THE TEA PLANT IN INDUSTRY: SOME GENERAL PRINCIPLES

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THE tea plant was originally classified as *Thea* but was later considered by some botanists not to differ sufficiently from those characters already defined as *Camellia*. At an international conference of botanists which was held in Holland in 1935, it was decided that the tea plant should in future be classified as *Camellia*. An international conference of horticulturists held at Paris in 1932 had already come to a similar decision. It is, in fact, now considered that there is no valid distinction between the characters which have been used to define a plant as a *Thea* and those used to define a plant as a *Camellia*. The tea plant may satisfactorily be called *Camellia Thea* Link. The term "Link" refers to a preserved specimen and to a description—in unmistakable scientific terminology—of the plant recognised by the German naturalist Link as *Camellia Thea*: the word "Link" is not part of the plant name but is a reference for the purpose of comparison and its employment is a precaution against confusion. Quotation of the botanist's name (usually given in an abbreviated form) is necessary for strict accuracy because, through ignorance of what botanists in other countries are doing, the fault has often been made of giving a slightly different classification (and hence coining a different name) for the same, or variable forms of the same plant. This does not matter much if all botanists have a revision of their classification from time to time, *i.e.*, if they put their files in order: anyone used to working in a large office knows that the classification of files has to be revised from time to time as more material and knowledge accumulate; also, very frequently the first classification is a temporary one and different clerks may not be unanimous about this. The fault of one plant being classified slightly differently in different places would be of importance only if the discrepancy persisted for such a length of time that two names for one plant came into general usage. Such discordance is not very likely

to occur nowadays and would not persist for long with more rapid means of communication and a more general diffusion of knowledge. The classification of plants is to-day an international affair and frequent references on doubtful points are made between different countries. It is unfortunate that several names for the tea plant have already come into use. According to Fischer, writing in the *Journal of the Bombay Natural History Society* (No. 4., 1937), "it was pointed out at the 1935 Congress at Amsterdam that botanists engaged in economic studies have neither the time nor the facilities for keeping abreast with nomenclatural research. This difficulty was admitted by the Congress. Accordingly, it was resolved to draw up a list of the important economic and horticultural plants named in accordance with the International Rules, which list shall remain in force for the usage of such applied botanists for a period of ten years. A special Committee was appointed to consider all those species for which claim for inclusion has been put forward and it is hoped that the list will be ready for publication before long." The tea industry's botanists in Java, Ceylon, and India have, with the support of their respective Directors, jointly approached the special Committee appointed by the 1935 Congress with a request that the nomenclature of the tea plant be considered by the Committee. This request was forwarded by Dr. Tubbs of Ceylon through Sir Arthur Hill, the director of Kew Gardens. It is possible that the name for the tea plant will again be revised—but this time with approved international authority; pending the report of the Committee, the tea industry botanists in N.E. India, S. India and in Ceylon have decided to use the name *Camellia Thea* Link. whilst it seems that Java prefers the term *Thea sinensis* Linn. given to the tea plant by Linnaeus in 1753. It will be seen that either term is perfectly satisfactory provided that the appropriate reference Link or Linn.—the latter short for Linnaeus—is given. Recent English usage has favoured *Camellia Thea* Link. The tea plant is sometimes referred to as *Camellia sinensis*, this term utilizing the specific name given to the plant by Linnaeus in 1753 and re-classifying the plant as a *Camellia* in accordance with current ideas. Russian botanists favour *C. sinensis* which, according to Sealy writing in the *Journal of the Royal Horticultural Society* for August, 1937, is the correct name now that the genus *Thea* is merged in *Camellia :* for technical literature this name would at times need to be written "*Camellia sinensis* (L.) O. Kuntz" thus giving reference to the authority for the union of the old name with the new genus. *C. sinensis* is sometimes written *C. chinensis*—this is a difference of spelling, the former method being more commonly used. Eleven different names are to be found in botanical literature referring to various plants all of which are now

regarded as belonging to the one species *Camellia Thea* Link: of these terms Masters' *Thea assamica* and Griffiths' *Camellia theifera* are commonly met with.

The tea plant has been cultivated in England since 1768 and the genus *Camellia* has long been known to gardeners: several species are in cultivation, *Camellia japonica* Linn. being a familiar example. Another species of wide geographical distribution, *Camellia drupifera* Lour. occurs in the Naga and the Khasi Hills and is used in one hill village for the manufacture of tea. Watt considers it probable that the Burmese at one time used *C. drupifera* for the manufacture of "letpet" tea, a kind of pickle popular with the Burmese and Shans and now made from the true tea plant: according to Watt "letpet" is the vernacular name of *C. drupifera*. The seeds of *C. drupifera* contain appreciable quantities of oil (Seeman. 1859. p. 344) as also do those of *C. oleifera* Abel: "this latter species is indigenous to China, where it is widely cultivated for the seeds from which an oil is obtained" (Sealy. 1937. p. 361)—this oil is presumably the half mythical "tea seed oil" referred to at times in literature dealing with the tea industry. An oil known to commerce as "tea tree oil" and valuable for its disinfectant properties comes from *Melaleuca alternifolia*, an Australian plant related to eucalyptus. Several genera closely related to *Camellia* occur wild in India: an example of the genus *Pyrenaria*—*Pyrenaria barringtoniaefolia* Seem.—found its way in small quantities into one Assam tea garden and, because of its superficial similarity to tea, for a long time remained undetected: the presence of this plant was found to be detrimental. *Pyrenaria* has been confounded by botanists with the tea plant: a plant considered by Prof. Choisy in 1855 to be a *Thea* allied to the wild tea of Assam is now regarded as a *Pyrenaria* (*P. attenuata* Seem.). A *Schima*—*Schima Wallichi* Chois.—is common in N.E. India and is known in the Dooars and Darjeeling as *Chilauni* (Chalouni Tea Estate in the Dooars taking its name from the previous abundance of this tree) and in Assam as *Bher Gos*. Attempts at Tocklai to cross *Schima* and *Pyrenaria* with tea have failed. Crosses of tea with other *Camellias*, as *C. drupifera*, are more likely to succeed; some of these related species—particularly those native to Assam and Bengal—might also make suitable rootstocks on which to bud or graft selected types of tea.

The chromosome content of the tea plant has recently been established by Subba Rao of the United Planters Association of South India as 30, thus confirming the earlier work of Dutch and, more particularly, Russian and Japanese investigators. Subba Rao found that the chromosome number of 30 also applies to a China type.

The tea plant shows an appreciable degree of self-sterility and invariably sets a better crop of seed with pollen from another bush : considering any seed bearer it is always possible to find one source of pollen (*i.e.*, one other bush) which, if this alone is caused to fertilize the flowers of the seed bearer, will result in an outstandingly good crop of seed : use of the best pollinator will result, on an average, in twice as much seed as that to be set with equal supplies of pollen from every bush in the neighbourhood, and in particular cases nearly four times the crop has been obtained. The average crop of seed set by a tea bush with its own pollen alone is about one quarter of that which would be set if the flowers are able also to receive adequate supplies of pollen from numerous other bushes; though in particular cases both greater and lesser success might be expected from self-pollination. Russian botanists found that the plants resulting from self-pollination were inferior in vigour to those resulting from cross-pollination, besides which the self-fertilized seed showed a marked reduction in germinating capacity. Insects, such as bees and wasps, will carry pollen from bush to bush, but as the tea plant in the plains of N.E. India flowers at a time of lessened insect activity and at a time when bees probably migrate to the hills, it seems likely that the cross transfer of pollen by insects is not very effective and self-fertilization may sometimes occur under these conditions. With an efficient cross transfer of pollen it is unlikely that more than 3 per cent. of the total seed formed will be the result of self-fertilization—nevertheless it has been found possible for artificial self-fertilization to give as big a crop of seed as that resulting from natural pollination under conditions where it is evident that insects do not provide an efficient cross transfer of pollen. Complete cross transfer of pollen by artificial means has been shown to result in 13 per cent. of the flowers setting seed thus giving a seed crop six times that estimated, on inadequate data, to be usual in a bari* under Upper Assam conditions. Wellensiek, in Java, obtained germinated seed totalling 12 per cent. of the number of flowers artificially pollinated as against a similar figure of 8 per cent. for flowers pollinated naturally. Expressed on the same basis as that used by Wellensiek, the Tocklai result, quoted above, of 13 per cent. successful pollinations gives a total seed germination of 17 per cent. of the number of flowers pollinated. In Russia, Bakhtaj estimates that only 2 per cent. of the flowers normally form seed.

The conclusion that tea must, in nature, be almost entirely cross-fertilized accounts for the extreme variability of the seed

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*The term "bari" applies to an enclosure, *e.g.*, "seed bari" means a seed garden.

available on the market: the seed sold by any one concern is mixed so that in some cases there is little difference between populations of plants raised from two or more sources of supply: in some cases distinctive strains characterize a particular source of supply. Seed is sold on the market under various trade names as Khelmati, Kukilamukh, Sibsagar, &c., which are generally derived from place names of the locality where a particular dealer's seed-bearing trees are situated. These names are to be taken as indicating that the bulk progeny of a particular area of more or less variable seed-bearing trees interfertile amongst themselves. A point to note is that seed-selling concerns may extend their seed-bearing area either with progeny from the original area or from other sources, and may also thin out or replace supposedly undesirable trees in the original area; so that an area of tea raised from, say, Khelmati seed may differ from an area of tea raised 10 years later from seed still marketed as Khelmati: this point requires consideration when one is interpreting the result of experiments dealing with jāt differences. All tea may be broadly classified into dark and light leaf types, and seed dealers market, as far as possible, either dark-leaf or light-leaf types under a particular trade name. These trade types, as Khelmati, Kukilamukh, Sibsagar, &c., are referred to in the tea industry as *jāts*.

All the commercial types of tea and all the wild types, as Lushai and Indo-China, belonging to the one species *Camellia Thea* Link. (=*Thea sinensis* Linn.). This is very variable and the leaves of different tea bushes make tea of decidedly different quality—in some cases poor quality. As tea is largely cross-fertilized, individual variations are continued indefinitely and the only practical method of overcoming this is by some method of vegetative propagation, as in the case of the apple. The apple, like tea, does not come true from seed and each so called "variety" of apple is but one selected tree multiplied indefinitely through the process of grafting. An individual so split up that parts of it lead an independent existence in different places and in union with different rootstocks is spoken of as a clone: a clone may also be formed by rooting many cuttings from the same plant. At the moment there seems little prospect of tea clones being used for leaf production, but bushes selected because of their particularly desirable progeny may with advantage be propagated to form a clonal seed bari: in this case due consideration would also have to be paid to the propagation of a source of pollen likely to ensure the continued production of desirable progeny—in fact, the successful application of clonal selection for seed production necessitates some knowledge of the reciprocal fertility of one bush with another and this knowledge becomes the more important the less the number of bushes propagated.

The respective merits of dark- and light-leaf types under different climatic conditions are often discussed. Russian botanists have shown that dark-leaf types are, in general, much more resistant to frost than the light-leaf types: whilst non-hardy strains of dark-leaf were found, dark-leaf jāts on the whole — particularly those with small leaves—contained more hardy types than light-leaf jāts; jāts with predominating light leaf characters did not occur amongst those jāts with the highest resistance to frost. It seems possible that scientific investigation will prove the dark-leaf types of tea to be, in general, but probably with notable exceptions, more drought-resistant than the light-leaf types—or, to be more explicit, drought-resistant strains will mostly be found amongst dark-leaved tea. Individual differences in resistance to desiccating conditions seem to be as marked as those shown by any other character and there is little doubt that strains notable for resistance to the hot, dry winds of the Terai and W. Dooars could be isolated. China types are included under dark-leaf in these remarks on frost and drought resistance. In the Russian investigations seed from a Darjeeling garden gave the maximum number of frost-resistant plants and a Cachar dark-leaf seed came high in the list. Observations at Tocklai give no indication of any invariable relation between the dark or light leaf character and die-back of the branches. It is possible to find a dark-leaf stock and a light-leaf stock of which the dark-leaf shows more die-back than the light-leaf and *vice-versa*, though the question remains open as to whether die-back is more commonly associated with the one type of leaf than the other.

It is a matter of experience that dark-leaf jāts do not give the high level of quality of a modern light-leaf: at the same time it must be remembered that some of the best modern light-leaf tea shows signs of being the result, or partly the result, of cross-fertilization between two forms not likely to have been growing together naturally: some of the earliest of the lighter leaf "indigenous" jāts, now no longer grown, were markedly deficient in quality, though general opinion indicates at least one notable exception to this statement. Dark-leaf jāts at present on the market do not give the quality of the best light-leaf but it must not be assumed that it is impossible to obtain a dark-leaf type of good quality: individual dark-leaf bushes with excellent manufacturing characteristics are to be found.

Our knowledge of quality is, unfortunately, based upon the purely subjective determinations of the tea taster: the taster's estimation of quality for experimental work has been systematized but nevertheless remains at a level of exactitude which compares very unfavourably with the methods of measurement usually employed in scientific work. There is reason to believe

that the taster's sense of quality rests upon a material basis of substances known to the chemical and physical sciences, though precisely what these substances are and where and how they occur in the tea leaf is unknown. It has been found that there is a difference in the smell of the fresh green leaf upon different bushes and it was proved that bushes, the leaves of which possessed a noticeable aroma, were quite independently selected by one taster as high quality bushes (Wight and Gilchrist 1937). This suggests that the presence in the leaf of a substance with aromatic properties was responsible for " quality " as assessed by the taster; and it would appear that " quality " and " flavour " as assessed by some tea tasters differ only in degree.

Individual dark-leaf bushes have no lesser quality than the best light-leaf bushes, but dark-leaf stock usually contains a higher percentage of low quality bushes, and hence in bulk gives lower quality : quality for quality the dark-leaf bushes generally give thinner liquors—and this would appear to be true whether we include or exclude China types from the dark-leaf class. Dark-leaf bushes (of both the Manipuri and the China type) with thin liquors have been remarked upon by the taster (in ignorance of the origin of the leaf) as desirable types and give good valuations. This statement regarding the combination of quality and strength in dark-leaf bushes is a generalization : taking particular bushes of the highest and equal levels of quality, some dark-leaf plants can be found with strength equal to the light-leaf. Summarizing the characters of dark-leaf relative to light-leaf, it is found that a population of dark-leaf bushes usually contains fewer bushes of good quality and amongst these latter there are again fewer bushes which combine strength with quality. It is evident that the dark-leaf types offer great possibilities for the plant breeder, particularly when one considers their cultural characteristics. The difference between the best and the worst of the light-leaf stocks so far examined is of interest—the " stocks " in this case are fair samples of commercial jāts. The seed garden from which one of these stocks was taken was established from seed taken from " indigenous " tea found, supposedly, wild : at the time of planting this seed garden it is doubtful if any conscious selection took place, and if it did it is equally doubtful whether the selection was of any practical utility : this jāt is regarded as being a fair representative of the original so called " indigenous " tea of Assam. The better jāt is a " modern " light-leaf of later introduction and popular to-day. It is thought that a good deal of the difference between these two jāts has very probably been brought about by consciously directed selection on the part of the modern seed grower and our comparisons of the two jāts are discussed in this light : whether

this dynamic interpretation is accepted or not, the validity of the comparison remains. Both strength and quality have improved in about the same proportion and each of these has moved upwards along about 6 per cent. of their respective scales of values as recognized by the taster. Quality and strength both commenced below their half way levels and each now stands, in the better jāt, at about 50 per cent. of their possible best. This 6 per cent. move along the scale, bringing both quality and strength up to approximately the half way mark, has meant an improvement on the previous lower level of the order of 14–15 per cent. and this improvement was worth, in 1935, an extra eight pies per pound—this was under the 1935 market conditions for Tocklai manufactures when the "indigenous" light leaf was getting Ans. 9/8·56, the more modern jāt Ans. 10/4·51 and typical dark-leaf tea Ans. 10/0·52 (valuations from data supplied by Mr. Harrison of the Chemical Laboratory). It is doubtful as to how far mass selection as now practised by the seed grower can improve the better jāt.

It is considered by the botanist that dark-leaf tea will, in general, better resist vagaries of climate, particularly when the latter occur in conjunction with the kind of financial policy somewhat inadequately described as economical. On the other hand it is unlikely that any dark-leaf seed so far offered for sale will *en masse* give quality or tip equal to a good light-leaf. On the present market, increased quality (above the desirable minimum produced by good jāts of dark or light leaf) does not give very much return in the way of increased valuations; but one must also regard tea planting as a long period investment and the demands of the European market are constantly in the direction of better quality. For the Indian market, other factors such as crop and liquors being equal, increased quality is desirable. A good light-leaf jāt will give crop, quality, and appearance when properly grown and kindly treated: certain dark-leaf jāts, whilst not giving the very best quality and appearance of the light leaf, will nevertheless give good average quality and crop and can be better than an inferior light-leaf jāt; but one of the poorer light-leaf jāts will be better under conditions of plains than unselected China types. There are, however, some grounds for believing China to be desirable in the Darjeeling district where the development of flavour is seemingly associated with China dark-leaf types growing under the peculiar local conditions. In Darjeeling the continued production of flavoury teas must of necessity outweigh most other conditions owing to the inability of many gardens there to maintain competition with other districts of importance on a basis of crop alone: one must consider whether the success of a tea in another district is sufficient criterion for its introduction in Darjeeling; at present there is a tendency to introduce

outside types and justification for this practice should be sought by the local industry. In the Bengal Dooars, conditions are so varied that it is impossible to generalize : on a given garden one Manager will make a success of light-leaf type where another Manager would fail ; and the generous policy of one Company will make a financial success of light-leaf where another's more stringent methods would be useless. Quite apart from financial aspects one might draw a parallel with the way in which some gardeners can succeed with exceedingly difficult subjects ; such ability is not to be entirely dissociated from individual predilections. In a district with extreme and varied climatic conditions such as the Dooars, and presuming little or no scientific attention, light-leaf types cannot in general be said to be desirable : on favourable gardens in the same district, and giving an interested Manager a free hand with manures, the cultivation of a light-leaf type is a justifiable financial venture.

The terms dark-and light-leaf are used in the preceding pages in the very broad classificatory sense in which they are understood in the industry. The planting community separately distinguish a China plant of shrubby form with small, dark leaves and classify other tea as either " dark " or " light " leaf (China " hybrids " are intermediate between China and the larger-leaved forms and often with a noticeable number of light-leaved plants). " Dark " and " light " are terms derived from the dark green and light, sometimes chlorotic, green appearance of the leaves. The terms are relative and any block of tea can be separated into darker and lighter forms. An increasing percentage of darker forms corresponds with an increasing expression of several other attributes recognized by Russian botanists as *Northern* characteristics. The correspondence of dark leaf with northern attributes is not perfect and colour of the leaf alone enables one to recognize at the most three classes of plant—" dark," " intermediate," and " light " —which are not always completely consistent as to their other characteristics : consideration of several attributes of the plant enables more classes to be recognized. In this article " dark " and " light " refer mainly to trend of type (the common usage) and may be taken as indicating a broad correspondence with more northern and more southern forms as recognized by Russian botanists. The China types of the Indian planter are to be included in the extreme northern forms.

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