Its ordinary use in this country is in the manufacture of yellow soap.

438. "The *Wax palm of the Andes* (Ceroxylon Andicola) grows to the height of 160 or 180 feet. The stem shows in its whole length rings, resulting from the fall of the leaves: the spaces between these are covered with a mixture of *wax* and *resin*, which the inhabitants use for the manufacture of candles."—*Pereira*, *Mat. Med.*, p. 616.

NAT. ORD. 80. JUNCACEÆ, *Dec.*—THE RUSH TRIBE.

439. *The COMMON SOFT RUSH* (Juncus effusus) *is known by its green, smooth, stiff, upright, leafless, and pointed stem; having a loose bunch of small flowers at the side, and the seed-vessels blunt at the extremity. It grows chiefly in and beside water.—Sex. Syst.* Hexandria Monogynia.

Although rushes are generally considered by farmers noxious weeds, they are applicable to a variety of useful purposes; but particularly for making the wicks of rush-lights. For this purpose they are usually cut a little after Midsummer, and immediately afterwards thrown into water, and kept there, that they may not become dry, and that they may be the more easily peeled.

At first a person would find it no easy matter to divest a rush of its rind, so as to leave on each side, from top to bottom, one regular, narrow, and even rib, that may support the pith. But this practice soon becomes familiar even to children. When rushes are thus far prepared, they are spread on the grass to be bleached; and afterwards they are dried in the sun for use.

If only one rib of peel be left instead of two, rushes will supply the place of cotton wicks for candles. In many parts of England the labouring people form wicks of this description, dip them into melted fat, and use them in place of candles. In Japan this species is cultivated for making floor-mats.

Rushes are sometimes manufactured into a slight kind of baskets. In the vicinity of Farnham, in Surrey, they are cut about Midsummer, and dried in the same manner as hay. After this they are formed into a kind of rick, and sheltered till the succeeding spring. They are then usefully employed for bands or ties in fastening hop-binds to the poles. In a fresh state they are sometimes made into brooms for blacksmiths, and other artisans working in metals.

It ought to be observed, that the *soft rush* is not the only rush employed for the wicks of candles, &c. The *Juncus conglomeratus*, or COMMON RUSH, and some others, are also advantageously used.

NAT. ORD. 79. BROMELIACEÆ, *Lindl.*—THE PINE-APPLE TRIBE.

440. *The PINE-APPLE* (Bromelia ananas) *is a rich and highly fragrant fruit, of a large size, and of a yellowish colour, with protuberances on its surface; and crowned by a tuft of strong and pointed leaves, edged with sharp spines called a crown.—Sex. Syst.* Hexandria Monogynia.

This, the best and finest-flavoured of all known fruits, was originally imported into England from South America during the latter part of the seventeenth century: it was first raised by Sir M. Decker at Richmond, about 1715. In America and the West Indies it has long been cultivated in the open ground; and from free access to a congenial atmosphere, it attains there a much finer flavour than is possible in a forced state in the hot-houses of Great Britain. From America it was also carried to the East Indies.

It is anticipated that the steam-boats now building in Mr. Pitcher's yard, at Northfleet, Kent, and elsewhere, for the West India mails, will perform the passage in so short a time (fifteen days) as to enable them to import this among other foreign fruits to our markets, in a fresh state.

Pines are planted in earth, and the pots which contain them are immersed in beds of bark, after it has been used by the tanners. About the month of April the young fruit begins to advance, but the usual season for ripening does not commence till July, and the fruit is in greatest perfection from the middle of August to the end of September. The ripening of pines is discoverable by the fragrant odour which they emit, and by their protuberances yielding to pressure with the hand; their flavour speedily dissipates if left uncut longer than three or four days after they are fully ripe. When brought to table, their leafy crowns should be reserved for planting. These, if placed in pots and plunged in the bark-bed, or in a hot-bed, and covered for some time with glass, will in two years bear fruit. There are many varieties of the pine in the West Indies obtained from the seed; in this country we have also a great number; the *Queen* and *New Providence*, and one or two others, are most esteemed.

In the West Indies an excellent liquid sweetmeat or confection is made from pines. This fruit is also sometimes preserved whole, and when taken out of the syrup is iced over with sugar. Sweetmeats of this kind were formerly sent into Europe in great quantity from the Antilles. Wine made from pines is almost equal to Malmsey: at the end of about three weeks it becomes somewhat acid, but it recovers by longer keeping. Pines in the West Indies are frequently put into rum to communicate to that liquor their peculiar aromatic flavour.

NAT. ORD. 78. AMARYLLIDACEÆ, *Lindl.*—THE NARCISSUS TRIBE.

441. *The GREAT or AMERICAN ALOE* (Agave Americana) *is a large plant, the leaves of which are thick, fleshy, and spinous at the edge, and the stem branched and of great height.*

The flowers of this plant are distinguished by having the tube of the corolla narrowed in the middle, the stamens longer than the corolla, and the style longer than the stamens.—Sex. Syst. Hexandria Monogynia.

This magnificent native of North America is by no means an uncommon plant in our gardens, but with us it is seldom seen in flower. There is indeed a notion, but it is an erroneous one, that the American aloe does not bloom until it is a hundred years old. The fact is, that the flowering depends almost wholly on its culture. In hot countries it will flower in a few years; but in colder climates the growth being slower, it is necessarily longer in arriving at maturity. One of considerable size and beauty was recently exhibited in flower at the Surrey Zoological Gardens. The stem which bears the blossom rises from the centre of the leaves, and frequently exceeds the height of twenty feet. An American aloe in the garden of the King of Prussia was forty feet high. Branches issue from every side, and in such a manner as to form a kind of pyramid, composed of greenish-yellow flowers, which stand erect, and are seen in thick clusters at every joint. When in full flower, the appearance of this aloe is extremely splendid; and if the season be favourable, and the plant be sheltered from the cold in autumn, a succession of blossoms will sometimes be produced for nearly three months.

In the warmer parts of Europe, American aloes are cultivated as objects of considerable utility. In Spain, Portugal, and Italy, they are frequently grown in rows, as fences for enclosures. In Algarva the leaves are employed for scouring pewter and other kitchen utensils, and floors; and, cut into slices, are used for the feeding of cattle.

The inspissated juice of the *leaves* is said to be employed instead of soap, and will lather with salt water as well as with fresh. The fibres of the leaves, when properly prepared, may be separated into threads that are useful in various ways; but it has been said that, although they can be applied for all the purposes of *thread*, they are neither strong nor durable.

NAT. ORD. 77. IRIDACEÆ, *Lindl.*—THE CORN-FLAG TRIBE.

442. *The YELLOW WATER-FLAG, or COMMON IRIS* (Iris Pseudacorus), *is a very conspicuous plant in most of our marshes. It has sword-shaped leaves, and about the middle of July bears large and beautiful yellow flowers.—Sex. Syst.* Triandria Monogynia.

The roots of this plant possess qualities which render them capable of being applied to many useful purposes. Their astringency is such that it is supposed they might be employed with great advantage in the tanning of leather. In the island of Jura, one of the Hebrides, they are used for dyeing a black colour; and the inhabitants of some parts of Scotland adopt them instead of galls in the making of ink. For this purpose they are cut into thin slices, and boiled, or infused in water, till the liquor is deeply tinged with blue. This is poured clear off, and the blade of a knife, or some other piece of iron, is put into it, and rubbed hard with a rough white pebble, by which process, after a little while, the liquor becomes perfectly black.

A slice of the fresh root, if held between the teeth, will, it is said, almost instantly remove the sensibility, and thus alleviate the pain, of tooth-ache. The leaves of this plant are considered poisonous to all cattle except sheep. The fresh juice of the root is a powerful cathartic, and thus taken has cured, it is said, inveterate dropsies.

443. *ORRIS-ROOT is the root-stock of a white-flowered kind of orris, called* Florentine Iris (Iris Florentina,) *which is a native of Italy, and is distinguished by having two flowers on each stalk, the petals bearded, and the leaves sword-shaped.—Sex. Syst.* Triandria Monogynia.

In a dried state this root-stock is well known on account of its grateful odour, which approaches that of the violet. It is consequently much used in the manufacture of hair-powder, and other articles for which an agreeable scent is required. The fresh root is emetic and cathartic; it is also extremely acrid, and, when chewed, it excites in the mouth a pungent taste, which continues for several hours; but this acrimony is almost wholly dissipated by drying. As a medicine it is not considered in either state of any importance.

Orris-root is chiefly imported from Leghorn and Trieste in casks, and is principally used for perfuming tooth-powders, oils, hair-powder, &c.

444. *SAFFRON is the orange-coloured pistil, or centre part, of a purple species of crocus* (Crocus sativus) *which flowers in September, and is chiefly distinguished by having the three extremities of the pistil so long as to hang out of the flower.*

Saffron is a perennial bulbous plant, now found apparently wild in some parts of this country; but it is probable that it was originally brought from Asia.—Sex. Syst. Triandria Monogynia.

In Cambridgeshire there is a town called Saffron Walden, that received its name from the quantity of saffron which was annually produced in its neighbourhood.

The roots of the saffron crocuses are planted in July, in rows six inches apart, three inches from each other, and two inches deep in the ground. As soon as the flowers appear, they are gathered by hand every morning just before they open; and as they continue to open in succession for several weeks, the saffron harvest of course continues so long. When the flowers are gathered, they are spread on a table: the upper part of the pistil only is picked out, and the rest of the flower is thrown away. As soon as a sufficient quantity of the pistils have been collected, they are dried in a kind of portable kiln; over this a hair cloth is stretched, and upon it a few sheets of white paper. If it be desired to form the *cake* saffron, the saffron is scattered upon these to the thickness of two or three inches, and is then covered with several sheets of paper, over which is laid a coarse blanket five or six times doubled, or a canvas bag filled with straw. As soon as the fire has heated the kiln, a board on which a weight is put is placed upon the blanket to press the saffron into a cake. By the end of the first hour, a strong fire being employed, the cake is formed. This is then turned, and for another hour is subjected to an equal degree of heat. It is then turned a second time, and a more gentle heat is employed, till the cake becomes dry, during which time it is turned every half hour; but this process is now nearly exploded.

Two pounds of dried cake was considered the average crop of an acre after the first planting, and twenty-four pounds for the next two years. After the third crop the roots are taken up, divided, and transplanted.

The saffron which is grown in England was considered superior to any that was imported from other countries. Spain affords the best kind now in the market. The best saffron may be known by the breadth of the blades. It ought not to be of too deep a red or orange colour, and it should be fresh and tough, and have a strong but pleasant aromatic odour. *Cake* saffron is almost always bad, being mostly made of safflower and gum water; the best saffron is that called *hay saffron,* which may be kept for any length of time by being occasionally moistened with rectified spirit of wine.

Saffron was much used by the ancients as a perfume, but in this respect their taste was very different from ours. Not only were the halls, theatres, and courts through which they wished to diffuse an agreeable smell strewed with this substance, but it was used by them for a scent in vinous extracts. From saffron, with the addition of wax, the Greeks as well as the Romans prepared scented salves. In our own country it was formerly much used in medicine, having been esteemed an excellent remedy in hysterical and other complaints; but it is now considered of little or no importance. It is sometimes used by bakers to colour and flavour different kinds of cakes and biscuits. With water or spirits it gives out a beautiful yellow colour; but this is not useful as a dye, as on exposure to the air it soon fades; and no means have hitherto been discovered by which it can be fixed and rendered permanent.

Mr. Pereira finds that one grain of good commercial saffron contains the stigmata and styles of nine flowers; hence 4,320 flowers are required to yield one ounce of saffron.—*Mat. Med.*

NAT. ORD. 76. MUSACEÆ, *Agardh.*—THE BANANA TRIBE.

445. *The PLANTAIN-TREE* (Musa paradisiaca), *which is much cultivated in the West Indies and South America, has a soft stem, fifteen or twenty feet high, with several leaves on the summit; and bears a fruit of a pale yellow colour, somewhat shaped like a cucumber, about a foot in length, and two inches thick.*

The leaves are frequently eight feet long, and more than two feet broad, and are so thin and tender that they are often torn by the wind. The fruit is produced in bunches so large as each to weigh forty pounds and upwards. It is a native of India.– Sex. Syst. Hexandria Monogynia.

To the negroes of the West India islands the plantain is an invaluable fruit, and, like bread to the Europeans, is with them denominated the *staff of life.* In Jamaica alone many thousand acres are planted with these trees. The fruit is usually gathered before it is ripe, and, after the skin has been peeled off, is roasted for a little while in a clear fire; it is then scraped and eaten as bread, for which it is an excellent substitute. Plantains are sometimes boiled, and eaten with salt meat ; they are also cut into slices and fried, pounded, and made into puddings, and used in various other ways. Horses, cattle, swine, and other domestic animals, are fattened with them. When ripe they may be eaten raw, and, in this state, they have somewhat the taste of a ripe pear.

The *leaves* of the plantain-tree, being soft and smooth, are sometimes employed in the country where it grows as dressings after blisters, and also to dress the wounds inflicted after flogging in the army ; when green, they are used as food for hogs. They are also used for mats and other purposes.

The vegetation of this tree is so rapid that if a line or thread be drawn across and on a level with the top of one of the leaves, when it begins to expand, it will be seen, in the course of an hour, to have grown nearly an inch.

446. *The BANANA is a valuable plant* (Musa *now grows in the West Indies and other tropical countries, and has leaves about six feet in length, and a foot broad in the middle ; and fruit four or five inches long, and about the shape of a cucumber. It is supposed to be a native of Guinea.—Sex. Syst.* Hexandria Monogynia.

When ripe, the banana is an agreeable *fruit*, with a soft and luscious pulp ; and is frequently introduced in desserts in the West Indies. The Spaniards have a superstitious dislike to cut this fruit across ; they always slice it from end to end, because, in the former case, the section presents an imaginary resemblance to the instruments of our Saviour's crucifixion. The banana is sometimes fried in slices as fritters. If the pulp of this fruit be squeezed through a fine sieve, it may be formed into small loaves, which, after having been properly dried, may be kept for a great length of time.

NAT. ORD. 75. ZINGIBERACEÆ, *Lindl.*—THE GINGER TRIBE.

447. *GINGER is the dried root of a somewhat reed-like plant* (Zingiber officinale, *Rosc* Fig. 57, *and* Pl 1. Fig. 2), *which grows wild in several parts of Asia ; and is much cultivated both in the East and West Indies.*

The flowers of the ginger plant issue from stalks distinct from *those which support the leaves, and form a kind of ear or spike of beautiful colours and of a very fragrant smell.—Sex. Syst.* Monandria Monogynia.

The cultivation of ginger is nearly similar to that of potatoes. The land is first well cleansed from weeds: it is then dug into trenches similar to those which our gardeners make for celery; and the plants are set in these trenches in March or April. They flower about September; and in January, or February, when the stalks are withered, the roots are in a proper state to be dug up.

These are prepared for use in two ways. When intended for what is called *white ginger*, they are picked, scraped, separately washed, and afterwards dried with great care, by exposure to the sun. For *black ginger* they are picked, cleansed, immersed in boiling water, and dried. This process is much less laborious and expensive than the other, consequently the price of the article is not so great. By boiling, the ginger loses a portion of its essential oil, on which its odour depends; but its pungency resides in a resino-extractive matter, which is given out to hot water. This kind is sometimes bleached with chloride of lime.

Fig. 57.

Ginger.

The uses of ginger, both in medicine and as a spice, are numerous and well known. In the West Indies this root is frequently eaten fresh in salads, and with other food; and the roots, when dug up young, namely, at the end of three or four months after they have been planted, are preserved in syrup, and exported as a sweetmeat to nearly all parts of the world. It is said that the ginger which is brought into this country from the East Indies is much stronger than any we have from Jamaica; but this is questionable.

A great part of the Jamaica ginger of the shops has been washed in whiting and water (or *white washed*, as it is technically termed), under the pretence of preserving it from insects (*Pereira*).

The duty on ginger is eleven shillings per cwt. In 1838 the quantity imported was, from the British West Indies, 9,305 cwts.; from the East Indies, 1,911 cwts., making 11,216 cwts.; while the total of that imported the preceding year amounted to 12,677 cwts.

448. *TURMERIC ROOT is thick, fleshy, and solid, usually from half an inch to two inches and upwards in length; it has a yellowish and rugged surface, and is of a shining saffron-brown colour within. It grows both in the East and West Indies.*

The flowers of the turmeric plant (Curcuma longa, *Linn.*) *are white, and form an ear or spike which issues immediately from the root. The leaves are spear-shaped, and each eight or nine inches long.—Sex. Syst.* Monandria Monogynia.

This *root-stock*, which has an aromatic smell somewhat resembling that of ginger, is much cultivated in the East Indies, where it is in common use as a seasoning for ragouts and other dishes. It constitutes a principal ingredient in *curry powder* and *curry paste;* and under this form is used in great quantities, both in India and Europe. Some years ago it was used as a medicine for the removal of jaundice, diseases of the liver, and other complaints. The chief purpose for which it is now esteemed is its imparting a rich yellow dye to silks, linen, or woollen; and for heightening and rendering brighter the red colours dyed with cochineal and vermilion. It is in much request by glovers, for dyeing yellow gloves. Some of the Indian tribes use it in painting their bodies. As a dye, turmeric is very fugacious. It is much used by chemists in the preparation of *turmeric paper*, for detecting the presence of alkalies, which turn it from yellow to brown.

449. *The TRUE, or OFFICINAL CARDAMOMS, are the seeds of an East Indian plant, the* Elettaria Cardamomum *of Maton* (Pl. 1. Fig. 4), *which has shining reed-like stalks, with spear-shaped, pointed leaves, downy above, and silky beneath. They are brought into Europe in their pods, which are small, oblong, triangular, and each divided into three cells.*

The roots are thick, fleshy, and knotted. The stalks grow from seven to twelve feet high; the flowers are of an irregular shape, and in colour are green, pink, and white.—Sex. Syst. Monandria Monogynia.

In those woody parts of India where cardamom plants spontaneously grow, the inhabitants form plantations of them by a very simple process. They clear from particular spots the greater number of the trees, and towards the close of the fourth rainy season afterwards, they look for the first crop of cardamoms (raised from the scattered seeds which have lain dormant in the ground), and they are seldom disappointed.

The cardamom harvest usually commences in October, and lasts till December. Women or children pluck the fruit-stalks from the roots, carry them into the houses, and there spread them upon mats to dry. The pods are then separated from the stalks by stripping them with the fingers; they undergo some further processes of drying, after which they are packed for exportation, in large chests, which are well pitched at the joints and seams, to prevent them from being injured by moisture. It is estimated that about 76,000 pounds weight of these seeds are annually brought for sale at Malabar.

Cardamoms have a pleasant aromatic smell; and when chewed, impart to the mouth a warmth and pungency which to most persons are extremely grateful. The Indians use them in considerable quantity in their food; and also mix them with betel, and chew them, under a belief that they tend to facilitate digestion. They are sometimes used with us in medicine, but more frequently for the purpose of concealing the nauseous taste of other medicines.

Three varieties of the Malabar kind are known in the market, viz. *shorts*, *short-longs*, and *long-longs*, the former of which is reckoned the best.

NAT. ORD. 74. MARANTACEÆ, *Lindl.*—THE ARROW-ROOT TRIBE.

450. *INDIAN ARROW-ROOT, in the state that we see it, is a kind of starch, obtained from the root-stock of a plant which is cultivated in the West Indies.*

This plant (Maranta arundinacea) *is about two feet high, has broad, pointed, and somewhat hairy leaves; small white flowers in clusters, and a nearly globular fruit about the size of a currant.—Sex. Syst.* Monandria Monogynia.

The plant which affords the Indian arrow-root was so named because its thick fleshy root was thought to extract the poison from wounds inflicted by the poisoned arrows of the Indians. They likewise consider it efficacious against the stings of those venomous insects with which the countries of nearly all hot climates abound.

The starch or powder of arrow-root is obtained by the following process:—The roots or tubers, when a year old, are dug up, washed, and beaten to a milky pulp in deep wooden mortars. This pulp is afterwards well washed in clean water, the fibrous parts being carefully separated from it and thrown away. It is next passed through a sieve or coarse cloth, and suffered to stand for some time to settle. The water that remains is subsequently drawn off, and the white mass at the bottom is again washed. After this the water is entirely cleared away, and the pulp, when dried in the sun, is an extremely pure kind of starch, which requires only to be reduced to powder to attain the state in which we import it. Of all the kinds which are imported, that from Bermuda is considered the best.

There is no European vegetable, if we except the *salep* or *orchis-root*, which yields so large a proportion of nutritive mucilage as this. Consequently, as an article of diet for children, and persons recovering from illness, it has of late years been found extremely valuable. The high price for which it is sold is frequently the cause of its being mixed with starch obtained in this country. It is even said that the article usually sold in London under the name of arrow-root consists chiefly of starch made from potatoes, constituting the *English arrow-root.* Indeed the starch obtained from potatoes is, perhaps, equally as valuable and useful as that obtained from the arrow-root; it may be distinguished from the West Indian by means of a good microscope.

In the year 1838, 2,538 *cwts.* were imported into this country, on which a duty of one shilling *per cwt.* was paid.

Other kinds of arrow-root are met with in the market, obtained from different plants: the *East Indian* from the *Curcuma angustifolia;* the *Brazilian,* from the *Jatropha Manihot.*

NAT. ORD. 73. VANILLACEÆ, *Lindl.*—THE VANILLA TRIBE.

451. *VANILLA is obtained from the* Vanilla aromatica. *Sev*
It is a climbing plant, growing on trees in Peru, Mexico, Cuba, and

the West Indies. The fruit has a very strong odour.—Sex. Syst. Gynandria Monandria.

By some the flavour of this plant is much esteemed. Its principal uses in domestic life are for the flavouring of chocolate and ices, the perfuming of snuff, &c. On the continent it is used as a medicine, and exerts considerable stimulating and exhilarating effects on the constitution. It is the *Epidendrum Vanilla* of the old writers.

NAT. ORD. 72. ORCHIDACEÆ, *Lindl.*—THE ORCHIS TRIBE.

452. *SALEP is the powder of the dried roots of several well-known field-plants of the orchis tribe* (Orchis morio, O. mascula, O. latifolia, &c.)—*Sex. Syst.* Gynandria Diandria [1].

As an article of diet, salep is supposed to contain the largest portion of nutriment, in an equal compass, of any known vegetable production; even arrow-root is, in this respect, inferior to it. The orchises flourish in great abundance in meadows and pastures of several parts of England, flowering about the months of May and June. As soon as the flower-stalks begin to decay, the roots should be dug up, and the newly-formed bulbs, which have then attained their perfect state, should be separated. After which they should be washed in water, and have their external skin removed by a small brush, or by dipping them in hot water, and rubbing them with a coarse linen cloth. The next process is to place them on a tin plate, and put them into a hot oven for about ten minutes, during which they will lose their milky whiteness, and acquire a transparency like horn. They are then to be spread in a room, where in a few days they will become dry and hard.

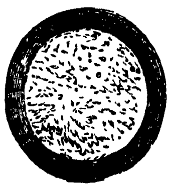
Although salep might be procured in our own country, we import nearly the whole of what we use from the Levant, which is generally in oval pieces of a yellowish white colour, somewhat clear, and of an almost horny substance. When the dried root or its powder is put into boiling water, it dissolves into a thick mucilage.

[1] The genus *Orchis* is arranged by Loudon under the order *Monandria.—Encycl. of Plants*, p. 7.

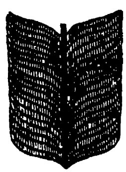
With the Turks, salep has great celebrity on account of the restorative qualities which it is supposed to possess. It is much recommended as nutritive food for persons recovering from illness; and in particular as a part of the stores of every ship about to sail into distant climates. It not only yields a valuable nutriment, and in a great measure conceals the saline taste of sea-water, but it is said to be of essential service against the sea-scurvy. When it is stated that one ounce of this powder and an ounce of portable soup, dissolved in two quarts of boiling water, will form a jelly capable of affording sustenance to one man for a day, the utility of salep will be further seen as a means of preventing famine at sea for an infinitely longer time than any other food of equal bulk.

Although the salep of this country is produced by the plants above mentioned, that imported from the East is obtained from different species of the Order. According to Professor Royle, the salep of Cachmere is procured from a species of *Eulophia.*

With the consideration of the Endogenous Class of Plants used as food, &c. the first volume is concluded. The cuts inserted below will recall to the mind of the reader the peculiarities of the *leaves* and *stems* of Ingrowing Vegetables.



Homogeneous Structure of the Stems.



Parallel Veins of the Leaves.

END OF VOL. I.

(The Index is at the end of Vol. II.)

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J. Shirt sculpt

VEGETABLES.

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