

GENE EXPRESSION AND TRANSMISSION IN *KERRIA LACCA* (KERR)

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SUMMARY

Cytological studies of the Indian lac insect *Kerria lacca* (Kerr) resulted in contrary reports suggesting two quite distinct chromosome systems, the orthodox and the unorthodox "Lecanoid" system. Genetic tests with the first discovered mutant, namely yellow, confirmed elimination of the paternal chromosome in *K. lacca*, but unlike the "Lecanoid" system the male was found to express the paternal allele. The results reported here with the other marker genes provide further evidence that the unorthodox genetic system of *K. lacca* differs from the "Lecanoid" system in gene expression.

1. INTRODUCTION

THE coccids are noteworthy for their diverse and complex genetic system; those involving heterochromatisation are of particular interest for the problem of gene and chromosome inactivation. The Indian lac insect *Kerria lacca* (Kerr) (Syn. *Laccifer lacca* (Kerr)) is an economically important species, and has, therefore, attracted attention. However, the cytological picture remains rather confused. Thus, while Tulsyan (1963) reported normal chromosome behaviour with XX : XO sex-determining mechanism, Dikshith (1964*a, b*) suggested the unorthodox "Lecanoid" system as determined in the mealy bug, *Planococcus citri*. Genetic tests with the yellow mutant (Chauhan, 1970) suggested a different situation for although elimination of the paternal chromosome was confirmed during the formation of the male sex-cells, unlike the "Lecanoid" system both the maternal and paternal chromosomes appeared to be somatically active. The present communication reports results obtained with the other marker genes that are now available in *K. lacca* which help clarify the situation.

2. MATERIALS AND METHODS

All experiments were carried out in the Institute Plantation at Namkum. The insects used in these experiments originated from the laboratory maintained homozygous wild-type and mutant stocks of *K. lacca*. The test insects were cultured on potted plants of *Moghania macrophylla* (Willd.) O.Ktze. covered by a fine muslin cloth cage to control contamination and prevent losses due to parasitic and predatory activity. For the tests involving colour genes, the progeny was scored at the time of sexual maturity since the lac larvae, on hatching, invariably retain the colour of their mother and the change in colour produced by their own genotype becomes apparent only after they have grown on the host plant for some time, usually in the

second instar (Chauhan, 1967). The sexes were also scored at about this time when they were clearly distinct. Five or more progeny were scored from each class of mating.

3. RESULTS

The genetic stocks of *K. lacca* used in the present tests included the wild-type crimson which produces a yellow resin and the following mutants.

Yellow (y). The yellow lac insect has been known for some time (Negi, 1954), but only recently established as a mutant (Chauhan, 1967). The body colour is changed from crimson to yellow and it behaves as a simple recessive.

White (w). This mutant was first picked up in a F_4 progeny from a cross of two distinct races of *K. lacca* (Chauhan and Teotia, 1973) and was later recorded occurring in low frequencies in two of the eight wild stocks of *K. lacca* maintained at this Institute (Chauhan, 1976).

The mutant is conspicuous because of the dye-free state of the insect and its resin, which behaves like a simple recessive and is non-allelic to the yellow (N. S. Chauhan, unpublished). Homozygosity for the recessive

TABLE 1

Progeny phenotypes in crosses of white (w) and wild-type (w⁺) stocks of K. lacca

Genotype of		No. of progenies	Daughters		Sons		Expected genotype of sons
Mother	Father		Wild-type	White	Wild-type	White	
w^+/w^+	w/w	7	979	0	297	0	$w^+/(w)$
w/w	w^+/w^+	9	314	0	132	0	$w/(w^+)$

The allele contributed by the father is shown in parentheses.

allele at the white locus masks the manifestation of colour genes at the yellow locus, presenting a situation that is referred to as recessive epistasis in the classical sense. The expression of normal insect colour in *K. lacca* is thus dependent on the presence of at least one dominant allele at each of these two loci.

Kusmi. The so called *rangeeni* and *kusmi* strains of *K. lacca* differ most conspicuously in their ability to utilise *Schleichera oleosa* (Lour) Oken. as the host plant (Glover, 1937). Chauhan and Mishra (1970) have shown that the *kusmi* strain is genetically adapted for survival on *S. oleosa*, but the *rangeeni* strain is not. The *kusmi* phenotype is dominant to that of the *rangeeni*.

The progeny phenotypes in crosses of the colour forms are shown in tables 1 and 2. These results are similar to those obtained earlier with the yellow mutant (Chauhan, 1970). The identical phenotype of the reciprocal F_1 males in crosses of the white and wild-type (table 1) and expression of the wild-type phenotype by the F_1 males in crosses of the white and yellow mutants (table 2) provide further evidence that both the maternal and paternal chromosomes are somatically active in the male *K. lacca*.

The characteristic physiological difference of the *rangeeni* and *kusmi* strains of *K. lacca* in their ability to utilise *S. oleosa* as the host plant could also be used to test the somatic activity of chromosomes in the male *K. lacca*.

TABLE 2

Progeny phenotypes in crosses of the white (w) and yellow (y) mutant stocks of K. lacca

Genotype of		No. of progenies	Daughters		Sons		Expected genotype of sons
Mother	Father		Wild-type	Mutant	Wild-type	Mutant	
$w^+/w^+ y/y$	$w/w y^+/y^+$	6	1010	0	383	0	$w^+/(w)y/(y^+)$
$w/w y^+/y^+$	$w^+/w^+ y/y$	7	275	0	121	0	$w/(w^+)y^+/(y)$

The allele contributed by the father is shown in parentheses.

If the paternal chromosomes are indeed inactivated as in the ‘‘Lecanoid’’ system, we would expect the F₁ progenies from *rangeeni* mothers and *kusmi* fathers, when cultured on *S. oleosa*, to contain no males at all. It will be seen from table 3 that such progenies included both sons and daughters and the average proportion of males does not differ much from that in the *kusmi* progenies.

TABLE 3

Average percentage males in crosses of rangeeni and kusmi stocks of K. lacca when cultured on S. oleosa

Mother	Father	Sex ratio		
		Daughters	Sons	% males
<i>kusmi</i>	<i>kusmi</i>	1551	204	11.6
<i>rangeeni</i>	<i>kusmi</i>	990	167	14.4

Earlier tests with the yellow mutant (Chauhan, 1970) had confirmed that the male transmitted only the maternal chromosome through the sperm. The reciprocal F₁ males and females from crosses of the white and wild-type stocks of lac insects were also backcrossed to the recessive homozygous parent to test the kinds of gamete they produced. Table 4 shows that, as expected, the heterozygous females produced two kinds of gamete, but the heterozygous males produced only the maternal kind, providing further confirmation that the paternal chromosome is not transmitted through the sperm. Similar results have since been obtained in crosses of the white and yellow mutants, the F₂ always behaving like a backcross to the maternal parent due to the male transmitting only the maternal chromosomes through the sperm.

It will be seen from tables 1, 2 and 4 that the number of progeny scored

TABLE 4

The test-cross distribution of white (w) and wild-type (w⁺) in crosses of the two colour forms of K. lacca

Genotype of		No. of progenies	Daughters		Sons	
Mother	Father		Wild-type	White	Wild-type	White
$w/(w^+)$	$w/(w)$	5	369	341	114	97
$w^+/(w)$	$w/(w)$	5	296	281	101	89
$w/(w)$	$w/(w^+)$	7	0	251	0	71
$w/(w)$	$w^+/(w)$	8	301	0	97	0

The allele contributed by the father is shown in parentheses.

from the crosses with white as the maternal parent were distinctly fewer than those from the others, and this was certainly due to the reduced fecundity and survival of the white mutant.

4. DISCUSSION

The results in the present tests are similar to those obtained earlier with the yellow mutant. The identical phenotype of the reciprocal F_1 males in crosses of the white and wild-type, the expression of wild-type phenotype by the F_1 males from crosses of the white and yellow mutants, and the normal survival of F_1 males from crosses of the *rangeeni* mothers and *kusmi* fathers on *S. oleosa* leave no doubt that both the maternal and paternal chromosomes are somatically active in the male *K. lacca*. The fact that the paternal alleles for the known loci in *K. lacca* are expressed in the male presents a situation distinctly different from that demonstrated for the "Lecanoid" system by Brown and Nur (1964), Brown (1969) and Brown and Wiegmann (1969). Although Dikshith claims a "Lecanoid" system in *K. lacca*, his actual observations relate only to spermatogenesis, and this is confirmed in the genetic tests. The available cytogenetic evidence thus clearly suggests that the heterochromatisation of the paternal chromosome-set is confined to the male germ line. The *K. lacca* genes are thus autosomal in expression, but sex-linked in transmission.

Of the coccid systems involving heterochromatisation and elimination of chromosomes, the "Lecanoid" has been considered the ancestral one and derived from the orthodox XX:XO system (Brown and McKenzie, 1962; Brown, 1963). The cytological features of the *K. lacca* system closely resemble those of the "Lecanoid" (Dikshith, 1964a, b), but for the fact that the former still retains the diploid somatic status of the male. It is tempting, therefore, to consider the *K. lacca* system as the progenitor of the "Lecanoid" system.

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