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OBSERVATIONS ON SOME ANATOMICAL FEATURES USED IN IDENTIFICATION AND TAXONOMY*

J. D. BRAZIER

Building Research Establishment, Princes Risborough Laboratory, Princes Risborough, Aylesbury, Buckinghamshire, Great Britain

Summary. The Princes Risborough card key for the identification of hardwoods has been in use for almost forty years. As first described by S. H. Clarke, it comprised sixty-four anatomical features and fourteen others, to cover geographical origin, colour, weight, etc.; but, with new knowledge and in the light of experience, it was modified and some additions made in 1961. No further change has been made since but it has been in daily use and some observations are given on the confidence with which some of the selected features can be used. In preparing the key for publication, it was sometimes necessary to make comparative studies of groups of timbers, often including others than those finally incorporated in the key, which was restricted, for publication purposes, to woods of commercial significance. In this work, not only the diagnostic but also the taxonomic value of some features was reviewed and comment is made on this. Examples are given of variability within units of classification; some causes for this are suggested, and examples cited where the evidence of wood anatomy is of special interest in respect of current classification.

Timber identification has always been an important aspect of the work at Princes Risborough and a key for the identification of hardwoods using marginally perforated cards has been in use for about forty years. Before this, a key card system had been described by Bianchi (1931) for Dutch East Indies woods,using separate cards for each anatomical feature and recording on the card those genera, from a prescribed list, in which the feature was present. It must have been tedious to prepare and it required a manual sorting of individual cards for its use; it was used for only a limited time at Bogor because of these limitations (Bianchi, personal communication). S. H. Clarke made two major improvements on the Bianchi system. First, he recognised the advantage of having a card for each timber and not for individual features, a more satisfactory arrangement as there are more timbers requiring description than the variety of features likely to be used, and, secondly, he arranged that each feature on the card was represented by a marginal hole. This led to ease of preparation and a rapid method of sorting using a thin steel rod. Clarke, in co-operation with Chalk and others, listed sixty-four anatomical features of diagnostic interest and in 1938 (Clarke 1938) published a description of a micro-key card incorporating these features and others giving

physical information and details of geographical origin. In total, seventy-eight features were used in Clarke's card. At the same time lists of anatomical features for many timbers, coded to correspond with the card features, were recorded at Princes Risborough and Oxford, and the anatomical details used by Chalk in his contribution to the Anatomy of the Dicotyledons (Metcalfe and Chalk, 1950) were stored on the Princes Risborough card. At Risborough a key was in use during and after the war and much experience was gained on the reliability of the structural features adopted. It was the writer's task, some years after going to Risborough, to review the use of the key and with the assistance of G. L. Franklin to prepare it for publication.

In the first place, the features selected by Clarke were re-examined and twenty-one amendments were made; some features were added, others were re-defined or modified, and a few were omitted. Such alterations were made with some reluctance as the cards used formerly were no longer compatible with the new design (Brazier & Franklin, 1960), though use has demonstrated the very great benefit derived from the modifications. In part, changes derived from new knowledge, such as the treatment of ray tissue following Kribs' (1935) work on evolutionary development and his proposals for a ray classification. Ray classification was the subject for a debate which continued for many years until the concept of tissue types was included by the I.A.W.A. Committee on Nomenclature in the Glossary of Terms used in Wood Anatomy (1957). In other cases, anatomical features of diagnostic interest were added to the key, for example, the presence of silica, different types of vessel to ray pitting, and forms of apotracheal parenchyma.

An important aspect in preparing the key for publication was the examination of the many timbers that appeared on the U.K. market in the late 1940s and during the 50s. This often posed two problems—the first was the separation of anatomically similar but often unrelated timbers, and the second, of perhaps more botanical interest, the examination of related timbers to determine in the first place their grouping though this often led to observations on their classification. It was in studies of the latter types that the contribution of the wood anatomist in providing information of interest, and, hopefully, importance to the taxonomist was made very clear. In some instances the results were published elsewhere but P.R.L. Bulletin 46 includes many short dichotomous keys or tabular statements for the separation of such timber groups which derive from these comparative studies.

But what observations can be made on the anatomical features customarily used in examining hardwoods? In any consideration of these, there are two main points that need to be made. The first is that it is necessary to distinguish between the value of a feature for diagnostic and taxonomic purposes, and secondly it is important that there is an understanding of variability within and between trees and the factors causing it. This last is an aspect which warrants further study; we know much about the change in cell morphology with age or distance from the pith but far less about the change in the structural pattern, yet there can be striking changes in ray structure and in the pattern and distribution of the vessels as seen on the end-grain. *Shorea albida* can have a three-

fold increase in density from juvenile to adult wood, accounted for largely by a marked increase in fibre wall thickness; other species are known to have a significant if not quite so marked change in wood density with age. There is a tendency to ignore this by insisting on the examination of 'mature' wood and yet this is not always possible. A recent problem concerned the confirmation of a sample as *Shorea laevifolia*; it had many of the characters of light red meranti but it was from near the centre of the tree and almost certainly represented the juvenile condition of the heavy *Shorea*. But if structural differences occur within a tree, they occur also between trees. Perhaps the most striking example is the contrast in wood structure between many eucalypts grown as exotics and the same species growing naturally in Australia; many similar examples could be cited but an interesting observation concerns ray width in *Liriodendron tulipifera*. As grown in the United States this is typically bi- and tri-seriate but in samples examined of the species grown in the United Kingdom the rays are wider both in linear width and number of cells, commonly four and even five-seriate. It represents, possibly, the difference between forest-growth and parkland trees, but such an observation points to the need for care in using some structural features of a quantitative type, such as vessel size and number, fibre wall thickness, ray width, and amount, as distinct from type, of axial parenchyma development. There seems to be a tendency for amounts of parenchyma to increase as conditions of growth become less favourable; thus *Parashorea malaanonan* from a dry site in the Philippines can have abundant parenchyma whereas in lowland wet forest in Sabah, parenchyma is far less marked. Such an observation is important, too, in a consideration of botanical relationships, for example *Daniellia oliveri*, a savannah species, has abundant parenchyma, unlike *Daniellia ogea*, a rain forest tree; however, the *type* of parenchyma is the same and species of *Daniellia* have such a distinctive combination of anatomical features that there can be no doubt as to their botanical affinity. An interesting example is provided by *Calpocalyx* in Liberia and the Ivory Coast. There are two species, both from the wet forest, but whereas *C. aubrevillei* is an emergent species, *C. brevibracteatus* is an under story tree. Their timbers differ markedly in density and amount, though not in type, of parenchyma, which is more abundant in *C. brevibracteatus*, and it is of interest to speculate how far this reflects different conditions of growth.

The usefulness of an anatomical feature for taxonomic purposes has to be considered anew for each group under study; there are no prescribed rules. Thus examples can be cited of a feature which is of taxonomic interest for one group but of little significance for another. An example is the presence of silica in the Dipterocarpaceae; it occurs in all species of *Anisoptera*, *Dipterocarpus*, and *Dryobalanops*, but not at all in *Hopea*, *Pentacme*, and *Parashorea*. *Shorea* offers a very special case, for one section alone, *Anthoshorea*, contains silica, and for the anatomist there are differences within *Shorea* which are quite as great as occur between other genera in the family. Yet in another family, genera can be found with some species which are siliceous and others not, for example *Entandrophragma* and *Guarea* of the Meliaceae. Perhaps the features which are

most useful in taxonomic studies are those which are clearly present or absent, such as axial and horizontal resin canals, provided that they are not of traumatic origin, scalariform and minute pitting, scalariform perforation plates, etc, rather than those that exhibit a variable form or incidence, such as parenchyma amounts, ray widths, fibre wall thickness, storied rays, etc.

Is it possible to point to a structural feature which is characteristic of a distinct botanical group, whether genus, family or order? At the family level tanniniferous tubes appeared to be confined to the Myristicaceae, and tile cells of the *Durio* type are confined to the Bombacaceae and Tiliaceae. But these are exceptions and it is usually a combination of features which gives a family its distinctive appearance. However, the fact that such determinations can be made by the trained observer indicates that the information is capable of record and how worthwhile it would be, though clearly a major undertaking, to prepare a family key.

Returning to the contribution of the anatomist to classification at the generic level, a number of interesting examples can be cited where the wood lends support to the case for re-classification. Thus the grouping of species formerly included in *Piptadenia* into a number of genera (Brenan, 1955) is in accord with technical and anatomical differences in their woods. *Copaifera* at one time included some species with axial resin canals and others in which they were absent; the latter are now distinguished as *Guibourtia*, a genus which though anatomically uniform nevertheless contains timbers of two technical types. *Pseudosindora*, in which resin canals are absent, is distinguished from *Sindora* in which they are present, and the proposal to include *Pseudosindora* in *Copaifera* (de Wit, 1954), which also has axial resin canals, must surely be rejected on anatomical grounds.

These are examples where re-classification has already taken place but what of those where there are distinctive anatomical or technical types in a group which is maintained as a genus? Reference has already been made to *Shorea* and other generic examples are *Aspidosperma*, *Tabebuia*, *Ocotea*, and *Eucalyptus*. *Terminalia* is an interesting genus—it contains some species with uniseriate rays and others with three- and four-seriate rays and the timbers of the two anatomical groups differ in appearance and performance. *Baikiaea* contains two very distinctive types in *B. plurijuga* and *B. insignis*; this might be an extreme form of anatomical adaptation to different conditions of growth but it is noteworthy that the parenchyma *type* differs between the species. *Canarium* contains some species which are siliceous and others which are not, and some with horizontal resin canals and others in which they are absent. *Nauclea diderrichii* with exclusively solitary vessels is quite different from *Nauclea pobequinii* in which the vessels are in radial chains, and many species of *Diospyros* can be distinguished into one of two groups according to whether they have crystals in axial chambered cells or have crystals in their rays.

These are a few examples, chosen almost at random, where wood anatomy may point to differences of taxonomic interest. No one welcomes change where it results in the

loss of a familiar name but if it leads to a more meaningful classification either for the plant systematist or the technologist concerned with a more effective and efficient use of the world timber resource then it becomes tolerable.

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