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the good jaggery. If on any account the normal recovery was not got from the first rab, it was found possible to get the balance as second sugar, when the first molasses is boiled and made into second rab.

**Cost of production.** The cost of preparing white sugar and molass jaggery from a 30 ton crop works out to Rs. 75. During the last season Fiji B cane yielded at the rate of 41 maunds of white sugar and 53 maunds of molass jaggery per acre. Valuing a maund of sugar at Rs. 10 and a maund of molass jaggery at Rs. 1–8–0 the receipts per acre less cost of making sugar is Rs. 415 while the receipts per acre when jaggery is made amounts to Rs. 240. There is thus a clear margin of Rs. 175 in favour of sugar making. Already two ryots have started this industry in North Arcot and Chingleput Districts and it is pleasing to hear that they got an extra profit of Rs. 200 per acre by making sugar instead of jaggery.

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# RECENT WORK ON THE GENETICS OF MILLETS IN INDIA.*

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Millets are the food crops of the poor and till recently received very little attention. Much of the work recorded herein has been done at the Millets Breeding Station, Coimbatore in collaboration with the band of young workers devoting themselves to these crops. Work reported by other workers is also summarised with suitable references.

## *Sorghum*—The Great Millet.

**Seedlings.** In certain cases seedlings give an indication of pigmentation in the adult plant. The coleoptile with or without the root may be coloured. There are seedlings with no purple colour. These distinctions could be utilized to observe segregation in the seedling stage. This practice is very old and has been utilized at Coimbatore for a number of years (Rangaswami Ayyangar, 1930).

**Sap Colour.** There is a sap colour character, characterised by redness in the leaves, grain, dry stigma and anther. The presence of this group has proved dominant to its absence (Graham, 1916). Ramanathan (1924) records the dominance of red pedicelled spikelets to their non-pigmented condition. This latter is what is observed in

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segregates at grain stripping time, Graham's being a field observation. Both of these are aspects of the same character which colours all these parts. Segregations of this comprehensive group have been met with at Hagari.

**Colour of leaf sheath and glume.** The colour of the leaf sheath and the colour of the glume go together. The association has been so constant that it is not possible to say whether it is a case of linkage or the expression of the same factor in different places. A factor P separates the purple pigmented from the brown sheathed varieties, the former being dominant. In the purple group a factor Q helps to separate the purple into reddish purple and blackish purple, the latter being recessive (Rangaswami Ayyangar et. al., 1933 a).

**Midrib of leaf and Juiciness of Stalk.** Hilson (1916) records the dominance of white midrib with pithy stalk to dull midrib with sweet stalk. Swanson and Parker (1931) find distinct genetic factors responsible for juiciness and sweetness, but have not pursued the inheritance of the latter.

**Pubescence.** Ramanathan (1924) records that felty hairiness on the outermost glume, the rachis and the band above the node go together and are dominant to the sparsely to practically no hairy condition in those places. He is not sure if they are mono-factorial or bi-factorial in composition.

**Panicle.** Karper (1929) working at the Texas Agricultural Experiment Station on head characters in kafir, records that the classification of the $F_3$ generation data on the basis of the means and standard deviations of the characters, shows that length of rachis, number of nodes to head, and number of seed branches are inherited in a simple Mendelian fashion, the data grouping themselves into a 1 : 2 : 1 ratio.

The shape of the panicle and its inheritance is very complex especially when characters have to be read through the various manifestations of different varieties. The simple dominance of the loose panicle over the compact has been recorded by Ramanathan (1924) and also reported from Kansas. These panicle characters are under study at Coimbatore. In *S. nervosum* a segregation of loose-conical to compact-spindle has been met with, the former being a simple dominant. In *S. Roxburghii* characterised by its very loose streaming branches this recessive compactness has also been met with, in the shortening of these branches and clustered disposition of the spikelets.

**Glumes.** Grain sorghums have to develop a plump grain in their glumes. In the *S. Durra* and *S. cernuum* groups which embrace many of the grain sorghums, glumes in the mature earhead develop a transverse wrinkling which accommodates the growing grain and helps to keep it clipped up. This wrinkling does not occur in some other grain sorghums. Ramanathan (1924) records a simple mono-hybrid ratio between wrinkled and non-wrinkled glumes. His figure suggests a segregation between *S. cernuum*, a grain sorghum, and *S. nervosum*, a fodder sorghum, with poor grain development. This wrinkling seems to be an independent factor operating in the grain sorghums themselves and at Coimbatore experiences in segregates in the grain sorghums (*S. Durra*) have been met with.

In the *S. Roxburghii* and *S. margaretiferum* groups, which are also grain sorghums, the freedom of the small grain from the glume is achieved by an in-curving of the edges of the glume giving the spikelet a winged appearance, the small grain sticking out of the gaping glumes. This gaping condition of the *S. Roxburghii* group has proved a simple recessive to the normal glumes. Graham (1916) records that short glumes are dominant to long glumes. Vinall and Cron (1921) find that broad truncate glumes are dominant to narrow ovate glumes.

**Sorghum Durra × S. papyrascens.** *S. papyrascens* is characterised by long and narrow glumes, poor setting, irregular flowering and poor extrusion of anthers. This character group of *S. papyrascens* has proved a simple recessive to the short and wide glumes, good setting, regular flowering, and good protrusion of anthers of *S. Durra.*

**Awns.** Long awns are a simple recessive to 'Nil' awns. In some races a 1:2:1 ratio has been obtained of long : short : nil, the shorts proving heterozygous.

**Glume Tip Colour.** Ramanathan (1924) finds that the glumes with red tips are dominant to those without the red tips. While expecting a relationship between this red tip and red in the pedicelled spikelets, his separate numbers for these two experiences have not been interrelated; the families in these are not the same. The red tip to the glume has no constant relationship to the redness in the pedicelled spikelets.

**Grain Colours. Red, Yellow and White Grains.** The relationship between Red, Yellow and White grain colours have been worked out by Graham (1916), Vinall and Cron (1921), Conner and Karper (1923), and Sieglinger (1924). Rangaswami Ayyangar and his co-workers (1933) determined Yellow (factor Y) as the basic factor in the colour scheme. With R, red grains are produced. A factor W determines the manifestation of colour in wholeness. Without W, R gives a white grain with a red base. Similarly Y gives a white grain with a yellow base. Dry anther colours run parallel to grain colours and help in the separation of the white grains into their respective allelomorphs to coloured grains. A factor I determines the intensity of colour manifestation and is unmistakably noticeable in the red group. Red without the I factor gives a pink grain. Monogenic and digenic interactions of these factors have been met with.

**Brown Grains.** Vinall and Cron (1921) found a bi-factorial expression of Brown. They refer to an under-coat of brown in some white grains. Their 15 : 1 ratio of coloured to white grains is obviously an interplay of one B factor and W, though no such explanation is given. Sieglinger (1924) explains his brown grains experiences in terms of the existence of a brown nucellar layer above the aleurone layer, possibly similar to the brown under-coat of Vinall and Cron. This basic presence is made manifest into pericarp brown and further ramifications with other colours is thus made possible. Swanson (1928) after microscopic examination elaborated Sieglinger's experience by letting in (1) the presence or absence of the nucellar layer and its brown, (2) a thick or thin mesocarp masking the expression of above colour, and (3) a factor determining epidermal and hypodermal pigmentation. In our experiences the nucellar brown has not been met with. Two factors $B_1$ and $B_2$ are responsible for the production of a full brown colour on the grain, produced by their concurrent presence. Each of the B factors is capable of giving a light brown wash to the grain provided the W factor determining the expression of pericarp colour is also present. In white grained varieties the B factors can be detected only through the colour of the dry anther, so much so that chance matings bring about brown grains in crosses between some white grain varieties. This possibly explains the spontaneous occurrence of browns gradually vitiating a pure white grained crop. The interplay of the B factors which are not anthocyanic, over and above the anthocyanic red and yellow and their colourless allelomorphs, leads to the wealth of blended colours met with in sorghum.

**Linkage between Sheath—Glume and Dry Anther—Grain Colours.** There is a linkage probably complete, between Qq (factors for leaf sheath and glume colour) and Bb (factors for brown colour in dry anther and grain).

**Pearly and Chalky Grains.** Sorghum grains fall into the two broad groups Pearly and Chalky. The former is translucent and the latter opaque. Chalky grains are characterised by a large deposit of starch in their thick mesocarp. The deposit being uneven, gives the grain a banded appearance. The opaque grains seem, by virtue of their quicker absorption of water, to be specially suited for sowing in light loams. Pearly (factor Z) is a simple dominant to the Chalky character. Coloured grains also manifest this banded appearance when chalky. A separation can be attempted in lighter colours, but with the depth in colouring the colourless allelomorphs have to be depended upon for this classification of coloured grains into pearly and chalky.

**Panicle Shape—An instance of Linkage with grain consistency.** *S. nervosum* is characterised by pearly grains, that keep enclosed in the prominent glumes. An instance has been met with of a linkage between the characters pearly (Z) and chalky (z) and between loose-conical and compact-spindle earheads. Whereas the loose earheads gave both pearly and chalky grains the compact ones were all pearly, the ratio of pearly to chalky as well as loose to compact was 3 : 1.

**Endosperm Characters.** Karper (1933) has recorded the dominance of the starchy endosperm to the waxy one. There was pollen dimorphism indicative of this; as also xenia. At Coimbatore races of sugary grains with dimpled appearance have been met with. This sugary dimpled character has proved a simple recessive to the starchy non-dimpled character. Xenia was experienced in this character also.

**Anther Tip.** The anthers are commonly not coloured purple. A rare form with coloured anthers was met with. In cultivated forms rare instances of purple colour at the tip of the anther and occasionally at its base have occurred. The association of this character with other plant characters is under investigation; but it is worth recording one experience in which anthers with purple colour at their bases were closely linked to brown grains which segregated as dominants to white grains having no purple in the anthers.

**Nodal Band.** There is a band of soft tissue above the nodes which in some varieties is coloured purple. The purple is of two kinds, one of these is associated with factors for brown grains and in segregates is dominant to a green band. There is a rare kind of band colour a bit checkered in appearance which is associated with a good sienna anther and its linkage with that anther is so strong that this coloured band is automatically a dominant or recessive according to the segregate in which this sienna anther finds itself.

**Height of Plant.** Sieglinger (1932) records a segregation of a bi-factorial type giving Talls, Dwarfs and Extra-Dwarfs. Two dwarfs gave the tall. Karper (1932) records a dominant tall mutation arising and proving dominant to the standard shorter variety of kafir (*Sorghum caffrorum*). Sieglinger (1933) records through mutation the occurrence of an extra-dwarf recessive to the standard dwarf. There seem to be mutative tendencies productive of differential heights in sorghum, sometimes towards tallness, a reversion to parental form. and more often towards dwarfness and the consequent perpetuation of dwarf varieties of commercial value. This latter has been much in evidence consequent on the new introductions into America. At Coimbatore, there has been recently an experience in S. Durra of "Short early" plants proving a sharp dominant to "Tall late" plants. Another experience has been met with in *S. Roxburghii var. Hians* in which a tall plant of the same duration appeared as a mutant among dwarfs and proved heterozygous for height, tall being dominant.

**Albinism.** Five types of chlorophyll deficiencies have been noted: (1) Lethal white, (2) Lethal virescent white, (3) Lethal pale, (4) Lingering lethal pale, (5) Surviving pale. Each of these is a recessive to the normal healthy green. The first four types proved lethal of varying degrees. In one type of deficiency distorted 3 : 1 ratios have been set to the presence of a zygotic lethal factor (Rangaswami Ayyangar and Sankara Ayyar, 1932). Karper and Conner (1931) record that the factor R for red stem and W for albino were found to be linked with a cross over percentage of 41·34. This linkage between anthocyanic and chlorophyll factors should if pursued prove of great interest (Rangaswami Ayyangar, 1932.)

**Disease Resistance.** Whereas much work has progressed in determining varietal resistance to the various diseases to which sorghum is subject, very little has been done on the inheritance of such resistance. Swanson and Parker (1931) find that susceptibility to smut (*Sphacelotheca sorghi*) is dominant to its resistance. They find a tendency in the juicy stalked sorghums to greater susceptibility, but do not mention any definite linkage between the two. They think it probable that this susceptibility might go with sweetness rather than juiciness. Reed's (1930) experiences point to both the dominant and recessive condition of susceptibility.

**Tenuous Plants.** Sieglinger (1929) working in kafir records a segregation between normal kafir plant and grass-like ones, characterised by an absence of coronal roots and the thickening of stems and leaves, the latter being recessive.

*Pennisetum typhoideum* (The Pearl Millet).

This millet is protogynous and its genetics present very great practical difficulties. Protogyny results in cross pollination, so much so that it can be said that most varieties of this millet are characterised by a fair uniformity in duration, the type of the earhead, and crop height. This uniformity in essentials being secured, the rest of the non-essential characters tend to be kept up in a perennial heterozygous condition. *P. Leone* was a new form from Africa and has a big long cylindrical truncate head, glumes purple and felty, grains pearly white with a pointed apex, and with anthers emerging while the stigma is fresh. This was crossed with the Coimbatore variety with a tapering head, not so compact, glumes green and glabrous, dark leaden coloured grains with round apex and with anthers emerging when the stigmas shrivel up. The Leone characters have proved dominant in the $F_1$ plants now on the Millets Breeding Station at Coimbatore.

**Chlorophyll Deficiencies.** Albinism was met with in this millet. All albinos proved lethal. The albinos range themselves into pure whites, whites with the leaf tip greenish, and those with cream coloured leaves. These may occur singly or in combinations. The commonest occurrence is of pure whites, the next common is in combination with green tips. Of the earheads taken, about a tenth came pure green. The segregations varied within wide limits from 1·5 : 1 to 20 : 1, indicative of the existence of a number of factors for chlorophyll, so difficult of pursuit in this protogynous crop. A type of chlorophyll deficiency, non-lethal, producing pale green foliage has been met with. Plants with these attributes are economically weak. They have proved recessive to normal green and dominant to the lethal albino.

Apart from the basic attributes of similarity in duration, height and earhead characters, the other distinguishing features are pigmentation on the plant, hairiness on the leaf, and bristles on the earhead. In each of these characters, the stronger manifestation appears to be dominant to the weaker aspect of it. A number of generations have been studied by Godbole, (1927), Patvardhan (1927), and at Coimbatore, and the pursuit of the inheritance of these characters is beset with practical difficulties. They are valuable in keeping up heterozygosity in non-essentials to the benefit of the crop community. The only method of determining initial dominance is to try crosses with fresh importations (as was done with *P. Leone*) and in the light of the $F_1$ behaviour, make back crosses and suitably modulate future mass selection work to fix a variety fairly pure in essentials

*Eleusine coracana* (The Finger Millet).

**Purple Pigmentation.** As in the case of other cereals, purple pigmented plants are dominant to green-throughouts in Ragi. Four distinct types of pigmentation, localised purple, dilute purple, medium purple and purple, varying in intensity are met with, each showing a single factor difference of advance over the next lower group. Localised purple is the basic purple and arises by the presence of factor P. This P with $I_1$ becomes dilute purple. $I_2$, the second intensifying factor acts only in the presence of $I_1$, and with dilute purple becomes medium purple. Two factors, $H_1$ and $H_2$ either alone or together determine the depth of manifestation of purple pigmentation in the glumes. These act only in the presence of all the three factors, P, $I_1$ and $I_2$ making the medium purple into purple. Green-throughouts, that altogether lack purple pigmentation, are capable of being classified into various types of purple pigment producing potentials.

**Grain Colours.** The characteristic brown colour of the Ragi grain has been designated Ragi Brown. Two factors $B_1$ and $B_2$ either alone or together are capable of producing this brown. A third factor S in association with either or both of the B factors, results in plant purple pigmentation. This fact accounts for the absence of white grained ragi in purple pigmented plants. The S factor is carried by some races of white grains. A factor D that deepens the effect of brown factors behaves as a simple dominant. This is independent of the factors concerned in the plant purple pigmentation and is not in selective association with either of the B factors.

**Depth of green in the Pericarp.** The pericarp of the developing grain of ragi is usually green. Minor races with a light green pericarp are met with. A factor $C_x$ is responsible for the green of the pericarp.

In its absence, the pericarp is light green. This is independent of P, I and B factors. The tint of dry anthers shows a differentiation in depth corresponding to the depth of the green pericarp, and is associated with it.

**Sterility.** Chronic sterility, short of complete sterility is occasionally met with in Ragi. The cause of this sterility is two-fold. It may be due to the non-dehiscence of anthers or to the agglutination and consequent absence of free pollen. Normal dehiscence occurs with the presence of the X factor. Free pollen is produced by the Y factor. Both the factors X and Y behave as simple dominants to their absence resulting in sterility.

**Albinism.** Two factors $C_1$ and $C_2$ either alone or together are responsible for the production of chlorophyll in the plant. In the absence of both, the resulting seedling turns white and dies. Plants with $C_1$ and $C_2$ have been isolated and crossed with the result that in the $F_2$ they segregated and threw albinos one in sixteen. The factor $C_x$ inducing a differential depth in the pericarp has no influence whatever on $C_1$ or $C_2$. (Rangaswami Ayyangar, et al. 1931).

**Earhead Shapes.** The earheads in ragi vary in their length. Two factors $E_1$ and $E_2$ determine this elongation. Either of them gives a short length, both give a long length. When neither is present a very short length is obtained. A factor Q, determining the density of disposition of spikelets per centimetre length results in a crowding and consequent curving of the earheads leading to the three types of curveds viz., Top-curved, In-curved and Fist-like. The number of spikelets in the earheads of ragi being about equal, such crowding naturally reacts on length. In the absence of Q, the corresponding opens are Long Open, Short Open and Very Short Open. Factors Q, $E_1$ and $E_2$ are independent of P, $I_1$ and $I_2$ and $H_1$ and $H_2$ (Plant Purple Pigmentation), $B_1$, $B_2$ and S (Grain Colour) and $C_x$ (Unripe pericarp colour) factors. (Rangaswami Ayyangar et al. 1932).

*Setaria italica* (The Italian Millet).

Rangaswami Ayyangar and his co-workers at the Millets Breeding Station, Coimbatore, have begun a genetic analysis of this millet and their work is summarised below:—

**Plant Purple Pigmentation.** Plants are pigmented (anthocyanic) and without purple pigment (green-throughouts.) The former condition is dominant and arises by the basic presence of a factor P. There are various manifestations and intensities in this pigmentation. A factor I determines a manifestation in intensity and is dominant to a weaker depth. The degree to which P is operative, in addition to being dependent on the presence of I, is conditioned by two other factors V and H, which determine the alacrity with which P manifests in the vegetative or earhead parts. An interaction of P, I, V and H factors produce the diversity of forms characterising varieties of this millet.

**Grain Colours.** Six grain colours have been noted in Setaria italica. These fall into two groups (a) Black, Tawny Buff and Korra Buff, and (b) Sepia, Red and Tawny Red. A factor K (after Korra, the Telugu name for this millet) is present in group (a) and absent in group (b). In each of these groups the basic colours Tawny Red and Korra Buff, with the addition of a factor I, turn into Red and Tawny Buff. This Red and Tawny Buff with the addition of another factor B turn into Sepia and Black respectively. Factor B has an individuality, but its presence is not visible except in association with I. (Rangaswami Ayyangar and Narayanan, 1931).

**Anther Colours.** Two fresh anther colours are met with, viz., brownish-orange and white. These, when dry and seen *en masse* appear brownish-black and buff-yellow respectively. These colours form a simple Mendelian pair, with orange dominant. (Rangaswami Ayyangar and Narayanan, 1932).

**Bristles.** The bristles fall into four groups 'long', 'medium', 'short', and 'dwarf'. The 'dwarf' bristle represents the basic bristle condition in all setarias. This is due to a factor X. Three other factors E, $L_1$ and $L_2$ acting on X are responsible for the four differential lengths. E determines the expression of the various bristle types, and depends for its manifestation on the factor $L_2$. X with or without E remains a 'dwarf'. $L_1$ and $L_2$ contribute to the lengthening of the bristle. $L_1$ and $L_2$ acting individually on the dwarf (Xe) produce a short bristle; together they produce a 'medium'. $L_1$ with XE gives a 'short'; $L_2$ with XE gives a 'medium'. $L_1$ and $L_2$ together with XE produce a 'long'. The factors governing bristles and their expression are independent of those for grain (K, B and I) and anther colours.

**Spikelet Tipped Bristles.** The bristles in Setaria occasionally bear an extra spikelet at their tips in some races. This is more common in the cultivated *Setaria italica* than in the wild *S. glauca* or *S. verticillata*, and behaves as a definite heritable character. The condition where most of the bristles are tipped with a spikelet is designated 'full' and it is allelomorphic to the 'nil' spikeletted bristle condition. The 'full' in some families has been found to be a simple mono-hybrid recessive to 'nil'. In other families dominance is incomplete and an intermediate heterozygous class 'stray', where only a few bristles are spikeletted, is present, the three classes occurring in a 1 : 2 : 1 ratio. The full spikeletted condition has been found to be incompatible with a long bristle.

**A Type of Lax Earhead.** A primitive type of 'lax' earhead characterised by fewer spikes, fewer spikelets, and chronic sterility,

G. N. Rangaswami Ayyangar.



has suddenly occurred and behaved as a simple recessive to the normal economic 'dense' earhead. A factor A is set down to be responsible for this difference.

**Albinism.** A simple segregation of mono-factorial type for green and albino seedlings has been met with in Setaria italica. Factor $C_1$ is responsible for green seedlings, its absence resulting in albinos which do not live. (Rangaswami Ayyangar et. al. 1933 b.).

*Paspalum scrobiculatum* (The Kodo Millet).

**Albinism.** In *Paspalum scrobiculatum* a case of variegation occurred. Its progeny gave green seedlings and albinos in the proportion of about 8 : 1. In the succeeding generations, with populations varying from 500 to 2000 a series of ratios from 2.3 : 1 up to 469 : 1 was experienced. The tenable explanations for this behaviour are numerous. But the second observed fact, that the proportion of segregating to pure families is about equal, suggests as most probable an explanation based on complementary factors lying on two or at most three different chromosome pairs and functioning in the capacity of chemical determiners for the production of chlorophyll.

*Panicum miliaceum* (The Proso or Common Millet).

**Hairiness.** In this millet grown as a catch crop in the cold weather many of the cultivated forms are chararcterised by hairiness of degrees. The commonest is a medium hairy type. This type of hairiness has behaved as a dominant to the recessive glabrous forms. Both 3 : 1 and 15 : 1 ratio have been met with indicative of the bi-factorial composition of hairiness.

**Purple Pigment.** Plants with anthocyanin pigment in parts have given 3 : 1 ratios to green-throughouts.

**Grain Colour.** The commonest shades of grain colour in Madras varieties are dark olive grey and buff yellow. In crosses between these two the former colour proved a simple dominant.

*Panicum crusgalli* var. *frumentaceum* (The Barn-Yard Millet).

**Plant Purple Pigmentation.** In this millet there are plants with and without anthocyanic pigment. The pigmented plants vary in depth of manifestation. The whole manifestation is so light that it is a question of degrees in this limited manifestation. The touchiest parts for this difference are the stigmas and anthers. A good purple is brought about by two supplementary factors each one of them of different dilutions so much so that 3 : 1 and 15 : 1 ratios are obtained for purple and green. One grade of dilution is fairly separable resulting in a 12 : 3 : 1 ratio of good purple, dilute purple and green.

**Panicle Shapes.** The panicle shapes fall into two broad groups, open and closed, which on crossing give an intermediate. The segregates fall into a rough 1 : 2 : 1 grouping.

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## ABSTRACTS

**The Vitamin $B_1$ and $B_2$ contents of cotton seed products.** By M. L. Whitsilt (*Jour. Ind. & Eng. Chem. Vol. 25, No. 10, P. 119*). By methods of rat growth, cotton seed meal was found by the author, to be a rich source of vitamin $B_1$, and a fairly good source of vitamin $B_2$. On the other hand the cotton seed oil was found to contain no vitamin at all; the cotton seed hulls were found to be as rich as the meal in vitamin $B_2$, though of vitamin $B_1$ not much was found in the hulls. The results tend to indicate, in confirmation with general belief, that the seed coats are richer in vitamin contents, than the seeds themselves. (M. R. B.)

**Potato starch.** By T. C. Taylor and T. J. Schoch (*Jour. Amer. Chem. Soc. Vol. 55, No. 10, October 1933, P. 4248*) Potato like many cereals is rich in starch, but $\alpha$ amylose or amylopectin, which is present in cereal starches is found to be absent in potato starch. Experiments of the author show that a former impression that potato starch was similar to cereal starches, is due to the fact that the associated material in the potato starch granule, gets disorganised and thus gives rise to an insoluble material, which is difficult of dispersion and which is similar to the $\alpha$-amylose of the cereal starches. Light has also been thrown in this paper, on the fact, that organic phosphorus, the distribution of which was not clear before, is found to be randomly distributed throughout the starch and not attached to any amylose fraction. (M. R. B.)