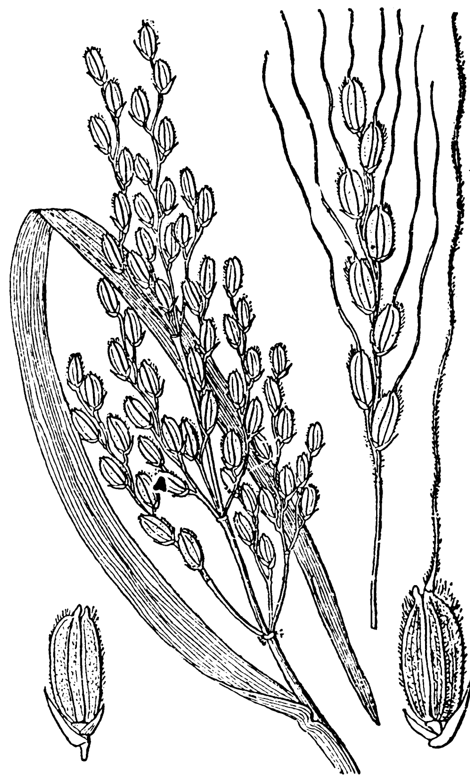
each part of the steeped rice and a milky fluid results which contains about 25 per cent. of solids. This starch suspension may be diluted until it contains about 2·5 per cent. of solids and then allowed to settle in vats or it may be treated in centrifuges for the removal of the starch. The thick starch suspension is put into cloth-lined boxes, about 5 ft. long × 9 in. × 9 in., having perforated bottoms and allowed to drain, the boxes being filled up with more of the suspension as the mass

FIG. 5. Rice *Oryza sativa* Linn. Inflorescence without awns and a portion of an inflorescence with awns. 1 and 2, enlarged figures of spikelets from each. (After Lindley, 1862.)



contracts. The damp starch, containing about 44 per cent. of water, is cut into cubical blocks and transferred to a crusting-oven at 50° to 60°. After forty-eight hours the brownish outer layer, about ½ in. thick, is scraped off and the starch, containing 28 to 30 per cent. of moisture, is wrapped in paper and dried slowly in an oven at 30° to 50° for about fourteen days. Cracks appear in the drying masses and gradually spread, so that the blocks break up into irregular pieces (often referred to as columnar masses), giving the best quality rice starch, known as " crystal " starch. See also Fig. 5.

Manufacture of Potato Starch. The average percentage composition of potatoes (the tubers of *Solanum tuberosum*, family Solanaceæ) is ponents, they average about 12 × 20 microns; they are rare in commercial starch because they become broken into individual granules during the process of preparation. The average number of granules per mg. of the air-dry commercial starch is 10,500,000 and the moisture content is about 12 to 15 per cent. Individual granules of rice starch measure about 3 to **5** to **8** to 12 microns in diameter. Commercial rice starch is usually alkaline in reaction. See Fig. 7. *Ash* 0·38 to 0·78 per cent. *Reaction*, 10 g. require from 0·1 to 4·4 ml. of N/10 H_2SO_4 or more rarely from 0·2 to 0·8 ml. of N/10 NaOH.

Potato starch is used as a disintegrant in making medicinal tablets. It is also extensively employed for various technical purposes. It is the variety of starch which is preferred for use in chemical testing. The granules are flattened-ovoid or subspherical; the ovoid ones are 30–**45**–**70**–100 microns and the rounded ones 10 to 35 microns in diameter; a few of the granules are compound, with two or three components. The hilum is a point at the narrower end of the granule ; concentric striations are well marked. Commercial potato starch is usually neutral in reaction and is graded according to the size of the granules, the more esteemed varieties being those which contain a greater proportion of the large granules. The number of granules per mg. of the air-dry starch is about 73,000 and the moisture content is about 20 per cent. See Fig. 7. *Ash* 0·19 to 0·33 per cent. *Reaction*, 10 g. require from 0·2 to 0·8 ml. of N/10 NaOH.

Maranta starch, obtained from the rhizomes of *Maranta arundinācea* Linn., family Marantaceæ, is known in commerce as St. Vincent, Bermuda, and Natal arrowroot, or simply as arrowroot, but as the latter term is applied to a number of other starches, it is desirable that this, the arrowroot of English commerce, should be specified as maranta starch. Thus the starch of *Curcuma angustifolia* Roxburgh, and *C. leucorhiza* Roxburgh, family Zingiberaceæ, is known as East Indian arrowroot; that of *Manihot utilissima* Pohl, family Euphorbiaceæ as cassava starch or Brazilian arrowroot and that of *Ipomœa batatas* Choisy, family Convolvulaceæ, as Sweet Potato starch; that from the rhizomes of *Canna edulis* Ker-Gawl, and other species of Canna, family Cannaceæ, as Queensland arrowroot, or Tous les Mois starch, the granules of which are the largest known, being up to 150μ by 90μ with an average of 100μ. See Fig. 7.

The granules of maranta starch are ovoid with a few small tuberosities; the striations are concentric and rather indistinct; the hilum is usually at the broader end of the granule and is represented in commercial starch by a split which usually has the form of two radiating, curved lines. They are 7 to **30** to **45** to 75 microns in diameter and are all simple. See Fig. 7.

Curcuma starch, from the rhizomes of *C. angustifolia* Roxburgh and *C. leucorhiza* Roxburgh, family Zingiberaceæ, is known as East Indian arrowroot and is largely used in India, although it does not find its way, to any great extent, to this country.

The granules are flattened rectangular ovoid with a slight projection at one end; the striations are numerous, transverse and indistinct; the hilum is a point in the terminal projection. They are 15 to **30** to

CHAPTER IV

FOSSIL ORGANISMS, SHELLS AND MINERALS

DIATOMITE. Diatomaceous Earth. Kieselguhr

Sources. Diatomite consists almost entirely of the siliceous skeletons of fossil diatoms, family Bacillariaceæ (formerly Diatomaceæ), a subdivision of the Algæ. Abundant deposits occur in many parts of the world, notably in California and Virginia in the United States of America, Algeria, Denmark, Germany, Kenya Colony and also in less amount in Scotland (Skye and Aberdeen) and in Northern Ireland. These deposits have been formed in geological time by the rapid growth of diatoms, which have died, and their siliceous contents have fallen to the bottom of the sea or inland lake and have accumulated in vast quantities. Some deposits have been formed in sea-water and others in fresh water.

Collection and Preparation. The deposit is usually mined in open quarries, and large blocks, containing from 25 to 40 per cent. of moisture, are arranged in stacks to become air-dry, with a moisture content of 5 to 6 per cent. The blocks are next crushed in mills and the powder is graded by special machinery, usually by air-separators of the " cyclone " type, into products of different finenesses. A certain amount of diatomite is imported in blocks and much comes in the form of powder. For pharmaceutical use the powder is digested with diluted hydrochloric acid, thoroughly washed and dried.

Description. Diatomite is a light brownish grey powder or, after treatment with acid, a white powder; smooth, but not slippery, adherent to the skin when rubbed; tasteless and odourless. It is highly absorbent and is unaffected by incineration. Owing to the large volume of air enclosed by the material, the apparent density varies from 0·11 to 0·32, the actual density of silica being about 2·3.

Microscopy. A diatom skeleton is formed of two parts, each of which consists of a flat or slightly waved siliceous plate which is sculptured so as to present a pattern of very beautiful design. This flat plate varies much in shape and may be oblong, oval, circular, triangular, sigmoid or of some more complex shape; it is named the *valve*. The margin of the valve is slightly bent over and to it is attached, at right angles to the valve surface, a band, which gives the entire structure the form of a box lid. The two portions of the skeleton fit together like the lid and bottom of a pill-box, so that one valve is always slightly smaller than its fellow; the two overlapping bands form together the *girdle* of the diatom. The appearance of a diatom is therefore quite different according to its position when under observation; the valve-view shows the surface of the valve plates and the girdle-view shows the diatom from the side. There are two main groups of diatoms, named the *Pennatæ* or pennate forms, which are elongated, and the *Centricæ* or discoid forms, which are usually circular or triangular. Fresh-water diatoms are more robust in structure than montmorillonite distributed throughout the lump. The colour may vary from nearly white to yellowish or greenish grey depending upon the amount of iron present in the earth. It is odourless and tasteless.

Microscopy. When mounted in cresol, the powder is seen to consist of particles of various sizes, some of them being transparent and irregularly angular with conchoidal surfaces while others are brownish grey and semi-opaque. Many of the particles are small, about 4 to 15μ in diameter and others are much larger, about 25 to 75 or up to 135μ in greatest dimension. The brownish grey particles swell in water to show very small fragments embedded in a gelatinous matrix, a reaction indicating montmorillonite; the clear particles are of two kinds, some soluble in hydrochloric acid, indicating calcite, and others are insoluble in the acid, indicating quartz. If the powder is mounted in a 0·1 per cent. solution of methylene blue in alcohol, 95 per cent., the montmorillonite particles stain deep blue while the others are unaffected. The powder, mounted in cresol and examined by polarised light on a dark field, shines brightly and many of the particles, both large and small, exhibit bright colours.

Constituents. Analysis of fullers' earth gives the following average percentage composition, SiO_2, 56; Al_2O_3, 16; CaO, 3·5; MgO, 2·0; Fe_2O_3, 6; H_2O, 10. These figures correspond approximately to the following percentages, montmorillonite, 56; silica, 18; calcite, 9; magnesite, 4; iron oxide, 6; water, 7.

Uses. The absorbent property of fullers' earth makes it useful for dusting powders; it is also used as a clarifying and filtering agent and for cleansing woollen fabrics by removing grease, etc.

Note. *Attapulgite* is a variety of fullers' earth found in Georgia, U.S.A.; none of its particles swells in water.