A STUDY OF THE INHERITANCE OF FOUR RECESSIVE COLOR PATTERNS

OF THE GROUSE LOCUST, PARATETTIX TEXANUS HANCOCK

by

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TABLE OF CONTENTS

INTRODUCTION

This paper represents a continuation of the study of the genetics of the Grouse Locust, <u>Paratettix</u> <u>texanus</u> Hancock, which has been carried on by Dr. Robert K. Nabours since 1908. Heretofore, the characters described in Grouse Locusts have behaved as dominants to the wild type (Nabours, 1914, 1917, 1923, 1925, and 1929; Nabours and Snyder, 1928; Bellamy, 1920). The experiments herein reported have been made for the purpose of learning the mode of inheritance of four color patterns which behave as recessives and of determining the number of factors involved, as duplicate genes, modifiers, or inhibitors, and the possible linkage with other factors whose loci had been previously located.

METHODS AND MATERIALS

In the breeding of the grouse locusts, the cages are made of heavy glass cylinders 9" x 15" set in tile bulb pots 5" x 11" which are filled with steam sterilized, sandy loam. A small flower pot (4" x 4") with the hole plugged is placed upside down in the center of the bulb pot. This arrangement apparently provides better aeration for the soil, and serves as a dry retreat for the grasshoppers and as a rack for the algae upon which they feed. The soil in the pot is kept quite moist in order to simulate that of their natural

habitat. The lid of the cage is made of 24 mesh screen wire (Nabours, 1914, 1929).

Paratettix texanus has proved to be very suitable for experimental breeding because it does not go through a period of hibernation as do the more northern forms of Acrydiinae* (Nabours, 1929). For this reason, if individuals of this species are kept in the greenhouse at a temperature somewhat similar to that of their natural environment in Louisiana and Texas, as many as four generations a year may be produced. These include two very prolific generations from March to June, inclusive, and two more slowly developing and less prolific generations during the remainder of the year (Nabours, 1914, 1925, 1929).

The composition of both the male and the female of a mating and the source from which each was taken is recorded. When the offspring appear they are transferred to renovated cages. During the third and fourth instars, the males and females are put into separate jars and the composition of each is recorded on the same page with that of the parents. This insures a definite record of the composition of each

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Hancock (1902) gave the grouse locusts a family status in placing them under the name Tettigidae. Since then this group has also been placed under the sub-family names Tettiginae (Blachley, 1902), Tettriginae (Hancock, 1906), and Acridiinae (Hancock, 1912). The classification of grouse locusts as the sub-family Acrydiinae of the family Acrididae is that adopted by Hebard (1931).

individual as well as a means whereby pedigrees may be traced.

The characters of _Paratettix texanus_, hitherto studied, have been described by Nabours (1914, 1917, 1929). The pattern which is most abundant in Nature, and consequently may be considered the "wild type", is the mottled gray recessive designated as +/+. There are twenty-two conspicuous, elementary, dominant or epistatic patterns which are, as well as their factors, designated by the symbols B, C, Cof, Cext, D, E, F, H, I, J, Jof, K, L, M, N, N_1, N_2, P, S, S_1, Sm and Sn, respectively. These represent a group of extremely closely linked, or allelomorphic, factors which subsequently will be referred to as the series. There are two other dominant patterns, one Hm, very closely, and the other, Θ, very loosely linked with the series. The latter has a crossover value, with the series, of 25.34 per cent in males and 47.58 per cent in females (Haldane, 1920; Nabours, 1929).

The loci and mode of inheritance of the above mentioned factors for dominant characters have been fairly definitely ascertained in previous experiments by Nabours and colleagues (loc. cit.). The experiments, now to be described, deal with the inheritance of the factors for the recessive color patterns, red ($\emptyset$), dull red ($\emptyset'$), specked (spk), and specked femora (sf).

INHERITANCE EXPERIMENTS WITH THE COLOR
PATTERNS RED ($\emptyset$) AND DULL RED ($\emptyset$)

Description of Red ($\emptyset$)

The factor $\emptyset$, when homozygous, is expressed by a red-
dish cast of varying shades and varying degrees of extension
and intensity, depending upon its hybrid environment. This
pattern is most pronounced on the anterior part of the body,
especially on the head. Apparently there are several
factors governing the variability of its expression. It
shows up brighter soon after molting and becomes duller with
the age of the instar. The other characters with which it
may be associated also affect its shade and extension. Thus,
when it is associated with Cof or Cext, the head is more of
a deep brownish red. When $\emptyset$ is associated with S, Sn, or
Sm, it is much lighter than it is with the other patterns of
the series. Patterns such as H, Hm, D, and K, which do not
cover a great part of the animal's body, limit the extension
of $\emptyset$ less than do such characters as B, Cext, or Cof. When
$\emptyset$ is associated with other factors producing red patterns
such as M, N, N_1 and N_2, the character may be distinguished
by the reddish head since these other patterns do not cover
this part of the animal's body. Contrary to what might be
expected, Θ does not affect the shade or intensity of the

expression of ϕ appreciably, but it does limit its extension over the thorax.

Description of Dull Red (ϕ')

The dull red pattern which is the expression of the factor ϕ', is very similar to the red pattern of ϕ. The factorial basis of this pattern was known before the writer was able to distinguish it as a different character. It manifests itself as a dull reddish brown cast especially over the anterior part of the animal and its expression is subject to variations in extension and intensity in much the same way as the red of ϕ. This pattern can be distinguished because it is browner and has less luster than most shades of ϕ.

Explanation of Table I

The greater part of the data of ϕ and ϕ' was taken before the writer was able to distinguish between the two. For this reason, data for both characters are here presented in a single table. There are several types of matings given. For example, the type $+/\phi$ x ϕ/ϕ, beginning with mating 12, means that the male of this mating was heterozygous for the factor ϕ and that the female was homozygous for it.

The figures of the first column on the left are the mating numbers. The next column, which is made up of the figures in parentheses, indicates the source from which the parents came. The upper number, in each pair of parentheses, is the one of the mating from which the male parent came; the lower number is that of the mating from which the female parent came. One number, only, in the parentheses, means that both parents came from that particular mating. The symbol, Na, in the parentheses, indicates that the parent was taken directly from nature. The symbol, Nt, means that the parent was taken from a mating which was not placed in this table, either because it was believed that the parent did not contain the factors under consideration, or their composition was uncertain, or because they were taken from matings made prior to the time of this study. The symbol ♂ means that the composition of the male parent was not known at the time the mating was made but was inferred from the composition of the offspring and the symbol ♀ signifies the same thing for the female parent. The symbol ♂♂ means that two males were used in the mating and ♀♀ means that two females were used. The third column, above which the symbol ∅ is placed, includes those offspring which show the redness of either ∅ or ∅'. The figures on the left of the hyphen in this column indicate the number of the males, while those on the right represent the females of this

composition in the respective batches. A third figure to
the right of a second hyphen refers to those, the sex of
which was not recorded. The fourth column, above which the
symbol + is placed, has reference to those offspring in
which the character did not show. Since both ∅ and ∅' be-
have as recessives, this column includes only those indi-
viduals which are not homozygous for either. Such indi-
viduals may, however, be heterozygous for either or both
factors, or they may be homozygous for the dominant
allelomorph of either or both. The sexes of the offspring
in this column are indicated in the same way as those in the
third column.

For example, in mating 18, the male parent was hetero-
zygous for ∅, and had been taken from a mating not included
in the table. The female parent was homozygous for ∅ and
was taken from mating 116. The symbol ♂ means that the
composition of the male parent was unknown at the time the
mating was made but was inferred from the composition of the
offspring. The third column shows that there were one male
and three females in the batch which showed the ∅ pattern.
The fourth column shows that there are 3 males and 1 female
in the batch which did not show the pattern.

Table I. Showing Pedigrees of Individuals Carrying ø and ø'

No.	(Nt)	ø	+
	(Nt)	ø/ø x ø/ø	
1	(Nt)	35 - 22	0 - 0
2	(Na)	4 - 1	0 - 0
3	(85)	14 - 8	0 - 0
	(126)		
4	(121)	54 - 55	0 - 0
	(22)		
5	(51)	11 - 14	0 - 0
	(24)		
6	(51)	14 - 14	0 - 0
	(23)		
7	(121)	1 - 2	0 - 0
8	(52)	20 - 18	0 - 0
	(55)		
9	(56)	14 - 23	0 - 0
10	(88)	0 - 6	0 - 0
11	(9)	3 - 9	0 - 0
	(Na)♂	+/ø x ø/ø	
12	(Nt)♂	3 - 3	0 - 6
	(Na)♂		
13	(Nt)	10 - 13	10 - 10
	(Nt)♂		
14	(Nt)♀	11 - 7	12 - 16
	(Na)♂		
15	(42)	3 - 8	9 - 5
	(Na)♀♀		
16	(Nt)♂♂	1 - 4	3 - 4
17	(116)	0 - 2	1 - 2
	(Nt)♂		
18	(116)	1 - 3	3 - 1
19	(77)	4 - 3	1 - 1
20	(85)	31 - 32	25 - 30
21	(77)	9 - 5	8 - 3
	(77)		
22	(85)	4 - 0	2 - 2
	(77)		
23	(120)	6 - 3	7 - 6
24	(85)	1 - 2	4 - 0
25	(85)	8 - 4	4 - 6
	(121)		
26	(126)	4 - 7	5 - 7
	(89)		
27	(25)	1 - 2	1 - 0
28	(51)	6 - 9	7 - 6
	(71)		
29	(50)	3 - 4	3 - 5
	(93)		
30	(21)	10 - 14	14 - 16
	(128)		
31	(123)	2 - 1	1 - 0
32	(123)	0 - 2	1 - 3
	(129)		
33	(28)	6 - 6	7 - 6
	(128)		
34	(54)	1 - 1	2 - 1
	(128)		
35	(94)	5 - 7	10 - 8
	(128)		
36	(26)	16 - 19	13 - 14
	(129)		
37	(26)	9 - 7	10 - 9
	(128)		
38	(56)	1 - 0	1 - 0
	(56)		
39	(6)	2 - 0	2 - 2
	(1)	ø/ø x +/ø	
40	(Nt)♀	3 - 12	5 - 5
	(40)		
41	(Nt)♀	11 - 6	11 - 10
	(Nt)		
42	(Nt)	36 - 41	32 - 37
	(41)		
43	(111)	5 - 2	0 - 2
	(Nt)		
44	(Na)♀	4 - 10	9 - 17
	(Nt)		
45	(Na)♀	5 - 6	9 - 4
	(27)		
46	(Na)♀	5 - 10	8 - 5
	(116)		
47	(12)	4 - 2	2 - 3
	(116)		
48	(Nt)	15 - 12	9 - 14
49	(16)♂♂	15 - 18	15 - 11
	(85)		
50	(127)	8 - 2	4 - 5
	(85)		
51	(77)	6 - 8	5 - 2
52	(86)	3 - 3	2 - 4
	(119)		
53	(69)	1 - 3	0 - 1
	(50)		
54	(121)	0 - 1	1 - 0
	(50)		
55	(71)	8 - 4	5 - 5
	(51)		
56	(121)	16 - 9	9 - 12
	(20)		
57	(Nt)	4 - 6	6 - 2
	(20)		
58	(51)	5 - 1	2 - 2
	(20)		
59	(23)	11 - 6	7 - 11
	(7)		
60	(94)	1 - 5	1 - 2
61	(26)	19 - 22	21 - 16
	(6)		
62	(73)	0 - 2	6 - 4
63	(56)	9 - 10	11 - 6
64	(56)	2 - 2	1 - 1
	(56)		
65	(98)	0 - 1	0 - 0
	(Nt)	ø/ø x +/+	
66	(Nt)	0 - 0	0 - 2
	(Nt)		
67	(Na)	0 - 0	15 - 15
	(116)		
68	(Nt)♀	0 - 0	91 - 89
	(116)		
69	(Nt)	0 - 0	49 - 63
	(85)		
70	(Nt)	0 - 0	31 - 41
	(85)		
71	(Nt)	0 - 0	20 - 21
	(85)		
72	(Nt)	0 - 0	11 - 21
	(50)		
73	(Nt)	0 - 0	1 - 2
	(20)		
74	(89)	0 - 0	9 - 4
	(4)		
75	(Nt)	0 - 0	15 - 12
	(Nt)♂	+/+ x ø/ø	
76	(40)	0 - 0	61 - 68
	(Nt)		
77	(117)	0 - 0	30 - 29
	(Nt)		
78	(117)	0 - 0	50 - 58
	(Nt)♂♂		
79	(116)♀♀	0 - 0	23 - 43
	(Nt)		
80	(116)	0 - 0	36 - 32
	(Nt)		
81	(3)	0 - 0	19 - 28
	(Nt)		
82	(4)	0 - 0	19 - 16
83	(94)	0 - 0	5 - 5
	(Nt)	+/ø x +/ø	
84	(Nt)♀	3 - 6	8 - 9
85	(Nt)♀	19 - 25	53 - 67
86	(Nt)♂	9 - 5	27 - 18
87	(Na)♀	5 - 5	4 - 6
88	(86)	1 - 1	5 - 6
	(80)		
89	(69)	0 - 0	4 - 5
	(120)		
90	(77)	1 - 2	1 - 0
	(69)		
91	(77)	0 - 0	0 - 1
	(77)		
92	(80)♂♂	6 - 11	4 - 1
	(69)		
93	(80)	5 - 4	7 - 10
	(50)		
94	(71)	11 - 16	28 - 35
	(N)		
95	(71)	1 - 1	7 - 5
	(50)		
96	(70)	1 - 2	1 - 3
	(20)		
97	(50)	0 - 0	2 - 2
	(92)		
98	(93)	0 - 1	0 - 2
99	(128)	16 - 9	44 - 47
100	(129)	2 - 1	4 - 6
101	(129)	6 - 3	18 - 16

Table I. Showing Pedigrees of Individuals Carrying ∅ and ∅'
Cont'd

		∅		+
102 (73)	:	0 - 2	:	4 - 4
103 (129)	:	5 - 6	:	6 - 20
104 (129)	:	2 - 2	:	2 - 5
105 (128)	:	1 - 1	:	13 - 4
(Nt)♂♂				
106 (128)	:	2 - 1	:	2 - 2

+/∅ x +/+

(125)				
107 (Nt)	:	0 - 0	:	46 - 45
(77)				
108 (Nt)	:	0 - 0	:	0 - 1
(51)				
109 (Nt)	:	0 - 0	:	0 - 1
(128)				
110 (Nt)	:	0 - 0	:	1 - 2

+/+ x +/∅

(Nt)				
111 (14)	:	0 - 0	:	50 - 55
(Nt)				
112 (125)	:	0 - 0	:	97 - 96
(140)				
113 (69)	:	0 - 0	:	6 - 6
(140)				
114 (69)	:	0 - 0	:	8 - 3
(Nt)				
115 (71)	:	0 - 0	:	12 - 6

∅/∅ +/∅' x +/∅ ∅'/∅'

(Nt)				
116 (Nt)	:	21 - 31	:	12 - 5
117 (Nt)	:	6 - 2	:	0 - 1
118 (117)				
(116)	:	4 - 6	:	3 - 3

∅/∅ +/∅' x ∅/∅ ∅'/∅'

| (15) | | | | |
| 119 (116) | : | 6 - 7 | : | 8 - 9 |

∅/∅ +/∅' x +/∅ +/∅'

120 (116)	:	10 -20	:	7 - 15
121 (120)				
(77)	:	7 - 15	:	3 - 9

+/∅ +/∅' x ∅/∅ +/∅'

(12)				
122 (116)	:	13 - 12	:	6 - 7
123 (121)	:	7 - 9	:	2 - 2
(128)				
124 (123)	:	16 - 14	:	8 - 4

+/∅ ∅'/∅' x +/∅ +/+

(Nt)				
125 (Na)♀	:	3 - 3	:	11 - 13
(85)				
126 (127)	:	3 - 6	:	11 - 8

+/+ ∅'/∅' x +/∅ +/+

127 (116)	:	0 - 0	:	40 - 34 - 1
(121)				
128 (126)	:	0 - 0	:	18 - 20
129 (126)	:	0 - 0	:	19 - 19
130 (22)				
(85)	:	0 - 0	:	2 - 4
(23)				
131 (121)	:	0 - 0	:	1 - 3

∅'/∅' x -/∅'

| (Nt) | | | | |
| 132 (98) | : | 28 - 48 | : | 36 - 41 |

∅/∅ (Parthenogenetic)

133 (116)	:	0 - 3	:	0 - 0
134 (85)	:	0 - 5	:	0 - 0
135 (4)	:	0 - 4	:	0 - 0
136 (56)	:	0 - 4	:	0 - 0

-/∅ (Parthenogenetic)

137 (66)	:	0 - 14	:	0 - 17
138 (Na)	:	0 - 10	:	0 - 23
139 (116)	:	0 - 2	:	0 - 1
140 (116)	:	0 - 1	:	1 - 2
141 (69)	:	0 - 0	:	0 - 1
142 (96)	:	0 - 5	:	0 - 5

Those matings, whose ratios show that two similarly acting factors were probably involved, are placed in separate groups (matings 116 to 131). Since at first there was no distinction made between ϕ and ϕ', there is usually no way of definitely knowing which of these factors is indicated. However, ϕ is of much more common occurrence in the stock and it is assumed that this is the one present in most cases.

Discussion of Data on ϕ and ϕ'

At first there was no distinction made between ϕ and ϕ' and any individuals carrying either was recorded as having ϕ. In the majority of cases (matings 1 to 115, Table I) the records showed evidence of a factor which behaves as a simple recessive*. However, there were some matings whose ratios were exceptions to the expectation. The study of such discrepancies was begun from matings 128 and 129 where a 19:19 ratio of those which were red to those which were not red would have been expected, if only a single uninhibited factor were involved; but as may be seen, none of the 38 offspring, in either case, showed the pattern. This gives

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*Of 62 matings homozygous for ϕ, which were made before this study was begun, all bred true. Likewise, in 20 heterozygous-homozygous and 70 heterozygous-heterozygous matings made during this time, ϕ behaved as a simple recessive.

a deviation which is definitely within the limits of significance. There were two possible interpretations to be placed upon the ratios of these matings: (1) that there are two distinct factors, both of which express themselves in a similar way; (2) that there is a dominant inhibiting factor for which the parent, that did not show the redness, was homozygous.

Tracing back the origin of the parents of these matings, it will be seen that one parent of mating 128 and both parents of mating 129 came from mating 126. While the deviation from the 1:1 ratio, in this mating, is less than three times the probable error, the results more nearly approached the 1:3 ratio. The other source of mating 128 was mating 121 whose ratio, also, is within the limits of expectation for a single pair of factors, yet shows a nearer approach to the 5:3 or 3:1 ratios than it does the 1:1 ratio. The same interpretations, i.e., that there is a dominant modifier present or that there are two recessive factors, both of which express themselves in a similar way, can be applied to these matings as were applied to matings 128 and 129.

As shown in the table, one of the sources of mating 126 was mating 127 which was similar to matings 128 and 129. One of the sources of mating 121 was mating 120 which was somewhat similar to mating 121. It may be seen that both of

these matings were taken from mating 116. The results of
this mating, together with those of 117, 118, and 119 are
entirely contrary to what would be expected if only a
single uninhibited factor were involved. Since both members
of this mating were red, the expectation is that all the
offspring would be red if only a single simple recessive
factor were present; yet one-fourth of the offspring were
not red. The fact that both parents were red precludes the
possibility of the presence of a dominant inhibiting factor.
The fact that none of the offspring of matings 128 and 129
were red precludes the possibility of the presence of a
recessive inhibitor. Therefore, the presence of two factors,
both of which are recessive, and each resembling the other,
were assumed, and these were designated as $\emptyset$ and $\emptyset'$,
respectively.

Under this view, if it is assumed that one parent was
homozygous for $\emptyset$ and heterozygous for $\emptyset'$ and the other
parent was of the reverse composition, as is indicated in
mating 116, the expectation would be a 3:1 ratio to which
the actual 52:17 is a very close approximation. Where one
parent is homozygous for either $\emptyset$ or $\emptyset'$ only, and the other
parent is heterozygous for the factor not carried by the
first parent, the expectation would be that none of the off-
spring would show the pattern of either factor as was the
case in matings 127 to 131. Where one parent is homozygous

for one of the factors and heterozygous for the other, and the other parent is heterozygous for both factors, the expectation would be the 5:3 ratio which was very closely approximated in mating 121. The close approximation to the 1:3 ratio in mating 126 can likewise be explained, if there are similarly acting factors present, by assuming that the parent which showed the red pattern was homozygous for one factor and heterozygous for the other, while the other parent was homozygous for the dominant allelomorph of the factor for which the first parent was homozygous and heterozygous for the factor for which the first parent was heterozygous.

Upon the assumption that the discrepancies were due to two factors, both of which express themselves in a similar way, several matings were made from the offspring of matings 128 and 129. One of these matings was 124 from which there were 8 males and 4 females which were not red and 16 males and 14 females which showed the redness. Of these, 4 males and 5 females were of the ϕ' pattern. It was from these that the distinction between the two characters was first made.

When most of the data, suitable for checking linkage, were taken, no distinction had been made between the two characters, but since ϕ' is known to occur in only a few cases, it is assumed that most of the linkage data are

applicable to ϕ. From the available data, ϕ shows 50.10 per cent segregation in males and 49.34 per cent segregation in females when checked for linkage with the closely linked loci of the dominant series (Table II) and 49.06 per cent segregation in males and 50.18 per cent segregation in females when checked for linkage with the locus of Θ (Table IV). Since the series and Θ are so loosely linked, and since there is little evidence to show that ϕ is linked with either, it is safe to conclude that the locus of ϕ is on a separate pair of chromosomes.

Mating 132 yielded suitable material for checking the linkage relations of ϕ' with the series and with Θ in females. This mating showed evidence of linkage. Out of 76 individuals checked for linkage with the series, there was a cross-over value of 22.37 per cent. Out of 153 individuals checked for linkage with Θ, there was a crossover value of 44.44 per cent. This evidence, though meager, fairly indicates that the locus of ϕ' is somewhere between the loci of the series and the locus of Θ.

DESCRIPTION AND BEHAVIOR OF SPECKED

In October, 1932, the cultures were restocked with new material from San Antonio, Texas. One of the female individuals brought in was mated to one of the males of the old stock (mating 22, Table V). From the offspring of this

Table II. Showing Segregation of ∅ from the Factors of the
Dominant Series. Source of ∅ Known.

	Segregation of ∅ from factors of the dominant series in males			Segregation of ∅ from factors of the dominant series in females		
	Number of gametes checked	Number of gametes segregating	Percentage of segregation	Number of gametes checked	Number of gametes segregating	Percentage of segregation
+	25	13	52.00	17	5	29.41
B	261	142	54.41	232	116	50.00
C	117	67	57.26	0	0	0
Cext	98	39	39.79	101	53	52.50
Cof	15	7	46.66	0	0	0
E				6	4	66.66
H	124	59	47.58	237	115	48.52
Hm				5	1	20.00
J	84	48	57.14	74	40	54.54
K	133	62	46.62	227	110	48.46
N	0	0	0.0	12	7	58.33
S	90	36	40.00	241	114	47.30
Sm	4	4	100.00	34	19	55.88
Sn	15	7	46.66	22	12	54.54
Total	966	484	50.10	1208	596	49.34

Table III.   Showing the Segregation of ∅ from the Factors of the Dominant Series.   Source of ∅ Unknown and Selected Arbitrarily

	Segregation of ∅ from the factors of the dominant series in males			Segregation of ∅ from the factors of the dominant series in females		
	Number of gametes checked	Number of gametes segregating	Percentage of segregation	Number of gametes checked	Number of gametes segregating	Percentage of segregation
B	144	67	46.53			
Cof				12	7	58.33
E	125	69	47.20			
H	4	4	100.00	52	28	53.85
Hm	201	107	53.23			
I	144	67	46.53			
K	28	17	60.72	74	36	48.65
P	58	34	58.62			
Sm	50	25	50.00	10	3	30.00
Total	754	390	51.33	148	74	50.00

Table IV. Showing the Segregation of ø from Θ

	Segregation of ø from Θ in Males			Segregation of ø from Θ in Females		
	Number of gametes checked	Number of gametes segregating	Percentage of segregation	Number of gametes checked	Number of gametes segregating	Percentage of segregation
Source of:						
ø known	212	104	49.06	277	139	50.18
Source of ø unknown	80	48	60.00			

Table V. Showing Pedigrees of Individuals Carrying Spk

(The explanation for Table I also applies to this table)

	:	Spk	:	+
		spk/spk x spk/spk		
1 (14)	:	3 - 0	:	0 - 0
		spk/spk x +/spk		
2 (13)	:	2 - 14	:	12 - 12
3 (2)	:	1 - 0	:	4 - 2
4 (½)♂♂	:	1 - 0	:	5 - 5
		+/spk x spk/spk		
(8)				
5 (2)	:	3 - 5	:	13 - 2
6 (2)	:	6 - 8	:	2 - 6
7 (5)				
(15)	:	0 - 1	:	3 - 0
		spk/spk x +/+		
(13)				
8 (Nt)	:	0 - 0	:	5 - 2
(17)				
9 (Nt)	:	0 - 0	:	19 - 15
(1)				
10 (Nt)	:	0 - 0	:	7 - 8
(15)				
11 (Nt)	:	0 - 0	:	7 - 15
		+/+ x spk/spk		
(Nt)				
12 (5)	:	0 - 0	:	10 - 7
		+/spk x +/spk		
13 (22)♂♂♀	:	1 - 0	:	22 - 24
14 (23)♂♂♀♀	:	2 - 2	:	8 - 19
15 (2)	:	5 - 6	:	17 - 25
(8)				
16 (2)	:	1 - 1	:	2 - 1
17 (2)	:	3 - 4	:	2 - 3
18 (24)	:	3 - 2	:	13 - 6
19 (2)	:	0 - 2	:	0 - 1
20 (2)	:	0 - 4	:	20 - 14
(2)				
21 (16)	:	2 - 5	:	8 - 10
		+/+ x +/spk		
(Nt)				
22 (Na)	:	0 - 0	:	60 - 69 - 2
(Nt)				
23 (22)	:	0 - 0	:	104 - 86 - 1
24 (13)	:	0 - 0	:	23 - 16

mating, two males were mated to a female and in the off-
spring from these there appeared a new character, heretofore
not presented in the stock (mating 13). This pattern is a
white speckledness over the body of the animal except in
places covered by the patterns of the dominant, closely
linked, or allelomorphic series. It gives, therefore,
especially to the head, legs, sides of the thorax, and
abdomen a very striking pepper and salt appearance and for
this reason, has been named "specked". The factor for this
character is designated by the symbol spk.

With the exception of those matings involving more than
two parents, all the ratios of Table V indicate that spk
behaves as a simple recessive. In mating 13, in which the
character first appeared, only one individual, a male, out
of 23 males and 24 females showed the pattern. This wide
deviation from the expectation may be explained by assuming
that one of the two males to which the female was exposed
did not carry spk. This assumption was supported by the
results shown in mating 2, wherein an F_1 female was shown
to have been heterozygous for spk when mated to the F_1
specked brother. These results show that spk had probably
been carried heterozygously since the introduction of the
new stock from nature.

It has been possible to check 111 gametes in males and 14 gametes in females for linkage with the factors of the dominant series and these show a segregation of 55.85 per cent and 42.85 per cent, respectively (Table VI). Although this number is small, the amount of segregation strongly indicates that there is no linkage between spk and the series.

DESCRIPTION AND BEHAVIOR OF SPECKED FEMORA

The factor sf, which is expressed by the pattern "specked femora", was described by Nabours (1929) as a recessive. Because of the variability of the expression of this factor, accurate recording is very difficult. For this reason, much of the previously recorded data is of little value and is not presented here.

Normally this pattern appears to behave as a recessive as the following matings would indicate:

+/sf x +/sf neither parent showed specked femora

38 not specked femora

22 specked femora with varying degrees of intensity

+/sf x +/sf neither parent showed specked femora

25 not specked femora

13 specked femora with varying degrees of intensity.

Table VI. Showing the Segregation of Spk from the Factors of the

Dominant Series.

	Segregation of spk from the factors of the series in males			Segregation of spk from the factors of the series in females		
	Number of gametes checked	Number of gametes segregating	Percentage of segregation	Number of gametes checked	Number of gametes segregating	Percentage of segregation
B :	56	31	57.14	7	3	42.85
E :	31	17	54.84	7	3	42.85
H :	1	1	100.00			
L :	23	13	56.52			
Total	111	62	55.85	14	6	42.85

There are several degrees in the intensity of the expression of sf. When it is uninhibited and in a homozygous condition, it is expressed as two large conspicuous white spots on the mid-dorsal side of each hind femur and usually by a white border on the anterior part of the pronotum. There is another degree of intensity in which the pattern is quite evident but less pronounced. There is also another condition in which the spots are quite dull. Besides these there are conditions where spots are reduced to rather inconspicuous dimensions, being in some cases, tiny specks which are barely perceptable and often questionable.

B, C, Cext, Cof, Jof and D of the dominant series are epistatic to sf/sf. θ does not reduce the intensity of sf/sf but it does seem to reduce the size of the spots and consequently may be epistatic to the pattern where it normally shows as small specks. Probably there are also other modifiers of the pattern as the variability apparently indicates.

Formerly, where the spots showed at all, the individual was recorded as being homozygous for the factor and no record was made of the intensity of its expression. The results of such recording proved to be quite unintelligable. For this reason, an attempt has been made to keep records of the different degrees of intensity of the pattern in each individual. Although the gradual variability of the

pattern make accurate recording very difficult, this procedure has given somewhat more promising results.

One mating was made in which both parents showed specked femora very strongly, yet, more than one-fourth of the offspring showed the pattern very faintly or not at all. Since sf apparently behaves as a recessive, this mating indicates the presence of a recessive inhibitor. Under this supposition, the mating and the offspring may be given in the following way:

sf/sf +/i x sf/sf +/i - both parents showed specked
femora very strongly

83 sf/sf +/+ and sf/sf +/i showed specked femora
distinctly

42 sf/sf i/i showed specked femora faintly or not at
all

Another mating which gave definite results in support of the belief that there is a recessive inhibitor present, is one in which the male parent showed specked femora strongly and the female parent did not show specked femora at all, yet all the offspring showed the character very distinctly. The supposed composition of this mating is here given:

sf/sf +/+ x sf/sf i/i

116 sf/sf +/i - all offspring showed specked femora
distinctly.

Although most of the matings seem to indicate that sf is a recessive, there is still the possibility of its being

a dominant. If this were true, an inhibitor must also necessarily have been present in such matings as the first mentioned above in which sf appeared to be recessive.

SUMMARY

1. <u>Paratettix texanus</u> has proved to be very suitable for experimental breeding because it produces as many as four generations a year and because of the many distinct hereditary color patterns.

2. Previous to the time of this study, a series of 22 dominant allelomorphic or very closely linked factors had been described. The factor θ, which also had been described previous to this study, is very loosely linked with the dominant series.

3. The factors ϕ and ϕ' are expressed in a very similar way and at first were not distinguished from each other. A study of discrepancies in ratios lead to the discovery that there are two distinct factors instead of one, as had previously been thought. From later matings it became possible to distinguish between the patterns of these factors.

4. There was found to be a 50.10 per cent segregation in 966 gametes in males and a 49.34 per cent segregation in 1208 gametes in females between ϕ and the factors of the series. There was a 49.06 per cent segregation in 212

gametes in females between ϕ and Θ. This is fairly conclusive evidence that ϕ is on a separate pair of chromosomes from that of the other factors.

5. One mating yielded suitable material for checking the linkage relations in females of ϕ' with the factors of the series and with Θ. Out of 76 individuals, there was found to be a 22.37 per cent segregation between ϕ' and the series. Out of 153 individuals there was found to be a 44.44 per cent segregation between ϕ' and Θ. This fairly indicates that the locus of ϕ' is somewhere between the loci of the factors of the series and the locus of Θ.

6. The factor spk behaves as a simple recessive. The checking of 111 gametes in males and 14 gametes in females showed a 55.85 per cent and 42.85 per cent segregation, respectively, between spk and the series. These results indicate that spk is on a separate pair of chromosomes from the series.

7. The knowledge of the nature of the inheritance of sf is very indefinite. Most of the matings apparently indicate that sf is a recessive. If it is true that sf is a recessive, it is subject to the action of a recessive inhibiting factor.

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