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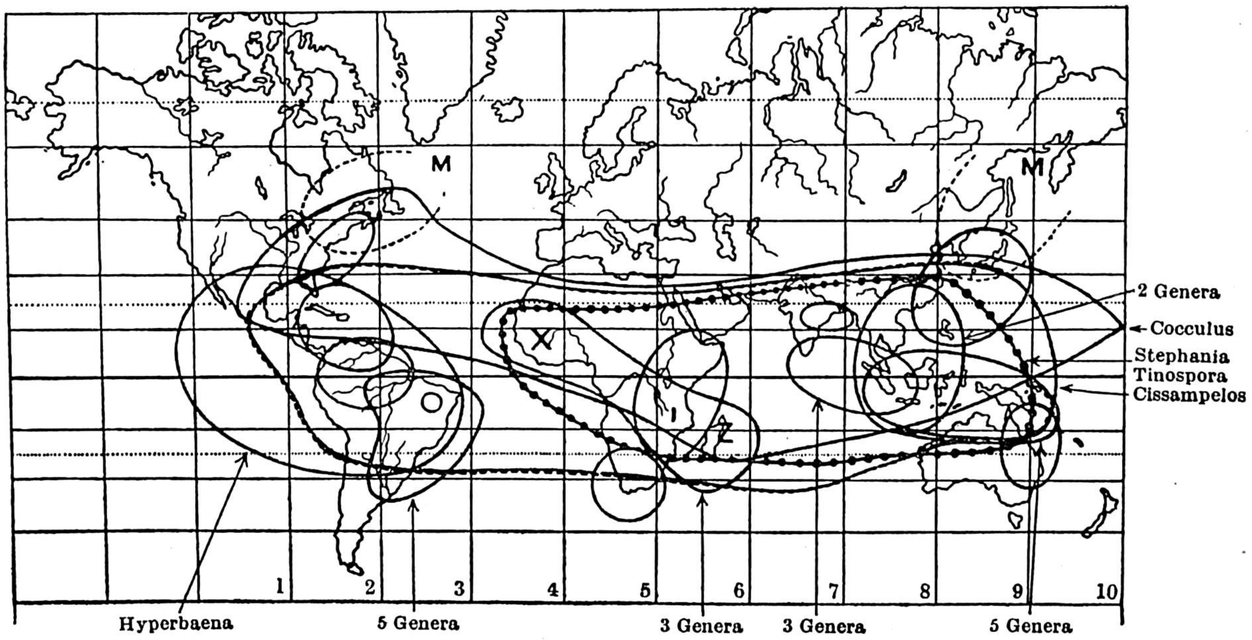
CHAPTER VII

Endemic and other genera

Going southwards from BRITAIN, one meets first endemic species, increasing in number as one goes, mainly in broken and especially in mountainous regions. After a while one also encounters endemic genera, few at first, increasing later, and further still one may even encounter families so localised that one would be sure to count them endemic. The bulk of the endemic genera belong to large families rather than to small, even in such an ancient home of endemism as the HAWAIIAN Is., where a very large proportion of them belong to the group of allied families *Compositae*, *Campanulaceae*, *Rubiaceae*, and *Araliaceae*.

Genera follow the same rules as species, and are therefore probably as a rule such as have not yet had time to spread to larger areas, especially when this has been made difficult or practically impossible by barriers like the sea or a chain of mountains. The areas occupied vary from very small, as in the case of *Itatiaia* on that mountain in SOUTH BRAZIL, *Leichhardtia* on the DAINTREE River in AUSTRALIA, *Cephalotus* at KING GEORGE'S SOUND in WEST AUSTRALIA, and so on, upwards. In NEW ZEALAND, two genera are found only in the outlying islands, while others range along the main islands for various distances from a few miles to 1000, the larger half being below the moiety of the length. If one look at the map of *Menispermaceae* here reproduced from *Age and Area*, one can see how the smaller genera are more local, obeying the law of size and space, while the largest (especially *Cocculus* and *Cissampelos*) occupy the bulk of the entire range of the family.

We have dealt with endemic genera at some length in *Age and Area*, Ch. XVI, p. 169, and esp. pp. 175-83, and



Outline Distribution of Menispermaceae
12 genera at X, 5 at Z. M = Menispermum
(By courtesy of the Royal Society)

need not repeat what has there been said. As people usually only consider as endemic those on small areas, of course the bulk are monotypes, and the numbers taper away very rapidly upwards. In MADAGASCAR, for example, where there are a great many, they show (figures of 1922) 191/1, 37/2, 10/3, with a maximum at 20. The phenomena that they show are exactly paralleled by the non-endemic genera, giving great support to our supposition that endemism is simply a miniature representation of distribution in general, which is chiefly controlled by the laws of ASA, working upon the material supplied to them by the law of divergent mutation in its various manifestations.

There is no sound basis upon which to build any theory or a satisfactory distinction between things that are endemic, and those that are not so, for no two writers seem to agree about the extent of area that an endemic species or genus may cover. This is partly due to the false impressions made by the varying scales of maps, where, for instance, the whole of INDIA, or even of S. AMERICA, is shown on one page, like the comparatively infinitesimal area of ENGLAND. While in RIO, we were asked by one of the most famous of British botanists to get him a plant from the higher levels of ACONCAGUA, more than a thousand miles away, in CHILE, to say nothing of the dense tropical forest between, and of the ascent.

If age alone were operative in this case, one would still tend to get very much the same distribution as actually exists, when one allows for geological and climatic changes, and for the action of barriers, whether more or less permanent, like sea or mountains, or temporary, like the boundaries between different ecological associations. The table given on p. 180 in *Age and Area* with the figures on p. 181, shows how mechanical is the basis of all geographical, as distinguished from local ecological, distribution. In face of such results, it becomes very difficult to uphold relicdom or local adaptation (other than that which everything must possess in order to survive at all) as an explanation of endemism, whether for species or for genera.

As we have seen in the tables of *Ranunculaceae* on pp. 30-31, and shall see again even more strikingly in the case of *Acanthaceae* in a later chapter, there is no possibility of drawing a line anywhere between endemics and non-endemics, except at the personal choice of the author, for as one goes up the list, the small and local genera are followed by genera that steadily decrease in numbers, and increase in area occupied, until at the top one comes to the actual leaders of the family. The laws of ASA are obeyed as closely as is possible, or almost exactly by the genera at the bottom, which do not come into serious differences of conditions, because by reason of their small age they occupy but small areas. As they grow larger, and occupy more space, possible differences of conditions increase, until when they reach the size of say 20-30 species they begin to come within the range of great geological and climatic changes of long ago, for their age is great enough to take them so far back. Thus, with our present very limited knowledge, speculation must begin as the genera with which we are concerned increase in size, so that with genera larger than say twenty species, we must bring geology, climate, and other conditions into the matter, and when possible trace the conditions under which the genus began its life.

Endemics belong mainly to mountainous and broken countries, as a reference to the map of *Siparuna* (p. 224) will show for a single case, and one to that of the *Menispermaceae* above. Great numbers also occur on islands, but in general islands are also mountainous, and one cannot disentangle the two factors. The proportion of endemics also increases as one goes southward, and the increase seems to go well south of the equator, reaching a maximum somewhere about the tropic of Capricorn. It is not unlikely, as to a large extent endemics mark the progress of invasions, that the current of invasion, as HOOKER has said, ran largely from north to south.

The endemics of mountains are less related to the species of the plains, in warm countries, than are those of islands to those of the nearest mainland. This is probably due to the fact that travel could often take place, or had to take place, along the higher levels of the mountain chains. One must not forget that isolation has probably something to do with the formation of endemics (*cf. AA*, pp. 17, 148, and *Evol.*, pp. 25-7, 101).

Like the species, endemic genera belong mainly to the large families. Of approximately 1879 endemic to the islands of the world, not including AUSTRALIA, nearly

90% belong to the first 40 families in world-size, while about 150 small families have no endemics upon islands at all, they having been in general too young to have reached any islands. It is thus extremely probable that the genera are formed by single mutations in the same way as the species. This is confirmed by the fact that hardly any endemic genus does not belong to an important subgroup of its family, when such a group exists; one does not often find an endemic genus in a small and insignificant group. Here again, the result is simply due to the operations of the law of doubling, by which evolution appears to work. A small group necessarily has but few offspring, while a large has many, and large groups are usually headed by large genera. This shows everywhere; let us take the *Connaraceae*, the latest monograph of which *(PR)* is lying upon my table. Placing the genera in order of size, and mentioning the position of each in the subgroups (tribes), we get :—

Connaraceae in order of world size

Genus	World size	Tribe
Connarus	121 spp.	Heading the *Connareae*
Agelaea	46 spp.	Heading the *Agelaeeae*
Santaloides	45 spp.	Heading the *Byrsocarpeae*
Cnestis	37 spp.	Heading the *Cnestideae*
Rourea	32 spp.	second in Connareae
Byrsocarpus	17 spp.	second in Byrsocarpeae
Ellipanthus	13 spp.	Heading the *Castanoleae*

and other genera of 12, 10, 8, 8, 6, 4, 4, 4, 4, 3, 2, 2, 2, 1, 1, 1, 1

All the tribes given in the list belong to and are all that make up what taxonomists consider to be the sub-family *Connaroideae*, while one small genus *Jollydora*, with three species in WEST AFRICA, forms by itself alone the other sub-family *Jollydoroideae*. The two sub-families are thus distinguished :—

Jollydoroideae :	seeds two in indehiscent follicle
Connaroideae :	seed one in dehiscent follicle

Here we have a striking double divergence, appearing late in the life of the family, for *Jollydora* has only three species, though it is West African like most of the family. But, upon structural evidence only, without reference to the size or the geography of the genus, it is considered to be different enough to make a sub-family, though it must, fairly evidently, have been the offspring of one of the other West African *Connaraceae*, and therefore related as closely as possible to *one* of the *Connaroideae*. Its present position is therefore not genetically natural, though such as will enable its easy identification. But the grouping of the family is artificial. A genetic grouping does not, under present conditions, lend itself to the great purpose of most classifications—identification. At a certain very early period in the life of the *Connaraceae* when there were only four genera, *Connarus* to *Cnestis*, with perhaps 4, 2, 2, and 1 species, there were already four subgroups represented! Such an early formation of subgroups as this, which we shall see to be the rule, shows how families follow the rule of early divergence that we have seen so strikingly manifested by the families that contain two genera each, only, a list of which was given as Appendix III in *Evol.*, p. 199.

SCHELLENBERG's classification frankly adopts geographical separation as a means of dividing some of his groups, and this is certainly a step towards a natural system of classification though perhaps mainly dictated at present by its convenience as a way of splitting up a family upon natural grounds. The smaller the area with which we have to deal, the easier is it to identify the plants upon it, as is familiar enough, though the reason for, and the meaning of, the greater divergences (which make classification simpler) under such conditions has escaped notice. The question now comes up—can sufficient structural differences be found between plants of the old world and of the new in the same genus or group, always to enable us to separate them, or must we go on with the whole genus, as at present, with what little help we can draw from the geography? Here, *Connarus* is the only genus large enough to occur in both worlds, and its third section, *Euconnarus*, seems to occur only in the old world, the second only in the new, but the first section, *Connarellus*, has about half its 30 species in each. Any character found in a family seems capable of turning up anywhere that a member of the family may be found, and there seems no certainty of finding any character confined to any particular region, with no discontinuous occurrence somewhere else. Characters that mark what we regard as a good and reasonably large group are almost sure to turn up elsewhere than in that group. They are then put down as exceptions, but they are exceptions to man-made, not to natural, rules.

Though geographical propinquity, or the reverse, is evidently a character that cannot be neglected if we are to arrive at a natural classification, it will make the classification by characters—at present we use only structural characters—much more complicated and difficult, if it is to be a natural classification also. In fact, it looks as if a natural classification would prove to be almost so complicated that for a real and practically useful one we shall have to fall back upon something artificial. Our present system, by putting together, for example (p. 107), as closely allied all those species of *Rhamnus* which show C5, A5, and distinguishing them from those which show C0, A4, evidently violently divorces the two closely related species of the CEYLON hills, and also those of the MADRAS hills, to say nothing of similar divorces all over the whole range of the genus. Both the sub-genera thus made at once show a very discontinuous geographical range, whereas they cover the ground very well if one add them together. The more that we try to break up a family or genus into subgroups, by structural characters only, the more do these subgroups show what we have called in Chapter IV discontinuity of character or of structure, and if we force into these subgroups, as we do, all those plants that agree with what we have arbitrarily chosen as characters for those subgroups, then we commonly get geographical discontinuity, for which we can find no reason, and though sometimes this may be explained by the presence of an overriding genus that covers both localities, this is not always the case.

One can no longer use one or two marked characters, as has hitherto been the custom, as showing, when they are the same in two species or genera, that these are necessarily closely related, for we have seen how strongly marked the tendency is, for divergence between parent and offspring to appear. We shall see as we go on that what shows in the *Connaraceae*, where the early closely related genera mostly belong to different subgroups, shows in practically all families where the distinction of these subgroups is by morphological characters and differences. Here there is a parent genus *Connarus*, and all or nearly all its earliest descendants are placed each in a different subgroup from that to which it belongs itself. From the genetic point of view, which is supported by the geographical, they must be the closest of relatives, largely in fact parent and child, but from the taxonomic point of view, which at present is simply the structural, they are all very definitely separated, each into its own subgroup. The next chapter will go into more detail, and give a table showing the actual facts for all the leading families, facts which cannot be gainsaid, and which it is perhaps worth specially noting, were obtained, as most of thediscoveries in this book have been obtained, by prediction. This endless possibility of prediction has lent force to the setting out of the new principles here advanced, and has formed them all into a connected whole.

With characters showing as they do, not necessarily inherited from parent to child, but liable at times to some complete and divergent change in that passage, it is clear that we cannot construct a natural classification upon a structural basis alone. On the other hand, it is equally clear that a classification which followed the evolution of plants by the doubling law, and therefore was a " natural " one, would probably show so many changes back and forward from character A to a, or from B to b, or even from A to B, and so on, that it would be impossible to use it as a means of identification of plants, and until we have a far more complete and thorough knowledge of characters and their incidence, would be impossible to construct. It will be better to go on with our present system, artificial though it will be in parts, and anywhere liable to be so, and to regard a really natural system of classification as a dream of the future, as we regard the formation of a gene and chromosome map. On the other hand, the arguments that go on as to the relative value of this or that character in the placing of a genus, especially when they are not based upon actual figures of frequency of occurrence, seem often to be very largely a mere waste of time.

We are as yet without any standard against which to value characters. We cannot say whether, for example, the distinction of the sub-genera in *Homalium*, single antepetalous stamen/stamens in antepetalous bundles, is larger or smaller as a mutation than the distinction between the two Hawaiian *Portulacas* (one wide, one endemic), stamens 7-12/∞, or the distinction between the two species of the endemic genus *Tetraplasandra*, stamens 3-4 times the petals/6-8 times. In general it would seem as if the distinction was probably of much the same value whether of wide and endemic with large or small genus, of the species of small genera, or of subgenera. The value is really as much imparted by age as by any factor.

Endemic genera of Ceylon. Let us now consider some of the 25 endemic genera of Ceylon, using the placings of Trimen and Hooker (**125**), and begin with *Schumacheria* in the *Dilleniaceae* (l. c., vol. 1, p. 10), which is worth a little consideration. Trimen puts it next to *Acrotrema* in his key :—

Filaments dilated upwards (*Delimeae*)	1. Delima	2. Tetracera
Filaments not dilated upwards (*Dillenieae*)		
Carpels 3; anthers opening by slits		
Perennial herbs		3. Acrotrema
Shrubs		4. Schumacheria
Cpls 4-20 ; anthers by pores; trees	5. Wormia	6. Dillenia

The characters are the usual *divergent* characters upon which keys are based, in fact, without which keys could hardly be made. The difference which our work brings into former conceptions of relationship is that divergence in some feature or features, which was supposed to mark wide separation if it were a " large " divergence, need not necessarily mark anything wider than the difference between closely related species or genera. *Schumacheria* in any case comes fairly near to *Acrotrema* in many characters, like the sheathing broad-based petiole, the strong lateral veins of the leaf, the ∞ stamens, not dilated upwards, the anthers dehiscent by slits, the three carpels, &c. But it differs in three important characters; it is a shrub, while *Acrotrema* (7 spp. Ceylon, one showing many forms, 1 Madras; 1 Malaya) is the only herbaceous genus in the family; it has monadelphous stamens, posterior in the flower, instead of regular or triadelphous, and its carpels are 1-ovuled, not 2 or more. These characters have hitherto been supposed to outweigh those of agreement, even with the geographical argument added, which is that *Schumacheria* is an endemic genus in the heart of the " *Acrotrema country* ", and therefore probably a very close relative, while genera that have its unusual characters in common with it are far away, thus showing " structural " or " character "-discontinuity. Great stress has been laid upon the herbaceous nature of *Acrotrema*, and this genus is commonly given a group to itself, but a herb is a perfectly natural divergence from a shrub, and the two occur side by side in many genera in many parts of the vegetable kingdom. We have shown in the last few chapters that argument from structural similarity will not bear the load that is often placed upon it, and that geographical continuity is just as important, unless there be an overriding genus to cover wide gaps, as described in (**151**).

Prominently displayed among the characters of *Schumacheria* (fig. in **125**, Plate II), however, is a monadelphous column of stamens on the posterior side of the flower, and thus in strong contrast with the usual regular, or sometimes triadelphous, androeceum, found in most *Dilleniaceae*. It turns up again in the largest, and probably oldest, genus, *Hibbertia* in AUSTRALIA, NEW CALEDONIA, &c, but even there in only part of the genus, the sixth section, *Pleurandra*, though there is a suggestion of it in the fifth section, *Hemistemma*. The first four sections show little or no sign of such a thing. Nor does it show anywhere else in the family, though it turns up in BRAZIL in the genus *Luxemburgia* of the allied family *Ochnaceae*, and there is a suggestion of it in the family *Lecythidaceae*, which is largely Brazilian. If one call in destruction of transition forms to connect these great discontinuities of character, one has to call it in upon a simply incredible scale, including the destruction of many species of *Schumacheria* itself, to bring the genus down to the small and local thing that it now is, and which, if it were never any bigger, could not be closely related to anything in BRAZIL, by reason of its youth, and the great age of the separation of the two great land masses. We have no evidence for any such destruction, and even then we must have a great deal more of it to connect with *Hibbertia*, which is also a difficult proposition, with no overriding genus to help us. It is in a very high degree improbable, therefore, that these appearances of this very peculiar character have any connection with one another except through some very far back ancestor, which of course means that the character must have been handed down through other ancestors that did not themselves show it, though the potentiality of producing it was in their make-up. Given some combination of conditions of which at present we have no idea, it appeared in the places where they were operative. As a general rule, character discontinuity like this is fairly wide, and it is often so wide that (as here) it probably goes right back to the head of the family. Hence my suggestion that the head may carry with it, in a kind of Pandora's box, all the characters (or potentialities) that may afterwards appear in any member of the family. In this case, the change in *Hibbertia* was not accompanied by such marked changes as in *Acrotrema*, and the species with the peculiar androeceum were left in *Hibbertia*, while in *Acrotrema* a new genus was produced. Here again we have one of the phenomena which produce what it is becoming the fashion to call a complex of genera; in this case it is possible that the family *Dilleniaceae* is combining with *Ochnaceae* and other families to produce one.

In these cases of occurrence of peculiar characters in two or more genera of a family, when they occur at great distances apart, and there is no overriding genus (151) to connect them, it not infrequently happens that one or both of the bearers is very small (young), probably if not certainly too young to allow of transition forms or of direct descent the one from the other. Any common ancestor that carried the character could often not have been an *immediate* ancestor, so that there must have been intermediate ancestors that were not carrying it. One soon finds, as the writer found 40 years ago, that the distribution of characters is an intricate set of permutations and combinations. The only way in which both could receive the character from an immediate ancestor is by having as such some overriding genus, covering both localities sufficiently early and giving rise to the same character in two separate mutations, in which case the origin of the character would be polyphyletic. The important characters are fewer in number than the plants that show them, so that nothing but permutations and combinations could produce the results shown. The actual characters go in what we may call series, or sets, like stamens 5, 10, 15, ∞, 2, 3, didynamous, &c, &c, where the changes are often inconceivable except as sudden mutations. In fact the combinations are so complex that the only common ancestor from which all characters could, and must, have come, is the actual leader of the family (in size or age), in which we must always imagine that all but one character in any series is lying dormant or recessive. At each dip into the Pandora's box the most common result will probably be no change worth very special notice in any character—result, another member of the same species. The next most common will be a change in a few characters—result, a new species. The next a new genus, and so on. There are slight indications that a character recently acquired in the ancestry is perhaps somewhat more likely to appear in any new genus than the one that it diverged from and superseded at a previous birth. But for anything that we can tell, there is nothing to prevent an old character being taken back at the very next birth in the family. This is confirmed for example by the remaining important difference in *Schumacheria*, the single ovule in the carpel in place of the two or more in *Acrotrema*. Some *Hibbertias* in AUSTRALIA, and some *Dillenias* in the MALAY ARCHIPELAGO, show one ovule, but nothing in CEYLON, and again it looks as if the character in *Schumacheria* had been derived from a remote ancestor. Any member of a family must carry in itself the potentiality of producing any character that may appear in that family.

A great part of this family seems artificial in its grouping. Let us for example take the species of *Tetracera* given in ENGLER (1st ed.). Each bracket includes the range of one species.

§ 1. Empedoclea	2 spp.	(Bahia) (Minas), adjacent Brazilian states
§ 2. Eutetracera	6 in A	(E. Brazil), (Trinidad, French Guiana) (Antilles to NE. Brazil), (Surinam), (Madagascar), (Sumatra, Borneo)
	3 in B	(Minas, Fr. Guiana), (trop. Afr.), (N. Austr., NE. New Guinea)

	6 in C	(E. Brazil), (Mexico), (Borneo), (Indomalaya), (Further India), (W. Afr.)
	6 in D	(Rio de Janeiro), (do), (W. Afr.), (Further India, Malaya), (Queensland), (do)
§ 3. Delima	2 spp.	(Further India, Malaya, China), (Fr. and Dutch Guiana).

The few species discovered since the date of this list do not fill the enormous gaps there shown. The second section illustrates especially well the widespread and important feature in taxonomic work, that the more a family or genus is split up into smaller divisions, the more marked does the geographical divergence between their members become, in most cases, thus apparently indicating that divergences of character may be the same at different places.

The second section above is divided into its four groups by the distribution or absence of leaf-hairiness. One may see the same thing in one genus in one country, in many CEYLON genera, TRIMEN making rather a feature of hairiness in his flora. Thus in *Vernonia* there are two wides of great dispersal, *cinerea* (palaeotrop.), hairy on both sides of the leaf, and *arborea* (Indomalayan), glabrous above and finely but densely felted beneath. There are nine endemics in CEYLON, and a tenth reaching the NILGIRIS in INDIA, none of which show these characters, even though they are almost certainly directly descended from the wides. The NILGIRI species, and four CEYLON, are glabrous or slightly hairy on both sides, two roughly hairy, and the other three show glabrous above/tomentose below, finely pubescent/densely felted, and cottony/white with fine wool. No gradual selection could produce such characters, localised in such a way.

The geographical relationships of these *Tetraceras* are particularly bad, showing much structural discontinuity. Those in 2A are scattered over the continents, and so are most of the rest, with little geographic continuity. But *if one run them all together*, the total area of dispersal is much better covered (*cf. Rhamnus* on p. 107). The American species will then be RIO, MINAS, BAHIA, E. BRAZIL (2), GUIANA, TRINIDAD, the ANTILLES, MEXICO, a practically continuous stretch of country which might easily have been covered by a single line of descent, but which is here broken up among the whole of the six divisions of the genus. The four American species discovered since the publication of Engler, in Peru, British Honduras, Trinidad, and Brazil, help to cover the American space better. The more that we break up any group, family or genus, upon our present structural lines, the more incongruous do its geographical relations become, and the more do they demand the destruction of connecting links in vast profusion, if we are to regard any structure as arising out of something like itself. Some of the facts that I have observed, here and elsewhere, go so far as to suggest that not only has the same character been inherited at different places and in different connections, but that perhaps there has not even been an adhesion to the same genus, and that something like what BOWER suggested in the ferns, that a fern might go through an *Acrostichum* (or other) stage, may take place; for example an *Acrotrema* might go through a *Schumacheria* stage, and again go back to *Acrotrema*. Some *Dilleniaceae* show such a combination of characters that one puts them in *Tetracera regardless of geography*, while others may drop out of the genus for lack of one or more of the obvious characters that mark it, though there is no particular reason why these characters should be any more fixed than others. We must get more into the way of regarding characters as a whole. At some place in a family, characters A, B, and C may be well marked, and we call that group of plants the genus X; at another place E, F, G may be well marked in a number of forms, so we call them the genus Y, and so on. But the whole set of characters seems more or less fluid, and apparently any of them may change at any time, though some seem more likely to do so than others, under certain conditions at any rate. Upon our suppositions, something happened in CEYLON to the parent of the first *Schumacheria*, which belonged to another genus, probably *Acrotrema*, and rearranged the sexual nuclei in such a way that certain characters were no longer produced, but replaced by something divergent, so that characters that were new for that geographical region, like shrubby habit, and a posteriorly developed androeceum, appeared. The very next mutation may change a *Schumacheria* into something else probably causing the origin of a new endemic genus.

Everything seems to indicate that taxonomy based upon structural characters only cannot be reconciled with geographical distribution, nor with evolution by divergent mutation. Our present interpretation of taxonomic facts depends upon certain assumptions, one of which is that any character must have been directly inherited from an ancestor that showed something like it, from which it might be derived, and not from one quite different from itself, as a simple is different from a compound leaf. This divergence was one of DARWIN's great difficulties, now being better recognised, and when we find that species with structural affinities are so often so discontinuous geographically, we are evidently coming to a deadlock. From this the work described above seems to offer us a way of escape, even though it may mean scrapping what we may have hitherto regarded as almost axiomatic.

In many cases, overriding genera will afford explanation of geographical discontinuity, but there are a great many where this is not the case, and where we must probably put down the affinity to the independent appearance of the same character, in widely separated places. It seems to be an independent inheritance from a far back ancestor, most probably the actual head of the family.

But if polyphyly like this is possible among the younger genera that chiefly show such discontinuities, it is difficult to produce any reason why it should not also have occurred in the older genera, though of course much less often, as they are much fewer in number. An element of uncertainty is thus introduced into all our taxonomic work as at present conducted, and the same thing may be said about the results that are now beginning to show in genetic work. For a natural classification both this and geography must be added to morphology; it seems to the writer that without these additions it is impossible to make a classification natural.

The next CEYLON endemic genus is *Trichadenia* (*Flacourtiaceae*, *l. c.* I, 75) with one species, distinguished by its undivided calyx that opens by an irregular separation about the middle, throwing off the upper part as a cap. It also has plicate cotyledons, and only five stamens, and belongs to the tribe *Pangieae*, largely distinguished by an adnate scale on the inner side of the petal. The only other CEYLON member of this group is the widespread Indo-malayan *Hydnocarpus* (35 spp.) which has two CEYLON species, both endemic (*cf.* ALSTON in TRIMEN, *l. c.* VI, p. 15).

The peculiar throwing off of the calyx in *Trichadenia* is practically unique in the family, though *Prockiopsis* (tribe *Oncobeae*, 1 sp. MADAG.) throws off the whole calyx as a cap. The two genera are both monospecific (young) so could not have had direct connection across the INDIAN OCEAN, and are widely separated, both structurally and geographically. It is thus clear that their calyx characters must have been independently acquired, from parents that in all probability did not themselves possess them except in a recessive condition. Now that we have seen what mutation can do in the production of endemics (young beginners) differing widely from their immediate parents, there is no difficulty in accepting polyphyletic origin like this. *Gynocardia* (*Pangieae*) with one species from ASSAM to TENASSERIM, has a calyx that tears into sepals, but it is probable, again from the geography, that this character was also independently acquired.

Pangieae are divided into the group that we have just considered, and another group composed of the single genus *Kiggelaria* with seven species in S., E., and trop. AFRICA, where there is little or no likelihood that *Hydnocarpus*, which is fading out at the CEYLON level, ever appeared, especially as neither itself nor *Kiggelaria* appear in MADAGASCAR. The latter owes its inclusion in a separate group to the opening of its anthers by apical pores, or short slits, against long slits, and a fruit usually dehiscent as against indehiscent. But though thus isolated structurally as well as geographically from the Asiatic *Hydnocarpus* group, the characters of the two overlap. Structural discontinuity in fact, as proves to be so very commonly the case, refuses to agree with geographical discontinuity, and as the latter is an unquestionable fact that requires explanation, while the former is mainly an important fact *because we have assumed* that close similarity of structure necessarily goes with close relationship, regardless of geography, it is clearly the former that must be wrongly based.

As it is evident that selection cannot explain the constant occurrence of the same characters in different places (*cf.* also Testcase XXIV in *Evol.*, p. 138), as usually they have no conceivable adaptational value, there seems nothing for it but to imagine them each produced at a single mutation, but anywhere in the family. Hitherto, the family has been supposed to have a " tendency " to produce certain things, and anatomical or structural necessity has been supposed more potent than selection in the case of occurrences like this. (*Cf. Evol.*, top of p. 120, pp. 123-4, and Testcases XXIII and XXIV, p. 138.)

It seems likely that our suggestion that any member of a family may be carrying all the characters (or more probably the potentialities or the factors), and may produce them at any time, as illustrated by the facts of teratology, is perhaps the most probable solution of this problem for the present. Something happened to the progenitor of *Schumacheria* or of *Trichadenia*, which caused their peculiar characters to come out, but the same thing might, under the same or similar circumstances, happen to any of the family.

Incidentally, it is worth while to look at the floral diagrams of five *Flacourtiaceae* given in ENGLER (1st ed., p. 5) to see how impossible it would be to produce these by selection, or in fact by anything but by straight mutation. Another good illustration will be found in *Phytolaccaceae* (*PR.* p. 10).

The next CEYLON endemic genera are three *Dipterocarpaceae*, and we shall begin with a table of the whole family, arranged by world size (curve on plate, p. 33).

Subfam. I. *Dipterocarpoideae*

Genus	World size and dispersal	Tribe	Found in Ceylon
1. Shorea	100 Indomal.	Heading *Shoreae*	5, all endc.
2. Dipterocarpus	70 Indomal.	Heading *Dipterocp.*	5, all endc.
3. Hopea	55 Indomal.	2nd Shoreae	3, all endc.
4. Vatica[1]	48 Indomal.	Heading *Vaticeae*	4, all endc.
5. Anisoptera	18 Malaya	2nd Dipterocp.	nil
6. Balanocarpus	16 Indomal.	3rd Shoreae	1, endc.
7. Stemonoporus	13 Ceylon	Heading *Vaterieae*	13, endc. genus
8. Doona	12 Ceylon	4th Shoreae	12, endc. genus
9. Cotylelobium	5 do, M. P., Borneo	2nd Vaticeae	1, endc.
10. Pachynocarpus	5 Malaya	3rd Vaticeae	nil
11. Pentachme	5 Burm., Malaya, Phils.	5th Shoreae	nil
12. Parashorea	4 SE. Asia	6th Shoreae	nil
13. Dryobalanops	4 Born., Sum.	Heading *Dryobalan.*	nil
14. Vateria	3 S. Ind., Ceyl.	2nd Vaterieae	1, endc.
15. Monoporandra	2 Ceylon	3rd Vaterieae	2, endc. genus
16. Cotylelobiopsis	1 Borneo	4th Vaticeae	nil

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[1] Incl. Synaptea. M. P. = Malay Peninsula. Sum. = Sumatra

Genus	World size and dispersal		Tribe	Found in Ceylon
17. Isoptera	1 M. P., Borneo, Phils.	7th	Shoreae	nil
18. Dioticarpus	1 S. India	8th	Shoreae	nil
19. Vateriopsis	1 Seychelles	4th	Vaterieae	nil
20. Scaphula	1 Burma	3rd	Dipterocp.	nil

Subfam. II. *Monotoideae*

21. Monotes	13 trop. Afr.			
22. Marquesia	3 trop. Afr.			

This is a very interesting table, and shows as usual how the larger genera have the larger dispersal, and are best represented, and contain the heads of the subgroups. CEYLON has 45 species, and the heads of four of the five subgroups, in the genera 1, 2, 3, 4, 6, 7, 8, 9, and only 4 species in all the rest. As MALAYA has a somewhat similar but larger representation, we may imagine that the family began somewhere between the two, but nearer to MALAYA, and the separation is now so broad and deep that it is evidently very old.

Beginning with the division into the two sub-families, the first with anther firmly united at base to a short filament, with resin and balsam passages, the second with moveable anther inserted at middle on a long filament, and no passages, we get what is evidently a sound division, for *Dipterocarpoideae* are tropical Asiatic, fading out with one species in the SEYCHELLES, while *Monotoideae* are purely tropical AFRICA, the two not meeting anywhere, even in MADAGASCAR, and *Monotes* being so large that it could only have come from one of the four at the top. But the union, if it ever existed, must be so far back that geological help must be mainly relied upon, and the botanical evidence shows nothing to suggest that they should be kept in the same family. The anatomical difference is the same as that between *Anacardiaceae* and *Corynocarpaceae* (*Anacardiaceae* p. p. BENTH. and HOOK. f.), but evidently older, and must be mutational.

Taking this dispersal as it stands, it is clear that the geographical distribution of the genera, as usual, completely disregards the taxonomic grouping, so that the classification does not represent the real affinities, except at times, and then more or less accidentally.

Shoreae, with the largest head, is the largest group, with seven apparent descendants (for we can no longer feel sure that every one of the seven really belongs to the group), and to define it we must give it a combination of characters; the most important probably being the calyx imbricate in bud, and the two, or three, sepals enlarging to wings. But one finds the imbricate calyx again in the *Vaterieae*, which however have an equal calyx, not winged even in fruit, and in the *Dryobalanopseae*, where the equal calyx later becomes 5-winged. While most of the *Shoreae* have three wings, one subgenus of *Shorea* itself (the oldest and largest genus, be it noted) has two, and another has five.

In *Dipterocarpeae*, there are only two others that show the characters of the leader. As this is the second genus in the family, one may imagine that its genetic descendants are perhaps really more numerous, but that in the mutations that formed them they perhaps lost the particular characters that mark the subgroup. And so on.

The *Vaterieae* form a somewhat improbable group. *Stemonoporus*, as a CEYLON endemic, could hardly be its real head, and is probably a part of *Vateria*, to which it is united in the *Flora of British India*, thus centring the genus in CEYLON, while *Monoporandra*, the other endemic in the group in that country, would take its natural place as an endemic in the " *Vateria* country ".

CEYLON, with about half the genera of the family represented in it, shows the heads of four of the five sub-groups, the only one not represented, *Dryobalanopseae*, having only one small genus, in MALAYA. In so small a family, this shows up very well the underlying artificiality of our present system of classification. This same kind of thing is an universal phenomenon. It is clear that only those things are put in *Shoreae*, for example, which *happen* to have the two characters mentioned above, and that these characters may be found singly in other places (pp. 134-6). We have drawn certain lines of distinction in taxonomic work, to divide families or other groups into smaller divisions, and having done so, we find that the incidence of any single character frequently crosses these lines in an apparently arbitrary way, so that at bottom our system is largely artificial, and in places natural, just as was the case with the Linnean system, from which the writer was taught his botany only 70 years ago. In *Diandrae*, for example, one found *Circaea*, *Veronica*, and *Anthoxanthum* side by side, while the *Tetradynamae* was the single, and well established, family *Cruciferae*. The wide separation that always shows between the leading genera of a family, which are really very closely related indeed, goes to show that our present system of taxonomy is too narrowly based to form a natural classification, which would in actual fact be so complicated as to be of little use.

The work upon endemism has shown, almost beyond doubt, that in a genus with WE only, in any country—much the commonest way in which endemism is shown—the wide is the parent of the endemic, and this is confirmed by the division of the characters of the wide between the two endemics in WEE. Everything, whether in species or in genera, goes to show that any character may turn up anywhere (probably within certain limits, which as yet we do not comprehend). A character like the posterior androeceum of *Schumacheria* may be recessive for a long period, turning up again quite unexpectedly. It is possible that mere lapse of time may have some influence in the matter.

The next CEYLON endemic genus is *Julostylis* (*Malvaceae*), in the tribe *Hibisceae*, where it was probably derived directly from *Hibiscus* itself, leader of the family, which has 11 species in CEYLON, seven of them common or very common. It is distinguished from the others of the tribe by having only 10 stamens in two rows against their ∞ in many rows, again an evident mutation character. *Thespesia*, the only other member of the tribe, is a dry-country and coast plant, and *Julostylis* is common in the moist low country, where several *Hibiscus* grow. The top five *Malvaceae* by size are :

Hibiscus	160 warm	11 Ceylon.	Heads *Hibisceae*
Abutilon	120 warm	5 Ceylon.	Heads *Malveae-Abutilinae*
Malvastrum	85 Am., S. Afr.	—	Heads *Malveae-Malvinae*
Sida	75 cosmop.	6 Ceylon.	Heads *Malveae-Sidinae*
Pavonia	70 warm	3 Ceylon.	Heads *Ureneae*

and there are also in CEYLON *Wissadula* (25 trop. especially AM.), *Thespesia* (5 warm *), *Urena* (3 warm), *Dicellostyles* (2 CEYLON and SIKKIM HIMALAYA, perhaps a case of polyphyletic development of characters), and *Julostylis* (1 CEYLON, endemic). In fact the only group of *Malvaceae* not found in Ceylon, for *Hibisceae* and *Ureneae* are not divided into subtribes, is the first tribe, *Malopeae*, which is very badly constructed from a geographical point of view, its head being *Palava*, a small genus of five species in Chile and Peru, and the others *Malope* with three Mediterranean, and *Kitaibelia* with one on the lower Danube. This must be a case of polyphyletic development of the peculiar mutation character of carpels in vertical rows that marks this group.

Pityranthe, the next genus, with one species, in *Tiliaceae*, is placed in the *Brownlowieae*, whose characters, chiefly (K), and anther-thecae confluent after dehiscence, are evidently such as have been found to mark *a number of genera*. But these eight genera also show, in one or more,

petals present or absent
stamens free, or united at base
stamens all fertile, or some sterile
anther spherical or two-headed
ovary 2- to 5-locular
ovules 1, 2, or 4 or more in each loculus
panicles terminal or lateral, &c.

It has evidently just happened that this group shows two of the many characters that are possible, while to get a group that is really natural much more comparison of characters is necessary, more characters must be used, and geography, genetics, and statistics must be brought in. The mere sizes of the eight genera show that the group is probably an accidental one. They are 10, 10, 6, 4, 1, 1, 1, 1, ranging from Cuba to Polynesia.

Before leaving the Ceylon endemic genera it is worth while to note, in the family *Orchidaceae*, the variation of number of endemics, which are here plentiful, with the size of the widely dispersed genera in the family.

5 Genera	down to	200 spp.	have	21 wides,	21 endcs.	(av. per gen.	4.2)
6		100		14	19		3.2
5		50		7	10		2.0
12		25		13	9		0.75
19		10		21	11		0.58
4		5		4	1		0.25
7	below	5		7	1		0.14

and three endemic genera of one species each.

The falling off in arrivals of genera below 10 in this island is interesting.

Other interesting problems appear if we glance at the endemic genera of other countries. Let us take NEW ZEALAND, where we find *Tetrachondra*, where the first species found (in NEW ZEALAND) was placed in *Boraginaceae* (**23**), and then a second species was found in CHILE. The difficulty thus opened was temporarily shelved by making it into a new family *Tetrachondraceae*, and supposing that all the links that connected the two across the great distance that separates them have been killed out, though it is rather remarkable that just one local species should be left upon each side. But in a case like this, if we do not accept the simpler explanation of polyphyletic development, we are dealing with a thing whose previous history is practically lost. One does not seem to gain by the prevalent fashion of making new families. *Corynocarpus* in NEW ZEALAND and NORFOLK I. is another case, which used to be considered as a somewhat " abnormal " *Anacardiaceae*. *Every genus is liable*, in dichotomous formation, *to need a new group for itself*.

Other interesting NEW ZEALAND endemics are *Alectryon*, *Entelia*, *Hectorella*, *Rhabdothamnus*, *Teucridium*, &c. Special interest attaches to *Myosotidium*, very isolated with its one species on the far-out CHATHAM Is. east of NEW ZEALAND. The only other *Boraginaceae* there is *Myosotis spatulata* Forst., but is placed in tribe *Lithospermeae*, while *Myosotidium* is placed in *Cynoglosseae*, which has no other representative either in the CHATHAMS or in NEW ZEALAND proper, again evidently a case of polyphyletic development. Our present grouping, which necessarily depends upon divergence, or one could not make keys, but also assumes that a character can only be gradually acquired, or gradually got rid of (whether by small steps or by very small ones does not matter), is evidently an illogical and artificial one. We place a plant in a genus, or in a tribe, by our estimation of degrees of divergence.

As a rule an endemic genus is found to belong to the same tribe as one of the wides among which it is living, but this is not always so, and there is then a tendency to erect a new family. Sometimes this is done for several genera, as in the case of *Buxaceae* (*Euphorbiaceae* p. p. BENTHAM and HOOKER), where it has already been found necessary to make three tribes :—

Buxeae	Sarcococcus	5	Ceylon, India, Sumatra
	Pachysandra	4	Alleghanies, Japan (*cf.* p. 89)
	Buxus	25	palaeotemp., W. I., the latter being sometimes placed in a separate genus
Stylocereae	Notobuxus	1	Natal
	Styloceras	3	Andes of Colombia and Bolivia
Simmondsieae	Simmondsia	1	California

One does not often meet a more impossible geographical distribution. It is clearly another case of the same mutation occurring in different places, but producing the ovule of the order *Sapindales*, not of *Geraniales*, in which *Euphorbiaceae* is placed. It is also another example of how breaking up into smaller structural groups destroys the geographical and curve continuity.

Let us now glance briefly at the endemics of the HAWAIIAN Is. which are looked upon as the chief support of the theory of relicdom. The chief thing to strike one in (62) is the absence of any Monocotyledons among them, and though a few have since been made by splitting, this has also been applied to the Dicots, whose prominence remains as great as ever.

Nearly all belong to large (old) families and genera. In (62) 8 belong to *Compositae*, 5 *Campanulaceae*, 4 *Rubiaceae*, and 3 *Araliaceae*, or 20 to this group of allied families, while the other ten families that contain endemics have only 16 among them. One of these, *Begoniaceae*, is almost entirely composed of the one great genus *Begonia*, with 800 species. The tribes to which the endemic genera belong are also usually important. In the *Compositae*, five belong to *Heliantheae*, and *Lipochaeta* (not counted as endemic) has 11 of its twelve species in the HAWAIIANS, the other in the GALAPAGOS. Counting this, the *Heliantheae* have 56 out of the 70 species of *Compositae* found. In BRITAIN they are represented only by *Bidens*, with 150 species, but the leader of the group. There are no *Cichorieae* upon these islands, nor *Cynareae*, nor *Vernonieae*. *Senecioneae* are only represented by *Senecio* itself, with one species on one island, and another doubtful as to locality, so that if the genus, as the oldest of the *Compositae*, led the way to these islands, it must have mutated fairly soon into some other group. And this looks like a possible explanation of the fact that the only member of *Heliantheae*, other than the endemics, present is a solitary species of *Verbesina* (80 spp. warm AM.) upon one island.

The *Heliantheae*, though their head, *Bidens*, is one of the smallest heads with its 150 species, form one of the largest tribes of *Compositae*, with (roughly) the following composition 76/1, 39/2, 14/3... 10/10... 3/25... 90 100 150, or 216 in all. The *Senecioneae*, on the other hand, with their gigantic leader, *Senecio*, with at least 2000 species, form quite a small group. But the distinction is largely that the pappus of *Senecio* is, and that of *Bidens* is not, hairy, a very simple character, but one only possible, in the perfection in which it is shown, by the work of mutation. It would seem quite possible that *Heliantheae* might really be a subtribe of *Senecioneae*, with *Bidens* as the leader, but a much younger group than the parent tribe, as shown by the size of the leader (3-4 species-generations younger than *Senecio*).

Let us now go on to consider some of the endemics individually.

Isodendrion (*Violaceae*) has three species, found on 5 islands, and on 2 and 1, all having OAHU in common. It is distinguished from *Viola*, the head of the family, and the only other genus of it in the islands, by its equal petals without spur or sac, and by the absence of an appendix at the end of the anther. Both are evident mutation characters. The maximum dispersal of five islands is well below that of *Viola* (all), and shows the greater youth of *Isodendrion*. *Viola* was evidently its parent, though it belongs to tribe *Violeae*, the endemic genus to *Paypayroleae*. We shall return in the next chapter to the consideration of this structural divergence, which is one of the well marked features of evolution.

The next two genera are in *Caryophyllaceae*—*Schiedea* with 17 species (on 4, 3, 3/2, 12/1 islands), and *Alsinidendron* with 1 upon OAHU, both belonging to tribe *Alsineae*, while *Silene*, the only other Caryophyll upon the islands, belongs to *Sileneae*, and has only four species (4,2, 2/1). It is thus a bit of a puzzle to trace the descent of the two endemic genera, though *Silene*, as the actual head of the family, is much the most probable. The dispersal indicates more or less equal age, while *Schiedea* has four times the number of species.

It is quite possible that the first two or three mutations of *Silene* resulted in the loss of petals—the chief distinguishing mark—and provided more potential parents for the larger number of species of *Schiedea,* and also for the other petalless genus *Alsinidendron,* which is distinguished from *Schiedea* by the number of its staminodes, and the union of the stamens at the base. All the work that we have been doing in the last few years seems to indicate that cross-mutation such as we have just suggested plays a not unimportant part in evolution.

It should be profitable to investigate the flora of the Hawaiian Is. with especial reference to the individual islands, where the eastern are larger than the western. The two columns here given show the rough position of the seven most important :

West	East
N(iihau)	K(auai)
	O(ahu)
	M(o)l(okai)
L(anai)	Ma(ui)
	H(awaii)

The letters not enclosed in brackets are used as abbreviations.

The Caryophylls occur on these islands as follows, taking them always in the order K, O, Ml, Ma, H, L, N

Silene	K, Ma, H, L		Ma, H	Ml	Ma	K	K
Schiedea	K, O, Ml, Ma	O, Ml, Ma	O, Ml	K	K		
			Ma, H	O	O	O	O
			Ma, L	Ml	Ma	H	N
Alsinidendron	—	—	—	O			

Of these 34 occurrences K shows 6, O 8, Ml (a rather small island) 5, Ma 8, H 4, L 2, N 1. The greatest number of occurrences is upon the eastern and central islands, fading out to the others, and again giving a general impression of possible cross-mutation from *Silene.* I have done much work on these lines, but it will now, I fear, never be ready for publication, so these indications of the lines of it have been given.

The next family showing endemic genera, again a large (old) one, be it noted, is *Rutaceae* with *Pelea* (20 spp.), *Platydesma* (4), both endemic, and *Zanthoxylum* (6), a genus with only about 20 species in E. ASIA and N. AMERICA, united by BENTHAM and HOOKER with *Fagara*, which with its 200 species is regarded as the head of the family, and is much more likely to appear in the HAWAIIAN Is. than a small genus.

Another family which presents many points of interest is the *Rubiaceae*, of which eleven genera with 48 species (to which have probably to be added many more *Coprosmas* (cf. **111**) occur; these are (endemics in italics):

Genus	Tribe	Spp. in world	Spp. in Haw. Is.
Kadua	*Oldenlandieae*	16	16, all endc.
Gouldia	*Mussaendeae*	5	5, all endc.
Gardenia	*Gardenieae*	80	2, both endc
Plectronia	*Vanguerieae*	100	1, wide (all islands)
Bobea	*Guettardeae*	5	5, all endc.
Psychotria	*Psychotrieae*	500	2, both endc. (Kauai I)
Straussia	*Psychotrieae*	5	5, all endc.
Coprosma	*Anthospermeae*	50	9, all endc.
Nertera	*Anthospermeae*	10	1, wide (all islands)
Morinda	*Morindeae*	50	1, endc.
Richardsonia	*Spermacoceae*	10	1, endc.
			48

No fewer than nine of the 19 tribes of the *Rubiaceae* are represented in these 11 mostly rather small genera, of which four are endemic, three of them having each a tribe to itself, but a tribe, be it noted, that *occurs elsewhere*. The representation is different from what shows in northern EUROPE. The only large head of a tribe here is *Psychotria*, the leader of all the *Rubiaceae*, but represented only by two endemics upon the rather outlying island of KAUAI. There are two genera that each have one wide (only), but upon all the islands. Of these, *Morinda* (100 spp.) is the only one big enough to have so large a following, and it is not impossible that it should be the parent. But perhaps the most likely thing is that *Psychotria* mutated on arrival, and again later, giving rise to many of the other forms, while two of its descendants show its own characters, or that all the endemics are descendants of the three oldest genera, *Psychotria*, *Morinda*, and *Coprosma*, and that *Plectronia* and *Nertera*, though widely dispersed, are later arrivals. The mere presence of so many tribes, with generally one representative each, and that not always endemic, is a very difficult thing to explain upon the theory of relicdom. But this, and many other similar problems will remain simply matters for speculation for the present, until we begin to gain some knowledge of the laws of incidence and of transmission of characters, and there is plenty of work waiting to be done in the simpler problems that do not involve so much ancient history.