METHODS FOR CALCULATING THE ACTUAL GAMETIC
$F_2$ SERIES FROM A GIVEN ZYGOTIC SERIES \(^1\)

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INTRODUCTION

In order to determine linkage intensities, it is necessary to know the gametic ratio, as formed by the $F_1$ individuals of a cross. Crossing-back the $F_1$ with the double recessive is, of course, the most ideal method, since every individual resulting from this back-cross

\(^1\) The methods described in this paper were worked out when the writer was an International Education Board fellow at University Farm, St. Paul, Minnesota. Thanks are due to Dr. H. K. Hayes for reading and commenting upon the manuscript.
is a personified gamete. According to Bridges (1915), differential
mortality may be eliminated in this method by combining equal
amounts of coupling data with repulsion data.

In many cases, however, the back-cross method offers great dif-
ficulties. The number of seeds formed in each crossing may be relatively
small, so that back-crossing takes much time. Furthermore, the double
recessive may not be available, which means, in most cases, loss of
two generations. It is therefore perfectly natural that many attempts
have been made to determine linkage intensities from $F_2$ data.

Bateson and Punnett (1911) were the first to give formulae for
the theoretical expectation in coupling and repulsion, followed by
Emerson (1916) and Castle (1916). Woodworth (1923) modified
Emerson's formulae when duplicate factors (referring to two poly-
meric factors in European terminology) were involved, and Brunson
(1924) did the same for complementary factors.

Collins (1912) worked out a method, based on the coefficient of
association formula, given by Yule (1900). Bridges (1914) and Col-
kins (1924) extended this method. Collins (1924) compared critically
the method of Emerson (1916), a method worked out by Haldane
(1919), and his own method. Another method was worked out by
Claussen, as mentioned by Hor (1924), while recently Alberts (1926)
and Kappert (1927) published still other methods.

All these methods are accurate when the zygotic $F_2$ ratio agrees well
with the theoretically expected one, but they are more or less inaccu-
rate when there are deviations from the theoretical ratio. The advan-
tage of the back-cross method, as compared with the methods of the
investigators mentioned above, lies in the fact that the actual gametic
ratio is revealed by back-crossing and this is what we want to know.
The present author has worked out a method which makes it possible
to find the actual gametic ratio from $F_2$ data. This method does not
show, however, the differences between the female and male gametic
series. Therefore, a second method has been developed by which it is
possible to calculate both gametic series from $F_2$ data when there is
only partial dominance, and from $F_2$ and $F_3$ data when there is com-
plete or almost complete dominance. The mathematics of this second
method has been worked out by Dr. M. J. Van Uyen, professor of
mathematics at the Agricultural College, Wageningen, Holland, to
whom I am greatly indebted for his help.