TRIBOLIUM INFORMATION BULLETIN

Number 11

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California State College, San Bernardino

California

1969

NOTE

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TRIBOLIUM INFORMATION BULLETIN

Number 11

March, 1969

Notes - Research (continued)

FOREWORD

The long lapse between publication of TIB-10 and TIB-11 is due to the fact that funds for its continued publication came to an end with the end of support from USPHS. Despite repeated efforts to obtain funds from Federal agencies and request for a small budget to continue this activity as part of the Tribolium Stock Center, I have obtained negative results. If TIB is to continue, it must do so on a self-sustaining basis and this requires that a subscription program be instituted. More details about this will be sent to individuals in a separate letter.

I thank Pat Brodaric Cavataio and Denise Inman and Sue Eldridge for putting this issue together.

The publication of TIB-11 was made possible by an Institutional Grant to the California State College, San Bernardino.

A. Sokoloff

San Bernardino, California
March, 1969

ANNOUNCEMENTS

Pure line cultures of Lasioderma serricorne (F.) (Col., Anobiidae) are kept at this laboratory and can be supplied to investigators. One line from field stock has been bred through to the 28th generation of brother sister mating at 30 C and 60% R. H. and lines from laboratory stock cultures have reached generation 27 at 30° C and 60% R. H. and generation 19 at 25° C and 70% R. H.

This note supersedes that published in T. I. B. no. 10.

Miss J. E. Currie, Agricultural Research Council
Pest Infestation Laboratory
London Road
Slough Bucks, England

* * * *

Dr, N, H, Bubggekum International Atomic Energie Agency, Vienna, Kaerntnerring, Austria has compiled and published a fully annotated bibliography on "Radio-isotopes and ionizing radiation in Entomology". Volume 1 (covering the 10 year period between 1950 and 1960) is Bibliographical Series No. 9 of the Vienna, IAEA. Vol. 2 (covering 1961-1963) is Bibliographical Series No. k5, Vienna, IAEA, Vol. 3 (covering 1964-1965) is Bibliographical Series No. 24, Vienna, IAEA. Vol 4, is in preparation.

* * * *

Request for Material

Dr. R. J. Milner would appreciate it if samples of diseased Tribolium cultures be sent to him at School of Agriculture, The University of Newcastle upon Tyne, England.

Stock Lists

BALTIMORE, MARYLAND
THE JOHNS HOPKINS UNIVERSITY, DEPARTMENT OF CHEMISTRY

Known to have the following stocks:

I. Wild type strains

Gnathocerus cornutus pearl
Latheticus oryzae + /+
Tribolium anaphe + /+ (Ho)
Tribolium brevicornis +/+
Tribolium destructor +/+
Tribolium madens +/+
Tenebrio molitor +/+

II. Mutant

Tribolium confusum melanotic stink glands (meg) (Ed.)

BOWLING GREEN, OHIO
BOWLING GREEN STATE UNIVERSITY, DEPARTMENT OF BIOLOGY

Wild type strain of T. castaneum
(Address Dr. Karl Schurr) (Ed.)

BRIDGEPORT, CONNECTICUT
UNIVERSITY OF BRIDGEPORT, DEPARTMENT OF BIOLOGY

Tribolium confusum

Wild type strains derived from Dr. Fraenkel's laboratory at the University of Illinois.

CARLISLE, PENNSYLAVANIA
DICKINSON COLLEGE, DEPARTMENT OF BIOLOGY

Tribolium confusum

A. Wild type

1. Six strains started from females captured in a feed bin in New York City, 1955

2. Three strains, one each from T. Park, Chicago; J. Stanley, Montreal; S. Smith, Sault Ste. Marie, Canada.

3. One strain consisting of several above strains mixed together about three years ago.

4. One strain started with individuals taken from (1) above, which has been freed of eye mutations.

NOTE: Some of the wild strains listed in (1) and (2) are known to be carrying pearl-like mutations.

B. Mutant

1. Black--Sault Ste. Marie (1956)
2. Ebony--Chicago (1957)
3. Eyespot--sex-linked--from a wild strain in (A.1) above (1959).
4. Rough--from strain (B.1) above (1957).
5. Split--from a wild strain in (A.1) (1956)
6. Striped--sex-linked--from (B.1) above (1957)
7. One strain each of Striped/black and split/black.

Oryzaephilus surinamensis

One strain started from insects captured in New York City, 1955.

D. J. McDonald

CHICAGO, ILLINOIS
UNIVERSITY OF CHICAGO, DEPARTMENT OF ZOOLOGY

Tribolium castaneum

"Chicago" --a wild type strain.
"paddle" --a sex-linked recessive antennal mutant.
"pearl" --an autosomal recessive eye mutant.
"Chicago black" --an autosomal semi-dominant body color mutant.

Tribolium confusum

"Chicago" --a wild type strain.
"ebony" --an autosomal recessive body color mutant.

Latheticus oryzae

"Chicago" --a wild type strain.
"pearl" --an autosomal recessive eye mutant.

(Known to have a number of inbred strains. Ed.)

COLLEGE PARK, MARYLAND
UNIVERSITY OF MARYLAND, DEPARTMENT OF ZOOLOGY

I. Wild type strains

A. Tribolium castaneum

1. Chicago (via Sokoloff) — Berkeley, 1964
2. University del Valle-1 — Cali, Colombia, 1964
3. University of Maryland-2*

*Formerly listed as Tribolium confusum in March, 1966, Tribolium Information Bulletin 9 and earlier issues. Whether the error occurred through original misidentification or an originally mixed species culture is not known.

Inbred strains

4. E 2 (originally from Edinburgh, via Boylan) — Manitoba, 1964

B. Tribolium confusum

1. So. Illinois University-1 — Carbondale, Illinois, 1962

Inbred strains
2. CFI-11 — Berkeley, California, 1965

II. Mutants

1. confusum$_{I\&H}$ — Berkeley, California, 1959
2. Ebony ($e^{I\&H}$)

J. W. Crenshaw, Jr.

CORAL GABLES, FLORIDA
UNIVERSITY OF MIAMI, DEPARTMENT OF BIOLOGY

A. Wild type strains

1. Tribolium confusum — Chicago
2. Tribolium castaneum — Chicago

B. Mutant strains

1. Tribolium castaneum - "jet" — Chicago
2. Tribolium castaneum - pearl type origin in local stocks
3. Tribolium castaneum - jet x pearl
4. Tribolium confusum - "ebony"

Earl R. Rich

EAST LANSING, MICHIGAN
MICHIGAN STATE UNIVERSITY, BIOLOGY RESEARCH CENTER

Tribolium castaneum

A. Wild strain

1. McGill — Chicago via Berkeley, 1964

B. Mutant strains

1. Paddle — Chicago via Berkeley
2. spotted — Berkeley

O. C. Scheidt

EAST LANSING, MICHIGAN
MICHIGAN STATE UNIVERSITY, DEPARTMENT OF ZOOLOGY

Tribolium confusum

A. Wild strain

1. Chicago wild, Chi +/+ — Berkeley, 1964

B. Mutant strains

1. ruby eyespot (rus) — Berkeley, 1964
2. melanotic stink glands, (msg^{Ho}) — Berkeley, 1964
3. light ocular diaphragm, pearl (lod p) — Berkeley, 1964
4. black, melanotic stink glands, ruby eyespot (b msg rus) — Berkeley, 1964
5. black, ruby eyespot (b rus) — Berkeley, 1964
6. McGill black. light ocular diaphragm, pearl (McGill b, lod, p) — Berkeley, 1964

T. castaneum

wild type strain
black strain

H. M. Slatis

HAMPTON, IOWA
FARMERS HYBRID COMPANY

Tribolium castaneum

A. Wild strain

1. Chicago — via Berkeley, 1965

B. Mutant strains

1. r py
2. j ms
3. Be/+

E. L. Lasley

HUMACAO, PUERTO RICO
UNIVERSITY OF PUERTO RICO, COLLEGE OF HUMACAO
DEPARTMENT OF BIOLOGY

Tribolium castaneum

A. Wild strain

1. Chicago

B. Mutant strains

1. paddle
2. pearl
3. Microcephalic
4. Bar eye, sooty
5. Short antennae (Sa-2)

Pedro Gonzalez Ramos

IMMACULATA, PENNSYLVANIA
IMMACULATA COLLEGE, CANCER RESEARCH UNIT

Wild type strains

Alphitobius diaperinus	PIL
Alphitobius laevigatus	PIL
Gnathocerus cornutus	PIL
Gnathocerus maxillosus	PIL
Latheticus oryzae	Berkeley
Tenebrio molitor	PIL
Tenebrio obscurus	PIL
Tribolium anaphae	Berkeley
Tribolium brevicornis	Berkeley
Tribolium castaneum	Berkeley
Tribolium confusum	Berkeley
Tribolium destructor	Berkeley
Tribolium madens	Berkeley

Mutants

Tribolium confusum melanotic stink glands (msg)

Note: The insect strains formerly maintained by one of us (S.K.L.) at the Johns Hopkins University, Chemistry Dept., in Baltimore, Md., have been transferred to Immaculata College.

R. K. Ladisch

IRVINE, CALIFORNIA
UNIVERSITY OF CALIFORNIA
DEPT. OF ORGANISMIC BIOLOGY

Tenebrio molitor

E. A. Steinhaus

ITHACA, NEW YORK
CORNELL UNIVERSITY, DEPARTMENT OF ANIMAL SCIENCE

Tribolium castaneum

The Purdue Foundation wild type obtained from the Population Genetics Institute in April, 1965

L. D. Van Vleck

ITHACA, NEW YORK
CORNELL UNIVERSITY, DEPARTMENT OF ENTOMOLOGY AND LIMNOLOGY

Wild type strains

T. confusum from Dr. H. Ducoff, University of Illinois.

T. confusum infected with *Nosema whitei*.

J. P. Kramer

(Dr. L. V. Knutson, same department, is said to have a wild type strain of *T. confusum*. Whether this strain is the same as that listed above is not known. Ed.)

JAMAICA, NEW YORK
ST. JOHN'S UNIVERSITY, DEPARTMENT OF BIOLOGY

Tenebrio molitor

J. P. Duffy

KENT, OHIO
KENT STATE UNIVERSITY, DEPARTMENT OF BIOLOGICAL SCIENCES

Wild type strains

A. Tribolium castaneum

Synthetic strain combined from Chicago wild type derived from Dr. Thomas Park and a strain obtained from Dr. Karl Schurr, Department of Biology, Bowling Greeb State University, Bowling Green Ohio.

B. Tribolium confusum

Derived from stock maintained by Dr. L. V. Knutson, Department of Entomology, Cornell University, Ithaca, New York.

C. Oryzaephilus surinamensis--from infested flour.

Mary E. Averill

LAFAYETTE, INDIANA
PURDUE UNIVERSITY, POPULATION GENETICS INSTITUTE

Tribolium castaneum

I. Wild type
A. Base populations for quantitative genetics studies:

1. Foundation + - wild type population formed from a broad genetic base and maintained with no artificial selection and minimum of inbreeding.

2. Foundation s - some genetic base as Foundation + but marked with sooty (s).

3. Foundation b - marked with black (b) and unrelated to Foundation +, groad genetic base, no selection, minimum inbreeding.

4. Foundation p - marked with pearl (p) and unrelated to Foundations + and b, broad genetic base, no selection, minimum inbreeding.

B. Laboratory stocks:

5. Arkansas — Fayetteville, 1954
6. Brazil — Vicosa, 1958
7. Capetown — South Africa, 1958
8. Carbondale — Illinois, 1958

9. Chicago	University of Chicago, 1954
10. Colombia	South America, 1958
11. Florida	Gainesville, 1958
12. Georgia	Tipton, 1954
13. Japan	Kyoto, 1958
14. McGill	Montreal, Canada, 1958
15. Minnesota	Minneapolis, 1958
16. Texas	College Station, 1954
17. Virginia	Blacksburg, 1954
18-30. Inbred lines with 10-50 generations of full sibbing.	

II. Mutants

31. antennapedia, ap	Purdue Sa Stock,1962
32. Bar eye, $\underline{Be}$	Berkeley,1962
33. black, b^D	Carbondale, Illinois,1964
34. chestnut, c	Purdue + Foundation, 1961
35. cordovan, b^{cd}	Purdue + Foundation, 1962
36. corn oil sensitive, cos	Purdue + Foundation,1966
37. ivory, i	Purdue + Foundation, 1961
38. jet, j^E	Purdue + Foundation, 1961
39. light ocular diaphragm, lod^D	Carbondale, Illinois,1964
40. maroon, m	Purdue + Foundation, 1962
41. paddle, pd	Chicago, 1955
42. peach, r^{ph}	Carbondale, Illinois,1964
43. pearl, p_M	Chicago, 1955
44. pearl, p_S	Malta via Pest Infest. Lab.,1966
45. pearl, p^S	Fla. Inbred. (Purdue),1963
46. pygmy, py	Chazy, New York,1960
47. red, r	Chazy, New York,1960
48. red, r^S	Purdue + Foundation, 1964
49. ring, rg	Purdue + Foundation, 1961
50. rose, rs	Purdue + Foundation,
51. ruby, rb	Carbondale, Illinois,1964
52. Short antenna, Sa	Purdue + Foundation, 1960
53. short antenna, sa_3	Purdue + Foundation, 1966
54. sooty, s	Purdue Foundation, 1956
55. squint, sq	Chazy, New York,1960
56. wine, r^w	Purdue + Foundation, 1963.

A. E. Bell

LARMIE, WYOMING
UNIVERSITY OF WYOMING, DEPARTMENT OF ZOOLOGY AND PHYSIOLOGY

Tribolium castaneum

A. Mutant strains

1. Fta c

2. Be s
3. pd py pte
4. sp
5. Spa s eju
6. p b
7. p lod
8. ap sq

G. R. Johnson

LAURINGBURG, NORTH CAROLINA
ST. ANDREWS COLLEGE

Tribolium confusum

A wild stock that is infected with Nosema whitei.

Carol Brown

LIVERMORE, CALIFORNIA
BIOLOGICAL FRONTIERS INSTITUTE

Only wild type strains of T. confusum and T. castaneum are maintained. We have a number of stocks of these species received from Dr. I. Michael Lerner and described by him in Tribolium Information Bulletin #3 (p. 28). In addition we have a number of stocks of both species collected locally.

We have also a wild type strain of the saw-toothed grain beetle, Oryzaephilus surinamensis (L.)

L. S. Rosenblatt

LAWRENCE, KANSAS
UNIVERSITY OF KANSAS, DEPARTMENT OF ENTOMOLOGY

Tribolium castaneum

A. wild type

1. UPF Foundation	Purdue University
2. CS-4	University of California
3. Chicago	University of California
4. Sacramento	University of California

B. Mutants

1. sooty (s)	Purdue
2. paddle (pd)	University of Chicago
3. pearl (p)	University of Chicago
4. McGill black (McGb) Univ. of Chicago stock	University of California

Tribolium confusum

A. Wild type

1. Chicago	University of California
2. Chicago (Sonleitner)	University of Chicago
3. New York	University of Chicago

B. Mutants

1. McGill black (McGb)	University of California
2. ebony (e)	University of Chicago

LORETTO, PENNSYLVANIA
ST. FRANCIS COLLEGE, BIOLOGY DEPARTMENT

A. Wild type strains

1. Tribolium castaneum	Chicago via Berkeley
2. Tribolium confusum	Chicago via Berkeley

LOS ANGELES, CALIFORNIA
UNIVERSITY OF CALIFORNIA MEDICAL CENTER
DEPARTMENT OF MEDICAL MICROBIOLOGY

A. Wild strain

1. Tribolium confusum	Chicago via Berkeley

Marietta Voge

MANHATTAN, KANSAS
KANSAS STATE UNIVERSITY, DEPARTMENT OF ENTOMOLOGY

I. Stock list

A. Sitotroga cerealella (Oliv.)

1. Angoumois grain moth from Anderson Co., Kansas, about 1960.
2. (Lab strain) AGM from Anderson Co., Kansas, about 1960.
3. (Red-eyed) AGM from Stock cultures, about 1966, K. B.
4. (Field strain) AGM from Riley Co., popcorn, about 1966, RBM.

B. *Plodia interpunctella* (Hbn.)

1. Indian Meal moth, from Kansas.

C. *Cadra cautella*

1. Almond moth from USDA Savannah, Georgia, 1966 RBM.

D. *Ephestia elutella*, Tobacco moth from USDA Savannah, Georgia, 1966.

E. *Sitophilus oryzae* (L.), Lesser rice weevil, from Kansas, (old strain) 1955.

1. Lesser rice weevil from Kansas, McLain Co. 1965.
2. Lesser rice weevil from Georgia, Atlanta, USDA.

F. *Sitophilus zeamais* (Mot.) from Arkansas, Stuttgart, 1955.

1. Mexican Larger rice weevil, from Veracruz, Mexico, 1964.

G. *Sitophilus granarius* (L.) Granary weevil; from Kansas.
H. *Oryzaephilus surinamensis* (L.), Saw-toothed grain beetle, Kansas.
I. *Cryptolestes pusillus* (Schonh.), Flat grain beetle, Kansas.
J. *Cryptolestes ferrugineus*, Rusty grain beetle, Kansas.
K. *Rhizopertha dominica* (F.), Lesser grain borer, Kansas.
L. *Tribolium castaneum* (Hbst.), Red flour beetle, Kansas.
M. *Tribolium confusum* duval, Confused flour beetle, Kansas.
N. *Oryzaephilus mercator*, Merchant beetle, Georgia, Savannah, 1964.
O. *Palorus ratzeburgi*, Small-eyed flour beetle, Kansas, 1965.
P. *Gibbium psylloides* (Czemp.) Spider beetle, Flour Mill Chicago, Ill. 1966.
Q. *Lasioderma serricorne* (F.), Cigarette beetle, Kellogg's All Bran, Man. Kansas, 1966.
R. *Trogoderma parabile*, Carpet beetle, Kansas.
S. *Tenebrio molitor*, Yellow mealworm, Kansas.
T. *Attagenue piceus* (Oliv.), Black Carpet beetle, Kansas, recent.

II. New Mutant

A. *Sitotrya cereolella*

1. red-eyed (bb), from Kansas.

MIDLAND, MICHIGAN
THE DOW CHEMICAL COMPANY, BIOPRODUCTS DEPARTMENT

Tribolium confusum

Wild strain maintained in laboratory more than 20 years.

14. CF-9 Oakland, Calif., 1958
15. CF-13 Oakland, Calif., 1961
16. CF-14 Oakland, Calif., 1961

C. Tribolium anaphe

1. PIL Pest Infestation Laboratory, Slough, 1963

D. Tribolium brevicornis

1. Riverside Riverside, California, 1965

E. Tribolium destructor

1. PIL Pest Infestation Laboratory, Slough, 1963

F. Tribolium madens

1. PIL Pest Infestation Laboratory, Slough, 1963

G. Gnathocerus cornutus

1. Berkeley (1) Oakland, Calif., 1959
2. Berkeley (2) Oakland, Calif., 1961
3. PIL Pest Infestation Laboratory, Slough, 1963

H. Latheticus oryzae

None

I. Tenebrio molitor

1. Berkeley Pet Shop, 1964

J. Oryzaephilus surinamensis

1. Synthetic from Cold Spring Harbor, N. Y. and Oakland, Calif. populations.
2. San Bernardino 1968

K. Carpophilus dimidiatus

1. PIL Pest Infestation Laboratory, Slough, 1963

L. Cryptolestes turcicus

1. PIL Pest Infestation Laboratory, Slough, 1963

M. Stegobium paniceum

1. San Bernardino 1969

2. Trogoderma inclusum USDA Lab., Fresno, 1968

II. Synthetic strains

A. Tribolium castaneum

1. Berkeley. Synthetic strain from six different laboratory strains marked with sooty. Prepared in 1958.

2. Berkeley. Synthetic strain from seven laboratory strains (Chicago, Texas, Virginia, CS-2, CS-3, CS-4, CS-14) not marked with body color genes. Prepared in 1964.

B. Tribolium confusum

1. Berkeley. Synthetic strain from six wild type laboratory strains (CF-1, CF-2, CF-3, CF-4, CF-5, CF-6,) not marked with body color genes. Prepared in 1958.

III. Inbred lines

A. Tribolium castaneum

1. Started October, 1958, from the Berkeley synthetic strain (now in 69 generation of brother-sister mating--all marked with sooty).

a. CSI-3
b. CSI-10

2. Started in 1964 from the Berkeley synthetic strain (now in 33-35 generation of brother-sister mating--all marked with sooty).

a. CSI-14
b. CSI-16

B. Tribolium confusum

1. Started October 8, 1958 from the Berkeley synthetic strain now in 73-79 generation of brother-sister mating, not marked with body color genes.

a. CFI-1
b. CFI-2
c. CFI-5
d. CFI-8
e. CFI-11
f. CFI-12

2. Started in 1964 from the Berkeley synthetic strain, now in 37-39 generation of brother-sister mating, not marked with body color genes.

a. CFI-13
b. CFI-14
c. CFI-15
d. CFI-23
e. CFI-24

IV. Mutants

A. Tribolium castaneum

Chromosome I

1.	paddle (pd)	Park, 1955
2.	paddle-1 (pd-1)	Berkeley, 1965
3.	red (r)	Chazy, New York, 1959
4.	red (r^{Ho})	Berkeley, 1962
5.	red (r^{D})	Berkeley, 1963
6.	pygmy (py)	Chazy, New York, 1959
7.	spotted (sp)	Chazy, New York, 1959
8.	divergent elytra (dve)	Chazy, New York, 1959
9.	truncated elytra (te)	Chazy, New York, 1959
10.	platinum eye (pte)	Berkeley, 1965
11.	pokey (pok) (as heterozygotes)	Berkeley, 1962
12.	red modifier (r^{Mr})	Berkeley, 1961
13.	serrate (ser)	Berkeley, 1963
14.	deformed podomeres (dpm)	Berkeley, 1964
15.	pte pd	
16.	py pd	
17.	sp pd	
18.	py r pd	
19.	py r	
20.	r te	
21.	sp r	
22.	r pd	
23.	py r M^{r}	
24.	pte py pd	
25.	r te M^{r}	
26.	sp dve py pd	
27.	ser py r	
28.	te-1	

Chromosome II

29.	pearl (p)	Park, 1955
30.	pink (p^{Pk})	Chazy, New York, 1959
31.	pegleg (pg)	Chazy, New York, 1959
32.	p; pg	

Chromosome III

33. aureate — Berkeley, 1965
34. McGill black (McGb) — Stanley, 1964
35. Chicago black (Cb) — Park, 1955
36. Synthetic (McGb/Cb) — Chazy, New York, 1958
37. black (b^S) (Chicago background) — Chazy, New York, 1960
38. black (b^{S-1})(Brazil background) — Berkeley, 1963
39. light ocular diaphragm (lod) (pearl background)
40. melanotic stink glands (msg) — Berkeley, 1964
41. scar (sc) — Purdue, 1964
42. tawny (b^t) — PIL, 1965

Chromosome IV

43. Bar eye (Be) — Chazy, New York, 1959
44. cut prothorax (ctp) — Berkeley, 1962
45. deformed legs (dfl) — Chazy, New York, 1959
46. elongated juvenile urogomphi (eju) — Berkeley, 1963
47. fused antennal segments-2 (fas-2) — Berkeley,
48. incomplete mesosternum (ims) — Berkeley, 1962
49. juvenile urogomphi (ju) — Berkeley, 1962
50. reduced juvenile urogomphi (rju) — Berkeley, 1963
51. Spatulate (Spa) — Berkeely , 1964
52. sternites imcomplete (sti) — Berkeley, 1963
53. Be s
54. fas-2s
55. mahogany (my)

Chromosome V

56. jet (j) — Park, 1955
57. microcephalic (mc) — Chazy, New York, 1959
58. fused antennal segments-3 (fas-3) (= agg) — Berkeley, 1961
59. fused antennal segments-3a (fas-3a) — Berkeley, 1963
60. j spl mc

Chromosome VI

61. Microphthalmic (Mo) — Chazy, New York, 1959

Chromosome VII

62. Short antenna (Sa) — Purdue, 1962
63. Short antenna (Sa-1) (= Gn) — Purdue, 1961
64. Short antenna (Sa-2) (= Ds) — Berkeley, 1959
65. Short antenna (Sa-3) (= Cua) — Berkeley, 1962
66. short antenna (sa) (= ca) — Chazy, New York, 1959
67. blistered elytra (ble) — Berkeley, 1962
68. short antenna (sa-2) (= vg) — Berkeley, 1962

69. chestnut (c) (ex Eddleman) 1961
70. Fused tarsi and antennae (Fta) Berkeley, 1962
71. Fta-ble
72. sa-c
73. Fta c
74. Sa c
75. Fta ca c
76. ble c

Chromosome VIII

77. antennapedia (ap^D) Berkeley, 1962
78. antennapedia (ap^S) (= fas-6) Berkeley, 1963
79. squint (sq) Chazy, New York, 1959

Chromosome IX

80. missing abdominal sternites (mas) Berkeley, 1964
81. prothoraxless (ptl) Chazy, New York, 1959
82. prothoraxless-1 (ptl-1) Berkeley, 1965
83. partially pointed abdominal sternites Berkeley, 1963

Chromosome X

84. abbreviated appendages (aa) Cold Spring Harbor, N. Y., 1961
85. abbreviated appendages-1 (aa-1) = (cspl) Chazy, New York, 1960

Multichromosomal

Note: The Roman numerals indicated the linkage groups involved. The symbol ? means the linkage group for that gene has not been established.

86. py pd; p I, II
87. sp; p I, II
88. py; b I, III
89. py r; lod I, III
90. sp; j I, V
91. pd; Mo I, VI
92. sp; p; j I, II, V
93. p; lod II, III
94. p; b II, III
95. p; b; Mo II, III, VI
96. p; b; mc II, III, V
97. p; mc II, V
98. b; Mo III, VI
99. j; Mo V, VI
100. Be Fta IV, VII
101. Be Sa IV, VII
102. ju ctp c IV, VII
103. Mo; sa VI, VII
104. b (p) apt III (II), ?
105. mc apt V, ?
106. apt j V, ?
107. Mo (c) mas VI, (VII), IX
108. (p) b mas (II), III IX
109. p Bamp/+ II, III ?
110. Bamp/+ ap^D III ?, IX
111. Bamp/+ ptl^{Hoy} III ?, IX
112. b max III, ?
113. j max V, ?
114. au Npp IV, ?
115. ap Npp VIII, ?
116. Be au IV
117. Fta ppas VII, ?
118. mc ppas V, IX
119. fas-3a ptl^{Hoy} III, IX
120. b ap^s III, VIII
121. au ctp IV
122. j ppas V, IX

Unassigned (but possibly in II)

123. creased abdominal sternites (cas)	Berkeley,	1963
124. abnormal abdominal sternites (aas)	Berkeley,	1965
125. akimbo (akb)	Berkeley,	1964
126. alate prothorax (apt)	Berkeley,	1964
127. antennae and tarsi fused (atf)	Berkeley,	1961
128. ballooned (bal)	Berkeley,	1963
129. banjo (bj)	Chazy, New York,	1960
130. bead (bd)	Bell,	1967
131. bent elytral tips (bet)	Chazy, New York,	1964
132. bent tibia (bt)	Berkeley,	1961
133. Blunt abdominal and metathoracic projections (Bamp) (possibly in III)	Berkeley,	1965
134. bowed femur (bf)	Berkeley,	1963
135. bowleg	Bell,	1967
136. bumpy (by)	Bell,	1966
137. Charcoal (Chr)	Berkeley,	1966
138. deflected epimera (dep)	Berkeley,	1964
139. deformed femur (dff)	Berkeley,	1964
140. deformed tibia (dft)	Berkeley,	1964
141. dented	Bell,	1967
142. diminutive appendages (dim)	Berkeley,	1966
143. elbowed antennae-1 (elb-1)	Berkeley,	1964
144. elongated elytra (ele)	Berkeley,	1964
145. elytra and tarsi affected (eta)	Berkeley,	1963
146. extra urogomphi (eu) (black)	Chazy, New York,	1960
147. fused antennal segments-1 (fas-1)	Chazy, New York,	1959
148. Fused antennal segments-4 (Fas-4)	Berkeley,	1963
149. Fused antennal segments-5 (Fas-5)	Berkeley,	1963
150. jagged antecoxal piece (jac)	Berkeley,	1964
151. knobby prothorax (knp)	Berkeley,	1966
152. looped median groove (lmg)	Berkeley,	1964
153. maxillopedia (max)	Berkeley,	1965
154. minature appendages (ma^D r)	Bell,	1967
155. Multi-urogomphi (Mu)	Bell,	1966
156. Nonpunctate prothorax (Npp)	Berkeley,	1965
157. overhang split (ohs)	Berkeley,	1966
158. padded prothorax (pdp)	Berkeley,	1965
159. pectinate antennae (pec)	Berkeley,	1964
160. reduced gin traps (rgt)	Berkeley,	1965
161. reduced pleurosternal suture (rps)	Berkeley,	1965
162. reduced tarsi and antennae (rta)	Berkeley,	1966
163. rough (ro)	Berkeley,	1964
164. rugose elytra (rue)	Berkeley,	1966
165. scalloped prothorax (scp)	Berkeley,	1965
166. short median abdominal projection (smp)	Berkeley,	1966
167. short split spinasternem (sss)	Berkeley,	1965
168. sleek (slk)	Berkeley,	1964
169. split, curved elytra (spce)		1963

170. split-back (sb) — Bell, 1966
171. stumpy (stu) — Berkeley, 1965
172. Tetra urogomphi (Tu) — Berkeley, 1965
173. tiny (ti) = (ty) — 1962
174. troll (tro) — Berkeley, 1964
175. umbilicus (umb) — Berkeley, 1964
176. urogomphiless (u) — Bell, 1967

B. Tribolium confusum

Chromosome I

1. Striped (St) — McDonald, 1961
2. eyespot (es) — McDonald, 1961
3. light eyespot (es^{lt}) — Berkeley, 1963
4. red (r) — Berkeley, 1962
5. antennae and elytra reduced (aer) — Berkeley, 1962
6. labiopedia (lp) — Berkeley, 1962
7. pointed abdominal segments (pas) — Berkeley, 1963
8. thickened elytral tips (tet) — Berkeley, 1963
9. lethal-1 (l_1) (in heterozygotes) — Berkeley, 1962
10. crumpled (cru) — Berkeley, 1964
11. prothoraxless-like (ptll) — Berkeley, 1964
12. St es
13. es lp
14. es lp (synthetic background)
15. $\frac{es^{lt}}{}$ lp
16. St es lp
17. alate prothorax (apt) — Berkeley, 1965

Chromosome II

18. pearl (p) — PIL, via Stanley, 1960
19. pearl (p^S) — Berkeley, 1962
20. ebony-2 (e_2) — PIL, via Stanley, 1960
21. creased abdominal sternites (cas) — Berkeley, 1963
22. dirty pearl eye (dpe) = (fro) — Berkeley, 1963
23. $e_2 p$ — PIL, via Stanley, 1960
24. p cas

Chromosome III

25. McGill black (McGb) = (b^{HO}) — Stanley, 1960
26. black-3 (b-3) — Berkeley, 1964
27. ruby spot (rus) — Chazy, New York, 1960

28. melanotic stink glands (msg) Berkeley, 1962
29. rus msg
30. b rus
31. b msg

Chromosome IV

32. thumbed (thu) Berkeley, 1963
33. thumbed^{s} (thu^{s}) = (rsp$^{P.\ S.\ D.}$) Berkeley, 1963

Chromosome V

34. ebony (e) Park, via Stanley, 1960
35. ebony (e$^{L\&H}$) Berkeley, 1959
36. synthetic (e/e$^{L\&H}$) Berkeley, 1961
37. blistered elytra (ble) Chazy, New York, 1960
38. e ble

Chromosome VI

39. disjoined (dj) Berkeley, 1963

Unassigned (but possibly in III)

40. light ocular diaphragm (lod)(pearl) Berkeley, 1961

Multichromosomal

41. p; lod
42. p; rus
43. b; sp
44. rus; sp
45. rus; ble
46. b (;) lod; p
47. b twa
48. ems dt msg
49. jac dt b
50. McGill b p
51. bent femur (btf) Berkeley, 1964
52. bent tibia (btt) Berkeley, 1962
53. black-3 (b-3) Berkeley, 1964
54. crumpled elytra (cru) Berkeley, 1964
55. creased abdominal sternites (cas-1) 1963
56. deflected epimera (dep) Berkeley, 1964
57. deformed legs (dfl) Berkeley, 1965
58. elongated elytra (ele) Berkeley, 1963
59. fused antennal segments-1 (fas-1) Berkeley, 1962
60. fused antennal segments-2 (fas-2) Berkeley, 1963
61. incomplete meso-metathoracic suture (ims) Berkeley, 1965
62. incomplete metathoracic projections (imp) Berkeley, 1964

63. knobby prothorax (knp)	Berkeley 1964
64. legless (lgl)	Berkeley, 1966
65. medial abdominal groove (mag)	Berkeley, 1964
66. nude (nd)	Berkeley, 1964
67. pockets (poc)	Berkeley, 1965
68. prosternumless (psl)	Berkeley, 1966
69. Reduced eye (Re)	Berkeley, 1965
70. rough (ro)(black)	McDonald, 1960
71. ruby (rby)	Berkeley, 1962
72. scar (sc) (= engraved metasternum)	Berkeley, 1962
73. separated epimera (sep)	Berkeley, 1964
74. short elytra (sh)	Berkeley, 1961
75. split (sp)	McDonald, 1961
76. sternites incomplete (sti)	Berkeley, 1963
77. stilted legs (stl)	Berkeley, 1962
78. stunted (stt)	Berkeley, 1966
79. tiny (ty)	Berkeley, 1961
80. twisted abdomen (twa)	Berkeley, 1965
81. umbilicus (umb) (= dent)	Berkeley, 1962
82. warped elytra (we)	Berkeley, 1962
83. wingless (wgl)	Berkeley, 1965

C. Tribolium anaphe

1. sternites incomplete (sti)	Berkeley, 1964
2. creased abdominal sternites (cas)	Berkeley, 1965

D. Tribolium destructor

1. bent tibia (btt)	Berkeley, 1964
2. creased abdominal sternites (cas)	Berkeley, 1964
3. split (spl)	

E. Tribolium madens

1. fused antennal segments-1 (fas-1)	Berkeley, 1964
2. creased abdominal sternites (cas)	Berkeley, 1964
3. split (spl)	Berkeley, 1964
4. bent tibia (btt)	Berkeley, 1964

F. Gnathocerus cornutus

1. pearl-1 (p-1)	PIL., 1964
2. pearl-2 (p-2)	Berkeley, 1962

Unassigned

3. light ocular diaphragm (lod) (pearl)	Berkeley, 1962

G. Latheticus oryzae

Chromosome I

1. red-1 (r-1) — from PIL +/+ stock, 1963

Chromosome II

2. creased abdominal sternites (cas) — Berkeley, 1963
3. brown body (bwb) — ex Dyte, 1963
4. p cas
5. p bwb

Unassigned

6. droopy elytra (dre) — Chazy, New York, 1960
7. elongated elytra (ele) — Berkeley, 1964
8. fused antennal segments-1 (fas-1) — Berkeley, 1963

H. Tenebrio molitor

None

I. Oryzaephilus surinamensis

None

J. Carpophilus dimidiatus

None

K. Cryptolestes pusillus

1. dark form — PIL, 1963

L. Cryptolestes turcicus

Chromosome I
1. red (r) — PIL, 1963

Unassigned

2. crooked antennae (cka) — Berkeley, 1964
3. runty (rty) — Berkeley, 1964
4. pink
5. tiny

M. Palorus ratzeburgi

None

N. Stegobium paniceum

None

A. Sokoloff

SANTA BARBARA, CALIFORNIA
UNIVERSITY OF CALIFORNIA, DEPARTMENT OF BIOLOGICAL SCIENCES

I. Wild type strains

A. Tribolium castaneum

1. "Chicago"	Park, 1966
2. derived from cI (Brazil)	Park, 1966
3. derived from cIV-a	Park, 1966

B. Tribolium confusum

1. "Chicago"	Park, 1966
2. derived from bI	Park, 1966
3. derived from bIV	Park, 1966

D. B. Mertz

SANTA FE, NEW MEXICO
SANTA FE PREPARATORY SCHOOL

A. Wild strains

1. Tribolium castaneum	Chicago via Berkeley
2. Tribolium confusum	McGill via Berkeley

K. H. Wilson

SAVANNAH, GEORGIA
STORED PRODUCT INSECTS RESEARCH AND DEVELOPMENT LABORATORY

I. Wild type strains

A. Lepidoptera

1. Cadra cautella	USDA, Tifton, Ga., 1964
2. Ephestia elutella	Richmond, Virginia,

3. *Plodia interpunctella*		
4. *Sitotroga cerealella*	Tifton, Georgia,	1962
5. *Tineola bisselliella*	Savannah, Georgia,	1962

B. *Coleoptera*

1. *Anthrenus flavipes*		
2. *Attagenus megatoma*		
3. *Cryptolestes pusillus*		
4. *Dermestes maculatus*	Madison, Wisconsin,	1967
5. *Lasioderma serricorne*		
6. *Oryzaephilus mercator*		
7. *Oryzaephilus surinamensis*	Manhattan, Kansas,	1964
8. *Rhyzopertha dominica*		
9. *Sitophilus granarius*	Manhattan, Kansas,	1966
10. *Sitophilus oryzae*		
11. *Sitophilus zea-mais*	Estill, S. C.,	1961
12. *Tenebroides mauritanicus*	Canada,	1960
13. *Tenebrio molitor*		
14. *Tribolium castaneum*		
15. *Tribolium confusum*	Manhattan, Kansas,	1960
16. *Trogoderma glabrum*	Madison, Wisconsin,	1967
17. *Trogoderma inclusum*	Madison, Wisconsin,	1967

II. Mutant strain

A. *Tribolium confusum*-black	Savannah, Georgia,	1967

SOUTH LANCASTER, MASSACHUSETTS
ATLANTIC UNION COLLEGE, BIOLOGY DEPARTMENT

Tribolium castaneum

A. Wild type strains

1. Brazil (C-1)
2. Chicago
3. McGill
4. Sacramento
5. Texas
6. Veracruz, Mexico
7. Virginia

B. Mutants

1. red (r^D)
2. red ($\overline{r}$)
3. red ($\overline{r^{Ho}}$)
4. red modifier ($\overline{R^r}$)
5. McGill black ($\overline{McGb}$)
6. Chicago black ($\overline{Cb}$)
7. black (B^S-1), Brazil black

8. sooty (s)
9. jet (j)
10. chestnut (c^S)

David O. Kissinger

SOUTH ORANGE, NEW JERSEY
SETON HALL UNIVERSITY, DEPARTMENT OF BIOLOGY

A. Wild type strains

1. Tribolium confusum	Fordham University
2. Tenebrio molitor	Fordham University
3. Tribolium castaneum McGill	Montreal, Canada via University of California

B. Tribolium castaneum mutant strains

1. McGill black	via University of California
2. Pearl	via University of California
3. Pygmy	via University of California

C. Inbreds

1. CSI-5	via University of California, 1966

STATE COLLEGE, MISSISSIPPI
USDA, ARS, BOLL WEEVIL RESEARCH LABORATORY

Anthonomus grandis

A. Wild type strains

1. A & M	College Station, Texas
2. Oktibbeha	State College, Miss.
3. Thurberia	Tucson, Ariz.
4. Iguala	Iguala, Mexico

B. Mutants

1. yellow (y)	A & M strain
2. slate (s)	Acala, Mexico
3. ebony (e)	A & M strain
4. pearl (p)	A & M strain

C. Insecticide resistant

1. Endrin Resistant — Auburn University (W. Ivey)

ca. 20 µg/weevil

A. C. Bartlett

ST. BERNARD, ALABAMA
ST. BERNARD ABBEY

Tribolium castaneum

A. Mutant

1. Chicago +/+ — via Berkeley
2. jet (j^g) — via Berkeley
3. McGill black (McGb) — via Berkeley
4. pearl (p) — via Berkeley
5. U. C. sooty (synthetic) — via Berkeley

Tribolium confusum

1. ebony (e) — via Berkeley
2. black (b) — via Berkeley
3. New York +/+ — via Berkeley
4. pearl (p) — via Berkeley

Michael Morgan

ST. PAUL, MINNESOTA
UNIVERSITY OF MINNESOTA, DEPARTMENT OF ENTOMOLOGY, FISHERIES AND WILDLIFE

Anobiidae

Lasioderma serricorne-cigarette beetle — USDA, Savannah, Ga., 1963
Stegobium paniceum-drugstore beetle — U. of Calif., Riverside, 1967

Bostrichidae

Rhyzopertha dominica-lesser grain borer — Kansas State U., Manhattan, 1963

Bruchidae

Acanthoscelides obtectus-common bean weevil — U. of Calif., Riverside, 1967
Araecerus fasciculatus-coffee bean weevil — USDA, Tifton, Ga., 1967
Callosobruchus maculatus-southern cowpea weevil — USDA, Tifton, Ga., 1967
Zabrotes subfasciatus-Mexican bean weevil — U. of Calif., Riverside, 1967

Cucujidae

Cryptolestes pusillus-flat grain beetle	Kansas State U., Manhattan, 1967
Oryzaephilus mercator-merchant grain beetle	USDA, Tifton, Ga., 1966
Oryzaephilus surinamensis-saw-toothed grain beetle	USDA, Savannah, Ga., 1963
Cathartus quadricollis-square-necked grain beetle	USDA, Tifton, Ga., 1967

Curculinonidae

Sitophilus granarius-granary weevil	Univ. of Minn., St. Paul,
Sitophilus oryzae-rice weevil	Kansas State U., Manhattan, 1960

Dermestidae

Attagenus Piceus-black carpet beetle	USDA, Savannah, Ga., 1963
Trogoderma parabile	

Gelechidae

Sitotroga cerealella-Angoumois grain moth	U. of Calif., Riverside, 1967

Ostomidae

Tenebroides mauritanicus-cadelle	U. of Calif., Riverside, 1967

Ptinidae

Gibbium psylloides	
Ptinus fur-white marked spider beetle	

Pyralidae

Corcyra cephalonica-rice moth	Univ. of Minn., St. Paul, 1963
Anagasta kuhniella-Mediterranean flour moth	USDA, Savannah, Ga., 1963
Plodia interpunctella-Indian meal moth	Univ. of Minn., St. Paul, 1963

Tenebrionidae

Gnathocerus cornutus-broad-horned flour beetle	U. of Calif., Berkeley, 1963
Latheticus oryzae-long-headed flour beetle	U. of Calif., Berkeley, 1963
Palorus ratzeburgi-small-eyed flour beetle	USDA, Tifton, Ga., 1967
Tenebrio molitor-yellow mealmoth	Atwater, Minn., 1967
Tribolium castaneum-red flour beetle	U. of Calif., Berkeley, 1963
Tribolium confusum(black strain)-confused flour beetle	Univ. of Minn., St. Paul,
Tribolium confusum-confused flour beetle	Univ. of Minn., St. Paul,
Alphitobius diaperinus-lesser meal moth	Rochester, Minn., 1967

ST. PAUL, MINNESOTA
UNIVERSITY OF MINNESOTA

Tribolium castaneum

A. Inbreds

1. CSI-5	University of California, Berkeley, 1963
2. CSI-10	University of California, Berkeley, 1963

B. Segregating populations (marked with sooty)

1. Random bred (no selection) since 1963 from a single cross.
2. Random bred with selection for pupa weight.

F. D. Enfield

ST. PAUL, MINNESOTA
UNIVERSITY OF MINNESOTA, DEPARTMENT OF ANIMAL SCIENCE

A. Inbreds

1. CSI-10	University of California, Berkeley
2. E 1	Institute of Animal Genetics, Edinburgh
3. E 2	Institute of Animal Genetics, Edinburgh

B. Purdue Foundation, p — Purdue University

C. Segregating population selected for pupa weight, synthesized by crossing CSI-10 and E 2 lines.

W. J. Boylan

SYCAMORE, ILLINOIS
DE KALB AGRICULTURAL ASSOCIATION, INC.

Dr. R. R. Shrode has moved to the University of Tennessee; fate of his Tribolium stocks is not known. (Ed.)

TIFTON, GEORGIA
ABRAHAM BALDWIN AGRICULTURAL COLLEGE

Known to have at least the following strains:

Tribolium castaneum

A. Wild type

1. Chicago

B. Mutant

1. black
2. squint

(All derived from stocks maintained at Berkeley. Ed.)

URBANA, ILLINOIS
UNIVERSITY OF ILLINOIS, DEPARTMENT OF ZOOLOGY

I. Wild type strains

A. Tribolium castaneum

1. Berkeley	Berkeley, 1966
2. Chicago	Urbana, 1966
3. Carbondale	Maryland, 1966
4. del Valle	Maryland, 1966
5. Kansas	Kansas, 1966

B. Tribolium confusum

1. Berkeley	Berkeley, 1966
2. Chicago	Urbana, 1966
3. Kansas	Kansas, 1966
4. Maryland	Maryland, 1966
5. Minnesota	Minnesota, 1966
6. Oklahoma	Urbana, 1966

II. Inbred lines

A. Tribolium castaneum

1. CSI-2	Berkeley, 1966
2. CSI-3	Berkeley, 1966
3. CSI-5	Berkeley, 1966
4. CSI-10	Berkeley, 1966
5. CSI-12	Berkeley, 1966
6. CSI-14	Berkeley, 1966
7. CSI-15	Berkeley, 1966
8. CSI-16	Berkeley, 1966
9. CSI-22	Berkeley, 1966

B. Tribolium confusum

1. CFI-1	Berkeley, 1966
2. CFI-2	Berkeley, 1966
3. CFI-3	Berkeley, 1966
4. CFI-5	Berkeley, 1966
5. CFI-7	Berkeley, 1966
6. CFI-8	Berkeley, 1966

7. CFI-11	Berkeley, 1966
8. CFI-12	Berkeley, 1966
9. CFI-13	Berkeley, 1966
10. CFI-14	Berkeley, 1966
11. CFI-15	Berkeley, 1966
12. CFI-16	Berkeley, 1966
13. CFI-18	Berkeley, 1966
14. CFI-19	Berkeley, 1966
15. CFI-20	Berkeley, 1966
16. CFI-21	Berkeley, 1966
17. CFI-22	Berkeley, 1966
18. CFI-23	Berkeley, 1966
19. CFI-24	Berkeley, 1966

III. Mutants

A. Tribolium castaneum

1. sa-2 (+/s)	Berkeley, 1966
2. i	Purdue, 1967
3. w	Purdue, 1967
4. b, mc, p	Berkeley, 1966
5. bal, s	Berkeley, 1966
6. pd	Urbana, 1966
7. Be	Berkeley, 1966
8. mc	Berkeley, 1967
9. aa (+/p)	Berkeley, 1967
10. r^{Ho}	Berkeley, 1966
11. Mo	Berkeley, 1966
12. b	Berkeley, 1966
13. ap^{D}, s	Berkeley, 1966
14. i	Berkeley, 1966
15. r (+/py)	Berkeley, 1966
16. Fta/+, c	Berkeley, 1966
17. c	Berkeley, 1966
18. Spa/+, +/c	Berkeley, 1966
19. p	Berkeley, 1967
20. sq	Berkeley, 1967
21. msg	Berkeley, 1967
22. sh^{s}	Berkeley, 1967
23. p, lod	Berkeley, 1967
24. Sa-2, s	Berkeley, 1967
25. rg	Berkeley, 1967
26. fas-3a	Berkeley, 1967
27. r^{D}, s	Berkeley, 1967
28. dve, pd	Berkeley, 1967
29. h	Urbana, 1967
30. rs	Purdue, 1967
31. rb	Purdue, 1967
32. i, m	Purdue, 1967
33. ctp, lu	Berkeley, 1967

URBANA, ILLINOIS
UNIVERSITY OF ILLINOIS, DEPARTMENT OF PHYSIOLOGY AND BIOPHYSICS

Tribolium confusum

A. Wild type	G. Fraenkel, 1960
B. McGill black	A. Sokoloff, 1966

Also available:

Nemeritis canescens (Ichneumon.)

From University of Cambridge Zoology Department. Carried on Anagasta kuehniella.

H. S. Ducoff

WASHINGTON, D. C.
THE CATHOLIC UNIVERSITY OF AMERICA, DEPARTMENT OF BIOLOGY

R. H. Arnett moved to Purdue University. Fate of Tribolium stocks at the above institution is not known. (Ed.)

AUSTRALIA

BRISBANE, QUEENSLAND
DEPARTMENT OF PRIMARY INDUSTRIES, ENTOMOLOGY LABORATORY

COLEOPTERA

A. Tribolium castaneum

1. Wild type strains
2. Black mutant (reoccurrence of b)
3. Lindane resistant

B. Sitophilus oryzae

1. Wild type strains
2. DDT resistant (single semi-dominant sex-linked factor)
3. Lindane and dieldrin resistant (single and multi-factor strains.)
4. Black strain

C. Sitophilus zeamais--wild type

D. Sitophilus granarius--wild type

E. Oryzaephilus surinamensis

1. Wild type strains
2. Lindane resistant strains (impure)

F. Lasioderma sericorne--wild type

G. Rhizopertha dominica--wild type

H. Mezium americanum--wild type

LEPIDOPTERA

A. Cadra cautella--wild type

B. Phthorimaea operculella

1. DDT-endrin resistant
2. Red-eyed mutant (single autosomal recessive)

HYMENOPTERA

A. Microchelonus sp.--wild type

B. R. Champ

BELGIUM

GEMBLOUX
INSTITUT AGRONOMIQUE DE L'ETAT, ZOOLOGIE GENERALE

Tenebrio molitor

F strain--selected for small weight since 1950
G strain--selected for large weight since 1950

J. LeClercq

LOUVAIN
F. A. JANSSENS MEMORIAL LABORATORY FOR GENETICS
AGRICULTURAL INSTITUTE OF THE UNIVERSITY

Tenebrio molitor

Wild type — Belgium

Tribolium confusum

Two inbred and a wild type — Berkeley, 1965

BRAZIL

CAMPINAS, SÃO PAULO
INSTITUTE AGRONOMICO, SECAO DE ENTOMOLOGIA

Anobiidae

Lasioderma serricorne (F)--Campinas, SP--wild type

Bostrichidae

Rhizopertha dominica (F)--Campinas, SP--wild type

Bruchidae

Acanthoscelides obsoletus (Say)--Campinas, SP--wild type

Curculionidae

Sitophilus oryzae (L.)-- Campinas, SP--wild type

Silvanidae (Cucujidae)

Oryzaephilus surinamensis (L.)--Campinas, SP--wild type

Tenebrionidae

Tribolium castaneum (Herbst.)--Campinas, SP--wild type

L. O. T. Mendes

CANADA

EDMONTON, ALBERTA
UNIVERSITY OF ALBERTA, DEPARTMENT OF ANIMAL SCIENCE

A. Brazil	Purdue, 1965
B. Capetown	Purdue, 1965
C. Chicago	Chicago, 1965
D. Consejo	Madrid, 1965
E. Japan	Kyoto and Purdue, 1965
F. Kano	Scotland, 1965
G. Kenya	Scotland, 1965
H. Kingston	Scotland, 1965
I. Lisbon	Portugal, 1965
J. Purdue Foundation +	Manitoba, 1963
K. Scotland	Edinburgh, 1965
L. Seychelles	Scotland, 1965
M. Surrey	England, 1965
N. Veracruz	Berkeley, 1965

R. T. Hardin

GUELPH, ONTARIO
UNIVERSITY OF GUELPH, DEPARTMENT OF POULTRY SCIENCE

A. mass mated population obtained from A. B. Bell, Purdue, 1961

B. two lines selected for larva weight for eight generations in a high humidity environment

C. two lines selected for larva weight for eight generations in a low humidity environment

D. two lines selected for high offspring number for eight generations in a high humidity environment.

E. two lines selected for high offspring number for eight generations in a low humidity environment.

G. W. Friars

GUELPH, ONTARIO
UNIVERSITY OF GUELPH, DEPARTMENT OF ZOOLOGY

A. Sitophilus granarius (L)

1. GG strain, dark, heavy and symbiotic
2. MW strain, paler, lighter and aposymbiotic
3. Two new strains as yet unclassified

B. Sitophilus oryzae (L.)--small rice weevil

C. Sitophilus zea-mais (Mots.)--large rice weevil

A. J. Musgrave

MONTREAL, P. Q.
MCGILL UNIVERSITY, DEPARTMENT OF GENETICS

Tribolium castaneum

1. Berkeley CS-synthetic	Berkeley, 1967
Berkeley CSI-3, 5, 10, 14, 16	Berkeley, 1967
Berkeley CS-pygmy	Berkeley, 1967
2. Chicago wild	via D. Bray, 1966
3. Purdue Foundation via E. Scheinberg	Ottawa, 1967
4. Several strains selected for high pupal weight	via D. Bray, 1966

K. Sittmann

OTTAWA, ONTARIO
ANIMAL GENETICS SECTION, ANIMAL RESEARCH INSTITUTE
CENTRAL EXPERIMENTAL FARM

Tribolium castaneum

Purdue Foundation

RSILW - A population selected for high larval weight for 10 generations restricting developmental time and pupal weight (derived from Purdue Foundation).

RSIDT - A population selected for short developmental time for 10 generations restricting larval weight and pupal weight (derived from Purdue Foundation).

RSIPW - A population selected for short developmental time for 10 generations restricting larval weight and developmental time (derived from Purdue Foundation).

TSLW - A population selected for high larval weight for 10 generations (derived from Purdue Foundation).

TSDT - A population selected for short developmental time for 10 generations (derived from Purdue Foundation).

TSPW - A population selected for high pupal weight for 10 generations (derived from Purdue Foundation).

QUEBEC, P. Q.
UNIVERSITE LAVAL, DEPARTMENT OF BIOCHEMISTRY

Tribolium confusum Duval

Strain: Laval
Origin: Quebec City

A. Lemonde

QUEBEC, P. Q.
UNIVERSITE LAVAL, DEPARTMENT OF BIOLOGY

Tribolium confusum Duval

Strain: Laval
Origin: Quebec City

L. Huot

VANCOUVER, B. C.
UNIVERSITY OF BRITISH COLUMBIA, DEPARTMENT OF POULTRY SCIENCE

I. Wild type strains

A. Tribolium confusum inbred lines

1. CFI-2a	Berkeley, 1965
2. CFI-3	Berkeley, 1965
3. CFI-5	Berkeley, 1965
4. CFI-7	Berkeley, 1965
5. CFI-8b	Berkeley, 1965

II. Mutant strains

A. Tribolium confusum

1. eyespot (es); chromosome I	Berkeley 1965
2. red (r); chromosome I	Berkeley 1965
3. dirty pearl eye (dpe);chromosome II	Berkeley 1965
4. ebony-2 (e_2); chromosome II	Berkeley 1965
5. pearl riboflavinless (p^r); chromosome II	Berkeley 1965
6. pearl slough (p); chromosome II	Berkeley 1965
7. ruby spot (rus) ; chromosome III	Berkeley 1965
8. light ocular diaphragm (lod); chromosome III	Berkeley 1965
9. p; dre; cas; multichromosomal	Berkeley 1965
10. rus; b; multichromosomal	Berkeley 1965
11. St; b; multichromosomal	Berkeley 1965

B. Tribolium castaneum

1. red (r); chromosome I	Berkeley 1965
2. pearl (p); chromosome II	Berkeley 1965
3. pearl riboflavinless (p^r) (formerly "ivory")	Purdue 1967
4. pink (p^{pk}); chromosome II	Berkeley 1965
5. light ocular diaphragm (p background) chromosome III	Berkeley 1965
6. jet H. L. E. ; chromosome V	Berkeley 1967
7. chestnut (c); chromosome VII	Berkeley 1965
8. s; r^D; Multichromosomal	Berkeley 1965

C. W. Roberts

WINNIPEG, MANITOBA
CANADA DEPARTMENT OF AGRICULTURE, RESEARCH STATION

I. Wild type strains

A. Coleoptera

1.	Acanthoscelides obtectus (Say) Bruchidae	Winnipeg
2.	Alphitobius diaperinus Panzer Tenebrionidae	Alberta
3.	Cryptolestes ferrugineus (Stephens) Cucujidae	Manitoba
4.	Cryptolestes ferrugineus (Stephens) Cucujidae	Pest Infestation Laboratory, U. K.
5.	Cryptolestes turcicus Grouvelle Cucujidae	Ontario
6.	Cryptolestes turcicus Grouvelle Cucujidae	Pest infestation Laboratory, U. K.
7.	Cynaeus angustus Leconte Tenebrionidae	Manitoba
8.	Gnathocerus cornutus Fabricius Tenebrionidae	Manitoba
9.	Oryzaephilus mercator (Fauvel) Silvanidae	Ontario
10.	Oryzaephilus surinamensis (L.) Silvanidae	Manitoba
11.	Perimegatoma vespulae Milliron Dermestidae	Winnipeg
12.	Rhyzopertha dominica (Fabricius) Bostrichidae	Australia
13.	Sitophilus granarius (L.) Curculionidae	Manitoba
14.	Sitophilus zea-mais (Motschulsky) Curculionidae	Montreal
15.	Sitophilus zea-mais (Motschulsky)Curculionidae	Japan
16.	Stegobium paniceum L. Anobiidae	Winnipeg
17.	Tenebroides mauritanicus (L.) Ostomatidae	Manitoba
18.	Tenebrio molitor (L.) Tenebrionidae	Manitoba
19.	Tribolium castaneum (Herbst) Tenebrionidae	Manitoba
20.	Tribolium confusum (DuVal) Tenebrionidae	Ontario
21.	Tribolium madens (Charpentier) Tenebrionidae	Manitoba
22.	Trogoderma parabile Beal Dermestidae	Alberta

B. Lepidoptera

1.	Plodia interpunctella Hübner Phycitidae	Manitoba

II. Mutants

A. Coleoptera

1.	Tribolium confusum DuVal ebony (e Smith and Loschiavo)	Winnipeg, Manitoba 1963

L. B. Smith

DENMARK

LYNGVY
STATENS SKADEDYRLABORATORIUM
(GOVERNMENT PEST INFESTATION LABORATORY)

Tribolium confusum

A couple of cultures is as a rule maintained, now and then supple-

mented with specimens sent to the Laboratory for inquiry. They descend from insects caught in Denmark, but some of these are likely to have been newly imported from abroad.

Tribolium destructor

This species is a rather common household pest in Denmark and we maintain a couple of cultures descending from this stock.

F. S. Andersen

EASTERN NIGERIA

PORT HARCOURT
THE NIGERIAN STORED PRODUCTS RESEARCH INSTITUTE

A. Wild type

1. Dermestes maculatus De Geer — Port Harcourt Strain, 1966
2. Oryzaephilus mercator Fauv. — Port Harcourt Strain, 1966
3. Sitophilus zeamais Motschulsky — Kano Strain, 1965 (Ex Kano Lab. Stock) November, 1965
4. Tribolium castaneum Hbst. — Kano Strain, 1965 (Ex Kano Lab. Stock) October, 1965
5. Tribolium confusum duVal. — Kano Strain, 1965 (Ex Kano Lab. Stock) December, 1965
6. Trogoderma granarium Everts — Kano Strain, 1965 (Ex Kano Lab. Stock) November, 1965

A. K. Onyearu

EGYPT, U. A. R.

GIZA
PLANT PROTECTION DEPARTMENT, MINISTRY OF AGRICULTURE

A. Wild type strains

1. Bruchus rufimanus — Egypt, U.A.R.
2. Corcyra cephalonica — Egypt, U.A.R.
3. Ephestia kühniella — Egypt, U.A.R.
4. Latheticus oryzae — Egypt, U.A.R.
5. Rhizopertha dominica — Egypt, U.A.R.
6. Silvanus surinamensis — Egypt, U.A.R.
7. Sitophilus granarius — Egypt, U.A.R.
8. Sitophilus oryzae — Egypt, U.A.R.
9. Tribolium castaneum — Egypt, U.A.R.
10. Tribolium confusum — Egypt, U.A.R.

NOTE: Dr. M. A. Hafeez is at present in London. Fate of above stocks is unknown. (Ed.)

FRANCE

LYON, RHÔNE
LABORATOIRE DE ZOOLOGIE GÉNÉRALE, FACULTÉ DES SCIENCES

Tribolium castaneum

Wild type strain from Alès, France.

J. David

VILLEURBANNE (LYON) RHÔNE
INSTITUT NATIONAL DES SCIENCES APPLIQUÉES, LABORATOIRE DE BIOLOGIE

A.	Acanthoscelides obsoletus --wild type	France
B.	Blabera fusca	
C.	Clitumnus extradentatus	
D.	Galleria mellonella	Saint Cyr au Mont d'Or
E.	Oryzaephilus surinamensis--from imported dried apricots	
F.	Periplaneta americana	
G.	Pseudococcus citri	Antibes
H.	Sitophilus granarius	Infestation Control Laboratory, Surbiton
I.	Sitophilus oryzae	P.I.L., Slough
J.	Sitophilus sasakii--wild type	Lyon
K.	Stegobium paniceum	P.I.L., Slough
L.	Tenebrio molitor	
M.	Tenebrio obscurus	P.I.L., Slough
N.	Tribolium castaneum--wild type	Alès

P. Nardon

GERMANY

MUNICH
BAYER. LANDESANSTALT FÜR BODENKULTUR
PFLANZENBAU U. PFLANZENSCHUTZ

Coleoptera

Cucujidae

Cryptolestes turcicus (Grouv.) Munich, 1966

Curculionidae

Sitophilus granarius (L.)	Munich, 1966
Sitophilus zea-mais (Motsch.)	1966

Ptinidae

Gibbium psylloides (Czemp.)	Regensburg, 1960

Silvanidae

Oryzaephilus mercator (Fauv.)	Munich, 1966
Oryzaephilus surinamensis (L.)	Munich, 1959

Tenebrionidae

Gnathocerus cornutus (F.)	Munich, 1966
Tribolium confusum (Duv.)	Munich, 1960
Tribolium destructor (Uyttenb.)	Munich, 1957

LEPIDOPTERA

Phyticidae

Anagasta kuehniella (Zell.)	Munich, 1966

E. Naton

GREAT BRITAIN

BIRMINGHAM, ENGLAND
THE UNIVERSITY OF BIRMINGHAM
DEPARTMENT OF ZOOLOGY AND COMPARATIVE PHYSIOLOGY

Tenebrio molitor
Tenebrio obscurus
Blaps sp.
Tribolium sp.

DUNDEE, ANGUS
UNIVERSITY OF DUNDEE, DEPARTMENT OF NATURAL HISTORY

Only those stocks unique to this laboratory are described

Wild stocks

1. Tribolium castaneum - Kenya. Collected in December, 1967, from stored maize in the Nairobi district.
2. Tribolium castaneum - Kenya. Collected in 1964 from stored maize in Machakos district.
3. Tribolium confusum

DUNDEE, ANGUS
UNIVERSITY OF ST. ANDREWS, QUEEN'S COLLEGE,
NATURAL HISTORY DEPARTMENT

Only those stocks unique to this laboratory are described. The unlisted stocks are all derived from cultures at the Pest Infestation Laboratory.

A. Wild stocks

1. Tribolium anaphe.

2. Tribolium castaneum--Kenya. Collected in 1964 from stored maize in the Machakos district.

3. Tribolium castaneum--Kingston (Jamica). Collected in 1964 from maize entering central storage.

4. Tribolium castaneum--Kano (Nigeria). Collected in 1964 from from cassava flour in Northern Nigeria.

5. Tribolium castaneum--Umuahia (Nigeria). Collected in 1964 from cocoa beans in Eastern Nigeria.

6. Tribolium castaneum--Ibadan (Nigeria). Collected in 1963 from maize silos in Western Nigeria.

7. Tribolium castaneum--Tokyo (Japan). Obtained in 1965.

8. Tribolium castaneum--Rangoon (Burma). Obtained in 1965.

9. Tribolium confusum--Kenya. Collected in 1964 from stored maize in Machakos district.

10. Tribolium destructor.

11. Tribolium madens.

12. Cathartus quadricollis--Nigeria. Collected in 1961.

B. Mutant stocks

13. Tribolium castaneum--pearl (p). Isolated from P. I. L. stocks.
14. Tribolium castaneum--mahogany. Isolated from P. I. L. stocks.
15. Tribolium castaneum--black (Kingston). Isolated from (4).

F. L. Waterhouse

EDINGURGH
UNIVERSITY OF EDINBURGH, INSTITUTE OF ANIMAL GENETICS

Tribolium castaneum

A. Wild type strains

1. Chicago wild type

Tribolium castaneum

B. Mutant strains

1. Microphthalmic (Mo)
2. microcephalic, pearl (mc,p)
3. Bar eye, sooty (Be s/+ s)
4. squint (sq)

Stocks obtained from Berkeley, California.

C. H. Waddington

EDINBURGH, SCOTLAND
DEPARTMENT OF AGRICULTURE AND FISHERIES FOR SCOTLAND
AGRICULTURAL SCIENTIFIC SERVICES, EAST CRAIGS

Tribolium castaneum Herbst.

Wild type strain of unknown origin, collected from imported foodstuffs.

Tribolium confusum J. du V.

Wild type strain of unknown origin, collected from imported foodstuffs.

J. R. Cutler

LONDON
QUEEN ELIZABETH COLLEGE, DEPARTMENT OF BIOLOGY

Bruchus pectinicornis
Latheticus oryzae
Sitophilus granarius
Tenebrio molitor
Tribolium anaphe
Tribolium castaneum
Tribolium madens
Trogoderma

All insects are derived from the Pest Infestation Laboratory, Slough, Bucks.

M. Hafez

NEWCASTLE UPON TYNE
THE UNIVERSITY OF NEWCASTLE UPON TYNE, SCHOOL OF AGRICULTURE

Tribolium castaneum

A. Wild type

1. pearl (p)

2. black (b), tawny (b^t)
3. antennapedia (ap)
4. paddle (pd)
5. red (r)

Tribolium confusum

A. Wild type

1. ebony (e^2)
2. pearl (p)

All stocks derived from cultures at Pest Infestation Laboratory, Slough, Bucks.

M. Bichard

SLOUGH, BUCKS
PEST INFESTATION LABORATORY

I. Wild type strains

DICTYOPTERA	Common Name	Culture Medium	Rearing Temp. °C
Blattidae			
Nauphoeta cinerea (Oliv.)		5 + 33	27.5
Blatta orientalis L.	Common cockroach	5 + 33	27.5
Blatella germanica (L.)	German cockroach	5 + 33	27.5
Periplaneta americana (L.)	American cockroach	5 + 33	27.5
Periplaneta australasiae (F.)		5 + 33	27.5
Pycnoscelus surinamensis (L.)		5 + 33	27.5
Supella supellectilium (Serville)		5 + 33	27.5
THYSANURA			
Lepismatidae			
Lepisma saccharina L.	Silver fish	7 + 33	25
Thermobia domestica (Packard)	Firebrat	7 + 33	30
DIPTERA			
Calliphoridae			
Calliphora erythrocephala (Meigen)	Blowfly	27a + 34	
Muscidae			
Musca domestica L.	Housefly	10 + 34	

	Common Name	Culture Medium	Rearing Temp. C.
HYMENOPTERA			
Formicidae			
Monomorium pharaonis (L.)	Pharaoh's ant	27	
Ichneumonidae			
Nemeritis canescens (Grav.)		30	25
Braconidae			
Bracon hebetor Say		31	25
Chalcidoidea			
Dibrachys cavus (Walker)		31	25
LEPIDOPTERA			
Galleriidae			
Aphomia gularis (Zell.)		2a + 20	25 + 30
Achroia grisella (F.)	Lesser wax moth	4 + 33	25
Galleria mellonella (L.)	Honeycomb moth	4 + 33	25
Gelechiidae			
Sitotroga cerealella (Oliv.)		15 + 24 + 33	25
Phycitidae			
Anagasta kühniella Zell.	Mediterranean flour moth	2 + 33	25
Cadra cautella (Walk.)	Tropical warehouse moth	2 + 33	25
Ephestia elutella (Hübn.)	Warehouse moth	2 + 33	25
Plodia interpunctella (Hübn.)	Indian meal moth	2 + 33	25
Tineidae			
Tinea columbariella Wocke		11 + 19	25
Tinea pellionella (L.)	Case bearing clothes moth	11 + 19	25
Tinea flavescentella Haworth		11 + 19	25
Tineola bisselliella (Humm.)	Common or webbing clothes moth	11 + 19	25
Nemapogon granella (L.)	Common moth	2 + 33	25

	Common Name	Culture Medium	Rearing Temp. °C
Pyralidae			
Pyralis farinalis (L.)		8 + 33	20
COLEOPTERA			
Anobiidae			
Anobium punctatum (Deg.)	Furniture beetle	29	20
Lasioderma sericorne (F.)	Cigarette beetle	3	25
Stegobium paniceum (L.)	Biscuit beetle	3	25
Bostrichidae			
Rizopertha dominica (F.)	Lesser grain borer	15	30
Bruchidae			
Acanthoscelides obtectus (Say)	American seed beetle	21	30
Callosobruchus analis (F.)		23 + 18	30
Callosobruchus chinensis (L.)	Cowpea or lentile "weevil"	23 + 18	25
Callosobruchus maculatus+ (F.)		18	30
Callosobruchus rhodesianus (Pic)		22	30
Caryedon gonagra (F.)	Groundnut beetle	20	30
Zabrotes subfasciatus			
Collydiidae			
Murmidius ovalis			
Cleridae			
Necrobia rufipes (Deg.)	Copra beetle	11 + 16	30
Cucujidae			
Cryptolestes ferrugineus (Steph.)	Red Rust grain beetle	7	30
Cryptolestes pusilloides (Steel and Howe)		7	25
Cryptolestes turcicus+ (Grouv.)		7	25
Cryptolestes ugandae (Steel and Howe)		7	25
Cryptolestes capensis (Waltl)		7	25
Cryptolestes pusillus (Schönherr)	Flat grain beetle	7	25

COLEOPTERA (con't)	Common Name	Culture Medium	Rearing Temp. °C
Curculionidae			
Sitophilus zeamais Motsch.	Rice weevil	15	25
Sitophilus oryzae (L.)	Lesser rice weevil	15	25
Sitophilus granarius (L.)	Grain weevil	15	25
Dermestidae			
Anthrenocerus australis (Hope)	Australian carpet beetle	11+ 19	25
Anthrenus verbasci (L.)	Varied carpet beetle	11+ 19	20
Anthrenus flavipes Lec. (= Anthrenus vorax Waterh.)	Furniture carpet beetle	11+ 19	25+30
Attagenus gloriosae			
Attagenus alfieri muct.		6+ 33	25
Attagenus megatoma (F.) (= picous (Oliv.))	Black carpet beetle	11+ 19	25
Dermestes ater Deg		11+ 16	25
Dermestes frischii Kug.	Hide beetle	11 +16	25
Dermestes lardarius L.	Bacon beetle	11 +16	25
Dermestes maculatus* Deg.	Leather beetle	11 +16	25
Dermestes haemorrhoidalis Knuster & Praze		11 +16	25
Dermestes peruvianus Castelnau		11 +16	25
Trogoderma granarium Everts.	Khapra beetle	8	30
Trogoderma inclusum (Creutz.)	Larger cabinet beetle	7	30
Trogoderma anthrenoides (Sharp)		8	30
Trogoderma parabile (Beale)		8	30
Trogoderma glabrum (Herbst)		8	30
Trogoderma irroratum Reitt.		8	30
Mycetophagidae			
Typhaea stercorea (L.)		8a	25
Nitidulidae			
Carpophilus dimidiatus+ (F.)	Corn-sap beetle	12	25
Carpophilus hemipterus (L.)	Dried fruit beetle	13	25
Ostomatidae			
Tenebroides mauritanicus (L.)	The Cadelle	7+ 20+ 35	30
Lophocateres pusillus (Klug.)	Siamese grain beetle	7+ 20	30
Ptinidae			
Gibbium psylloides (Czenp)	Hump spider beetle	6+ 33	20
Mezium affine (Boield)		6+ 33	20
Mezium americanum Lap.		6+ 33	

COLEOPTERA (con't)	Common Name	Culture Medium	Rearing Temp. °C
Ptinidae (con't)			
Niptus hololeucus (Fald.)	Golden spider beetle	6+ 33	20
Pseudeurostus hilleri (Reitt.)		6+ 33	20
Ptinus hirtellus Sturm.		6+ 33	20
Ptinus sexpunctatus Panz.		6+ 33	20
Ptinus tectus Boield.	Australian spider beetle	6+ 33	25
Stethomezium squamosum Hint.	African spider beetle	6+ 33	20
Trigonogenius globulus Sol.	Globular spider beetle	6+ 33	20
Trigonogenius particularis Pic		6+ 33	25
Tipnus unicolor P. & M.		6+ 33	20
Silvanidae			
Ahasverus advena†(Waltl)	Foreign grain beetle	7	25
Cathartus quadricollis (Guer.)		7	25
Oryzaephilus surinamensis (L.)	Saw-toothed grain beetle	7	25
Oryzaephilus mercator (Fauv.)	Merchant grain beetle	7	25
Tenebrionidae			
Alphitophagus bifasciatus (Say)	Two-banded fungus beetle	8a	25
Alphitobius diaperinus (Panz.)	Lesser mealworm	1	25
Alphitobius laevigatus (F.)	Black fungus beetle	1	25
Alphitobius sp. (viator?)		1	25
Ganthocerus cornutus (F.)	Broad-horned flour beetle	3	25
Gnathocerus maxillosus (F.)	Slender-horned flour beetle	3	25
Latheticus oryzae Waterh.	Long-headed flour beetle	3	30
Palorus ratzeburgi (Wissm.)	Small-eyed flour Beetle	3	25
Palorus subdepressus (Woll.)	Depressed flour beetle	1	25
Tenebrio molitor L.	Yellow mealworm	7 + 33	25
Tenebrio obscurus F.	Dark mealworm	7 + 33	25
Tribolium castaneum (Herbst)	Rust-red flour beetle	14	25
Tribolium confusum† Duv.	Confused flour beetle	14	25
Tribolium destructor Uytt.	Dark flour beetle	3	25
Tribolium anaphe Hint.		6	25
Tribolium madens Charp.		6	25

Culture Media

No.	Food	Weight Ratio (ounces)
1.	Wheatfeed on a wet pad	10
2.	Wheatfeed, glycerine	10 : 2
2a.	Rice bran, glycerine	10 : 2
3.	*Wheatfeed yeast	10 : 1
4.	Wheatfeed, rolled oats, glycerine, honey, brood-comb	5 : 5 : 2 : 2 : 2
5.	Wheatfeed, rolled oats, fishmeal, yeast	5 : 5 : 2 : 1
6.	Wheatfeed, fishmeal, yeast	8 : 4 : 1
7.	Wheatfeed, rolled oats, yeast	5 : 5 : 1
8.	Wheatfeed, wheat	6 : 14
8a.	Wheatfeed, wheat wet pad	6 : 14
9.	Wheatfeed, wholemeal flour	6 : 10
10.	Wheatfeed, grassmeal, yeast, stortex	5 : 3 : 1 : 1
11.	Fishmeal, yeast	16: 1
12.	Rolled oats, yeast	10 : 1
13.	Rolled oats, boiled dates, yeast	6 : 6 : 1
14.	Wholemeal flour, yeast	12 : 1
15.	Wheat	16
16.	Bacon ends	4
17.	Kibbled cocoa beans	10
18.	Dried peas	12
19.	Flannel	½
20.	Ground nuts	12
21.	Haricot beans	16
22.	Cowpeas	16
23.	Lentils	8
24.	Maize	12
27.	Liver, swiss roll, honey	
27a.	Liver	
29.	Wood	
30.	Moth culture (Fam. Phycitidae)	
31.	Galleria mellonella	
32.	Sitophilus spp.	
33.	Drinking tube	
34.	Sugar and water	
35.	Cork	

II. Mutants

A. Ahasverus advena (Silvanidae)

1. black form — Soulbury U.K., 1960

* Yeast = dried powder (Saccharomyces cerevisiae)

B. Carpophilus dimidiatus (Nitidulidae)

1.	pearl (p) (from lab. stock of unrecorded origin)	1960

C. Cryptolestes pusillus (Cucujidae)

1.	black form	Trinidad, 1960

D. Cryptolestes turcicus (Cucujidae)

1.	red (r) (from lab. stock of unrecorded origin)	1960

E. Dermestes frichii (Dermestidae)

1.	creased sternites (from lab. stock of unrecorded origin)	1965

F. Dermestes maculatus (Dermestidae)

1.	pearl (p) (from lab. stock of unrecorded origin)	1960
2.	fuscous (fu)	Australia, 1964
3.	light wing (l)	Australia, 1964
4.	second sex pit (ssp)	Australia, 1964
5.	double antennae	S. Africa, 1964
6.	dark antennae	India, 1964
7.	light antennae	India, 1964
8.	pink eye (from lab. stock of unrecorded origin)	1964
9.	white abdomen	Khartoum, 1964
10.	rufous (ru)	Kenya, 1964
11.	2 y chromosomes	India , 1963
12.	3 y chromosomes	
13.	dented pronotum	

G. Gnathocerus cornutus (Tenebrionidae)

1.	pearl (p) (from lab. stock of unrecorded origin)	1958

H. Latheticus oryzae (Tenebrionidae)

1.	brown body (bwb) (from lab. stock of unrecorded origin)	1962

I. Oryzaephilus surinamensis (Silvanidae)

1.	pearl (p)	Australia, 1961

J. Rhyzopertha dominica (Bostrichidae)

1.	black (b) (from lab. stock of unrecorded origin)	1964

K. Sitophilus granarius (Curculionidae)

1.	pearl (p) (from lab. stock of unrecorded origin)	1964

L. Tribolium castaneum (Tenebrionidae)

Linkage Group I

1. pygmy, paddle (py pd) — Sokoloff, 1962

Linkage Group II

2. pearl (Mp) — Malta, 1959

Linkage Group III

3. black (b) — Sokoloff, 1962
4. tawny ($\overline{b^t}$) — Australia, 1961
5. melanotic stink glands (msg) — Sokoloff, 1966

Linkage Group IV

6. sooty (s) — Sokoloff, 1962

Linkage Group V

7. microcephalic (mc) — Sokoloff, 1962
8. jet (j) — Sokoloff, 1965
9. jet ($\overline{j^k}$) — Kingston, Jamaica, via St. Andrews (Dundee), 1965

Linkage Group VI

10. Microphthalmic (Mo) — Sokoloff, 1965

Linkage Group VII

11. short antenna (sa) — Sokoloff, 1965

Linkage Group VIII

12. antennapedia (ap^D) — Sokoloff, 1964

Linkage Group IX

13. prothoraxless (ptl) — Sokoloff, 1964

Linkage Group X

14. abbreviated appendages (aa) — Sokoloff, 1966

Multichromosomal

15. p; $\frac{b^t}{c}$
16. $\frac{b}{s}$; $\frac{c}{p}$
17. $\frac{s}{}$; $\frac{p}{}$

Unassigned

18. mahogany	St. Andrews, Scotland, 1965
19. long abdomen	St. Andrews, Scotland, 1965
20. pearl-like	St. Andrews, Scotland, 1965
21. aurate (au)	Sokoloff, 1966
22. pectinate (pec)	Sokoloff, 1966

M. Tribolium confusum (Tenebrionidae)

Linkage Group II

1. e_2p/e_2p

Linkage Group III

2. black (b) — Sokoloff, 1965

Linkage Group 7

7. ebony (e) — Sokoloff, 1965

M. Trogoderma granarium (Dermestidae)

1. pearl (p) — U.K., 1958

SLOUGH, BUCKS, U. K.
TROPICAL STORED PRODUCTS CENTRE, MINISTRY OF OVERSEAS DEVELOPMENT

Wild type strains

COLEOPTERA

Anobiidae

Lasioderma serricorne	Cyprus, 1964

Silvanidae

Oryzaephilus surinamensis	Crete, 1964
Oryzaephilus surinamensis	Cyprus, 1964
Oryzaephilus surinamensis (bicornis)	Crete, 1964
Oryzaephilus surinamensis (Small)	Far East, 1967

LEPIDOPTERA

Phycitidae

Cadra cautella	Cyprus, 1964
Cadra cautella	Rhodesia, 1965
Cadra figulilella	Cyprus, 1967
Plodia interpunctella	South Africa, 1965
Plodia interpunctella	N. Nigeria, 1965

TOLWORTH, SURBITON, SURREY
MINISTRY OF AGRICULTURE, FISHERIES AND FOOD
INFESTATION CONTROL LABORATORY

Insects in Culture
1965

	Culture Medium	Rearing Temp. °C.
THYSANURA		
Lepismatidae		
Lepisma saccharina L.	1 + 33	25
Thermobia domestica (Pack.)	1 + 33	31.1
DICTYOPTERA		
Blattidae		
Blatta orientalis L.	7 + 33	27.8
Blattella germanica (L.)	7 + 33	27.8
Blattella germanica (Resistant Strains)	7 + 33	27.8
Periplaneta americana (L.)	7 + 33	27.8
Periplanta australasiae (F.)	7 + 33	27.8
Pycnoscelus surinamensis (L.)	Potato + 33	27.8
Blaberus craniifer Burm.	7, 36,37,33	27.8
ORTHOPTERA		
Gryllidae		
Acheta domesticus (L.)	7 + 33	27.8
LEPIDOPTERA		
Galleriidae		
Achroia grisella (F.)	31	R
Paralipsa gularis (Zell.)	32	R
Corcyra cephalonica (Staint.)	18	25
Galleria mellonella (L.)	31	R
Gelechiidae		
Sitotroga cerealella (Oliv.)	10	25
Phycitidae		
Angasta kühniella (Zell.)	1	R
Cadra cautella (Walk.)	5	25
Ephestia elutella (Huebn.) (diapausing)	5	UR

LEPIDOPTERA (con't)	Culture Medium	Rearing Temp. °C
Phycitidae (con't)		
Ephestia elutella (Huebn.) (non-diapausing)	5	25
Plodia interpunctella (Huebn.)	5	25
Pyralidae		
Pyralis farinalis (L.)	1, 4, 9, 12, 34	R
Nemapogon granellus (L.)	1 + 8	25
Tinea columbariella (Wocke)	25 + 29	25
Tinea pellionella	25 + 29	25
Tineola bisselliella (Hum.)	6, 4, 34	R
Aglossa caprealis (Huebn.)		
COLEOPTERA		
Anobiidae		
Lasioderma serricorne (F.)	3 + 19 + 24	25
Stegobium paniceum	3	25
Anthribidae		
Araecerus fasciculatus (Deg.)	10 + 11	25
Bostrichidae		
Rhyzopertha dominica (F.)	8	24
Bruchidae		
Acanthoscelides obtectus (Say)	15	25
Callosobruchus analis F.	14	25
Callosobruchus chinensis (L.)	14	25
Callosobruchus chinensis (Strain 'A')	14	25
Callosobruchus maculatus (F.)	14	25
Callosobruchus rhodesianus Pic	14	25
Caryedon gonagra F.	22	27.8
Caryedon pallidus (Oliv.)	38	31.1
Cleridae		
Necrobia rufipes (Deg.)	21 + 24	27.8
Necrobia ruficollis (F.)	35 + 39	25
Cucujidae		
Cryptolestes ferrugineus (Steph.)	3 + 6	25
Cryptolestes pusilloides (Steel & Howe)	3 + 6	25
Cryptolestes pusillus (Schon.)	3 + 6	25
Cryptolestes turcicus (Grouv.)	1	25

COLEOPTERA (con't)	Culture Medium	Rearing Temp. C.
Curculionidae		
Sitophilus granarius (L.)	8	25
Sitophilus zea-mais (Motschulsky)	10	25
Sitophilus oryzae (L.)	8	25
Dermestidae		
Anthrenocerus australis (Hope)	25+ 29	25
Anthrenus verbasci (L.)	25+ 29	R
Anthrenus vorax Waterh.	25+ 29	25
Anthrenus fuscus Oliv.	25+ 28	R
Attagenus pellio (L.)	2+ 25	R
Attagenus piceus (Oliv.)	3 + 5+ 25	25
Dermestes ater Deg.	25	25
Dermestes frischii Kug	25	25
Dermestes haemorrhoidalis Kuster	25	25
Dermestes lardarius L.	25	25
Dermestes maculatus Deg.	25	25
Dermestes peruvianus Cast.	25	25
Trogoderma glabrum (Herbst)	3	27.8
Trogoderma granarium Everts	13 + 24+ yeast	27.8
Trogoderma inclusum Le Conte	2	25
Trogoderma granarium (Egyptian strain)	9 + 12+ yeast	27.7
Nitidulidae		
Carpophilus dimidiatus (F.)	16+ 24	25
Ostomatidae		
Lophocateres pusillus Klug	2+ 6+ 33	31.1
Tenebroides mauritanicus (L.)	6+ 10	25
Ptinidae		
Gibbium psylloides (Czenp.)	2	25
Mezium affine Boield.	1	25
Mezium americanum Laporte	1	25
Niptus hololeucus (Fald.)	3+ 25 + 33	R
Pseudeurostus hilleri (Reitt.)	3+ 25 + 33	R
Ptinus clavipes Panz.	3+ 25 + 33	R
Ptinus pusillus Sturm	1+ 33	UR & R
Ptinus sexpunctatus Panz.	3+ 25 + 33	25
Ptinus tectus Boield.	3+ 25 + 33	R
Stethomezium squamosum Hinton	3+ 33	25

COLEOPTERA (con't)	Culture Medium	Rearing Temp. C.
Silvanidae		
Ahasverus advena (Waltl)	3 + 21 +33	25
Cathartus quadricollis Guer.	6	27.8
Oryzaephilus mercator (Fauv.)	16 + 24	25
Oryzaephilus surinamensis (L.)	6	25
Oryzaephilus surinamensis (small strain)	5	27.8
Tenebrionidae		
Alphitobius diaperinus (Panz.)	2 + 6 + 30	25
Alphitobius laevigatus (F.)	2+ 6+ 30	25
Alphitobius sp.	2+ 6 + 30	25
Gnathocerus cornutus (F.)	1	25
Gnathocerus maxillosus (F.)	3	25
Latheticus oryzae Waterh.	1	25
Palorus ratzebrugi (Wissm.)	1+6	25
Palorus subdepressus Woll	2	25
Tenebrio molitor L.	1+ 6+ 30	25
Tenebrio obscurus F.	1+ 6+ 30	25
Tribolium anaphe Hinton	2 + 24+ 25	25
Tribolium castaneum (Herbst)	1	25
Tribolium confusum J. du V.	1	25
Tribolium destructor Uyttenb.	1	25
Tribolium madens (Charp.)	1	25

Culture Media
(Proportions by weight)

1. Whole-meal flour (20 pts.) and yeast (1 pt.)
2. Whole-meal flour (10 pts.), fine wheat feed (10 pts.) and yeast (1 pt.)
3. Fine wheat feed (20 pts.) and yeast (1 pt.)
4. Broad bran (dry)
5. Broad bran (5 pt.) and glycerine (1 pt.)
6. Rolled oats (20 pts.) and yeast (1 pt.)
7. Crushed dog biscuit (20 pts.) and yeast (1 pt.)
8. Wheat
9. Crushed wheat
10. Maize
11. Maize (kibbled)
13. Barley
14. Dried peas
15. Haricot beans
16. Dried fruit
17. Cocoa beans
18. Cocoa beans (crushed)

19. Locust beans (kibbled)
20. Wood
21. Copra
22. Ground-nuts (undecorticated)
23. Decorticated ground-nuts
24. Ground-nuts (decorticated and crushed)
25. Whale-meat meal (20 pts.) and yeast (1 pt.)
26. Bacon
27. Dried figs and yeast
28. Dried insects
29. Woolen cloth
30. Damp cotton-wool pad
31. Honeycomb
32. Sweet almonds
33. Water supply--an inverted beaker over a cotton-wool pad in a petridish, or a 3" X 1" tube of water fitted with a biological stopper or filter paper strip
34. Grass seed
35. Wood sawdust
36. Bread and butter
37. Sweet biscuits
38. Senna pods
39. Bones

G. A. Brett

INDIA

GORAKHPUR, U. P.
UNIVERSITY OF GORAKHPUR, DEPARTMENT OF ZOOLOGY

Wild type strains

1. Tribolium castaneum from local godowns.

R. P. D. Lyall

HISSAR, HARAYANA
PUNJAB AGRICULTURAL UNIVERSITY, DEPARTMENT OF GENETICS

I. Wild type Strains (Tribolium castaneum)

1. IZT	I	
2. MAD	I	
3. PAU	I	
4. PAU	II	
5. Chicago wild		via Sokoloff Berkeley
6. Brazil		via Sokoloff Verkeley
7. Inbred lines in 8th generation of full sibbing.		

II. Mutants (Tribolium castaneum)

S-8	Py	via Sokoloff Berkeley
S-12	P	via Sokoloff Berkeley
S-20	Me	via Sokoloff Berkeley
S-24	Squint	via Sokoloff Berkeley
S-26	sa	via Sokoloff Berkeley
S-28	mc	via Sokoloff Berkeley
S-35	pyr	via Sokoloff Berkeley
S-53	jet	via Sokoloff Berkeley
S-71	sa	via Sokoloff Berkeley
S-74	ju	via Sokoloff Berkeley
S-81	Bes	via Sokoloff Berkeley
S-90	Pyr M^r	via Sokoloff Berkeley
S-100	bMo	via Sokoloff Berkeley
S-154	BeFta	via Sokoloff Berkeley
S-248	Ftacca	via Sokoloff Berkeley
S-253	lod p	via Sokoloff Berkeley
S-304	Msg	via Sokoloff Berkeley
S-313	serpyr	via Sokoloff Berkeley
S-325	Fta	via Sokoloff Berkeley
S-333	Spa	via Sokoloff Berkeley
S-341	r	via Sokoloff Berkeley
S-346	Fas^{-3}	via Sokoloff Berkeley
S-483	pd	via Sokoloff Berkeley

P. N. Bhat

BAHADU SHAH TAFAR MARJ, NEW DELHI-1
MAULANA AZAD MEDICAL COLLEGE, DEPARTMENT OF BIOCHEMISTRY

T. castaneum

Wild strain of local origin

R. P. D. Kapoor

ITALY

PAVIA
UNIVERSITA PAVIA, CENTRO DE GENETICA

1. Tribolium confusum Duval, wild strain obtained from Professor A. Kock, Biological Institut, Regensburg.

2. id. id., strain of recent colonization from speciments collected in Pavia; small, difficult colony.

JAPAN

KYOTO
KYOTO UNIVERSITY, FACULTY OF AGRICULTURE

Bruchidae

Callosobruchus chinensis	Kyoto and many other districts in Japan Iran Thailand
Callosobruchus maculatus	Louisiana, U.S.A. California, U.S.A. Fresno Lab., U.S.D.A. Burma Israel Thailand Malaya
Zabrotes bifasciatus	Hong Kong

Curculionidae

Sitophilus zeamais	Kyoto
Sitophilus oryzae	Kyoto

Tenebrionidae

Tribolium castaneum	Kyoto

S. Utida

MIYAZAKI
MIYAZAKI UNIVERSITY, DEPARTMENT OF BIOLOGY

Alphitobius diaperinus--wild type strains
Callosobruchus chinensis--Kyoto strains
Martianus dermestoides--wild type strains
Palorus ratzeburgi--wild type strains
Sitophilus oryzae--wild type strains
Sitophilus zeamais--wild type strains
Tenebrio obscurus--wild type strains
Tribolium castaneum--wild type strains
Tribolium confusum--wild type strains

T. Yoshida

MISIMA, SIZUOKA-KEN
NATIONAL INSTITUTE OF GENETICS

No stock list available.

MEXICO

CHAPINGO
CAMPO EXPERIMENTAL "EL HORNO"

Tribolium castaneum
Tribolium confusum

Both cultures have long been maintained in our rearing chambers. Their source is unknown.

E. De Las Casas

NEW ZEALAND

NELSON
DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH
ENTOMOLOGY DIVISION

Stegobium paniceum --from infested rat food pellets at Otago University Dunedin
Oryzaephilus surinamensis--from infested rat food pellets at Otago University, Dunedin

Gnathocerus cornutus--from infested rat food pellets at Otago University Dunedin

Sitophilus oryzae--from spaghetti in galleys of overseas ships at Port Nelson
Sitophilus zeamais--from rice in galleys of overseas ships at Port Nelson

J. C. Watt

PRIVATE BAG, HAMILTON
RUAKURA AGRICULTURAL RESEARCH CENTRE, DEPARTMENT OF AGRICULTURE

Tribolium castaneum

1. Wild type strains derived from imported strain from Edinburgh.
2. Mutant strain carrying the chromosome II mutant pearl (p) and obtained from Tribolium Stock Center, Berkeley, California.

A. R. Quartermain

PRIVATE BAG, PALMERSTON NORTH
DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH
GRASSLANDS DIVISION

Tribolium castaneum

1. Heavy and Light populations resulting from 18 generations of selection for increased and decreased pupal weight.

2. Strong, Moderate and Weak populations resulting from 20 generations of within-family selection for increased pupla weight at three selection intensities.

PORTUGAL

LISBON
LABORATORIO DA DEFESA FITOSSANITARIA DOS PRODUTOS ARMAZENADOS
MINISTERIO DA ECONOMIA

The laboratory maintains the following cultures in the breeding room at 27° - 29° C and 55 - 70% R. H. The origin of the culture, the year of commencement and the culture media are given for each insect species.

Acanthoscelides obtectus--white bean	Angola, 1957
Callosobruchus sp.--California black eye	Lisbon, 1964
Carpoglyphus lactis--fig (Acari)	Portimão, 1963
Cryptolestes pusilloides--broken wheat	Portugal, 1961
Glycyphagus destructor--yeast (Acari)	Coimbra, 1964
Lasioderma serricorne--toppings and yeast powder	Lisbon, 1964
Oryzaephilus mercator--broken maize	Portugal, 1964
Oryzaephilus surinamensis--broken wheat	Portugal, 1960
Plodia interpunctella--toppings and yeast powder	Portugal, 1955
Rhizopertha dominica--broken wheat	Lisbon, 1956
Sitophilus granarius--wheat	Malveira, 1963
Sitophilus oryzae--wheat	Lisbon, 1957
Sitopholus zeamais--wheat	Lisbon, 1957
	Villa Franca de Xira, 1963
Tribolium castaneum--flour	Bissau-Guiné, 1957
Tribolium confusum--flour	Lisbon, 1955
Tyrophagus putrescentiae--yeast (Acari)	Alhantra, 1964
Zabrotes subfasciatus--white beans	Cabo Verde, 1956

SPAIN

MADRID
INSTITUTO NACIONAL DE INVESTIGACIONES AGRONOMICAS
LABORATORIO DE GENETICA DE POBLACIONES

Tribolium castaneum

A. Wild type strains

1. Canarias	Canarias, Spain, 1966
2. Consejo	CSIC, Madrid, Spain, 1964
3. Florida	INIA, Madrid, Spain, 1967
4. Purdue	Purdue, USA, 1964

B. Mutant type strains

5. black Consejo (b)	Consejo (+), INIA, Madrid, 1965
6. black Purdue (b)	Purdue Foundation (+), Purdue, 1964

Tribolium castaneum (con't)

C. Mutants

7. antennapedia (ap)	Purdue, 1966
8. Bar eye (Be)	Purdue, 1966
9. chestnut (c)	Purdue, 1966
10. paddle (pd)	Purdue, 1966
11. pearl (p)	Purdue, 1966
12. pygmy (py)	Purdue, 1966
13. red (r)	Purdue, 1966
14. short antenna (Sa)	Purdue, 1966

F. Orozco

REPORT OF P. N. BHAT, Hissar, India

1. HSR Black-Bhat, 1967. Found during a selection experiment in Tribolium Castaneum. Body colour black preliminary tests reveal it to be an autosomal recessive with good penetrance and viability. The allelic tests are in progress.

2. Deformed hind leg. Bhat, 1967. The hind leg is deformed, an autosomal recessive with incomplete penetrance.

REPORT OF P. S. DAWSON

I. New Mutants

Tribolium castaneum:

1. hazel (h)--Dawson, 1967. Autosomal recessive; not allelic with p, c, i, w, rb, or m. Eye color varies from light reddish brown to a darker brown, and is easily idenfifiable in old beetles.

REPORT OF C. E. DYTE, D. G. BLACKMAN and T. BINNS.

Dermestes maculatus (Dermestidae)

dented pronotum (dp). This mutant is recognized by two shallow dents, one on each side of the pronotum of the insects. The phenotype varies considerably in expression. Mode of inheritance not yet established.

Tribolium castaneum (Tenebrionidae)

"pearl-like" reported in TIB-10 p. 68, has proved to be a reoccurrence of "ivory" in linkage group II.

"maroon" (m). Autosomal recessive isolated from a "jet" strain from Kingston, Jamaica (see TIB-9, p. 59). This is a reoccurrence of "maroon" (m) reported in TIB-5, p. 14.

REPORT OF LANGE AND SHIDELER

1. Stock list-Tribolium castaneum, same as TIB 10.

2. New Mutants: Tribolium castaneum.

a. Scute (Sct) Lange, 1967. Autosomal recessive of good penetrance isolated from Purdue Black Foundation. It causes the long setae of the pupal stage to be reduced in size in a manner similar to scute in Drosophila.

The phenotype is variable but does not overlap normal. It is easily recognizable by the reduction in size of the long setae that appear on the edge of the pupal thorax. There is not apparent effect in the adult stage. Linkage is being studied.

b. Reduced eye notch (Ren). Schideler 1967. Eye notch is reduced similarly to mc, but the eye is unaffected and is not indented at the leading edge. The reduction in the eye notch is parallel to the longitudinal axis of the beetle as in mc, but with the eye appearing normal, there is no "barbed" effect. Autosomal dominant with a recessive lethal effect. Found in progeny from "barbed" parents in wine (rw) stock. Closely linked to pearl (p) in Linkage group II.

c. midget (mi). Shideler 1965. Sex linked recessive with reduced viability found in a selected line out of Purdue pearl Foundation. Similar to pygmy in being smaller than normal during all stages of development. Also, has delayed pupation and elytra are frequently divergent. Not allelic to pygmy and preliminary linkage studies suggest that mi is not allelic to pokey. Further studies are underway.

d. juvenile urogomphi - 7 (ju-7) Shideler 1965. Autosomal recessive with 75-80% penetrance and found in urogymphiless stock. Has a pair of moveable styli located laterally to and just ahead of the anus in both males and females. The size is variable, in some it is necessary to protrude the ovipositor to see them while in others the tips extend beyond the margin of the 8th sclerite. Appears similar to the "juvenile urogomphi" reported by Sokoloff, the "folds" along the proximal portion of the styli appear to be lacking. Recombination tests place ju-7 in Linkage Group VII with about 7 cross-over units from Sa. It is of interest to report that ju-7 showed 20% recombination with Be of Linkage Group IV. the linkage group where Sokoloff (TIB 8, page 148) assigned several mutations with juvenile-urogomphi-like appendages.

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*Preliminary observations on the distribution and biology of Tribolium castaneum on a temperature gradient.

Using the temperature and moisture gradient equipment described by Graham, Onyearu and Waterhouse (Can. Ent. 1967, 97, 880-886), a temperature gradient ranging from about 23.5 to 32.5°C in a perspex trough 1 m long, was obtained. The concomitant inverse moisture gradient, measured in terms of percentage moisture content (m.c.) of the wheatflour food medium contained in the trough, ranged from about 9.7 to 11.7% m.c. Two replicate troughs each containing about 100 ml of finely divided wheatflour (60 mesh per inch) were used, in each of which were placed 15 females and 15 males (30-86 days old). After 48 hours, the numbers of adults occurring in the various regions of the gradient were noted and then removed; the numbers of eggs laid in the wheatflour were ascertained. The eggs were allowed to develop on the gradient and, at periodic intervals, inspections made for newly formed pupae which were then isolated by placing in a gelatine capsule and returned to the same region in which they were found. The pupae were examined daily for adult eclosion, the time taken for egg to adult development, together with details of the sex and weight of the individual being recorded. A summary of the results is given in Table 1.

There was no distinct difference between the male and female adult distributions, both being strongly biased towards the hot regions of the gradient. The egg distribution was similar to that of the female except that the mode occurred in region 2 (31°C). The total number of eggs laid was 638 and represented an average oviposition rate of about 21 eggs per female per 2 days. About 60% of all the pupae occurred in region 1 (32°C), and about 85% in regions 1-2 (32-31°C). A little pupation occurred in regions 4-6 (29-27°C) and none at all in regions 7-8 (26-25°C). The development period (egg to adult) of adults eclosing from a region of high temperature was, on average, less than that from regions of a lower temperature.

The mean developmental period on the gradient as a whole for the 434 adults was 24.9 days, (S.D. ± 2.8 days). The survival was in the region of 68%. The sex ratio of the newly emerged adults (223 females: 211 males) did not deviate significantly from unity ($X^2 = 0.28$ N=1 $P > 0.05$). The females weighed, on the average, 2.02 mg, ranging from 1.31-2.55 mg, and the males 1.86 mg, ranging from 1.41-2.33 mg.

Further studies are being carried out in which both the behaviour and biology of the species are considered in relation to different types of environment.

Table 1. Summary of the results (sum of two replicates) of the distribution and developmental period (egg to adult) of Tribolium castaneum on a temperature-moisture gradient.

Regions	1	2	3	4	5	6	7	8	Total number
Moisture (% moisture content)	9.7	9.8	10.3	10.5	10.8	11.3	11.5	11.7	
*Temperature (C)	32	31	30	29	28	27	26	25	
Adults Total (%)	23.3	25	6.7	13.3	10	8.3	5	8.3	60
Male (%)	20	30	10	10	10	0	6.7	13.3	30
Female(%)	26.7	20.0	3.3	16.7	10	16.7	3.3	3.3	30
Eggs (%)	20.1	27.1	16.5	13.3	8.3	9.2	4.2	1.3	638
Pupae (%)	60.6	26.3	9.9	1.8	0.9	0.5	0	0	434
Developmental Period (Days)									
Number	263	114	43	8	4	2	0	0	434
Mean	24.5	24.9	26.0	27.9	30.0	29.5	-	-	
Range	20-39	21-39	22-34	24-32	27-36	29-30	-	-	

*Temperature at the mid point of the region; overall range 23.5°C to 32.5°C.

ASHMAN, F., and HIGGS, G.H.,
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London Road,
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Bucks, England.

Laboratory and "Field" studies on Oryzaephilus surinamensis variety bicornis

Oryzaephilus bicornis (Erichson) was described as a species in 1848, separated from O. surinamensis by the two backwardly curving horns originating from the supra-antennal ridges of adult males. Many workers have questioned the validity of this species and it is now considered to be a variety of surinamensis, (Aitken 1966).

In a paper shortly to be published by the authors the validity of three genetic "field" strains of O. surinamensis, here termed, "small", "large" and bicornis, is examined. A summary of the principal observations are given below.

Aitken (1966) demonstrated that two strains of surinamensis existed which she termed "small" and "large". These have been compared with a "field" population of surinamensis in which over 90% of the females were of the bicornis type. F_1 progeny from parents of these three types obtained under identical conditions of density, food, temperature and relative humidity, differed in two ways.

(1) There were distinct differences in body length; the sampled population means are given in Table 1.

Table 1.
Differences in body length in O. surinamensis

Population	Body Length m.m. (Head + pronotum + elytra)	SE of mean
small	2.191	0.010
large	2.770	0.013
bicornis	2.916	0.011

(2) Only bicornis males had horns and these were restricted to individuals above 2.6 m.m. in body length. The ratio of horn length to body length could be demonstrated as heterogonic. In the so-called "large" strain the body length of many males measured well over 2.6 mm. (in some it was up to 3.0 m.m.) and no horns were observed. In crosses between the three types which were interfertile, horns were only found in male progeny where bicornis was used as one of the parents.

There were no other morphological differences observed and there were no observed differences in male or female genitalia.

It appears that there are three distinct genetic strains of O. surinamensis and it is proposed to refer to these in the order given in Table 1. above as "small", "normal", and bicornis, the term normal replacing Aitken's term large.

No work on the genetics of these three strains is contemplated and it is hoped that some other worker will carry this study further. Material of all three strains can be supplied.

Literature Cited

Aitken, A.D. (1966) A strain of small Oryzaephilus surinamensis (L), (Coleoptera Silvanidae) from the Far East. J. Stored Prod. Res. 1966, Vol. 2.

BERCK, B.
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Assessment of Toxicity to T. confusum Duv. of cereal products fumigated with phosphine.

In a laboratory investigation (1) , phosphine, PH_3, was applied as a fumigant in the range 0.15-0.60 mg. PH_3/l. air to wheat, oats, barley, flax and various cereal fractions. To determine whether treatment of cereal products with PH_3 would leave residues that might kill insects or affect insect development, tests were conducted with adults and 1-day old larvae of the confused flour beetle, Tribolium confusum Duv. Flour, bran, shorts, middlings, wheat germ, groats ("green oats", prior to kiln treatment), rolled oats, wheat gluten powder, and wheat starch, all of which had been treated to a dosage of 0.60 mg. PH_3/l. air for 3 days at 4°, 24°, and 35°C., respectively, and then aerated with N_2, were used as substrates. The insects were exposed on the products for 28 days.

No effects on feeding behavior, egg laying, or insect development were ovserved during and after the 4-week period. The insects survived and developed equally well on treated and untreated flour, bran, shorts, middlings, wheat germ, groats and rolled oats. No free PH_3 remained in the substrates and any chemisorbed residues that might have resulted from the treatment (1) were deemed nontoxic and innocuous to this species. With wheat starch and gluten powder, however, 100% of the insects died in both the treated and control samples, since wheat starch and wheat gluten powder are evidently not suitable media for this species.

References Cited

Berck, B. Sorption of phosphine by cereal products. J. Agric. Food Chem. 16,1968. In press.

CAPPAROSSA, B. AND L. D. VAN VLECK
Cornell University,
Ithaca, New York.

Some observations on the correlations among pupal weight, length, and width.

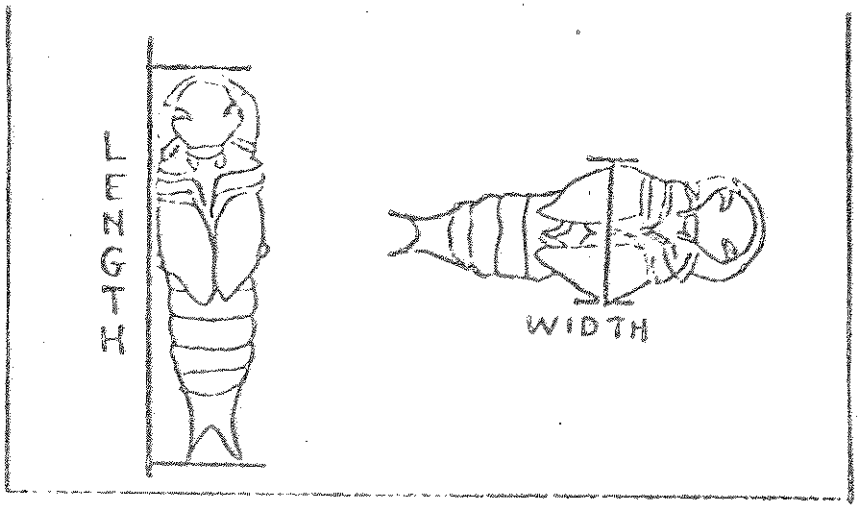
Although logical to assume that the body measurement most closely related to pupal weight would be pupal length, in the process of finding this correlation to determine whether weight and length would be useful traits to use in testing the theory of the restricted selection index, it was observed that pupal width may be even more closely related to pupal weight. Therefore, a student conducted project was set up to estimate the genetic and phenotypic correlations between pupal weight, length and width.

Experimental Procedure

Twenty pair matings were made each week for three weeks in 3/4 oz. creamers containing a medium of 95% whole wheat flour and 5% Brewers yeast. A Hotpack incubator provided an average environmental temperature of 32°C. and average relative humidity of 75%. Three male and three female progeny were randomly selected from each mating and weighed and measured with a micrometer within 24 hours after pupation. Figure 1 describes the measuring procedure.

FIGURE 1

Measurements of length and width in T. castaneum



Components of variance and covariance were computed for the three traits according to the model: $Y_{ij} = \quad + g_i + e_{ij}$ where g_i is the effect common to the i^{th} full sib group and e_{ij} is a random effect associated with the j^{th} progeny of the i^{th} full sib group. Thus, σ^2_g, the variance due to full sib groups, is an estimate of one-half the additive genetic variance, one-fourth the dominance genetic variance, small portions of variances due to higher order epistatic effects, and possibly environmental variance common to a full sib group. If all except additive genetic variance are zero, then twice σ^2_g divided by $\sigma^2_e + \sigma^2_g$, the total variance, estimates heri-

Table 1. Heritability and total variance estimates

Trait	Males (46) Heritability	Variance	Mean	Coefficient of variation	Females (46) Heritability	Variance	Mean	Coefficient of variation
Weight (g)	.41	48729	2155	.10	.18	85264	2328	.13
Length (m)	.81	3703	975	.06	1.13	3955	1011	.06
Width (m)	1.10	278	317	.05	.28	248	321	.05

Trait	Average Heritability	Coefficient of variation
Weight (g)	.30	.11
Length (m)	.97	.06
Width (m)	.69	.05

Table 2. Estimates of genetic and phenotypic correlations

	Males		Females		Average	
Correlation	Genetic	Phenotypic	Genetic	Phenotypic	Genetic	Phenotypic
Weight-length	.35	.55	.31	.41	.33	.48
Weight-width	.63	.64	1.09	.46	.86	.55
Length-width	.29	.39	.32	.26	.30	.33

tability in the narrow sense. Full sib components of covariance and variance were similarly used to estimate genetic correlations. Total variances and covariances were used to estimate the phenotypic correlations. Analyses were done separately for males and females because of the chance of different variances for males and females.

Results

The results (Tables 1 and 2) tend to support the hypothesis that width is more closely related to weight than is length. For both sexes both the estimated genetic and phenotypic correlations were greater for weight-width than for weight-length.

The heritability estimates for length averaged higher than for width but the ranking of heritability was different for males than for females. The results would suggest that both pupal width and length may have high heritability values. The average heritability of weight is well within the range of estimates which have been reported. Both width and length have lower coefficients of variation than does weight.

There is probably much more error in the measurement of length since the pupae have the ability to curl up, thus reducing the length when measured on their backs. The angle of the curl probably is different for most pupae and at least partly depends on temperature and other stimuli. The uncurled length may be more highly correlated with weight than the lengths taken with random curling.

Summary

Although the sampling variances of the estimates are large, it appears that measured pupal width is more highly related to pupal weight than is measured pupal length.

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In vivo oxidation of linoleate-1-C^{14} and stearate-1-C^{14} in Tribolium castaneum.**

Our objective in writing this note is to relate our experience with a proce-

dure developed to measure, in vivo, the oxidation of fatty acids in Tribolium castaneum. Consequently, emphasis is placed on presenting and evaluating the test procedure. The impetus for this work is the hypothesis that the corn oil sensitive (cos) mutant is hypomorphic with respect to the utilization of unsaturated fatty acids (1, 2, 3, 4, 5). The following preliminary procedure was employed to examine this proposal.

Linoleate-1-C^{14} and stearate-1-C^{14} in hydroquinone diethyl ether were added to standard medium (95% whole wheat flour and 5% dried brewer's yeast) and the ether evaporated under nitrogen. One-half gram of medium containing either linoleate-1-C^{14} (1 μc) or stearate-1-C^{14} (1 μc) were added to a 50 ml. Erlenmeyer flask. Although the activity of the two fatty acids was the same, the molar concentration of linoleate-1-C^{14} was more than twice as great as the molar concentration of linoleate-1-C^{14}. One hundred beetles (+/+, +/cos or cos/cos, genetically) were placed in the flask. To absorb the evolved CO_2, 0.5 ml of hydroxide of hyamine was placed in a small glass vial containing a thin strip of filter paper (to increase the surface area). To prevent the larvae from coming in contact with the glass vial containing the hydroxide of hyamine, a metal brace was attached to the serum rubber stopper which held the vial aloft. The flask was sealed and incubated at 33°C and 70% relative humidity for six hours. At the end of the incubation period, the glass vial was removed and placed with the filter paper into a counting vial to which 20 ml of Buhler's solution (6) was added. The radioactivity in the vial was then determined by liquid scintillation counting.

As noted, it was planned to incubate the larvae for six hours, unfortunately, the animals were dead after four hours although the system appeared to be quite satisfactory after two hours of incubation. In controlled experiments without hydroxide of hyamine (HOH), the larvae survived from 15- 20 hours in the sealed flask; therefore, attention was focused on the CO_2 absorbing material. As an alternative to HOH, 0.5 ml of a 30% solution of KOH was used. With this base, the animals lived well beyond six hours making this a reasonable incubation time.

To evaluate this procedure, the following design of experiment was used:

The fatty acids and three genotypes were arranged factorially and three random samples of one-hundred 13-day larvae were measured for each fatty acid-genotype combination, yielding nine observations per fatty acid. This basic arrangement was replicated to yield a 2 X 3 X 2 factorial in a completely randomized design. The analysis of variance model is given by

$$Y_{ijkl} = \mu + R_i + G_j + (RG)_{ij} + A_k + (RA)_{ik} + (GA)_{jk} + (RGA)_{ijk} + \epsilon_{ijkl},$$

where

Y_{ijkl} = counts per minute (cpm) of the i^{th} replicate, j^{th} genotype, k^{th} fatty acid, and l^{th} experimental unit ($i = 1, 2$; $j = 1, 2, 3$; $k = 1, 2$; $l = 1, 2, 3$).

μ = grand mean

R_i = replication effect

G_j = genotype effect

$(RG)_{ij}$ = effect of the i^{th} replicate and j^{th} genotype

A_k = fatty acid effect
$(RA)_{ik}$ = effect of the i^{th} replicate and k^{th} fatty acid
$(GA)_{jk}$ = effect of j^{th} genotype and k^{th} fatty acid
$(RGA)_{ijk}$ = effect of i^{th} replicate, j^{th} genotype and k^{th} fatty acid
ϵ_{ijkl} = random error

The variables were considered fixed and the inference space consisted of the two replications, three genotypes, and two fatty acids examined. The restricted inference space reflected out caution with these initial studies of the procedure.

The results of the statistical analysis are summarized in Table 1. All of the F values for the main effects were in the critical region and the null hypothesis in each case was rejected at the indicated probability level. The analysis suggests that the procedure could be improved if the variation due to replications were more effectively controlled. As noted by the absence of significant interaction variation, the differences among genotypes and between fatty acids were consistent. With these reservations in mind, (i.e. inference space, etc.) it was noted that oxidation of both fatty acids was reduced in the cos homozygote as compared to the wild type (+/+).

Table 1

Analysis of variance of an in vivo test experiment

Source of variation	d.f.	Mean square
Replications	1	339811.3*
Genotypes	2	108269.7*
Fatty Acids	1	370637.5*
Replications X Genotypes	2	17828.7
Replications X Fatty Acids	1	77562.2
Genotypes X Fatty Acids	2	70614.8
Replications X Genotypes X Fatty Acids	2	24766.9
Residual	24	21634.8

* ($p < 0.05$)

Literature Cited

1. Costantino, R.F., A.E. Bell, J.C. Rogler 1966. Genetic control of lipid metabolism in Tribolium. Nature 210:221-222.

2. Costantino, R.F. 1966. Section on new mutants. Tribolium Inform. Bull. 10:66.

3. Costantino, R. F., A. E. Bell, and J. C. Rogler 1967. Genetic analysis of a population of Tribolium: I. corn oil sensitivity and selection response. Heredity 22:529-539.

4. Costantino, R.F. 1967. On population biology: Unification of biochemical, genetical and biometrical concepts. Ph. D. Thesis, Purdue University, Lafayette, Indiana.

5. Costantino, R.F., J.C. Rogler, and A.E. Bell. 1968. Genetic analysis of a population of Tribolium: II. Metabolic pattern of the corn oil sensitive anomaly. Heredity (in press) .

6. Buhler, D.R. 1963. A simple scintillation counting technique for assaying $C^{14}O_2$ in a Warburg flask. Anal. Biochem. 4:413.

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Beta Alanine incorporation into insect proteins*

To homogenates of Tenebrio molitor pupae and adults were added 14.3 µc. of radioactive beta alanine (1-C^{14}). Samples were taken hourly from 0 - 5 hours and the proteins initially precipitated by cold 10% TCA. The precipitated proteins were retained on Whatman No. 1 filter paper disks of a Buchner filter set up. Sub-

If the data of the two replications are pooled, the recombination rate for the cis linkage phase is 10.6± 0.9, while that for the trans phase is 7.3± 1.0. The difference exhibited can be considered significant on the basis of the pooled data.

An effort was also made to examine the possible effects of age and temperature upon the recombination rates of the two phases. To accomplish this, sisters of those beetles utilized in the single pair matings above, which were reared at 33°C., were mass mated and reared at 25± 3°C. Two progeny samples were taken from the same set of parents four months apart. The results are presented below:

Sample No.	Linkage Phase	Total No. of Progeny	Recombination rate ± S.E.
1 (Dec.)	cis	100	19.0± 3.9
1 (Dec.)	trans	126	6.3± 2.1
2 (March)	cis	90	27.8± 4.7
2 (March)	trans	117	5.1± 2.0

It is seen that age has no apparent effect upon the rate of recombination, but highly significant differences exist between the linkage phases. When the data are pooled, the recombination rate observed for the cis linkage phases is 23.2± 3.0, while that for the trans phase is 5.8± 1.5.

From these data it would appear that temperature does exhibit an effect upon recombination rate, but in an unusual manner. The rate of recombination for cis phase linkage is doubled, while it is almost the same for the trans phase under the two temperature conditions. It should be noted that in both cases the recombination rate is greater when the two genes are in the cis configuration, than when they are in the trans phase.

These results disagree with those reported by Englert and Bell (1963) where the recombination rate in linkage group VIII was greater in the trans phase when female data only are considered for comparison purposes. Additional tests involving other marker genes of this linkage group are being initiated to determine whether the phenomenon observed in this study are consistent for linkage group I.

Literature Cited

Dewees, A.A. 1967. Sex differences in recombination values for linkage group V of T. castaneum. Tribolium Information Bull. 10:89-90.

Englert, D.C. and A.E. Bell. 1963. "Antennapedia" and "Squint", recessive marker genes for linkage group VIII in Tribolium castaneum. Can. Jour. Genet. Cytol. 5:467-471.

sequently, the protein precipitates were washed three times in hot (90°C) 5% TCA, twice in cold 10% TCA, twice in other-ethanol 1:1 (v/v) at 37° C and twice in ethyl ether. The paper disks were placed into scintillation fluid in scintillation vials and their redioactivity determined in a Packard Tri-Carb Liquid Scintillation Counter. Radioactivity at the level of 0.02% up to 0.05% after 5 hours was found in the protein precipitates. This indicated that beta alanine, either directly or indirectly, incorporated into proteins precipitated by 10% TCA.

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*Linkage phase differences in recombination rates for linkage group I in Tribolium castaneum.

The frequent occurrence of sex differences in recombination rates for a number of linkage groups in Tribolium castaneum has been reported: linkage group V, Dewees (1967): linkage group VII, Sokoloff (1964): and linkage groups IV and VII, Johnson (1966). However, only in linkage group V were both the cis and trans linkage phases considered. The pattern of recombination of differences was found to be the same for both phases, i.e., recombination greater in the male than female.

Englert and Bell (1963) reported unequal rates of recombination between the two sexes for linkage group VIII only in the cis phase (female recombination exceeded that of the male), while the trans phase exhibited equal recombination rates for the two sexes.

In an effort to remove the confounding of sex with linkage phase, recombination rates were investigated for two recessive marker genes, pygmy (py) and red (r), of linkage group I. The recorded distance between these two loci is 14 map units. Single pair matings were utilized in all instances and cultures were raised at a temperature of 33 ±2°C and a relative humidity of 60 ±10 percent.

The calculated recombination rates and standard errors are shown below:

Replication No.	Linkage Phase	No. Matings	Total No. of Progeny	Recombination rate ± S.E.
I	cis	11	391	12.0±1.6
I	trans	11	280	7.1±1.5
II	cis	11	766	9.9±1.1
II	trans	11	353	7.4±1.4

Johnson, G.R. 1966. Recombination differences with reciprocal crosses in Tribolium castaneum. Genetics 53:111-115.

Sokoloff, A. 1964. Sex and crossing over in Tribolium castaneum. Genetics 50: 491-496.

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*Tests for repellency of oils, lubricants and waxes to Tribolium castaneum.

In earlier work by the author and associates 145 aromatic materials were screened for their repellency or otherwise against adults of Tribolium castaneum Herbst. The test materials were used in cream of wheat at four different concentrations. Detailed results have been published in the papers listed.

In more recent tests 26 oils, lubricants and waxes were screened for repellency to T. castaneum using a different technique. The liquids were applied on kraft paper (6'' x 24'') at the rate of 2 ml./sq. ft. and semisolids and solids at the rate of 1 gm./sq. ft. Test materials were applied on one-half of the paper without contaminating the other half. Glass rings (10 cms x 10 cms) were placed on the test paper in such a way that each ring covered an equal area of treated and untreated paper. Twenty beetles from the laboratory culture were released in each ring. After 24 hours, counts were taken of the number of insects on each side of the paper and average percent repellency calculated. Results indicated that jutebatching oil, cedar oil, and beeswax were potential repellents. A detailed report of this work is in manuscript to be published elsewhere.

Further screening for carriers, stablilising agents revealed that beeswax was very superior material for stabilising volatile odoriferous materials.

Literature Cited

Bano, A., H.R. Gundu Rao, and S.K. Majumder. 1962. Food preference of Sitophilus, Tribolium, and Bruchus. Proc. Sec. All Ind. Congr. Zool. p.393. 1962.

Majumder, S.K. and H.R. Gundu Rao. 1962. Possible use of food preference of an insect pest as a factor for its control in stored commodities. Curr. Sci., 31:238. 1962

Gundu Rao, H.R. and S.K. Majumder. Spices as repellents for some stored grain pests. Symp. on Spices, Assoc. Food Tech., CFTRI., India May 1962.

Gundu Rao, H.R. and S.K. Majumder. 1963. Repellency of Kaempferia galanga Linn. (zingiberaceae to adults of Tribolium castaneum (Hbst) Sci. and Cult., 32:461, 1963

Gundu Rao. H.R. and S.K. Majumder. 1965. Repellency of Spices, aromatic plant materials and essential oils to adults of Tribolium castaneum. Pros. Symp. Utilization of Medicinal Plants. R.R.L., Jammu and Kashmir, India.

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Reprints of these publications can be obtained from: The Director, C.F.T.R.I. Mysore, India.

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Annotated references to sex differences not included in Halstead, D.G.H. (1963) External sex differences in stored products coleoptera. Bull. ent. Res. 54 (1): 119-133.

Rhyzopertha dominica (F.)

STEMLEY, P.G. and WILBUR, D.A. (1966) A colour characteristic for sexing live adult Lesser Grain Borers. J. econ. Ent. 59 (3): 760-761.

♂ last abdominal sternite (5th) generally uniformly brown, occasionally several pale patches are present on the sternites but the last is never completely pale.

♀ last abdominal sternite pale yellow, mottling may occur over 3rd and 4th sternites.

A somewhat difficult character requiring experience. Distinctive colour lost soon after death.

Tenebroides mauritanicus (L.)

BOND, E.J. and MUNRO, H. (1954) Rearing the Cadelle Tenebroides mauritanicus (L.) (Coleoptera : Ostomidae) as a test insect for insecticidal research. Can. Ent. 86 (9) : 402-408.

♂ ventral side of abdomen with punctures very numerous, some very fine.

♀ ventral side of abdomen with punctures less numerous and always coarse.

Tenebrio molitor L. (character also present in T. obscurus F.)

DOYEN J.T. (1966) The skeletal anatomy of Tenebrio molitor (Coleoptera: Tenebrionidae) Misc. Publs ent. Soc. Am. 5 (3): 102-150.

♂ front tibia with a large apical process on the inner angle and setal fringe of inner margin denser than in ♀.

♀ front tibia without an apical process.

Sitophilus spp.

CANCELA DA FONESCA, J.P. (1965) Sur le dimorphisme sexuel chez les charançons due Blé du genre Sitophilus Schönh. Bull. Mus. Hist. nat. Paris 37 (2): 290-293.

A more detailed account of sex differences in Sitophilus zeamais Mots, S. oryzae (L.) and S. granarius (L.).

Acanthoscelides obtectus (Say)

BUSHNELL R.J. amd BOUGHTON D.C. (1940) Longevity and egg production in the common bean weevil, Acanthoscelides obtectus (Say). Ann. ent. Soc. Am. 33:361-370.

CARLE, P. (1965) Essai d'analyse expérimentale des facteurs conditionnant la fécondité chez la bruche du haricot (Acanthoscelides obtectus Say). Annls Epiphyt 16:215-249.

Ventral view of abdomen:

♂ 8th sternite distinctly emarginate (very obvious in old ♂♂); comparatively large area of pygidium seen in ventral view, apex of pygidium resting in emargination of 8th sternite.

♀ 8th sternite not distinctly emarginate; little of pygidium seen in ventral view.

Erratum Bull, ent. Res. 54 (1)

p. 126, lime 12
for "Hind coxal process" read "Hind trochanter".

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Effect of gregarines on Tenebrio molitor

The larva of Tenebrio molitor harbours considerable numbers of gregarines in its mid-gut. These are not necessary for the normal growth of the larva. Neither

do they prolong the life of the larvae when they are grown under optimal conditions of temperature, relative humidity and diet.

When larvae were grown on a sub-optimal diet the gregarines had a considerable effect on the final pupal weight and on the ability of the larva to complete its development.

Reference

Harry, O.G., 1967. The effect of a Eugregarine Gregarina polymorpha (Hammerschmidt) on the mealworm larva of Tenebrio molitor (L.). J.Protozool. 14: 539-547.

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*Resume

Ph. D. Thesis (1965) entitled- "Studies on the morphology & Biology of a stored grain pest, Tribolium castaneum (Herbst)".

Studies on the insect were categorized into two main heads (1) Morphology and (2) Bionomics. The following is a resume of a portion of the work done on bionomics.

Food Preference

Experiments show that for the first half to one hour T. castaneum (Herbst) exhibits greatest attraction to 'Suji' flour. With the increase in duration of the experimental time, it shows marked preference for white flour. As particle size of food can be considered to exercise their influence only after contact of these insect with the food is established, it is therefore likely that smell plays a guiding role in the beginning.

Effects of high temperatures

At 40°C incubation period was reduced to 2.8 days while, at 30°C eggs hatched in 3.5 days. Relative humidity (R.H.) has no effect on the egg stage. At 40°C and 90% R.H. no larvae pupated, while at 70% R.H. combination a few larvae pupated. The larval period of 30°C and R.H. 90% was 17.0 days, and at a temperature of 30°C and 70% R.H. 25.5 days. Thus the rate of development increases with increase of relative humidity even when the temperature is same. At 40°C all pupae died irrespective of the different relative humidity combinations. At 30°C pupal period was 5.1 days.

The adults exhibit highest mortality at 45°C and 75.8% relative humidity.

Respiratory Metabolism

It is found that the temperature considerably effects the rate of respiratory metabolism as is illustrated by an increase in the rate of O_2 consumption from

1.0847 (S.D. ± 0.26)* at 35°C. The unit expressed is in terms of microliters of oxygen consumed per milligram fresh weight per hour. The value of Q_{10} between 30-32°C is 1.2037 and between 32-35°C is 0.3474. Thus there is diminution of Q_{10} at higher temperatures which is consistent with the widely accepted conception for poikilotherms where Q_{10} is higher for lower range of temperature and lower for the higher range (Rao and Bullock 1954; Bullock 1955).

* at 31°C, 18801 (S.D. ±0.12) at 32°C to 2.3906 (S.D. ± 0.26)

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*Behavioral characteristics of Tribolium confusum

Tribolium confusum has a number of interesting behavioral characteristics. Two of these are cannibalism and egg distribution. The results presented here are from experiments concerned with strain differences in these two behavioral traits.

The first experiment consisted of 415 pair matings of a red wild type and a mutant strain (black). Estimates were obtained of cannibalism and egg distribution, from 83 pairs of red x red (R), black x black (B), red ♀ x black ♂ (RF), black ♀ x red ♂ (BF) and red-black heterozygotes (H). Cannibalism is measured by providing each pair with 25 colored eggs in 5 gms. of flour for 48 hours, and determining the number of eggs missing at the end of this period. This procedure is repeated five times and then each pair generates a population in another vial of flour. A census of live adults and eggs is conducted in each population at weeks 6,8, and 10. Tribolium will deposit eggs loose in the flour or attached to the sides of the glass vial. Random observations in previous experiments suggested that the patterns of egg deposition existed between and within strains. In these experiments eggs were classified as either loose or attached so the data could be analyzed for variation in egg laying behavior.

The results of the cannibalism experiment are provided in Tables 1 and 2. While the number of eggs cannibalized by each pair is not great, the experiment is large enough to reveal significant differences among the five crosses. Hartley's sequential test shows that the H and BF crosses differ from B, RF and R, and from each other ($P < .05$). There also appears to be differences among pairs within each cross ($F = 1.32$, $P < .005$). This may be an indication of genetic variablity in cannibalism but of course, nothing about that can be deduced from these experiments. Since most of the cannibalism is usually attributed to the female, it is not surprising to find the R and RF crosses without any demonstrable differences. A number of reasons might be postulated for the differences in the cannibalistic behavior of BF and B pairs, and the H pairs compared to the others. For example, variation in the repellent and attractant substances produced by wild and mutant individuals may be involved. None of the numerous possibilities have yet been explored.

Table 2 Analysis of variance for cannibalism*

Source of variation	Sum of Squares	Degrees of Freedom	Mean Square	Significance F	P
Cross	91.49	4	22.87	44.52	<.005
Populations Within Cross	210.69	410	0.51	1.32	<.005
Determinations Within Population	645.78	1660	0.39		
Total		2074			

* The number of eggs consumed is usually small and often zero. Therefore each datum was increased by one and the square root of this sum ($\sqrt{x+1}$) was used in the analysis (see Snedecor, G.W., Statistical Methods, p.316)

Table 3 Analysis of variance for egg distribution*

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	Significance F	P
Cross	2846.75	4	711.69	9.49	<.005
Populations Within Cross	30743.58	410	74.98	1.62	<.005
Determinations Within Population	38296.68	830	46.14		
Total		844			

*Since each datum was the proportion of eggs loose in the flour an angular transformation (arcsin $\sqrt{x}$) was applied before analysis.

Table 4 The mean egg distribution of the parental pairs and the offspring populations.

	Cross	Loose	Attached	Total
Parents	R	8.8 (98.2)	0.20 (0.8)	9.0
	B	8.9 (99.7)	0.02 (0.3)	8.92
	RF	8.9 (98.9)	0.17 (1.1)	9.07
	BF	9.3 (99.5)	0.08 (0.5)	9.38
	H	11.3 (99.6)	0.07 (0.4)	11.37

(Table 4 continued next page)

(Table 4 continued)

Cross	Loose	Attached	Total
R	47.4 (90.9)	4.5 (9.1)	51.9
B	58.4 (88.8)	7.4 (11.2)	65.8
RF	45.3 (86.8)	6.9 (13.2)	52.2
BF	39.5 (87.3)	5.8 (12.7)	45.3
H	43.0 (85.9)	7.1 (14.1)	50.1

Table 5 Analysis of variance for egg distribution*

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	Significance F	Significance P
Parents					
Cross	7207.8	4	1801.9	8.84	< .005
Populations Within Cross	91692.3	450	203.8	1.37	<.005
Determinations Within Population	337576.4	2275	148.4		
Total		2729			
Offspring					
Cross	3379.2	4	844.8	11.41	<.005
Populations Within Cross	33315.0	450	74.0	1.17	<.005
Determinations Within Population	57374.5	910	63.0		
Total		1364			

* Since each datum was the proportion of eggs loose in the flour an angular transformation (arcsin $\sqrt{x}$) was applied before analysis.

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*Genotype x Environment interactions in Tribolium castaneum

Effects of wet (75 ± 3 per cent relative humidity) and dry (50 ± 5 per cent relative humidity) environments, at a constant temperature of 28°C, on response

to selection for 21 day larva weight and offspring number (number of 21 day larvae) in Tribolium castaneum have been studied for nine generations in each of two replications. The selected and the genetic control lines were propagated by 25 and 50 single pair matings respectively. The four selected lines may be defined as follows:

1. A line selected for larva weight in the wet environment.
2. A line selected for larva weight in the dry environment.
3. A line selected for high offspring number in the wet environment.
4. A line selected for high offspring number in the dry environment.

A control line was propagated in each of the dry and wet environments.

Analysis of variance of the deviations of means of the selected lines from the genetic controls regressed over all generations for generations five, six and seven revealed significant interactions of environment selected in x environment tested in ($P < 0.05$) for the traits noted in Table 1.

Table 1 Offspring Number and Larva Weights of Selected Lines as expressed by deviations from regressed genetic control lines for generations five, six and seven.

		Environment Selected in			
		Wet		Dry	
		Environment Tested in		Environment Tested in	
Trait Selected on	Trait Measured	Wet	Dry	Wet	Dry
(Offspring Number + 1)^{½}	(Offspring Number + 1)^{½}	11.6	7.2	10.3	11.2
Larva Weight	Larva Weight (in micrograms)	797	257	700	795

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The karyotype of Timarcha goettingensis L. ssp. catalaunensis Fairm.

The species of the genus Timarcha, specially those of the subgenus Timarchostoma Mots., constitute a very closed group for its biology, ecology and biometry. The karyotype of a catalonian strain, T. goettingensis L. ssp. catalaunensis, Fairm. has been demostrated as 2 n = 18+Xy, with three pairs of large submetacentric chromosomes, six pairs of small metacentric chromosomes, a large submetacentric X and a small y. This chromosome number contributes to characterise the genus within

The analysis presented in Table 3, 4 and 5 is concerned with egg distribution. Sequential testing of the means reveals that the distribution of eggs in the R crosses differ from the other four. Table 5 shows that in the R tubes eggs are more frequently found loose in the flour. It is not clear whether a pattern of egg deposition or egg depredation determines the distribution. Within each cross significant differences in distribution can also be found, and some of this variation may prove to be genetic.

Further information on egg distribution was derived from experiments designed to explore relationships between the fecundity of an adult pair and the characteristics of the population they produce. Six estimates of the female founder's net fecundity was obtained by counting the eggs in a vial of flour inhabited for two days by the pair, transfering them to another vial and repeating this process through six transfers. The pair is then allowed to produce a population and this is censused three times over a period of several weeks. Only the information on egg distribution for the parents and offspring is given here (Tables 4 and 5). Obviously, the patter of distribution is different in vials containing a population as compared to vials with only a single adult pair. Since a smaller proportion of loose eggs are found in the population this could be an indication that cannibalism and egg distribution are related forms of behavior. Perhaps loose eggs are more readily cannibalized and cannibalism is greater in the populations. Of course, there are other possible explanations. Table 5 reveals significant differences in distribution both within and between strains. Variation in egg distribution in the pairs ranged from more than 10% attached to zero, and in the populations from 31% to less than 5%. While the experiments were not designed to reveal how much of this variation is genetic, correlation coefficients between parent and offspring egg distributions were calculated for each cross. Only the RF crosses showed a significant correlation ($r = .22$, $P < .05$). Obviously, the low percentage of attached eggs in the pair vials make egg distribution a refractory behavioral trait. However, it will probably be possible to get a clearer picture of egg distribution patterns in single pairs by either allowing more than two days for a test period or increasing the glass surface available for attachment. A glass slide or rod might be inserted in the flour or a different shape vial substituted.

Table 1. The mean number of colored eggs consumed out of 25 provided by one pair of adults in two days (cannibalism), and the mean egg distribution of new eggs laid in the offspring population.

Cross	Cannibalism	Egg Distribution		
		Loose	Attached	Total
R	1.29	50.3 (91.1)	4.9 (8.9)	55.2
B	1.03	63.5 (87.5)	9.1 (12.5)	72.6
RF	1.06	55.0 (88.2)	7.3 (11.8)	62.3
BF	1.96	41.8 (87.3)	6.1 (12.7)	47.9
H	2.91	45.9 (86.4)	7.2 (13.6)	53.1

the Chrysomelidae and corraborates the studies on its morphology, biology and male genitalia that place it in the family basis, since this number seems to be the primitive in the order Coleoptera.

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*Some observations on the effect of disturbance on oviposition rate

It is common knowledge among investigators who assay fecundity rates of Tribolium that disturbance inhibits oviposition. This effect is evident from the very low rate of oviposition in the first few hours following introduction into a suitable medium. It is possible that several factors may contribute to this effect: 1) Mechanical disturbance involved with handling, 2) Physical displacement to the surface, 3) Disruption of the tunnel structure of the medium, 4) Exposure to the physical conditions of the laboratory. Whatever mechanicms may be involved it is clear that the existence of such a phenomenon makes it essential that the duration of the period of observation be considered in terms of the effect that disturbance has on fecundity rate estimations.

As a part of more extensive investigations on the biology of Tribolium it was necessary to obtain some estimate of magnitude of the disturbance effect and in particular to examine the purely mechanical aspect which could be involved with handling culture containers. The experiment has two phases; a control in which oviposition rate is estimated from observations of 4, 8 and 12 hours duration, and an experimental group in which the same observation durations were used but in addition each two hours the vial was agitated. The agitation was of 10 seconds duration and consisted of holding the vial against a massage type electrical vibrator. It is of sufficient intensity to break up the tunnels in medium but does not cause any mortality even when animals are subject to as much as ten minutes of continuous vibration. Certainly the ten second agitation is much more violent than would ever be encountered in routine handling.

The design of the experiment is such that if the disturbance were exclusively the effect of mechanical agitation one would expect that the experimental group (agitated every two hours) would not achieve as high a level of oviposition rate as that shown by animals which were observed without disturbance for even so short a period as four hours. A replicate consists of the observation of 8 males and 8 females in 8 grams of standard laboratory medium (95% whole wheat flour and 5% brewers yeast). The specific observation was the number of eggs recovered and is simply translated to rate for 24 hours per female without correction for cannibalism.

Observation period	Control oviposition rate	replicates	Experimental oviposition rate	replicates
4	3.18	(18)	0.96	(6)
8	5.98	(12)	1.96	(12)
12	6.36	(12)	3.76	(12)

It is obvious that the rate of oviposition is depressed by mechanical disturbance but it is also clear that this does not account for all of the disturbance effect. The fact that the rate increases with increasing length of the observation period although the culture is vigorously agitated every two hours indicates that the situation is a bit more complicated. This experiment is exploratory in nature and it should be pointed out that none of our observations allow any consideration of the possibility of a limitation on the duration of inhibition. It would be consistent with the facts to hypothesize the total effect due to mechanical disturbance but that even mechanical disturbance will not force a beetle to retain an egg for a very long time.

This little experiment serves to raise an interesting and potentially important question of ecological significance in terms of the effects of crowding.

I wish to express my appreciation to Mr. Richard Wehr who executed these observations as a part of an undergraduate research project. This work is part of a program supported by NSF GB4024 and NIH MH14040-01.

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*Predicting selection response in Tribolium — Preliminary Report

As part of a recent Ph.D. thesis, the author compared various methods of predicting selection response from the base population of a project. Selection was carried out in two directions, for heavier and lighter pupae, in two populations of T. castaneum. There were six replications in each population and 32 pairs of pupae were weighed in each replication, the heaviest (or lightest) four females and four males being selected and mass-mated in each generation. Over the first six generations a significantly greater response was obtained in the upward generation than downwards. This asymmetry could not be predicted by the standard methods of assessing heritability in a base population, namely halfsib and fullsib variance analysis and parent-offspring regression, though they predicted quite accurately the heritability averaged over both directions of selection. More interest was therefore taken in the linear heritability system of Abplanalp (1961) which involves displacements rather than variance data, partitioning the selection differentials of prospective parents into sire, dam and individual effects. It therefore has the special merits of catering for selection in one direction, and at the intensity intended later.

The heritabilities predicted by this method were : -upward = .29; downward = .19; and compared quite well with those realized over the first six generations of subsequent selection (upward = .27; downward = .04). The latter values however are means of six generations in each of six replications in both populations, and the apparent agreement was weakened by the high fluctuations of response between generations and differences between replications. Very little discrepancy was caused by systematic trends of falling or accelerating response, but preliminary analysis of the large and random fluctuations suggested that such prediction theory was applicable only to populations in which a much greater number of animals were weighed, and a greater number used as parents.

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Research note.

A T. confusum mutant having blisters midway down one or both elytra appeared spontaneously in the F_2 of a pearl riboflavinless, ruby spot cross. It bears great similarity to the "blistered elytra" mutant described by Sokoloff. (The Genetics of Tribolium and Related Species. 1966. Academic Press. p. 99.) The mutant has yet to be made homozygous and tested to determine if it is indeed the same genotype as ble.

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Effect of selection for high and low body weight on survival of T. castaneum and T. confusum in mixed cultures.

Dr. Ian Franklin had selected T. castaneum for high and low body weight and the selection proved effective. Since this material was available it seemed desirable to determine how (if at all) "competitive ability" is modified through selection for body weight. Using the Lerner and Ho (1961) technique, 10 pairs of the T. confusum synthetic strain and 10 pairs of T. castaneum selected for high body weight (CS-High) were introduced into two sets of vials, each with 10 replicates. One set contained standard medium (whole wheat flour enriched with five per cent brewer's yeast) and the other set corn medium of the same particle size not enriched with brewer's yeast. The same was done with the T. castaneum beetles selected for low body weight (CS-low). The CS-High and CS-low beetles had been selected for five generations. Later, when T. castaneum had been selected for high and for low body weight for 12 generations, the whole experiment was repeated. In both cases the vials were maintained at 29° and 70 percent relative humidity. The results of the two experiments are shown in Tables 1 and 2.

It is clear that during the early stages of selection for either high or low body weight (and despite the fact that by this time body weight had been nearly doubled in the strain selected for High body weight and nearly halved in the strain selected for low body weight) "competitive" ability had not been affected. T. castaneum eliminated CF in both whole wheat flour plus yeast and in corn. To be sure, neither the CS-Hi nor the CS-lo strains were as effective in eliminating CF as the unselected strains (see Table 2) which can eliminate CF in as little as 2-4 generations.

There is also a suggestion in the data presented in Table 1 that the strain

selected for low body weight may not be as efficient a competitor as the strain selected for high body weight: the CS Hi eliminates CF in whole wheat flour plus yeast clearly more rapidly (by about three generations) than the CS-Lo.

There is however, some variability in the CS High strain: in one replicate CS is eliminated, while in the other nine replicates CF is eliminated when the two species are pitted with each other in corn medium. In corn medium, the low strain can eliminate CF more rapidly than the high strain. Perhaps the difference in size is important in a medium which is nutritionally deficient, and Sokoloff and Lerner, 1966; Lerner and Inouye, 1966; Sokoloff, Lerner and Lakhanpal, 1965 and other references have shown that the corn medium is nutritionally deficient to T. castaneum.

Table 2 shows the results of the same experiment initiated when T. castaneum had been selected for high and low body weight for a period of 12 generations of selection. Because of reduction in viability of the strains, Dr. Franklin found it necessary to relax selection by selecting a larger number of beetles each generation to start that particular generation.

"Competitive ability" had been clearly affected by the additional generations of selection. Whereas in the previous experiment (Table 1) CS was the sole survivor in all but one replicate, in the second experiment, in standard medium (WY) CF eliminated the CS-Hi strain in 9/10 of the replicates in 14.25 generations, while CF was eliminated by CS-Hi in one replicate in 19 generations. In corn, CS Hi was able to eliminate CF in all replicates in about 12 generations.

In regard to the CS-Lo strain, the conclusions must be regarded as tentative since the experiments are still in progress. In the WY medium CS-Lo has been eliminated from five replicates and it appears to be losing to CF in three replicates at the twenty-sixth transfer. In the remaining vials CS-Lo is eliminating CF. In corn essentially the same picture has been obtained: in three replicates CS-Lo has been eliminated, and in four replicates CF at transfer 27 appears to be winning. In two replicates CF has been eliminated, and in one replicate CS and CF are equally numerous at transfer 27.

It is evident, therefore that selection for body weight in both directions has had important consequences: one is in regard to viability. As the material is intensively selected it becomes more homozygous in respect to genes which have to do with determining body size, and there is a reduction in viability. This increase in homozygosity also is reflected by "competitive ability." When few generations of selection for high or low body weight have elapsed, CS is able to eliminate CF readily in both adequate and nutritionally deficient media. With more generations of selection for high or low body weight CF is able to eliminate the CS-Hi or the CS-Lo in a higher and higher proportion of the cases.

When the character " competitive ability" is compared in the CS-Hi and CS-Lo strains it becomes apparent that selection for high body weight has more drastic consequences: In CS-Hi vs T. confusum in whole wheat flour plus yeast CS was eliminated from 9/10 of the replicates. In unfavorable medium (corn), possibly because of an increase in cannibalism on the part of CS-Hi to make up for the nut-

Table 1. Mean number of generations or transfers before a species is eliminated. The "competing" strains were 5-generation selected. CS-Hi (T. castaneum with high body weight) and CS-Lo (with low body weight) against unselected T. confusum (CF) in whole wheat flour plus yeast (WY) or corn (C).

STRAINS	MEDIUM	Transfers before elimination N	M	±	S.E.	SPECIES ELIMINATED
CS Hi: CF	C	9	11.89	±	3.68	CF
		1	40			CS
CS Lo: CF	C	9*	10.78		0.68	CF
CS Hi: CF	WY	10	11.10	±	1.54	CF
CS Lo: CF	WY	10	14.6	±	1.47	CF

*One vial discarded by mistake at T_{12}. At this time there were 7 CF and 34 CS adults.

Table 2. Mean number of generations or transfers before a species is eliminated. The "competing" strains were 12-generation selected CS-Hi (T. castaneum with high body weight) and CS-Lo (with low body weight) against unselected T. confusum (CF) in whole wheat flour plus yeast (WY) or corn (C).

STRAINS	MEDIUM	Transfers before elimination N	M	S.E.	SPECIES ELIMINATED
CS Lo: CF	WY	5	17.25	2.93	CS
		2	16.5	1.5	CF**
CS Lo: CF	C	3	17.33	2.40	CS
		2	16.5	0.50	CF***
CS Hi: CF	WY	9	14.25	1.384	CS
		1	19	——	CF
CS Hi: CF	C	8	11.88	1.420	CF*

*2 replicates discarded at T_{18} because of Nosema. CF appeared to be losing

**at T_{26} (transfer 26) CF>CS in 3 replicates.

***at T_{27} CF>CS in 4 replicates, and CF≅CS in one replicate.

ritionally deficiency imposed by the medium, CF is eliminated.

In regard to the CS-Lo strain the conclusions are tentative since the experiments are still in progress, but it is clear that in the vials where it is eliminated it is able to survive longer than CS-Hi, and in the vials where CS-Lo is the winner the elimination of CF takes longer than in vials where CS-Hi is the winner.

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Effect of alternating environmental conditions on the outcome of "competition" between T. castaneum (CS) and T. confusum (CF)

Lerner and Ho (1961) had shown that by manipulating the genotype through inbreeding they could modify the indeterminacy of "competition" (observed by Park in his experiments apparently because of a founder effect). The usual result when the synthetic strains are introduced in the same environment is that CS eliminates CF. The outcome when inbred strains are used depends on probably numerous factors which determine "competitive" ability. In some cases the genotype of CF is superior and in other cases inferior to CS in competitive ability, and it has to be determined experimentally for each strain, but, again, the strain is either the loser or the victor in all replicates.

In the present experiment carried out by Lerner and Sokoloff (unpublished) with the Berkeley synthetic and inbred strains, the same technique was followed as that used in Lerner's original experiments: ten pairs of each species for each strain combination and set of environmental conditions were introduced into each of 10 vials containing standard medium. For each combinations of strains one set was maintained in an incubator at 29°C. and 70 per cent relative humidity and another in an incubator at 29°C. and 40 per cent relative humidity. A third set was left in one incubator for one month, and, after censusing and discarding the adults, the juvenile stages were placed in a vial containing fresh medium and the vial was placed in the other incubator. Thus in alternate fashion the populations were exposed for one month to a "wet" environment and for the next to a "dry" environment. The results are shown in Table 1.

The synthetic strains give typical results: when the two species are grown in the same vial in whole wheat flour plus yeast, CS usually eliminates CF regardless of the prevailing relative humidity, but this elimination of CF is more rapid at the higher relative humidity. In comparison with this value, the elimination of CF by CS at the lower relative humidity is about three times slower.

Table 1. Mean number of transfers before elimination of T. castaneum (CS) or T. confusum (CF) synthetic and inbred strains at 29°C. Type A cultures were maintained alternating one month at 70 percent and another at 40 percent relative humidity. Type B cultures were maintained at 40 percent and type C cultures at 70 percent relative humidity throughout the experiment.

Strains	N Replicates	Conditions	Generation at which other species was eliminated m ± S.E.	Replication in which species won CS	CF
CS +, CF +	10	A	9.9 ± 1.16	10	0
	10	B	8.8 ± 0.63	10	0
	10	C	3.5 ± 0.08	10	0
CSI-5, CFI-1b	10	A	6.3 ± 0.30	0	10
	10	B	4.8 ± 0.63	0	10
	10	C	10.2 ± 0.69	0	10
CSI-2C, CFI-1b	10	A	2-3*	0	10
	10	B	2-3*	0	10
	10	C	5.8 ± 1.53		9
CSI-5, CFI-3b	10	A	11.5 ± 2.20	8	
			4.5		2
	10	B	20.8 ± 1.55	0	10
	10	C	3.4 ± 0.16	10	0
CSI-2C, CFI-3b	10	A	2.0 ± 0	0	10
	10	B	2.7 ± 0.26	0	10
	10	C	2.7 ± 0.26	0	10

* The presence of the parasite Nosema whitei caused the early discarding of this set, but by then the outcome of "competition" appeared to be quite clearcut in all vials.

Under alternating conditions of relative humidity the time elapsed before the elimination of CF by CS is closer (9.9 generations) to that observed at the constant, lower relative humidity (8.8 generations) than at the constant higher relative humidity (3.5 generations).

For the inbred strains used it is clear that the combination CSI-5 and CFI-1b produces elimination of CS regardless of the environmental conditions, the elimination of CS proceeds more rapidly in the dry or alternating environments and more slowly in the constant "wet" environment. Essentially the same results are ob-

tained when CFI-1b is reared together with CSI-2C: CF is the sole survivor in the vials kept in a dry or alternating environment, and except for one vial in which CS is the sole survivor at the end of 27 generations, CF eliminates CS from the remaining replicates at a fairly rapid rate.

When CFI-3b is introduced with CSI-2C CF is the sole survivor regardless of the environmental conditions, and the elimination is very rapid (less than three generations or transfers). Pitted against CSI-5, the CF inbred is swiftly eliminated in the "wet" environment, and in turn it eliminated CSI-5 in the "dry" environment. Under alternating conditions CF is eliminated from eight replicates and the survivor in two replicates.

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"Competition" between Tribolium anaphe, T. castaneum, T. confusum, T. destructor and T. madens by pairs II. The final results of "competition" between T. confusum and T. madens.

A previous communication (Sokoloff and Ho, 1966) summarized the results of "competition" between species of Tribolium in the confusum and castaneum group by pairs. One series of replicates contained T. confusum and T. madens, and the two series, one maintained at 29° and 70 per cent relative humidity, and the other 29°C and 40 per cent relative humidity, still contained both species. Violent oscillations in the number of each species, not necessarily in phase occurred in these vials. Because of the interest that this experiment has, the data from these vials are shown in their entirety in Table 1.

These data, in addition to these violent oscillations, show that at 70 per cent relative humidity T. confusum was the survivor in nine replicates, having eliminated T. madens at the end of about 7 generations, while in one vial T. madens was the sole survivor at the end of 10 generations. In the drier (40 per cent relative humidity) environment T. confusum was the winner, at the end of about 20 (range 16 - 24) generations in 6 replicates, while T. madens was the winner in four replicates at the end of about 16 (range 10 - 22) generations.

Table 1. Adult T. madens (numerator) and adult T. madens plus T. confusum at a given transfer. Upper Block: 29°C, 70% R. H.; lower block: 29°C, 40% R. H.

Replicate	Transfer										
#	0	1	2*	3	4	5	6	7	8	9	10
1	20/40	20/40	51/91	3/55	12/131	0/78	0/86	0/110	--	--	---
2	20/40	20/40	45/90	2/93	19/66	0/66	0/54	1/75	0/136	--	--
3	20/40	20/40	44/100	3/72	28/174	3/58	0/98	0/109	0/240	--	--
4	20/40	20/40	36/93	1/89	1/129	0/240	0/35	0/218	--	--	--
5	20/40	20/40	49/93	0/98	13/158	0/29	41/43	0/32	23/23	54/55	6/6
6	20/40	20/40	30/85	1/122	11/144	0/63	-3/81	0/159	10/175	0/109	11/58
7	20/40	20/40	46/73	7/77	8/186	13/26	0/47	64/69	2/22	13/32	27/32
8	20/40	20/40	37/58	6/78	12/114	4/48	2/121	0/86	0/121	0/166	--
9	20/40	20/40	11/71	1/144	3/219	7/115	1/80	4/86	1/134	2/150	0/111
10	20/40	20/40	45/78	8/41	27/74	20/37	0/60	3/104	5/65	5/86	0/138
1	20/40	20/40	64/117	1/39	63/65	27/27	43/43	45/45	--	--	--
2	20/40	20/40	73/147	5/78	30/48	8/60	58/71	5/68	25/56	4/120	10/45
3	20/40	20/41	14/110	2/72	8/93	0/35	20/41	0/53	57/69	0/17	48/57
4	20/40	20/40	51/104	1/68	34/66	1/10	63/70	53/61	17/37	42/55	14/32
5	20/40	19/38	58/113	1/2	155/705	4/31	53/82	22/73	31/51	0/64	26/68
6	20/40	18/38	38/113	0/63	70/81	3/80	25/50	1/76	74/105	0/53	77/105
7	20/40	20/40	9/62	1/257	1/55	0/34	1/92	0/37	--	--	--
8	20/40	20/40	57/116	0/124	23/91	0/24	69/83	3/22	43/60	0/35	34/52
9	20/40	18/38	13/105	2/232	14/144	0/26	52/77	0/45	23/57	0/60	15/59
10	20/40	20/40	33/101	1/91	53/54	6/13	65/77	35/37	25/27	24/25	14/14

* Heavy non-microbial mortality of MD at eclosion in both sets of vials.

Table 1. (Continued)

Replicate #	Transfer 11	12	13	14	15	16	17	18	19	20
1	--	--	--	--	--	--	--	--	--	--
2	--	--	--	--	--	--	--	--	--	--
3	--	--	--	--	--	--	--	--	--	--
4	--	--	--	--	--	--	--	--	--	--
5	33/33	--	--	--	--	--	--	--	--	--
6	0/96	5/129	0/145	0/163	--	--	--	--	--	--
7	10/18	41/47	16/22	15/21	21/28	20/25	27/30	25/25	19/19	16/16
8	--	--	--	--	--	--	--	--	--	--
9	0/124	0/151	--	--	--	--	--	--	--	--
10	1/135	0/95	0/63	0/98	--	--	--	--	--	--
1	--	--	--	--	--	--	--	--	--	--
2	0/126	8/52	0/106	8/74	0/73	3/155	0/38	2/128	0/19	0/227
3	1/38	23/75	0/112	52/56	0/18	59/65	44/63	21/29	20/86	7/31
4	48/71	12/25	76/104	7/22	61/70	11/37	14/26	4/111	7/14	4/195
5	0/76	37/69	0/101	53/84	1/14	61/90	1/30	24/49	0/46	50/112
6	0/22	125/141	3/10	119/133	3/29	96/107	9/26	79/95	5/36	93/122
7	--	--	--	--	--	--	--	--	--	--
8	0/117	43/52	0/31	194/213	1/3	80/83	22/32	28/28	20/23	73/73
9	0/72	39/125	0/17	28/100	0/56	16/75	0/62	1/28	0/45	0/171
10										

Table 1. (Continued)

Replicate #	Transfer 21	22	23	24	25	26	27	28	29	30	31
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
1	--	--	--	--	--	--	--	--	--	--	--
2	--	--	--	--	--	--	--	--	--	--	--
3	16/114	39/70	6/50	22/54	5/43	62/129	0/8	16/95	0/45	2/121	0/15
4	2/3	3/358	0/112	1/149	0/25						
5	0/9	43/109	0/36	18/89	0/26						
6	4/8	110/131	6/26	52/58	10/20	47/51	19/25	86/87	3/4	68/68	13/13
7	--	--	--	--	--	--	--	--	--	--	--
8	12/12	69/69	--	--	--	--	--	--	--	--	--
9	0/30	0/195	--	--	--	--	--	--	--	--	--
10	25/25	94/94	--	--	--	--	--	--	--	--	--

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Outcome of "competition" between T. castaneum and T. confusum strains, adapted and non-adapted to soy, in different media and at two relative humidities

In 1963 10 pairs of beetles of the synthetic Berkeley strains of T. castaneum were introduced into each of two vials containing eight grams of soy plus yeast. In another series 10 pairs of the synthetic strain of T. confusum were introduced into each of two vials containing the same medium. The vials were kept in an incubator at 29° C. and 70 per cent relative humidity. Artificially discrete generations were created by scoring and discarding the adults every month when the medium was renewed, and by continuing the populations with the juvenile stages found in the vials. The history of these populations was as shown in Fig. 1. The two replicates of T. castaneum produced very few adult beetles-- the bare number to enable the population to replace itself. T. confusum produced about twice or three times more adults than T. castaneum. At the end of 33 transfers the T. castaneum vials showed the same adult population density as at the beginning of the experiment. T. confusum, on the other hand, exhibited a remarkable change: the population density trebled, indicating a change had occurred. Whatever the change may have been, this species of flour beetle was better adapted to utilize the soy-yeast medium.

An earlier experiment pitting the synthetic T. castaneum and T. confusum in soy plus yeast had shown that T. confusum is rapidly eliminated, leaving T. castaneum as the sole survivor. Since the soy adapted T. confusum produced larger populations than the soy-adapted T. castaneum, it was of interest to determine whether the outcome of "competition" between T. castaneum and T. confusum could be modified. It will be recalled that when the synthetic T. castaneum (CS) and T. confusum (CF) were introduced into wheat or corn media enriched with brewer's yeast the latter was eliminated by the former, but the outcome could be modified by changing the diet (for example by omitting the brewer's yeast) or the environmental conditions (for example, by placing the cultures in an incubator maintaining lower relative humidity).

In the present experiment the T. castaneum soy-adapted (CS_{SA}) and non-adapted (CS) and T. confusum soy-adapted (CF_{SA}) and non-adapted (CF) were introduced in the combinations of strains shown in Table 1 into soy plus yeast, wheat plus yeast, corn plus yeast, and corn. Each vial contained 10 pairs of beetles of each species. One set was placed in an incubator maintained at 29°C. and 70 per cent relative humidity (wet) and another set in another incubator kept at 29 C. and 40 per cent relative humidity (dry). In addition, 10 pairs of the CS_{SA} and CF_{SA} strains were introduced into each of 20 vials containing rice plus yeast. One set was placed in the wet and another in the dry incubator.

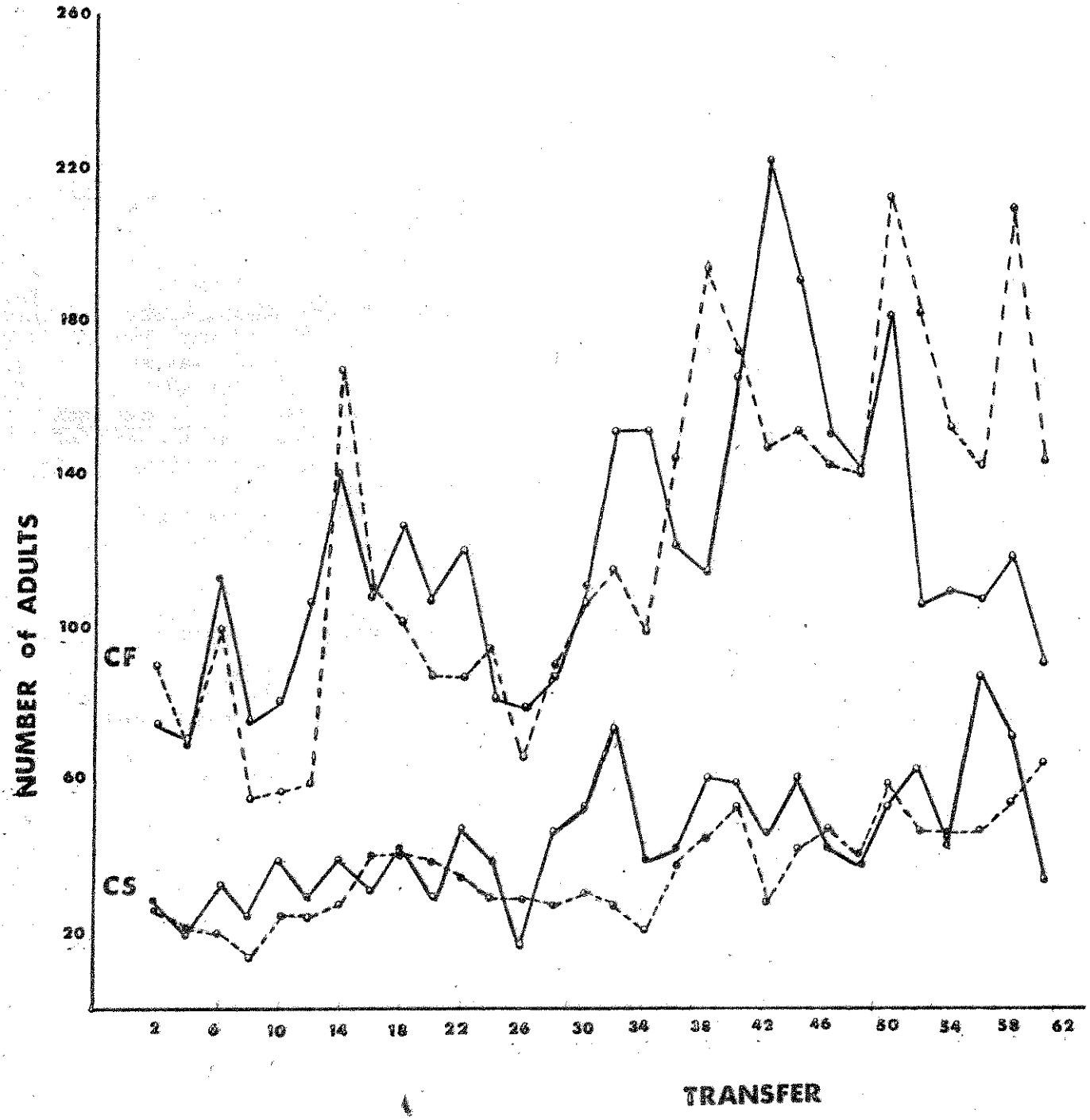
260
220
180
140
100
60
20
NUMBER of ADULTS
CF
CS
2
6
10
14
18
22
26
30
34
38
42
46
50
54
58
62
TRANSFER

FIGURE 1

RESULTS

1. Soy plus yeast (S + Y) medium.

The results at present stand as summarized in Table 1. In the S + Y medium the elimination of CF by CS is as expected under 70% relative humidity conditions and so is the reversal in outcome when these two strains are reared at 40 per cent. In the CS-CF_{SA} vials kept at 70 percent CF_{SA} is eliminated. At 40 per cent the experiment, still in progress, shows CS had won in three replicates at the end of about 12 transfers; CS was also winning in four replicates and losing in three at transfer 17 (T_{17}). In vials combining CS_{SA}:CF CF had eliminated CS in all replicates in an average of about 5.4 transfers in the 40 per cent incubator--indicating that CS_{SA} was not as good a competitor as CS in the dry environment. In the CS_{SA}-CF_{SA} vials CF_{SA} won as expected in the dry environment and CS_{SA} won in the "moist" environment.

2. Whole wheat plus yeast medium.

It has long been established that in this medium the Berkeley synthetic CS eliminates CF under wet and dry conditions, although CF may survive somewhat longer under the dry conditions. The results of the present experiment conform to previous experience, and it is clear that the CS_{SA} have not changed in competitive ability.

3. Corn plus yeast (C + Y)

This medium is somewhat more advantageous for CF than CS, but under wet conditions the latter still eliminates CF. Coupled with dry conditions, CF can eliminate CS in some vials. The data from completed experiments indicate that when CS was pitted against CF the latter was the winning species in three vials and CS was the winner in four vials. CS appears to be winning in one additional vial at T_{26}. Two vials had to be discarded because of Nosema. When CS was pitted against CF_{SA}, the latter was eliminated from seven replicates. At this writing, at T_{34}, CF_{SA} is winning in two replicates and losing in another.

The sets of vials including the combinations CS_{SA} vs. CF and CS_{SA} vs. CF_{SA} had to be discarded because of Nosema.

4. Corn.

In this medium CS is placed at a greater disadvantage since it is more deeply affected than CF by the lack of vitamins and some nutritional requirements which it tries to make up by cannibalizing CF (Lerner and Inouye, 1965; Sokoloff, Lerner and Ho, 1965; Dawson, 1967).

CS and CS_{SA} win over CF and CF_{SA} in the "wet" incubator. CS wins over CF_{SA} in 5.2 ± 1.16 transfers and CS_{SA} over CF_{SA} in 11.5 ± 2.24 transfers. The difference, at the five per cent level of probability is not statistically significant ($t = 1.85$).

Table 1. Results of "competition" between T. castaneum soy adapted (CS_{SA}) and non-adapted (CS) and T. confusum soy-adapted (CF_{SA}) and non-adapted (CF) strains in different media, at two relative humidities. (The figures given represent the mean number of generations or transfers (T_n) before a given species was eliminated.)

			Winner in 40% R.H.						Winner in 70% R.H.					
			CS			CF			CS			CF		
Medium	Strains		Rep#	m ± S.E.		Rep#	m ± S.E.		Rep#	m ± S.E.		Rep#	m ± S.E.	
SY	CS	CF	-	-	-	9	10.33 ± 1.51		9	4.33 ± 0.41		-	-	-
	CS	CF_{SA}			*		*		10	5.2 ± 0.32		-	-	-
	CS_{SA}	CF	-	-	-	10	5.4 ± 0.70			**			**	
	CS_{SA}	CF_{SA}	-	-	-	9	9.22 ± 1.14		10	6.4 ± 0.96		-	-	-
WY	CS	CF	10	12.2	± 0.92	-	-	-	-	-	-	-	-	-
	CS	CF_{SA}	10	10.5	± 1.42	-	-	-	10	3.1	± 0.10	-	-	-
	CS_{SA}	CF	10	15.2	± 1.49	-	-	-	10	3.9	± 0.23	-	-	-
	CS_{SA}	CF_{SA}	10	12.9	± 1.18	-	-	-	10	2.0	± 0	-	-	-

Table 1 (continued)

CY	CS	CF	4	18	± 1	3	21.3	± 1.7	-	-	-	-	-	-
	CS	CF_{SA}	7	13.57	± 0.37	-	-	-	10	1.9	± 0.23	-	-	-
	CS_{SA}	CF	10	***		-	-	-	10	3.9	± 0.28	-	-	-
	CS_{SA}	CF_{SA}	10	****		-	-	-	10	3.1	± 0.18	-	-	-
C	CS	CF	4	17.25	± 1.48	1	23		-	-	-	-	-	-
	CS	CF_{SA}	7	20	± 1.33	1	9		10	5.2	± 1.16	-	-	-
	CS_{SA}	CF	-	-	-	10	15.7	± 1.72	8	13.5	± 0.42	-	-	-
	CS_{SA}	CF_{SA}	1	25	± 0	8	16.25	± 2.24	10	11.5	± 2.29	-	-	-
RY	CS_{SA}	CF_{SA}	4	21.25		3	24	*****	10	2.1	± 0.10			

* Experiment still in progress. 1 CS won at T_8; 1 CF at T_{12}; at T_{14} CS in losing in most replicates.

** Experiment still in progress. CS won in 3 rps at $T_{12.33}$; at T_{17} CS in winning in four replicates and losing in three.

*** Discarded at T_8. Nosema.

**** Discarded at T_{12}. Nosema.

***** CF winning in two vials at T_{34}.

5. Rice plus yeast.
CS_{SA} wins over CF_{SA} handily in the "wet" conditions, but the outcome is a toss up when these two strains are reared in the "dry" incubator.

We can conclude, therefore, that the strains of CS and CF reared continuously in soy plus yeast for 33 generations have not changed in the competitive ability exhibited in the synthetic strains from which they were derived.

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*Effects of density on egg-to-pupa period in Tribolium castaneum

In an experiment investigating the operation of natural selection in populations of Tribolium castaneum involving the mutant black (b), an apparent selection for longer developmental period, brought about presumably by the pressure of cannibalism, was observed. (Sokal and Sonleitner, 1965. Proc. XII Int. Congr. Ent. London, 1964,; 1968, manuscript in preparation) The generations in these experiments were kept discrete. When all the individuals of one generation had become adults, they were allowed to oviposit for three days. These adults were then discarded and the eggs thus produced formed the beginning of the next generation. While the beetles are in the larval stages, slower-developing individuals would be more likely to be cannibalized by the larger, more active and faster-developing individuals. When individuals begin to pupate, however, the faster-developing ones, which would pupate first, would be cannibalized by the many active larvae still present in the population. Those that pupated later would be in less danger because there would be fewer cannibals present. Thus, if cannibalism were the main mortality factor operating in these populations, the best developmental "strategy" for the survival of an individual living in a dense population would be to grow rapidly to the mature larval stage and then hold off pupation as long as possible. Some observations, made during the course of experiments measuring the developmental rates of the genotypes involved, seemed to indicate that, indeed, most of the increase in the egg-to-pupa period that accompanied increased population density occurred in the last larval stage. The present experiment was designed to further investigate this hypothesis.

Mean time to pupation was measured at three egg input densities (200, 2000, and 4000 eggs/jar) in half-pint jars containing 40 grams of medium (stone-ground whole wheat flour plus 5% by weight Brewers' yeast, fine-sifted through 5xx bolting cloth.) The environmental conditions were 85°F temperature and 70% relative humidity. The eggs used were produced over a three day period in egg farms containing bb individuals descended from the mixed cultures of one of the selection experiments (Sokal and Sonleitner, 1965).

Beginning on the 15th day after the three experimental cultures were started, and at daily intervals thereafter, the jars were inspected for pupae which were then removed. Table 1 gives the composition of the jars on the 18th day and also indicates the 1st day on which pupae were found. At all three densities, almost all individuals were large (last instar) larvae on the 18th day and the first pupae appeared at about the same time in each jar.

TABLE 1

Density	larvae small	larvae medium	larvae large	pupae	% of larvae as large larve	day of appearance of first pupae
200	1	13	158	66	91.86	18.5
2000	3	52	1366	162	96.13	17.5
4000	0	147	2773	39	94.97	17.5

Inspection of Table 2 shows that there is no difference in the egg-to-pupa periods of the two lower densities but that of the highest density (4000/jar) is greatly increased in length --by about two weeks. This clearly indicates that the large larvae, already present on day 18, are remaining in the last larval stage for a longer period of time, thus delaying pupation. There is also a great increase in the individual variability of the egg-to-pupa period as density increases, as shown by the coefficients of variability and the range of the period of pupal formation. Some of the large larvae at the high density delayed as long as 31 days before finally pupating.

TABLE 2

Density	n	mean days to pupation	S. E.	C. V.%	range (days)
200	174	21.93	0.132	7.94	12
2000	1557	21.96	0.057	10.24	21
4000	1681	35.28	0.177	20.53	31
4000a	98	21.77	0.089	4.04	5

This lengthening of the last larval stage is probably a result of an immediate, direct effect of density of conditioning of the medium acting on the large larvae rather than to any accumulation of effects on the individuals during their preceeding life stages. This is substantiated by jar 4000a which contained 100 individuals, removed as larvae from the high density jar (4000/jar) on day 17 and transferred to a new jar at low density. They pupated as promptly as the individuals raised at the low density (200/jar), demonstrating that their development and readiness to pupate was not affected by their previous growth in the high density environment.

The work reported above was carried out during the summer of 1967 when the author was employed as a research associate in the laboratory of Prof. R. R. Sokal in the Department of Entomology, University of Kansas.

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Teratologies in the beetle Tenebrio molitor. Gross Morphology of certain abnormality types.

Summary.

Gross teratological forms of the yellow mealworm, Tenebrio molitor, are recorded. The principal teratologies observed involved abnormalities in wings

and elytra, legs, antennae, segments, and other structures. Of special interest is an abnormality (pupal-winged adult) in which the adult insect retains the wings and elytra of the pupal stage. It is intended to study this particular teratology in depth. Comparisons of the abnormalities found in the colony studied are made with similar abnormalities found by other investigators in Tenebrio and in other insects. Beetles suffering major teratological changes were definitely shorter lived than were normal or slightly deformed specimens. At least three external factors contribute to the reduced longevity: dehydration, loss of coordination, and cannibalism. Wing, elytral, and some leg abnormalities occurring spontaneously in our colony could be produced in adults by exposing pupae and late larvae to ultraviolet irradiation.

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*Dietary supplementation and survival of irradiated Tribolium adults

Previous reports from this laboratory demonstrated that irradiated adult beetles displayed higher survival if maintained in cornstarch than if kept either in white flour supplemented (4%) with brewers' yeast (FY medium) or in the basal medium supplemented (20%) with casein. By contrast, cornstarch is not adequate to sustain either the normal life-span of adults nor the growth and development of larvae. We are now examining the influence of various nitrogenous nutrients on the survival and life-span of irradiated beetles. This not reports the effects of supplementation of cornstarch with different levels of either brewers' yeast or Torula yeast.

Yeast was mixed at concentrations of 1%, 4%, or 16% (w/w) with cornstarch. Pupae from stocks in FY were sexed and distributed in groups of 10 of 1 sex to plastic vials of the appropriate medium; six days later, the vials of beetles were exposed to X-ray doses in the 9 to 15 kR range. Survival was scored after 4 weeks of incubation at 30°; by that time, all deaths attributable to the irradiation would have occurred. The nutritional adequacy of the various mixtures was tested simultaneously: groups of young (1 week) larvae were transferred from FY and checked 3 times weekly for pupation and eclosion.

The 2 kinds of yeast were indistinguishable in their effects on either rate of larval development or survival of irradiated adults. Survival after irradiation was the same in 1% and 4% yeast (LD_{50} = 12.2 kR), which was somewhat better survival than that in FY; survival in 16% yeast was markedly lower (LD_{50} = 10.4 kR). Cornstarch with 16% yeast supported larval development about as well as FY (median pupation time of 15-16 days after transfer). The median pupation time on 4% yeast was extended to 27 days. There was no pupation in 33 days on 1% yeast, and in cornstarch alone there was not only no pupation, but more than 50% mortality of the larvae within 33 days.

These results suggest a negative correlation between the nutritional adequacy of a diet and its ability to promote survival of irradiated adults. It appears likely, however, that the critical factor is not the nutritional adequacy of a given diet, but its content of protein and/or other nitrogenous

components. This interpretation is supported by out preliminary data which indicate that survival is no better on medium containing 20% oxidized casein than on medium containing 20% casein. The former, completely lacking in methionine, does not support larval growth or development.

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*Periodicity of oxygen comsumption in the confused flour beetle, Tribolium confusum

OBJECTIVES: To determine periodicity phenomena in Tribolium confusum by measuring oxygen comsumption over a 48-hour period. Following this determination a quick-acting insecticide will be used to determine whether maximum effectiveness varies in relation to periodicity of oxygen consumption.

METHODS: Adult beetles 21 days old were reared at 25°C using a 12-hour light, 12-hour dark period for 15 days prior to the respirometry determinations. Oxygen comsumption was determined on a recording Gilson Differential respirometer under continuous light during the experimental period. The respirometers were reset after 24 hours with oxygen consumption recorded for 48 hours.

RESULTS: Oxygen consumption of Tribolium confusum adults was calculated at 2-hour intervals (continuous recording makes it possible to calculate at any chosen internal). The prelimary results are shown in Table 1.

Table 1. O_2 consumption (expressed as % of the average) of T. confusum Duval at different times of the day. Calculations are based upon several 48-hour experiments.

Time	%of average
8:00 A.M.	92.80
10:00 A.M.	86.30
12:00 P.M.	89.15
2:00 P.M.	92.05
4:00 P.M.	89.40
6:00 P.M.	91.80
8:00 P.M.	106.90
10:00 P.M.	114.15
12:00 A.M.	114.45
2:00 A.M.	113.00
4:00 A.M.	107.60
6:00 A.M.	102.40
8:00 A.M.	92.80

The results indicate a greater oxygen consumption around midnight, but a statistical treatment will be necessary to determine the precise periodicity. Another experiment is being done to determine the relationship, if any, of O_2 consumption and susceptibility to the insecticide Vapona of T. confusum.

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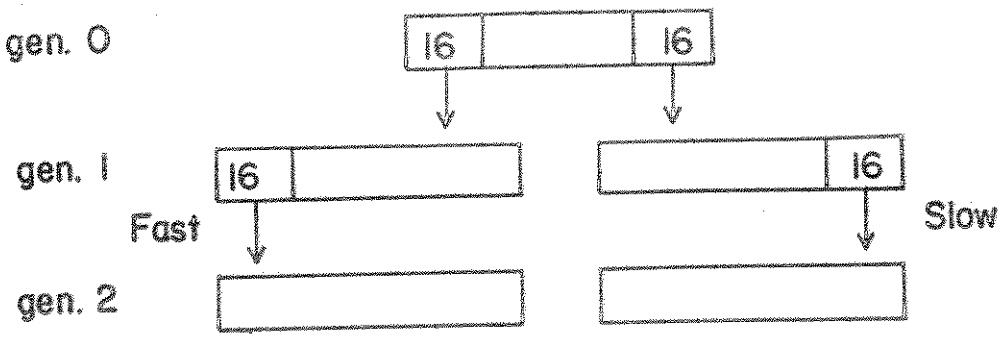
*Selection for fast and slow development in pure cultures of T. castaneum strains.

This study was stimulated by the publications of Dawson (1965, 1966, 1967), who selected for fast and slow development in T. castaneum. It was intended to last for a few generations after which the competitive ability of the selected strains was to be compared with those of the nonselected stocks. For reasons unrelated to the study itself, the experiment was discontinued after two generations of selection. However, the responses of the two strains to selection for fast and slow development are of interest, and these are presented below.

Materials and methods. The strains employed in this study were the wild type and black T. castaneum strains, used regularly in experiments in this laboratory (see stock list). All experimental cultures were kept in 6-dram vials with 8 g flour, prepared in the usual manner, and only one density was used (20/g = 160 eggs per vial).

Three pure cultures each of ++ and bb eggs (laid over a 3-day period) were used to start generation "0". Eclosing adults were removed daily from the cultures to holding vials. Each generation 0 culture gave rise to two lines (fast and slow) —initiated by the first 16 and the last 16 adults to emerge. This number—10% of input—was between 15-20% of the adult output from the cultures. The selected adults were transferred to an "egg farm" jar after a maturation period of minimmally 24 hours and allowed to oviposit for three days, 160 of their eggs being used for the next generation. The adults were then discarded. In generation 1 a similar pattern of selection was practiced, except that selection for fast development was only from fast lines, and similarly for slow development from slow lines.

Schematically, the pattern of the experiment was the following:



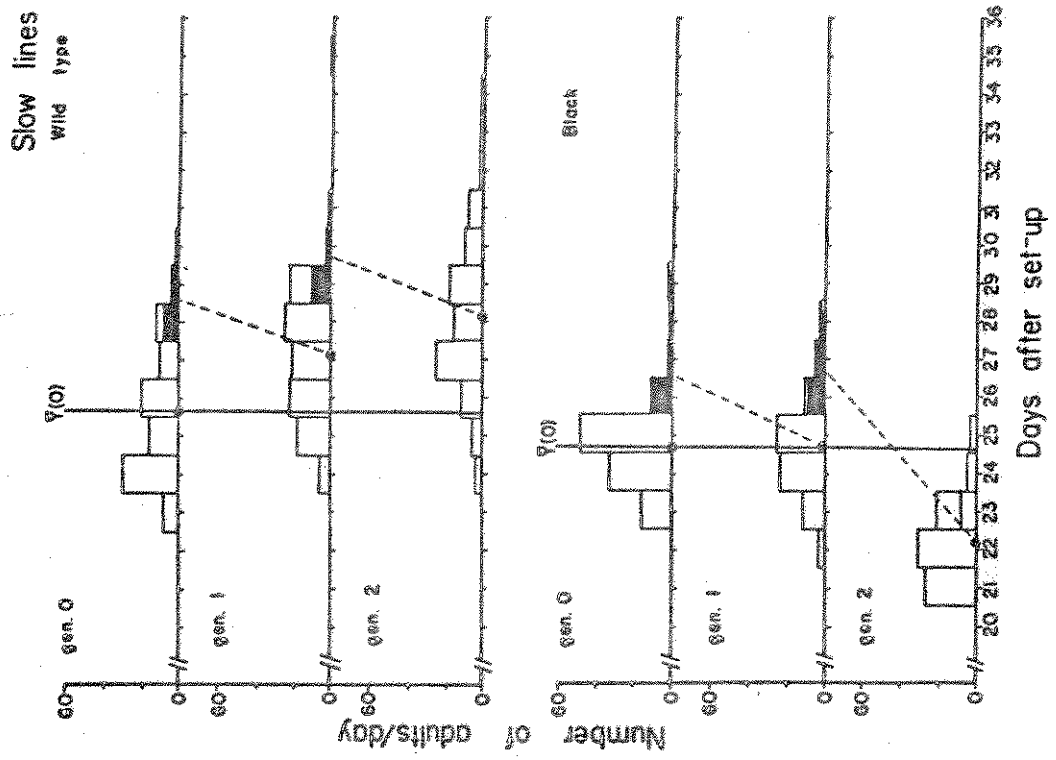


FIGURE 2

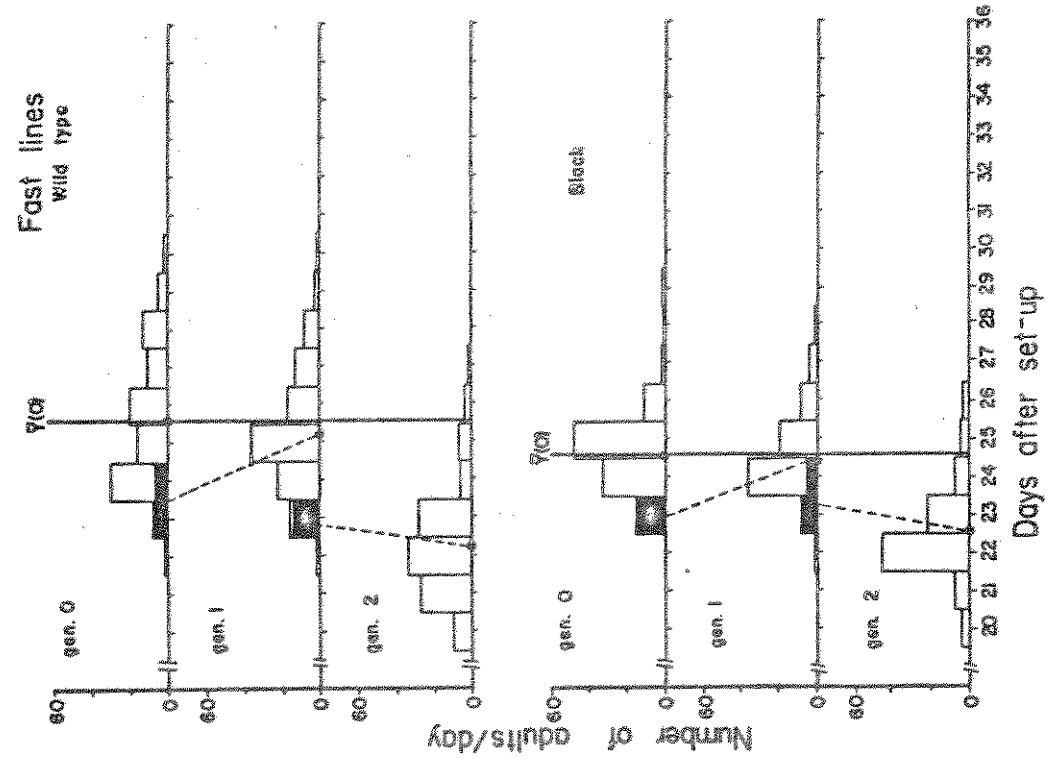


FIGURE 1

Table 1. Deviations from previous generations.

Fast lines

Line	First generation				Second generation			
	Deviation (in days)	Standard error of difference	d.f. $(n_1 + n_2 - 2)$	t	Deviation (in days)	Standard error of difference	d.f. $(n_1 + n_2 - 2)$	t
+/1	-0.5374	0.2253	232	2.386*	-2.0076	0.2135	241	9.403***
+/2	-0.3391	0.2318	222	1.463 ns	-2.9381	0.2047	233	14.355***
+/3	+0.7382	0.2333	228	3.164**	-4.3511	0.2900	227	19.778***
b/1	-0.1240	0.1628	192	0.762 ns	-1.8440	0.2041	178	9.035***
b/2	+0.3144	0.1664	190	1.889 ns	-2.4485	0.1666	240	14.701***
b/3	-0.5546	0.1431	245	3.876***	-3.5461	0.1424	245	24.902***

The intended direction of selection was (-).

Slow lines

Line	First generation				Second generation			
	Deviation (in days)	Standard error of difference	d.f. $(n_1 + n_2 - 2)$	t	Deviation (in days)	Standard error of difference	d.f. $(n_1 + n_2 - 2)$	t
+/1	+1.7303	0.2396	231	7.220***	+1.4519	0.2801	198	5.184***
+/2	+1.5327	0.2390	223	6.412***	+1.0183	0.2807	220	3.627***
+/3	+1.8257	0.2521	216	7.242***	+0.7688	0.2764	219	2.782**
b/1	-0.0093	0.1810	190	0.051 ns	-2.4690	0.1861	162	13.267***
b/2	+0.2205	0.1439	231	1.532 ns	-1.5325	0.1334	286	11.484***
b/3	-0.1253	0.1692	207	0.741 ns	-1.5915	0.2089	198	7.617***

The intended direction of selection was (+).

* .05>P>.01 ** .01>P>.001 *** P<.001

Results. The effects of selection on the length of the developmental period are summarized in Figures 1 and 2, for the fast and slow lines, respectively. The figures represent one replicate per strain. The other replicates showed identical patterns.

In the figures are shown frequency distributions of developmental times of the experimental populations. $\bar{Y}_{(0)}$ denotes the original mean at generation 0. The dark area describes the distribution of the adults selected as parents for the new generation. Means of any one generation are shown as solid circles. Dashed lines connect the mean of a selected adult group with that of their offspring.

Fast lines. Selection for fast development (shorter developmental time) in both wild type and black had little effect in the first generation (two replicates showed a significant deviation in the opposite direction). In the second generation, all lines showed a strong effect of selection in the intended direction, the means of generation 2 being smaller than those of generation 1. These differences were all highly significant ($P < 0.001$).

Slow lines. Selection for longer developmental time was effective in the wild type from generation 1, but not in black, which showed no significant extension of the developmental period.

In the second generation, the wild type lines showed continued progress toward a longer development, but the black lines showed the opposite trend—all replicates showed highly significant ($P < 0.001$) deviations toward a shorter developmental time than in generation 1.

The deviations of developmental time from the previous generation, together with their standard errors, degrees of freedom, and t-tests of significance are given in Table 1. (Tests of equality of variances failed to indicate inequality, so ordinary t-tests were legitimate.)

Variation in developmental time was invariably larger in the wild type lines than in the black lines (C.V. was about twice as large in wild type as in black). In black, but not in the wild type, an increase in C. V. took place from generation 0 to generation 2.

Survival. Analysis of variance of percentage of eggs surviving to adulthood (angular transforms) failed to show any significant reduction in survival in the selected lines, although in some of them survival in generation 2 was lower than in generation 0 or 1.

Discussion. Since the results are similar in all replicates of a strain, the possibility of drift due to the small number of parents can be excluded.

Dawson was successful in selecting for slow and fast development in his strains. However, there are two major differences in procedure between this experiment and Dawson's: (1) daily removal of adults from the cultures (Dawson removed pupae), and (2) eggs were laid over a 3-day period (24-hour period in Dawson's experiment). Thus, pupal cannibalism by larvae, important in similarly designed experiments (Sokal and Sonleitner, 1965; Sokal and Sonleitner, 1968), was much reduced in Dawson's experiment.

It is possible that the apparent inability of selection to produce a major decrease in developmental time in generation 1 was caused by the earliest pupae

being cannibalized by the larvae. The reason for the breakdown of this mechanism in generation 2 is not understood. An explanation to the behavior of the slow lines, especially to our inability to select for slow development in black, is also difficult to give. It is possible that slower-developing larvae find disadvantageous conditions in the flour.

It is difficult to say at present whether genetical or ecological factors are more important in determining the nature of these results.

Literature Cited

Dawson, P. S. 1965. Genetic homeostasis and developmental rate in Tribolium. Genetics 51:873-885.

Dawson, P. S. 1966. Developmental rate and competitive ability in Tribolium. (I) Evolution 20:104-115.

Dawson, P. S. 1967. Developmental rate and competitive ability in Tribolium. II. Changes in competitive ability following further selection for developmental rate. Evolution 21:2,292-299.

Sokal, R. R., and F. J. Sonleitner, 1965. Components of selection in Tribolium and houseflies. Proc, XII Int. Congr. Ent., London.

Sokal, R. R., and F. J. Sonleitner, 1968. The ecology of selection in hybrid populations of Tribolium castaneum. (in press)

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Teratology in the beetle Tenebrio molitor. The development and gross description of the pupal-winged adult.

A teratology characterized by the retention of essential aspects of the pupal wing in the adult mealworm, Tenebrio molitor is described. The developmental sequence which leads to the emergence of the abnormal adult was studied in the pupa, and the significance of the general state of health of the pupa in the emergence of the abnormal beetle is considered. By an observation of the various normal and abnormal pupae, the following became evident: (1) Morphologically normal pupae emerge as morphologically normal, or, in

rare instances, very minimally defective adults. (2) The type of pupal abnormality is not as significant in the emergence of a pupal-winged adult as is the extent of the abnormality and the resulting general state of health of the pupa. (3) Size, flatness of the abdominal area, and the subcuticular blackened areas in the head and prothoracic area contribute significantly to the retention of the pupal wing by affecting the state of well-being of the pupa, while the condition of the wing itself plays only a secondary role inasmuch as it affects the general health of the insect. (4) There is often a rapid deterioration in the condition of the pupa prior to emergence of the pupal-winged adult. This is evidenced by a general softness and swelling of the abdominal area followed by a loss of response to tactile stimuli and a collapse of the abdomen. There is a depletion of internal moisture, and reduction in the amount of fat body.

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*The effect of brief periods of freezing on population paramenters of black and wild type T. castaneum.

Introduction: In the course of another experiment, it became necessary to find a way to kill the adults in a culture after oviposition without damaging the eggs. The treatment also had to be as harmless as possible to the medium in the vial. Freezing was tried, because the adult was expected to be more sensitive to the treatment than a freshly laid egg. The results proved to be unsatisfactory from the point of view of the planned experiment, but they yielded some information on the effect of freezing on the survival of adults, on the fecundity of the survivors and on the fertility of treated eggs and those laid by the treated adults.

Materials and Methods: Thirty-five samples of 100 eggs (laid over a 24-hour period) and 33 samples of 50 adults in 6-dram vials about 2/3 filled with flour were prepared from stock cultures of each of two strains, wild type and black T. castaneum. The strains used were those regularly employed in experiments in this laboratory (see stock list).

Three adult samples and five egg samples of each strain were used as controls. The remaining samples for each strain were divided into six groups of five (for both eggs and adults) and subjected to freezing at -10°C in the freezing chamber of an ordinary refrigerator for periods of 30, 60, 90, 120, 150 and 180 minutes. After treatment the egg samples were returned to ordinary rearing conditions (29.5°C and 70% R. H.). The adult samples were allowed to stand at room temperatures for three hours; then the adults and also all eggs they laid were removed and the number of dead adults recorded. The surviving adults were returned to the original vials to lay eggs for two days; then they were discarded, and the new eggs counted and their hatchability recorded over the subsequent week. Control adults and eggs were processed in the same way, except for freezing.

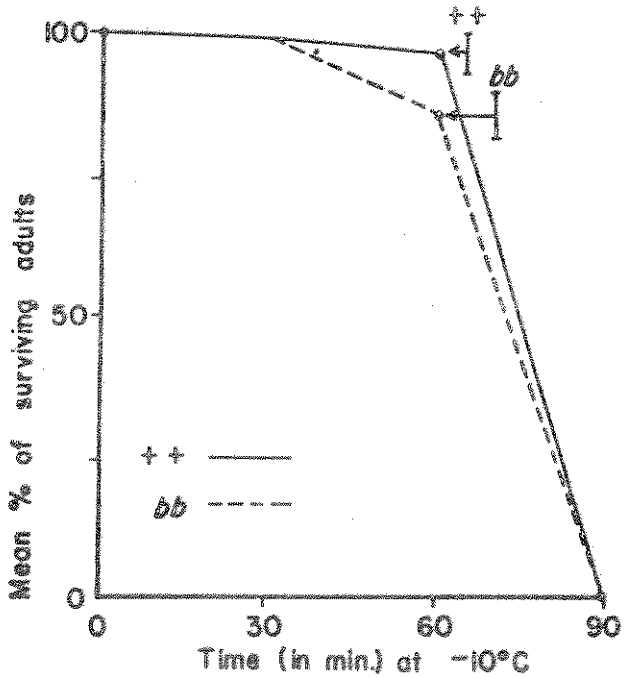
Results. The results for the tested paramenters are graphed in Figs. 1-4 expressed as means and their 95% confidence limits for both strains.

Survival of adults (Fig 1). In both strains, 30 minutes of freezing did not cause appreciable mortality of the adult beetles. In all, only 5 out of 500 beetles died as a result of the treatment.

After 60 minutes of freezing, wild type beetles survived better than black beetles ($0.05 > P > 0.01$ tested by analysis of variance of angular transformations of proportions of surviving adults) but survival was still greater than 70% in both strains.

No adults survived the 90 minutes freezing treatment, although there were indications that wild-type beetles are a little more resistant. The reason for the slow onset of the effects of freezing and their subsequent rapid death must be the time required for the critical temperature conditions to penetrate to the center of the vial through the flour. Once these conditions were reached, all the beetles died rapidly. (No beetles survived a 30-minute freezing without flour under the same conditions.)

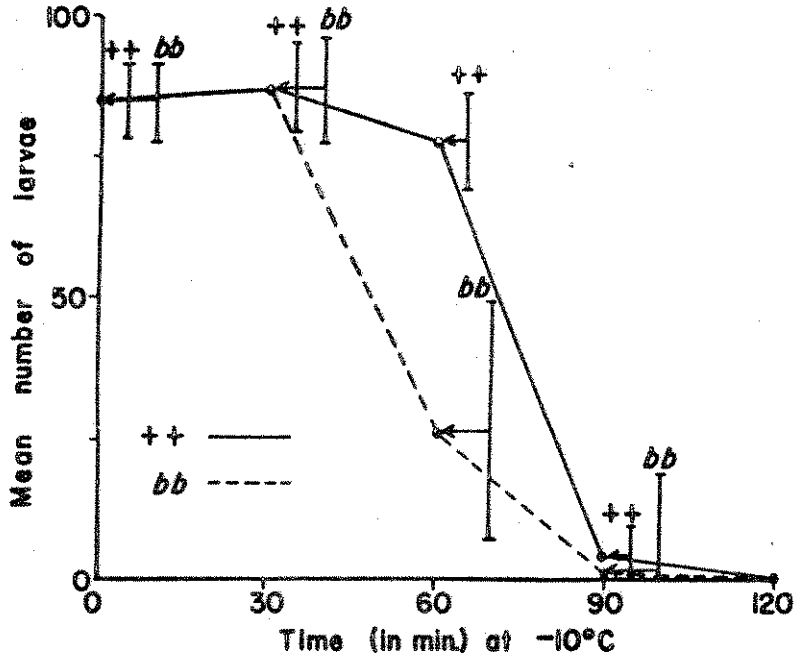
Figure 1. Survival of adults as a function of time at -10°C.



Survival of eggs (Fig. 2). Eggs seem to be slightly more resistant to freezing than adults (some eggs survived 90 minute freezing). It seems that black is more sensitive to freezing, a sudden drop in survival of eggs occurring after 60 minutes freezing in bb, while in ++ this occurred after 90 minutes.

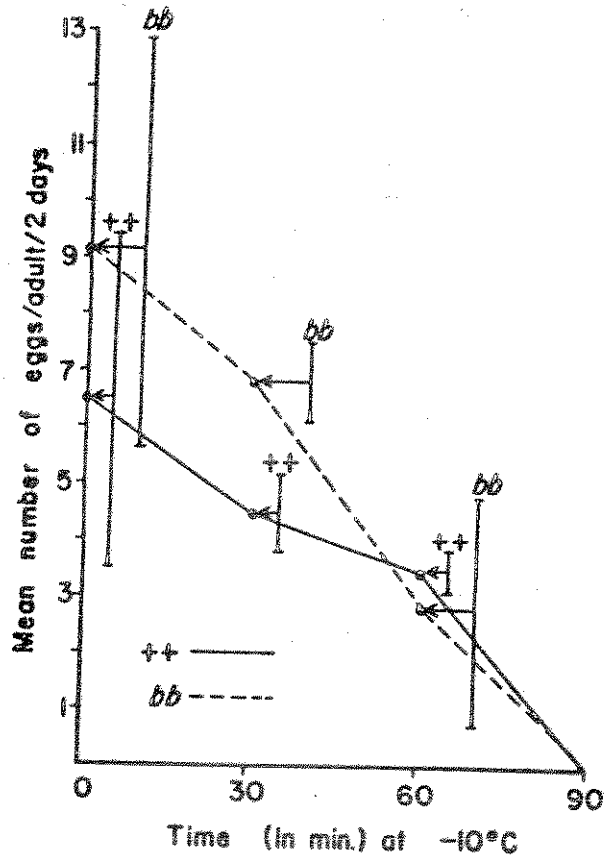
Analysis of variance of square root transformations of the number of surviving larvae shows a highly significant strains X freezing times interaction ($P < 0.001$) difference between strains and among freezing times. A significant strains X freezing times interaction ($P < 0.001$) reinforces the conclusions about the different reaction of the strains to freezing times.

Figure 2. Surviving larvae after treatment of eggs at -10°C for varying periods of time.



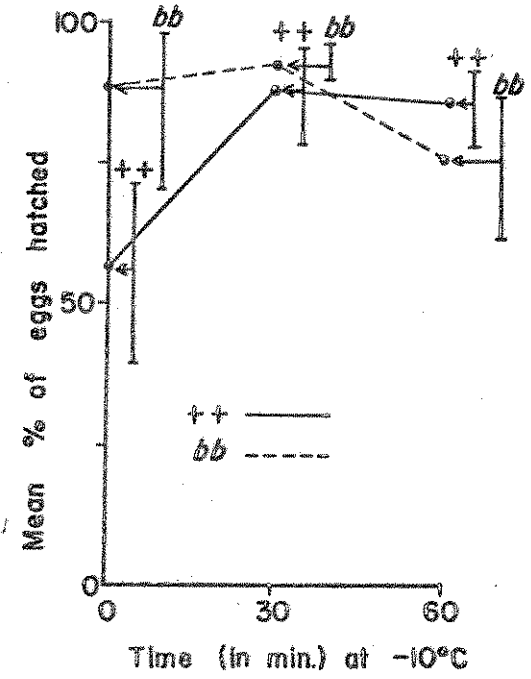
Fecundity of adults after the treatment. A reduction in fecundity (expressed as number of eggs/adult/2 days) in the treated adults compared to controls is noticeable in both strains even after 30 minutes of freezing (Fig. 3). Analysis of variance showed the differences among the means for the different freezing periods and the different strains to be significant ($P < 0.01$). A posteriori SS-STP tests (Sokal and Rohlf, 1968) showed the means of the controls to be significantly different from the 60-minute groups ($P < 0.05$), and the mean for the 30 minute group to be different from that of the 60-minute group in the black strain but not in wild type. A significant interaction ($P < 0.01$) confirms that freezing affects the fecundity of adults of the two strains to a different extent.

Figure 3. Fecundity after treatment of adults at -10°C for varying periods of time.



Hatchability of eggs laid by the treated adults (Fig. 4). Analysis of variance of angular transforms of the percent hatching in eggs laid by adults surviving treatment and by the controls reveals lower means for the 60-minute group than for the 30-minute group in black ($P < 0.01$), but not so in wild type. Curiously, the means for the untreated group were lower than those for the frozen groups.

Figure 4. Percentage if eggs hatched as a function of treatment of their parents at -10°C for varying periods of time.



Conclusions: The deleterious effects of freezing on various population parameters act differentially on the two strains. Eggs have some superiority over adults in surviving the freezing treatment.

Literature Cited

Sokal, R. R. and F. J. Rohlf. 1968. Biometry. W. H. Freeman, San Francisco and London (in press).

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Techniques for Making Pellets of Ground Milled Wheat Fractions for Rearing Internal-feeding Stored-grain Insects.

New techniques have been developed for pelleting ground milled wheat fractions for use in preparing artificial diets for internal-feeding grain insects. These were primarily for rearing the internal feeding Angoumois grain moth; however, lesser grain borer grows very well in certain pelleted diets and it is possible that they may be suitable for rearing weevils, also.

Grain to be pelleted was first ground to pass through a 40 or 60-mesh sieve using a Wiley mill. The materials were then mixed with enough distilled water to be kneaded to a "moist-dough" consistency. The optimum amount of water to add can be determined by "trial-and-error". Following preparation of the dough, a small piece is torn off and rolled between the fingers into a round, elongate shape. It is then placed in a Brown and Williamson cigarette roller and rolled through twice into an elongate pellet. In order to attain the desired pellet diameter, new holes for the belt pins can be drilled closer to the ends of the roller base. After making the long pellets, they are placed on paper toweling and allowed to dry until a light crust is formed after which they are cut to desired length using a sharp single-edged razor blade.

Pellets with high bran content of 40% or more could not easily be made by this method. To make high bran pellets, enough distilled water is first added to the materials to bring them to a moist consistency. The material is then packed into cocktail-sized cellophane drinking straws using the end of a suitable stiff wire. After packing the straws, they are cut to desired lengths and are allowed to dry until the ends begin to harden. The molded pellets are then pushed out of the straw-sections with the stiff wire.

After the pellets are made they should be spread out on paper toweling and allowed to dry at room temperature for about 12 to 30 hours depending upon the ingredients used. When making pellets from various combinations of ground mill wheat fractions (germ, bran, endosperm), it was found that less drying time was required for pellets with high endosperm content and more time for those containing high percentages of germ. Over-drying of pellets containing high percentages of endosperm content sometimes resulted in severe cracking and breaking. Under-drying of pellets containing high germ content resulted in moldy pellets when they were placed in a rearing room with a high humidity. Following drying, the pellets should be stored in a 50 to 70% relative humidity environment to prevent excessive drying.

The cigarette rolling machine used is available at many drug stored, tobacco shops, and some groceries. They are included in Brown and Willaimson Tobacco Corporation's "Bugler" or "Kite" brands cigarette rolling kits. Many grocery and liquor stores stock the small cocktail drinking straws.

This work was supported in part by Kansas Agricultural Experiment Station Project 5850.

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Procedure for Collecting Tribolium Eggs.

The following procedures have been useful when large quantities of Tribolium eggs are required. Place approximately 200 adults, 7-14 days old, in a quart jar containing 3 grams of wheat germ. This suffices not only as a stimulus to oviposition by supplying a nourishing media and to facilitate easier egg removal but it also helps prevent damage to the eggs by serving as a buffer area between the beetles, and the eggs. Also counting and removal of the desired number of eggs is much easier since the wheat germ is flaked; this prevents the eggs from becoming as heavily covered by powder as when a flour media is used. Fit clean, preferably new, 40 mesh screens in the jar lids since eggs stick more firmly to corroded screens. Invert the jars on the glossy side of an oil cloth. This not only prevents eggs from adhering to the surface on which the jars are placed but also helps maintain the covering of wheat germ over the eggs by preventing it from falling through the screen. The jar containing beetles are then placed in a rearing room maintained at 80 ± 2 F. and 70 ± 5% relative humidity for 48 hours. During oviposition the females insert the eggs through the wire mesh to the outside surface of the screen. This facilitates their removal with a #0 camel hair brush wetted with distilled water.

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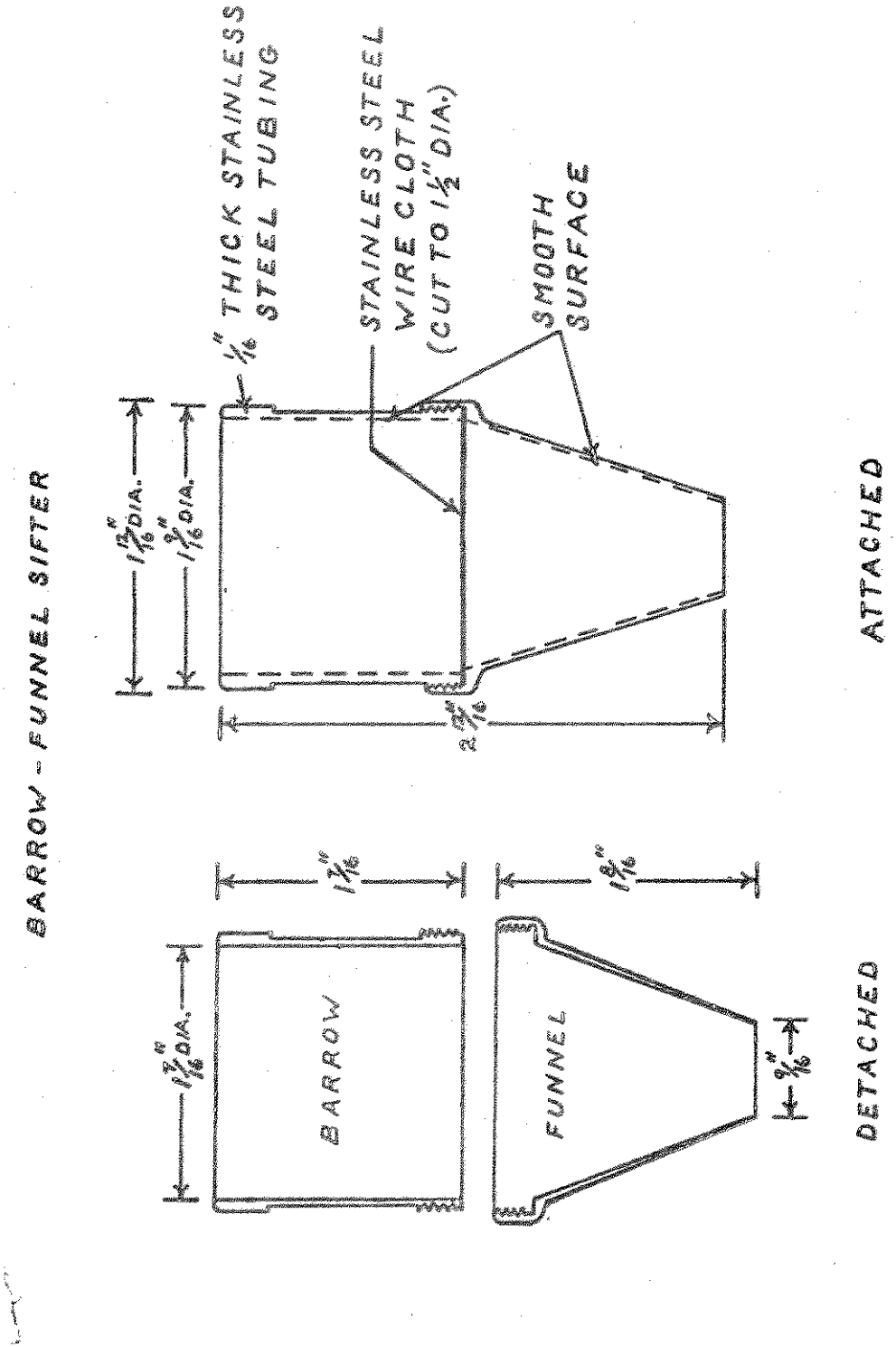
Recovering of Tribolium eggs, larvae, pupae or adults from small amounts of flour.

One often wishes a readily available method for recovering small populations resulting from one or more females and maintained in flour midway in 3/4 oz. creamers without using large amounts of laboratory equipment and minimized error due to faulty equipment. It was for these reasons that a detachable barrow-funnel sifter was designed.

The barrow is made out of stainless steel tubing while the funnel was machined from a solid piece of stainless steel so that a groove would not catch eggs or four. The barrow and funnel can be attached by a standard thread so that they are interchangeable with others. Stainless steel wire cloth was purchased in meshes of No. 20, 30, 40, 50, 60, 70 and 80. This allows for the selection of a mesh for the unique operation being performed and easy detachment of the sifter for cleaning purposes.


BARROW - FUNNEL SIFTER
1/8" THICK STAINLESS STEEL TUBING
STAINLESS STEEL WIRE CLOTH (CUT TO 1½" DIA.)
SMOOTH SURFACE
1⅞" DIA.
1⅝" DIA.
2 3/16"
ATTACHED
BARROW
FUNNEL
1⅞" DIA.
1⅞"
1⅞"
⅝"
DETACHED

DIRECTORY

GEOGRAPHICAL

NOTE: An asterisk denotes the individual who, as far as known, has worked or is working on Coleoptera. A dagger before the geographical locality indicates there was no current contribution. Since the information was obtained from previous issues of TIB, there is no guarantee that the information is accurate.

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