YEAR BOOK, 1918.

SOME NOTES ON THE HABITS AND LIFE HISTORY OF THE STEM WEEVIL ATTACKING CAMBODIA COTTON (*Pempheres affinis, Faust*).

By T. V. RAMAKRISHNA AYYAR, B.A., F.E.S., F.Z.S.,
Acting Government Entomologist.

The variety of cotton known as Cambodia cotton has become very popular and is being cultivated on a fairly large scale in and around the Coimbatore district and there are signs of its further extension year after year. But one of the most important factors for consideration in the introduction and extended cultivation of this crop appears to be the damage done to this plant by a small beetle pest called the 'stem weevil.' Among the different insects that levy their toll on this variety of cotton, this insect seems to be the most important. In view of this fact the insect has been under observation for the past few years and the following forms the results of the study and observations made so far, with regard to its life history and habits. These results are by no means very complete and the study is being continued to fill up other lacunæ.

The insect—its systematic position and bibliography.—The cotton stem weevil belongs to the group of beetles called weevils, which are characterised by the head with the mouth parts being drawn forwards into a more or less pointed snout. It is a

very small creature about an eighth of an inch in length resembling more or less the stored rice weevil 'Calandra oryzæ' but has a thick-built body and is of a pale brownish colour. The insect was first described by Faust in his paper on New Coleoptera 'Beschreibung neur Coleoptera von Vorder und Hinterindien au der Sammlung des Hrn Andrewes in London' on page 319 of the German periodical D. Ent. Z. for 1898. The next reference to this appears in Lefroy's Indian Insect Pests, page 103, as 'the cotton stem weevil.' Lefroy refers to it again in page 389 of his volume on 'Indian Insect Life' and calls it by the name 'Phylaitis.' The latest reference to it is in Fletcher's 'Some South Indian Insects' under its correct name on page 339.

Distribution.—As far as is known this little insect has a very curious distribution in India. It has been noted in Behar in North India, and in South India it appears to be confined to the Coimbatore district. In none of the other cotton tracts of South India—such as the Ceded Districts or Tinnevelly—has the insect been noted. There is not sufficient ground yet to state with any amount of authority that the insect is one of the many introduced forms in India. But that it should be found in widely distant areas, such as Behar and Coimbatore, without being found anywhere between these two shows something surprising regarding the distribution and occurrence of this insect. If it exists in other tracts there is no reason why it should not appear on cotton in the other tracts as this creature does not confine its attacks solely to Cambodia cotton but also to local varieties as is found on the Coimbatore farm.

Nature and extent of injury to the cotton plants.—The adult weevil is not directly concerned in the damage to the plant. It is the young one of the insect called the 'grub' that causes the damage to the plant stem. The short thick-set smooth fleshy grub bores through the stem tissue and affects the growing plants seriously. All affected plants, especially those that are bad, can be easily detected by the presence of gall like swellings on the lower regions of the stem usually just above ground level (see figure 1). These galls are the result of the abnormal growth of the plant due to the irritative action of the beetle grub inside the stem ; an abnormal overgrowth of tissue takes place and causes the nodular swelling. When this knotty portion of the stem is cut open we see the galleries made by the boring grub along the inner layers of the bark, and in many cases the borer itself is found in one of its different stages. It is not easy to detect a plant soon after it becomes infested, as it takes some time for the abnormal growth on the stem to grow and show itself out. When young plants are attacked they are in most cases killed, as the slender stem is unable to stand the attack. In the case of those that are grown up, say 4 or 5 months, though the stem is infested and nodes are formed, though many dry up altogether, several plants withstand the same. A strong wind, however, lodges the heavier plants, the stem getting bent just near the nodular swelling. Even in the case of such plants all plants do not die ; some of them continue to get the plant nutrition through the slender attachment still left even though a greater part of the stem gets broken off. Though many of the affected plants survive, the influence

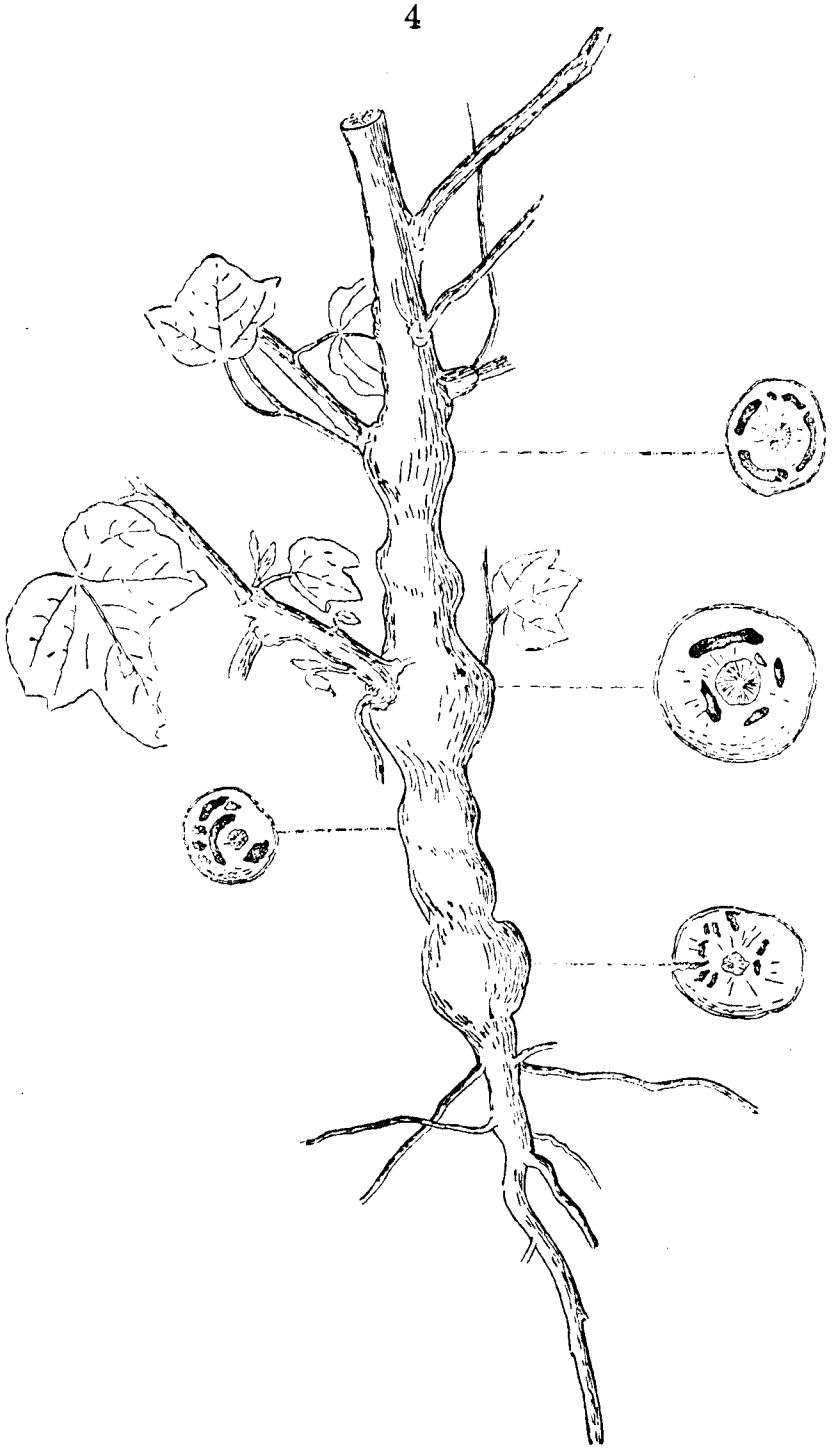


FIG. 1.—THE AFFECTED COTTON PLANT SHOWING SWELLINGS.

of the pest on the vigorous growth and outturn of the crop is considerable.

As to the extent of damage, though the loss is not seen as much by the number of plants killed, it is considerable in view of the fact that very few plants in a field of Cambodia cotton show freedom from infestation ; this goes a great way in seriously checking a healthy growth and a good outturn. In bad cases we might put down the loss to be from 15 to 20 per cent of the usual out-turn.

Life history of the insect.—The egg—The whole life of the insect from the egg to the adult stage is spent on the plant itself. The small shining whitish egg is thrust by the mother weevil just underneath the thin bark of the plant stem through a minute slit made by the weevil for the purpose. It is very difficult to get the eggs in the field ; one has to patiently examine numerous plants before he ever comes across a stem containing an egg. They are also likely to be easily overlooked even where a stem containing the egg is got ; for, the egg is so small and in colour so like that part of the stem where it is deposited that it easily escapes our notice. After some experience one can make out a stem containing the egg by the small holes seen on the stem surface and when this portion of the bark is gently sliced and opened the egg is found placed in a small chamber excavated by the mother weevil. Sometimes one stem in the field is often found to contain seven or eight eggs. Each egg is oval in shape and measures one-third mm. across. The surface is smooth and shining. In colour it is glistening white. The egg remains in this small chamber for a period of nine to ten days at the end of which it hatches out into an active little grub.

The grub.—The young larva is short and cylindrical in shape and comparatively thickest for its shortness. It is of a pale whitish yellow colour with the mouth parts having a brownish tinge. From this time onwards the young larva feeds on the tissue of the plant stem by slowly biting through the tender portions of the bark. It throws the usual periodical moults and grows in size. Gradually, as it increases in size and its biting mouth parts get stronger, it begins to tunnel through the interior of the stem bark and make irregular galleries causing a drain on the plantsap going up through the stem and producing the characterstic swellings on the stem. The period of larval life in captivity has been found to be thirty to forty-five days and may therefore be put down roughly at from one month to a month and a half. When the grub has reached its full growth it measures five mm. or one-fifth of an inch in length. The body is short, more or less cylindrical and fleshy. When taken out of its burrow in the stem, the body appears slightly curved almost like that of white grubs. The dorsal surface is slightly convex while the ventral region is somewhat flattish. The head is small and is made up almost wholly by the mouth parts which are very well developed—especially the mandibles. There are found a few short hairs on the surface especially near the region of the mouth parts. In colour the head is brownish with the tips of the mouth parts showing a darker hue. The thorax is slightly swollen and muscular. The surface above is smooth and the colour is yellowish white. The

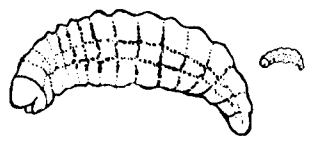


FIG. 2.—GRUB OF STEM WEEVIL MAGNIFIED AND NATURAL.

abdominal region is made up of wrinkled up lobes of flesh corresponding to the different segments. These wrinkles at the sides overlap at the ventral region to some extent. The anal segment is slightly bigger than the penultimate one and shows a few hairs on the surface. The abdomen has a uniform pale yellowish white colour characteristic of most stem boring larvae. As is the case with all weevil grubs there are no thoracic or abdominal appendages and locomotion is effected solely by the muscular contraction and expansion of the body wall. The spiracles are very minute and not easily seen by the naked eye.

As it is the grub stage of the insect that is directly responsibe for the damage done to the plant, it may be worth while noting the habits of the insect during this stage. The grub generally confines its depredations to that portion of the stem between the bark and the main stem. Here it makes irregular tunnels sometimes spiral, sometimes the burrows crossing each other and so on. It does not generally travel far up the stem. As it tunnels through, it fills the track with frass and excrement. At the region of the swelling where the inner tissue has grown irregularly and has become more or less soft and spongy the grub often reaches the main stem and burrows through that region also.

The Pupa.—The pupa is found in the burrow itself and is naked not being covered by any silken or chitinous cocoon. It is a delicate object measuring 4-4½ mm. and having a uniform pale white colour with a tinge of yellow.

FIG. 3.—PUPA OF STEM WEEVIL MAGNIFIED AND NATURAL SIZES.

The grub.—The young larva is short and cylindrical in shape and comparatively thickest for its shortness. It is of a pale whitish yellow colour with the mouth parts having a brownish tinge. From this time onwards the young larva feeds on the tissue of the plant stem by slowly biting through the tender portions of the bark. It throws the usual periodical moults and grows in size. Gradually, as it increases in size and its biting mouth parts get stronger, it begins to tunnel through the interior of the stem bark and make irregular galleries causing a drain on the plantsap going up through the stem and producing the characterstic swellings on the stem. The period of larval life in captivity has been found to be thirty to forty-five days and may therefore be put down roughly at from one month to a month and a half. When the grub has reached its full growth it measures five mm. or one-fifth of an inch in length. The body is short, more or less cylindrical and fleshy. When taken out of its burrow in the stem, the body appears slightly curved almost like that of white grubs. The dorsal surface is slightly convex while the ventral region is somewhat flattish. The head is small and is made up almost wholly by the mouth parts which are very well developed—especially the mandibles. There are found a few short hairs on the surface especially near the region of the mouth parts. In colour the head is brownish with the tips of the mouth parts showing a darker hue. The thorax is slightly swollen and muscular. The surface above is smooth and the colour is yellowish white. The

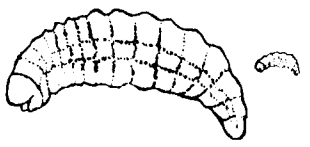


FIG. 2.—GRUB OF STEM WEEVIL MAGNIFIED AND NATURAL.

abdominal region is made up of wrinkled up lobes of flesh corresponding to the different segments. These wrinkles at the sides overlap at the ventral region to some extent. The anal segment is slightly bigger than the penultimate one and shows a few hairs on the surface. The abdomen has a uniform pale yellowish white colour characteristic of most stem boring larvae. As is the case with all weevil grubs there are no thoracic or abdominal appendages and locomotion is effected solely by the muscular contraction and expansion of the body wall. The spiracles are very minute and not easily seen by the naked eye.

As it is the grub stage of the insect that is directly responsibe for the damage done to the plant, it may be worth while noting the habits of the insect during this stage. The grub generally confines its depredations to that portion of the stem between the bark and the main stem. Here it makes irregular tunnels sometimes spiral, sometimes the burrows crossing each other and so on. It does not generally travel far up the stem. As it tunnels through, it fills the track with frass and excrement. At the region of the swelling where the inner tissue has grown irregularly and has become more or less soft and spongy the grub often reaches the main stem and burrows through that region also.

The Pupa.—The pupa is found in the burrow itself and is naked not being covered by any silken or chitinous cocoon. It is a delicate object measuring 4-4½ mm. and having a uniform pale white colour with a tinge of yellow.

FIG. 3.—PUPA OF STEM WEEVIL MAGNIFIED AND NATURAL SIZES.

The anterior end of the body is thicker while the anal end is bluntly attennuated. The future legs, feelers, wings, etc., are all tucked up underneath the anterior region ; the legs extend far into abdominal region behind, almost as far as the curved anal end. The snout is curved downwards. Four or five days after pupation the eyes get a brownish tinge. Gradually the distal ends of the snout and limbs and then the whole body become brownish. The pupal skin is thrown off on the ninth or tenth day after pupation and the insect assumes its adult form ; though it has now finished the pupation period it does not emerge from the stem as the body is very soft and delicate for exposure. After a day or two during which period the body and the limbs get hardened, the weevil comes out in its natural colours. Thus, the pupation period practically occupies about 12 days.

The adult insect.—The adult weevil is a small insect about the size of the ordinary rice weevil but somewhat short and stout built. It is 3 mm. in length. The head is almost wholly made up of the two eyes and the snout ; the eyes approximate at the mid-dorsal region. The snout is very prominent and comparatively long and pointed ; it is curved downwards and backwards. The feelers are small and are attached to the snout far forwards from its proximal region as two slender pieces ; their tips are slightly swollen and have a darker hue. The prothoracic portion is prominent and more or less cylindrical. The elytra are rough

FIG. 4.—THE ADULT WEEVIL MAGNIFIED. THE SMALL FIGURE SHOWS THE INSECT A LITTLE BIGGER THAN NATURAL SIZE.

and with longitudinal striations. The wings are transparent and membranous and kept folded under the elytra. Just in front of the anterior coxae there are two sharp tubercles on the ventral surface of the body one in front of each coxa. Three segments are visible in the abdomen and of these the last is the biggest. The general colour of the beetle is a dark brown speckled with minute greyish or whitish markings. At the central region of the posterior margin of the thorax is a amall diamond shaped white mark and this is continued backwards in a lighter shade along the inner edges of the upper wings. The legs above have the colour of the dorsal surface of the body. The sides of the thorax and body and the ventral region are soft and have a pale greyish white colour. The weevil is a very active little insect and is able to fly well. It is not observed in the field unless very carefully looked for because of its small size and more or less protective colouration. Though the insect has not been noted to readily feed while in captivity, it has been occasionally observed to feed on the tender tissue of young cotton plants and is often found to thurst its beak into the succulent portion of the stem. Weevils have been kept in captivity for 25 or 30 days and so it is not unlikely that it may have the same period of adult life in the fields.

The whole developmental period of the beetle in captivity occupies on the average 57 days (egg 10, larva 35, and pupa 12) and it may be a few days more or less in nature. Roughly therefore one generation takes about a couple of months to complete.

Natural enemies of the insect.—So far no natural enemies whether in the shape of parasites or predators have come to my notice and experiments are still conducted to find out whether any exist.

Other host plants.—Cotton is the chief plant on which this insect commonly breeds and of the several varieties of this plant, Cambodia cotton is the chief. The local varieties of cotton such as Uppam, etc., grown on the Coimbatore farm and around do show weevil infestation, but to a very small degree compared to that in the Cambodia variety. Besides cotton, the insect has been noted on the stem of Gogu (Hibiscus cannabinus) but to a very small extent. It has also been found on the Bhinda stem (Hibiscus esculentus) but not more than two or three cases of this have been noted till now. So far it has not been noted on any of the wild plants around the farm ; perhaps further examination might show it breeding on some wild malvaceous plant ; but since the cotton plant is found in the tract almost throughout the year it appears unnecessary for the insect to seek alternative food plants. In Pusa it was very recently noted to breed on a wild plant—*Triumfetta sp.*

Occurrence through the year.—In the Coimbatore district the Cambodia crop in many places does not appear to be an annual one grown only for a few months in the year and then pulled out. I have seen fields of cotton kept on right through the year or even for a longer period. This necessarily allows the weevil to breed continuously all the seasons without a break. And, at the rate that one generation passes, about six broods can emerge during the year and this accounts for the rapid

and unchecked multiplication of the pest. The presence of the cotton plant all round the year does not also induce the insect to seek any alternative food plant as stated above. It also happens that in many cases the same plant gets reattacked after a month or two and this is gathered from the fact that in stems with young grubs we find old galleries containing pupae or the just emerging weevil, and in some cases all the different stages of the insect are found in the same stem. From what I have seen till now, I don't think there is any period of hibernation or æstivation. In some cases the adult weevil is found to remain in its pupal burrow for a longer time, say a week or ten days. The following particulars regarding the occurrence of the pest on the plants have been worked out so far :—

(*a*) Weevils emerge for a period of a month and a half from infested plants pulled out and kept under shade.

(*b*) Weevils emerge from similar ones exposed to the hot sun but not in such numbers and not for such a long period. A week or fortnight afterwards no weevils emerge. The drying up of the plant does not very much affect the larval burrow.

(*c*) Weevil infestation begins from such an early period as the twenty-seventh day after the plant comes up ; so practically from the first month onwards the infestation continues.

(*d*) The grub, pupa and just emerging adult are found in the same stem up to a month after the attacked plant is pulled out.

Control methods.—With regard to the important aspect of control measures, from the knowledge gained so far of the life history and habits of the

insect and from the experience gained after miscellaneous trials in this direction one can safely state that all methods to check the pest must be only of a preventive nature. When once the field is badly infested there is hardly any successful method of killing the pest and saving the attacked plant. In the first place this is due to the fact that the insect is a borer—an internal feeder, which cannot be easily reached or affected by any external applications. Secondly because the external indication of insect attack becomes visible only when the plant is fairly well bored, it is not possible to remove the insect without interfering with the growth of the plant or completely splitting the stem open in which process the plant may have to be sacrificed.

All preventive measures, whatever be the nature of the method, have to be directed to the prevention of the weevil laying eggs on healthy plants.

With this idea in view the following methods were tried:

(*a*) When the pest was apprehended young plants were smeared at the stem just above the ground with dilute phenyl.

(*b*) The stem at the ground level was earthed up with a mixture of loose soil and lead arsenate powder.

(*c*) The plucking and burning of badly infested plants.

The first two methods have not produced any results worth recording as the plants so treated became infested as usual. The prevention method of pulling out and destroying the first attacked plants has considerably checked the ravages of this pest. But this of course has to be resorted to by

all cultivators in one tract, else the benefit of this method cannot be appreciably noticed. I am led to believe that if there is a lull of at least two months in the middle between one cotton season and the other when there will be no cotton plants at all in a tract, the pest may be starved out and some reduction in its numbers effected ; and if this is done every year I think something substantial could be done in checking this pest. I believe there is a law somewhere in East Africa to the effect that all plants should be off the ground at a certain period and that no plants should be found growing before some fixed date. When any legislation regarding pests is contemplated I think this insect might be brought under those that may be scheduled. Further observations and trials are being continued with regard to the distribution, habits, other food plants and natural enemies of the pest to see whether any further clue is got which might help us in devising control measures. Trials are also being made with trap crops of gogu and Hibiscus esculentus and other preventives and the results are being watched and noted carefully

---

REPORT UPON THE EXTENT AND CHARACTER OF THE SALINE LANDS OF THE MADRAS PRESIDENCY.*

By W. H. HARRISON, D.Sc.,
Government Agricultural Chemist.

The Board of Revenue in 1902 when referring to the improvement of saline soils stated :—"The

---

* Originally prepared in 1909.

matter has never been regularly investigated in this Presidency, as hitherto the saline soils have not been generally of such importance as imperatively to demand an experimental enquiry; moreover, they have as in the Kistna proved amenable to successive floodings." These remarks may well apply at the present time, for, the saline soils of this Presidency, although amounting in the aggregate to a considerable area, are, in general, found in comparatively small isolated tracts and in the deltas; when the necessary water for successive flooding is available, they are gradually being brought under cultivation.

Alkaline soils do not appear to occur on the Nilgiris, in the Wynaad and other places of high elevation and neither do they occur on the West Coast where the rainfall is upwards of 100 inches and fairly well distributed. These soils, however, occur in small tracts in most of the other districts of the Presidency.

Mr. R. C. Wood, the Deputy Director of Agriculture for the Northern Division, reports the occurrence of saline soil in all his districts, the most serious being in the littoral tract of the Nellore district. Other particular bad patches occur in the district around Ongole where, owing to the flatness of the district and its proximity to the sea, drainage is bad. Saline areas are found at the bottom ends of both the Gōdāvari and Kistna deltas, where the lands are often but slightly raised above the sea-level and the sea is kept out by a bar or raised sandbeach. He also states that, in these last cases, systematic flooding gradually removes the noxious salts and that finally crops may be grown. Patches of salt land occur in the Ceded Districts in regada

soil and often in most unlikely places, e.g., the salt patches on the Bellary farm or on moderate slopes.

Mr. H. C. Sampson, the Deputy Director of Agriculture for the Southern division, very briefly reports that in his division saline land arises in patches in irrigated soils, but that it also occurs in dry land both in black cotton soils and in red soils, while many of the wells are too brackish to use for irrigation purposes. He states that to him saline soils do not seem to be a serious problem in this Presidency, at least for many years to come for, in very few places as yet, is the cultivation intense, and the good land is capable of producing a much greater outturn.

Investigations having as their object the amelioration of these saline soils have been undertaken in past years chiefly in the Madura, Bellary and Coimbatore districts, and quite recently the lands under the large tank at Ponnalur in the Nellore district were examined. No systematic survey of the saline lands has been undertaken and consequently no maps of the areas are available.

In the following sections the results of these investigations are given so far as they are concerned with the character of soil :—

Section I.—The Saline soils of the Periyar Delta.

The Executive Engineer of the Madura district in 1901 drew the attention of the Madras Government to the presence of saline soils in the area commanded by the Periyar channels and proposed that a certain area of land in the village of Terkutheru

should be set apart for experiments in reclamation. Previously to this, however, he had sent several samples of soil from the delta to Dr. Leather for analysis who returned the following results :—

—	652/1900 Athalai village S. No. 171.	653/1900 Athalai village S. No. 172.	654/1900 Athalai village S. No. 179.	655/1900 Athalai village S. No. 180.	656/1900 Koil-pappa-gudi S. No. 142.	657/1900 Koil-pappa-gudi S. No. 242.	663/1900 Koil-pappa-gudi S. No. 242.
Na_2CO_3 ...	·096	·072	·121	·116	Nil.	·014	Nil.
Na_2SO_4 ...	·048	·186	·064	·035	·146	·122	·303
NaCl ...	·499	1·840	·439	·176	1·574	1·375	12·949

At a later date, 18 samples of soil from the village of Terkutheru were forwarded to Dr. Leather for analysis. The following table sets out the results obtained :—

Laboratory No.	Survey No.	Na_2CO_3	Na_2SO_4	NaCl	Total per cent of salts.
985 of 1902 ...	142	Nil.	Nil.	·049	·080
986 ,, ...	151	·024	·030	·062	·143
987 ,, ...	157	·178	·021	·213	·412
988 ,, .. .	160	·136	058	·165	·359
989 ,, ...	286	Nil	Nil.	·070	·112
990 ,, ...	159	·329	·134	·300	·763
991 ,, ...	153	·064	·182	·773	1·019
992 ,, ...	285	·227	·122	·213	·562
993 ,, ...	284	·109	·042	·125	·276
994 ,, ...	283	Nil.	·014	·160	·194
995 ,, ...	136	·170	·039	·151	·360
996 ,, ...	147	·048	·024	·047	·119
997 ,, ...	161	·272	Nil.	·476	·748
998 ,, ...	158	Nil.	Nil.	·511	·940
999 ,, ...	156	·127	Nil.	·111	·238
1000 ,, ...	138	·132	·196	·473	·801
1001 ,, ...	154	·173	·030	·158	·361
1002 ,, ...	155	·098	·048	·143	·303

These soils were thus shown to contain large quantities of sodium salts and the Government in 1902 agreed to the proposals and a piece of land was placed aside for experimental purposes.

Dr. Leather analysed the soils of these experimental plots and returned the following analysis :—

Plots.	Revenue field.	Na_2CO_3	Na_2SO_4	NaCl.	Total per cent of salts.
53, 54	138	·132	·196	·473	·801
22 ,, ...	155	·098	·048	·143	·303
34	158	Nil.	Nil.	·511	·940
91, 93, 94, parts of 96 and 97	160	·136	·058	·165	·359
78, 90...	285	·227	·122	·213	·562
96	286	Nil.	Nil.	·070	·112

The experiments, although carried out in a manner somewhat at variance with the original proposals, have continued until a very recent date and, in 1908, together with the Deputy Director of Agriculture, Southern Division, I visited the station and inspected the trial holes which had been dug in most of the experimental plots.

The character of the plots varied greatly according to their past treatment. Some were still exceedingly saline and covered with rank grasses but others were of a much better character. Generally speaking the soil was heavy and a clayey layer varying in thickness was found immediately below the surface soil. In the worst plots this layer extended to a depth of several feet, but in the better plots it was not more than a foot in thickness and in the best plots drainage took place by means of sandy channels through the clay into the sub-soil. In every case a water bearing sandy layer was met with at depths varying from 3 to $5\frac{1}{2}$ feet and the water was found to be perfectly sweet and of fairly good quality.

In three cases samples of soil and sub-soil were taken and analysed :—

Soluble Salts.	Plot No. 96.				Plot No. 97 (*a*).			Plot No. 97 (*b*).				
	0″ to 1′ 0″.	1′ 0″ to 2′ 0″.	2′ 0″ to 2′ 10″.	2′ 10″ to 3′ 6″. Water level.	0″ to 1′ 0″.	1′ 0″ to 2′ 0″.	2′ 0″ to 3′ 0″. Water level.	0″ to 10½″.	10½″ to 1′ 10½″.	1′ 10½″ to 2′ 10½″.	2′ 10½″ to 3′ 10½″.	3′ 10½″ to 5′ 6″. Water level.
Calcium Carbonate	·036	·018	·017	·020	·032	·019	·029	·011	·004	·005	·006	·002
Magnesium Carbonate.	·010	·023	·010	·016	·013	·019	·003	·017	·002	·003	trace	·003
Magnesium Sulphate.	·016	·002	·003	Nil.	·001	Nil.	·003	Nil.	Nil.	Nil.	Nil.	Nil.
Magnesium Chloride.	·013	Nil.	Nil.	Nil.	Nil.	Nil.	·006	Nil.	Nil.	Nil.	Nil.	Nil.
Potassium Carbonate.	Nil.	Nil.	Nil.	·001	Nil.	·001	Nil.	·001	trace	trace	Nil.	Nil.
Potassium Sulphate.	Nil.	·003	trace	Nil.	·001	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.
Potassium Chloride.	·002	·001	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.
Sodium Carbonate.	Nil.	Nil.	Nil.	·006	Nil.	·007	Nil.	·098	·101	·095	·154	·100
Sodium Sulphate.	Nil.	Nil.	·003	·002	·005	·001	Nil.	·074	·033	·021	·018	·009
Sodium Chloride ..	·001	·005	·007	·007	·007	·005	Nil.	·061	·059	·054	·046	·022

A comparison of these analyses with those made at a previous date by Dr. Leather shows a decided improvement in the amount of harmful salts in the soil of two of the plots. It will be noticed that I have estimated the amount of other salts besides those of sodium and this was done because of the results obtained by Kearney and Cameron of the United States of America, Department of Agriculture, who have shown that, in pure solution, $MgSO_4$ and $MgCl_2$ are more toxic to plants than even Na_2CO_3 and Na_2SO_4. They also showed that, in the presence of excess of $CaCO_3$ and $CaSO_4$ the toxicity of these magnesium salts is so modified that they become the least toxic of soil salts. None the less this points to the importance, in any analysis of saline soils, of paying attention to the presence of compounds other than those of

sodium alone. In the case of plot 96, the toxicity of the soil is probably due to the presence of magnesium salts and not to sodium salts and it is possible that it would readily become amenable to cultivation if dressed with gypsum.

Plot 97 (*b*) was an exceedingly bad piece of ground, the amount of Na_2CO_3 being excessive at all depths. The mechanical analysis of the different layers of this plot is given :—

	0″ to 10½″.	10½″ to 1′ 10½″.	1′ 10½″ to 2′ 10½″.	2′ 10½″ to 3′ 10½″.	3′ 10½″ to 5′ 6″.
Fine gravel	33·6	26·0	35·8	24·5	21·8
Coarse sand	32·0	33·3	27·5	24·9	27·7
Fine sand	15·1	17·0	13·2	17·2	19·5
Silt	6·7	6·5	6·9	10·8	11·1
Clay	8·9	13·8	13·3	17·8	15·9
Moisture and loss ...	3·7	3·4	3·3	4·8	4·0
Total ...	100·00	100·00	100·00	100·00	100·00

The fact that, beneath this land, there is a water bearing layer and that, in the best plots, drainage takes place into this layer by means of sandy channels through the overlying clay, suggests a treatment for this area by inducing drainage by digging holes through the clay layer and filling in with sand.

The area in question lies in a depression in the surrounding land and consequently drainage by ordinary methods would be difficult to carry out.

With regard to the Periyar delta, generally, the saline lands stretch in bands across the delta and lie in the natural drainage basins of the country. In carrying out the irrigation system, these old

drainage channels seem to have been ignored to some extent and they now form shallow depressions into which the drainage from the surrounding land tends to accumulate and the evaporation which consequently takes place, leads to a concentration in them of the saline salts brought by the water. The same phenomenon is stated to occur in the bottom end of the Kistna delta and consequently the problem in these irrigation tracts is not merely to supply the water necessary for the growth of crops, but to supply it in such a manner that drainage from low-lying lands is not interfered with. This means the construction of adequate drainage channels for such lands.

Much of the saline soil of the Periyar delta has been brought under cultivation and the remaining portion constitutes only a small percentage of the total area and as the present water supply is barely sufficient for the productive lands, it is improbable that any attempts will be made to reclaim the unproductive portion at present.

Section II.—The Sivaganga Zamindari.

The lessees of the Sivaganga Zamindari which is situated in the Madura district have for many years been experimenting with a tract of saline soil and, together with the Deputy Director of Agriculture, Southern Division, in November 1907, I inspected this land and took soil and subsoil samples from several plots. It was impossible to draw definite conclusions from the experiments as the cultivation had not been conducted on systematic lines and the treatment of the individual lines in consequence varied from year to year. There was no doubt, however, that the land had

improved and in many cases the plots were yielding very fair crops.

The lessees had two samples of this soil analysed some time previous to January 1902 by Messrs. Newland & Brothers and Ling of London, but their analysis was only a complete soil analysis and paid no attention to the soluble salts.

The samples taken during our inspection were obtained from plots of very diverse productiveness and also from an adjoining plot of waste saline soil not then brought under cultivation :—

	Plot No. 40.			Waste land.			Plot No. 80.	Plot No. 68.	Plot No. 25.
	0″–9″	9″–18″	18″–27″	0″–8″	8″–16″	16″–25″	0″–12″	0″–12″	0″–9″
Na_2CO_3 ...	·108	·021	·021	·028	·044	·032	·041	·018	·026
Na_2SO_4 ...	·028	·097	·054	·073	·029	·020	·027	·007	·003
NaCl ...	·098	·399	·298	·021	·128	·092	·070	·011	·013
Character of crop.	Unsatisfactory.						Bad.	Good.	Good.

Section III.—The Nellore District.

In September 1908, some eighteen samples of soil and subsoil were collected from the ayacut of the Ponnalur tank in the Nellore district and forwarded to me for analysis.

In this case the problem was rather different to that obtaining in the Periyar delta, where only wet cultivation is practised. Here the owners of the land were prohibited from using water for wet cultivation, but were allowed to use the water free of charge for the irrigation of dry crops, the intention being to encourage the cultivation of dry crops in place of paddy, so that the largest amount

of food grain possible could be obtained from the available water supply.

In the area from which the samples were taken, dry crops had been grown with irrigation, but the ryots alleged that the crops became worse each year, owing to the accumulation of harmful salts in the soil. The ryots were anxious, however, to use the water for paddy cultivation, stating that the heavy flooding in that case would wash the soil free and that, where paddy had been grown experimentally, good yields were obtained.

The distribution of the soluble salts is shown in the following table :—

—	Survey No. 51.		Survey No. 130.		Survey No. 132.		Survey No. 129.		Survey No. 112-B.		Survey No. 112-D.		Survey No. 115.	Survey No. 70/1.		Survey No. 40.		
	Soil.	Subsoil.	Soil.	Subsoil.	Soil.	Subsoil.	Soil.	Subsoil.	Soil.	Subsoil.	Soil.	Subsoil.	Subsoil.	Soil.	Subsoil.	Soil.	Subsoil.	Soil.
$CaCO_3$	·011	·011	·013	·018	·010	·066	·018	·026	·013	·018	·024	·026	·016	·019	·018	·014	·020	·013
$CaSO_4$	·325	·096	...	·010	·047	...	·092	·011	·086	·079	·283	·117	·134	·066	...	·031	·003	·231
$CaCl_2$	·123	·086	...	...	...	...	...	...	...	...	...	...	·053	...	...	·117	...	·115
$MgCO_3$	...	...	·004	...	...	·001	...	...	...	...	...	...	...	...	·004	...	...	...
$MgSO_4$	...	...	...	·007	·005	...	·022	·020	·057	·152	·206	·104	...	·018	·005	...	·031	...
$MgCl_2$	·064	·036	...	·001	·009	...	·018	...	...	...	...	...	·056	·004	...	·054	...	·057
Na_2CO_3	...	...	·001	...	...	·012	...	...	...	...	...	...	...	...	·047	...	...	...
Na_2SO_4	...	...	·033	...	...	·002	...	·151	·094	·307	·720	·612	...	...	·047	...	·121	...
NaCl.	·310	·307	·008	·085	·012	·006	·167	·252	·069	·123	·841	·228	·311	·035	·029	·127	·117	·254
Cultivation.	Irrigated dry crops. *Fasli* 1315—crops poor and germination bad. Very poor ragi crop in previous year. No crop in season when sampled.		Irrigated dry crops. Moderate yields.		Irrigated dry crops.		Very patchy cumbu crop. Paddy is grown by permission on one portion where there is percolation.		Paddy grown for three years as there is always a seepage of water on to the land. Crop = 1 putti per acre and called a three-fourth crop.		For one year irrigated fodder cholam followed by paddy. No crop in season when sampled.		Paddy grown for one year. In a small portion irrigated chillies were growing. Saline efflorescence.			Irrigated dry crops.		

The land is a mixed clay loam and a serious feature brought out by the analysis is the fact that the immediate subsoil is strongly impregnated with deleterious salts. Under these circumstances

the irrigation of dry crops could not be recommended as the methods of cultivation employed combined with intense surface evaporation and a limited water-supply would tend to concentrate the salt of the subsoil into the surface soil.

Section IV.—The Bellary and Coimbatore Districts.

In 1903, samples of saline soil were sent to Dr. Leather for analysis, two from the Bellary Agricultural farm and two from near Coimbatore.

—	Bellary farm.		Coimbatore.	
	A.	B.	Field No. 310.	Field No. 314.
Na_2CO_3	Nil	·007	·143	·209
Na_2SO_4	·312	·219	·100	?
NaCl	·364	·277	·010	?

With regard to the samples from Coimbatore, Field No. 310 was yielding very poor crops. Field No. 314 had been waste from time immemorial.

In connexion with the saline soils in the Bellary district the following analysis of the water from a well sunk upon the Hagari farm will be of interest :—

	Parts per 100,000.
$CaCO_3$	29·5
$CaSO_4$	77·7
$MgSO_4$	139·5
Na_2SO_4	427·4
NaCl	561·1
Total ...	1,235·2
Total solids ...	1,310·0

Section V.—Native Methods of Reclaiming Saline Lands.

Of the crops cultivated in the Presidency which do fairly well in moderately saline soils, ragi, (Eleusine coracana) and Kudirai Vali (Panicum frumentaceum) among the cereals may be mentioned. Lucerne and the sunflower also do tolerably well. Of the trees, the coconut, babul, butea frondosa, zizyphus jujuba, casuarina and the palmyra are salt proof to some extent. Of paddy, the following varieties are well suited to alkaline soils :

Mosanam in North Arcot and Chingleput,
Kadai kaluttan, Vellai kattai, Vellarikkiravi } in Tinnevelly,
Devarayan Samba in Coimbatore,
Ore pandiyan in Calicut and Pinnatragada in Masulipatam are varieties which can withstand an excess of salt.

The native methods of reclaiming alkali soils may be classified as follows :—

(1) Adding bulky organic matter.
(2) Application of organic substances which yield a strong acid on decomposition.
(3) Soil mixing.
(4) Washing out the soluble salts.
(5) Growing resistant plants.

1. The use of varagu straw (Paspalum scrobiculatum) which is unfit for cattle-feeding is general throughout the Tamil districts ; in the Kistna and Gōdāvari deltas paddy straw is used and no doubt when available the ordinary plants used for green manuring answer the same purpose. Margosa leaf and aloe vulgaris are also used.

Section V.—Native Methods of Reclaiming Saline Lands.

Of the crops cultivated in the Presidency which do fairly well in moderately saline soils, ragi, (Eleusine coracana) and Kudirai Vali (Panicum frumentaceum) among the cereals may be mentioned. Lucerne and the sunflower also do tolerably well. Of the trees, the coconut, babul, butea frondosa, zizyphus jujuba, casuarina and the palmyra are salt proof to some extent. Of paddy, the following varieties are well suited to alkaline soils :

Mosanam in North Arcot and Chingleput,
Kadai kaluttan, Vellai kattai, Vellarikkiravi } in Tinnevelly,
Devarayan Samba in Coimbatore,
Ore pandiyan in Calicut and Pinnatragada in Masulipatam are varieties which can withstand an excess of salt.

The native methods of reclaiming alkali soils may be classified as follows :—

(1) Adding bulky organic matter.
(2) Application of organic substances which yield a strong acid on decomposition.
(3) Soil mixing.
(4) Washing out the soluble salts.
(5) Growing resistant plants.

1. The use of varagu straw (Paspalum scrobiculatum) which is unfit for cattle-feeding is general throughout the Tamil districts ; in the Kistna and Gōdāvari deltas paddy straw is used and no doubt when available the ordinary plants used for green manuring answer the same purpose. Margosa leaf and aloe vulgaris are also used.

2. Cissus quadrangularis, Euphorbia tirucalli, the chaff of cumbu, paddy, etc., and, where available, tanning refuse probably fall under this head.

3. Under this head falls the application of tank silt, sand, etc.

There is no doubt that this method improves the soil temporarily in certain cases, but sooner or later the harmful salts are again concentrated in the new layer and bad crops again produced.

4. The ryots of the Gōdāvari and Kistna deltas in particular employ this method, and usually in conjunction with paddy straw and in addition the water for this purpose is free of charge for a limited number of years. Where there is any natural drainage, this method answers well.

5. This has been referred to in previous paragraph.

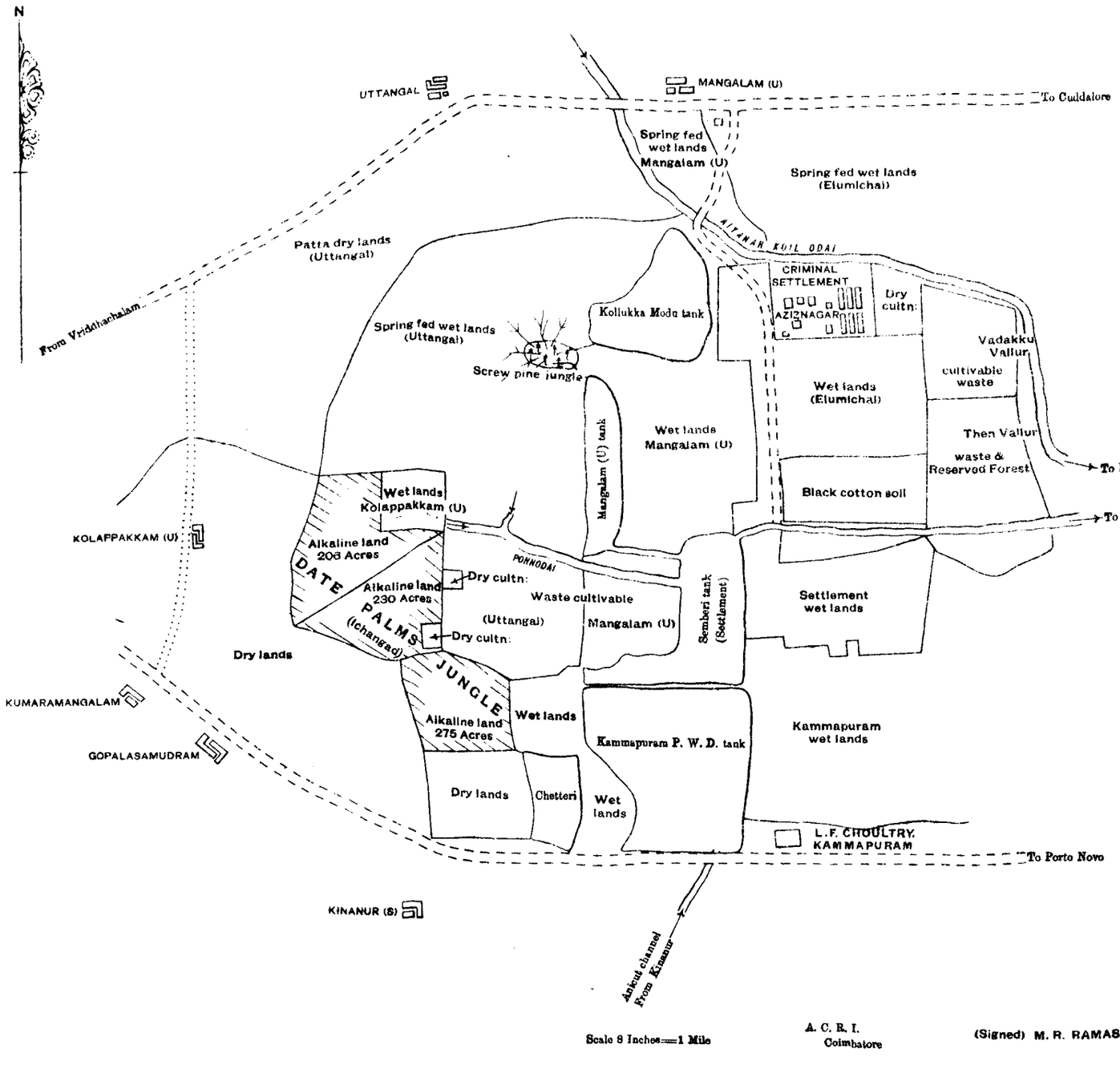
A PECULIAR ALKALINE TRACT IN SOUTH ARCOT DISTRICT.

By M. R. RAMASWAMI SIVAN, B.A.,
Acting Government Agricultural Chemist.

I

The existence of some alkaline patches, which were said to show a tendency to natural reclamation, near Kammapuram, the Salvation Army's Criminal Settlement in the Vriddhachalam taluk of South Arcot (Aziznagar), was brought to the notice of the Chemistry Section by Mr. J. Chelvaranga Raju, acting Deputy Director of Agriculture, IV Circle, and I inspected the locality with him in February 1916. (Vide Map attached.)

MAP
of
PORTION OF SOUTH ARCOT DISTRICT
Showing The Locality of
ALKALINE PATCHES



Situated about 7 miles east of Vriddhachalam and bounded by the Porto Novo–Vriddhachalam road and Cuddalore–Vriddhachalam road, the locality visited is a stretch of land about 12 square miles in extent, presenting some interesting features. The lands on the south, west and north, slope gently towards the plain from which water is drained off towards the sea on the east by the Paravanar (literally spreading river). The geological formation outside is Cuddalore sandstone, but no visible rock is found in the vicinity. On the south, the village of Kammapuram consists of black coloured wet lands. In the villages to the immediate west and north of the locality, the soil which is red, gravelly or sandy, overlies stiff white clay to considerable depths, that little water is obtained even from deep sunk wells.

In the northern half of the plain, extending over the villages of Uttangal (literally spring fed), U. Mangalam and Elumichai, there is a perennial flow of underground water over at least 1,000 acres of very decent double crop wet lands. In the middle of this wet area, there exists an impenetrable screwpine jungle of 15 to 20 acres near which the soil is so soft that cattle are drawn in deep in the mire and ploughing is never attempted and in which field bunds are improvised by laying stems of screwpines across, with earth thrown over, the bunds shaking when one treads along.

The centre of attraction was the Ichangād (literally date palm jungle) block of nearly 700 acres, comprising the alkaline lands. On the outskirts of the date jungle is heavy black soil interspersed with babool trees and growing fair crops of cotton

and dry cereals. The alkaline tract is not one stretch of land but consists of several hundreds of isolated patches, almost geometrically circular, 6 to 20 feet in diameter and lying close to or far away from one another. A close examination of the different kinds of patches, coupled with enquiries made of the villagers, leads one to presume that the patches have been formed in the following stages :—

1*st stage*.—A white coloured patch, with a concave surface from which water oozes out and collects in the hollow, the water being brown in colour and alkaline in reaction. An incrustation is formed in dry weather and occasionally scraped out by dhobies. The whole patch shakes when pressed at the circumference with the foot. The soil is soft and slimy and men and cattle are drawn in 5 or 6 feet easily. There is no vegetation whatever, though crabs and fish live. This is the worst type.

2*nd stage*.—There seems to have been an upheaval, the soil having been thrown out into a convex heap. A friable, black soil, about 1 foot deep, is left on the surface, mixed with kankar. The soil below the first foot is still soft and slimy for about 5 or 6 feet, below which the soil becomes comparatively hard. When the long soil-sampling tool was inserted into the deeper layers and withdrawn, a rumbling noise was distinctly heard as of confined air escaping outside. Such sudden noise seems to be heard occasionally in this area. The soil just below the surface does not show any kankar while the dried surface abounds in it. Recently upheaved portions contain only small

particles of kankar, the size of peas, but older patches contain ½″ to 2″ nodules. The upheaval goes on, apparently, for several years, the kankar nodules becoming bigger each time. There is no vegetation in the patches at this stage, although at a distance of a foot from them, the soil is hard and firm and perfectly green with a good variety of grass.

3rd stage.—After several years' upheaval, there is then a slight depression. The soil does not shake any more, and one can trample upon the patches with perfect safety. Moss and other low vegetation grow in the depression and decay and, on this vegetable debris, coarse grass and two particular kinds of weeds flourish, namely, *Eleocharis capitata* கேலப்பாக்கட்டிப்புல் and *Herpestis monniera* பொடைப்பூண்டு.

4th stage.—Good grass grows luxuriantly, the area being the principal grazing ground for the cattle of the surrounding villages. The cattle, however, avoid the soft patches carefully, by instinct, when grazing here. Date palms begin to flourish and the whole block is really a jungle of date trees. In some of the larger depressed patches, water may accumulate in later years and coarse paddy is said to be sometimes grown here without any further irrigation. This is very rare.

Whether the alkaline patches have been formed and get naturally reclaimed in the above order is a matter of surmise, but what can be vouched for is that distinct circular patches corresponding to the different stages described are found in the locality.

II

The following points with regard to the alkaline patches were sought to be investigated in the laboratory :—

1. How have these patches been formed ?
2. How do they get naturally reclaimed ?
3. How is the formation of kankar accounted for ?
4. Are the patches still being formed ?
5. Is the water flowing from the date palm jungle harmful to crops ?

Although the wet soil was soft and very slimy and no gritty matter was suspected, a mechanical analysis of the soil (vide Table I) showed 27 per cent of sand consisting mostly of opaque siliceous grains, a few, however, being white kankar. The fractions of clay, silt and fine silt, amounted to 73 per cent, were white in colour and effervesced freely and copiously with acids showing much carbonate of lime. Containing such a large proportion of fine grained particles the soil is one which would not allow of easy percolation of air or water and further experiment amply proved it.

TABLE I.

	Per cent calculated on dry soil.
Gravel	6·75
Coarse sand	10·03
Fine sand	10·10
Silt	7·53
Fine silt	13·09
Clay	52·50
	100·00

When examining the soil for alkalinity, the first step is to get an aqueous extract of the soil,

The usual process of shaking 300 grams of dry soil with 750 c.c. of water yielded a pasty mass from which no filtrate was obtained under the pump. Next when 100 grams of dry soil were shaken with 1,000 c.c. of water, filtering was very slow and the amount of filtrate too small for examination. Lastly 100 grams of dry soil were shaken with 1,500 c.c. of water, and filtering under the pump was continued for three days, the candle being cleaned thrice during the operation. Filtering was still very slow and 500 c.c. of filtrate was obtained on the fourth day. This filtrate was examined for CO_2, Cl, SO_3, CaO, MgO and total solids and, from the results tabulated in Table II, the alkalinity is found to be due to sodium salts, chiefly sodium carbonate, and the sliminess of the soil in particular is due to this salt. The large percentage of soluble organic matter tends to produce black alkali of a bad type as judged from the fact that the water oozing out of the soil is brown in colour and alkaline in reaction. The high percentage of clay and fine silt also helped to render the soil impervious to water and air, and convert it into a typical alkaline soil.

TABLE II.

	Per cent.
Total solids	0·78
„ organic matter	0·26
*„ inorganic matter	0·52
* Containing—	
Na_2CO_3	0·278
Na_2SO_4	0·049
NaCl	0·193

Note.—There was no lime or magnesia in the filtrate.

As the phenomenon of natural reclamation is accompanied with the occurrence of nodules of

kankar in the reclaimed soil, the presumption is that the soil must contain plenty of lime, and this is actually the case, for there is as much as 3·61 per cent of lime in the dry soil. The process of reclamation is probably taking place in the following manner :—

The organic matter of which there is plenty in the soil (vide Table II) apparently undergoes decomposition and produces gases. Under ordinary conditions the confined gases cannot overcome the resistance offered by the slimy impervious soil and come to the surface. When, however, the gases accumulate, they force themselves out, owing to increased pressure, with a rumbling noise ; and then the upheaved soil dries and on drying, develops particles of kankar and becomes friable soil. That this inference is possible is seen from the following experiments :—

(1) When the soft slimy soil was dried in the air, it was converted into a friable soil with well developed kankar particles.

(2) When the soil was shaken up with water and separated into two main fractions by decantation—a gritty sand and a soft clay—and portions of the separated sand and clay were mixed in the proportion of 1 to 3—the proportion being based on the mechanical analysis—and allowed to dry, the mixed soil at the end of a week was a friable clay, containing kankar nodules, while no kankar developed in either of the separate fractions.

(3) Some big, clean nodules of kankar picked in the locality when treated sufficiently long with dilute acid, left gritty sand behind.

That the cause of the upheaval is the pressure exerted by the confined gases produced by the decomposition of the organic matter is guessed from the rumbling noise heard when I inserted the sampling tool and also from the testimony of the villagers who, on account of the noise sometimes suddenly reported, ascribe mythological stories to the locality.

TABLE III.—Analyses of samples of water (in parts per 100,000).

Lab. No.	Locality.	$CaCO_3$.	$CaSO_4$.	$CaCl_2$.	$MgCO_3$.	$MgSO_4$.	$MgCl_2$.	Na_2CO_3.	Na_2SO_4.	NaCl.	Total.	Remarks.
4	Alkaline patch (worst type)	7·14	Nil.	Nil.	3.02	Nil.	Nil.	58·25	8·52	29·83	106·76	Brown alkaline.
3	Drain in date palm jungle.	39·28	Nil.	Nil.	16·84	23·52	15·35	Nil.	Nil.	136·00	230·99	Hazy, white.
12	Small pond in date palm jungle.	13·25	1·41	Nil.	Nil.	2·86	8·86	Nil.	Nil.	7·71	34·00	Colourless.
22	Ponnodai flowing from date palm jungle into Semberi tank.	12·50	Nil.	Nil.	2·98	6·51	5·63	Nil.	Nil.	5·09	26·71	
15	Semberi tank (Settlement wet lands).	8·93	Nil.	Nil.	1·95	1·55	3·40	Nil.	Nil.	9·33	25·16	
21	Screw pine jungle ...	18·75	2·33	1·08	Nil.	Nil.	6·84	Nil.	Nil.	4·61	33·61	Good growth of paddy.
16	Ayyanarkoil odai—perennial spring—(U. Mangalam).	12·50	Nil.	Nil.	1·26	0·51	4·16	Nil.	Nil.	8·55	26·93	Spring water.
24	Kulapakkam dry lands (from well) representing area on the west.	4·00	5·25	3·17	Nil.	Nil.	3·42	Nil.	Nil.	0·50	16·34	Hazy, white.
26	Kammapuram village (from well) representing area on the south.	1·30	1·16	7·30	Nil.	Nil.	2·53	Nil.	Nil.	1·50	13·79	Colourless.

With regard to the point whether the alkaline patches are still being formed, the villagers say that new patches appear year after year. Ebullition (கொதிப்பு—literally) is the word used by them to represent the formation of new patches. In other words, the sodium carbonate which is the cause of the alkalinity may come up to the surface, but is not completely washed out although a portion of the efflorescence may be scraped out by dhobies. The analyses of waters, shown in Table III show clearly that little or no sodium

carbonate is found in the drainage waters of the locality. Lime is present only as a carbonate in the soil and leaves an incrustation of carbonate in the form of kankar. As there is no interaction between calcium carbonate and sodium carbonate, the latter salt remains, therefore, close to the reclaimed patches. It has the peculiar property of possessing a comparatively slow diffusive power.* When favourable conditions arise, it will again help to form alkaline patches slowly diffusing from the centre.

SUMMARY.

The alkalinity in the alkaline patches is due to the presence of sodium carbonate combined with soluble organic matter and the existence of a large proportion of clay.

2. The natural reclamation which is noticed is due to the upheaval of these patches, when, on drying, kankar is formed by the infiltration of lime round the sand particles, the soil containing over $3\frac{1}{2}$ per cent of lime.

3. The alkaline patches still continue to be formed, as the sodium carbonate is not present in the drainage waters of the locality; and as it possesses a comparatively slow diffusing property it probably accumulates close to the old patches.

4. The water flowing from the date palm jungle is quite safe for irrigation.

---

* (Vide Table on page 449 in Hilgard's book on Soils; Physical Properties of soils by Warrington, pages 194 and 217; California Station Report, 1892—3-4, page 142.)

PHOSPHATIC NODULES OF TRICHINOPOLY AND THEIR AVAILABILITY AS MANURE.

By M. R. RAMASWAMI SIVAN, B.A.,
Acting Government Agricultural Chemist.

Of all the geological formations in Peninsular India, probably none are more interesting than the cretaceous beds of Trichinopoly, containing well-preserved fossils in the midst of azoic rocks of bygone ages. Apart from a few isolated earlier observers, a party of the Geological Survey surveyed the locality over half a century ago. The marine fossils were, however, more interesting to Blanford * who was in charge of the party, than the septarian nodules about which he makes nothing more than a passing reference and which, he surmises, "may have been formed round similar organisms the impression of which has disappeared in the subsequent shrinking of the interior and the infiltration of calcspar and gypsum which fill the septaria."

In January 1892, thirty years later, Dr. Warth, Superintendent of the Madras Central Museum, visited the locality to collect fossils for the Museum and he reported to Government "the existence of a large area in Perambalur taluk, strewn over with nodules of phosphate of lime lying on the surface." On analysing them later in the laboratory of the Presidency College, he reported that the deposit was of real economic importance, "the quantity being great, reckoned by the square miles of the

* Memoirs of the Geological Survey of India, 1862. Vol. IV. Part I. page 83.

tract where the deposits were found." The Collector of Trichinopoly issued at once, under orders of Government, a prohibitive order that no land would be given on darkhast in or near the locality.

Applications for the lease of the exclusive right to quarry for the phosphate of lime were made to the Collector, in March 1892 by H. G. Turner, I.C.S. (retired), and in April 1892, jointly by A. M. Hooper of Messrs. McDowell & Co., and A. Massey of Messrs. Massey & Co. H. J. Eunson of Vizianagaram mines inspected the locality on behalf of Turner and reported that the stones had merely to be picked off the surface, requiring no mining or digging, and asked for a definite ruling whether the land would be leased out for a certain fixed amount per square mile or whether a seigniorage or royalty per ton would be levied. The Collector would not grant an exclusive right to any one party and allowed the quarrying of the nodules at the same rate as for gravel, i.e., at six pies per cart load, pending the receipt of the orders of the Government of India, sanctioning the new rules for the issue of prospecting and exploring licences and of mining leases.

A ton of nodules was sent to the Secretary of State for examination and valuation, and the following is the analysis of Dr. J. A. Voelcker * :—

Moisture	1·53
Water of combination and organic matter	2·85
† Phosphoric acid	26·05
Lime	45·51
Oxide of iron	3·14
Alumina	2·63
Magnesia	0·34

* The Agricultural Ledger, 1898, No. 20, page 8.
† Equal to tribasic phosphate of lime ... 56·87

	Sulphuric acid	0·60
*	Carbonic acid	7·23
	Fluorine and alkalies	4·81
	Insoluble siliceous matter	5·28

In his exhaustive report, Dr. Voelcker stated that the deposit, though essentially a phosphatic one, was not a true coprolitic deposit in the sense of being fossilised excreta. It consisted of phosphate of lime which, by infiltration of water charged with carbonic acid and holding dissolved carbonate of lime, had, on evaporation of water, become filled with carbonate of lime. It would be a useful phosphatic supply, comparable with Carolina phosphate, the phosphate of lime being fairly high (57 per cent) and the insoluble matter small (6 per cent), but the high percentage of lime (16 per cent) and of iron and alumina (6 per cent) would involve considerable waste of sulphuric acid in superphosphate manufacture. He suggested that a mill might be set on the spot, the nodules ground into powder and applied directly on to the land as a slow acting fertiliser and that the carbonate of lime would then be no objection.

In spite of Dr. Voelcker's clear report, it is surprising that so many firms in India should have attempted to export the nodules to foreign market, ostensibly for superphosphate manufacture and, as was only to be expected, all such attempts have completely failed.

Dr. Warth again visited the locality in December 1892 and reported that the area of phosphatic nodules extended to over a length of ten miles, from Sirugambur to Neikkulam and a breadth of

* Equal to Calcium carbonate ... 16·43

one mile and that the nodules just picked off from the surface would amount to not less than 4,000 tons. By this time, orders of the Government of India * were issued, laying down the rules for the grant of prospecting and exploring licences and of mining leases—the same as are printed in Board's Standing Order No. 25. In addition to the previous applicants, Messrs. Arbuthnot & Co., who had their manure works at Calicut and Messrs. Stanes & Co. of Coimbatore now entered the field and, at their request, all the applicants were each supplied with 50 tons of nodules for experimental purposes.

In view of the increasing demand for the nodules from different parties, Dr. Warth was directed by Government to conduct a more detailed inspection of the locality and submit a proper estimate of the nodules. Dr. Warth † made an examination of the ground along a measured line of 6,400 feet across the strike of the strata from Uttatur and confirmed his previous estimate of surface deposits. He also made a number of excavations to different depths and, from a study of the strike of the strata, concluded that the nodules were present to great depths, that 100 cubic feet of clay would yield an average of 28 lb. of nodules and that, from 7 to 8 million tons of nodules were present to a depth of 200 feet.

Government immediately ordered the locality to be surveyed by the Revenue Survey Department and demarcated into blocks of about one

* G.O. Mis. No. 648, Revenue, dated 15th February 1893.

† G.O. No. 821, Revenue, dated 14th September 1893, contains the final report of Dr. Warth.

square mile each, with the result that nine mining block maps were prepared.*

The boom about phosphatic nodules seems to have subsided, for some reason or other, for three years until Messrs. Arbuthnot & Co. applied in February 1896 for a mining lease of all the blocks. The firm was allowed to collect nodules, in anticipation of the sanction of Government, from June 1896. Meanwhile there were two other competitors for the mining lease, Messrs. Peirce Leslie & Co. of Calicut and Messrs. Stanes & Co., and the Collector who first suggested the leasing of all the nine blocks to Messrs. Arbuthnot & Co., now recommended the assigning of five blocks to Messrs. Arbuthnot & Co., three blocks jointly to Messrs. Peirce Leslie & Co. and Messrs. Stanes & Co., and keeping over of one block for any future applicant. The two latter firms seem to have taken no further interest in the matter.

Next there was much controversy over the terms of the lease. The Board of Revenue were of opinion that a royalty of two annas per ton—the same rate as for coal, then selling at Rs. 4-8-0 per ton—was too low for the crushed nodules which were expected to fetch Rs. 40 to Rs. 50 per ton and ordered an *ad valorem* royalty of five per cent on the value of the crushed nodules, as for mineral oils, and that a dead rent of 4 annas per acre should be levied in addition. Messrs. Arbuthnot & Co. asked for a reconsideration of the order,

* G.O. No. 821, Revenue, dated 14th September 1893, contains the original of the sketch map showing village boundaries and mining blocks. Mining Block Maps I to IX are available at the Collector's office, Trichinopoly, at one rupee each, drawn to a scale of 1 inch to a mile and showing Survey numbers included in each mining block, whether inam, poramboke or Government land and the area and nature of cultivation, if any.

both with regard to the refusal to grant more than five blocks and to the rate of royalty. As regards the former point, they said that, in starting a new industry and where there was no reliable market, it was only at considerable expense and trouble that a new business could be worked up and that it was natural that everyone should hesitate to risk capital and undertake trouble when it would be open to others to step in afterwards, when the preliminary obstacles had been removed and a demand had been created, to reap the benefits of the trouble and expense incurred by the originators, in fact to build on the foundations laid by the originators and to profit by their mistakes. As regards the second point, they asked that the royalty at 2 annas per ton, originally fixed by Government, be adhered to or an *ad valorem* duty be fixed at 3 per cent on the value of the nodules at the pit's mouth, as in coal. They further demanded that they should be allowed to cancel the lease at any time during the 30 years, if the mine should not be profitable.

Government sanctioned in August 1896, the lease of five blocks to Messrs. Arbuthnot & Co. for 30 years, empowering the firm to determine the lease on proof being shown to Government that the nodules did not exist any longer for profitable working ; a dead rent of Rs. 448-8-0 was fixed on 1,734 acres payable in two half yearly instalments and also a royalty of 5 per cent on the market value of the crushed material on the spot. A lengthy correspondence ensued and, after three years, the firm refused, in May 1899, to accept the terms of the lease, unless they were revised to their satisfaction.

As a result of some further correspondence and of a conference between two members of the firm and the Board of Revenue, the terms were modified much to the advantage of the firm. The terms, finally sanctioned by the Government of India* and which have apparently remained in force ever since, are the following :—

(1) The lease to run for 30 years from the date of execution.

(2) The firm to be given a monopoly over all the mining blocks.

(3) The firm to be given the first option of searching for and leasing other minerals.

(4) No royalty to be charged for the first five years and a fixed charge of 2 annas per ton to be levied thereafter.

(5) Dead rent of 4 annas per acre to be levied on the total area covered by the lease, e.g., 4,706 acres.

(6) Surface rent of one rupee per acre on poramboke and ordinary assessment on assessed waste lands to be levied on the area on which operations are carried.

(7) There need be no continuous working or residential agents or maintenance, searching or inspection of books or accounts ; railway weighments to be considered sufficient for all purposes of Government.

(8) The firm need not give proof to show that the mine has become unprofitable if they should like to cancel the lease.

These terms were accepted by the firm and the Government Solicitor was directed to draft the lease deed. Information is not available, whether Messrs. Arbuthnot & Co. executed the deed, and, if they did, whether and how long they worked, and when they were allowed to cancel the lease. From the paucity of records in the Collector's office on the subject, it would appear that very little was done.

* Government of India Resolution No. 1840—50/2, dated 31st May 1900.

Seven years later, Leon Tardivel, Mayor of Chandernagore, applied for a prospecting licence and, at his request, a prospecting licence was issued to his partner A. Ghose in September 1909. A. Ghose, F.C.S., F.G.S., M.I.M.E., is an enterprising miner in the Presidency, working manganese mines in Bellary, copper, lead and steatite in Kurnool and diamond mines in Banganapalle. Beyond renewing the prospecting licence for two or three years, maintaining a local maistri and repairing the Roman Catholic bungalow at Uttatur and collecting a few baskets of nodules, and asking that the dead rent may be reduced to 2 annas per acre in view of the depression of the phosphate market and the low grade nature of the nodules, he seems to have done very little. He applied for a mining lease for 30 years but does not appear to have submitted the necessary plans and sketches.

H. G. Turner who was the first applicant in 1892 was once again an applicant in 1913 and a prospecting licence was issued to his Power of Attorney, Robert D. Connell, Manager of the Salem Magnesite works, in July 1913. The licence was not renewed. Messrs. Stanes & Co., Coimbatore, took out a prospective licence of one of the blocks, Teranipalaiyam village for one year which expired on 7th October 1917 and Karai village for one year with effect from 23rd June 1917. There the matter rests.

It is a matter for regret that, in an agricultural country like India, a large export trade in bones should exist, amounting to over 80,000 tons valued at £300,000,* and that the few phosphatic

* Records of the Geological Survey of India, 1910, Vol. XXXIX.

deposits of any value should not be worked. The only other sources than the phosphatic nodules of Trichinopoly seem to be the small quantities of apatite in the waste of the Nellore mica mines and the isolated crystalline forms of mangan-apatite in the Kodurite series of the Manganese mines of Vizagapatam ; and all that can be said about this apatite is that very little is known about it.

A description of the area of phosphatic nodules of Trichinopoly is given in Agricultural Ledger No. 20 of 1898 by D. Hooper, Government Quinologist, extracted partly from the old memoirs of the Geological Survey and partly from Dr. Warth's reports. He has analysed several samples of the nodules and gives results of the application of the powdered phosphate to several plants in the Nilgiris, viz., jalap, ipecacuanha, oats, lucerne and mustard and arrives at the conclusion that the powdered material is a valuable manure.

A short description of the locality and the manner in which the nodules are distributed will be given below :—

The principal village of Uttatur in the locality is connected by a good metalled road to Trichinopoly and is 26 miles from Trichinopoly Fort. A new road was proposed to be constructed from Uttatur to Kilapaluvur whereby its distance to Tanjore would be about 25 miles, across the Coleroon. In other words, the locality is within easy distance of the Tanjore paddy tracts.*

The locality of phosphatic nodules is situated in a long strip of land, 10 miles long, from Siru-

* Vide map of the portions of Tanjore and Trichinopoly districts. Fig. 1.

MAP

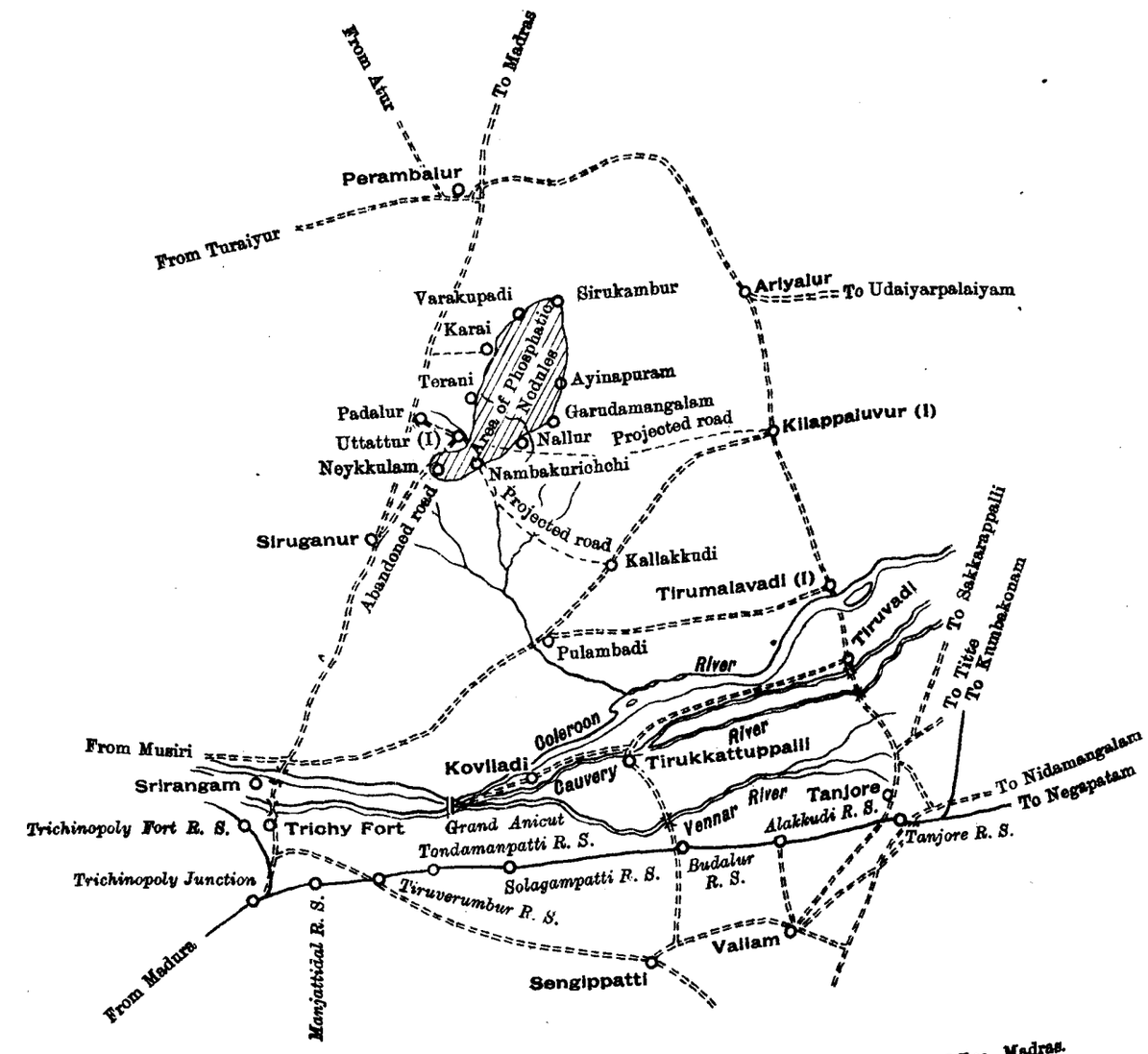
of Portions of

TRICHINOPOLY & TANJORE DISTRICTS

Showing the Position of the Area of

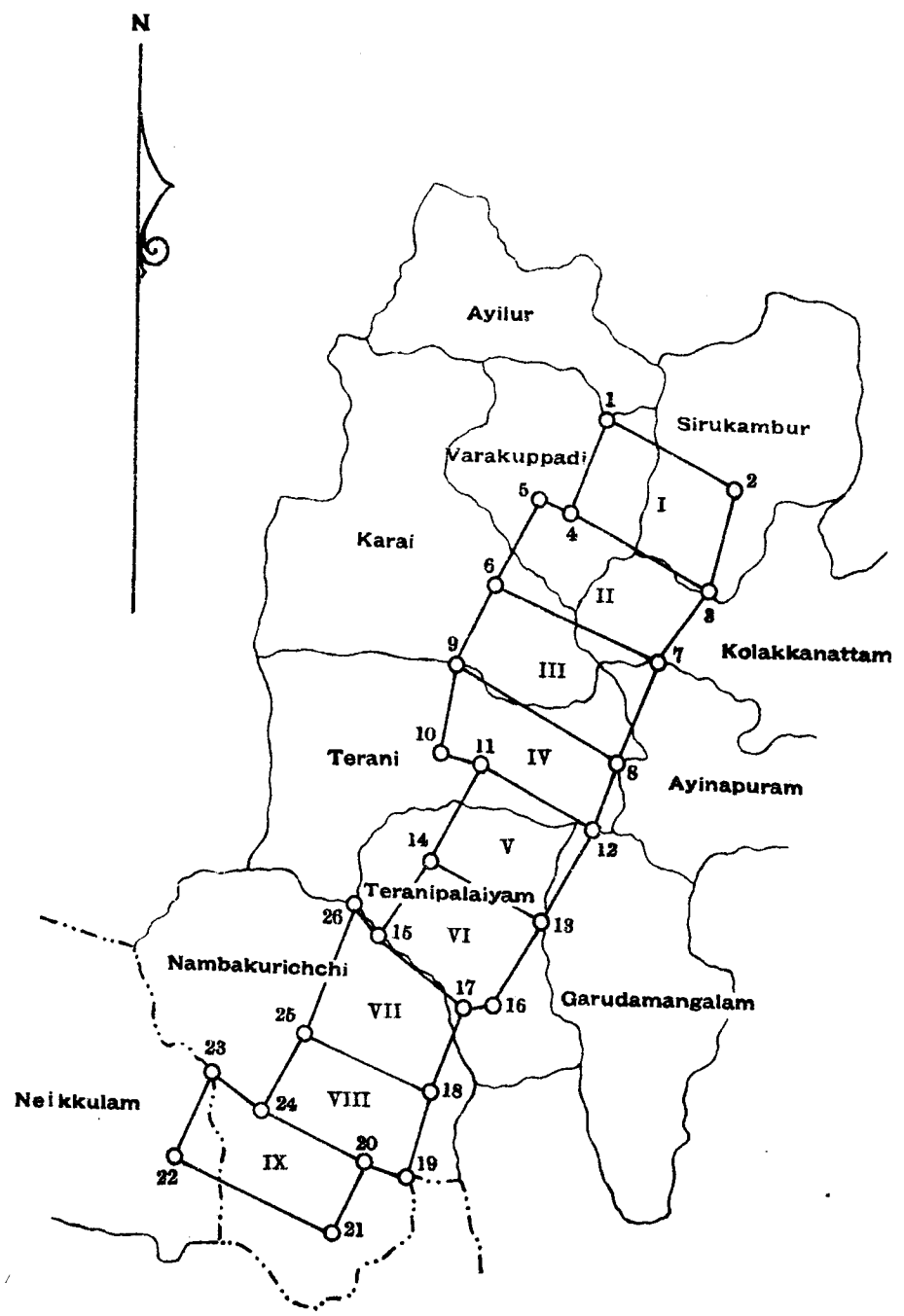
PHOSPHATIC NODULES

Scale 1 Inch = 8 Miles



Zinco., Survey, Office, Madras.
1918

Reg. No. 2738
Copies 1000 + 200



gambur on the north to Neikkulam on the south, and approximately 1 to 1½ miles in breadth and consists of portions of the villages of Terani, Teranipalaiyam, Karai, Varagampadi, Sirugambur, Ayinapuram, Garudamangalam, Nallur, Nambikurichi, Neikkulam and the inam devastanam village of Uttatur.* On the west are broken hills of azoic rocks, on the north is broken open country, on the east are the younger cretaceous formations overlying the older Uttaturs, and on the south, the drainage is carried off by a number of ravines into the Nandyar river which flows into the Coleroon. The enclosed tract is made up of white or yellow shales cut up, through the denudation of centuries by several gullies, into a number of small mounds.† In these conical heaps‡ of soft yellow clay, are seen white lines of chalk,§ 2 to 3 inches in diameter, branching in all directions on the surface and underground. On these lines, round or oval stones are attached, usually enclosed, partly or wholly, in a rind of hardened shale and rarely chalk, and often separated by a layer of crystalline gypsum. These stones are the phosphatic nodules.‖ They are of all sizes from 1 inch to 10 inches in length and from half an inch to 5 inches in breadth, usually oval and sometimes spherical. Occasionally the phosphate of lime is found in other forms than the septaria. They show a peculiar crystal-line structure when broken, which distinguishes them from calcareous

* Vide map of the mining blocks. Fig. 2.
† Vide photograph of mounds. Fig. 3.
‡ Vide sketch of ground plan and section. Fig. 4.
§ Vide photograph of mounds showing white lines. Fig. 5.
‖ Vide photograph of specimens. Fig. 6.

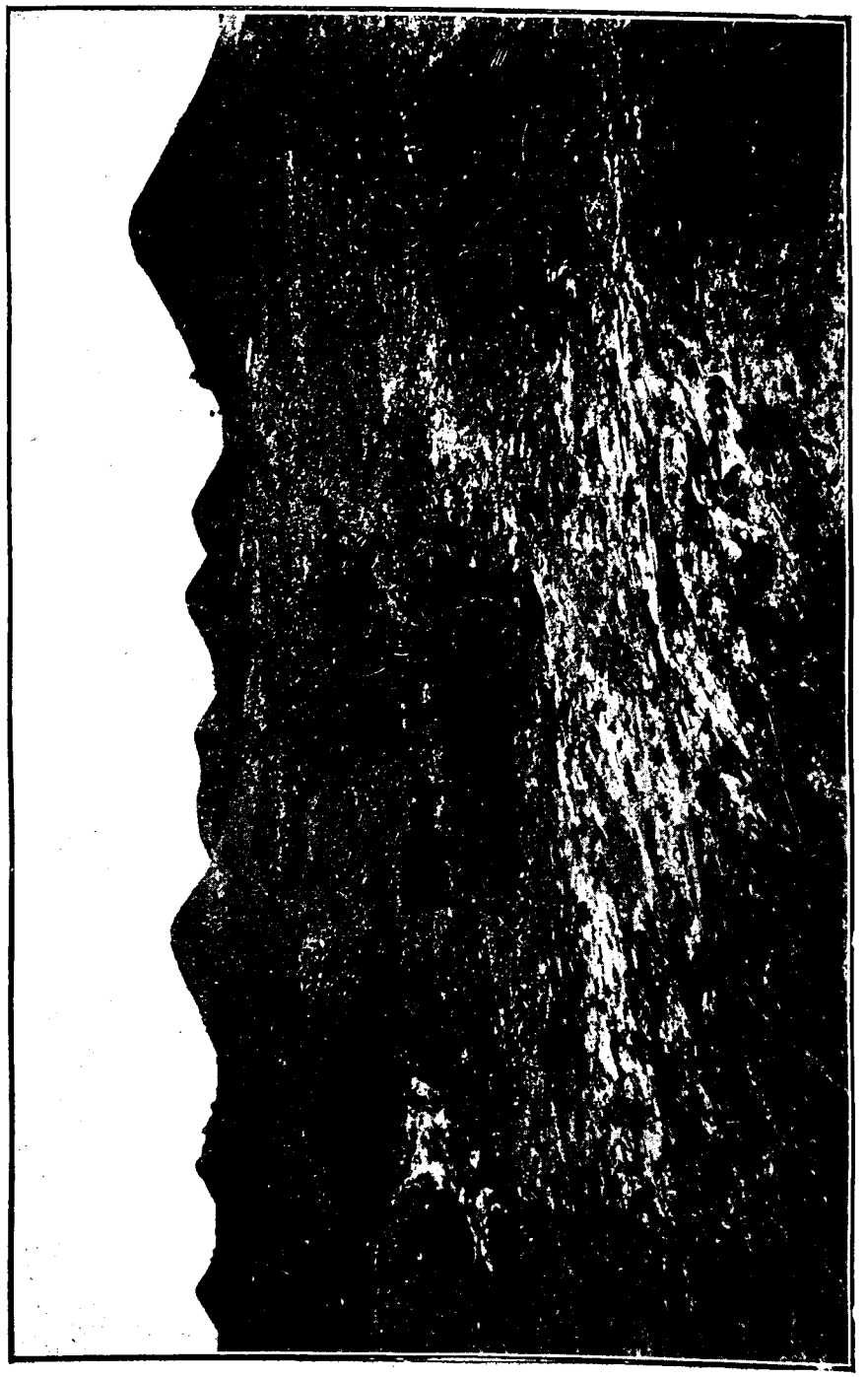
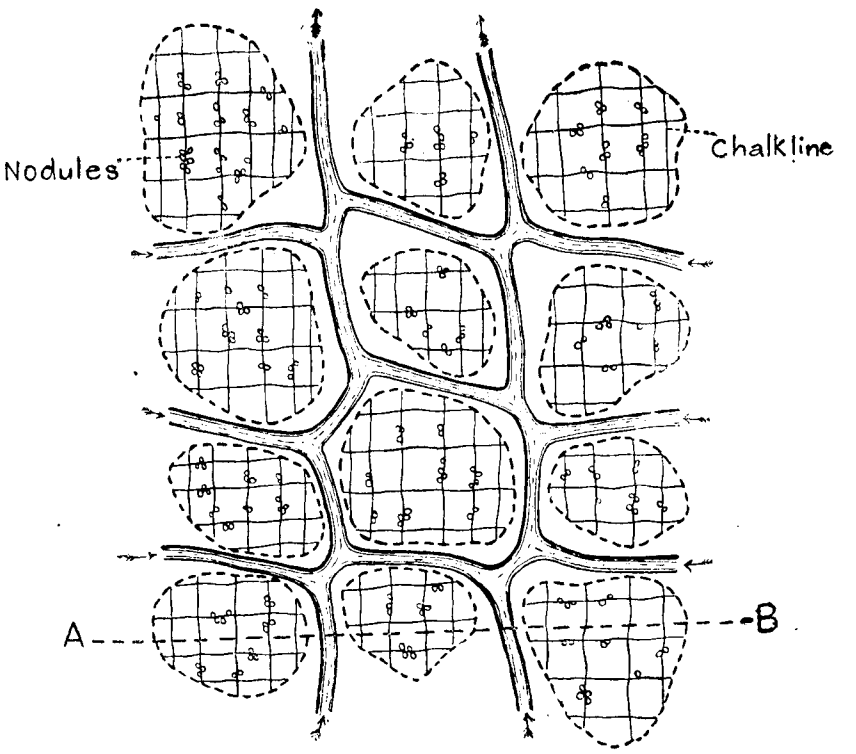


FIG. 3.—PHOTOGRAPH OF MOUNDS.



SECTION ALONG AB.

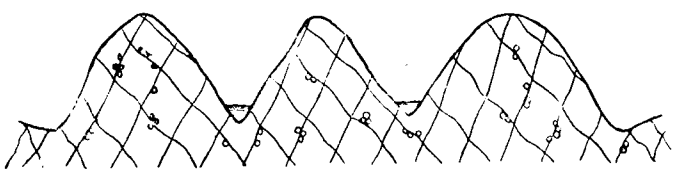


FIG. 4.—SKETCH OF GROUND PLAN OF MOUNDS.

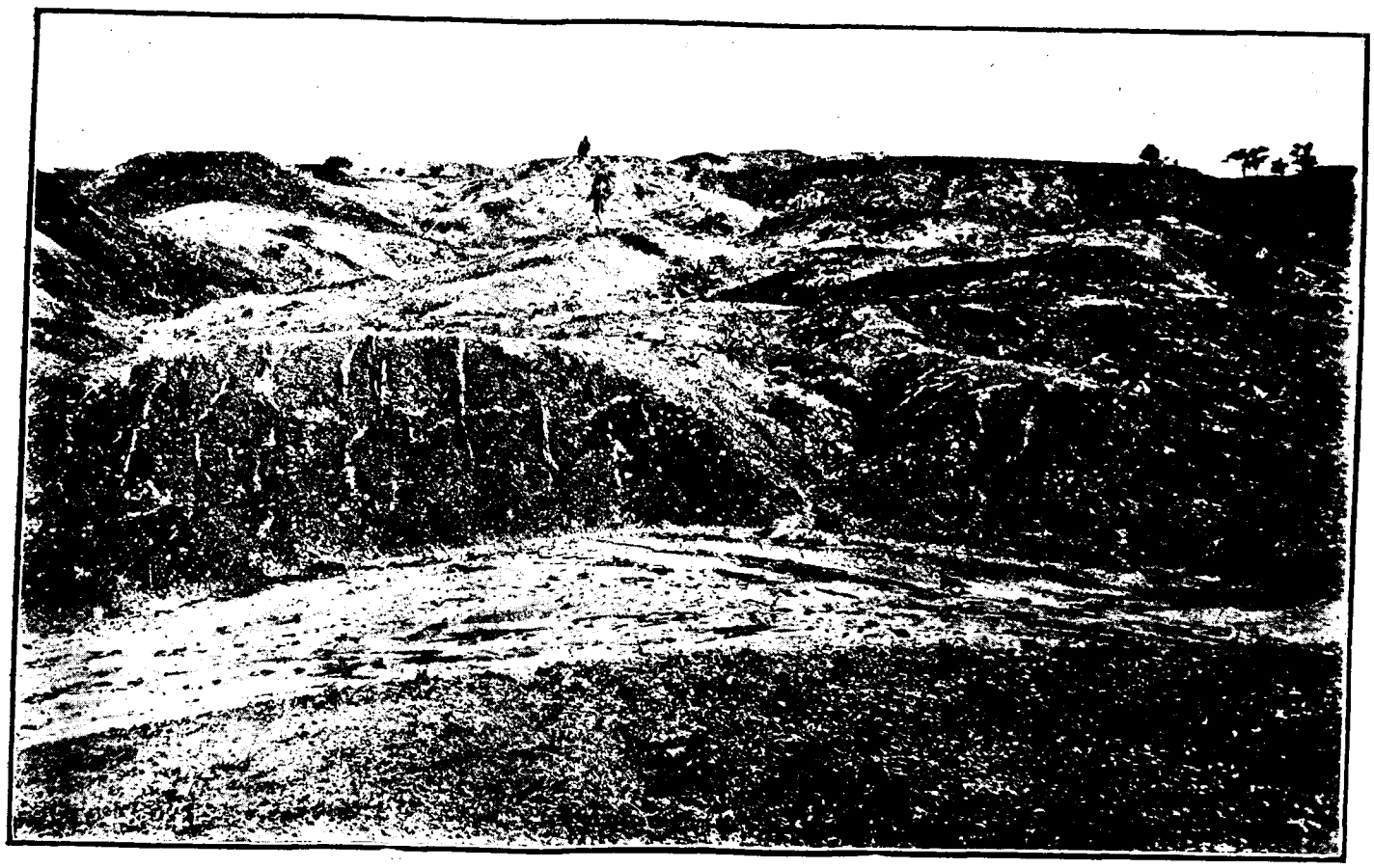


FIG. 5.—PHOTOGRAPH OF MOUNDS SHOWING WHITE CHALK LINES.

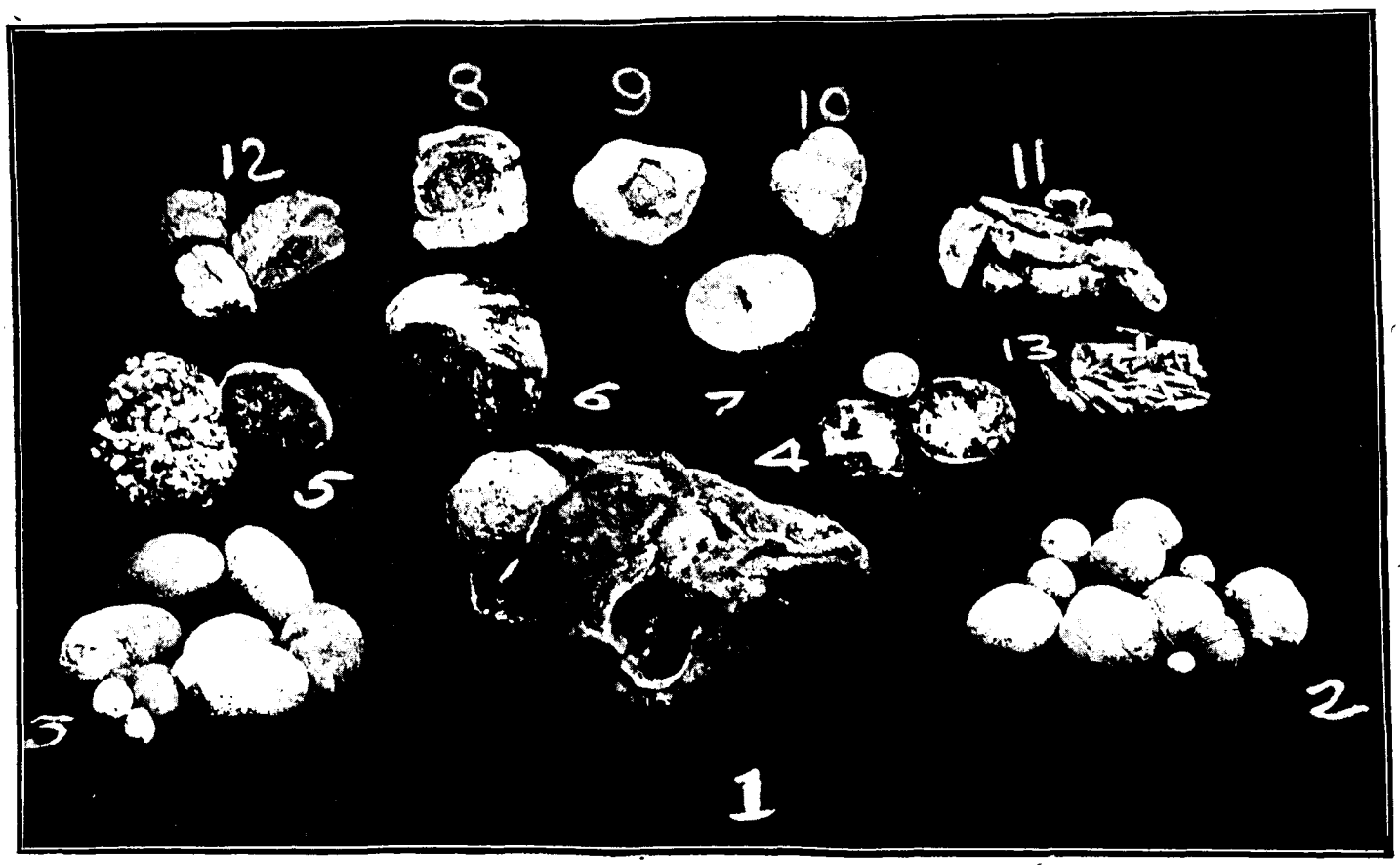


FIG. 6 PHOTOGRAPH OF SPECIMENS.—(1) PHOSPHATIC NODULES, INBEDDED IN YELLOW CLAY, IN *situ*. THE NODULES MAY BE SPHERICAL (2) OR OVAL (3). THE PHOSPHATIC NODULES, WHEN BROKEN, GIVE A PECULIAR CRYSTALLINE FRACURE (4), WHICH IS ABSENT IN PURELY CALCAREOUS NODULES (7). WHEN THE PHOSPHATIC NODULES UNDERGO WEATHERING THE DARK CORE INSIDE IS SEEN (5). SOMETIMES THE PHOSPHATES MAY BE PRESENT IN OTHER FORMS THAN THE SEPTARIA (6). THE NODULES ARE ENCLOSED IN A RIND OF HARDENED SHALE (10), SOMETIMES CHALK (9). BETWEEN THE RIND AND THE NODULES, THERE IS USUALLY A LAYER OF CRYSTALLINE GYPSUM (8). THE REGION OF PHOSPHATIC NODULES ABOUNDS IN GYPSUM (11), CELESTINE (12) AND BELEMNITES (13).

nodules. The nodules when weathered lose their white covering and expose the dark core inside. Gypsum, celestine, chalk and belemnites are always found associated with the phosphatic nodules ; and the nodules are present only in the region of yellow clay and are completely absent in the black soils of the immediate vicinity. The nodules on the surface have been mostly removed from Uttatur and Nambikurichi by petty contractors who deliver the nodules at Rs. 12 per ton at Trichinopoly Fort where a few agents buy the same and supply to the manure firms, the contractors paying a royalty of 3 annas for every cartload to the local temple authorities. It is surmised that from 200 to 500 tons are thus being removed from the locality every year during the last five or six years.

The analyses of South Indian soils, especially the soils of the Cauvery delta in Tanjore, show a general deficiency in phosphoric acid.* Many of these soils being double crop wet land and the grain largely exported from the tract, the depletion of the phosphatic ingredient in these soils continually goes on, though partly recouped by the silt, and the necessity of utilizing all the phosphatic manure in the country distinctly arises. Besides bonemeal and fish manure—which, by the by, are also exported—the phosphatic nodules of Trichinopoly are the most prolific source, and being situated so near to the rice fields of the Cauvery delta, should, naturally form the most important supply of phosphatic manure to the Tanjore district.

* Tanjore Delta, Madras Agricultural Bulletin, Vol. III, No. 68, 1914.

In what form or forms the nodules are to be applied is the question. Dr. Voelcker reported a quarter of a century ago that it would not be remunerative to export them to foreign market for superphosphate manufacture and my experiments go to confirm that it will not pay to manufacture superphosphate even in this country. The composition of typical nodules is as follows :—

	Moisture	1·22
	Combined moisture and organic matter	3·59
	Sand and insoluble silicates	7·32
	Soluble silica	1·20
	Oxide of iron	2·58
	Alumina	4·52
	Lime	42·06
	Magnesia	1·16
	Sulphuric acid	0·45
*	Phosphoric acid	25·63
†	Carbonic acid	8·94
	Potash	0·57
	Soda	0·76
		100·00

The nodules, according to this analysis, may be calculated to contain approximately 55·95 per cent of tricalcic phosphate, 17·41 per cent of calcium carbonate, 2·44 per cent of magnesium carbonate and 7·10 per cent of ferric oxide and alumina. Every 100 parts by weight of nodules require 35·44 parts of sulphuric acid to convert the tricalcic phosphate into mono-calcic phosphate and 37·68 parts to dissolve the carbonates and the iron and alumina ; in other words, as much sulphuric acid is wasted in reacting with the impurities as in the conversion of the insoluble phosphate into a soluble form. At

* Equal to 55·95 per cent tricalcic phosphate.
† Equal to 17·41 per cent calcium carbonate.

the price at which sulphuric acid can be procured in Madras—there is only one sulphuric acid factory in the Presidency, at Ranipet—superphosphate cannot be manufactured out of the nodules at a less cost than Rs. 12 per unit of phosphoric acid, while the manure firms in Madras are now selling bonechar superphosphate at about Rs. 5 per unit. The high percentage of calcium carbonate (17 per cent) and of iron and alumina (7 per cent) detract from the value of the nodules for superphosphate manufacture, and the material cannot be converted into super until sulphuric acid (chamber acid) sells at about 9 pies per pound. This explains why so many firms who have been interesting themselves in these deposits from 1892 up to date have given up the idea of working them.

The manufacture of super from the nodules being out of the question, in what other ways can they be utilized? Within the last few years, an electrolytic method,* worked on a small factory scale in Sweden, has been suggested whereby even low-grade phosphates can be converted into dicalcic phosphate easily soluble in soil water; but until cheap electric supply is available in this country the manufacture of nodules into dicalcic phosphate is out of the question.

There is then only one alternative left and that is, to utilize the nodules in a powdered form as flour phosphate directly as a manure—a recommendation made by Dr. Voelcker 25 years ago.

Earlier trials† with the powdered phosphate in some of the coffee plantations in Southern India

* Vide Chemical News, 29th August 1913, paper by Palmaer at the Eighth International Congress of Applied Chemistry.

† Mineral resources of India, by Holland, page 51.

and Ceylon seem to have been disappointing, while D. Hooper says that the nodules gave increased crops with a few plants in the Nilgiris* Flour phosphate has given as good a yield as bone meal with paddy in the Manganallur† Farm. Recent American publications‡ are all recommending the direct application of powdered rock phosphate, especially when applied along with organic matter in the form of green manure or cattle manure. Cameron and Bell, § speaking of South Carolina phosphates—which are similar in composition to the nodules—show that the solubility and decomposition of rock phosphates are much increased and hastened by the presence of carbonic acid in water and that, when organic matter especially green manure, is thoroughly incorporated in the soil with the phosphates, the carbonic acid and possibly other acids resulting from the decomposition of the organic matter so increase their solubility as to make them compare favourably with the rapidly soluble phosphates.

Several experiments are in progress to determine the availability of the flour phosphate under *swampy paddy soil conditions*, by estimating the phosphate rendered soluble as a result of composting with green manure and cattle manure, and by measuring the growth of paddy plants manured with flour phosphate with and without green manure.

* Agricultural Ledger 1898, No. 20, pages 16 to 19.

† Agricultural Station Report, 1916-17, Manganallur.

‡ Journal of Agricultural Research, Vol. VI, No. 13, dated 26th June 1916, pages 485-514. Availability of mineral phosphates for plant nutrition by W. L. Burlisn, Illinois.

§ U.S. Bulletin No. 41, Bureau of Soils, 1907. The action of water and aqueous solutions upon soil phosphates by Frank Cameron and James M. Bell.

SOME NOTES ON MANURES IN SOUTHERN INDIA.*

By W. H. HARRISON, D.Sc.,
Government Agricultural Chemist.

I.—Mineral Manures.

The mineral resources of South India, in so far as they have any agricultural application, are exceedingly limited either on account of their quan tity or their uneven distribution and the consideration of this subject is practically restricted to lime, gypsum, magnesia and phosphates. Potash also calls for some consideration owing to the large amount of saltpetre annually produced in India.

Lime.—Many soils in South India, of which those of the Nilgiris and the West Coast may be instanced as types, are very deficient in lime and would be greatly benefited by heavy dressings of this substance. The soils of many districts and deltas, although not depleted to the same extent as the instances given, have a very low lime content and would be materially improved by lime manuring.

There is consequently a fairly general necessity for applications of lime to soils, but unfortunately it is just those soils to which this refers that are most remote from the limestone deposits of the Presidency, and the difficulties arising from freight charges and poor internal communications militate against an extended application of the manure.

It is true that all around the coasts shell-lime is available and that in many districts burnt

* Originally prepared in 1914.

kankar may be relied upon as a source of supply, but both of these sources can only have a local value. The necessity of many districts can only be met by a cheap and abundant supply of lime which can only occur in areas where limestone deposits are found, and these are both limited in area and not uniformly distributed throughout the Presidency. The largest deposits of limestone occur in Cuddapah, Kurnool and Guntūr districts and, apart from these, small deposits are found in the Trichinopoly and Coimbatore districts. Large specimens of calcite have been obtained in the Tinnevelly district but no knowledge regarding the extent of this deposit is available. Considering these sources of supply, it is probable that there is sufficient limestone in South India to satisfy the agricultural demand of the near future, but the cost of transport will always react against its use in requisite quantities in many localities of which the planting districts of the West Coast may be taken as a type.

Gypsum.—The only deposits of any importance are those of the cretaceous formation of the Trichinopoly district. These could be utilized for the amelioration of those saline soils to which the cheaper and more effective method of flooding and draining cannot be applied. There is, at present, no demand for gypsum for this purpose and such a demand can only arise through the agency of successful demonstration work. Even supposing that its application was found to be successful, the cost of transport would largely determine the extent of its use.

Magnesia.—The subject of the value of direct magnesia manuring for crops is one which has

received considerable attention during recent years, but it cannot yet be said that any clear principles have been enunciated. In certain cases magnesia manures have produced very greatly increased yields but in other cases the results have been negligible or even detrimental.

The action of these manures on the varied soils of this Presidency can only be determined by experiment, but if they were found to be successful, the magnesite deposits of Salem insure an abundant supply of the substance. It would, however, probably be found that, instead of heavy dressings of magnesite or magnesia, very much smaller amounts of magnesium sulphate would have the same effect, and in this case the latter substance could be manufactured at the mines or some central works.

Mineral Phosphates.—The only important deposit of phosphate is that of the Trichinopoly district where nodules containing calcium phosphate are found distributed irregularly through a bed of clay which is estimated to contain eight million tons of the mineral. Attempts appear to have been made in the past to utilize these deposits, but they have proved abortive and at present there would appear to be no prospect of their being mined for export. A certain amount of surface working does, however, go on and the product is sold to certain manure firms in South India and utilized locally as flour phosphate.

The great difficulty presented is the fact that the mineral is of low grade quality and as such cannot compete with the better class deposits found in other parts of the world, or with bone-ash, in the manufacture of superphosphates. These high

grade phosphatic deposits are, however, undergoing very rapid depletion and, as a consequence, the attention of chemists has lately been directed to the introduction of new methods by means of which these low grade phosphates may be economically utilized and several of these methods are now being tried on a manufacturing scale with promising results. It is certain that, before very long, such deposits as those at Trichinopoly will be in demand and the question naturally arises, cannot Government arrange that these deposits shall be exploited for the benefit of India and that they shall not be allowed to be exported out of the country ?

Much of the land on which these deposits occur is Government property and it would thus be possible to prevent the latter contingency occurring by refusing to issue new licences or to renew lapsed ones until some means are evolved which would make their utilization in this country possible. That such a possibility is more than probable is evinced by the fact that one of the latest methods is an electrolytic one which produces a very pure basic super, and, if successful, could be carried out in this Presidency where water-power is available for the production of electricity.

The soil survey recently carried out in the adjoining Tanjore delta has shown that there is a great need for some form of phosphatic manuring in that locality and it is probable that these nodules used in the form of flour phosphate would be of some value. It is true that the availability of this manure is very low and that its utilization in this form would be wasteful in the sense that much would be dormant in the soil for several

years, but such a method of manuring has the advantage of cheapness.

Potash Minerals.—With regard to the mineral resources, in potash, of South India, it can only be said that they are non-existent and India, like all other countries, will be entirely dependent upon the potash mines of Stassfurt for the supply of this type of fertilizer if a large demand arises in the future.

It is true that there is a considerable production of saltpetre in India and this is probably capable of meeting the present demand of that substance for use as a manure, but apart from this any demand for purely potassic manures must be met from external sources.

II.—Some Indigenous Manures.

In considering this subject it is proposed to consider only the more important classes of manures from the following standpoints :—

(*a*) Variations in composition and their causes.

(*b*) Evidences of adulteration.

(*c*) Possible extensions in production.

By the term adulteration I do not wish it to be understood that I refer to intentional and fraudulent adulteration but rather that the term is used in a loose sense to cover the occurrence of impurities in the manures from any cause such as careless and uncleanly workmanship on the part of the producer.

The manures considered will be poonacs, fish-manures, bone products, farmyard manure, poudrette and saltpetre.

Poonacs.

Poonacs.—The most important poonacs produced in this Presidency are castor, neem, groundnut, pungam, safflower and gingelly and, in all cases, considerable variations in composition are liable to occur.

Castor cake.—A number of samples from different parts of the Presidency have been analysed with the result shown in the following table :—

Table 1.—Variations in the composition of castor cake.

—	Average.	Maximum.	Minimum.
Nitrogen	6·37	7·60	5·38
Phosphoric acid	2·55	3·62	1·80
Potash	·96	1·24	·65

The variation in these cases is partially accounted for by the varying amounts of insoluble mineral matter (sand) found. Good samples contain only about 1 per cent of sand, but some of them contained as much as 5 per cent. These figures, however, sink into insignificance when compared with other samples, not included in the above, which were found to contain amounts of sand varying from 20 to 35 per cent.

This addition of earthy matter must undoubtedly be looked upon as an adulteration and, whether brought about by intention or through carelessness, is to be guarded against. Dr. Lehmann, late of the Mysore Department of Agriculture, pointed out several years ago that a large proportion of the variation in composition which he found was due to the incomplete separation of the husk.

Neem or margosa poonac.—

TABLE II.—Variations in the composition of neem poonac.

—	Average.	Maximum.	Minimum.
Nitrogen	5·53	5·73	4·7
Phosphoric acid	1·36	1·63	1·2
Potash	1·75	1·97	1·4

With this poonac too, abnormal samples have been examined which contained undue proportions of sand, as much as 31 per cent being recorded in one case, whilst other samples, judging from the proportion of nitrogen, potash and phosphoric acid contained, had been adulterated by the addition of poonacs of inferior quality.

Pungam poonac.—Of the comparatively few samples hitherto examined, only one showed the admixture of an undue proportion of earthy matter, viz., $6\frac{1}{4}$ per cent. The remainder gave the following results :—

TABLE III.—Variations in the composition of pungam cake.

— —	Average.	Maximum.	Minimum.
Nitrogen	3·95	4·00	3·91
Phosphoric acid	·77	·84	·64
Potash	·79	·94	·62

Groundnut cake has, generally speaking, been found to be of good quality. In no case has the amount of sand present reached $3\frac{1}{2}$ per cent, but on the other hand samples have been received which had the abnormally low nitrogen content of $6\frac{1}{4}$ to $6\frac{1}{2}$ per cent. In one case this was obviously due to incomplete extraction of the oil, but in the other cases it was impossible to determine the cause

which might be due to inferior seed or to admixture with other poonacs.

The normal samples gave the following results :—

TABLE IV.—Variations in the composition of groundnut poonac.

—	Average.	Maximum.	Minimum.
Nitrogen	7·92	8·63	7·36
Phosphoric acid	1·37	1·66	1·11
Potash	1·20	1·36	1·08

Gingelly cake has not shown evidences of impurity—

TABLE V.—Variations in the composition of gingelly cake.

—	Average.	Maximum.	Minimum.
Nitrogen	6·23	6·59	5·76
Phosphoric acid	2·21	3·36	1·54
Potash	·99	1·14	·79

Safflower cake showed considerable variation in composition, but no evidences of earthy admixture—

TABLE VI.—Variations in the composition of safflower cake.

—	Average.	Maximum.	Minimum.
Nitrogen	4·5	5·8	3·1
Phosphoric acid	1·2	1·5	1·0
Potash	·7	·8	·5

Two samples not included in the above appeared to be abnormal in composition as they contained a larger proportion of potash than phosphoric acid, whereas pure safflower cake showed the reverse ratio. They agreed in fact more with the composition of neem cake than safflower cake and may

be looked upon as having been subjected to admixture.

Average composition of poonacs.

From the above results it would appear that the *minimum values* of good South Indian poonacs are approximately as follows :—

TABLE VII.—Minimum composition of South Indian poonacs.

	Nitrogen.	Phosphoric acid.	Potash.
Castor	5·4	1·8	·7
Neem	4·5	1·2	1·4
Pungam	3·9	·6	·6
Ground-nut	7·3	1·1	1·1
Gingelly	5·5	1·5	.8
Safflower	3·0	·8	·5

Extension in the production and use of poonacs.

Although large quantities of poonac are annually employed in the shape of manure in India, yet there is room for considerable extension when the large export of cakes and the larger export of whole oil-seeds is considered. This development can only be slow in a country where such a large proportion of cultivators neglect to manure their fields, but none the less some progress has been made in recent years. The slow progress is also partly to be accounted for by the rapid rise in prices during recent years which has prevented the poorer cultivators from using these manures, and partly by the system under which the land is let out to cultivators in certain districts.

Still there is no reason to suspect that India cannot produce sufficient poonac to satisfy all ultimate demands. The recent heavy demand for oils for manufacturing purposes has led to increased

raising of oil bearing crops, and this will continue so long as prices warrant it, and in present conditions much of this seed will continue to be exported to other countries and the cake will thus continue to be lost to India. If conditions would only allow of its being done, the rise of a large oil pressing industry based mainly on export of oil would tend to solve the difficulty.

Again there are many cakes produced in India, which have little manurial value, and consequently as yet are quite valueless. Yet these cakes enriched with some nitrogenous manure such as cyanamide, calcium nitrate, etc., which possibly can be produced cheaply in this country, would become effective from the manurial point of view, and thus make a cheap poonac available for the poorer cultivators. Pinnai and Dhupaka cakes are of this type.

The enormous extension of the manufacture of artificial foodstuffs has led the older class of oil-consumer to search for new sources of supply with the result that many forest trees have been shown to yield oil bearing fruit and which, if they could be exploited, would yield further quantities of poonac. Even if these poonacs are not of great value from the manurial point of view, they could be made available by enrichment with artificial nitrogenous manures.

III.—FISH MANURES.

Fish manures of whatever type constitute one of the most important classes of indigenous manures of South India, but the variations met with are so considerable that I have determined to set down all the analyses in detail.

Fish Guano.—Of this, seven representative samples have been examined with the result that it can be looked upon as a product of high purity. Of the seven samples, six contained less than 3½ per cent sand and the seventh only 7¼ per cent.

TABLE VIII.—Variations in composition of fish guano.

Number of sample.	Water.	Organic matter.	Mineral matter.		N.	P_2O_5.	K_2O.
			Sol.	Insol.			
51/10 ..	8·26	66·88	22·18	2·68	7·46	14·38	·47
276/10 ...	12·74	57·59	27·35	2·32	8·46	8·66	·34
134/13 ...	8·16	62·03	26·46	3·35	7·91	10·33	·48
177/13 ..	9·35	61·25	26·31	3·09	8·01	9·75	1·05
313/13 ...	7·87	56·30	34·15	1·68	7·88	13·49	·19
361/13 ...	11·47	59·28	27·62	1·63	7·66	10·42	·66
162/14 ...	8·01	62·42	22·30	7·27	7·11	8·82	·53
Average ...	9·41	60·82	26·62	3·14	7·78	9·40	·53
Average of the first six samples ...	9·64	60·55	27·34	2·46	7·89	9·55	·53

Fish Manure.—Under this heading is classed manures which are not guanos and which consist of either whole or milled fish. Two tables are given ; one gives the composition of good samples and one gives the composition of very impure products.

TABLE IX.—Variation in composition of good samples.

Number of sample.	Water.	Organic matter.	Mineral matter.		N.	P_2O_5.	K_2O.
			Sol.	Insol.			
277/10 ...	13·47	64·49	15·18	6·86	5·83	4·81	·60
325/10 ...	10·52	72·39	16·35	·74	8·66	6·48	·61
326/11 ...	7·02	71·43	18·00	3·55	8·41	7·00	·27
209/13 ..	4·36	71·02	19·24	5·38	7·62	6·93	·90
314/13 ...	3·22	63·87	30·81	2·10	6·91	6·18	·73
52/14 ...	8·43	51·07	26·85	7·65	8·51	6·61	1·07
Average ..	7·83	66·71	21·07	4·38	7·65	6·33	·69

TABLE X.—Variations in the composition of poor samples (sand).

Number of sample.	Water.	Organic matter.	Mineral matter.		N.	P_2O_5.	K_2O.
			Sol.	Insol.			
11/07 ...	15·05	48·96	14·39	21·60	6·15	5·31	·71
184/08 ...	10·13	53·83	17·38	18·66	6·79	2·81	·60
5/09 ...	9·56	60·16	14·39	15·89	6·39	5·12	·43
6/09 ...	7·18	65·99	13·42	13·41	7·31	5·36	·25
52/10 ...	6·47	48·03	14·47	31·03	4·38	3·99	·32
86/11 ...	6·57	43·36	12·23	37·84	3·53	3·15	·47
321/11 ..	3·86	32·17	24·82	39·15	1·26	3·31	·29
172/12 ...	5·74	55·08	6·31	32·87	6·37	3·43	·80
172/13 ...	9·86	57·84	10·96	21·34	6·46	7·67	...
312/13 ...	7·59	59·66	21·05	11·70	6·79	10·39	·79

Pit fish manure.—Only two authentic samples of this product have been received.

TABLE XI.—Variations in composition of pit fish manure.

Number of sample.	Water.	Organic matter.	Mineral matter.		N.	P_2O_5.	K_2O.
			Sol.	Insol.			
53/10 ...	40·38	36·55	18·14	4·93	5·59	2·11	·21
292/11 ...	5·06	22·35	29·42	44·67	1·05	4·22	·50

Prawn skins.—

TABLE XII.—Variations in the composition of prawn skins.

Number of sample.	Water.	Organic matter.	Mineral matter.		N.	P_2O_5.	K_2O.
			Sol.	Insol.			
175/14 ...	20·01	46·05	22·69	11·25	5·47	2·79	·55
174/14 ...	7·22	22·39	15·79	54·60	2·86	2·07	·38

Fish sand.—Only one sample of this substance has been analysed and its composition is thoroughly in accordance with its name :—

Water	1·54
Organic matter	12·21
Soluble mineral matter	5·50
Insoluble mineral matter	80·75
Nitrogen	1·18
Phosphoric acid	·38
Potash	·21

Fish Gutts.—

TABLE XIII.—Variations in composition of fish gutts.

Number of sample.	Water.	Organic matter.	Mineral matter.		N.	P_2O_5.	K_2O.
			Sol.	Insol.			
293/11 ...	10·51	35·21	35·29	18·99	3·16	13·68	·13
294/11 ...	8·86	48·71	24·99	17·44	5·28	8·95	·31
320/11 ...	8·01	32·28	41·58	18·13	3·79	15·17	·04
Average	9·13	38·73	33·95	18·15	4·07	12·60	·16

Conclusions.—Fish manures other than gutts and prawn skins, prepared with due precautions to prevent admixture with sand, do not contain more than two per cent of insoluble mineral matter, but a very large proportion of commercial samples undoubtedly contain undue proportions of this adulterant. This is not, as a general rule, due to fraudulent intention, but is brought about by the crude methods of dealing with the catch practised by the fishermen. Better conditions of drying and the systematization of the industry would go far to improve the quality of the product, but I am informed that one reason why inferior manures are so much in evidence in India is that exporters insist on obtaining the better qualities, with the

result that the home market remains the dumping ground for the remainder.

I am unable to draw general conclusions regarding the extension of the industry, but there is undoubtedly a considerable opening in one respect. So far as South Kanara is concerned, the gutts of fish, salted for food, are made practically no use of, and annually considerable quantities are either burned or thrown into the sea. These gutts have a fair manurial value (vide Table No. XIII) and some endeavour should be made to utilize them for manurial purposes.

IV.—FARM YARD MANURE.

Recently a bulletin was issued giving the results of the experiments conducted by the department on different methods of storing manure. To this, nothing new can be added, but in the following tables are given the analyses of a number of samples of ryots' manure collected in different parts of the Presidency.

TABLE NO. XIV.—Composition of ryots' manure.

Number of samples.	District.	Water.	Organic matter.	Mineral.		N.	P_2O_5.	K_2O.	Composition.
				Soluble.	Insoluble.				
302/09	N. Arcot.	7·01	21·56	7·67	63·76	·55	·30	·13	Heap manure containing dung, ashes, straw and road sweepings.
304/09	Malabar.	61·82	19·04	9·04	10·10	·60	·24	·17	Pit manure, dung and leaves.
178/10	Kistna ...	27·36	16·85	13·03	42·76	·47	·50	·79	Heap manure.
248/10	Do. ...	8·31	20·82	16·64	54·23	·46	·73	1·40	Do.

TABLE XIV.—Composition of ryots' manure.

Number of samples.	District.	Water.	Organic matter.	Mineral.		N.	P_2O_5.	K_2O.	Composition.
				Soluble.	Insoluble.				
249/10	Bellary...	5·08	27·26	14·95	52·71	·59	·69	·96	Heap manure with ashes and sweeping.
250/10	Do. ...	3·55	33·33	13·51	49·61	·77	·72	1·38	Do.
251/10	Do. ...	21·06	17·98	12·84	48·12	·53	·60	1·37	Do.
252/10	Do. ..	7·46	42·10	13·30	37·14	·91	·53	1·37	Do.
300/10	Do. ...	25·03	15·42	14·32	45·42	·33	·49	1·10	Do.
256/10	Kistna .	74·51	5·57	3·66	16·26	·33	·22	·30	Pit manure.
269/10	Kurnool.	45·28	22·92	8·53	23·27	·76	·38	·80	Pit manure, average of 10 pits.
287/10	Tinnevelly.	19·97	8·80	11·85	59·63	·27	·49	·16	Heap manure with litter, chaff and tank silt.
296/12	Tanjore.	14·50	17·39	63·50	4·61	·55	·29	·38	

Without exception these manures are inferior to those produced on Government Farms where reasonable care is exercised in storage and conservation, and they show that the ryot has much to learn in this respect. In many districts fuel difficulties will always lead to a waste of the dung, but, where such do not exist, there is large scope for extending the use of farm yard manure and improving the conditions of storage.

A NOTE ON THE BEST SEASON FOR LIFTING CUS-CUS ROOTS (ANDROPOGON MURICATUS, RETZ.).

BY B. VISWANATH,
Assistant to the Government Agricultural Chemist.

In the Annual Reports of the Board of Scientific Advice for India 1913–14, Puran Singh reports

having examined a number of samples of cus-cus roots obtained at different seasons from different parts of Northern India and his conclusion is that the most favourable period for lifting the roots lies between the end of the winter season and the commencement of the rains.

At the instance of the Deputy Director of Agriculture, Southern Division, Madras Presidency, this problem was investigated quite independently during the year 1913 and for this purpose a number of samples were obtained from the Taliparamba Farm and submitted to analysis. This investigation differs from that of Puran Singh in that all the roots examined were planted at the same time in the same plot of ground and thus the effect of variations due to varying local conditions was eliminated.

The plants were lifted on the 21st of each month and despatched early next month for examination as soon as the roots were properly dried. The essential oil content was determined by different methods. In the first method, the roots were distilled with water in a vessel heated by a direct flame : in the second method, the distillation was conducted by means of steam at ordinary atmospheric pressure ; and in the third method, the roots were first of all extracted with boiling 80 per cent alcohol for one day, the extract was allowed to slowly evaporate at 50°C and the residue submitted to distillation in steam. In each case, the roots were dried in vacuo over sulphuric acid before distilling.

The distillates obtained by these several methods were extracted with petroleum ether (b.p. 60°C), the ether was allowed to evaporate

completely at the room temperature, and the residue was dried in vacuo over sulphuric acid until constant in weight.

The following table gives the results obtained :—

Date of lifting.	Per cent oil by first method.	Per cent oil by second method.	Per cent oil by third method.	Average.
21 Nov. 1912	·28	...	...	·28
21 Dec. 1912	·32	·28	...	·30
21 Jan. 1913	·23	·25	·22	·23
21 Feb. 1913	·38	·37	·38	·38
21 Mar. 1913	·55	·50	·55	·53
21 Apr. 1913	...	·40	·43	·42
21 May 1913	·33	·38	·34	·35
21 Apr. 1914	·39	·38	·40	·39

These results confirm the conclusions drawn by Puran Singh and it would seem that the most favourable time for lifting the plants is about the month of March.

Oil distilled from a trial consignment of the roots lifted in December was examined, for us, at the Imperial Institute with the following results :—

Specific gravity 15°/15°	1·0035
Optical rotation	14° 54¹
Acid value	29·1
Saponification value	4·23
Acetylation value	146·7

Soluble in 1·1 volumes of 80 per cent alcohol.

These constants differ a little from those recorded for vetiver oil obtained from roots generally imported from India suggesting that the oil is of an inferior quality. This is perhaps due to the roots having been lifted in December which is too early in view of the results recorded in this note, and probably a better quality oil would be obtained from roots lifted about March.

I am thankful to Dr. W. H. Harrison, Government Agricultural Chemist, for many suggestions in the course of this work.

NOTE ON CERTAIN SPECIES OF SPOROBOLUS AND CHLORIS.

By K. RANGA ACHARIYAR and C. TADULINGAM.

In the course of the study of the grasses growing on the Farm of the Agricultural College, three distinct grasses belonging to the genus Sporobolus were found growing. On referring to the Herbarium, all these three forms were found placed under the species Sporobolus coromandelianus. In Hooker's Flora of British India the first two, Sporobolus coromandelianus and S. commutatus, are combined into one species Sporobolus coromandelianus. As these three plants were found growing side by side and looked quite distinct, they were critically studied and as the result of the study, the three are to be considered as distinct species.

1. SPOROBOLUS COROMANDELIANUS, LINK.

The plant is a densely tufted annual varying in size with the nature of the soil—small and stunted in hard dry soils and large and spreading in rich, loose and moist soils.

The stems vary in length from 2 inches (5 cm.) to a foot (30 cm.) are profusely leafy at the base and also covered by a few withered scale-like leaves ; these are closely spreading on the ground, sometimes rooting at the lower nodes and branching freely. Branches are procumbent at first and to a slight extent, then they are ascending and finally become erect at the time of flowering.

The leaf-sheath is glabrous, faintly and finely striate, distichously imbricate, compressed, somewhat keeled, outer margin

FIG. I.– SPOROFOLUS COROMANDELIANUS. LINK. (REDUCED.)

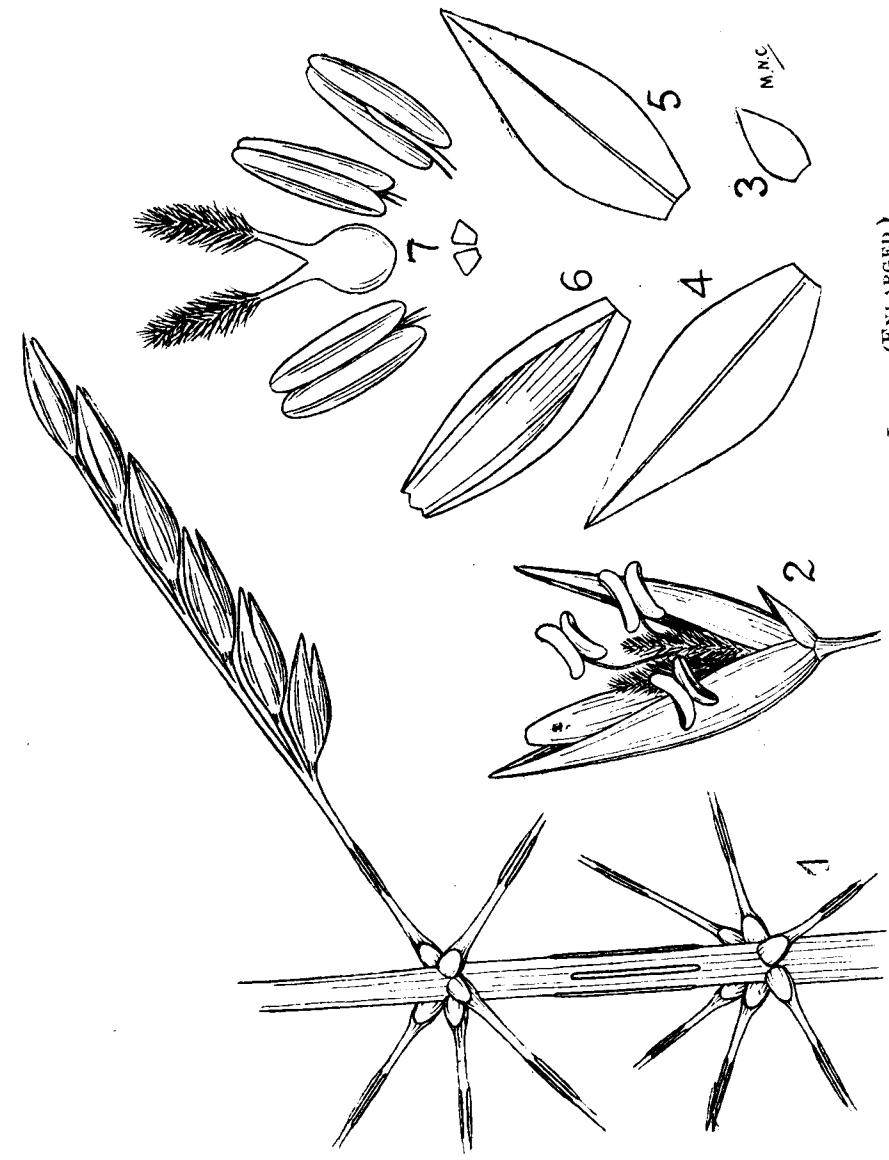


FIG. II.—SPOROBOLUS COROMANDELIANUS, LINK. (ENLARGED.)

ciliate, and bearded at the mouth. The ligule is a thin short membranous ridge with a fringe of dense fine hairs. The leaf-sheath enclosing the base of the peduncle is rather long, glabrous with a tuft of short hairs at the mouth.

The leaf-blade is green without any glaucousness about it, ½ to 6 inches (1·3 to 15 cm.) long, 3/16 to ¼ inch (5 mm. to 8 mm.) broad, lanceolate or linear-lanceolate, flat, acuminate, slightly coriaceous, many nerved with a prominent midrib, scaberulous throughout with a few long, scattered, deciduous, tubercle-based hairs towards the base, base subcordate, margin cartilaginous, scabrid and finely serrulate.

The inflorescence is a pyramidal panicle 1½ to 4 inches (3·8 to 10 cm.) long, erect on a terete glabrous peduncle 1½ to 6 inches (3·8 to 15 cm.), long ; the main rachis is slender, erect, striate, glabrous and has glandular streaks just above the insertion of the branches of the lowest verticil. Branches are capillary, stiff and spreading horizontally, verticillate or subverticillate, the lowest whorl consisting of 5 to 16 or 17 branches and the others from 3 to 9, shining, swollen at the point of insertion and provided with a glandular scar a little above the point of insertion ; branchlets are very close appressed to the rachis of the branch, never drooping or spreading, each bearing 2 to 5 spikelets. Spikelets are small, 1/20 to 1/16 inch (1 to 1·5 mm.), subsessile or pedicelled, always appressed to the rachis, solitary in the upper portions of the branches, and 2 to 5 on the branchlets in the lower portion, pale, green or rarely copper coloured, oblong or lanceolate, acute or acuminate, caducous or glumes 1 and 2 persistent.

There are three glumes. The first glume is very small, hyaline, ovate, obtuse, occasionally truncate or acute, about 1/5 of the third glume or less. The second glume is membranous, ovate or oblong lanceolate, acute or acuminate, thinly scaberulous and 1-nerved. The third glume is as long or a little shorter than the second glume, 1-nerved, and paleate. The palea is as long as the glume, oblong, 2-nerved, splitting into two portions between the nerves as soon as the grain is formed. Stamens are three with reddish purple anthers ; stigmas are white at first, but turning brown while withering. Lodicules are two, and minute. The grain is oblong, pale brown and obtuse at both ends, embryo about ⅓ of the grain.

Reference :—Hooker's Flora of British India, VII—252 ; Trimens's Flora of Ceylon, V—264 : Cooke's Bombay Flora, II—1021 : Roxburgh's Flora Indica, I—316 : Dalz and Gib. Bombay Flora, 296 : Duthie's Fodder Grasses of North India, 48 ; Boiss's Flora Orientalis, V—513 ; Kunth's Enum, pl., I—213 ; Trin. Sp. Gram. I. Pl. 11 (excluding gl. 1).

Distribution :—Throughout the plains of India and Ceylon Also in Afghanistan and South Africa.

This species is quite striking and distinct from the others in its leaves and the panicle. The leaves are broader, generally bright green without being glaucous, mostly basal, tufted and spreading on all sides. The branches of the panicle are stiff and horizontal and the spikelets are always appressed to the rachis and never drooping as in the other two species.

Illustration :—

Fig. I. Full plant.

Fig. II. 1, a portion of the main rachis showing the verticils and the glands ; 2, a spikelet ; 3, 4, the first and second glumes ; 5, 6, the third glume and its palea : 7, the ovary, stamens and the lodicules.

2. SPOROBOLUS COMMUTATUS, KUNTH.

This plant is an annual and usually grows in loose tufts. Stems are slender, always erect or ascending, leafy and branching, 2 to 15 inches (5 to 38 cm.) long.

The leaf-sheath is shorter than the internode, slightly compressed finely striate, glabrous and occasionally with a few, scattered, tubercle-based hairs, margin ciliate ; the uppermost sheath is cylindric somewhat long and embraces the greater portion of the peduncle of the panicle and has a bunch of short hairs at the top.

The inflorescence is diffuse, pyramidal 1 to 3 inches (2·5 to 7·5 cm.) by ¾ to 2 inches (17 mm. to 5 cm.) on a slender glabrous peduncle 1 to 6 inches long (2·5 to 12·5 cm.) ; main rachis is slender and angled, with a glandular streak or without it. Branches are effuse, fine capillary (more so than in S. coromandelianus) obliquely ascending, never stiff and horizontal, verticillate or irregularly subverticillate, the lowest whorl of 5 to 12 and the others 3 to 7 branches ; the rachis of the branches is obscurely scaberulous, slightly swollen at the point of insertion and with a glandular streak at the base near the point of insertion ;

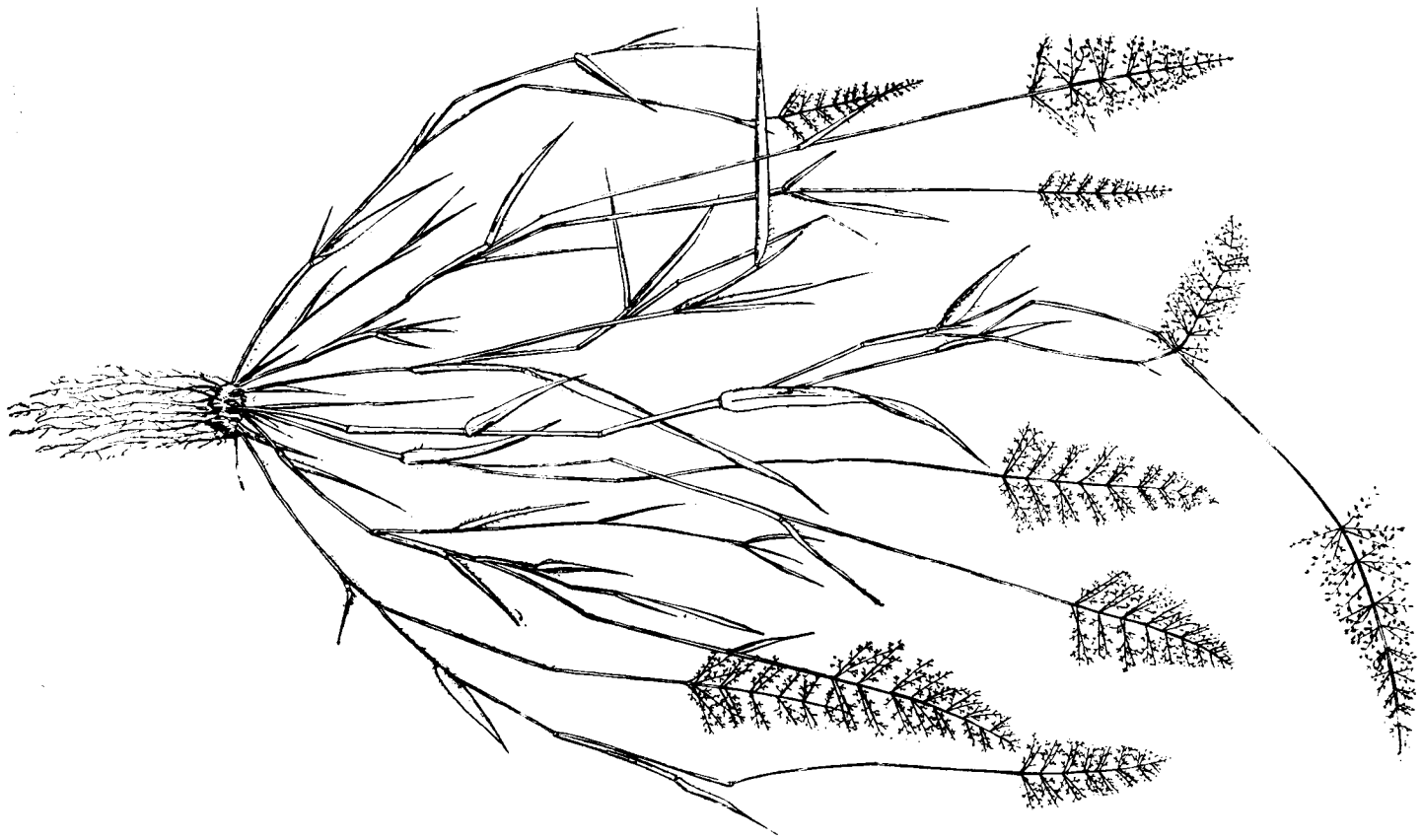


FIG. I.—SPOROBOLUS COMMUTATUS, KUNTH. (REDUCED.)

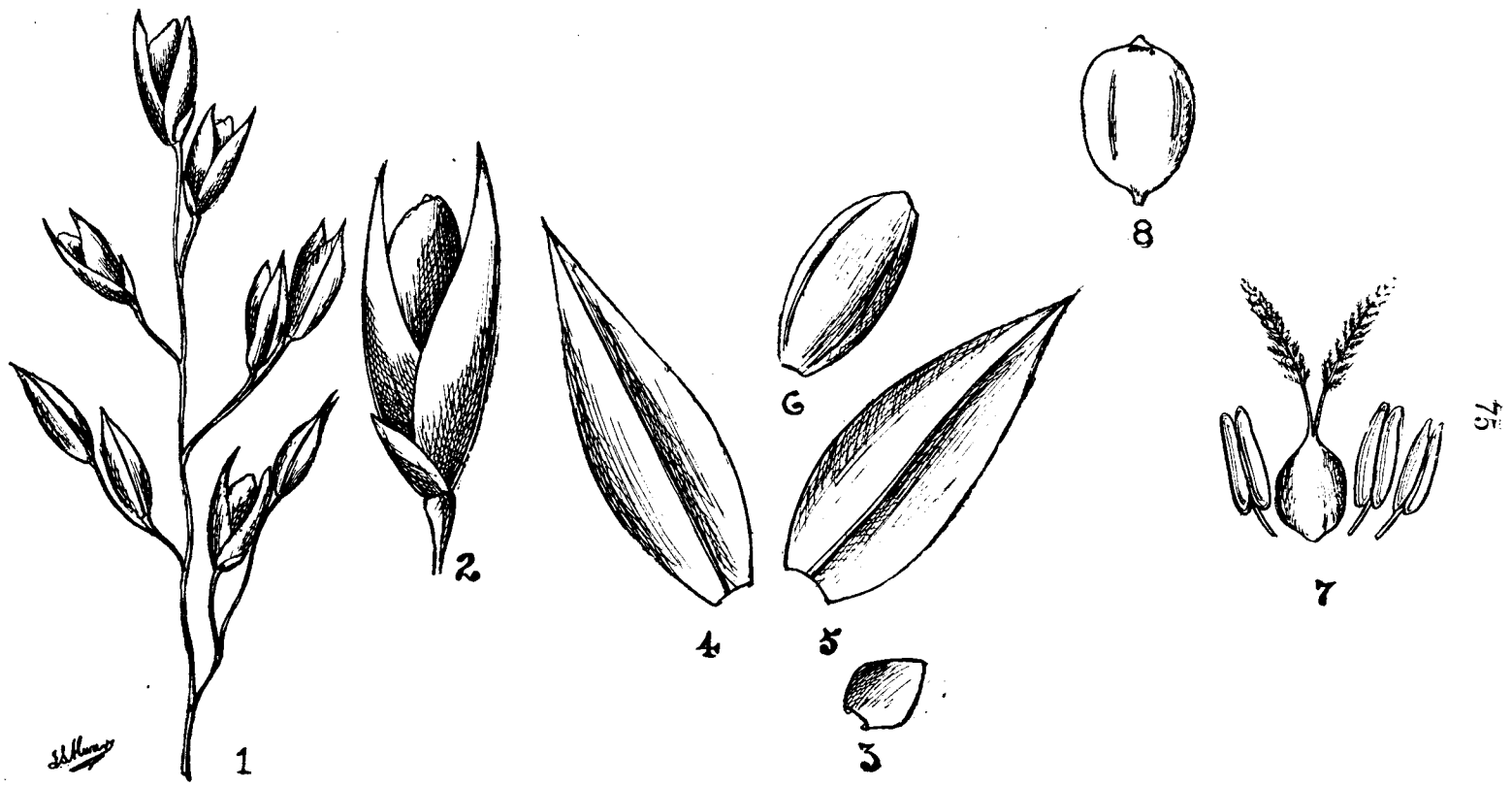


FIG. II.—SPOROBOLUS COMMUTATUS, KUNTH. (ENLARGED.)

branchlets are never appressed to the branch, always drooping and spreading on all sides and bearing 2 to 4 spikelets. Spikelets are about $\frac{1}{16}$ inch long, ovate lanceolate, acute or acuminate, dark or pale green, sometimes purplish, solitary or 2 to 4 on long, slender pedicels, drooping and never appressed.

There are three glumes. The first glume is minute, hyaline, ovate, obtuse or acute, nerveless. The second glume is 5 or 6 times as long as the first, ovate-lanceolate, 1-nerved, acuminate. The third glume is equal to or a little shorter than the second, ovate-lanceolate, acute, 1-nerved, paleate : palea is equal to or less than the third glume, 2-nerved, splitting into two halves between the nerves. Anthers are three and purple in colour. Stigmas are white and feathery. Grain as in S. coromandelianus.

In Flora of British India, this plant is included under Sporobolus coromandelianus. These two plants (S. coromandelianus and S. commutatus) are quite distinct and grow side by side. As the differences are not easily seen in herbarium specimens the two plants are put together under the one species S. coromandelianus. The plants are tufted and branches are decumbent at base, leaves are quite green and somewhat broad in S. coromandelianus, and in S. commutatus, branches are never decumbent, generally erect from the base, leaves green and glaucous, somewhat narrow. The most striking difference, however, is in the panicle. The branches of the panicle are always stiff and horizontal in S. coromandelianus and the spikelets are appressed to the branches and never spreading or drooping, whereas in S. commutatus the branches are never stiff and horizontal, always obliquely ascending and the spikelets are spreading and drooping. Judging from living plants these two are undoubtedly distinct and so we have ventured to separate this plant from S. coromandelianus and treat it as a distinct species retaining Kunth's name Sporobolus commutatus, Kunth Enumeratio Plantarum, I. 214.

Reference :—Hooker's Flora of British India, VII—253 Trinius Sp. Gram. I t. 10 (Vilfa commutata).

Illustration :—

Fig. I Full plant.

Fig. II Spike, spikelets and their parts. 1, portion of a spike ; 2, spikelet ; 3, 4, 5, the first, second and third glumes ; 6, palea of the third glume : 7, anthers and ovary ; 8, grain.

3. SPOROBOLUS SCABRIFOLIUS, BHIDE.

The plant is a very pretty one, especially when in flower. It is a loosely tufted annual, varying in height from 5 to 30 inches (12·5 to 78 cm.). Stems are slender, terete, 6 to 30 inches (14 to 78 cm.) long, bent at the base, then geniculately ascending and finally becoming erect, glabrous, pale green or purplish, and nodes glabrous.

The leaf-sheath is shorter than the internode, slightly compressed, obscurely keeled, glabrous and striate ; margin is thinly ciliate on one side, especially towards the mouth which is bearded. The leaf-sheath embracing the peduncle is longer than the lower sheaths. The ligule is a fringe of close set hairs on an inconspicuous ridge.

The leaf-blade is glaucous green, 1 to 5 inches (2·5 to 12·5 cm.) long, $\frac{1}{8}$ to $\frac{3}{8}$ inch (3 to 10 mm.) broad, linear-lanceolate or lanceolate, acuminate, flat, rounded or subcordate, and amplexicaul at base, scaberulous throughout, with tubercle-based deciduous hairs on both the surfaces, and bearded at the base above the ligule ; the margin is thickened, serrulate, ciliate with bulbous-based deciduous hairs.

The inflorescence is an effuse panicle, $2\frac{1}{2}$ to 7 inches (6 to 17·5 cm.) long and 1 to $4\frac{1}{2}$ inches (2·5 to 12 cm.) broad, pyramidal or elliptic on a slender peduncle 1 to 7 inches (2·5 to 17·5 cm.) long ; rachis is striolate, cylindric, glabrous and partly green and partly purplish. Branches are capillary, $\frac{1}{2}$ to $2\frac{1}{2}$ inches long, those in the middle of the panicle are often the longest, pale green at first, but turning purple later, whorled regularly or irregularly, with often a solitary or twin branches intervening, spreading, horizontal, reflexed, rarely one or two erect, dividing into still finer branchlets below, ending in a few solitary spikelets above, swollen at the base near the point of insertion and naked to a short length, scabrid. The lowest whorl consists of 5 to 10 branches and in the others they vary from 3 to 8 ; the branchlets are spreading and drooping bearing from 2 to 7 spikelets. There are glandular streaks at the base of the branches above the point of insertion in the naked portion.

Spikelets are $\frac{1}{20}$ to $\frac{1}{16}$ inch ($\frac{3}{4}$ to 1·5 mm.) long, lanceolate, acuminate, on finely capillary pedicels long or short, pale at first and becoming purplish when old. There are three glumes, the

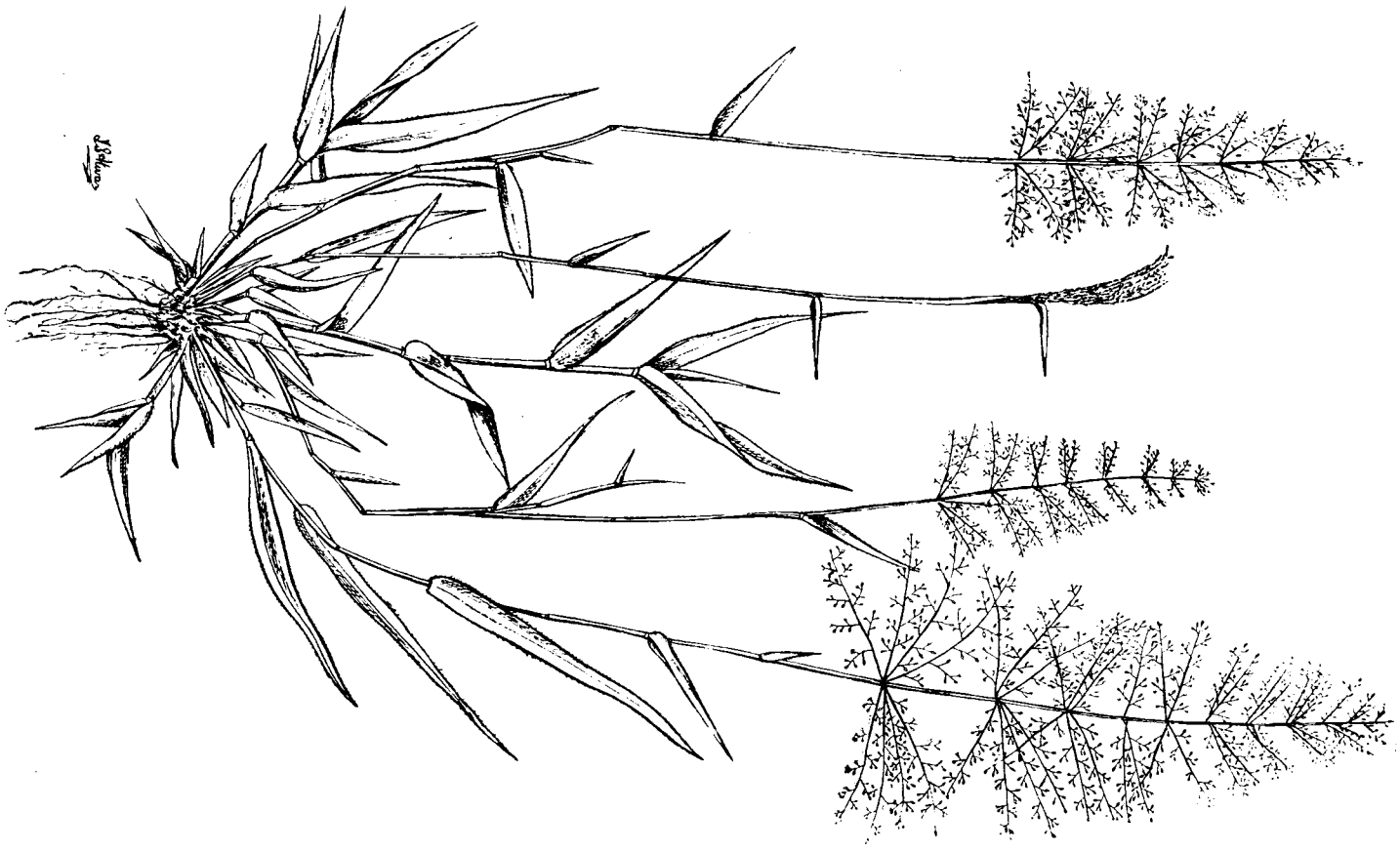


FIG. I.—SPOROBOLUS SCABRIFOLIUS. BHIDE. (REDUCED.)

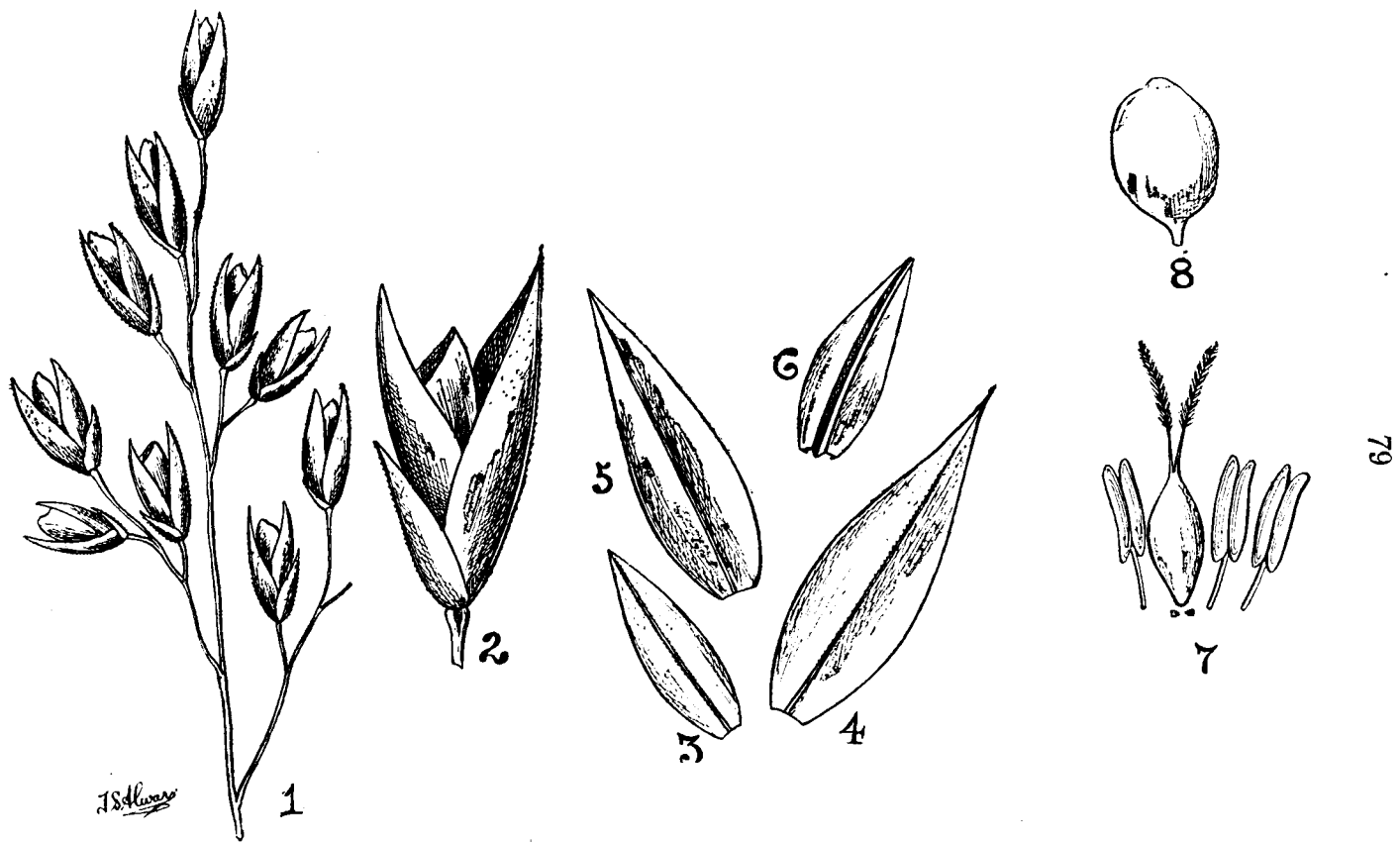


FIG. II.—SPOROBOLUS SCABRIFOLIUS. BHIDE. (ENLARGED.)

first two being empty. All the glumes are 1-nerved and membranous. The first glume is membranous about $\frac{2}{3}$ of the second, sometimes less, ovate-lanceolate, acuminate, slightly scaberulous on the keel. The second glume is a little longer than the third, ovate-lanceolate, acuminate, scaberulous on the keel. The third glume is oblong-ovate, acute, glabrous, flower-bearing, paleate ; the palea is shorter than the glume, 2-nerved, splitting, into two between the nerve. Anthers are three, small, pale yellow. Stigmas are pale. Lodicules are two and minute. Grain is rounded, slightly compressed, oblique at the base, nearly as long as broad.

Reference :—Journal and Proceedings of the Asiatic Society of Bengal, Vol. VIII, No. 8, pages 312 and 313, and Plate No. 24.

Distribution :—This species is for the present recorded only from Bombay and Coimbatore. It is a new species named by Mr. Bhide in 1912. This was collected at Ranibennur on the 30th November 1910 by Mr. Bhide of Poona and at Coimbatore in September 1912 and in June to September 1916 by us.

Illustration :—

Fig. I. Full plant.

Fig. II. Spike, spikelet and its parts. 1, portion of a spike ; 2, spikelet ; 3, 4, 5, the first, second and third glumes ; 6, palea of the third glume ; 7, anthers lodicules and ovary ; 8, grain.

4. CHLORIS Sq. Nov.

The plant appears to be a perennial. Stems are somewhat stout, tufted, erect or ascending geniculately from a creeping and rooting base, varying in length from 1 to 3 feet.

Leaves are linear narrow, slightly broadened and rounded at the base, keeled, finely acuminate, the upper surface with scattered long hairs and scaberulous, varying in length from 1 to 9 inches and in width $\frac{1}{12}$ to $\frac{1}{4}$ inch ; margins are scabrid ; leaf-sheaths are compressed, flat, distichous and spread like a fan, glabrous but bearded towards the mouth. The ligule is a narrow membranous ridge.

The spikes are 3 to 7 rarely even 9, digitate on a long slender glabrous peduncle, free at the base, all at the same level, or sometimes one being lower than the rest, varying from $1\frac{1}{2}$ to 4 inches in length. Spikelets are $\frac{1}{8}$ of an inch long (excluding the awns), biseriate, pedicelled, unilateral, 1 to 3 flowered, purplish and

disarticulating above the two lowest glumes. There are 3 to 5 awns in a spikelet. There are 5 to 7 glumes in a spikelet. The first two glumes are empty, hyaline and awnless. When five glumes are present the third glume has a hermaphrodite flower, paleate and awned, and the fourth and the fifth glumes are barren and

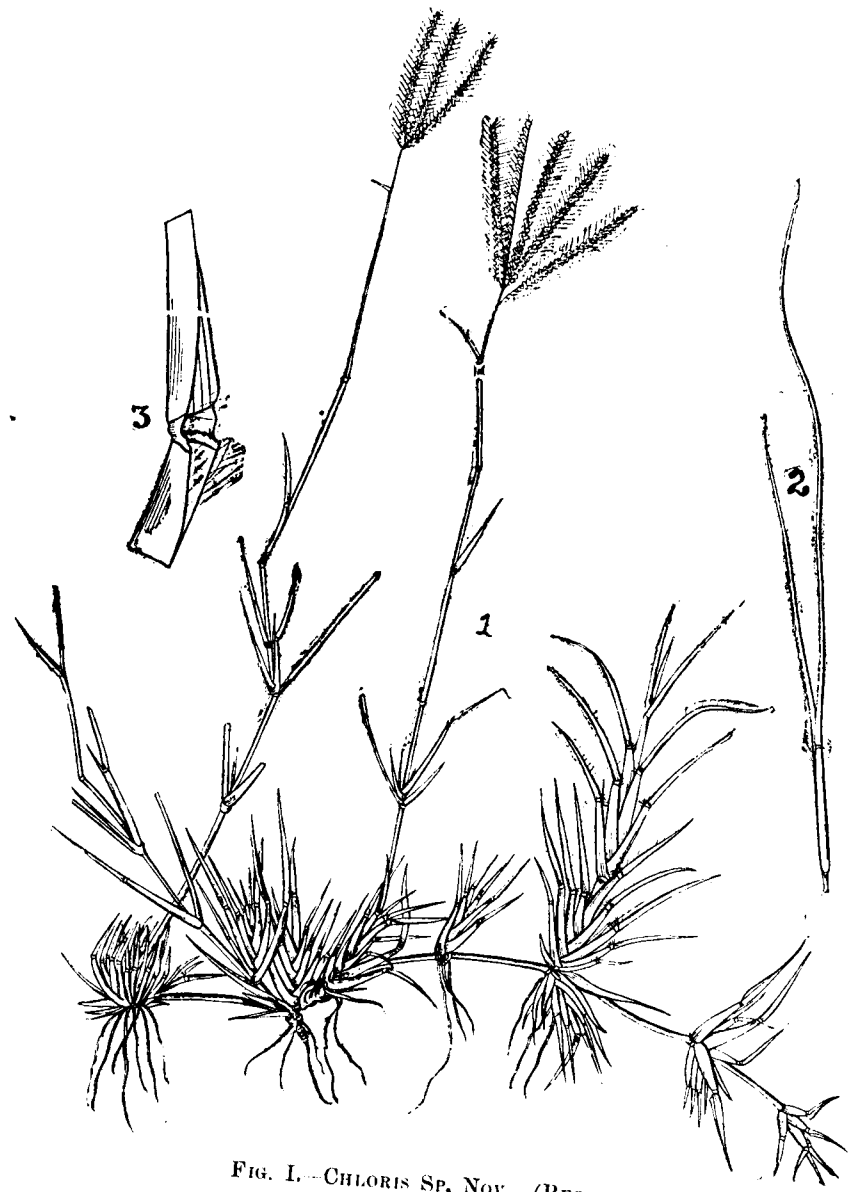


Fig. I.—Chloris Sp. Nov. (Reduced).

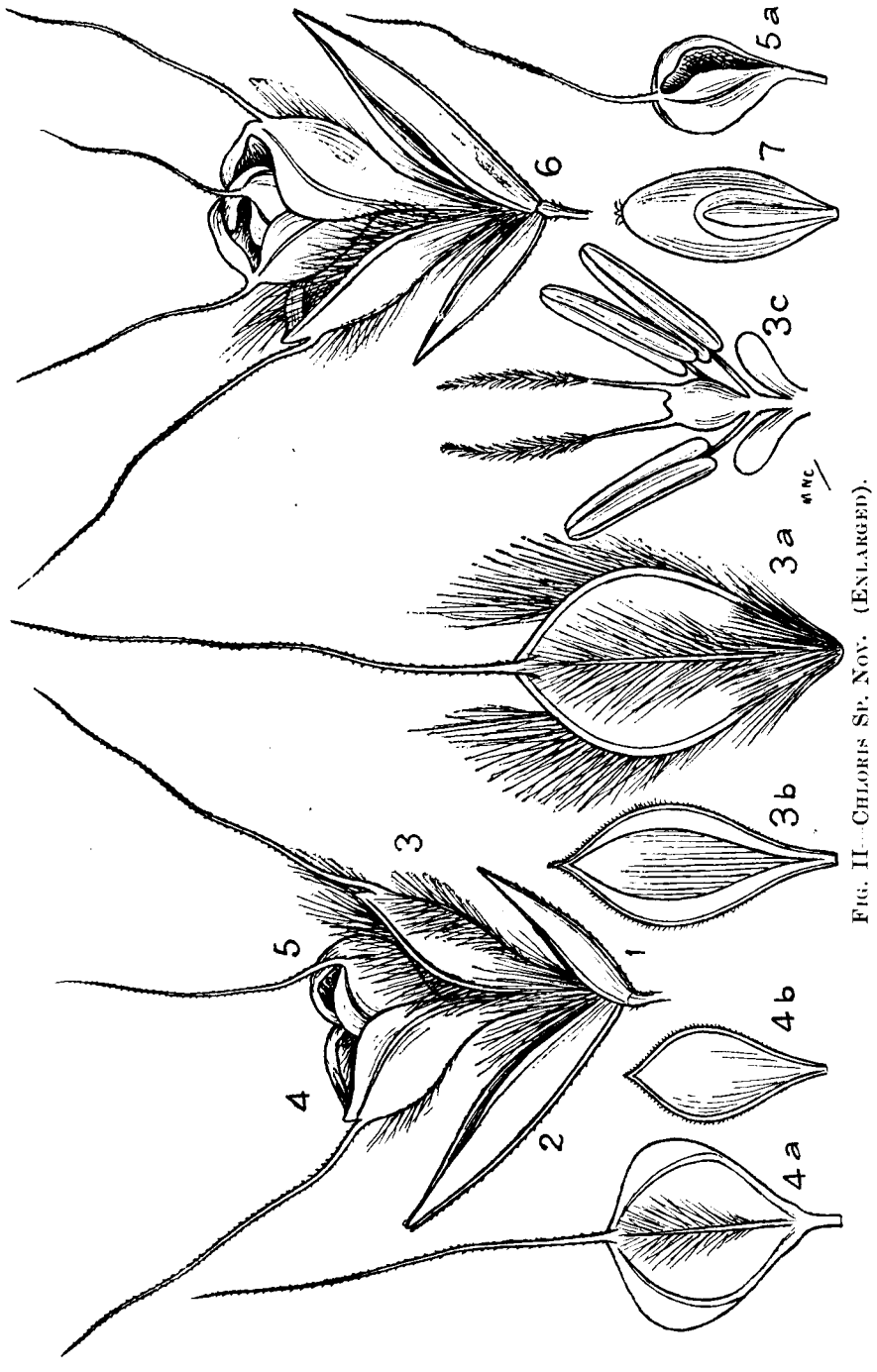


Fig. II—Chloris Sp. Nov. (Enlarged).

awned. The fourth and the fifth both bear hermaphrodite flowers and are paleate, if there are 7 glumes, and the former alone is flower-bearing, when there are only six glumes ; the fifth and the sixth glumes are barren, when the fourth is flower-bearing, and the sixth and seventh are so, when the fifth contains a flower. All the glumes except the first two are awned.

The first glume is hyaline, purplish about 1/10 inch long, ovate-lanceolate, acute or subacuminate, 1-nerved, keeled and keel scabrous. The second glume is also hyaline, about 1½ times as long as the first, oblong elliptic, minutely two-lobed at the apex, with a minute mucro between, 1-nerved with a scabrid keel. The third glume is as long as the second, exclusive of the awn, pale or purple tinged, chartaceous, ovate or obovate, apex shortly bifid with a purple dorsal awn, 3-nerved, paleate, flower-bearing ; the two marginal nerves are densely bearded with long hairs, white or purple, from the base to the top and the central nerve is also similarly bearded by long hairs on both sides all along from the base, the rest of the glume being glabrous ; the palea is as long as the glume, but narrower, coriaceous, obovate, cuneate, obtuse, ending in two short minute teeth, margins folded, two keeled and keels shortly ciliate. Stamens are three with yellow or purple tinged anthers. Lodicules are small and fleshy. The glumes 4 to 7 are on the produced rachilla, chartaceous, obcordate-ovate, cuneate, becoming gradually smaller as we go upwards ; all are 3 to 5 nerved. The glumes 4 and 5 have short dense hairs along the central nerve and glabrous elsewhere.

The grain is oblong, shining, reddish-brown, somewhat trigonous narrowed at both ends.

This grass resembling externally Chloris barbata, but with larger spikelets, was found growing in fields Nos. 13, 37 and 62 of the Coimbatore Central Farm. In the herbarium this was named Chloris montana with a query. As this does not agree with the description of C. montana, it was critically examined and found not agreeing with any of the species described in Hooker's Flora of British India and Cooke's Bombay Flora. It appears to be a new species and specimens have been sent to the Kew herbarium for examination and the results are awaited.

Distribution.—At present known to occur only in Coimbatore and Bellary districts.

Illustration :—

Fig. I.—Full plant (i) flowering branch, (ii) leaves, (iii) ligule.

Fig. II.—Spikelets and their parts.—1-5, the first five glumes in their order ; 3a, 3b, the third glume and its palea ; 3c, stamens, ovary and lodicules ; 4a, 4b, fourth glume and its palea ; 5a, fifth glume ; 6, a spikelet with six glumes and four awns ; 7, a grain.

NOTE ON A SPECIES OF SENECIO.

By K. RANGA ACHARIYAR and C. TADULINGAM.

SENECIO Sp.

An extensive climber found growing on small trees in shola forests. Stem is shrubby below and is freely branching above. Branches are slightly grooved and sparsely cottony tomentose when young, but becoming glabrous later.

Leaves are exstipulate, alternate, long petioled ; petiole is grooved, cottony, prehensile at the base, 1 to 2 inches long ; lamina is broadly ovate, membranous, rounded or shallowly cordate at base, abruptly or obliquely subacuminate, margin distantly callose dentate, 5 to 7 nerved from the base, glabrous or sparsely covered with cottony hairs especially on the nerves above, densely white tomentose and cottony below, varying from 2 to 4 inches in length and 1 to 3 inches in breadth.

Heads are in terminal and axillary corymbose panicles with long peduncles, varying in length from $\frac{1}{4}$ to $\frac{3}{8}$ inch and $\frac{1}{8}$ inch broad, bracteolate with 3 to 5 narrow linear bracteoles ; pedicels cottony tomentose $\frac{3}{16}$ to $\frac{5}{16}$ inch long and slender. Involucral bracts are 5, chartaceous, brownish, one-seriate, quincuncial, the two outer narrower than the other three, linear oblong, acute, with a thick mesial band which is sparsely cottony and glabrous scarious borders ; margin of involucral bracts is shortly ciliate above the middle : apex is shortly penicillate. Ligulate flowers are absent. There are only five tubular florets in a head. The receptacle is small, flat and pitted. The corolla tube is $\frac{1}{4}$ inch long, wider above the middle, lobes 5, acute, and tip recurved. Anthers have their connectives produced at the apex into a flat pale appendage, and are tailed at the base. Achenes (immature) are oblong, glabrous $\frac{1}{16}$ to $\frac{3}{32}$ inch long, somewhat

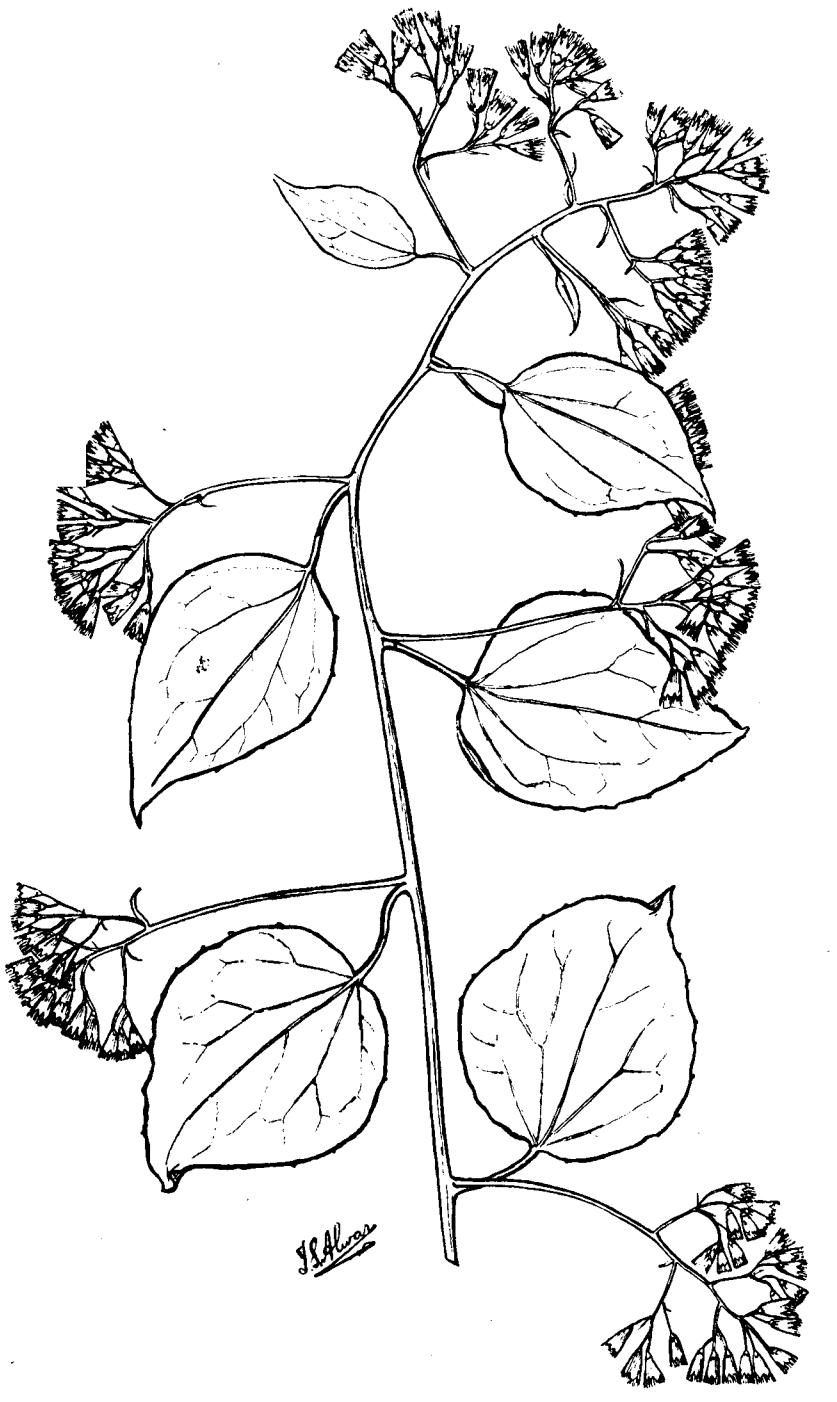


Fig. I.—Senecio Sp. (Reduced).

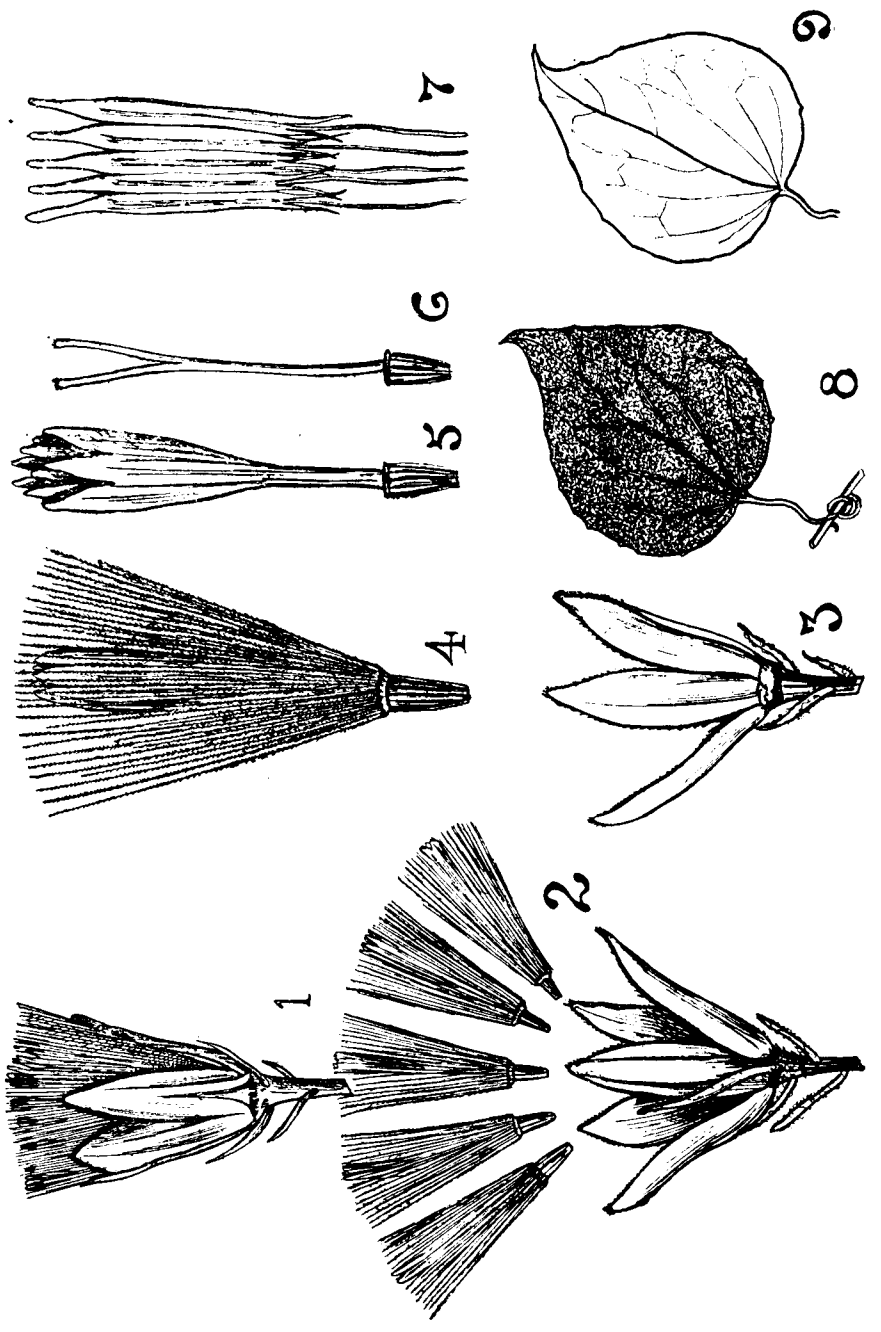


FIG. II.—SENECIO SP. (1 TO 7 ENLARGED AND 8 AND 9 REDUCED).

compressed or angular, 8 to 10 ribbed. Pappus hairs are white, copious, about $\frac{1}{4}$ inch long and minutely barbellate.

This plant is very closely allied to Senecio corymbosus, Wall, and differs from it in its branches, tomentum on the leaves and branches, and in the number of florets and involucral bracts in the heads. The young branches and the inflorescence are less araneose, and the leaves are white cottony tomentose beneath and not cinnamomeous, nerves less hairy and more prominent, corymbs more diffuse than in S. corymbosus. The involucral bracts and the florets in a head are always 5, but in Senecio corymbosus they are more and vary.

Distribution.—In shola forests between Naterikal and Sengalteri, Tinnevelly Hills about 3,500 feet. Collected by the systematic assistant Mr. K. Cherian Jacob in February 1917.

Illustration :—

Fig. I.—A bit of a branch with inflorescence and leaves.

Fig. II.— Details of the flower head and leaves.—1, a flower head ; 2, a flower head with florets and involucral bracts dissected out ; 3, receptacle ; 4, a single floret with pappus hairs ; 5, corolla and ovary ; 6, pistil ; 7, anthers ; 8, leaf with coiled petiole and lower surface ; 9, leaf upper surface.

PRELIMINARY NOTE ON THE GRASSES GROWING IN THE COCONUT STATIONS, KASARAGOD TALUK, SOUTH KANARA DISTRICT.

BY C. TADULINGAM,
Assistant to Government Lecturing Botanist.

During the second week of November 1917, I had an opportunity of studying the grass flora of the newly started three coconut stations in the neighbourhood of Pilicode (Charvatoor) and Nileshwar, bearing Nos. I, II and III. No. I is at Pilicode with a laterite soil and Nos. II and III near Nileshwar with a rich red loam and sandy soil respectively. The first two are enclosed by mud-walls while the third has an ideal wire fencing all

round, each of them having a small neatly built combined office and rest-house, and suitable wells. The good growth of grasses in these stations, in the month of November, will tempt any visitor to say "Ah! How well this would make a dairy farm!" The advantages of protecting a grazing area against cattle trespass for a certain period of the year can very well be demonstrated, comparing at the same time the neighbouring unprotected pastures, where grasses have been persistently eaten away and are almost extinct even during the best season of the year, due to over-stocking and over-trampling. The areas examined though limited, prove to me of some value in also systematic point of view, besides being economically useful in yielding good fodder suited for stacking. As a result of the survey, three species appear to be rather interesting. One of them, Eragrostis tremula, an elegant-looking annual, with its fine capillary tremulous flowering branches, a typical member of the sand flora in this part of the country, has been for the first time collected for the Madras Herbarium, from the Southern province. The others are two Dimerias, the two valuable thatching grasses of the west, locally known as Nei pullu and Sevveri, thus far remaining unmatched in the Madras Herbarium. A further investigation may show them to be even undescribed.

Before beginning to draw the list of grasses growing there, I would like to distinguish the following types of prevalence :—Dominant (D.) where the species are powerful enough to form the greater portion of the vegetation spreading over fairly large tracts in the areas examined ; Sub-

dominant (S.D.) in the case of such plants as, though sufficiently powerful, occur in patches here and there and Sporadic (Sp.) where the species occur in single plants or in groups of very few, commonly or rarely. In every type of vegetation there must generally be a dominant form and grasses show it more often, due to their hardiness. In the list I have also noted the ecological associates of some species wherever I am certain.

No. I Station.

Ischaemum ciliare, Retz., a slender or stout tufted, erect, sometimes creeping perennial, up to three feet high with generally two hairy digitate flowering spikes, one to two inches long, on slender stalks. Very abundant in the station locally known as Kadachi pul and is said to be the best grass of fodder value in these parts and appears to be well suited for stacking (D.).

Andropogon contortus, Linn., the well known 'Spear grass common all over India, a tufted perennial with abundant foliage and numerous branches ending in solitary, white-haired spikes with dark stiff twisted bristles, which injure the cattle while grazing. It is locally known as Yeyyam pul (porcupine grass) and is said to be liked by cattle both before and after it has flowered and the bristles fall off on maturity, but chiefly when it is young. It is common here but of poor growth in the midst of I. ciliare in the laterite soil, though some tufts planted on the mud walls all round grow very vigorously, covering the walls almost entirely. Those on the walls were cut during my stay there and will make a good hay. It is also said to keep well in stack for many years (D.).

Dimeria sps. These are two slender, erect, sometimes tufted shining grasses, with small tubercle-based hairy leaves, occurring in patches especially in the south-western corner of the farm near the entrance, where the soil appears to change into somewhat red loam. Some of them growing under Ischaemum are very poor, tiny and obscure. One of them has a solitary or two flowering spikes with flattened rachis and close-set spikelets (flowers), and the other with two or more slender capillary spikes with rather

distantly arranged spikelets, pale purple in colour. (S.D.) generally found in association with each other.

Apocopis vaginatus, Hack. (Cooke's Bombay Flora) common throughout though growing under Ischaemum and appearing weak and slender. It is a low slender annual, sometimes much branched and procumbent, ascending up to nine inches with small leaves and slender stalks bearing closely appressed two-nate spikes, appearing solitary, up to an inch long, looking like a miniature "Spear grass" with yellowish brown hairs. Not known to be good fodder (D.).

Arundinella Metzii, Hochst., not common except on the walls. A rough leaved tufted annual, growing up to three feet with branched inflorescences 1 to 8 inches long on slender peduncles. While growing under the shade of other plants it looks so different as to be mistaken for another species. It is known as Vellari pul so named after its being spread under cucumber (Vellari) fruits when ripe and is said to be no good fodder (Sp.).

Pseudanthistiria heteroclita, Hk. F., known as Siru Kidari, not common throughout in the station, but found in a small patch near the office room. It is used for thatching and is said to be liked by cattle when young. In all external appearance, it may be easily mistaken for a small form of Themeda imberbis, T. Cooke, known as Kidari pul and largely used for thatching (S.D.). It is an annual about two feet high with a leafy panicle, consisting of several, slightly broadened fascicles of spikes enclosed in spathes, with copiously hirsute shining bristles.

Pollinia argentea, Trin. An erect tufted perennial growing up to four feet with long narrow leaves and few to many long, lax flowered white-haired spikes. Not said to be of any value (Sp.).

No. II Station.

The soil here is a rich red loam and the vegetation is good.

Andropogon contortus Linn., is very abundant here in its full growth, sometimes up to five feet, in large tufts with plenty of foliage. It has an excellent growth in red loam, while it is poor in laterite (D.).

Apocopis vaginatus, Hack. (D.) common in the shade of A. contortus, becoming prominent when A. contortus is cut and removed.

Ischæmum ciliare, Retz., not so common as in No. I Station (S.D.).

Dimeria with flattened spikes, common opposite to the Manager's quarters becoming prominent after A. contortus is cut and stacked (S.D.).

Dimeria with capillary spikes, found common in the northern outskirt plot after A. contortus has been removed, (S.D.) noted in association with each other.

Perotis latifolia, Ait. (S.D.) a plant from $\frac{1}{2}$ to $1\frac{1}{2}$ feet high with a soft, spikelike raceme resembling a fox's tail.

Pollinia argentea, Trin. (Sp.).

Themeda imberbis, T. Cooke (= Anthistiria imberbis, Retz.) (Sp.) and Themeda tremula, Hack. (Sp.).

Arundinella Metzii, Hochst. (Sp.).

Eragrostis stenophylla, Hochst., a small plant rather common in the southern side of the plot (S.D.).

Sporobolus piliferus, Kunth., Aristida setacea, Retz. (only one plant found) Eragrostis amabilis, W. and A., a small plant with open panicles, Panicum distachyum, Linn., and Digitaria longiflora, Pers. occurring here and there are of very little importance in the station.

No. III Station.

This has a sandy soil.

Eragrostis tremula, Hochst., monopolizes the adjoining sandy wastes and is the most common grass in this station. It is an erect or ascending tufted annual, sometimes purplish, growing to about three feet, bearing very large, loose, nodding inflorescences, with fine, capillary branches supporting fine, tremulous branchlets, ending in slender, linear spikelets, up to an inch long, profusely seeding. A tuft of white long slender hairs will also be prominent at each joint in the panicle. The very slender pedicels give rise to the tremulous motion which is characteristic in this species (D.).

Eragrostis amabilis, W. and A. A close-panicled, purple spiked form, commonly found in association with E. tremula though not so very abundant. This is more common on the western side of the station (S.D.).

Apocopis vaginatus, Hack., found everywhere (D.) with a better growth than in the other stations.

Andropogon contortus, Linn., commonly occurring, second in growth to those in II station and much better than in I station (S.D.).

Perotis, latifolia, Ait. (S.D.) not uncommon.
Arundinella Metzii, Hochst. (Sp.).
Ischaemum ciliare, Retz. (Sp.).
Digitaria longiflora, Eragrostis amabilis with open panicles, Panicum trypheron, Panicum indicum and Eleusine aegyptiaca found here and there, are of insignificant importance.

During my stay there, grasses in stations I and II were being cut for stacking. Andropogon contortus and Ischaemum ciliare will probably make a good hay. I have sent some of these grasses to the Government Agricultural Chemist for analysis.

I might in conclusion point out, that Ischaemum ciliare, A. contortus and E. tremula are best suited to the laterite, red loam and sandy soils in I, II and III stations respectively and are the chief dominant species.

A HOT WATER PROCESS FOR THE EXTRACTION OF INDIGO AS CARRIED OUT IN THE GŌDĀVARI DISTRICT OF THE MADRAS PRESIDENCY.

By Dr. F. MARSDEN,
Special Indigo Research Officer.

The general method of indigo extraction prevalent in India at the present day is that of steeping the plant in water, whereby a vigorous fermentation is induced and when this fermentation commences to subside the steeping water is let off and violently agitated with air until separation of the indigo is complete.

The plant constituent from which the indigo is produced is soluble in water and the rate of extraction increases with rise of temperature; thus at the ordinary temperature the complete diffusion takes some hours, whereas at the boiling

temperature it is complete in a few minutes. In the latter case the constituent (Indican) is extracted and may be separated in an unchanged condition, but in the former during the lengthy period required for extraction the fermentative changes which take place affect the Indican in such a way that oxidation results in the formation of Indigotin—the blue dyestuff. The Indican solution obtained by extraction with boiling water does not yield Indigotin by simple oxidation, but requires first to be treated with an acid; this treatment results in the decomposition of the Indican into its components, one of which is the basis of Indigotin and is transformed into this by oxidation.

It has long been known that for the production of indigo from the plant fermentation was not necessary, and in an Essay on the Cultivation and Manufacture of Indigo by Dr. Shortt published in 1860 and awarded a prize by the Madras Government, a process for extraction by boiling is given in some detail. It is not clear, however, whether the description is that of a process actually in use or indicates lines upon which such a process should be worked.

After discussing the varieties of plants from which indigo may be extracted Dr. Shortt describes the method of cultivation of the plant common in Madras (Indigofera Tinctoria), Avari (Tamil), Neel (Hindustani), Neeli (Telugu) and goes on to mention the ordinary steeping process of extraction as we know it today. He calls this the 'Country' process but in the chapter on 'Manufacture' he devotes himself entirely to what he terms the 'European' method of manufacture

and although I have not found traces of or heard of any installation working in the manner described the instructions are so definite that it appears to me they must be based upon practical observation. He writes :—

"On the arrival of the plants at the factory no time should be lost in stacking them into large boilers filled with water for the purpose of being boiled. The boiling should be continued until the leaf yields its colouring matter to the water : in the meantime, each boiler should have an attendant with a large prong with which the plants should be constantly kept under water, and who should be careful to see that the heat of the fire is reduced the moment ebullition occurs, for if the boiling is carried on longer than necessary, the colouring matter will be destroyed. This requires a great amount of practical knowledge, and no rule can be laid down which alone will be sufficient for the guidance of the inexperienced. By opening the cocks occasionally, and observing the colour of the decoction (which should be somewhat oily in appearance, and have a reddish colour with a peculiar musty odour), we may judge that the period for discontinuing the boiling has arrived.

"At this stage the liquid should be drawn off into the beating vat and there beaten with oars or paddles."

In the attempts to improve the manufacture of indigo in Bengal attention was also devoted to a boiling process and a patent was actually granted for one which closely followed the method described by Dr. Shortt. Trials were made on a large scale about 1900, but Rawson in his report to the

Behar Indigo Planters' Association considered that although the process was capable of yielding an indigo of high quality the cost of fuel was prohibitive and other considerations caused him to doubt whether the process could ordinarily be made remunerative. He thought, however, that the uniformity in the high grade product obtained made it a process which deserved the attention of managers of factories in which the quality of the indigo produced was always poor. Investigation and research have now taken another line which has for its object the improvement of the steeping process by characterisation and regulation of the bacterial fermentation and if this results in the improved outturn expected there will be little chance of experiments upon the boiling process being renewed.

That a boiling process has been employed for some time however is seen from the Vizagapatam Manual of 1869 in which it is stated that the country method of indigo extraction was by slowly heating the leaves with water in earthernware chatties over a fire and when the boiling reached a certain point pouring the liquor into another, larger pot and churning. The 'Pot' manufacture which I found at present in vogue in the Vizagapatam district is nothing but a steeping process carried out inefficiently on a very small scale, but in certain villages in the Gōdāvari delta ryots still manufacture indigo by the process indicated in the Vizagapatam Manual. Watt in the article on Indigo in the Agricultural Ledger (page 62) indicates that this was in reality the general country method of manufacture. He states "Throughout India, wherever European planters' influence has not

and although I have not found traces of or heard of any installation working in the manner described the instructions are so definite that it appears to me they must be based upon practical observation. He writes :—

"On the arrival of the plants at the factory no time should be lost in stacking them into large boilers filled with water for the purpose of being boiled. The boiling should be continued until the leaf yields its colouring matter to the water ; in the meantime, each boiler should have an attendant with a large prong with which the plants should be constantly kept under water, and who should be careful to see that the heat of the fire is reduced the moment ebullition occurs, for if the boiling is carried on longer than necessary, the colouring matter will be destroyed. This requires a great amount of practical knowledge, and no rule can be laid down which alone will be sufficient for the guidance of the inexperienced. By opening the cocks occasionally, and observing the colour of the decoction (which should be somewhat oily in appearance, and have a reddish colour with a peculiar musty odour), we may judge that the period for discontinuing the boiling has arrived.

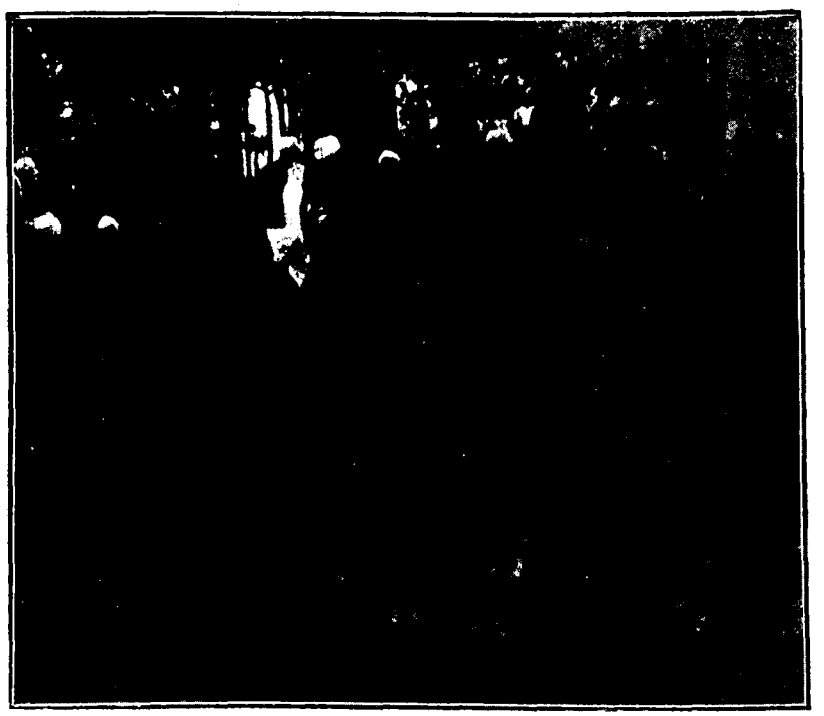
"At this stage the liquid should be drawn off into the beating vat and there beaten with oars or paddles."

In the attempts to improve the manufacture of indigo in Bengal attention was also devoted to a boiling process and a patent was actually granted for one which closely followed the method described by Dr. Shortt. Trials were made on a large scale about 1900, but Rawson in his report to the

Behar Indigo Planters' Association considered that although the process was capable of yielding an indigo of high quality the cost of fuel was prohibitive and other considerations caused him to doubt whether the process could ordinarily be made remunerative. He thought, however, that the uniformity in the high grade product obtained made it a process which deserved the attention of managers of factories in which the quality of the indigo produced was always poor. Investigation and research have now taken another line which has for its object the improvement of the steeping process by characterisation and regulation of the bacterial fermentation and if this results in the improved outturn expected there will be little chance of experiments upon the boiling process being renewed.

That a boiling process has been employed for some time however is seen from the Vizagapatam Manual of 1869 in which it is stated that the country method of indigo extraction was by slowly heating the leaves with water in earthernware chatties over a fire and when the boiling reached a certain point pouring the liquor into another, larger pot and churning. The 'Pot' manufacture which I found at present in vogue in the Vizagapatam district is nothing but a steeping process carried out inefficiently on a very small scale, but in certain villages in the Gōdāvari delta ryots still manufacture indigo by the process indicated in the Vizagapatam Manual. Watt in the article on Indigo in the Agricultural Ledger (page 62) indicates that this was in reality the general country method of manufacture. He states "Throughout India, wherever European planters' influence has not

extended the natives extract their blue dyes by a very similar process to that formerly pursued by the woad manufacturers" (i.e., by the use of warm water and lime) and goes on to mention as an example the practice as followed in Gōdāvari.



General View of Boiling Place.

As seen by me at Rāmēswaram village in the Cocanada taluk of the Gōdāvari district this process was carried out as follows :—

A fire place of mud some 15 feet long by 3 feet broad by 18 inches high is built in the open, and holes are left in the top in which a double row of earthernware pots, 12 in number, are placed. The pots are of 3–4 gallons capacity and the indigo plant being stripped of large stems the leaves and small twigs are pressed into the pot and covered

with water. The larger stems, palmyra leaves, and brushwood serve as fuel, the fire beneath the pots being continuously replenished and the smoke escaping by a hole at one end of the range.

Beating the Liquor.

The liquid in the pots is not heated to ebullition but the worker in charge of the boiling stands by with a small scoop with which from time to time he lifts some of the liquor and notes its colour and, judging from his experience that the extraction is right (the liquor being of a bright amber colour and free from any dull brownish tinge), the pot is removed and emptied into a large earthenware jar of about 80 gallons capacity whilst a freshly filled pot takes its place on the boiling range. One potful of cold water is used to rinse

the leaf in each two pots after boiling, the washings being added to the liquor in the large collecting jar. The boiled leaf is removed, the pots refilled at once with leaf and water, and placed ready by the boiling range to fill the range as required. A full range is thus always being heated and the process is practically continuous.

Immediately one of the collecting jars is full the contents are aerated whilst still hot by vigorous plunging with a stout rod, split at the bottom and the ends fastened to a ring of twisted fibre about 6 inches in diameter. At first a vigorous frothing is caused but this rapidly subsides and the beating is complete in about $\frac{1}{4}$ of an hour. A small quantity of an infusion of the bark of the Jambolana tree (Eugenia Jambolana) is then added, a few more strokes of the plunger given, and the contents of the jar left to settle.

Some 6 inches from the bottom of the jar is a hole in the side closed by a plug ; after settling, this plug is removed and the clear liquor, free from indigo, is run off. The jar is slowly tilted to bring the level of the draining hole lower and lower until the deposited indigo particles begin to come away with the liquor. The residual contents of the jar are then strained through a very rough woven cloth to remove leaves and small twigs and the thin indigo sludge is collected, drained on a fine cloth to remove excess of water and sold as a thick paste to merchants, or dried in the form of small balls and sold to local users.

About nine boilings in each pot are obtained per day and the total daily yield is about $\frac{3}{4}$ lb. of indigo ; there were some eight men and boys working together and I calculated that they were earning

less than 4 annas per day. The indigo I obtained direct from the workers was fairly bright in colour and analysed 43·5 per cent indigotin in the dried state. I had had forwarded to me previously however two samples of what purported to be indigo of this manufacture, but obtained from merchants to whom it had been sold in the paste form ; these samples contained only 7 and 8 per cent indigotin respectively and had been heavily adulterated with red clay and charcoal.

From the large scale experiments conducted by Rawson in Behar, there is no doubt that, although the total weight of matter extracted from the plant is smaller in the hot water process than by the usual steeping method the quality of the indigo is uniformly higher. In two trials, indigo testing 75 per cent was obtained with hot water whilst the comparative steeping trials on the same days yielded indigo of 65 and 60 per cent respectively, and in trials in small vats the difference was much greater in favour of the hot water process.

The difficulty in the steeping process lies in the lack of control which can be exercised over the bacterial fermentation ; in the hot water process the period of action is so short that the bacteria are not able to multiply to any material extent under the conditions under which the process is carried out, and the resolution of the indican extracted from the leaf must be due entirely to the enzymes present in the plant. Rawson states "When indigo plant is immersed in water at a temperature of 150°—160° F. the colouring principle is quickly extracted and transformed through the agency of enzymes (unorganized ferments) into a form of indoxyl which is converted into indigotin by the action of air. Experiments made on a

small scale have shown that the extraction and transformation take place in the course of 20 minutes or half an hour."

A NOTE ON GRADING COTTON.

By R. C. WOOD,

Principal, Agricultural College and Research Institute, Coimbatore.

The increase of cotton spinning in India has drawn increased attention to the grading of lint, with a view to meet the demands of spinners who are more likely to pay for improved quality than exporters.

It has usually been the practice here to effect a partial separation in the field, and our cotton pickers have generally kept dirty and stained lint separate, and brought it in at the end of the day in a separate bundle. Owing to a mistake last year, this lint was subsequently again mixed, and it was necessary therefore to pick the stuff over, in the store, if our cotton was to keep the reputation it had hitherto enjoyed. This grading after picking, was found easier than was expected, and an experiment was conducted this year to ascertain what benefit, if any, might be obtained by so doing.

This sorting resulted into a division into first and second grades, containing 63·5 and 31·5 per cent of kappas respectively. The samples were then ginned separately, with the result that the first sample gave about 33 per cent of lint, and the second sample a little over 29 per cent: the unsorted gave slightly over 30 per cent. These figures do not quite tally; the difference is

presumably due to the samples not being quite uniform.

1,000 lb. kappas at 30 per cent = 300 lb. lint.
635 lb. ,, at 33 ,, = 210 lb. } 316 lb.
365 lb. ,, at 29 ,, = 106 lb. } lint.

The three samples, i.e., the unsorted lint, and the two grades of sorted lint were then submitted to five firms, and their opinions obtained. The valuations are tabulated below as the increase and decrease in the price of the two grades respectively, when compared with the unsorted lint in rupees per candy (500 lb.)—

—	A	B	C	D	E
First quality	+ 10	+10/13	+ 17	+ 5	+ 10
Second quality	— 60	— 7	0	— 10	— 5

The profit or loss on the whole transaction can now be worked out. Taking 1,000 lb. of lint as the unit, the cost of handpicking comes to 5·8 rupees. (The actual test was made by handpicking 4,500 lb. of kappas, which gave 1,400 lb. of lint at a cost of Rs. 8.)

The valuations therefore run as follows :—

—	A	B	C	D	E
	Rs.	Rs.	Rs.	Rs.	Rs.
1,000 lb. lint at 250 a candy (500 lb.).	500	500	500	500	500
670 lb. first sort	349	350	358	342	349
330 lb. second sort	125	160	165	158	161
Total	474	510	523	500	510
Less cost of sorting	6	6	6	6	6
	468	504	517	494	504
Profit (+) or loss (—) ...	— 32	+ 4	+ 17	— 6	+ 4

There is thus seen to be very little prospect of the practice becoming popular. The biggest loss is shown with the valuation of Firm A, who are themselves spinners, and who subjected the samples to careful tests. They report that the blow room losses were, for the unsorted 6¼ per cent, for the first and second sorts 5 per cent and 8¼ per cent. When spinning 20s the quantities obtained at the spindle point were 60 lb., 67 lb. and 59 lb. respectively. The firm remark that "grading cotton does not always pay : much depends on the quantity of stain in the first instance." It is perhaps rather surprising to find consumers, as opposed to exporters, apparently placing so much importance on colour : in the case of an exporting firm it is more intelligible. Firms B and C are both in the latter class. Firm B complains of the cut seed in the second grade sample : Firm C point out that they cannot give a spinners' valuation, but that they have noticed that Cambodia cotton otherwise good in quality, does not fetch so good a price as the cotton "coming for instance from Udamalpet, which is whiter than Coimbatore Cambodia *due to Uppam admixture*" ! Firms D and E are spinning firms ; their valuation is, however, confined to a simple statement of the relative values.

The result of the experiment is disappointing and it is clear that to the extent shown above, quality in cotton does not fetch its full price. It is possible that the season was against it, because one firm who bought our lint last year complained bitterly of the deterioration which was noticeable in it this year.

The cause of this can, I think, only be the season, and I have some reason to believe that the difference between the first grade and the unsorted was very much more marked last year. It may be that the plant itself is actually undergoing a process of deterioration, though it is difficult to see why it should be so marked in a single season. It may be hoped that the recently imported Cambodia seed will give results something like those obtained when the crop was first introduced.

A PRELIMINARY EXPERIMENT ON THE INFLUENCE OF DIFFERENT FODDERS ON THE QUANTITY AND QUALITY OF MILK.

By D. ANANDA RAO,
Assistant Principal.

The College Dairy is mainly intended to supply pure and wholesome milk to the residents in the estate. A mixed herd of cows and buffaloes is maintained for this purpose which is always growing in numbers to keep pace with the demands of the also growing population.

The herd is always fed with a concentrated ration twice daily in addition to the bulky fodder which usually consists of green fodder like guinea grass, fodder sorghum or green grass. Occasionally, either due to insufficiency of green fodder or absence of it due to a precipitation of rain which would prevent cutting it, it is replaced by dry fodder like sorghum or paddy straw. It often happens that the yield of milk gets reduced due to various causes, e.g., change of milkmen.

inclement weather, variation in the quantity of milk left for calf, etc. But the milkmen invariably attributed the reduction to the dry fodder fed and it almost always synchronised with the feeding of the paddy straw. This set the writer to initiate the preliminary experiment to test the popular belief regarding the deleterious effects of paddy straw as fodder for milch cattle, at the same time to see what information could be obtained by feeding various fodders available at the time. The writer claims no great thoroughness or accuracy for the experiment. The ideal set before him was high although in conducting it, he could not come anything near it. The animals experimented upon should have been of nearly the same age ; only animals of the same lactation period or as near it as possible, should have been included ; steps should have been taken to strip the cows instead of the usual practice of suckling the calves before and after milking, and the same milkmen should have been employed to milk the same animals throughout the experiment. This was all found impossible owing to the smallness of the herd and the long period through which the experiment had to be conducted. If prominence was given to selecting animals of similar age and lactation period, the number of animals experimented upon would have been reduced to so small a figure that the accuracy ensured by a large number would not have been attained.

The total herd numbered 23 of which 17 were cows and 6 buffaloes. The milk of cows and buffaloes was kept and weighed separate, and the average sample of each of which was tested for fat in duplicate by the Leffmann and Beam method.

The herd received a basal concentrated ration consisting of 1½ lb. cotton seed, 1½ lb. groundnut cake, 1 lb. dholl husk and 2 lb. rice bran, throughout the experiment. The fodders were fed in the evening and the samples of milk were weighed and analysed the next morning. The fodders fed were: Teff grass, Tenai straw (Setaria Italica), Paddy straw, Sorghum straw, Cumbu fodder (Pennisetum typhoideum), Guinea grass and Fodder sorghum. These were analysed at the time of the experiment by the Government Agricultural Chemist, and analyses are recorded in Statement No. 1.

STATEMENT No. 1.—Analyses of fodders and straws fed.

Particulars.	Tenai straw (Setaria-Italica).	Teff grass (Eragrostis-Abyssinica).	Paddy straw (Oriza-Sativa).	Cholam straw Sorghum-Vulgaris).	Cumbu fodder green (Pennisetum-typhoideum).	Guinea grass green (Panicum maximum).	Fodder cholam green (Sorghum-vulgaris).
	%	%	%	%	%	%	%
Moisture	8·70	6·38	8·26	14·20	73·96	64·57	64·05
* Soluble mineral matter.	5·24	5·27	3·76	2·80	2·15	2·23	1·69
Insoluble mineral matter.	6·32	4·74	13·06	4·20	0·98	2·35	1·35
Fats and Extractives ...	1·95	2·08	1·64	2·00	0·53	0·83	0·66
X Crude Proteids ...	3·69	8·31	2·94	4·81	2·28	1·62	1·86
Fibre	32·84	31·98	32·06	30·84	7·75	13·00	10·00
Carbohydrates ...	41·26	41·24	38·28	41·15	12·35	15·40	20·48
Total ...	100·00	100·00	100·00	100·00	100·00	100·00	100·00
Containing.							
* Potash ... (K_2O)	1·79	1·91	1·09	0·98	0·94	0·77	0·55
* Phosphoric acid (P_2O_5)	0·13	0·49	0·075	0·14	0·14	0·16	0·10
* Lime ... (C_aO)	0·84	0·49	0·51	0·40	0·20	0·21	0·065
X Albuminoids ...	2·88	7·06	2·81	2·66	1·55	1·27	1·34

The quantity of albumen, fat and carbohydrates present in each fodder was calculated and the albuminoid ratio for each was worked out (vide Statement No. 2). The dry fodders were each fed at 15 lb. per animal at a time, while the green fodders fed were at 40 lb. per animal, so that the dry matter present in either fodder was approximately the same.

STATEMENT No. 2 showing the actual quantity of nutrients present in each ration.

Name of straw or fodder.	Quantity fed in lb.	Amount of albuminoids present.	Amount of fats present.	Amount of carbohydrates present.	Total of nutrients fed.	Albuminoid ratio.
1 Tenai grass	15	·432	·292	6·189	6·913	1/15·9
2 Teff grass	15	1·059	·312	6·186	7·557	1/66·5
3 Paddy straw	15	·421	·246	5·742	6·409	1/14·9
4 Sorghum straw	15	·399	·300	6·172	6·871	1/17·2
5 Cumbu fodder (green) ...	40	·620	·212	4·940	5·772	1/ 8·8
6 Guinea grass (green) ...	40	·508	·332	6·16	7·456	1/13·6
7 Fodder sorghum (green) ...	40	·536	264	8·192	8·992	1/16·4

Previous to the experiment, the whole herd was fed with paddy straw for four days, with the view that the previous feeding would have had time to work itself out through the animal's system. Then each fodder was fed for seven days between each of which the herd received paddy straw for three days for the reason stated above.

Paddy straw was chosen upon the assumption that it is the poorest of all fodders. The experiment lasted nearly ten weeks, having been

started on the 1st February and completed on the 9th April 1915. Of the seventeen cows present at the beginning of the experiment, one cow dropped off owing to its becoming dry. On the 10th February, one more cow dropped off for the same reason and the herd was left with 15 till the 23rd March during the period when teff grass, sorghum straw and cumbu fodder were fed. On the 24th March, when the guinea grass ration began, one more cow dropped off leaving 14, and just before fodder sorghum was begun another cow went dry, and during the same week two more followed suit, so that during the last few days of the experiment there were only 11 cows.

In the case of buffaloes, one went dry within three days of the beginning of the experiment, leaving five in the herd till the 20th March after which one more dropped off, so that there were only four when the experiment was completed. Besides this, owing to the lactation period of all the animals having advanced, some allowance has to be made for the diminished yield, if any, during the later stages, which probably meant a higher fat content.

Although the fat was tested for in duplicate, the fat percentages were afterwards reduced to the total quantity present in the individual average milk of the cow and buffalo. Similarly in the case of the total quantity of milk produced by the herd, it was subsequently reduced to the average per animal per day for each fodder.

The results of the experiment (vide Statements Nos. 3 and 4) are not particularly striking. There is a deal of variation from day to day both in the

quantity of milk produced and the amount of fat present which may be due possibly to the amount of milk the calf is allowed to take, change of milkmen, weather conditions, etc. Ignoring these for our present purpose and taking into consideration the effect of the fodders on the whole herd of

FEEDING EXPERIMENT WITH FODDERS.

(Abstract of Statements 3 and 4.)

Date.	Name of straw.	Cows. Rate given per animal in pounds. (3)	Number of animals experimented upon. (4)	Total quantity of milk given in. LB. (5)	OZ. (5)	Average milk per animal in. LB. (6)	OZ. (6)	Percentage of fat (average of duplicates). (7)	Total amount of fat present in milk in column No. 6. (8)
1915.									
5th to 11th February...	Tenai straw ...	15	16	55	4	3	8	3·7	0·125
15th to 21st February.	Teff grass ...	15	15	55	13	3	12	3·9	0·140
25th February to 3rd March.	Paddy straw ...	15	15	55	11	3	11	4·0	0·150
4th to 10th March ...	Sorghum straw ...	15	15	51	5	3	7	3·8	0·125
14th to 20th March ...	Cumbu fodder ...	40	15	55	0	3	11	3·6	0·126
24th to 30th March ...	Guinea grass ...	40	14	49	2	3	8	3·9	0·130
3rd to 9th April ...	Fodder sorghum ...	40	11	46	6	4	2	3·7	0·152

Date—*cont.*	Name of straw—*cont.*	Buffaloes. Rate given per animal in pounds. (9)	Number of animals experimented upon. (10)	Total quantity of milk given in. LB. (11)	OZ. (11)	Average milk per animal in. LB. (12)	OZ. (12)	Percentage of fat (average of duplicate). (13)	Total amount of fat present in milk in column No. 12. (14)
1915.									
5th to 11th February...	Tenai straw ...	15	5	25	9	5	1	6·2	0·309
15th to 21st February.	Teff grass ...	15	5	25	2	5	0	6·4	0·320
25th February to 3rd March.	Paddy straw ...	15	5	25	9	5	4	7·0	0·360
4th to 10th March ...	Sorghum straw ...	15	5	24	6	4	14	6·9	0·329
14th to 20th March ...	Cumbu fodder ...	40	5	23	3	4	10	7·9	0·330
24th to 30th March ...	Guinea grass ...	40	4	18	0	4	14	7·2	0·336
3rd to 9th April ...	Fodder sorghum ...	40	4	20	2	5	3	6·8	0·324

STATEMENT No. 3.—Feeding experiment with fodders on cows.

Date.	Name of straw.	Rate given per animal in pounds.	Number of animals experimented upon.	Total quantity of milk given in LB.	OZ.	Average milk per animal in LB.	OZ.	Percentage of fat (average of duplicates).	Total amount of fat present in milk in column 6.
1915.									
Feb. 1	Paddy straw	15	17	60	0	3	8	3·2	0·11
2	Do.	15	17	59	8	3	8	2·95	0·10
3	Do.	15	17	56	4	3	5	3·3	0·10
4	Do.	15	16	50	4	3	2	4·85	0·15
	Average per day ...	15	17	56	8	3	6	3·6	0·115
5	Tenai straw	15	16	54	12	3	7	3·45	0·12
6	Do.	15	16	62	12	3	15	3·7	0·14
7	Do.	15	16	51	4	3	4	3·7	0·12
8	Do.	15	15	54	12	3	10	3·6	0·13
9	Do.	15	16	54	12	3	6	3·7	0·12
10	Do.	15	16	57	0	3	9	3·75	0·13
11	Do.	15	15	51	8	3	7	3·75	0·12*
	Average per day ...	15	16	55	4	3	8	3·7	0·125
12	Paddy straw	15	15	52	4	3	8	4·05	0·14*
13	Do.	15	15	49	4	3	5	3·65	0·11*
14	Do.	15	15	52	0	3	7	4·05	0·14*
	Average per day ...	15	15	51	2	3	7	3·9	0·130
15	Teff grass	15	15	52	0	3	7	4·15	0·14*
16	Do.	15	15	53	8	3	9	3·65	0·13
17	Do.	15	15	56	0	3	11	3·7	0·13
18	Do.	15	15	57	4	3	13	4·2	0·15
19	Do.	15	15	57	4	3	13	3·95	0·15
20	Do.	15	15	59	4	3	15	4·0	0·15
21	Do.	15	15	55	8	3	11	3·75	0·13
	Average per day ...	15	15	55	13	3	12	3·9	0·140
22	Paddy straw	15	15	55	0	3	11	3·95	0·14
23	Do.	15	15	55	12	3	11	4·15	0·15
24	Do.	15	15	58	4	3	14	4·3	0·16
	Average per day ...	15	15	56	5	3	12	4·1	0·150
25	Paddy straw	15	15	56	4	3	12	4·05	0·15
26	Do.	15	15	59	4	3	15	3·95	0·15
27	Do.	15	15	53	8	3	9	4·1	0·15
28	Do.	15	15	55	12	3	11	3·75	0·13
Mar. 1	Do.	15	15	58	8	3	14	4·35	0·16
2	Do.	15	15	54	0	3	10	3·9	0·14
3	Do.	15	15	52	12	3	8	3·85	0·13
	Average per day ...	15	15	55	11	3	11	4·0	0·150

* One cow did not stand.

STATEMENT No. 3.—Feeding experiment with fodders on cows—*cont.*

Date.	Name of straw.	Rate given per animal in pounds.	Number of animals experimented upon.	Total quantity of milk given in	Average milk per animal in	Percentage of fat (average of duplicates).	Total amount of fat present in milk in column 6.
1915.				LB. OZ.	LB. OZ.		
Mar. 4	Sorghum straw ...	15	15	54 8	3 10	4·3	0·15
5	Do. ...	15	14*	45 8	3 4	4·0	0·13
6	Do. ...	15	15	51 4	3 7	...	...
7	Do. ...	15	15	53 8	3 9	4·0	0·14
8	Do. ...	15	15	48 0	3 3	3·0	0·09
9	Do. ...	15	15	52 12	3 8	3·65	0·12
10	Do. ...	15	15	53 8	3 9	3·65	0·12
	Average per day ...	15	15	51 5	3 7	3·8	0·125
11	Paddy straw ...	15	15	53 0	3 8	3·75	0·13
12	Do.	15	15	53 4	3 9	...	...
13	Do.	15	14†	51 12	3 11	3·6	0·13
	Average per day ...	15	15	52 10	3 9	3·6	0·130
14	Cumbu fodder ...	40	15	47 4	3 2	3·3	0·10
15	Do. ...	40	15	56 4	3 12	3·45	0·12
16	Do. ...	40	15	57 8	3 13	3·75	0·14
17	Do. ...	40	15	57 12	3 13	3·55	0·14
18	Do. ...	40	15	56 4	3 12	3·6	0·13
19	Do. ...	40	15	55 8	3 11	3·65	0·13
20	Do. ...	40	15	54 12	3 10	3·85	0·13
	Average per day ...	40	15	55 0	3 11	3·6	0·126
21	Paddy straw ..	15	15	50 4	3 5	4·0	0·13
22	Do. ...	15	15	52 12	3 8	3·95	0·13
23	Do.	15	15	49 0	3 5	4·3	0·15
	Average per day ..	15	15	50 10	3 6	4·1	0·140
24	Guinea grass ..	40	14	49 12	3 9	3·65	0·13
25	Do. ...	40	14	49 12	3 9	3·95	0·14
26	Do. ..	40	14	47 0	3 5	3·9	0·12
27	Do. .	40	14	48 12	3 7	4·0	0·13
28	Do. ..	40	14	47 12	3 6	3·95	0·13
29	Do. ...	40	14	50 8	3 9	3·95	0 14
30	Do. ...	40	14	50 4	3 9	3·9	0·13
	Average per day ..	40	14	49 2	3 8	3·9	0·130
31	Paddy straw ...	15	14	48 12	3 7	4·55	0·15
Apr. 1	Do. ...	15	13†	43 8	3 5	3·25	0·10
2	Do. ...	15	13	48 8	3 11	4·1	0·15
	Average per day ..	15	13	46 14	3 8	4·0	0·130

* One cow was sick.

† One cow did not stand.

STATEMENT No. 3.—Feeding experiment with fodders on cows—*cont.*

Date.	Name of straw.	Rate given per animal in pounds.	Number of animals experimented upon.	Total quantity of milk given in	Average milk per animal in	Percentage of fat (average of duplicates).	Total amount of fat present in milk in column 6.
1915.				LB. OZ.	LB. OZ.		
April 3	Fodder sorghum ...	40	13	50 4	3 14	3·95	0·155
4	Do. ...	40	12	47 8	3 15	3·9	0·153
5	Do. ...	40	12	47 0	3 14	3·7	0·143
6	Do. ...	40	11	45 12	4 2	3·5	0·144
7	Do. ...	40	11	45 12	4 2	...	...
8	Do. ...	40	11	47 4	4 5	3·7	0·159
9	Do. ...	40	11	47 0	4 4	3·7	0·157
		40	11	46 6	4 2	3·7	0·152

STATEMENT No. 4.—Feeding experiment with fodders on buffaloes.

1915.							
Feb. 1	Paddy straw	15	6	24 12	4 10	5·4	0·24
2	Do.	15	6*	29 12	4 15	5·7	0·28
3	Do.	15	6	33 12	5 10	6·85	0·38
4	Do.	15	5	16 0	3 3	7·25	0·23
	Average per day ...	15	6	25 0	4 11	6·3	0·28
5	Tenai straw	15	5	25 12	5 2	6·7	0·34
6	Do.	15	5	24 12	4 15	6·05	0·29
7	Do.	15	5	24 0	4 13	6·05	0·29
8	Do.	15	5	25 4	5 0	6·75	0·33
9	Do.	15	5	29 4	5 13	5·65	0·32
10	Do.	15	5	25 4	5 0	6·15	0·30
11	Do.	15	5	24 8	4 14	6·15	0·29
	Average per day ...	15	5	25 9	5 1	6·2	0·309
12	Paddy straw	15	5	24 12	4 15	6·05	0·29
13	Do.	15	5	24 8	4 14	6·55	0·31
14	Do.	15	5	22 12	4 8	6·75	0·30
	Average per day ...	15	5	24 0	4 13	6·4	0·300
15	Teff grass	15	5	24 12	4 15	6·25	0·30
16	Do.	15	5	25 8	5 1	6·15	0·31
17	Do.	15	5	25 0	5 0	6·15	0·31
18	Do.	15	5	25 8	5 1	6·25	0·31
19	Do.	15	5	23 8	4 11	7·05	0·33
20	Do.	15	5	26 4	5 4	6·65	0·34
21	Do.	15	5	25 8	5 1	6·75	0·34
	Average per day ...	15	5	25 2	5 0	6·4	0·320

* One buffalo did not stand.

STATEMENT No. 4.—Feeding experiment with fodders on buffaloes—*cont.*

Date.	Name of straw.	Rate given per animal in pounds.	Number of animals experimented upon.	Total quantity of milk given in	Average milk per animal in	Percentage of fat (average of duplicates).	Total amount of fat present in milk in column 6.
1915.				LB. OZ.	LB. OZ.		
Feb. 22	Paddy straw ...	15	5	24 0	4 12	6·95	0·33
23	Do. ...	15	5*	24 12	4 15	6·9	0·34
24	Do. ...	15	5	30 4	6 0	7·15	0·42
	Average per day ...	15	5	26 5	5 4	7·0	0·36
25	Paddy straw ...	15	5	24 8	4 14	7·75	0·37
26	Do. ...	15	5	24 8	4 14	6·6	0·32
27	Do. ...	15	5	32 6	6 6	7·0	0·44
28	Do. ...	15	5	29 0	5 13	7·2	0·41
Mar. 1	Do. ...	15	5	26 12	5 5	6·75	0·35
2	Do. ...	15	5	25 4	5 0	6·8	0·34
3	Do. ...	15	4*	16 12	4 3	6·95	0·29
	Average per day ...	15	5	25 9	5 4	7·0	0·36
4	Cholam straw ...	15	5	23 4	4 10	6·85	0·31
5	Do. ...	15	5	23 4	4 10	6·9	0·319
6	Do. ...	15	5	26 0	5 3	6·7	0·34
7	Do. ...	15	5	24 4	4 13	7·0	0·33
8	Do. ...	15	5	25 8	5 1	6·65	0·336
9	Do. ...	15	5	23 8	4 11	6·85	0·32
10	Do. ...	15	5	25 0	5 0	6·85	0·342
	Average per day ...	15	5	24 6	4 14	6·9	0·329
11	Paddy straw ...	15	4*	19 6	4 12	6·65	0·316
12	Do.	15	4*	21 0	5 4	6·5	0·341
13	Do.	15	5	19 4	4 12	7·2	0·342
	Average per day ...	15	4	19 12	4 9	6·8	0·333
14	Cumbu fodder ...	40	4*	22 12	5 11	6·5	0·369
15	Do. ...	40	5	22 0	4 6	7·5	0·262
16	Do. ...	40	4*	21 8	5 6	6·55	0·352
17	Do. ...	40	5	26 12	5 5	6·75	0·358
18	Do. ...	40	5	24 12	4 15	7·6	0·373
19	Do. ...	40	5	21 0	4 3	7·35	0·307
20	Do. ...	40	5	23 12	4 12	7·4	0·351
	Average per day ...	40	5	23 3	4 10	7·9	0·339
21	Paddy straw	15	4	21 0	5 4	6·45	0·339
22	Do.	15	4	18 12	4 11	7·0	0·328
23	Do.	15	4	19 12	4 15	7·05	0·348
	Average per day ...	15	4	19 13	4 15	6·8	0·338

One buffalo did not stand. † One buffalo went dry and one did not stand.

STATEMENT No. 4.—Feeding experiment with fodders on buffaloes—*cont.*

Date.	Name of straw.	Rate given per animal in pounds.	Number of animals experimented upon.	Total quantity of milk given in	Average milk per animal in	Percentage of fat (average of duplicates).	Total amount of fat present in milk in column 6.
1915.				LB. OZ.	LB. OZ.		
Mar. 24	Guinea grass	40	4	19 12	4 12	7·4	0·351
25	Do.	40	3*	14 0	4 10	6·65	0·307
26	Do.	40	3	13 8	4 8	6·85	0·308
27	Do.	40	4	18 0	4 8	7·8	0·351
28	Do.	40	4	19 12	4 15	7·0	0·345
29	Do.	40	4	20 8	5 2	6·55	0·335
30	Do.	40	4	20 8	5 2	6·9	0·354
	Average per day ...	40	4	18 0	4 14	7·2	0·336
31	Paddy straw ...	15	4	18 4	4 9	6·7	0·305
Apr. 1	Do.	15	4	22 0	5 8	7·0	0·385
2	Do.	15	3†	11 8	3 13	7·15	0·272
	Average per day ...	15	4	17 4	4 11	7·0	0·321
3	Fodder cholam ...	40	4	19 4	4 13	7·8	0·374
4	Do. ...	40	4	16 4	4 1	7·15	0·292
5	Do. ...	40	3†	10 12	3 9	6·25	0·224
6	Do. ...	40	4	19 0	4 12	6·65	0·313
7	Do. ...	40	4	23 8	5 14	6·3	0·370
8	Do. ...	40	4	24 8	6 2	...	...
9	Do. ...	40	4	22 8	5 10	6·6	0·371
	Average per day ...	40	4	20 2	5 3	6·8	0·324

* One buffalo went dry and one did not stand.

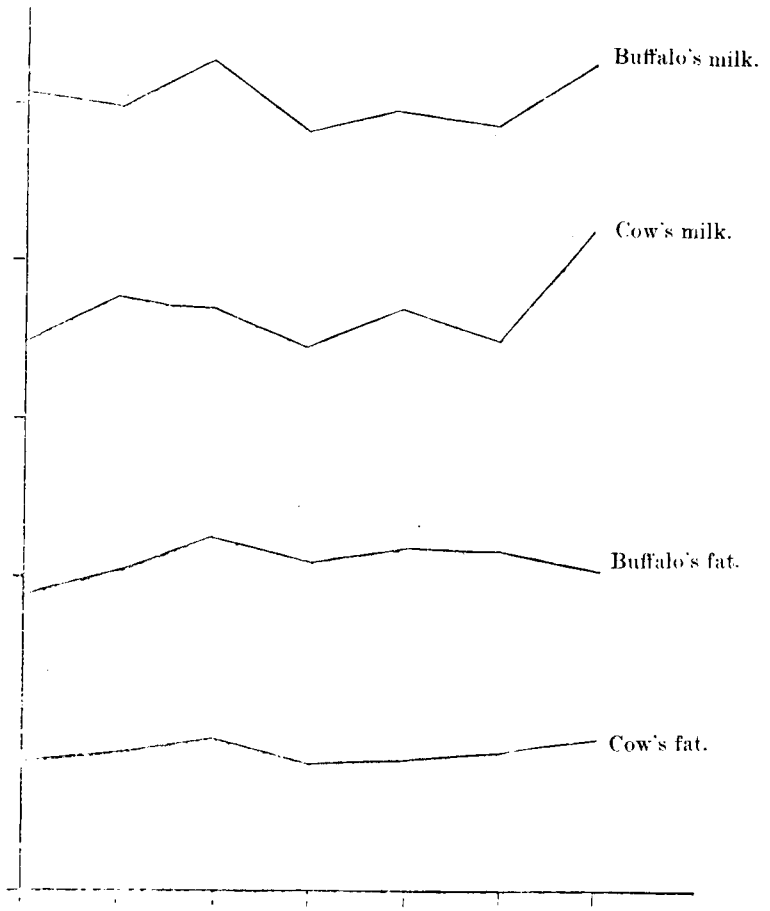
† One buffalo did not stand.

cows and buffaloes together, the experiment so far conducted does not seem to bear out the popular opinion held with regard to the paddy straw. From the chemical point of view it is much more nutritious than tenai or sorghum straw both of which are considered better than it. Both in the amount of milk produced and fat yielded paddy straw stands very high in the list. It is surprising that it is superior even to guinea grass which is a succulent fodder, invariably fed to our dairy animals. If the yield of milk is reduced

during the time when paddy straw is fed, it may be due perhaps to the sudden change effected in the animal system by transferring them suddenly from a succulent ration to a dry straw. It does not however seem to indicate that a prolonged feeding of paddy straw is deleterious to milch cattle. In the Northern Circars, in Deltaic tracts it is the custom to feed paddy straw to milch cattle during periods when green fodders are not available.

Teff grass has a very narrow albuminoid ratio, and probably such a fodder is not economical to feed dairy cows with. Besides it is a difficult crop to grow here and has not even good enough stand to recommend its cultivation. Tenai straw is considered good by farmers for working cattle but not for dairy animals and this opinion seems to be borne out by the experiment. The milk is specially poor in fat. Cumbu as a straw is of such poor quality that it is used for thatching, but it is fed only when green. The experiment does not contradict this opinion with regard to the yield of milk although the albuminoid ratio is very high indeed. The milk however is of high quality when fed with fodder sorghum, and as may be expected, the succulent fodder increased the flow of milk both in cows and buffaloes. It is also satisfactory that milk while this was fed was also rich. Unlike fodder sorghum, guinea grass has been disappointing. The nutritive ratio in this fodder is narrower than either paddy straw or fodder sorghum, and yet it is poor in yield and stands on a par with cumbu in quality so that one is tempted to question the desirability of feeding it on a large scale to dairy cattle. From the graph appended it is interesting to note that the general

effect of various fodders experimented with seems to be practically the same on both cows and buffaloes regarding quality and quantity of milk.



GRAPH SHOWING THE EFFECT OF DIFFERENT FODDERS ON QUANTITY AND QUALITY OF MILK IN A HERD OF COWS AND BUFFALOES.

This preliminary test proves more than anything else, that experiments concerning cattle, bristle with innumerable complexities, and that it is nothing short of temerity to deduce results from inconclusive experiments, since in dealing

with animals one is confronted with factors over which man has very little control. It is proposed to continue the experiment at a future date.

REPORT ON VISIT TO THE ESTATE OF RAI BAHADUR NALLATAMBI CHAKKARAI MANDRADIYAR, PATTAGAR OF PALAYAKOTTAI.

By A. CARRUTH,
Deputy Director of Agriculture, Live Stock.

This is one of the old historic estates with a time honoured name for good cattle and high class farming. Succeeding his father 15 years ago, the present Pattagar has not only worthily maintained, but has done much to enhance the enviable reputation of the family line in connexion with progressive agriculture in all its branches.

The estate extends to 10,000 acres or thereby, and lies on either side of the River Noyel which is almost perennial. Six thousand acres are leased out to tenants, and 4,000 are under the Home Farm management.

The soil is light and gravelly, and overlies a lime kankar bed. Good wells are found nearly all over the estate. Levelling and well digging proceed apace, and therefore the acreage of garden lands increases from year to year.

At the present time, about 1,500 acres are under dry cultivation, 500 acres as garden lands, and 2,000 acres under Kolakattai grass.

Dry Cultivation.

The dry cultivation area is mainly under cattle fodders, etc., such as cholam, horse-gram, cumbu,

cow-peas and castor, sown mixed. The rotation on the dry land is—grass 5 to 6 years—fodder crops, etc., 2 to 3 years. On the dry land there is also about 200 acres of cotton.

Garden Cultivation.

The 500 acres of garden lands are cropped with tobacco, ragi, cholam or cumbu and Cambodia cotton. There is generally about 100 acres put under each, but certain variations are introduced from time to time as found desirable. The general practice is to have the land under cumbu or cholam from April to the end of June ; ragi, early in July to October ; tobacco, November. The cotton is introduced in varying areas into the rotation as a cleaning crop. As regards cropping in general the Pattagar is a believer in a well thought out rotation of crops which takes into consideration the fertility of the land, needs of the Farm, suitability to the District, and practical farming economics.

Pastures.

The remainder of the Home Farm, 2,000 acres, is under the famous Kolakattai grass.* These pastures are formed by sowing one gunny bag of uncleaned seed per acre with the cholam crop. The seed is saved from the pastures as required. As to the length of time that the land lies in grass, no hard and fast rule is followed. The time varies from 6 to 15 years depending on circumstances. Bad seed seasons, partial failure of the young grass, etc., have to be reckoned with, as well as the general requirements of the farm. These pastures

---

* Pennisetum cenchroides.

are divided into 200 acre blocks, and are grazed in rotation. The grass lands are in addition, classified for special purposes. Some blocks are set apart for breeding stock—others for young stock, while others again are reserved for surplus stock being prepared for sale. This admits of the fullest advantages being obtained from all points of view. Generally the best stock are put on the best pasture, but all grades of cattle for sale may have a short period on the best grass just before marketing.

The cattle remain on the pastures at night during the grazing season, and their droppings are periodically spread.

The grazing season is divided into two periods, the first June and July, and the second from October to February. The pastures are closed during August and September, as the grass does not usually do well during these months. The grazing season of course depends on the rainfall, but this is the average.

The grazing rotation varies considerably, but taking an average season, a 200 acre block provides keep for 100 two and a half year olds for 2½ to 3 months. The many fine points in the management of pasture, such as stage of growth at which grazing should commence—rate of grazing—and condition of the grass when a period of rest is required, etc., are things in which the Pattagar is a past master. Indeed, no land is more difficult to manage to advantage than grazing ground.

Breeding and Stock.

The stock is of the Kangayam breed, and of a large Kangayam type. The herd is maintained

within itself, thus no breeding bulls or cows are purchased from outside. The bulls used are the highest grade selections from the male stock, and are put up for breeding when 6 teeth have cut. A bull serves cows for two seasons only, after which he is castrated and put to work. This system may be classed as line breeding. The Pattagar considers that this practice, breeding from young active bulls, gives fast road animals with good staying power.

The cows are in herds of 50, with one breeding bull to each. Each herd has a herdsman during the grazing season. The cows have a calf each year, and the heifers have their first calf when about three years old.

The calves suckle their dams for 6 to 8 months, and shortly after that the male and female stock are separated. The sexes are graded when about a year old. The lowest grades are disposed of soon, the intermediate grades at a later date, while only the highest grade stock is brought to maturity.

The best males of each year are reserved for breeding bulls.

The highest grade bullocks, 3½ to 4 years old, sold at the Tiruppur cattle show, realized Rs. 800 to 950 per pair.

The highest grade heifers are reserved to come into the herd as breeding stock.

The whole management is on the lines of discarding the worst animals and keeping the best. That no doubt is the secret of success. Some attention is paid to the qualities of parents when deciding between two equally good animals—say for a breeding bull—but faulty stock is cast aside, no matter how good the parentage may be.

It was a treat to see the graded lots of young stock, and to note the drop in quality with the grade.

During the dry season, the stock is fed on the straw of fodder crops from which the seed has been thrashed. An attempt is always made to store a reserve of fodder in good years. Garden forage crops are fed in a semi-green state after the seed is removed.

Groundnut cake is the principal concentrated food used for all classes of stock.

A few Australian cows were seen on the farm. These without exception were suffering from the climate, and generally in a somewhat unthrifty condition. Those with short-horn blood were suffering most, while the Ayrshire crosses fared rather better.

A three-year old, the produce of an Ayrshire cross Australian cow and a Kangayam bull, proved a rather interesting animal. She had all the characters of the Ayrshire as regards head and general body type, but was a very bad milker. The udder was typical of the Kangayam. This animal was in the very pink of condition, and as regards health and spirit, left nothing further to be desired.

Housing.

As regards housing during the dry season, it is interesting to note that very few of the stock are stalled in sheds. The cattle are tied in rows in paddocks, which are surrounded by 9 feet high walls to act as wind breaks. The number of paddocks is in excess of the requirements, so as to admit of the stock being moved to another when cleaning is to be done. The cattle may thus be

moved to clean quarters twice per day. During the middle of the day, the animals are tied under the shade of trees, thus in one day they may have been in three different places. The effect of this treatment on the health of stock appears to be very beneficial, as cases of sickness are very rare.

Management.

The whole management of the Home Farm, both in principle and detail, is in the skilled hands of the Pattagar himself, who does not consider the smallest item beneath his personal attention. Without the slightest doubt whatever, this is the secret of success at Palayakottai. From early morning to late at night, the various items of the Farm receive attention.

The vast amount of personal supervision required in successful farming, is a point that is not appreciated except by practical Agriculturists themselves. To any one who aspires to excel in mixed Farming in Madras, I should say, take the Pattagar as your model, for undoubtedly he deserves a place in the front rank of successful practical Agriculturists.

NOTE ON COCONUT CULTIVATION AT ALLEPPEY.

By W. McRAE,
Government Mycologist,
AND
R. D. ANSTEAD,
Deputy Director of Agriculture, Planting Districts.

Alleppey, the most important commercial town in the State of Travancore, is situated on a narrow

strip of land some three miles in width, and has the sea coast on the west and the Vembanaad lake on the east. It commands a fine harbour affording safe anchorage for the greater part of the year, cargo being landed or shipped by means of lighters at an iron pier with good facilities for handling. The town is intersected by a system of canals which join up to the rivers and back-waters leading to Cochin in the north and to Quilon in the south.

Being in the heart of the coconut growing area the manufacture of coir-matting, etc., is carried on on a large scale and steam coconut oil mills are established in considerable numbers.

Recently the writers of this note had an opportunity afforded them by the kindness of Mr. G. H. Davey of Messrs. Darragh Smail & Co., Limited, of seeing some interesting experiments on coconut cultivation which he has been carrying out, more or less in the nature of a hobby, for several years past.

The district is well situated for this cultivation and coconut gardens are to be found on the shores of the sea and back-waters as well as throughout the town : in fact the palm is the main feature in the local scenery which is surpassingly beautiful.

The average rainfall is 122 inches distributed over both monsoons, the north-east affording on the average 55 wet days with 33 inches of rain and the south-west 77 wet days and 76 inches, while the dry weather period gives 22 wet days with 13 inches of rain. The soil along the back-waters is very rich consisting of heavy black mud reclaimed from the bottom of the lakes, and is largely transported in boats, and heaped in small

mounds along the canal and river banks as well as along the bunds of the paddy fields. On these mounds the coconut palms are planted. Under such conditions the trees flourish and yield heavily. Along the sea-shore the soil is greyish sand and though very barren looking it bears quite healthy groves. Here Mr. Davey purchased a plot in 1909. Originally there were 134 trees, but in 1911, 14 trees were killed by lightning, one died and one was blown down in a gale. This left 118 trees of which 117 only were bearing. In 1912, 12 of these trees were removed (transplanted) to make room for the building of the bungalow and this naturally checked their cropping. In 1913–14, seven old trees were cut out. In 1913, Bamber's mixture was first applied, and similar applications were made in 1914 and 1916, but in 1915 the trees only received an application of coconut poonac. The yields were in

Year.	Nuts.	From trees.
1910 ...	3,188 ...	134
1911 ...	6,808 ...	118
1912 ...	6,993 ...	118
1913 ...	5,975 ...	118
1914 ...	4,763 ...	111
1915 ...	5,675 ...	111
1916 ...	7,355 ...	111

When the property was bought in 1909 it was very swampy and overgrown with screw-pine, which was so dense that he employed three elephants for three days rooting it up. The screw-pine debris was chopped up and placed in circles round the trees, and the land raised and levelled up by sand carried from the beach which seems to have accounted for the heavy increase in the

1911 crop. The unfortunate loss of trees through lightning, etc., makes it difficult to make a proper comparison of the benefits of manure and good cultivation, but on the face of it the general improvement is very good, and there are 90 young trees planted in 1911 and 1912, a few of the former of which have just commenced to bear nuts.

To the south of the town, however, there exists a large tract of land which under ordinary conditions is apparently infertile, and trees growing on it have a very stunted appearance. The sand here is almost pure white, and is underlain by a stiff layer of reddish clay and sand which is impervious and consequently prevents the rain-water from draining off below, so that the soil becomes water-logged, and although this area is 17 to 20 feet above the level of the back-water even in the dry weather there is always water a few feet below the surface. It was the general opinion locally that this land was unsuitable for cultivation of coconuts. Several small areas had been attempted and failed, and it is on this land that Mr. Davey has carried on his experiments. By digging and raising a series of banks twelve feet wide and two feet above the natural level leaving trenches also twelve feet wide and two feet below the natural surface, and cutting drains from these trenches down to the back-water and paddy fields he has succeeded in keeping the places properly drained. He has several small areas planted in this manner varying from 3 to 10 years of age and they are well grown and look very healthy, and a fair proportion of the older trees are beginning to bear well. Since 1911 all these areas have been systematically manured on recommendations

obtained from Mr. Kelway Bamber, and the results have been very satisfactory. The younger plantations which have been manured in this way from the commencement show growth equal to palms of similar age planted in the best back-water situations, and some of the 6-year old plants are commencing to give nuts. The only sign that the land was not of the best, was that the lower foliage was rather yellowish in colour, but applications of lime to correct soil acidity, which is almost certain to obtain after years of water-logging conditions, will in all probability correct this failing, and this treatment is now being adopted. By far the most interesting experiment however has been carried out with some old trees which Mr. Davey purchased in 1906. The ages of these trees at the time of purchase cannot be correctly ascertained, but they were certainly over 20 years old and probably nearer 30 years. That the then owner did not attach much value to them can be realized when he agreed to sell the 49 trees and about 4 acres of land for the sum of Rs. 350. Many of the trees had never borne a nut, and their stems show clearly the poor condition they must have been in. At first Mr. Davey experimented only with local manures. The crops obtained were as follows :—

1907	...	...	... 516	nuts.
1908	...	...	... 861	,,
1909	...	...	... 1,598	,,
1910	...	...	... 1,424	,,
1911	...	...	... 1,849	,,

In 1911 Mr. Davey sent samples of the soil to Mr. Kelway Bamber and after analysis, the latter

recommended the application of the following mixture :—

Ground-nut cake	150 lb.
Milled fish	309
Blood meal	100
Con. Super Phosphate	100
St. Bone meal	100
Kainit	200
Sul. of Patash	50
	1,000 *

This recommendation has been carefully followed though the mixture has had to be slightly modified lately owing to some of the ingredients being unobtainable owing to the war conditions

The crops have been as follows :—

1912	943 nuts.
1913	2,083 ,,
1914	2,298 ,,
1915	2,614 ,,
1916	4,810 ,,

and the crop for the year 1917 will also exceed 4,000 nuts. These old trees are now looking particularly healthy, and are a real contrast to the surrounding trees under ordinary local cultivation. They have particularly fine crowns of large well-developed leaves and are crowded with bunches of blossom and nuts in all stages of development. Many appeared ideal trees and the swollen bases of the stems are especially noticeable. The 24 best trees averaged 121 nuts each in 1916 whilst the average of the whole 49 trees was 98 nuts. These

* Applied at the rate 15 lb. per tree per annum.

figures prove conclusively that the land is quite suitable for coconuts if cultivated on proper lines, and it will be interesting to see later on the results that are obtained from the younger areas that have received proper attention from the time of planting. It may be noted in both the instances given that in the year after the first application of artificial manure, the crop fell, and this seems to point to this being usually the case. If this is so, it is important to call attention to it, as many cultivators would fight shy of continuing the treatment unless it was pointed out beforehand that it would probably happen.

It is interesting to compare these results with those obtained at the Porto Rico Agricultural Experiment Station. There it is found that while fertilisers produce but little increase in the yield of nuts during the first two years after application, marked gains in yield occur after this period. Thus given a complete fertiliser containing 6 per cent of nitrogen, 8 per cent of phosphoric acid and 12 per cent of potash at the rate of 10 lb. per tree, a gain of over 30 per cent in the yield of nuts per tree was obtained, and when 20 lb. per tree was applied, a gain of nearly 60 per cent per tree resulted. When nitrogen and potash were omitted from the mixture, no increase in yield was obtained, and when the potash only was omitted there was only a slight increase.

Another result of manuring is the increased copra contents of the nuts. Before commencing the application of these manures the number of nuts required to make a candy (660 lb.) of copra was from 2,300 to 2,400 whereas now 1,950 to 2,050 nuts suffice—a considerable improvement which is worth noting.

There is a common belief in the locality that coconuts thrive best "in the sound of the human voice" and it is customary to place the dwelling houses in the coconut groves. On one plantation we visited, there had been a number of such houses, but Mr. Davey finding his tenants unsatisfactory for various reasons had removed most of them. Wherever there had been a house-site the neighbouring trees had benefited, and were without question more flourishing than those situated elsewhere. It is obviously not exactly the human voice that these trees had benefited by, but rather the refuse, ashes, etc., which they had received from the human occupation. Under Indian conditions of sanitation, the fertilizing value of each household must be considerable. On tea estates it is a common practice to build a set of lines in a backward field of tea, and no other system of manuring brings it on so surely or so fast as this.

The yield of nuts in the neighbourhood of Alleppey appears to be high, frequently reaching 80 to 100 nuts per tree where manures are used, while we were told of a plantation 18 miles north which gives exceedingly high yields, some of the palms giving 400 and even 450 nuts yearly. This phenomenal yield is worth investigation. We are unaware of the average yield on the West Coast, but in other countries it apparently only reaches 60—80 nuts per tree per annum. Thus in their book "A Practical Guide to Coconut Planting" the authors, Munro and Brown, say "from large well cultured trees in full bearing all over the Peninsula (F.M.S.) we consider an average of sixty nuts a tree per annum the actual limit: nothing approaching this result, however, need be reckoned on without high cultivation."

Along the back-waters and sides of the canals the palms are much more vigorous, especially where they are not overcrowded,—a very common fault apparently. Since the trees are valued at so much each, the cultivators think the more trees per acre the more valuable the cultivation and lose sight of the crop yields. Here the frequent application of lime improves the growth and yield. Any other manure is scarcely necessary as the trees are grown in rich black alluvial soil dredged from the bottom of the lakes and brought considerable distances at large expense. It is usual, however, to give the trees a few baskets of river sand every second year which treatment is said to assist their growth.

We were specially shown two palms which bear particularly large nuts fetching high prices. These nuts owing to their large copra contents were fetching before the war Rs. 75 to 80 per thousand when ordinary nuts were sold at from Rs. 50 to 55. These trees have been used as seed-bearers and Mr. Davey showed us some small plantations raised from them. The type appears to be fixed, the progeny bearing similar large nuts while the growth is remarkably rapid. Three to six years old palms planted wide apart and limed show an astonishing development, and have particularly large bottle-shaped bases. We measured one tree of nine years and found it to be 110 inches in circumference at ground level.

Cultivation is a common practice especially in circles round the trees, but as far as we could see the use of green dressings was neglected. Possibly a green dressing would be difficult to establish on the sandy soils, but it should be possible as several leguminous weeds were noticed growing

naturally, one being a prostrate species of *Alysicarpus* or something very similar to it. Probably *Crotalaria striata* or *Tephrosia candida* could be established with a little trouble especially where manuring is done. On the rich back-water lands this form of manuring is not so necessary as there is generally a heavy crop of weeds which are periodically buried.

There is a considerable amount of disease of coconut palms in this district especially in the vicinity of the town, and properly organized remedial measures would lead to substantial gain to the cultivators. We particularly noticed the following diseases :—

A Root Disease which produces a gradual weakening of the tree resulting in an ever diminishing yield and smaller and smaller leaves of a yellowish unhealthy appearance, and finally in the death of the tree. *A Merulius* was found at the base of one tree.

A Leaf Disease which produces a very characteristic appearance quite distinct from the effect produced by root disease, namely, the destruction of the pinnae of the leaves before they unfold so that the expanded frond has a rat-tailed appearance at the extremity.

A Leaf Disease caused by *Petalozzia palmarum* which produces grey to brown decayed spots on the leaf surface. This detracts from the value of the leaves as it renders them useless for making cadjans.

Among insect-pests the following were noticed :—

The Rhinoceros Beetle *(Oryctes rhinoceros)*, the Red Weevil *(Rhynchophora ferruginea)*, and a scale insect which attacks the nuts, and is found in

black masses on the outside of the husk. This scale was also noticed on areca-nut fruits, but it probably does very little harm.

EXTRACT FROM THE MONTHLY REPORT OF MR. H. C. SAMPSON, DEPUTY DIRECTOR OF AGRICULTURE, V AND VII CIRCLES. DEALING WITH COCONUT CULTIVATION IN THE MALABAR DISTRICT.

On the 25th of January 1917 I started on a tour to select coconut trees from which to take seed nuts for planting on the new stations. My object was to first find topes where the conditions of soil, cultivation, etc., were uniform and then to select trees in these topes which were as far as possible uniform in cropping and in variety. My first stop was at Payyanur where gardens around the village of Annur are noted throughout the north of North Malabar for seed coconuts. I inspected these gardens and in many ways they were suitable for our purpose. The main objection to them, however, was that the cultivation in the gardens was very perfunctory. From here I went to Tellicherry. The village Dharmadam along the coast has a reputation here for seed nuts. Certainly the trees were bearing well, but it was impossible to make any selection of individual trees for our purpose. Some of the local nurseries were inspected and the seedlings were well grown and quite healthy. This was the only place in my tour where any selection of trees seemed to be made in selecting nuts. I propose purchasing seedlings here to fill up blanks

at Kasaragod. Uniformity among these is not of any importance as it is merely filling up blanks in an existing garden which is equally, if not more, promiscuously planted. If this were a question of under planting, i.e., the next generation, the matter would be different and equally great care would be taken to select for uniformity in seed nuts.

From Tellicherry besides seeing gardens to the north of the town at Dharmadam I visited several gardens to the east but these were mostly small in area and too mixed up with jack and mango trees. I also visited Kallai to the south of Tellicherry bordering French territory and from the top of a hill here had an extensive view of the plain from the sea to the foot of the ghauts. Except for projecting hill tops the whole view presented a sea of coconuts, with here and there dark dots of mango and jack trees and light patches of bamboo clumps, all of which last seem to be flowering this year. Even hill sides were in many places being planted up and a few even of the tops themselves were newly planted with coconut trees. This shows to what an extent the pressure of this cultivation has reached and when one goes down into this country you see the same pressure of coconut cultivation encroaching on the wet lands, which are bunded with high walls and filled in with soil to give the necessary drainage to the coconut trees which are planted here. It would be interesting to compare the cropping of some of these villages at the present day with thirty to forty years ago to see how far the coconut had encroached both on wet lands and uncultivated dry lands.

From Tellicherry I went to Badagara where I made enquiries into the copra trade with a view to finding out where the best copra came from. No

definite information was however obtained but the following statements seemed to be generally admitted.

1. Old trees give a better quality copra than young trees though the kernals are not so big as a rule.

2. Copra from dry land parambas is better than from back-water topes. It weighs better, dries better and keeps better.

3. Copra from year old ripe nuts is much superior to that prepared from newly-picked nuts, though nuts cannot be stored for more than eighteen months. Nuts if stored before they are ripe go mouldy in the store. These are practically the only two grades of copra, viz., that prepared from newly harvested nuts and that prepared from stored nuts.

There is also a certain amount of grading to suit the coast trade. Copra from small nuts is specially selected for the Karachi trade as this is sold by numbers and not by weight.

The process of copra manufacture is extremely simple. The nuts are split in two crossways and the halves are placed close together on a sanded drying ground with the kernel exposed to the sun. After one day's drying the kernel contracts sufficiently to remove this from the shell. Sometimes it will fall out but may have to be prised out with a specially pointed stick which is worked round between the meat and the shell. The kernels are then spread out to dry in the day time and heaped up on mats at night for 3—4 days until dry. Copra from stored nuts can be recognized by

(1) the darker coloured skin on the kernel,
(2) the edges are much sharper.
(3) the original shape of the nut is retained.

The reasons for (2) and (3) are that there is much less moisture in stored copra. In fact often the kernel is loose inside the shell even before the latter is split open.

The following villages were inspected—Pudupalam, Nadatakary and Menmunda in the neighbourhood of Badagara, besides 3 or 4 amsams between there and Tikkoti. Several persons in Pudupalam raise coconut seedlings for sale. The nuts they use are, however, obtained from inland parambas as their own trees are not healthy. Many of them have "bleeding" disease. This is a backwater village near the sea and the cultivation is a compromise between wet cultivation and coconuts. Coconuts are planted on bunds about 6 feet wide about 2—3 feet above the level of the wet land. These wet lands even now are sodden with brackish water and, though white in appearance on the surface, are black in colour when opened out showing complete lack of drainage. Any coconut roots found in this were dead and it is presumed that they only form in this soil in the monsoon when the heavy rains wash out the salt and help to aerate the soil. It was no wonder therefore that the trees succumbed to disease as this root system must be in a very rotten condition. Some of these trees even though the soil within 2 feet of the level on which they were planted was sodden with water, were being irrigated to keep them going. The only hope for coconut cultivation in a place like this would be to abandon wet cultivation and widen the bunds on which the coconut trees were planted and deepen the drains between. Except for one tree which showed signs of having at some time had this disease I saw none others attacked by this disease during my tour except in this one village

where possibly 20 per cent of the backwater trees were effected.

At Menmunda we marked one very fine paramba for selecting trees for seed nuts and also several on the red sandy soil near Tikkoti. In one village near here was one tree which it was asserted had more than 200 nuts on it. Certainly the nuts were small, but I have never seen a tree so crowded with fruit. Presumably it was a freak as the Tahsildar informed me that trees have been raised from this seed but only two of them have taken after the parent tree.

From Badagara I proceeded via Calicut to Nanmunda which is in the interior about 12 to 14 miles from the coast. Here most of the gardens are in laterite parambas and the cultivation is far in advance of anything I saw further north. The land is all terraced, each terrace is levelled and bunded and each bund is beaten like the mud wall of the West Coast. The land is frequently cultivated ; in some places as many as eight ploughings are given in a season.

Parambas were selected in Sivapuram, Punaseri and Nanmunda for taking seed nuts. The garden at Sivapuram was the best kept garden I have seen on the West Coast. From the top of a hill near here an extensive view of the Calicut and Kurambranad taluks were obtained. Eastwards the whole area except hill out-crops seemed to be coconuts, right up to the foot of the hills ; with occasionally a narrow strip of wet land following the course of a stream. To the west, the proportion of wet land was very much greater.

From here I went to Tirur where some good gardens were seen though not to be compared with those near Nanmunda. The conditions however

were different and much of the land was sandy. Even here on these sandy soils frequent ploughings are given while the surface is kept level and bunded.

The condition of the coconut varied very much from north as one went southward and this seemed to be largely due to conditions of tenure. In North Malabar the tenant appears to be much more at the mercy of the jenmi. Coconut gardens as a rule are ill-cared for. New planting is much too close and under-planting is usually much closer than the original old plantation. Things improve south of Badagara. Inland in Calicut and Kurumbranad taluks, tenures seem much more certain. Invariably trees are well spaced and underplanting is equally well spaced. Here tenants are I gather mostly of old standing and they have no fear of leases not being renewed. At Tirur planting seems to be equally good but the cause I gather is different here as it is the tenant,I was informed, who has usually the whip hand in that his jenmi owes him money and cannot turn him out.

One coconut pest which I have never heard recorded before is said to be the wood-pecker which pecks into the green nut near the tender base in order to drink the water within. In many places coconut leaf mats are used to cover the bunches as a protection against this pest. Everywhere the wood-pecker was blamed for this damage.

The tour which was completed on February 7 has been most instructive and one cannot help marvelling at the adaptability of the coconut tree which thrives wherever drainage is sufficient from the back-water area to the driest laterite parambas.

NOTE ON COLOUR INHERITANCE IN BELLARY SHEEP.

By G. R. HILSON,
Deputy Director of Agriculture, I—III Circles.

This breed of sheep is so called because, although it is by no means confined to Bellary district, it is in Madras Presidency found in greatest numbers there. It is a very mixed breed. A typical flock will consist almost entirely of woolled individuals, only one or two, if any, hairy sheep being present. Among the woolled animals the following types are to be found :—

Black, which may be either
all black, or ... ... (1)
all black except for a white blaze on the forehead. (2)
Pie-bald (black and white) ... ... (3)
Black-faced, i.e., white body with black on face, feet, etc., vide illustration. (4)
White-faced, i.e., all white, both body and face. (5)

The first three types make up the bulk of the flock. The last type is not common.

When black-faced, the colouration may be spread over almost the whole face, or be limited to a patch round one or both eyes and some black markings about the muzzle. One or both ears will generally be black from $\frac{1}{2}$ to $\frac{2}{3}$ of the distance from tip to base. The toes may all be black or one or more black and the rest all white or partly white and partly black. Occasionally there are black points on the pastern, sheath and hocks, and sometimes there are black spots on the skin growing black or white wool. The horns are

generally pigmented and in some cases there is a distinct black line running from the base to near the tip of one or both horns.

BLACK-FACED RAM, HAGARI NO. 2, OUT OF EWE NO. 1 (BLACK-FACED) BY A BOUGHT RAM (BLACK-FACED), BORN 5TH JANUARY 1913.

WHITE-FACED RAM, HAGARI NO. 3, OUT OF EWE NO. 5 (BLACK-FACED) BY HAGARI NO. 1 (BLACK-FACED), BORN 10TH OCTOBER 1913.
(HAGARI NO. 1=EWE NO. 1×?)

When all white (type 5), the eyelids may be pigmented and the skin alone or both skin and

hair at the tip of the ear is pigmented. The rest of the body is white.

Work on this breed was begun by the purchase in 1911 and 1912 of a few ewes and a ram, all black-faced with the exception of one ewe, which was

BLACK RAM, HAGARI NO. 4, OUT OF EWE NO. 10. (BLACK-FACED) BY HAGARI NO. 1 (BLACK-FACED), BORN 6TH OCTOBER 1913.
Note.—Grey fleece.

RAMS OF THE THREE TYPES.
WHITE-FACED. BLACK. BLACK-FACED.

white-faced. The intention was if possible to establish a black-faced white-woolled breed.

The first black-faced ram used was bought, and was of unknown parentage. The second was dropped by a ewe shortly after she was bought and was of unknown parentage on the father's side. The third was of known parentage. The results of the matings between black-faced ewes and black-faced rams are as follows.

Ewe.	Lambs. Black-faced.	Black.	White-faced.	Pie-bald.
1	3	1	1	...
2	1	2	3	...
3	6	...	...	...
4	3	...	2	...
5 (1)	4	1	3	...
6	2	2	2	...
7 (2)	4	...	2	...
8	3	1	1	...
9	2	4	2	...
10	1	2	1	...
11	2	2	2	...
12 (3)	2	2	...	1
13	1	1	2	...
15	4	1	1	2
16	3	...	...	...
17	...	...	2	...
18	1	1	2	...
19	2	1	2	...
21	1	1	...	...
22	...	1	1	...
24	1	2	1	...
26	1	..	...	...
27	2	...	...	...
33	...	...	1	...
34	1	...	...	...
36	...	...	...	...
38	1	...	...	...
39	...	1	...	...
44	1	...	...	...
Total	52	26	29	3

(1) This ewe gave twins in 1915 and in 1916. In the first case one black-faced and one white-faced, in the second case one white-faced and one black.

(2) This ewe gave twins in 1914. One black-faced and one white-faced.

(3) This ewe gave twins in 1916. One black and one black-faced.

Ewe No. 14 was white-faced. She did not do well and was got rid of after she had given one lamb (black-faced) by a black-faced ram.

Exactly what significance the occurrence of the pie-bald individuals has is not yet understood, but leaving them out of count for the meantime the figures obtained give a fairly close approximation to a 1 : 2 : 1 ratio with the black face as the heterozygote. The possibility of the blacks and the white faces being pure was referred to in the annual report of Hagari Agricultural Station for 1915-16 and since then endeavours have been made to test this point.

Ewes Nos. 23, 25, 28 all black and ewe No. 31 a white-face were kept at Nandyal with a black ram bred at Hagari, with the following results.

Ewe.	Lamb. Black.	Black-faced.	
23	4	...	
25	4	...	
28	1	...	
23(*a*)	1	...	(*a*) First lamb of ewe No. 23 bred to its own sire.
23(*b*)	1	...	(*b*) Second lamb of ewe No. 23 bred to its own sire.
31	...	3	
31(*c*)	...	1	(*c*) First lamb of ewe No. 31 bred to its own sire.
	11	4	

Ewes Nos. 29 and 35, both white-faces, were mated at Hagari with a farm bred white-face ram and both gave white-faced lambs.

Before being sent to Nandyal, ewe No. 28 was mated with a black-faced ram and gave a black-faced lamb. Ewes Nos. 37 and 43, both black, were mated with the same black-faced ram and gave black lambs.

This year (1917) the following ewes Nos. 2, 3, 4, 5, 6, 8, 9, 10, 12, 13, 15, 18, 19, 21, 24, 26, 27, 29, 33, 34, 36, 37, 38, 39, 41, 42, 43 and 44 were mated with the same white-faced ram mentioned above. Of these Nos. 37 and 43 are black, Nos. 29 and 42 are white-faced and the remainder are black-faced.

The expectations were 2 black-faced from the black ewes and 2 white-faced from the white-faced ewes, and 12 black-faced and 12 white-faced from the black-faced ewes. In the first two cases the expectations were realized, in the last case however the numbers were 17 white-faced and 7 black-faced. Thus up to date the following results have been obtained :—

Mating between	Number.	Black faced.	White-faced.	Black.	Pie-bald.
Black-faced and black-faced.	110	52	29	26	3
Black and black	11	...	...	11	...
White-faced and white-faced.	4	...	4	...	...
Black-faced and black ...	3	1	...	2	...
Black and black-faced ...	1	1	...	...	...
Black and white-faced ...	3	3	...	...	...
White-faced and black ...	2	2	...	...	
White-faced and black-faced.	24	7	17	...	...
Black-faced and white-faced.	1	1	...	...	...

So far the results point to the correctness of the theory that the black-faced type is a heterozygote and that the black and the white types are pure. The numbers are too small for that conclusion to be definitely drawn, but it is hoped that it will be possible to test this theory sufficiently at Bantanahal where there is room and keep for a large flock. The problem is important commercially, for though

all black wool brings the best price, grey wool, to which colour the fleece of the black sheep turns after the second shearing, fetches a lower price than white.

NOTE ON MADRAS EGG TRADE.

BY J. CHELVARANGA RAJU,
Acting Deputy Director of Agriculture, IV Circle.

1. *Fowl eggs.*—Fowl eggs come to Madras town from the following places :—

(*a*) Poonamallee and Sriperumbudur tracts, i.e., up to 20 miles west. By road via Poonamallee Road.

(*b*) Chingleput, Vandalur and Tiruporur tracts, i.e., up to 30 miles south. By road via Saidapet.

(*c*) Ponneri, Kathivakkam and Sholavaram tracts, i.e., up to 20 miles north. By road via Perambur.

(*d*) Sholingur, Wallajah road, Kaveripakkam, Katpadi and Chittoor tracts, i.e., up to 80 miles west. By rail via Madras and Southern Mahratta Railway.

(*e*) Shiyali, Chidambaram, Tindivanam and Acharapakkam tracts, i.e., up to 150 miles south. By rail via South Indian Railway.

(*f*) Kavali, Nellore tracts, i.e., up to 120 miles North. By rail via East Coast Railway.

2. The eggs when brought by road are packed loose one over the other in big baskets and carried in kavadis (shoulder yokes). A man can carry 400 to 500 eggs in a kavadi. The agent in the village receives advances from the middlemen and goes from house to house and purchases eggs at a quarter of an anna each. The village agent collects

enough eggs to fill a kavadi and sends to the wholesale merchant in Madras either by rail or road. When sent by rail these are packed in baskets with some grass between two layers of eggs. One hundred eggs are usually packed in a basket. Merchants pay Rs. 2-8-0 per 100 if the purchase is made without opening the baskets and inspecting. The purchaser takes all risk of breakages and small-sized eggs contained in the basket. The option of opening a basket and rejecting the broken and the bad ones is granted if the merchant pays Rs. 3-2-0 per basket of 100 eggs.

The majority of the supply is consumed locally in Madras town and a small quantity only is exported. The wholesale dealers say that some quantity is being purchased by merchants or shippers from time to time and sent to Bombay side, Rangoon and Ceylon, but the trade is small.

A large quantity of fowl eggs is reported to be exported from Cocanada as they are procurable cheaper there. The Cocanada traders are reported to export to Rangoon.

When fowl eggs are sent by steamer, the baskets are reported to be carefully taken and kept in the ice room. On an average 12 eggs are said to weigh 1 lb. The railway freight and other charges are borne by the middleman who sends the eggs to Madras. The price of fowl eggs therefore works out as follows at Madras :—

100 eggs if selected and packed in baskets. Rs. 3-2-0.

100 eggs if not selected and purchased as it is received by the dealer. Rs. 2-8-0.

The total imports into Madras are roughly estimated at from 10,000 to 25,000 eggs a day

according to season. The slack season is from October to December, i.e., the rainy season, north-east monsoon.

3. *Duck eggs.*—The export trade of duck eggs in Madras appear to be in the hands of two or three Muhammadan merchants in the 4th Line Beach, Madras. These confine themselves only to duck eggs and do not trade in fowl eggs. It may be stated that these three have the sole monopoly of the trade in Madras. They have agents all over the important places within the easy reach of Madras wherever there are facilities for duck rearing. These receive advances and roam all over the country from Tuticorin to Madras and from Malabar to Madras financing the duck rearers with small advances and consequently there are several 100,000 of laying ducks under the control of the above noted merchants. To the north of Madras, in Nellore, Gōdāvari, Kistna districts, they have not much scope for the business as the traders of Cocanada have made a similar monopoly. In Negapatam and Pondicherry, however, there appear to be some traders also. The Negapatam traders export the duck eggs to Ceylon, while the Madras traders export to Rangoon. The ducks appear to be the property of the wholesale export merchants and are leased out to rearers on condition of furnishing a rent of so many eggs. They are fed mostly in the rice fields where they glean all dropped grains.

4. *The packing of duck eggs* is made in big earthenware pots about $3\frac{1}{2}$ feet high. Each of these is said to hold about 1,600 eggs. The average weight of a dozen duck eggs is 2 lb. The pots above noted are provided with a thick straw base

which is tied on to the pot by means of two coir ropes, which are looped to form handles. The pot is cased in straw twist.

5. *Pickling of duck eggs and packing for export.*—About Re. 1 worth of slaked lime is used in each pot. Fresh lime is reported to be more effective in preventing the decay of eggs. The eggs are packed in the pot between the layers of slaked lime which fills interstices. The mouth of the pot is then stitched up with gunny bags down to the neck when the pot is ready for shipment. Four to five pots are usually taken in a cart.

6. *Cost of packing and transport.*—The total expenditure incurred in a pot of eggs for packing, transporting and freight is reported to Rs. 12 at present as shown below :—

	Rs.	A.	P.
Pot	1	8	0
Straw	0	8	0
Rope	0	2	0
Slaked lime	1	0	0
Steamer freight	6	0	0
Packing and incidental godown rent.	2	14	0
Total ...	12	0	0

The packing men are engaged on monthly wages who attend to other works also.

Eggs are procurable at Madras at Rs. 20 per thousand, although in the local market the wholesale price is Rs. 25 at present.

7. *Present condition of trade.*—Owing to uncertainty of steamer service on fixed days a large stock of pots packed ready for shipment are lying in godowns at Madras. As the eggs go bad when packed as described above if kept for more than forty days the merchants are incurring loss. The

CONTENTS