GENERAL PRINCIPLES OF SELECTION AND THEIR APPLICATION TO HEVEA.

R. A. TAYLOR, B.Sc.,

Physiological Botanist, Rubber Research Scheme (Ceylon).

Introduction and General.

It must be apparent to even the most unobservant what a large part the breeding or selection of desirable varieties of plant or animal has played in bringing Agriculture to its present state of efficiency. As an example may be cited the ordinary cereal crops, wheat, oats, etc. These plants of present day cultivation are so entirely different from the wild varieties from which they were developed that they might lead anyone to doubt their origin. Possibly a still more striking example is to be found in the Cabbage family where the fullest use has been made of ' Sports.' Besides the many varieties of ordinary cabbage the Cauliflower, Brussels sprout, etc., are included here.

It may seem strange that it is possible to alter so completely the nature and appearance of a plant. The individuals belonging to any one botanical species are usually assumed to be identical, but an inspection will reveal differences in some respects, possibly minute but none the less real. This variation between the individuals of a species and the benefits or handicaps in the struggle for existence imposed on the variants by the possession of some such difference is the basis of Darwin's theory of Natural Selection.

Before the most recent developments in plant breeding, this variation was made use of by agriculturists. Plants which showed the desirable character in the highest degree only were chosen as seed producers, and in the course of several generations an enormous improvement was made in the particular crop; take again the example of wheat. Some such selection is now being practised in rubber growing. Seeds are taken only from trees which show high yields which in this case is the desirable character. It may not be out of place to state here that the use of seed collected indiscriminately from a field which has a name for good yield need not give increased yields in the plants produced. It is essential that seeds from trees of known good yield only should be used. This is obvious from the fact that any field will contain a fairly high percentage of trees yielding less than the average, and seedlings from these cannot be expected to prove as good as those from the fewer really good trees.

In annual crops the method of selection may not take any very great number of years to produce a really good strain but with a tree crop such as rubber it would take too long and will only be used until a better method is devised.

One method of ensuring that all the trees of a field will yield above the average is to plant budded rubber, using buds only from proved mother trees. This is of course merely a method of reproducing any particular tree which gave an exceptional yield in previous years. All the individuals of the clone so formed are really parts of the same tree.

Breeding is different and implies the artificial crossing of two individuals showing desirable characters so as to produce a pure breeding strain combining these characters in each member. The nature of individuals produced by the crossing of others with known characters is explained by the Mendelian Laws.

Mendel's Laws of the Inheritance of Characters and Notes on " Sports " etc.

Assume that it is required to cross two individual plants. Take as example the plant used by Mendel namely the garden Pea, He first took two different strains which always bred true, a dwarf variety and a tall variety. He crossed these and found that no matter which was used as pollen and which as pistil flower, all the offspring were tall, and indistinguishable from the tall parents. The fact that the factor for tallness has been introduced into the strain obscures that for dwarfness or lack of tallness. Tallness is said to be dominant and the lack of it recessive. He next took each of these ' hybrid ' individuals and ' selfed ' them. In this resulting or second generation he obtained both tall and dwarf peas but the former outnumbered the latter by three to one. The dwarf character appeared again in the second generation. Now take another factor studied by Mendel, colour of the flower. Obtain a strain of peas which always have coloured flowers and another having only white flowers. Cross these and all the offspring will all be coloured. Colour is dominant to whiteness. By selfing the first generation as before both varieties are again obtained but in the proportion of three coloured to one white.

Now study a combination of these two characters, cross a tall-white with a dwarf-coloured. All the individuals of the first generation are tall and coloured as these factors are dominant. By ' selfing ' this first generation in the usual way four different varieties of pea are obtained and in the following proportion :—

9 Tall and coloured
3 Tall and white
3 Dwarf and coloured
1 Dwarf and white.

As will be seen there are 3 talls for every dwarf and 3 coloured for each white. In the above cases the factors are completely dominant or completely recessive, and the first generation is indistinguishable from certain of the parents, but sometimes such a cross produces an intermediate variety. Here also each character seems to be affected by only one factor which is carried by the nucleus of the reproductive cell. Some characters have been found to be affected by two or more factors, and different forms are obtained by omitting one or other of these modifiers from the composition of the zygote. It can be seen that a character appearing only when three factors are present in the zygote might, by the laws of chance, appear suddenly in a single individual and give the appearance of a new form. The factors are carried by the gametes and as has now been proved by the chromosomes of the nucleus of that cell. Now in the divisions of the cells of the reproductive organ immediately preceding the formation of the reproductive cell the nucleus of the parent cell undergoes many complicated modifications. In the mature plant the nucleus usually contains a certain even number of chromosomes but in the reproductive cell the number is halved. In the mature plant the chromosomes are in pairs and one of each pair goes to each reproductive cell at the final division.

In certain plants, for example the evening scented primrose, many ' sports ' have arisen. These show characters sufficiently different from those of the parents to necessitate the use of new specific names. In certain of these it has been proved that the division which halves the number of chromosomes has been irregular, and one cell has got one more and the other one less than the normal number. The possession of this extra chromosome has had the effect of altering the nature of the plant, it has a double charge of the characters borne by that chromosome. This explains one way in which ' sports ' may arise.

Also as has been proved in the case of colour of sweet peas, a factor is occasionaly for some reason lost, and the character affected by that factor is of course altered. The appearance of many of the earlier new varieties of sweet pea has been explained in this way.

Inherited Characters in Hevea.

Our present knowledge of inheritance of characters in Hevea is scanty but there is some evidence to show that yield is inherited. The following points may be given as evidence :—

(1) In plots of seedlings from a common mother tree the variation in yield between the individuals is much less than between trees in a plot of ' mixed ' seedlings.

(2) Seeds from good yielders produce offspring with a higher average yield than seeds from poor yielders.

As no work has yet been completed on the inherited characters in Hevea there is no means of saying whether yield is governed by one or more factors.

Methods of Crossing and ' Selfing.'

Without entering into detail about the technique of artificial pollination it may be stated that the ' selfing ' of Hevea has proved different, only a few trees have been successfully ' selfed ' and, as far as I know, none in Ceylon.

The method of isolated seed gardens provides an easier means of crossing two desirable trees. Budgrafts from the two mother trees are planted together in a special position which is several miles from the nearest rubber and allowed to cross naturally. The method is to be used in an attempt to ' self ' certain trees if satisfactory situations are available. Budgrafts from one tree only will be used in these seed gardens.

Work in hand.

The work at present in hand consists of the preliminary investigation of possible mother trees. Individual yield records are being kept of 140 to 150 trees on 19 estates in different districts. Stocks grown from seed from known trees are expected to be ready for budding in 1926.

Conclusion.

It willl be seen that the breeding of strains of high yielding trees will take a very long time unless some method of encouraging the tree to flower at an earlier age is discovered. Any delay in these operations will place Ceylon still further behind other countries, and it may be mentioned again that estates will benefit later by helping now in the testing out of possible mother trees,

DISCUSSION.

MR. BRUCE FOOTE made reference to the time it would take before any indications could be obtained on the characters of selected seedlings and their progeny. He stated that it must be at least 12 years from the time the first seeds were planted before anything would be known.

MR. TAYLOR replied that it should be possible to shorten the period of waiting by means of budding from trees of known parentage.

MR. WINTER then asked if the taking of buds from branches would not lead to the resultant plants having watery latex, the same as that from the branches themselves.

MR. O'BRIEN stated that when he was in Java some of the earliest budded plants were tapped and it was found that the latex was quite normal.

THE DIRECTOR OF AGRICULTURE outlined the work on budding and selection already done and indicated the nature of the work which would be carried out by the Research Scheme on the Experiment Station which it was now opening in the Kalutara district.

TREE SURGERY AS APPLICABLE TO RUBBER.

R. H. STOUGHTON-HARRIS, B.Sc., A.R.C.Sc.,

Mycologist, Rubber Research Scheme (Ceylon).

This paper is intended to give an outline of modern methods of tree-surgery generally and in particular of some methods worked out by the Rubber Research Scheme for use on Rubber especially.

'Tree-surgery' includes all such operations as removal of branches and roots, pollarding, treatment of snags and decayed forks, and excavation of the trunk for wood-rots, etc. The methods advocated and the common errors made on estates may be outlined as follows.

Removal of Branches.

In all cases it is essential that branches should be cut off level with the trunk so as to leave no projecting stumps or 'snags.' Branches should not be removed in one operation, but a first cut made on the underside about a foot from the main stem going half-way through the branch, followed by a second a few inches further from the stem cutting off the whole branch. The snag is then sawn off close to the trunk. The cut surface should be treated with a strong wood-preservative and/or coal tar.

Removal of Roots.

Where practicable dead or diseased roots should be removed in a similar manner to that advocated for branches. Otherwise they should be sawn off perpendicularly and cleanly, treated with a wood-preservative and tarred. The advisability of cutting roots during agricultural operations is a much disputed point, but there can be little doubt that unless great care is taken to protect the cut surfaces and to give them every chance to heal quickly, very great danger of root infection is probable.