II. A Survey of Modern Opinion

EDGAR ANDERSON

When I was originally asked to speak on genera from the viewpoint of cytogenetics, I replied that on this problem genetics could contribute nothing and cytology very little. The chief technique of genetics is to cross individuals and from the appearance of their progeny to make inferences as to the germplasms of the two individuals. Very few genera can be crossed and no exhaustive studies of the progeny have been made in the few exceptional cases which were semi-fertile. The chief technique of cytology is to make direct observations on the germplasm. This technique is obviously applicable to the study of generic differences but to yield significant results it would have to be applied in various families of the flowering plants and completely correlated with a taxonomic investigation of the same genera. Most of the cytological evidence compiled up to the present time has been assembled by cytologists who were quite innocent of any taxonomic training or insight and their data cannot therefore be used for this purpose. The few projects which are now under way (notably those of Babcock and Stebbins, 1937, on the Crepidinae and Clausen and Keck, 1933, on the Madinae) are as yet too incomplete and too restricted to permit effective generalizations.

Since, for the above reasons, it seemed to me that genera could not be discussed from the viewpoint of cytogenetics, I asked to be allowed to investigate them in another way. We may think of genera in two quite different ways, (1) as biological units, that is as gross discontinuities in organic nature, or (2) as cataloguing devices used by systematists. These two concepts are overlapping. Such a distinction may even be unwelcome to many biologists; it will, however, be a useful expedient in the following discussion.

It seemed to me that if one could not yet investigate genera as they may or may not exist in nature, he might at least learn something about them *as they exist in the minds of taxonomists.* This I set out to do by framing a questionnaire which would indicate something of the differences of opinion among modern taxonomists. With the help of preliminary discussions with Dr. J. M. Greenman and Dr. C. L. Hitchcock (who are, however, to be absolved from any responsibility) the following questionnaire was prepared and sent out to fifty taxonomists with whose work I was personally acquainted. The list was representative and for reasons which will be apparent below, was purposely devised to include monographers, plant geographers, and students of floristics.

For the symposium on Genera I am attempting to find the opinion of present day taxonomists. Will you, therefore, be kind enough to fill out the following questionnaire? A stamped, addressed envelope is enclosed for your reply. If you are unable to fill out the questionnaire will you at least indicate here your reason for not doing so?

( ) I am too busy. ( ) I feel the questions are trivial.
( ) I am out of sympathy with any such investigation.

Question No. I.

Which in your opinion is the more natural unit among the flowering plants, the genus or the species? (i.e., which of the two more often reflects an actual discontinuity in organic nature.)

( ) The genus is the more natural unit. ( ) The species is the more natural unit. ( ) I have no opinion on the subject. ( ) I think the question as phrased above is meaningless. ( ) I do not understand the question as phrased above.

Question No. II.

If genera are more clearly marked than species this may be due to either or both of two quite different processes: *A*. Genera may originate in the same way as species and achieve their greater distinctness by the disappearance of more intermediates. *B*. Genera may originate in a different way from species; i.e., it is conceivably possible that there are different forces which have operated in the origin of genera. If *"A"* has been the chief method by which genera have originated then the morphological differences between genera, though greater than those between species, should be the same *sort* of differences. If *"B"* has been the chief method then we might expect generic differences to be of another kind from specific differences. In the light of the above discussion will you indicate your opinion below? Check more than one space if you wish.

( ) Generic differences are of the same kind as specific differences though they may be greater. ( ) Generic differences are of a different kind from specific differences. ( ) I have no clear opinion on the subject. ( ) I do not think the statement has any meaning. ( ) In my opinion the statement is obscure.

Question No. III.

In an attempt to avoid misinterpretation the same idea has been phrased in another manner. Please check your reaction to the following statement: Generic differences could be compounded from specific differences.

( ) Yes. ( ) No. ( ) Question meaningless. ( ) Question obscure.
( ) No opinion on the subject.

To those who care for it a tabulated summary of the replies will be mailed. If you would like such a summary please make a check in the following space ( ).

The response to the questionnaire was most gratifying (Table 2). Practically all in the group checked their responses and a considerable number amplified the questionnaire with a discussion of the points which had been raised. It was immediately apparent that there was a very considerable relation between interest in the questionnaire and the age of the person replying. Among the younger men such expressions as "I am looking forward to this symposium" or "I have discussed your questions at length with such and such a colleague and they have stimulated an interesting discussion" were common. Many of the older botanists, on the other hand, answered with reluctance or expressed doubt as to the wisdom of the enterprise. By grading interest in four objective classes it is even possible to demonstrate this correlation in tabular form (Table 1). It is one

TABLE 1

Correlation between interest in the questionnaire and the age of those replying.

	UNDER 40	40 TO 55	OVER 55
Not in sympathy with questionnaire	..	..	2
Replied without comment	2	7	7
Replied with additional comment	6	6	5
Replied and also expressed interest in questionnaire	12	1	1

thing to demonstrate a correlation and another thing to interpret it correctly. In this case several factors are probably responsible for the correlation. Certain of the younger men might have been deferential towards the project, since I was older and presumably wiser. And for the same reason those older than I might have had less tolerance for a novel project by a much younger man. It is also undoubtedly true that the genus problem is so complex, and requires such a long apprenticeship, that few young biologists have enough experience to discuss it intelligently. The older men were experienced enough to realize this fact and to realize the complexity of the problem. One of this group wrote me as follows, and I quote his remarks because I find myself very much in sympathy with this point of view: "Your circular letter of August 26th does not arouse any warmth within me. All the questions you raise are purely speculative, and in the present state of our knowledge they cannot be answered. These problems work themselves out practically for each publishing taxonomist, and a

fair agreement has been reached as to the limits of genera and the limits of species without much reference to philosophical considerations. Discussion of such problems is likely to be made by persons who have no taxonomic training and the conclusions would be of little practical value. Probably I should not take the time to read them. Persons who have no actual contact in the diagnosis of species are likely to want definitions of what a species is. The taxonomist does not raise the question in that way, but meets each case as it come to him. Perhaps in a century or so from now we shall be able to approach such problems with sufficient knowledge to make the conclusions significant."

TABLE 2

Summary of 48 replies to questionnaire.

QUESTION I

Genus the more natural unit	26
Species the more natural unit	8
Sometimes one, sometimes the other	11
No opinion	1
Question meaningless	2

QUESTION II

Genera originate in the same way as species	31
Genera may originate in a different way	4
Genera may originate in same or in a different way	9
No opinion	4

In my opinion there is another, and more important reason for the correlation between age and interest. Many of our younger taxonomists have a different biological training from the older generations. Consequently they have a different attitude towards taxonomic work and that difference is reflected in the correlation shown in Table 1.

A large proportion of the replies warned me that I would find great differences of opinion on these questions. In the face of such statements it is particularly interesting that of the fifty replies received twenty-one were absolutely identical. A considerable proportion of the remainder differed only in one detail or another. Apparently therefore there is more agreement among modern taxonomists than they themselves realize. This orthodox point of view revealed by the questionnaire is that genera are on the average more natural units than species, that they originate in the same way as species and that generic differences could be compounded from specific differences.

The replies were then studied to see if there was any obvious correlation between the above point of view and the experience of the botanists who held it. Since there seemed to be a connection between monographic experience and "orthodoxy" an attempt was made to group the replies with

reference to the monographic experience of those replying. For this purpose it would have been ideal to have had twenty-five replies from botanists who had done nothing but monographic work and twenty-five from those who had done no monographic work whatever. Unfortunately there was no such clear cleavage and we had to content ourselves with selecting the following two groups, which have been called "monographers" and "non-monographers" to simplify Table 3 and its discussion. It would be more truthful to refer to the first group as "taxonomists whose experience has been rather exclusively in monographic work" and to the second as "taxonomists who are not monographers or who have had extensive experience in other biological disciplines."

Group I. "Monographers."

Blake, Epling, Fosberg, Gleason, Goodman, Greenman, Hitchcock, Hopkins, Johnston, Kearney, Munz, Ownbey, Pennell, Rosendahl, Sherff, Wright Smith, Lyman Smith, Svenson, L. O. Williams, Woodson, Yuncker.

Group II. "Non-monographers."

Anderson, Babcock, Camp, Cory, Deam, Hermann, Howell, Kinsey, Mattfeld, Merrill, Muenscher, Müntzing, Nelson, Palmer, Raup, Stebbins, Steere, Steyermark, Stockwell, Weatherby, Wiegand.

The replies of these two groups are tabulated in Table 3. It will be seen that even though the distinction between the two groups is somewhat imperfect there is a decided correlation. Two-thirds of the monographers are "orthodox" but less than one-third of the non-monographers.

TABLE 3

Correlation between monographic experience and "orthodox" opinion in regard to genera. Further explanation in the text.

	UNORTHODOX	ORTHODOX
Monographers	14	7
Non-monographers	6	15

SUMMARY

It should again be emphasized that the results of this investigation have probably little or no bearing on the question of genera as they may or may not exist as evolutionary units. The aim of the investigation was to ascertain something about genera as they exist in the minds of taxonomists. For a representative group of 50 taxonomists the following facts were established.

(1) There is a perceptible correlation between age and interest in discussing such concepts as genera. In part, at least, this probably reflects a

changing attitude towards taxonomic work. (2) Nearly one-half of those interviewed gave identical replies to the whole set of questions. (3) There is a very strong correlation between monographic experience and the tendency to the point of view that genera are more natural groups than species, that they originate in the same way, achieving their greater discontinuity by the disappearance of more intermediates.

CONCLUSIONS

The results reported above and the various comments, which accompanied the replies, lead me to conclude that much taxonomic work is strongly colored by a widely accepted hypothesis. The notion that individual differences are gradually built up into varietal, and these progressively into differences of specific and generic rank is so logical that it has, consciously or unconsciously, been accepted by many taxonomists as absolute dogma. More than one systematist in replying to the questionnaire expressed astonishment that one might even consider evolutionary forces which would lead to the separation of genera but which would not operate in the formation of species. Yet by experimental analysis we already know of various quite different isolating mechanisms of evolutionary importance (Dobzhansky, 1937). It is scarcely credible that there are not others still to be discovered. We already know of mechanisms which may operate in the deployment of subgenera but may not in the deployment of species. It is already possible to indicate species which are separated by evolutionary forces different from those forming varieties within the same species (Anderson, 1936). The patterns of evolution are too complicated and too various for the universal application of any simple phylogenetic hypothesis.

For such reasons as these I find myself in sympathy with those who dissented from the "orthodox" view reported above. In my opinion it would be well if monographers could approach their work with minds unprejudiced by evolutionary theories. We are so certain of the fact of evolution that we are prone to forget how little we know about the forces behind it. Personally I find myself in complete agreement with the following comment which was appended to one of the replies.

"It looks to me as if you were trying to generalize on the assumption that there is a basic uniformity in taxonomic groups. There is nothing of the sort. Taxonomy is only a glorified guess—an attempt to construct a cross-section of lines of descent in a form intelligible to the human mind. It always contains two variable quantities—the plasticity of animate nature and the differing points of view of the people who work at it. You can generalize successfully, if at all, only by keeping these facts constantly in mind. I suspect that the situation is best expressed by the old aphorism:

the only general rule is that there is no general rule. Therein lies the fascination of taxonomy for those who like it. It is not a matter of mechanically applying a universal set of categories to given groups of facts. Each group one tackles presents a fresh and original problem; for each, one has to work out anew the method by which he may best achieve that transforming of confusion into order which is the great satisfaction of pure taxonomy."

NOTE:—When replies to the questionnaire arrived, I realized that there had come into my keeping, material which was of extraordinary biological interest and which would be of increasing importance in the future. I am accordingly having the replies bound, together with their accompanying letters, and deposited in the library of the Missouri Botanical Garden.

THE MISSOURI BOTANICAL GARDEN AND WASHINGTON UNIVERSITY
ST. LOUIS, MISSOURI

Literature Cited

Anderson, Edgar. 1936. The Species Problem in Iris. V. The Evolutionary Patterns of the Genus Iris. Ann. Mo. Bot. Gard. **23**: 499–509.

Babcock, E. B., Stebbins, G. L., Jr. & Jenkins, J. A. 1937. Chromosomes and Phylogeny in Some Genera of the Crepidinae. Cytologia **Fujii Jub.**: 188–210.

Clausen, Jens, Keck, David D. & Heusi, William M. 1933. Experimental taxonomy. Carnegie Inst. Wash. Year Book **32**: 192–195.

Dobzhansky, Theodosius. 1937. Genetics and the Origin of Species. pp. i–xvi, 1–364. Columbia Univ. Press, New York.