With authors' compliments
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Observations on some South Indian varieties and forms of pepper (*Piper nigrum*, Linn).

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Introduction.—The existence of distinct varieties and forms in cultivated pepper (*Piper nigrum*, Linn) in South India is known for a very long time. Most of the experienced pepper growers of the West Coast knew the varieties of pepper they grew for their qualities and gave them different local names. As introductions from one tract to another have taken place the same

varieties are often known by different names in different localities. Some of the outstanding features of the common cultivated forms of pepper of Malabar and South Kanara have been mentioned by Watt (1908), Barber (1909), Govinda Kidavu and Venkateswaran (1929) and Krishna Menon (1949). *Kalluvally*, *Balamkotta*, *Cheriakody*, *Uthirankotta* and *Karinkotta* are the chief cultivated forms of Malabar and South Kanara mentioned by these authors and their descriptions of these were based on preliminary observations mainly on their habits.

The fact that pepper varieties are either monoecious or dioecious is also well known. Barber (1909) has recorded that all the wild vines he observed on the Tambracheri ghat in Wynaad were monoecious, either male or female and that the majority of the cultivated forms was hermaphrodite. To set fruit and to be sufficiently productive the vines should be hermaphrodite was also a fact realized by the same author. However, the vast variability that exists among the cultivated varieties and forms in their sexuality was not known hitherto. Detailed examinations during the last season (1950) of all the Malabar forms and a dozen Travancore forms available at the Agricultural Research Station, Taliparamba and the Malabar forms in the neighbouring gardens and in different tracts in Malabar revealed the vast variability that exists among them with regard to their sexuality. None of the cultivated varieties and their forms was found to be completely hermaphrodite. The higher the degree of hermaphroditism exhibited by a variety or form the greater was the percentage of fruit setting in it indicating that hermaphroditism is the most important factor determining the productivity of a variety or form of pepper. This is a clear indication that the " variety " or " form " is of fundamental importance in pepper cultivation. During the survey of the pepper growing tracts of Malabar and South Kanara in the year 1950 the authors realized that generally pepper growers were ignorant of the existence of sex in pepper and it was a real problem for them. Several pepper gardens were come across in these tracts which have proved to be complete failures due to the simple reason that they were planted with unproductive varieties and either male or female vines. This reveals the great need to provide the pepper growers of the West Coast with scientifically selected plant material and this can only be achieved as a result of intense study of all varieties and forms of pepper grown together at the research station. This short paper gives an account of the observations made on some of the pepper varieties and forms of Malabar and Travancore keeping in view the aspects mentioned in the foregoing lines.

Material and methods.—The studies were made in 1950 on the pepper varieties and forms of Malabar and a dozen Travancore forms grown at the Agricultural Research Station, Taliparamba and also Malabar forms growing in private gardens near this

Agricultural Research Station and in different pepper growing tracts in Malabar. The vines of the Malabar varieties of pepper examined were about twenty to twenty-five years old and those of the Travancore forms were eight years old.

The flowers of these varieties were examined *in situ* in certain cases with a hand lens and in others a representative sample of a large number of spikes gathered from different zones on each vine was examined under a dissecting microscope one by one and the nature of the flowers recorded. The total number of flowers, the proportion in which male, female and bisexual flowers occur on each spike and the zone on the spike in which these different kinds of flowers occur were recorded in several vines of each form studied. The morphology of the different types of flowers was also observed.

The sexuality of the flowers produced by vines in a private garden at Kunnoth in Chirakkal taluk was also studied in June 1950.

Observations—Pepper varieties.—The black pepper of commerce is the product of the species, *Piper nigrum*, Linn. The different varieties and forms of this species are only known by local names. Considerable personal experience is required to distinguish between these varieties and forms of pepper at sight as the differences among them are not always very distinctly marked and the outstanding differences are more in their habits of growth than in their morphology. Familiarity with pepper varieties by constant association is essential to acquire the ability to distinguish them. One and the same variety or form may often be called by different names in different localities. However, many a pepper grower does not know exactly the nature of the varieties he grows. Observations and studies made of pepper varieties and forms in different localities of Malabar and South Kanara and at the Agricultural Research Station, Taliparamba showed that the most common and outstanding varieties and forms of these districts are *Kallivally*, *Uthirankotta*, *Cheriakody*, *Balamkotta* and *Karinkotta*, the same as mentioned by Barber (1909), Govindakidavu and Venkateswaran (1929) and Krishna Menon (1949). Careful examinations and studies of these forms showed that they could be distinguished as follows:—

Kallivally is distinguished by its bushy growth and dark green ovate leaves which are borne usually at an angle of 30° to 45° on more or less horizontal branches. The spikes of this variety are generally short and twisted with close-set, medium sized dark green berries. Its leaves (Fig. 1) are smaller than those of *Balamkotta*, measuring on an average 17·11 cm. × 9·62 cm. The name *Kallivally* is derived from Kallu = stone, meaning hardy type with hard heavy berries, much heavier bulk for bulk and showing less loss of water when dry than in any other variety.

Kalluvally is the one variety of pepper showing the greatest variability in most of its features. Some forms have leaves with shape approaching that of *Balamkotta* and others with long and straight spikes like those of *Balamkotta*. Four or five distinct forms of *Kalluvally* are observed and even these forms show considerable variations within themselves. This is a very hardy variety and is reported by growers to withstand unfavourable weather conditions and exposed situations better than *Balamkotta*. This is easily the most widely grown variety of pepper found in Malabar district and is seen extensively grown in the taluks of Kottayam, southern parts of Chirakkal, Kurumbranad and Wynaad. It is either grown alone or mixed with *Balamkotta*, *Uthirankotta*, *Cheriakody* and some times with *Karinkotta*.

Balamkotta is distinguished by its larger pale green elliptical leaves borne drooping on the partially drooping branches. Leaves of this variety (Fig. 1) seem to be the largest measuring 19·35 cms. by 9·60 cms. The drooping of the leaves results in a tiled arrangement of the leaves hiding most of the spikes. The elliptical leaves are broadest in the middle, but the two halves of the blade are in some forms unequal. The spikes are long and straight and rather loosely and sparsely set with large pale green berries. The berries are lighter in weight bulk for bulk than those of *Kalluvally*.

This variety has much less variability than *Kalluvally* although three distinct forms were observed. One is a small leaved form usually met with in Wynaad (North Malabar) having shorter spikes and smaller berries but having the other features of the typical *Balamkotta*. The well known *Kottavally* which enjoys the greatest popularity among the South Kanara pepper growers is another form of *Balamkotta* differing from the typical *Balamkotta* in having dark green leaves and berries.

Balamkotta is a medium climber and reported to be a regular annual yielder suitable for naturally shaded localities. This is extensively cultivated in the Chirakkal, Kottayam and Kurumbranad taluks of North Malabar and Kasaragod taluk of South Kanara. In the Kurumbranad, Kottayam and southern part of Chirakkal taluk this is usually grown mixed with the varieties *Kalluvally*, *Cheriakody* and *Uthirankotta*. However, in this northern part of the Chirakkal taluk and in the Kasaragod taluk it is grown almost exclusively.

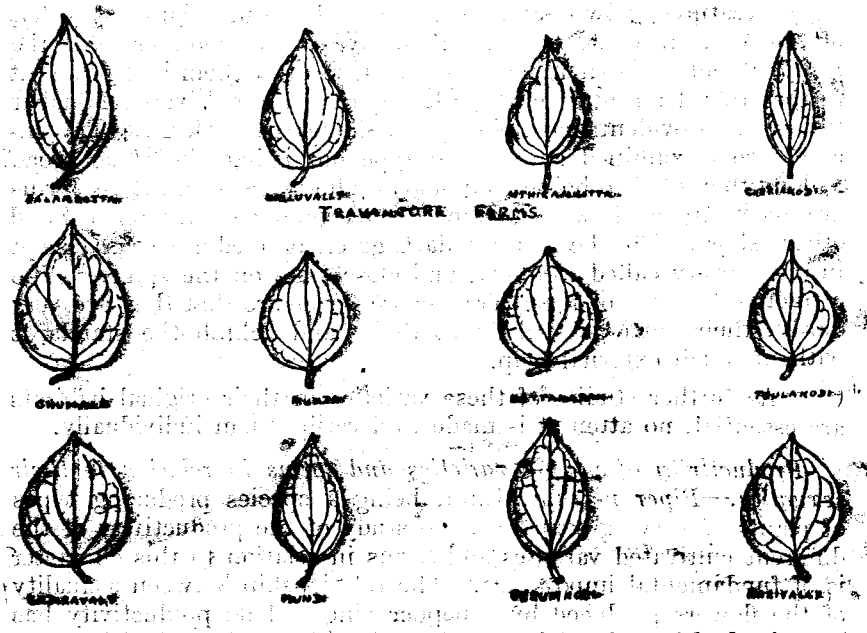
Cheriakody (Cheria = small) is distinguished by its much smaller leaves (Fig. 1) and berries than the other varieties and smallness in all other respects. The leaves measure 15·8 cm. x 6·88 cm. The vines are bushy with elliptical leaves with well marked veins which are deeply impressed, held in a vertical position on horizontal branches. The berries are also dark green and closely set. This variety is common in pepper gardens of

Kottayam taluk and southern part of Chirakkal taluk and is widely distributed.

FIG. 1.

Leaf shapes in Pepper.

MALABAR FORMS.



Uthirankotta (uthiran = shoulder) is distinguished from *Kalluvally* by its sparse branching slightly lighter green leaves with wavy margins borne at an angle of 50° to almost horizontal position. *Uthirankotta* is the most sparsely branched type among the cultivated forms of pepper. The berries are also larger than those of *Kalluvally*, light green, very sparsely set and borne on rather long and more or less straight spikes. In the horizontal position of the branches, colour and other features of the foliage this form resembles *Kalluvally* but its leaves are tough and leathery. A large proportion of the flowers produced by vines of this variety is female and this can therefore be called a predominantly female variety. The form although not favoured by growers is represented by a few vines in almost all pepper gardens in the Kottayam and Chirakkal taluks of North Malabar.

Karinkotta is distinguished from *Kalluvally* by its much larger dark green leaves and larger berries. The size of the leaves 19·83 cm. × 7·07 cm., approaches that of *Balamkotta*. Its berries are larger and more dark green than those of *Kalluvally*, smooth and shining and very closely set on short curved spikes. The most interesting feature about this variety is that the same vine produces leaves having the shape of those of *Kalluvally* as well as those of *Balamkotta*.

This variety is found grown here and there in the Kottayam taluk round about Mattanur and Iritty and Manantoddy in Wynaad taluk.

Travancore forms.—A dozen different forms of pepper obtained from Central and North Travancore and planted at the Agricultural Research Station, Taliparamba in 1942 were also available for observations. Their habits of growth and morphological features show that they are of a different origin from that of the Malabar varieties and forms. A few of them resemble the *Kalluvally* of Malabar in leaf shape, but most of them look different in that they have more circular leaves than the cultivated Malabar forms. It is evident that the shape of the leaves of all these Travancore forms examined are of oval type but being almost as broad as long they tend to become circular. The leaves of all these forms are dark green, however, some forms produce long spikes and others short. The berries are dark green of medium size, except in one variety called *chumala*, and closely set on the spikes. The attractive features of these Travancore forms are that they are very hardy, their cuttings strike root easily and climb the standards without much external help.

As further studies of these varieties in their original habitats are essential, no attempt is made to describe them individually.

Productivity of pepper varieties and forms in relation to their sexuality.—*Piper nigrum*, Linn, being a species producing types of plants of varying sexuality, the study of the productivity of the different cultivated varieties and forms in relation to this character is of fundamental importance. The relationship between sexuality of the flowers produced by a pepper vine and its productivity has not been fully realized by the very few previous workers on this plant in India, like Barber (1907) and M. Anandan (1924). The results of a careful study of all the varieties and forms of pepper available at the Agricultural Research Station, Taliparamba, in this regard are detailed below.

Fruit setting in relation to the nature of flowers in pepper forms.—The results of examination of four Malabar varieties or forms, a dozen Travancore forms and three wild forms are given below. (Table I)

TABLE I.

Serial number and name of variety	Number of vines studied.	Percentage of bisexual flowers.	Percentage of female flowers.	Percentage of male flowers.	Percentage fruiting.
Malabar forms.					
1 Kalluvally	10	80	14	6	80
2 Balamkotta	10	90	7	3	83
3 Cheriakody	2	84	12	4	75
4 Uppumkotta	10	2	88	10	20

Serial number and name of variety.	Number of vines studied.	Percentage of bisexual flowers.	Percentage of female flowers.	Percentage of male flowers.	Percentage of setting.
Travancore forms.					
5 Chumala	11	83	..	7	77
6 Kottanadan	10	81	..	19	87
7 Munda	13	86	12	2	76
8 Tulakodi	12	72	27	1	49
9 Mundi	6	11	88	1	44
10 Arikottanadan ..	8	93	4	3	60
11 Kaniakkadan ..	6	33	66	1	56
12 Kuthiravaly	9	84	16	..	81
13 Perumkodi	12	21	79	..	47
14 Karivally	11	67	32	1	73
15 Kumbhakody	8	93	..	7	73
16 Karivilanchy	12	2	98	..	44
Wild forms.					
17 Wild form of Talipparamba.	1	..	100	..	7
18 Wild form of Singampatta hills.	1	..	100	..	4
19 Wild form from Wynaad.	1	..	..	100	..

While making the above observations the zones in which male flowers occur on the spikes of these forms were also noted and are summarised in the Table given below (Table II).

TABLE II.

Serial number and name of variety.	Number of spikes.					Total.
	Base of spike.	Middle of spike.	Apex of spike.	Distributed all over the spike.	Spikes without male flowers.	
Malabar forms.						
1 Kalluvally	1	7	4	.. ..	13	25
2 Balamkotta	4	9	6	2 ..	29	50
3 Cheriakody	2	..	1	.. ..	7	10
4 Thirankotta	..	..	1	.. 7 ..	37	45
Travancore forms.						
5 Chumala	1	1	3	.. 2	15	22
6 Kottanadan	..	..	1	.. 3	19	32
7 Munda	..	3	..	.. ..	32	35
8 Tulakodi	2	..	..	.. ..	22	24
9 Mundi	..	..	..	.. 2	40	42
10 Arikottanadan ..	..	3	1	1 ..	11	16
11 Kaniakkadan ..	..	1	..	.. ..	11	12
12 Kuthiravaly ..	..	..	1	.. ..	17	18
13 Perumkodi	..	..	..	.. ..	24	24
14 Karivally	1	2	1	.. ..	18	22
15 Kumbhakody	..	2	1	5	8	16
16 Karivilanchi	..	..	..	..	24	24

The observations summarized in the tables given above enable the following inferences to be drawn :—

(*a*) In most of the cultivated forms the large majority of the flowers produced are bisexual.

(*b*) Some of the cultivated varieties and forms like the *Uthirankotta* of Malabar, *Mundi*, *Kaniakadan*, *Perumkodi* and *Karuvilanchi* of Travancore tend to produce more female flowers than male and bisexual flowers.

(*c*) Comparatively very few male flowers are produced in the cultivated forms of pepper. Completely male vines rarely occur. One such vine is spotted in *Kottanadan* variety of Travancore. A wild vine received from Wynaad is also found to be completely male. A wild vine found growing in the Agricultural Research Station, Taliparamba, and another received from the Singampatti hills are found to be completely females.

(*d*) Percentages of male flowers on the spikes of the cultivated varieties and forms vary from 0 to 19. There are spikes without any male flowers on them. Male flowers may be seen at the base, middle and apex of the spike and sometimes even distributed over the entire spike.

(*e*) The larger the percentage of bisexual flowers on the spikes of a variety or form the greater the setting of berries obtained.

To see whether those Travancore forms which were observed to produce a majority of bisexual flowers in the last season and showed higher percentages of setting were consistently productive during the past years, their yields during the last five years were referred to and are given in the table below (Table III).

TABLE III.

Serial number and name of form.	1944 number of vines bearing.	945 weight of berries in ounce.	1946 number of spikes.	1947 weight of berries in ounce.	1948 weight of berries in ounce.
(1)	(2)	(3)	(4)	(5)	(6)
1 Chumala	7	5	30	10	120
2 Kottanadan	9	..	24	14	213
3 Munda	13	2	39	22	333
4 Tulakodi	10	12	44	7	152
5 Mundi	10	2	97	25	194
6 Arikottakadan	11	1	3	1	48
7 Kaniakadan	8	4	2	1	63
8 Kuthiravely	9	1	2	1	140
9 Perumkody	12	2	12	3	89
10 Karivally	6	5	30	1	64
11 Kumbhakody	6	1	23	2	33
12 Karivilanchy	7	3	25	1	165

	1949 weight of berries in ounce.	1950 weight of berries in ounce.	1950 percentage of setting.	1950 percentage of bisexual flowers.
	(7)	(8)	(9)	(10)
1 Chumala	1,765	320	77	83
2 Kottanadan	1,446	184	87	81
3 Munda	1,927	167	76	86
4 Tulakodi	962	116	40	72
5 Mundi	402	70	44	11
6 Arikottanadan ..	483	34	60	98
7 Kaniakadan	13	19	56	33
8 Kuthiravaly	644	80	81	84
9 Perumkody	481	63	47	21
10 Karivally	971	42	73	67
11 Kumbhakody ..	644	39	73	93
12 Karivilanchy	650	40	44	2

From this it is sufficiently clear that one of the most important factors affecting productivity in a pepper variety is the percentage of flowers on a spike which set into fruit and a general examination of productivity based on fruit setting of all the varieties and forms growing at this station show that those having predominantly bisexual flowers on their spikes are the most productive. Those having predominantly female flowers are seen to be definitely less productive. To confirm these, observations were also made in the neighbouring pepper gardens during this season and the results of their examinations are given in Table IV.

TABLE IV.

Serial number and name of variety and source.	Percentage of bisexual flowers.	Percentage of female flowers.	Percentage of male flowers.	Percentage of fruit setting.
1 Kalluvally A.R.S. Taliparamba.	80	14	6	69
2 Kalluvally A.R.S. Karimbath garden I.	76	24	..	82
3 Kalluvally A.R.S. Karimbath garden II.	99	1	..	74
4 Balamkotta A.R.S. Taliparamba.	90	7	3	63
5 Balamkotta A.R.S. Karimbath garden I.	81	12	7	76
6 Balamkotta A.R.S. Karimbath garden II.	92	8	..	77
7 Cheriakody A.R.S. Taliparamba.	84	12	4	74
8 Cheriakody A.R.S. Karimbath garden I.	80	11	9	79
9 Uthirankotta A.R.S. Taliparamba.	2	88	10	29
10 Uthirankotta A.R.S. Karimbath garden I.	8	82	10	25
11 Uthirankotta A.R.S. Karimbath garden II.	..	100	..	10

It is interesting to see that the observations made in these private gardens have fully confirmed the observations made at the Agricultural Research Station, Taliparamba.

(*f*) It was seen that among the cultivated forms in Malabar, *Uthirankotta* has mainly female flowers and usually female flowers only. It can, therefore, be called a predominantly female variety. It is a well known fact that *Uthirankotta* is a poor yielder susceptible to early spike shedding and hence not favoured by pepper growers. In certain years *Uthirankotta* variety is known to produce good crops, perhaps in such years they get the advantage of pollen from other neighbouring varieties which flower at the same time. This variety is always grown mixed with other varieties. It may be presumed that if grown alone this variety will be a thorough failure just as the wild female ones. However, it is a hardy type producing profuse shoots at the base and the cuttings from this rarely fail to strike roots.

(*g*) In view of the observations that comparatively few male flowers are produced by these cultivated forms and those having predominantly bisexual flowers seem to be most productive, availability of pollen from the stamens of the bisexual flowers seems to be all important.

Sexuality of pepper varieties and forms in relation to shade.—At the Agricultural Research Station, Taliparamba, there is a large area (about 16 acres) of pepper crop abandoned for the last ten to fifteen years, overgrown with thick shade. In this area many of the old vines which are about 25 years of age still survive but are in a much deteriorated condition due to lack of sufficient sunshine and care. It was observed that setting of berries in these vines were generally very poor. The vines standing in this area are *Kalluvally*, *Balamkotta* and *Uthirankotta*. Twenty and twenty-one contiguous vines in two different patches in this area were examined in September 1950 to see why setting was generally poor under thick shade. A sample of a large number of spikes collected at random from each of the forty-one vines was examined for the sexuality of the flowers and percentage of fruit setting. The results of these examinations are summarized in the following table. (Table V.)

TABLE V.

Serial number and name of variety.	*The nature of the majority of flowers.*	*Percentage of fruit setting.*
	Patch I.	
1 Kalluvally	Female	14
2 Do.	Bisexual	10
3 Do.	Do.	13
4 Do.	Female	12
5 Do.	Do.	10
6 Do.	Do.	16
7 Do.	Do.	25
8 Do.	Do.	22
9 Do.	Do.	13

Serial number and name of variety.	The nature of the majority of flowers.	Percentage of setting.
	Patch I—cont.	
10 Kalluvally	Bisexual	27
11 Do.	Female	12
12 Do.	Bisexual	15
13 Balamkotta	Female	15
14 Do.	Do.	13
15 Do.	Do.	11
16 Do.	Do.	12
17 Do.	Do.	23
18 Do.	Bisexual	30
19 Do.	Do.	13
20 Uthiramkotta	Female	7
21 Do.	Do.	4
22 Kalluvally	Bisexual	21
23 Do.	Do.	22
24 Do.	Do.	27
25 Do.	Female	16
26 Do.	Bisexual	17
27 Do.	Female	13
28 Do.	Do.	16
29 Balamkotta	Do.	18
30 Do.	Bisexual	14
31 Uthiramkotta	Female	6
	Patch II.	
32 Kalluvally	Female	32
33 Do.	Do.	23
34 Do.	Do.	14
35 Do.	Bisexual	26
36 Do.	Female	20
37 Balamkotta	Do.	21
38 Do.	Bisexual	18
39 Do.	Female	18
40 Do.	Do.	22
41 Uthiramkotta	Do.	5

It is interesting to see that irrespective of the varieties percentage of setting of berries in these vines is invariably poor, far inferior to the vines of the same varieties standing in other fields where shade is regulated. It is also seen that unlike the vines growing in other fields, the percentage of female flowers is predominating in twenty-eight out of the forty-one vines. It, therefore, seems clear that intense shade has tended to produce more female flowers than bisexual flowers. Consequently the amount of pollen available would have been very limited and the poor setting of berries could be attributed to this. It is observed that the production of spikes is also very sparse under thick shade.

Discussion—Distribution of pepper varieties and forms of Malabar.—The brief descriptions of the chief pepper varieties of Malabar given above are only on their outstanding features which would help in their identification. Detailed and systematic studies on the morphology and classification of all these varieties and forms are in progress and will be presented in a future paper.

Little is known about the distribution of cultivated pepper varieties and forms in Malabar. Krishna Menon (1949) has briefly indicated some of the tracts in which these varieties and forms are grown, but the survey of pepper varieties in Malabar and South Kanara made by the authors during 1950 has brought out clearly the natural distribution of these varieties. Introductions from tract to tract have taken place in recent times but it is possible to trace more or less correctly the original home of these varieties and forms.

From the details regarding the distributions of pepper varieties and forms in the districts of Malabar and South Kanara given above, it may be seen that almost all the varieties and forms are found grown in the Kottayam taluk and southern parts of Chirakkal taluk of North Malabar. In fact, only in the tract round about Mattanur, Irikkur, Iritty, Velakode and in Peralimalai and Kalliat areas, all the Malabar varieties are found grown either alone or mixed together. In no other pepper growing area all these varieties are found grown together. It is thus clear that, apart from Travancore, this region which forms the hinterland of Tellicherry and Cannanore, the two most important commercial ports of North Malabar, was the original home of pepper on the West Coast from whence all the Malabar varieties have originated. History says that Vengad, a village near Anjarakandy, four miles south-west of Mattanur and about thirteen miles north-east of Tellicherry was the seat of pepper trade in Malabar in medieval times and was found so by the East India Company. It was from this tract that pepper cultivation has spread to Wynaad and Kurumbranad taluks and to the tract extending northwards from the north-eastern part of Chirakkal taluk to the south-eastern portion of the Kasaragod taluk of South Kanara. This last pepper tract which lies east of Payyanur and Kanhangad extending up to the Coorg border is a comparatively very new pepper area. Cultivation of pepper was introduced into this area not more than fifty years ago. The fact that the form of *Balamkotta* locally known as *Kottavally* alone is almost exclusively grown in this tract is a conclusive proof that this is a new tract and the variety has been introduced into this tract only recently.

Sexuality of pepper varieties.—It is clear from the observations on pepper varieties recorded above that there are considerable variations among them with regard to the percentage of bisexual flowers they produce on their spikes, the higher the percentage of bisexual flowers in a vine the greater being its productivity. In the Malabar varieties and forms it varies from 99 per cent in *Balamkotta* to 2 per cent in *Uthirankotta* with 60 per cent and 84 per cent in *Kalluvally* and *Cheriakody*, respectively. It may thus be seen that *Balamkotta*, *Kalluvally* and *Cheriakody* are productive types. *Uthirankotta*, however, has 88 per cent female flowers and this can definitely be called a predominantly

female form. It is this character that makes this variety unproductive and usually causes its spikes to be shed. If grown exclusively it can produce only very insignificant yields and its occasional productivity in mixed gardens is due mainly to the availability of pollen from other bisexual forms standing nearby. Similar variability is seen in the Travancore forms also, the percentage of bisexual flowers in them varying from 93 to 2. It may be mentioned in this connexion that the yield of pepper vines depends not only on the sexuality of the flowers produced by them but also on other inherent characters such as the number of spikes produced by a vine, the length of the spike, the number of bisexual flowers per unit length of the spike and the relative weight of the berries and black pepper produced by them. Anyway the fundamental importance of the sexuality of the vine in pepper cultivation cannot be over-emphasized. Although Barber (1909) and Anandan M. (1929) realized the relationship between sexuality and productivity in pepper they had not sufficiently realised, as mentioned above, the vast variability that exists among the cultivated varieties and forms in this respect.

During the survey of pepper growing tracts in Malabar and South Kanara the authors have come across a number of pepper gardens which have proved complete or partial failures simply because they are planted with unproductive types and vines producing only spikes, male or female. It was also observed that male vines generally flower earlier than female vines, the male vines thus being of no use in fertilising the female vines. A pepper garden at Kunnoth in Chirakkal taluk, North Malabar, which although planted twenty years ago in a suitable area of twelve acres have proved to be a complete failure all along. Only very meagre, unprofitable yields are obtained in spite of the best care bestowed on the garden. With a view to investigate the causes of failure of this garden a number of vines in different patches of the garden were examined in September 1950. The results of examinations of twelve contiguous vines in a row are given below (Table VI) as an example. The majority of vines in the garden is *Kalluvally* with a few *Uthiramkotta* and *Balamkotta* vines here and there.

TABLE VI.—*Serial number of vines arranged in a row.*

		1	2	3	4	5	6	7	8	9	10	11	12
Bearing or not	..	No	Yes	No	No	No	Yes	No	No	Yes	No	Yes	No
Average number of different kinds of flowers on a spike in a sample of ten spikes.	Bisexual.		12				7			50		17	
	Male vine.			Male vine.	Male vine.		Male vine.		Male vine.		Male vine.		Male vine.
	Female.		52				42			—		45	
	Male.		3				..			—		—	

It is interesting to see from the data given above that the majority of plants is male and only a minority productive. It is also observed that these bearing plants produce a large majority of female flowers, the percentage being 88. The percentage of fruit setting in these vines is also very poor. Obviously they are not sufficiently benefited by the pollen from the adjoining male vines, due perhaps to the different times at which male vines and other productive vines flowered. A similar examination of different patches of vines in the garden gave similar results. The above observations at once indicated that an examination of the few most productive vines scattered here and there in the garden is essential, and twelve such vines were individually examined for the nature of the flowers produced on the spikes. The results are given in the following table. (Table VII.)

TABLE VII.—*Serial number of vines.*

		(1)	(2)	(3)	(4)	(5)	(6)
Average number of different kinds of flowers per spike in a sample of ten spikes taken at random.	Bisexual	..	72	28	..	39	23
	Female	56	..	50	79	27	49
	Male	12	..	..	..	..	..

		(7)	(8)	(9)	(10)	(11)	(12)	*Total.*
Average number of different kinds of flowers per spike in a sample of ten spikes taken at random.	Bisexual	49	54	27	58	42	29	388
	Female	62	11	49	2	163	44	498
	Male	2	2	..	..	..	22	44

It is clear from the results that the large majority of the most productive plants has either a majority or a sufficiently good proportion of bisexual flowers. This seems to be a convincing proof of the direct relation between the occurrence of bisexual flowers and productivity in vines. There are innumerable such gardens in Malabar. The availability of suitable material for planting is therefore a serious problem for pepper growers at the present time and shows how the industry stands in great need of assistance in the matter of providing them with scientifically selected plant material. This is practically so in view of the fact that very few growers know the existence of sexuality in pepper and where they stand with regard to the varieties and forms they grow. The scope for the improvement of the pepper crop by selection of productive clones is also very great.

Influence of season and other factors on sexuality of pepper.—The fact that degree of shade can influence the sexuality of the flower is very interesting, in that environment can fluctuate the sexuality of a vine to a considerable degree. If so, it may be expected that a certain amount of seasonal fluctuations in the production of bisexual and unisexual flowers in pepper varieties may occur. This is under study and the results of these studies

will be presented in a future paper. However, a preliminary but interesting observation made on the pepper crop of this Research Station and the neighbouring gardens is worth recording. In the middle of April last (1951) over six inches of rainfall was received in North Malabar all of a sudden after a spell of six months of severe drought. This induced about 20 to 25 per cent of vines at this Research Station and in the neighbouring gardens to flush and put forth flowers. If very heavy rains are received in April to May pepper vines may begin to flush. The normal season for flushing is June, soon after the south-west monsoon starts. Early flushing in April or May is considered by pepper growers to be very undesirable as a spell of rainless period, which may usually follow, causes all the early spikes to shed. If a second flushing occurs on the same vines again at the beginning of the monsoon it will invariably be far below normal. Such sheddings of pre-monsoon spikes are usually considered by the pepper growers of Malabar as due to lack of sufficient rains immediately after the early flowering. All the vines that flushed early were examined carefully for the nature of the flowers on them. It was extremely interesting to see that the flowers produced on these vines were all females and no male or hermophrodite flowers could be seen. As these flowers are not fertilized due to absence of pollen the spikes are all shed a few days after they are formed. The shedding of these early formed flowers during the present season was found to be entirely due to lack of pollen. On five of the vines which flowered early bisexual flowers began to appear towards the end of May. It should also be mentioned that the vines which flowered early are mostly of the hermaphrodite forms like *Kalluvally* and *Balamkotta*, *Kalluvally* being the variety which manifested early flushing to the highest degree. The flowers produced by these vines are seen to be of the hermaphrodite type, indicating that the true nature of vines has begun to assert itself with the onset of the monsoon. In a recent visit to Cochin and Travancore made between the 13th and 21st of May 1951 one of the authors had occasion to observe the pepper vines on either side of the railway line and bus route. As one goes further and further south the intensity of flushing of vines was seen to increase in the south down Malabar. In Cochin and Travancore almost every vine had flushed in April itself. In the pepper gardens in central Travancore the vines were found to produce a majority of bisexual flowers. This is very interesting in view of the fact that Travancore and Cochin had plenty of rains in March, April and May giving the pepper vines in that region favourable conditions for exhibiting their natural habit of hermaphroditism. On the other hand in Malabar there was no rainfall at all for six months, and suddenly six inches of rain was received in the middle of April. This downpour of rain induced flushing in some of the vines. However, the preceding severe drought conditions had made the physiological condition of the vines unfavourable for exhibiting hermaphroditism. This is a clear indication that

sexuality in pepper vines is highly influenced by weather conditions, especially time and intensity of rainfall. This is a very important and interesting problem as far as pepper crop is concerned and is receiving due attention. If abnormalities in weather conditions can fluctuate sexuality of pepper vines within a season there is every reason to suspect that it can do the same thing from season to season also. As these are fundamental factors affecting productivity in pepper their investigation is of great importance and is being pursued.

Origin of cultivated pepper.—The data gathered so far is insufficient to attempt a discussion of the phylogeny of the varieties and forms of the species *Piper nigrum*, Linn. The cultivated pepper has originated from wild pepper. Pepper in its wild state is still found growing in the rain forests of the Western Ghats up to an elevation of 4,000 feet from Cape Comorin right up to North Kanara in the Bombay Presidency. The observations made so far show that the varieties and forms of Malabar and those of Travancore are of entirely different origin as far as could be judged from their external morphology. There is practically no difference among the pepper varieties of West Coast with regard to the external morphology of their flowers. The differences are noticeable only in their habits of growth and size, shape and colour of leaves, spikes and berries. These characters are sufficient to distinguish between the different varieties and forms. The distinct differences between the Travancore and Malabar varieties, especially in leaf shape (Fig. I) indicate that they are of different origin. The circular shape of leaves of the Travancore varieties is rarely found in Malabar. The *Balamkotta* type of leaf and habits of growth seem to be entirely absent in the Travancore region and it is to be presumed that the pepper varieties of each of these regions originated from the forests of the region.

The wild vines observed in the Thambracheri Ghat by Barber (1909) and those observed by the authors in the Singampatti hills are all monoecious, whereas most of the cultivated forms are hermaphrodite, a small minority like *Uthirankotta* of Malabar and *Karivilanchi* of Travancore being female. The cultivated hermaphrodite forms of pepper must have originated as a result of continuous selection by man from very ancient times. When he began to grow pepper for his own needs he started selecting the most productive from the wild vines existing at the time and this process of selection for hundreds of years has given him the present day cultivated hermaphrodite forms of pepper which are not found in a wild state. It is thus clear that the hermaphrodite forms have originated from wild monoecious forms the representatives of which still exist in the Western Ghats. No scientifically selected clone of pepper exist in India at present as no scientific work of this kind has been done in India yet.

Only when a survey of all the wild and cultivated varieties and forms of pepper throughout the south-west coast of India from Cape Comorin to North Kanara in the Bombay Presidency is completed and their characteristics studied, will it be possible to trace the full phylogenetic history of the existing forms of pepper.

Summary and conclusions.—(1) The most outstanding features which would help in the identification of the important pepper varieties and forms of Malabar, i.e., *Kalluvally*, *Balamkotta*, *Cheriakody*, *Uthirankotta* and *Karinkotta* are described. Mention is also made of the general features of twelve Travancore forms grown at the Agricultural Research Station, Taliparamba.

(2) Productivity of pepper varieties in relation to their sexuality is discussed. The following conclusions have been arrived at :—

(*a*) The wild varieties observed in Wynaad, Singampatti hills and the Agricultural Research Station, Taliparamba, are seen to be monoecious.

(*b*) Large majority of cultivated varieties of pepper are hermaphrodite, with the exception of the *Uthirankotta* of Malabar and four varieties of Travancore which are found to be predominantly female.

(*c*) Comparatively very few male flowers are produced in cultivated forms and they are distributed irregularly on the spikes.

(*d*) The larger the percentage of bisexual flowers produced by a vine the greater is the percentage of fruit setting on it.

(*e*) There is vast variability among the cultivated varieties and forms with regard to their hermaphroditism, the percentage of bisexual flowers in them varying from 93 to 2.

(*f*) The yields of the twelve Travancore forms grown at the Agricultural Research Station, Taliparamba, for the past five years invariably confirmed that there is direct relation between hermaphroditism and high yield.

(3) Intense shade has tended to produce more female flowers than bisexual flowers in hermaphrodite forms of pepper, resulting in poor setting of fruits and therefore poor yields.

(4) The distribution of the pepper varieties and forms of Malabar is briefly discussed. Survey of pepper growing tracts of Malabar and South Kanara indicated that Kottayam taluk and southern parts of Chirakkal taluk of North Malabar was the original home of the pepper varieties and forms found in Malabar and South Kanara.

(5) The cultivated forms of pepper which are mostly hermaphrodite originated from the wild vines, representatives of which are found growing in the forests of Western Ghats, while none of the cultivated forms is found in the wild state.

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DISCUSSION.

Observations on some South Indian varieties of pepper.

[By P. Abraham—Presented by G. V. Narayana.]

The full paper was not presented.

Sri M. B. V. Narasinga Rao wanted to know whether there were any foreign varieties in the collection that were now being studied at Taliparamba. A good deal of physiological and biochemical work was also needed for pepper improvement. Since wild types of pepper were reported to be present in the Circars also, it appeared to him that Malabar could not be claimed as the sole centre of origin for pepper.

Sri G. V. Narayana in his reply stated that there were very few varieties in collection at Taliparamba. Even the so-called different varieties from Java and Malaya were not likely to be very distinct from those cultivated in Malabar. Varieties from other places would be obtained and studied. The pepper area had not been properly surveyed and the available data were too meagre to postulate on the primary and secondary centres of origin of this crop.

Sri C. Rajasekhara Mudaliar enquired as to what would happen if the plants grown in the shade were subsequently exposed to sunlight.

Sri G. V. Narayana replied that this aspect would receive attention.

Sri T. Srinivasan asked whether any work had been conducted to produce viable seeds and whether the effects of hormones have been studied in this regard.

Sri G. V. Narayana replied that the pepper seeds are ordinarily viable and the study of effects of hormones would be included in the programme.

Sri P. Krishna Rao pointed out that only an abstract was available for discussion and in the absence of the full paper, profitable discussion was not possible.

Sri Sampath stated that for an understanding of the taxonomy of the pepper crop it was desirable to study plants raised from seeds, without restricting it to clonal types. Breeding and cytological investigations should go hand in hand. In Malaya certain trace elements were reported to have been estimated in pepper and Molybdenum was found in the seeds. He suggested that this aspect may be investigated to assess the effect of trace elements on pepper cultivation in Malabar.

Sri U. Narasinga Rao stated that greater uniformity was obtained in clonal propagation and wondered why the study should be extended to plants raised from seeds which may show wide variation.

Sri G. V. Narayana replied that the term varieties were used in relation to the agricultural varieties and not to botanical types. In Malabar, with the heavy rainfall of 100 to 150 inches it was quite possible that trace elements might be the limiting factors. This aspect would also be studied.

CONCLUDING REMARKS BY THE PRESIDENT.

As already mentioned this is the first conference of its kind. The worker gets an opportunity to know the problems tackled by the others and the methods adopted by them. If these papers are published, only a few, who are interested in the subject will read them, but in a conference of this kind an opportunity is afforded for knowing each other's difficulties. The results would have been still more helpful if the work had been planned beforehand in consultation with one another before being actually taken up for investigation. In present day research, a full co-ordination of effort is needed and team work in tackling different problems has always to be kept in view. In the olden days the Indian Council of Agricultural Research was sanctioning any scheme put up by the States without reference to duplication of similar work in other States, but this policy has now been reorientated and new schemes are sanctioned only on the following basis :—

(1) Problems of purely local importance have to be financed by the States concerned.

(2) Problems of regional importance covering a wider field with applicability for more than one State are considered by the Indian Council of Agricultural Research after scrutiny to avoid the duplication and ensure co-ordination.

(3) Problems of fundamental importance are to be tackled by the Universities where greater facilities are available in the shape of apparatus and personnel to tackle the problem.

I find that most of the papers discussed to-day relate to problems on plant breeding. I would like that attention is also paid to problems like weedicides and fodder grasses for a study of fodder grasses the conditions in the south appear to be more favourable than in the north.

Sri P. D. Karunakar, Principal, proposing a vote of thanks to the President remarked that besides the papers read at the Conference there were a number of papers which could not be taken up for want of time. He was thankful to the Director of Agriculture and the Headquarters Deputy Director of Agriculture, to whom is due the credit of conceiving the idea of a Conference of this kind.