TRIBOLIUM INFORMATION BULLETIN

Volume 34

1994

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NOTE

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ACKNOWLEDGMENTS

The Editor is indebted to BARBARA SOKOLOFF and ELAINE SOKOLOFF for assistance in the preparation and distribution of TIB 34.

From the Editor's desk:

I have received preliminary announcements of the following meetings:

1. International Plant Protection Congress

   to be held at The Hague, The Netherlands, 2-7 July 1995.

   For further information contact:

   Secretariat

   XIII INTERNATIONAL PLANT PROTECTION CONGRESS

   C/O HOLLAND ORGANIZING CENTER

   2514 V D The Hague, the Netherlands

* * *

2. CAF INTERNATIONAL CONFERENCE ON CONTROLLED ATMOSPHERE AND

   FUMIGATION IN STORED PRODUCTS

   NICOSIA, CYPRUS, April 21-26, 1996.

   For further information contact:

   Dr. Andreas Varnava
   Secretary of the Organizing Committee
   Cyprus grain Commission
   P.O. BOX 1777
   Nicosia, Cyprus

* * *

3. XX INTERNATIONAL CONBRESS OF ENTOMOLOGY
   FLORENCE, ITALY, august 25-31, 1996.

For further details contact

   ORGANIZING SECRETARIAT

   O. I. C.

   Via A. La Marmora, 24

   50121 FLORENCE, ITALY

ANNOUNCEMENT

Dr. Anne B. Lloyd, Publishing Editor, Journal of Stored Products Research, announces that Dr. N.D.G. White has been appointed as the U.S. Regional Editor of stored products research beginning 1 January, 1995. Colleagues having applicable material ready for publication are urged to submit their work to Dr. White. His address:

Dr. N.D.G.White
195 Dafoe Road
Stored Products Section
Research Station
Agriculture Canada
Winnipeg, Manitoba R3T 2M9, Canada

TRIBOLIUM INFORMATION BULLETIN

NUMBER 34

JULY, 1994

STOCK LISTS

Stock Lists

BURLINGTON, NORTH CAROLINA
CAROLINA BIOLOGICAL SUPPLY COMPANY

Tribolium castaneum

1. black
2. jet
3. pearl
4. Wild
5. High body weight
6. Low body weight

Tribolium confusum

1. Wild

(Ed.).

BURLINGTON, VERMONT 05401
UNIVERSITY OF VERMONT
DEPARTMENT OF ZOOLOGY
STEVENS/GOODNIGHT LAB

T. confusum	T.castaneum	Oryzaephilus surinamensis
bI	cI	
bII	cSM-+/+	
bIII	cCM-b/b	
bIV	cIV-a	
b-Chicago b/b	c-Brazil	
b-Chicago	c-Costa Rica	
b-Circle	c-Thailand	
b-yugo-Illinois b/b	c-Spain	
b-yugo-Illinois +/+	c-Israel	
bSM		
b-yugo-Kentucky		
b-McGill		
b-Thailand		
b- Nigeria		
b-Pakistan		

L. Stevens

CARBONDALE, ILLINOIS 62901
SOUTHERN ILLINOIS UNIVERSITY AT CARBONDALE
DEPARTMENT OF ZOOLOGY

Tribolium castaneum

I. Wild type strains

1. Purdue + Foundation

II. Mutant strains

1. antennapedia (ap)

D.C. Englert

Chicago, Illinois 60637-1573
The University of Chicago
Department of Ecology and Evolution

Stock lists

I. Wild type strains

A. Tribolium castaneum

1. c+, "Chicago" (from Thomas Park)
2. c-ARK, Arkansas
3. c-YUGO, Yugoslavia, now Croatia
4. c-Texas
5. c-BS, collected in Naperville, IL, on birdseed
6. c-Infantes, Spain
7. c-Jerez, Spain
8. c-Campanaro, Spain
9. c-Osaka, Japan
10. c-Nigeria

B. Tribolium confusum (*= infected with Wolbachia pipientis)

*1. b+, "Chicago" from Thomas park)
2. b-I, inbred strain derived from (1).
*3. b-II, inbred strain
*4. b-III, "   "
*5. b-IV   "   "
*6. b-YUGO, Yugoslavia, now Croatia
7. b-YUGO,   "
8. b-Illinois
9. b-Mississippi
10. b-Nigeria

Michael J. Wade   Norman T. Johnson

Stock Lists

CHICAGO, ILLINOIS
UNIVERSITY OF ILLINOIS AT CHICAGO CIRCLE
DEPARTMENT OF BIOLOGICAL SCIENCES

I. Wild type strains

A. Oryzaephilus surinamensis

B. Tribolium castaneum

1. "Chicago" (originally from Thomas Park)
2. "Brazil" (also known as cI) originally from Rio de Janeiro)
3. cIVa (an inbred strain derived from "Chicago"

C. Tribolium confusum

1. "Chicago" (originally from Thomas Park)
2. "Circle" (Collected in Chicago)
3. bI (derived from "Chicago")
4. bII (derived from "Chicago")
5. bIII (derived from "Chicago")
6. bIV (derived from "Chicago")

D. B. Mertz

CORAL GABLES, FLORIDA
UNIVERSITY OF MIAMI
DEPARTMENT OF BIOLOGY

I. wild type strains

1. Tribolium confusum (Chicago)	Chicago
2. T. castaneum (Chicago)	Chicago

II. Mutant

T. confusum - ebony--Sokoloff	Sokoloff
T. castaneum - jet - from Chicago wild	
T. cataneum - Chicago black-- Sokoloff	
T. castaneum - dark sooty (Sokoloff)	
T. castaneum - Charcoal--Sokoloff	

Earl R. Rich

Stock Lists

GAINESVILLE, FLORIDA
ARS, USDA
P.O. BOX 14565
INSECT ATTRACTANTS, BEHAVIOR AND BASIC BIOLOGY LABORATORY.

Attagenus megatoma	black carpet beetle
Cadra cautella	almond moth
Cylas formicarius elegantulus	sweet potato weevil
Lasioderma serricorne	cigarette beetle
Oryzaephilus surinamensis	sawtoothed grain beetle
Paramyelois transitella	navel orangeworm
Plodia interpunctella	Indian meal moth
Sitotroga cerealella	Angoumois grain moth
Sitophilus oryzae	rice weevil
Tribolium castaneum	red flour beetle
Trogoderma granarium	khapra beetle
Trogoderma inclusum	

(Ed.).

KINGSTON, RHODE ISLAND 02881
UNIVERSITY OF RHODE ISLAND
DEPARTMENT OF ZOOLOGY

Tribolium castaneum

Purdue Foundation	via Purdue
Black Foundation	via Purdue
Corn oil unsaturated fatty acid sensitive (cos)	

Tribolium confusum

Chicago	Park 1955
black	via San Bernardino
pearl	via San Bernardino

Tribolium madens via San Bernardino

Tribolium brevicornis via San Bernardino

(Ed.).

LAFAYETTE, INDIANA 47907
PURDUE UNIVERSITY
ANIMAL SCIENCES DEPARTMENT

Tribolium castaneum

I. Wild type strains

A. Foundation "+" - originated in 1954 at Purdue University from a broad genetic base and maintained with no artificial selection and minimal breeding.

B. Foundation s - Same genetic base as Foundation "+", but genetically marked with the sooty mutant (s).

C. Foundation b - Originated in 1959 at Purdue University with a broad genetic base unrelated to Foundation "+", no artificial selection, minimal inbreeding, and genetically marked with the black mutant (b).

D. Foundation p - Originated in 1959 at Purdue University with a broad genetic base unrelated to Foundation "+" and b, no selection, minimal inbreeding, and genetically marked with the pearl mutant (p).

W.M. MUIR

LEXINGTON, KENTUCKY
UNIVERSITY OF KENTUCKY
AGRICULTURAL EXPERIMENT STATION

I. Base populations

1. Purdue + foundation	Purdue
2. Purdue s foundation (sooty)	Purdue
3. Purdue b foundation (black)	Purdue
4. Purdue p foundation (pearl)	Purdue

II. Synthetic strains -- with a history of long-term selection for increased pupa weight but maintained in population cages without selection pressure but discrete generations.

1. MRS-1	Minnesota, 1970
2. MRS-2	Minnesota, 1970
3. P	Purdue, 1976

4. C Davis, 1976

III. Synthetic strain IS from a cross of CSI-10 X E1 inbred lines,maintained in population cages with extremely large
1. IS - From a cross of CSI-10 X e1 inbred lines, maintained in population cages with extremely large population size and random mating for 28 generations.

(Ed.).

MANHATTAN, KANSAS
KANSAS STATE UNIVERSITY
DEPARTMENT OF ENTOMOLOGY

LEPIDOPTERA

Phycitidae: Cadra cautella and Plodia interpunctella

Gelechiidae: wild and red eyed strains.

Pyralidae: Corcyra cephalonica

COLEOPTERA

Anobiidae: Lasioderma serricorne and Stegobium paniceum

Bostrichidae: Rhyzopertha dominica

Bruchidae: Callosobruchus maculatus

Cucujidae; Cryptolestes ferrugineus, C. pusillus,

Curculionidae: Sitophilus granarius, S. oryzae, and two strains of S. zeamais.

Dermestidae: Trogoderma inclusum, Attagenus megatoma

Ostomatidae: Tenebroides mauritanicus

Ptinidae: Gibbium psylloides

Silvanidae: Ahasverus advena, Oryzaephilus surinamensis, O. mercator

Tenebrionidae:

Palorus ratzeburgi,Kansas 1965
Tenebrio molitor, Kansas
Tenebrio obscurus Manhattan, Kansas, 1971
Tribolium castaneum, Kansas
Tribolium confusum, Kansas

Valerie Wright

MANHATTAN, KANSAS 66502
U.S. GRAIN MARKETING RESEARCH LABORATORY

Tribolium castaneum

I. Insecticide-resitant strains

1. GA-1, malathion-specific, collected in Georgia, 1980
2. NC-1, malathion-specific, collected in North Carolina. From W.C. CAMPBELL.
3. Kano, malathion-specific, collected in northern Nigeria, 1961. From W.R. wilkin.
4. CTC 12, nonspecific, oxidase type, collected in Kingaroy, Australia, 1968. From W.R. Wilkin.
5. TC 95, nonspecific. From B.R. Champ.
6. DDT C, DDT-resistant, collected in South Africa, 1959. From D.G. Blackman.
7. Rmal-2 allelic to Rmal-1
8. Rdiel--Resistant to lindane, dieldrin and other cyclodienes, linkage group not determined.

II. Mutant strains

(see next pages)

Stock Lists

Mutant	Full Name or description	Link. Group	Stocks	Source
1S65	Crossover supressor	2;9	1S65/mas,p	Manhattan
3P1	crossover supressor	3	3P1/au14	Purdue
3P2	crossover supressor	3	3P2/au14, 3P2/X(ab-2s)	Purdue
A(Ag1),Stm	abdominal (fr. Ag), cis Stm	2	A(Ag1), Stm /ptlD60	Manhattan
A(Ag2)	abdominal (from Ag)	2	A(Ag2)/Ey	Manhattan
A(mc)	abdominal (from mc)	2	A(mc),p/Stm,Cx5	Manhattan
A10	Abdominal 10	2	A10 / Ey	Manhattan
A10	Abdominal 10	2	A10,mxpA10/Utx1,mxp,apt	Manhattan
A10,mxpA10	Abdominal 10, mxp fr. A10	2	A10,mxpA10/Utx1,mxp,apt	Manhattan
A12	Abdominal 12	2	A12/Ey	Manhattan
A15, Stm	Abdominal 15, Stm cis	2	A15,Stm/Ey	Manhattan
A20 Rdiel	Dieldrin resistant	2	A20 Rdiel	Unknown
A4	Abdominal 4	2	A4/Stm,Cx5	Manhattan
A8	Abdominal 8	2	A8/Stm,Cx5	Manhattan
ab	antenna bifurcada	9	ab,pas30,p	Bogota, Colombia
ab	antenna bifurcada	9	ub,ab	Bogota, Colombia
ab	antenna bifurcada	9	ab/ab	Bogota, Colombia
ab	antenna bifurcada	9	ue,ab,msg,p,mxp,apt,pas30	Bogota, Colombia
AD100,Stm,Cx5	Notched gena,Stm,Cx5 (cis)	2	AD100,Stm,Cx5/Es1	Manhattan
Ag	Antennagalea	2	Ag/Es1	Manhattan
Ag	Antennagalea	2	Ag/mxpNG	Manhattan
Ag+RptlD1	Ag revertant-dominant ptl	2	Ag+RptlD1/Es1	Manhattan
Ag2, Stm	Antennagalea 2, Stm (cis)	2	Ag2,Stm/Ey	Manhattan
Ag5, Stm	Antennagalea 5, Stm (cis)	2	Ag5,Stm/Es1	Manhattan
AgPin	Antennagalea (Pinhead)	2	AgPin/Stm,Cx5	Manhattan
Ah	Arrowhead	8	Ah	Purdue
ap	antennapedia	8	b, ap	San Bernadino
ap	antennapedia	8	Bald,ap,sq1/ap,sq1	San Bernadino
ap	antennapedia	8	Bald,ap,sq2/ap,sq2	San Bernadino
ap	antennapedia	8	MMS (s.c,ap,au,mas)	San Bernadino
ap(psi)	ap(pleurosternal sutures incompl.	8	ap(psi)	Manhattan
Apl	Antennapalpus	2	Apl, apt, ub	Manhattan
Apl	Antennapalpus	2	Apl,apt,mas,pas	Manhattan
Apl	Antennapalpus	2	Apl/Apl	Manhattan
apt	alate prothorax	2	apt, mas, p	Manhattan
apt	alate prothorax	2	apt, pas	San Bernadino
apt	alate prothorax	2	b, apt, sa, c	San Bernadino
apt	alate prothorax	2	ba,mxp,apt,pas30	San Bernadino
apt	alate prothorax	2	Quad(mxp,apt,mas,pas	San Bernadino
apt	alate prothorax	2	quint	San Bernadino
apt	alate prothorax	2	s,h,b(t),mxp,apt,pas30	San Bernadino
apt	alate prothorax	2	s,h,j2,mxp,apt,pas30	San Bernadino
apt	alate prothorax	2	Utx1,mxp,apt/mxpX9,Es1	San Bernadino
apt	alate prothorax	2	s,j,b(t),mxp,apt,pas30,h	San Bernadino
au	aureate	3	au	San Bernadino
au	aureate	3	b(t),p,lod,au,msg	San Bernadino
au	aureate	3	au,lod isoline (JS)	San Bernadino
au	aureate	3	mas, p,au	San Bernadino
au	aureate	3	MMS (s.c,ap,au,mas)	San Bernadino
au14	aureate 14, lethal	3	3P1/au14, 3P2/au14	Purdue
b	black body color	3	b	San Bernadino
b	black body color	3	b, ap	San Bernadino
b	black body color	3	b, apt, sa, c	San Bernadino
b(ST)	black, dominant	3	Chr/b(ST)	Manhattan
b(t)	tawny body color	3	b(t)	San Bernadino
b(t)	tawny body color	3	b(t),p,lod,au,msg	San Bernadino
b(t)	tawny body color	3	s,h,b(t),mxp,apt,pas30	San Bernadino
b(t)	tawny body color	3	s,j,b(t),mxp,apt,pas30,h	San Bernadino
ba	broken antennae	2	ba, pas30	Manhattan
ba	broken antennae	2	ba, pas30	Manhattan
Bald	Bald (reduced setiferous pits)	8	Bald	Manhattan
Bald	Bald (reduced setiferous pits)	8	Bald,ap,sq1/ap,sq1	Manhattan

Bald	Bald (reduced setiferous pits)	8	Bald,ap,sq2/ap,sq2	Manhattan
Bamp14	Blunt anterior metastern. projection 1	3	Bamp14	Manhattan
Bamp27	Blunt anterior metastern. projection 2	3	Bamp27	Manhattan
Bamp27,au	Blunt anterior metastern. projection 2	3	Bamp27,au/au	Manhattan
Bamp29	Blunt anterior metastern. projection 2	3	Bamp29	Manhattan
Bamp31	Blunt anterior metastern. projection 3	3	Bamp31/+	Manhattan
Bamp31	Blunt anterior metastern. projection 3	3	Bamp31/Chr	Manhattan
Bamp58	Blunt anterior metastern. projection 5	3	Bamp58	Manhattan
BampSp	Blunt anterior metastern. projection f	3	BampSp	Manhattan
Be	Bar eye	4	Be	San Bernadino
Be	Bar eye	4	Be, s	San Bernadino
box	box (abdominal)	2	box / Es	Manhattan
c	chestnut eye	7	b, apt, sa, c	San Bernadino
c	chestnut eye	7	sa,c	San Bernadino
c	chestnut eye	7	MMS (s.c,ap,au,mas)	San Bernadino
Cg	Cleft gular (sutures)	?	Cg	Manhattan
Chr	Charcoal body color	3	Bamp31/Chr	San Bernadino
Chr	Charcoal body color	3	Chr	San Bernadino
Chr	Charcoal body color	3	Chr/b(ST)	San Bernadino
ChrE	Charcoal (Elytra indented)	3	ChrE	Manhattan
co	cola body color	9	co,p	Manhattan
co	cola body color	9	Se,co	Manhattan
co	cola body color	9	Se,co,p	Manhattan
Crab	Crab (warped legs)	7	Crab	Manhattan
Crab	Crab (warped legs)	7	Crab,s	Manhattan
Crab	Crab (warped legs)	7	Crab/PL4	Manhattan
CTC 12 Rabon R	Rabon resistant	?	CTC 12 Rabon R	Australia
Cv	Cross-veined elytra	?	Cv	Purdue
Cx20	Cephalothorax 20	2	Cx20/Es1	Manhattan
Cx6	Cephalothorax 6	2	Cx6/Es1	Manhattan
Dch1	Dachshund 1	2;9	Dch1/Es1	San Bernadino
Dch13,Stm	Dachshund 13, Stm (cis)	2	Dch13,Stm/Es1	Manhattan
Dch4	Dachshund 4	2	Dch4 / Es	Manhattan
Det43	Divergent elytral tips	4;5	Det43,h,s/Es,h,s	Manhattan
Det43	Divergent elytral tips	4;5	Det43/Es1	Manhattan
Df(Dch1)	Deficiency (from Dch1)	2	Df(Dch1)/Ey	Manhattan
Df(Lu)/Df(Lu)	Deficiency (from Lu)	2?	Df(Lu)/Df(Lu)	Manhattan
Df1-3/Ey	Deficiency	2	Df1-3/Ey	Manhattan
Df1-5/Ey	Deficiency	2	Df1-5/Ey	Manhattan
Dp	Duplication (from Dch1)	2	Dp/Es1/A10	Manhattan
Dp	Duplication (from Dch1)	2	Dp/Es1/Df(Dch)	Manhattan
Dp	Duplication (from Dch1)	2	Dp/Es1/Df1-3	Manhattan
Dp	Duplication (from Dch1)	2	Dp/Es1/pas30	Manhattan
Dp	Duplication (from Dch1)	2	Dp/Ey/Ey	Manhattan
Dp	Duplication (from Dch1)	2	Dp/Stm,ptlD57/pas30	Manhattan
DpLu	Duplication (from Lu)	2	DpLu/Ey	Manhattan
DpSpa	Duplication (from Spa)	2	DpSpa/Es1/pas30	Manhattan
Ds	Displaced sternellum	4	Ds/Spa (no Medea)	Manhattan
ds(euD)	displaced sternellum (from euD)	?	ds(euD)	Manhattan
ds-X	displaced sternellum, x-linked	4?;X	ds-X .	Manhattan
dve(mas,pas)	divergent elytra (from mas,pas stock	?	dve(mas,pas)	Manhattan
Em,A16s	Enlarged mentum, abdominal (cis)	2	Em,A16s/Stb	Manhattan
Er	Eye reduced	2	Er	Manhattan
Er	Eye reduced	2	Er,quint	Manhattan
Er	Eye reduced	2	Er,ub	Manhattan
Es	Extra sclerite (abdominal)	2;4	AD100,Stm,Cx5/Es1	Manhattan
Es	Extra sclerite (abdominal)	2;4	Ag+RptlD1/Es1	Manhattan
Es	Extra sclerite (abdominal)	2;4	Ag/Es1	Manhattan
Es	Extra sclerite (abdominal)	2;4	Ag5,Stm/Es1	Manhattan
Es	Extra sclerite (abdominal)	2;4	box / Es	Manhattan
Es	Extra sclerite (abdominal)	2;4	Cx20/Es1	Manhattan
Es	Extra sclerite (abdominal)	2;4	Cx6/Es1	Manhattan
Es	Extra sclerite (abdominal)	2;4	Dch1/Es1	Manhattan

Es	Extra sclerite (abdominal)	2;4	Dch13,Stm/Es1	Manhattan
Es	Extra sclerite (abdominal)	2;4	Det43/Es	Manhattan
Es	Extra sclerite (abdominal)	2;4	Dp/Es1/A10	Manhattan
Es	Extra sclerite (abdominal)	2;4	Dp/Es1/Df(Dch)	Manhattan
Es	Extra sclerite (abdominal)	2;4	Dp/Es1/Df1-3	Manhattan
Es	Extra sclerite (abdominal)	2;4	Dp/Es1/pas30	Manhattan
Es	Extra sclerite (abdominal)	2;4	DpSpa/Es1/pas30	Manhattan
Es	Extra sclerite (abdominal)	2;4	Es/tr	Manhattan
Es	Extra sclerite (abdominal)	2;4	Ey/Es1	Manhattan
Es	Extra sclerite (abdominal)	2;4	g/Es	Manhattan
Es	Extra sclerite (abdominal)	2;4	Ip69/Es1	Manhattan
Es	Extra sclerite (abdominal)	2;4	Spa/Es1	Manhattan
Es	Extra sclerite (abdominal)	2;4	Stb,Df(mas)/Es	Manhattan
Es	Extra sclerite (abdominal)	2;4	Stb/Es1	Manhattan
Es	Extra sclerite (abdominal)	2;4	Stbd/Es1	Manhattan
Es	Extra sclerite (abdominal)	2;4	Stm+RSptlD/Es1	Manhattan
Es	Extra sclerite (abdominal)	2;4	Stm,Ag4/Es	Manhattan
Es	Extra sclerite (abdominal)	2;4	Stm,Cx5/Es1	Manhattan
Es	Extra sclerite (abdominal)	2;4	Stm,Ns/Es1	Manhattan
Es	Extra sclerite (abdominal)	2;4	Stm-Es1/+NDJ	Manhattan
Es	Extra sclerite (abdominal)	2;4	Stm-Skl4-Es/+ NDJ	Manhattan
Es	Extra sclerite (abdominal)	2;4	StmR1/Es1	Manhattan
Es	Extra sclerite (abdominal)	2;4	StmR2/Es1	Manhattan
Es	Extra sclerite (abdominal)	2;4	StmR5/Es1	Manhattan
Es	Extra sclerite (abdominal)	2;4	StmR6/Es1	Manhattan
Es	Extra sclerite (abdominal)	2;4	Utx1,mxp,apt/mxpX9,Es1	Manhattan
Es	Extra sclerite (abdominal)	2;4	Utx1/Es	Manhattan
Es	Extra sclerite (abdominal)	2;4	vwe/Es	Manhattan
Es(Skl6)	Extra sclerite (from Skl6)	2	Es(Skl6)	Manhattan
Es1+R1/Stm	Extra sclerite revertant 1	2	Es1+R1/Stm	Manhattan
Es1+R9/Ey	Extra sclerite revertant 9	2	Es1+R9/Ey	Manhattan
Es2/Ey	Extra sclerite 2	2	Es2/Ey	Manhattan
Es3/Ey	Extra sclerite 3	2	Es3/Ey	Manhattan
eu	extra urogomphi	2	eu	San Bernadino
eu	extra urogomphi	2	eu, apt, mas	San Bernadino
eu	extra urogomphi	2	eu, mas	San Bernadino
eu	extra urogomphi	2	eu, mas, pas	San Bernadino
euD	Extra urogomphi (Abd B)	2	euD	Manhattan
Ey	eyeless	2;5	A(Ag2)/Ey	Manhattan
Ey	eyeless	2;5	A10 / Ey	Manhattan
Ey	eyeless	2;5	A12/Ey	Manhattan
Ey	eyeless	2;5	A15,Stm/Ey	Manhattan
Ey	eyeless	2;5	Ag2,Stm/Ey	Manhattan
Ey	eyeless	2;5	Dch3 / Ey	Manhattan
Ey	eyeless	2;5	Df(Dch1)/Ey	Manhattan
Ey	eyeless	2;5	Df(Lu)/Df(Lu)	Manhattan
Ey	eyeless	2;5	Df1-3/Ey	Manhattan
Ey	eyeless	2;5	DpLu/Ey	Manhattan
Ey	eyeless	2;5	Ey/Es1	Manhattan
Ey	eyeless	2;5	Lu,Skl6/Ey	Manhattan
Ey	eyeless	2;5	ptlD16,Stm/Ey	Manhattan
Ey	eyeless	2;5	Mcs1R1/Ey	Manhattan
Ey	eyeless	2;5	Mcs1R2/Ey	Manhattan
Ey	eyeless	2;5	Mcs1R5/Ey	Manhattan
Ey	eyeless	2;5	mxpD1,Skl6/Ey	Manhattan
Ey	eyeless	2;5	mxpX9,Es1/Ey	Manhattan
Ey	eyeless	2;5	Df1-5/Ey	Manhattan
Ey	eyeless	2;5	ptlD57,Stm/Ey	Manhattan
Ey	eyeless	2;5	ptlD60/Ey	Manhattan
Ey	eyeless	2;5	Skl4/Ey	Manhattan
Ey	eyeless	2;5	Skl4R1/Ey	Manhattan

Stock Lists

R. W. Beeman Laboratory August 12, 1994 Manhattan, Kansas

Ey	eyeless	2;5	Skl4R2/Ey	Manhattan
Ey	eyeless	2;5	Stm,Cx5/Ey,A14	Manhattan
Ey	eyeless	2;5	Stm,Cx5/Ey; s/s	Manhattan
Ey,A14	Eyeless, Abdominal 14 (cis)	2	Stm,Cx5/Ey,A14	Manhattan
Ey-Lethal-Free	lethal free from Eyless	NA	Ey-Lethal-Free	Manhattan
fs(sa)	short antennae, female sterile	?	fs(sa)	Manhattan
Fta	Fused tarsi and antennae	?	Fta	San Bernadino
g	glossy	2	g	Manhattan
g	glossy	2	g/Dch3	Manhattan
g	glossy	2	g/Es	Manhattan
Ga-1	Georgia 1, wild type	NA	Ga-1	Georgia
Ga-1	Georgia 1, wild type	NA	Ga-9s	Georgia
Gi	Giant (body size)	NA	Gi	San Bernadino
Go	Goliath (body size)	7	Go	Manhattan
h	hazel eye	4	Det43/Es	San Bernadino
h	hazel eye	4	h, s	San Bernadino
h	hazel eye	4	s,h,b(t),mxp,apt,pas30	San Bernadino
h	hazel eye	4	s,h,j2,mxp,apt,pas30	San Bernadino
Hw	Hairy wing	2	Hw/Es,mxpX9	Manhattan
Hw	Hairy wing	2	Hw/Stm,Cx5	Manhattan
Is	Incomplete sternellum	?	Is	Manhattan
j1	jet, body color	5	j,mc	San Bernadino
j1	jet, body color	5	rb,j	San Bernadino
j1	jet, body color	5	s,j,b(t),mxp,apt,pas30,h	San Bernadino
j2	jet, body color	5	j2	Cedar Rapids
j2	jet, body color	5	s,h,j2,mxp,apt,pas30	Cedar Rapids
ju	juvenile urogomphi	4?	ju,ptl	Manhattan
Lab-S Rusty	Lab strain, rusty, wild-type	NA	Lab-S Rusty	Manhattan
LF-3 (JS)	Lethal free	3	LF-3 (JS)	Purdue
lod	light optical diaphragm	3	au,lod isoline (JS)	San Bernadino
lod	light optical diaphragm	3	b(t),p,lod,au,msg	San Bernadino
lp69	labiopedia 69	2	lp69/Es1	Manhattan
lp69	labiopedia 69	2	lp69/Utx1,mxp,apt	Manhattan
Lu	Lucifer (dorsal head horns)	2	Lu / Stm,Cx5	Manhattan
Lu	Lucifer (dorsal head horns)	2	Lu,Skl6/Ey	Manhattan
Lu	Lucifer (dorsal head horns)	2	Lu,Skl6/Stb	Manhattan
Lu	Lucifer (dorsal head horns)	2	Lu/Stbd	Manhattan
m.l. 9.14	(Male linked)	2	9.14 (male linked)	Manhattan
M1	Medea 1	3	M1 - iso 3B1 (G)	Manhattan
M1	Medea 1	3	M1 isoline (JS)	Manhattan
M1	Medea 1	3	M1,au,M3	Manhattan
M1	Medea 1	3	M1,au,p,lod	Manhattan
M1	Medea 1	3	M1,b	Manhattan
M1	Medea 1	3	M1/M1, Bamp27	Manhattan
M3	Medea 3	3	M3,au	Manhattan
M3	Medea 3	3	M1,au,M3	Manhattan
mas	missing abdominal sternite	2	1S65/mas,p	San Bernadino
mas	missing abdominal sternite	2	apt, mas, p	San Bernadino
mas	missing abdominal sternite	2	mas	San Bernadino
mas	missing abdominal sternite	2	mas, p,au	San Bernadino
mas	missing abdominal sternite	2	mas, pas	San Bernadino
mas	missing abdominal sternite	2	ptl, mas, pas	San Bernadino
mas	missing abdominal sternite	2	Quad(mxp,apt,mas,pas	San Bernadino
mas	missing abdominal sternite	2	quint	San Bernadino
mas	missing abdominal sternite	2	MMS (s,c,mas,ap,au)	San Bernadino
mas2	missing abdominal sternite 2	2 ?	mas2	Manhattan
mc	microcephalic	5	j,mc	San Bernadino
mc	microcephalic	5	mc,rb,j	San Bernadino
mc	microcephalic	5	mc,j	San Bernadino
mc(eg)	microcephalic (eye growth)	5	mc(eg),p,lod	San Bernadino
Mc-2,Utx1	Microcephalic-2,Ultrathorax(cis)	2	Mc-2,Utx1/mxpNG	Manhattan
Mcs1	Miscadestral sclerite	2	Mcs1/Stm	Manhattan
Mcs1R1	Miscadestral sclerite, revertant 1	2	Mcs1R1/Ey	Manhattan

Mcs1R2	Miscadestral sclerite, revertant 2	2	Mcs1R2/Ey	Manhattan
Mcs1R4	Miscadestral sclerite, revertant 4	2	Mcs1R4/mxpNG	Manhattan
Mcs1R5	Miscadestral sclerite, revertant 5	2	Mcs1R5/Ey	Manhattan
Mo	Micro opthalmic	6	Mo	San Bernadino
msg	melanotic stink gland	?	b(t),p,lod,au,msg	San Bernadino
msg	melanotic stink gland	?	msg, pas	San Bernadino
msg	melanotic stink gland	?	ue,ab,msg,p,mxp,apt,pas30	San Bernadino
mt	melanotic tumors	?	mt	San Bernadino
mxp	maxillopedia	2	ba,mxp,apt,pas30	San Bernadino
mxp	maxillopedia	2	mxp, apt	San Bernadino
mxp	maxillopedia	2	mxp, apt, pas30	San Bernadino
mxp	maxillopedia	2	mxp, mas	San Bernadino
mxp	maxillopedia	2	ptl, mxp	San Bernadino
mxp	maxillopedia	2	A10,mxpA10/Utx1,mxp,apt	San Bernadino
mxp	maxillopedia	2	Quad(mxp,apt,mas,pas	San Bernadino
mxp	maxillopedia	2	quint	San Bernadino
mxp	maxillopedia	2	s,h,b(t),mxp,apt,pas30	San Bernadino
mxp	maxillopedia	2	s,h,j2,mxp,apt,pas30	San Bernadino
mxp	maxillopedia	2	s,j,b(t),mxp,apt,pas30,h	San Bernadino
mxp	maxillopedia	2	Utx1,mxp,apt/mxpX9,Es1	San Bernadino
mxp(Dch3)	maxillopedia dauchshund 3	2	X-31 pearl s.l./Dch3	Manhattan
mxp(Dch3)	maxillopedia dauchshund 3	2	X-31/Dch3	Manhattan
mxp(Dch3)	maxillopedia dauchshund 3	2	Dch3 / Ey	Manhattan
mxp(Dch3)	maxillopedia dauchshund 3	2	Dch3/X(ab-1s)	Manhattan
mxp(Dch3)	maxillopedia dauchshund 3	2	g/Dch3	Manhattan
mxp(Df1-3)	maxillopedia (from deficiency)	2	mxp(Df1-3)/Es	Manhattan
mxp170	maxillopedia 170, lethal	2	mxp170/Es1	Manhattan
mxp19	maxillopedia 19, lethal	2	mxp19/Es1	Manhattan
mxp8	maxillopedia 8, lethal	2	mxp8/Es1	Manhattan
mxpD1,Skl6/Ey	Maxillopedia, dom. 1, Skl6 (cis)	2	mxpD1,Skl6/Ey	Manhattan
mxpNG	maxillopedia, Notched Gena, lethal	2	mxpNG/Es1	Manhattan
mxpNG	maxillopedia, Notched gena	2	Ag/mxpNG	Manhattan
mxpNG	maxillopedia, Notched gena	2	Mc-2,Utx1/mxpNG	Manhattan
mxpNG	maxillopedia, Notched gena	2	Mcs1R4/mxpNG	Manhattan
mxpX9, Es	lethal maxillopedia, Es (cis)	2;4	Utx1,mxp,apt/mxpX9,Es1	Manhattan
mxpX9, Es	lethal maxillopedia, Es (cis)	2;4	mxpX9,Es1/Ey	Manhattan
mxpX9, Es	lethal maxillopedia, Es (cis)	2;4	Hw/Es,mxpX9	Manhattan
mxpX9,Es1/Ey	maxillopedia X9, lethal, Es (cis)	2;4	mxpX9,Es1/Ey	Manhattan
NDG-2 (#59)	Wild-type	NA	NDG-2 (#59)	Manitoba
p	pearl eye	9	1S65/mas,p	San Bernadino
p	pearl eye	9	ab,pas30,p	San Bernadino
p	pearl eye	9	apt, mas, p	San Bernadino
p	pearl eye	9	mas, p,au	San Bernadino
p	pearl eye	9	Se,co,p	San Bernadino
p	pearl eye	9	Se,p	San Bernadino
pas	pointed abdominal sternite	2	apt, pas	San Bernadino
pas	pointed abdominal sternite	2	ptl, mas, pas	San Bernadino
pas	pointed abdominal sternite	2	mas, pas	San Bernadino
pas	pointed abdominal sternite	2	Quad(mxp,apt,mas,pas	San Bernadino
pas	pointed abdominal sternite	2	quint	San Bernadino
pas30	pointed abdominal sternite 30	2	ab,pas30,p	Manhattan
pas30	pointed abdominal sternite 30	2	ba,mxp,apt,pas30	Manhattan
pas30	pointed abdominal sternite 30	2	s,h,b(t),mxp,apt,pas30	Manhattan
pas30	pointed abdominal sternite 30	2	s,h,j2,mxp,apt,pas30	Manhattan
pas30	pointed abdominal sternite 30	2	s,j,b(t),mxp,apt,pas30,h	Manhattan
pas30	pointed abdominal sternite 30	2	ub,pas30	Manhattan
pas30	pointed abdominal sternite 30	2	ue,ab,msg,p,mxp,apt,pas30	Manhattan
pd	paddle antenna	X	py, pd, plt	San Bernadino
PL4	Pseudo Linker 4	7;2	Crab/PL4	Manhattan
plt	platinum eye	X	py, pd, plt	San Bernadino
pnk (NDG-2)	pink eye, from NDG-2	?	pnk (NDG-2)	Manhattan
Ps	Pinched sternellum	2	Ps	San Bernadino
ptl	prothoraxless	2	ju,ptl	San Bernadino

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ptl	prothoraxless	2	ptl	San Bernadino
ptl	prothoraxless	2	ptl, mas, pas	San Bernadino
ptl	prothoraxless	2	ptl, mxp	San Bernadino
ptlD16,Stm	Dom. prothoraxless 16, Stm (cis)	2	ptlD16,Stm/Ey	Manhattan
ptlD2	Dom. prothoraxless 2	2	ptlD2/Stb	Manhattan
ptlD26Y	Dom. prothoraxless 26, Y-linked	2;Y	ptlD26Y	Manhattan
ptlD57,Stm	Dom. prothoraxless 57, Stm (cis)	2	ptlD57,Stm/Ey	Manhattan
ptlD60	dominant prothoraxless 60	2	A(Ag1), Stm /ptlD60	Manhattan
ptlD60	dominant prothoraxless 60	2	ptlD60/Ey	Manhattan
py	pygmy	X	py, pd, plt	San Bernadino
py	pygmy	X	py, ser	San Bernadino
Pyr-R	Pyrethroid resistant	9	co,Pyr-R	Peter Collins
QTC 279 (Pyr-R)	Pyrethroid resistant	9?	QTC 279 (Pyr-R)	Peter Collins
Rap	Recurved anterior pronotum	2	Rap	Manhattan
rb	ruby eye	5	mc,rb,j	San Bernadino
rb	ruby eye	5	rb,j	San Bernadino
Rd	Reindeer, homozygous viable	2	Rd/Rd	Dawson
Rd	Reindeer, homozygous viable	2	Rd, mas, p	Dawson
Rd	Reindeer, homozygous viable	2	Rd,mc,p	Dawson
Rd	Reindeer, homozygous viable	2	Rd,pas30	Dawson
Rd(CS)	Reindeer, crossover suppressor	2	Ps/Rd(CS)	Manhattan
Rdiel BC9 Lab-S	Dieldrin resistant from Lab-S	NA	Rdiel BC9 Lab-S	Unknown
Rmal-2 (Cogburn)	Malation resistant	NA	Rmal-2 (Cogburn)	Texas
Russell 1 BC4s	spontaneous sooty ?	NA	Russell 1 BC4s	Russell, KS
Russell 2 BC4s	spontaneous sooty ?	NA	Russell 2 BC4s	Russell, KS
s	sooty	4	Crab,s	San Bernadino
s	sooty	4	s	San Bernadino
s	sooty	4	Det43,h,s/Es,h,s	San Bernadino
s	sooty	4	h, s	San Bernadino
s	sooty	4	s,h,b(t),mxp,apt,pas30	San Bernadino
s	sooty	4	s,h,j2,mxp,apt,pas30	San Bernadino
s	sooty	4	s,j,b(t),mxp,apt,pas30,h	San Bernadino
s	sooty	4	Be, s	San Bernadino
s	sooty	4	Ga-9s	San Bernadino
s	sooty	4	MMS (s.c.ap,au,mas)	San Bernadino
sa	short antenna	?	b, apt, sa, c	San Bernadino
sa	short antenna	?	sa,c	San Bernadino
Sa-8	Short antenna-8	?	Sa-8	Manhattan
sa-X	short antenna, X-linked	X	sa-X	Manhattan
Se	Short elytra	9	Se	Manhattan
Se	Short elytra	9	Se,co,p	Manhattan
Se	Short elytra	9	Se,p	Manhattan
se 46	short elytra 46	?	se 46	Purdue
Se-2	Short elytra 2	8	Se-2	Manhattan
Se12	Short elytra 12	?	Se12	Purdue
ser	serrate antenna	X	py, ser	San Bernadino
Skl2s	Socketless spontaneous 2	2	Skl2s/Stm,Cx5	Manhattan
Skl4/Ey	Socketless 4	2	Skl4/Ey	Manhattan
Skl4R1	Socketless 4, revertant 1	2	Skl4R1/Ey	Manhattan
Skl4R2	Socketless 4, revertant 2	2	Skl4R2/Ey	Manhattan
Skl4R3	Socketless 4, revertant 3	2	Skl4R3/Stm,Cx5	Manhattan
Skl6	Socketless 6	2	Skl6/Stm,Cx5	Manhattan
Skl6R1	Socketless 6, revertant 1	2	Skl6R1/Stm,Cx5	Manhattan
small	small body size	?	small	Purdue
sp	shoulder pads	2	sp/Dch3	Manhattan
sp	shoulder pads	2	sp/Stm,Ag4	Manhattan
Spa	Spatulate antennae	2;4	Ds/Spa (no Medea)	San Bernadino
Spa	Spatulate antennae	2;4	Spa/Es1	San Bernadino
sq (Tiw-2)	squint (from Tiw-1)	?	sq (Tiw-2)	India
sq-B	squint (from Burma)	?	sq-B	Burma
sq1	squint eye 1	8	Bald,ap;sq1/ap,sq1	San Bernadino
sq1	squint eye 1	8	sq1	San Bernadino

sq2	squint eye 2	8	ap,sq2	Manhattan
sq2	squint eye 2	8	Bald,ap,sq2/ap,sq2	Manhattan
Stb	Stubby antennae	2;X	Em,A16s/Stb	Manhattan
Stb	Stubby antennae	2;X	Lu,Skl6/Stb	Manhattan
Stb	Stubby antennae	2;X	Stb/Es	Manhattan
Stb,Df(mas)	Stubby, deficiency in mas	2	Stb,Df(mas)/Es	Manhattan
Stbd	Stubold (short antennae)	2	Lu/Stbd	Manhattan
Stbd	Stubold (short antennae)	2	Stbd/Es	Manhattan
Stm	Stumpy	2	Stm/Stm	Manhattan
Stm+RSptlD	Stm spontan. revert. ptl	2	Stm+RSptlD/Es1	Manhattan
Stm,Ag4	Stm, Antennagalea 4	2	X-83/Stm,Ag4	Manhattan
Stm,Ag4	Stm, Antennagalea 4	2	X-47/Stm,Ag4	Manhattan
Stm,Ag4	Stm, Antennagalea 4	2	vwe/Stm,Ag4	Manhattan
Stm,Ag4	Stm, Antennagalea 4	2	sp/Stm,Ag4	Manhattan
Stm,Ag4	Stm, Antennagalea 4	2	g/Stm,Ag4	Manhattan
Stm,Ag4	Stm, Antennagalea 4	2	X-31/Stm,Ag4	Manhattan
Stm,Cx5	Stm, Cephalothorax 5, cis	2	A4/Stm,Cx5	Manhattan
Stm,Cx5	Stm, Cephalothorax 5, cis	2	A8/Stm,Cx5	Manhattan
Stm,Cx5	Stm, Cephalothorax 5, cis	2	AgPin/Stm,Cx5	Manhattan
Stm,Cx5	Stm, Cephalothorax 5, cis	2	Lu / Stm,Cx5	Manhattan
Stm,Cx5	Stm, Cephalothorax 5, cis	2	Skl2s/Stm,Cx5	Manhattan
Stm,Cx5	Stm, Cephalothorax 5, cis	2	AD100,Stm,Cx5/Es1	Manhattan
Stm,Cx5	Stm, Cephalothorax 5, cis	2	AD100,Stm,Cx5/Es1	Manhattan
Stm,Cx5	Stm, Cephalothorax 5, cis	2	Skl2s/Stm,Cx5	Manhattan
Stm,Cx5	Stm, Cephalothorax 5, cis	2	Skl4R3/Stm,Cx5	Manhattan
Stm,Cx5	Stm, Cephalothorax 5, cis	2	Skl6/Stm,Cx5	Manhattan
Stm,Cx5	Stm, Cephalothorax 5, cis	2	Skl6R1/Stm,Cx5	Manhattan
Stm,Cx5	Stm, Cephalothorax 5, cis	2	Stm,Cx5/Es1	Manhattan
Stm,Cx5	Stm, Cephalothorax 5, cis	2	Stm,Cx5/Ey,A14	Manhattan
Stm,Cx5	Stm, Cephalothorax 5, cis	2	Stm,Cx5/Ey; s/s	Manhattan
Stm,Ns	Stm, Narrow sternellum (cis)	2	Stm,Ns/Es1	Manhattan
Stm-Es1/+NDJ	Non-disjunction	?	Stm-Es1/+NDJ	Manhattan
Stm-Skl4-Es/+ NDJ	Non-disjunction	?	Stm-Skl4-Es/+ NDJ	Manhattan
Stm-Skl6/+NDJ	Non-disjunction	?	Stm-Skl6/+NDJ	Manhattan
StmR1	Stm revertant 1	2	StmR1/Es1	Manhattan
StmR2	Stm revertant 2	2	StmR2/Es1	Manhattan
StmR5	Stm revertant 5	2	StmR5/Es1	Manhattan
StmR6	Stm revertant 6	2	StmR6/Es1	Manhattan
T(Y;3)	Translocation Y-3	Y:3	T(Y;3)	Manhattan
T(Y;4)	Translocation Y-4	Y;4	T(Y;4)	Manhattan
T. brevicornis	Tribolium brevicornis	NA	T. brevicornis	Manhattan
T. confusum (apt,mas,sti)	T.c. with apt, mas, sti	?	T. confusum (apt,mas,sti)	San Bernadino
T. confusum (b,au,lod,p)	T.c. with b,au,lod,p	?	T. confusum (b,au,lod,p)	San Bernadino
T. confusum (PRC)	Tribolium confusum	NA	T. confusum (PRC)	P.R. China
T. freemani	Tribolium freemani	NA	T. freemani	Japan
T. madans	Tribolium madans	NA	T. madans	Manhattan
tar	anterior melanotic stink glands	2	tar	Manhattan
tib	tibialess (from ab)	9?	tib	Manhattan
Tiw-1	?	NA	Tiw-1	India
Tiw-1 (iso 43)	Tiw-1 isoline	NA	Tiw-1 (iso 43)	India
Tiw-1(iso 43) pink	pink eye from Tiw-1	NA	Tiw-1(iso 43) pink	India
tr	tremblor	2;4	Es/tr	Manhattan
tr	tremblor	2;4	tr	Manhattan
ub	unbuckled T1 epimera	2	Ey,ub/Es,ub	Manhattan
ub	unbuckled	2	ub	Manhattan
ub	unbuckled	2	ub, ab	Manhattan
ub	unbuckled	2	ub,g	Manhattan
ub	unbuckled	2	ub,pas30	Manhattan
ub	unbuckled	2	Quint(ub,mxp,apt,mas,pas)	Manhattan
ue	unsclerotized elytra	?	ue	Manhattan
ue	unsclerotized elytra	?	ue,ab,msg,p,mxp,apt,pas30	Manhattan
Utx(New)	Ultrathorax (New)	2	Utx(New)	Manhattan
Utx1	Ultrathorax	2	A10,mxpA10/Utx1,mxp,apt	Manhattan

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Utx1	Ultrathorax	2	Ip69/Utx1,mxp,apt	Manhattan
Utx1	Ultrathorax	2	Utx1,mxp,apt/mxpX9,Es1	Manhattan
Utx1	Ultrathorax	2	Utx1/Es	Manhattan
Utx1	Ultrathorax	2	Utx1/Utx1	Manhattan
Utx2,Stm	Ultrathorax 2, Stm (cls)	2	Utx2,Stm/Es1	Manhattan
vwe	vestigial wings and elytra	2	vwe/Dch3	Manhattan
vwe	vestigial wings and elytra	2	vwe/Es1	Manhattan
vwe	vestigial wings and elytra	2	vwe/Stm,Ag4	Manhattan
w	white eye	4	w	San Bernadino
X(ab-1s)	Lethal revertant from ab	9	Dch3/X(ab-1s)	Manhattan
X(ab-2s)	lethal revertant from ab stock	3	3P2/X(ab-2s)	Manhattan
X-31	lethal 31	2	X-31/Dch3	Manhattan
X-31 pearl s.l.	lethal 31 with pearl	2	X-31 pearl s.l./Dch3	Manhattan
X-47	lethal 47	2	X-47/Stm,Ag4	Manhattan
X-83	Lethal 83	2	X-83/Stm,Ag4	Manhattan

SUE HAAS.

SAN BERNARDINO, CALIFORNIA
CALIFORNIA STATE UNIVERSITY
BIOLOGY DEPARTMENT

I. Tribolium anaphe
  1. Wild
  2. Splprps (I)

II. Tribolium audax

III. Tribolium brevicornis

1. Wild	Riverside, 1969
2. Wild	Idaho 1975
3. Wild	San Bernardino, 1977
4. spl	

IV. Tribolium castaneum

A. Wild type strains

1. Chicago	Park, 1955
2. Consejo	Spain, a968
4. Davis	Davis, Ca, 1961
6. Florida	Bell, 1970
8. McGill	Stanley, 1958
10. PIL	?
12. Sacramento	1961
14. Texas	1958
16. Veracruz	Mexico, 1963
17. Virginia	
19. Synthetic 1 (has s)	Prepared 1958
20. Synthetic 2 (no body color)	Prepared 1958
23. New York UPF	1976
24. San Bernardino	1976
25. CS-4 (from New York)	1976

B. Mutants

1. Sex-linked

26. dve--divergent elytra	Chazy, 1959
30. pd--paddle	Park, 1955
34. pte	Berkeley, 1965
36. py--pygmy	Chazy, 1959
38. r--red	Chazy, 1959
39. r^D--red	Berkeley
54. pd, r--paddle, red	
55. py, r, M^r--pygmy, red, red modifier	
59. r, sp--red spotted	
61. pd, pte--paddle, platinum eye	

Stock Lists

Autosomal

63. p--pearl II New York 1976
64. p^{Pk}--pink II Chazy, 1959
65. p pearl II Park 1955
66. p^{S} pearl II
76. au--aureate III
78. b--black III
81. b^{S-1} -- black, Brazil
82. b--black Chicago 1955
84. b--black McGill 1959
85. b--black McGill via New York, 1976
86. b--black NASA 1959
88. b--black synthetic (Chicago/McGill)
90. Chr--Charcoal III
91. lod p--light ocular diaphragm, pearl III,II
94. msg--melanotic stink glands III
96. mt--mottled III
98. b^{t}--tawny III
105. fas-2--fused antennal segments-2 IV
107. ap, ju--antennapedia, juvenile urogomphi
113. s--sooty (Berkeley synthetic background) IV
114. s--sooty (New York) IV
135. j--jet V
136. j^{AS}--jet V
139. mc--microcephalic V Chazy, 1959
140. mc-1 microcephalic-1 (eyeless) V Hayward 1967
143. fas-3a fused antennal segments 3a V Berkeley, 1963
148. m--maroon V Purdue 1970
150. rb--ruby V Berkeley, 1962
156. Mo--Microphthalmic VI Chazy, 1959
162. sa=ca--short antenna VII Cold Sprg. Hbr. 1960
165. c--chetnut VII Purdue, 1962
168. ju-7--juvenile urogomphi VII-IV Purdue
170. ble--blistered elytra VII Berkeley 1962
173. c, Rd VII,II Corvallis 1975
180. ap^{S}--antennapedia VIII Berkeley 1962
186. sq^{D}--squint VIII Chazy 1959
189. apt--alate prothorax IX Berkeley 1963
192. ptl--prothoraxless IX Chazy 1959
194. ppas--partially pointed abdominal sternites Berk. 1963
196. mas--missing abdominal sternites II Berkeley 1964
228. Dch--Dachs II San Bernardino 1976
230. fas-1--fused antennal segments-1 Chazy 1959
233. imp--incomplete mesothoracic projections
238. mxp--maxillopedia II berkeley 1965
240. Npp--Non-punctate prothorax, a phenodeviant

245. pec--pectinate
252. sc--scar Purdue
259. w--white Purdue
261. fas-8--fused antennal segments-8
271. Gi--Giant PIL
278. la--long abdomen PIL
280. Veracruz small
288. fas-9 fused antennal segments-9 San Bernardino, 1975
295. pd,p--paddle, pearl I, II
296. pd,p,b--paddle, pearl black I, II, III
297. sp,p--spotted, pearl I, II
299. py,i,p--pygmy, ivory, pearl I, II, II
301. p, au, lod--pearl, aureate, light ocular diaphragm II, III, III.
302. p, au, mc--pearl, aureate, microcephalic II, III, V
303. p,b--pearl, black (II, III)
304. p,au,lod,msg--pearl, aureate, light ocular diaphragm, melanotic stink glands (II, III, III, III)
306. p,b,pe--pearl, black, pointed elytra (II, III,?)
308. p,mc--pearl, microcephalic II, V
310. p,s--pearl, sooty II, IV
312. p,j,Npp--pearl, jet, Non-punctate prothorax II, V
313. p,apt,Mo--pearl, alate prothorax, Microphthalmic II, II, VI.
315. p,mas--pearl, missing abdominal segments II, II
316. p, knp--pearl, knobby prothorax II, II
317. p,aa--pearl, abbreviated appendages II, V
322. p,Fas-4,b--pearl, Fused antennal segments-4, black II, ?, III
415. mxp,s--maxillopedia, sooty II, IV
416. au, s--aureate, sooty III,IV
417. h, s--hazel, sooty III, IV
428. c, Npp--chestnut, Nonpunctate prothorax VII, ?
430. au,Npp--aureate, Nonpunctate prothorax III, ?
436, au,mc--aureate, microcephalic III, V
442. Df,s,Mo--Deformed, sooty, Microphthalmic ?, IV, VI
444. i,lod,Mo--ivory, light ocular diaphragm, Microphthalmic II, III, VI
445. i,ppas-ivory, partially pointed abdom. sternites II, ?
448. Chr,ap--Charcoal, antennapedia III, VIII
450. au,ble--aureate, blistered elytra III, VII
454. p^{ELL} /p^{Pk} II
462. mas, mc--missing abdominal segments, microcephalic II,V
469. i,lod--ivory, light ocular diaphragm II,III
470. lod,rb--light ocular diaphragm, ruby III, ?
473. fas-6--fused antennal segments-6

V. Tribolium confusum

Wild type strains

1. Chicago Park, 1955

2. Chicago via Sokal, 1975
3. McGill via McDonald
4. McGill Stanley, 1958
5. New York 1961
6. Sacramento
7. San Bernardino 1968
8. Yugoslavia 1975

Synthetic strains

1. Berkeley

Mutant strains

apt--alate prothorax I
apt,fas-2--alate prothorax, fused antennal segments-2
b-black III
b,cas,p--black, creased abdominal segments, pearl
b,lod,p--black, light ocular diaphragm, pearl
b,p--black, pearl
b,rus--black, ruby spot
b,rus,spl--black, ruby spot, split
b,twa--black, twisted abdomen
b-2--black-2
b-2/b McGill--synthetic black
bZ,rZ--black Zagreb, red Zagreb
(black strains from Carlisle, Pa., Chicago, Donner lab, Georgia, McGill, Sault Ste. Marie, Winnipeg and Yugoslavia)
b-Chicago/b McGill--synthetic black
b-Mcgill,fas--black, fused antennal segments
b-Mcgill,p--black, pearl
b-SSM,spl--black, split
ble--blistered elytra V
ble,e--blistered elytra, ebony V,V
car,p--carmine, pearl
cas--creased abdominal segments II
cla-claret
cru--crumpled I
dpe--dirty pearl eye II
dj--disjoined VI
dt--dent (see umb--umbilicus)
dt,p--dent, pearl
e--ebony V Chicago, 1955
(other ebony alleles)
e,fas-3--ebony, fused antennal segments-3 V, ?
e-2--ebony-2 (not allelic with e) II
e-2,fas-1--ebony, fused antennal segments-1
ele--elongated elytra
ele,fas-2--elongated elytra, fused antennal segments-2
es--eyespot I
es,fas-1--eyespot, fused antennal segments-1
es,fas,msg--eyespot, fused antennal segments melanotic stink glands I, ?, III
es,fas,sti--eyespot, fused antennal segments, sternites incomplete

eu,fas-2--extra urogomphi, fused antennal segments-2
fas-2--fused antennal segments-2 II
fas-2,lod,msg,p--fused antennal segments-2, light ocular diaphragm, melanotic stink glands, pearl II,III,III,II
fas-2,lod,p--fused antennal segments-2, light ocular diaphragm pearl II,III,II
fas-2,msg--fused antennal segments-2, melanotic stink glands II,III
fas-3--fused antennal segments-3
fro--frosted
lod,rus--light ocular diaphragm, ruby spot
msg--melanotic stink glands III
msg,rus--melanotic stink glands, ruby spot III,III
msg,twa--melanotic stink glands, twisted abdomen III,?
ov-like--overshot-like
p-pearl II
p-Slough-pearl
p^R--pearl riboflavinless II
r-red I
r,sh--red, short elytra
r^U--red
r^Z--red from Zagreb
rby--ruby
rus--ruby spot III
sh--short elytra (Berkeley)
sh,sp,twa--short elytra, split, twisted abdomen
sp--split III
sp-1--split-1
twa--twisted abdomen
thu--thumbed IV
thu^S--an allele of thu. IV
thu, Xl--thumbed, Extra large
umb--umbilicus

VI. Tribolium destructor

VII. Tribolium freemani

VIII. Tribolium madens

A. Sokoloff

white via Cal State U., S.B.

Tribolium confusum -wild strain via Carolina Biol. Supply.

Eliot Krause

STORRS, CONNECTICUT 06268
COLLEGE OF LIBERAL ARTS AND SCIENCES
THE BIOLOGICAL SCIENCES GROUP

1. Tribolium brevicornis (two vials)

2. Tribolium castaneum

   a. Chicago
   b. Veracruz
   c. Berkeley synthetic, marked with s.
   d. Chicago black, b.
   e. mc, p (microcephalic, pearl
   f. pygmy
   g. Davis Low Body Weight
   h. Davis High Body Weight

3. Tribolium confusum

   a. Chicago
   b. Yugoslavia
   c. Inbred (Group L CFI-B, culture 8d; Generation 123)
   d. b,p (black, pearl
   e. dj, e (disjoined, ebony)
   f. sh (short elytra

(Ed.).

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

I. Wild type strains

A. Coleoptera strains

Dermestidae

Attagenus megatoma (F.)	Madison, Wis., 1975, Savannah, Ga. 1974
Trogoderma variabile Ballion	field collected, Mn. 1972

Cucujidae

Oryzaephilus surinamensis (L)	"
Oryzaephilus mercator (Fauvel)	
Cryptolestes pusillus (Schoenherr)	Manhattan Ka. 1967
Cryptolestes ferrugineus (Stephens)	Unknown

Silvanidae

Ahasverus advena Waltl.	Minnesota

SAVANNAH, GEORGIA
STORED-PRODUCT INSECTS RESEARCH AND DEVELOPMENT LABORATORY

I. Wild type strains

A. Lepidoptera

1. Cadra cautella (Walker)	N.C. Tifton, Ga.
2. Plodia interpunctella (hubner)	Modesto, Ca.
3. Sitotroga cerealella (Olivier)	Manhattan, Ka Can., and Durham, N.H.

b. Coleoptera

1. Attagenus megatoma (Fab.)	CSMA strains
2. Callosobruchus maculatus (Fab.)	Fresno, ca.
3. Cryptolestes ferrugineus (Stephens)	S. Carolina
4. Lasioderma serricorne (Fab.)	Unknown
5. Oryzaephilus mercator (Fauvel)	Unknown
6. Oryzaephilus surinamensis (L.)	Manhattan, Kan.
7. Rhyzopertha dominica Fab.)	Unknown
8. Sitophilus granarius (L.)	Manhattan, Kan.
9. S. oryzae (L.)	Ark., Calif., Kan., La.
10. S. zeamais Motchulsky	Estill, S.C.
11. Stegobium paniceum (L.)	Madison, Wis.
12. Tribolium castaneum (Herbst)	Unknown
13. Tribolium confusum duVal	Manhattan, Kan.
14. Trogoderma glabrum (Herbst)	Madison, wis., Riverside, Ca.

II. mutant strains. None

Richard T. Arbogast, Laboratory Director.

South Orange, New Jersey 07079
Seton Hall University
Department of Biology

Tribolium castaneum

Wild Type Strains

Seton Hall-1	South Orange, N.J.
McGill	via Cal State U., S.B.

synthetic Strains

Pearl Foundation	via Purdue Univ.
Black Foundation	via Purdue Univ.

Mutant Strains

Paddle	via Cal State U., S.B.
Red (Ho)	" " " " " "
Short antenna (Sa)	via Purdue Univ.
short antenna (ca)	via Oregon State
white	via Cal State U., S.B.

ELIOT KRAUSE.

South Orange, New Jersey
Seton Hall University
Department of Biology

T. castaneum

Wild Type Strains

Seton Hall-1

McGill, via California State

Synthetic Strains

Pearl Foundation, via Purdue University

Black Foundation, via Purdue University

Mutant Strains

Paddle (pd) via Cal State U., S.B.

Red ^{Ho} (R^{ho}) Via Cal State U., S.B.

White (w) Via Cal State U., S.B.

short antenna (ca) Via Oregon State

Short antenna (Sa) Via Purdue University

Tribolium confusum Via Carolina Biological Supply

Eliot Krause

STORRS, CONNECTICUT 06268
COLLEGE OF LIBERAL ARTS AND SCIENCES
THE BIOLOGICAL SCIENCES GROUP

1. Tribolium brevicornis (two vials)

2. Tribolium castaneum

   a. Chicago
   b. Veracruz
   c. Berkeley synthetic, marked with s.
   d. Chicago black, b.
   e. mc, p (microcephalic, pearl
   f. pygmy
   g. Davis Low Body Weight
   h. Davis High Body Weight

3. Tribolium confusum

   a. Chicago
   b. Yugoslavia
   c. Inbred (Group L CFI-B, culture 8d; Generation 123)
   d. b,p (black, pearl
   e. dj, e (disjoined, ebony)
   f. sh (short elytra

(Ed.).

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

I. Wild type strains

A. Coleoptera strains

Dermestidae	
Attagenus megatoma (F.)	Madison, Wis., 1975, Savannah, Ga. 1974
Trogoderma variabile Ballion	field collected, Mn. 1972
Cucujidae	
Oryzaephilus surinamensis (L)	
Oryzaephilus mercator (Fauvel)	
Cryptolestes pusillus (Schoenherr)	Manhattan Ka. 1967
Cryptolestes ferrugineus (Stephens)	Unknown
Silvanidae	
Ahasverus advena Waltl.	Minnesota

Tenebrionidae	
Cyaneus angustus (LeConte)	Winnipeg; Minnesota
Tribolium castaneum (Herbst)	Corvallis, Ore
Tribolium confusum duVal	Unknown
Tenebrio molitor	Carolina Biological, 1984
Anobiidae	
Lasioderma serricorne (Fab.)	Savannah, Ga.
Bostrichidae	
Rhizopertha dominica (F.)	Manhattan, Ka.
Prostephanus truncatus (Horn)	Unknown
Curculionidae	
Sitophilus granarius (L.)	Unknown
S. oryzae (L.)	"
B. Lepidoptera	
Pyralidae	
Anagasta kuehniella (Zeller)	Savannah, Ga.
Gelechiidae	
Sitotroga cerealella (Oliver)	Savannah, Ga.

(Ed.)

St. Paul, Minnesota 55108
University of Minnesota
Department of Entomology
Stored-Grain Pest Management Program

Eight species of stored-product beetles and two species of moths are maintained in the laboratory. These species include: Angoumois grain moth, flat grain beetle, Indian meal moth, larger brain borer, lesser grain borer, merchant grain beetle, red flour beetle, red flour beetle, rusty grain beetle, rice weevil, and sawtoothed grain beetle.
The Angoumois grain moth was obtained in June 1993 from Community Research Service, Kentucky State University, Kentucky. All other species were obtained in January 1992 from the Department of Entomology, Kansas State University, Manhattan, Kansas. Except for the merchant grain beetle, all species originated from farm-stored grain. The origin of merchant grain beetles is unknown.
Areas of research:
Developing and validating sampling schemes for insects associated with farm-stored grain.
Evaluating nonchemical alternatives for suppressing stored-grain traits.
Modeling population trends of insects from life-history traits.

Bhadriraju Subramanyam, Ph. D.

WASHINGTON, D.C. 20204
DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
DIVISION OF MICROBIOLOGY

Coleoptera

Anobiidae
Stegobiium paniceum (L.)

Anthribidae
Araecerus fasciculatus (Deg.) (poor condition; may be dead).

Bostrichidae
Rhyzopertha dominica (F.)

Bruchidae
Acanthoscelides obtectus (Say)

Cleridae
Necrobia rufipes (Deg.)

Cucujidae
Ahasverus advena (Waltl)
Cryptolestes ferrugineus (Steph.). Poor condition, may be dead.
C. pusillus (Schon.)
C. turcicus (Grouv.)
Oryzaephilus surinamensis (Linnaeus)

Curculionidae
Sitophilus granarius (L.)
S. zeamais Motschulsky

Dermestidae
Anthrenus flavipes LeC. Weak culture
Anthrenus verbasci (Linnaeus)
Dermestes maculatus De Geer
Trogoderma variabile Ballion

Ostomidae
Gibbium psylloides (Czemp.)

Silvanidae
Ahasverus advena (Waltl.)
Oryzaephilus surinamensis

Tenebrionidae
Alphitobius diaperinus (Panz.)
Gnathocerus maxillosus (F.)
Palorus ratzeburgi (Wissm.)
Tribolium brevicornis (LeConte)
T. castaneum (Herbst)
T. confusum Duv.
T. destructor Uytt.--weak culture, may be diseased.

T. madens (Charpentier)

M. Nakashima

AUSTRALIA

Burnley, Victoria
Victoria Plant Research Institute
Department of Agriculture

COLEOPTERA

Tribolium castaneum

Wild type strains
Malathion specific resistant strain
Malathion non-specific strain

Tribolium confusum

Wild type strains
Malathion specific strain

Oryzaephilus surinamensis

Wild type strain
Malathion resistant strain

Oryzaephilus mercator

Alphitobius diaperinus

Cryptolestes ferrugineus

Gnathocerus cornutus

Gnathocerus maxillosus

Latheticus oryzae

Rhyzopertha dominica

Sitophilus granarius

Sitophilus oryzae

Sitophilus zeamais

Tenebroides mauritanicus

LEPIDOPTERA

Ephestia cautella

Ephestia figulella

Galleria mellonella

Plodia interpunctella

P. Williams

Indooroopilly, Queensland 4068, Australia
Queensland Department of Primary Industries
Plant Protection Unit

Coleoptera

Oryzaephilus surinamensis

Wild type strains

VOS 48	insecticide susceptible	Victoria
QOS 42	fenitrothion susceptible	Queensland
QOS 115	chlorpyrifos-methyl-R a	Queensland

Rhyzopertha dominica

Wild type strains

QRD 369	phosphine-resistance	Queensland
QRD 14	insecticide susceptible	Queensland
QRD 2	multiresistant	Queensland
QRD 63	multiresistant	Queensland
QRD 318	pyrethroid-resistant	Queensland

Sitophilus oryzae

Wild type strains

LS 2	insecticide susceptible	Queensland
QSO 56	multi-resistant	Queensland
CSO 231	multi-resistant	W. Australia
QSO 388	phosphine-resistant	Queensland

Tribolium castaneum

Wild type strains

QTC 4	insecticide susceptible	Queensland
QTC 279	pyrethroid insecticide resistant	Queensland
QTC 285	multi-resistant, composite strain	Queensland
CTC 12	non-specific malathion resistant	Queensland
QTC 34	malathion specific-resistant	Queensland
QTC 320	phosphine-resistant	Queensland

Lepidoptera	Queensland
Ephestia cautella Wild	

Patrick J. Collins, Senior Entomologist

CANADA

Winnipeg, manitoba R3T 2M9
Ecology of Field and Stored Product Pests Section
Agriculture and Agri-Food Canada
Research Station,
195 Dafoe Rd.

All cultures are laboratory cultures maintained over several years. Geographic origins are not complete

Species	Origin	
1. Acanthoscelides obtectus	Phillips, Wis.	1993
2. Ahasverus advena	Argyle, MB	1991
3. Callosobruchus maculatus	Phyllips, Wis	1993
4. Cryptolestes ferrugineus	Manitoba (MB)	1991
5. Cryptolestes pusillus	Lac du Bonnet, MB	1988
6. C. turcicus		1971
7. Cynaeus angustus	Minnesota	1982
8. Lasioderma serricorne	Winnipeg, MB	1984
9. Liposcelis bostrychophilus	Winnipeg, MB	1994
10. Oryzaephilus mercator		
11. O. surinamensis	Landmark, MB	1991
12. Prostephanus truncatus	Mexico City, Mexico	1977
13. Rhyzopertha dominica	Manitoba	1993
14. Sitophilus granarius		
15. S. oryzae	Coal Lake, AB	1992
16. S. zeamais	Minnesota, USA	1982
17. Stegobium paniceum	winnipeg, MB	1993
18. Tenebrio molitor	Winnipeg, MB	1980
18. Tribolium audax		
19. T. castaneum	Manitoba	1991
20. T. confusum		

The following T. castaneum mutant strains were received in November 1985 from Dr. Sokoloff's laboratory at California State University

21. Culture S38	red eye
22. Culture S351	red eye, pigmy, fused antennal segments
23. Culture S156	Microphthalmic
24. Culture S136	jet (dark body)
25. Culture S113	sooty (dark body)
26. Culture S63	pearl eye
27. Culture S165	chestnut eye
28. Culture S148	maroon eye
29. Culture S38	paddle (antennae fused, flat)

The following mutant strains of Tribolium castaneum have had no linkage analysis.

30. malathion-specific resistance
31. black body and pearl eyes

The following mutant strains of Tribolium confusum have had no linkage analysis

32. red eyes
33. black body

34. Tribolium madens		
35. Trogoderma variabile		
36. Typhaea stercorea	Manitoba	1991

Lepidoptera

1. Plodia interpunctella	Winnipeg	1990
2. Sitotroga cerealella	Kansas	1982

COLOMBIA

SANTA FE DE BOGOTA, D.C.,
UNIVERSIDAD NACIONAL DE COLOMBIA
FACULTAD DE CIENCIAS
DEPARTAMENTO DE BIOLOGIA
APDO. AEREO #14490

Tribolium castaneum

I. Wild type strains

NAME	ORIGIN	DATE
1. ABBC	Synthetic, Bogota	1982
2. Apulo	Apulo (Cund.) Col.	1982
3. Bogota	Inst. Publ. Health,	1978
	Bogota, Col.	1981
4. Bucaramanga	Bucaramanga, (Sant.)	1981
5. Cartagena	Cartagena, Bol., Col	1980
6. Fusa	Fusagasuga, Cund. Col	1986
7. Honda	Honda, tol. Col.	1986

II. Domestic mutants

Mutant strains discovered in Colombia

NAME	SYMBOL	LINKAGE GROUP	ORIGIN	DATE OF ENTRY
	N			
8. Antennapedia	ap	VIII	Bog.	1981
9. Argentum eyes	ae	I	Bog	1993
10. Bifurcated antenna	ab	II	Bog.	1980
	N			
11. Black	b	III	Bog.	1983

12. colossal pupae	cp	?	Bog.	1993
13. Charcoal	Chr^b	III	Bog.	1979
14. Disjuncted elytra	ed	?	Bog.	1990
15. Fused antennameres	af	?	Bog.	1980
16. Glass legs	pv	?	Bog.	1980
17. Globose antenna	Ag	VII	Bog.	1989
18. Light eyes-1	oc	?	Bog.	1990
19. Light eyes-2	?	?	Bog.	1990
20. Light eyes-3	?	?	Bog.	1991
21. Light eyes-4	?	?	Bog.	1993
22. Metathoracic scar	sc	III	Bog.	1983
23. Miniature appendaged	ma^V	I	Bog.	1981
24. Narrow eyes	oje	?	Bog.	1980
25. Red eyes	or	?	Bog.	1986
26. White eye	obl	IV	Bog.	1982

III. Imported mutants from Tribolium Stock Center, 1985

27. Antennapedia	ap^D	VIII
28. Black	b	III
29. Charcoal	Chr	III
30. Miniature appendaged	ma	I
31. Microcephalic	mc	V
32. Microphthalmic	Mo	VI
33. Pearl eye	p	II
34. Platinum eye	pte	I
35. Pygmy	py	I
36. Short antenna	Sa	VII
37. Sooty	s	IV

Fernando Nunez del Castillo

DENMARK

LYNGBY
STATENS SKADEDYRLABORATORIUM
(DANISH PEST INFESTATION LABORATORY)

Anthrenus museorum
A. vorax
Attagenus smirnovi
A. unicolor (piceus)
A. woodroffei
Dermestes hemorrhoidalis
Lasioderma serricorne
Oryzaephilus surinamensis
Prostephanus truncatus
Ptinus tectus
Sitophilus granarius
S. oryzae

Stegobium (Sitodrepa) paniceum
Tenebrio molitor
Thylodrias contractus
Tribolium confusum
T. destructor
Trogoderma angustum
T. granarium

K. Arevad and H. Mourier

FRANCE

VILLEURBANE (LYON) RHONE
INSTITUT NATIONAL DES SCIENCES APPLIQUEES
LABORATOIRE DE BIOLOGIE

A. Wild type strains

1. Sitophilus granarius L.

2. S. oryzae L.
   a. FB strain (La Reunion)
   b. SFr strain (lyon) (56,500+3,000 ovarian symbiotes)
   c. W strain (Villeurbane) (22,700+1500 ovarian symbiotes)

3. S. zea-mais Mots--from PIL, Slough

B. Selected lines of Sitophilus oryzae

1. SS/Sfr strain:aposymbiotic strain (0 ovarian symbiotes) obtained from Sfr
2. LL strain (slow development)(42,000+3000 ovarian symbiotes)
3. RR strain (fast development) 88,000+5000 ovarian symbiotes)

P. Nardon
(No updated list available, Ed.).

ZOOLOGISCHES INSTITUT I
(ZOOLOGIE) DER ALBERT LUDWIGS UNIVERSITAT
D 78 FREIBURG IM BREISGAU
KATHARINENSTRASSE 20

Wild type strains
1. Oryzaephilus surinamensis Freiburg
2. Tribolium castaneum San Bernardino
3. T. confusum San Bernardino

Mutant strains (All from San Bernardino)
A. Tribolium castaneum
4. alate prothorax (apt)
5. Bar eye (Be)
6. black (Brazil background)
7. black (Chicago background)
8. Dachs (Dch)
9. Fused tarsi and antennae (Fta)
10. Microphthalmic (Mo)
11. nude (nd)
12. pygmy (py)

13. short antenna (sa)
14. Short antenna (Sa-2)
15. sooty (s)
16. Spatulate antenna (Spa)
weird eggs (wd)

B. Tribolium confusum
18. black-3 (b-3)
19. ebony (e)
20. ebony-2 (e-2)
21. McGill black (McGb)

K. Sander

MUNICH,
BAYER. LANDESANSTALT FUR BODENKULTUR
UND PFLANZENBAU, ABT. PFLANZENSCHUTZ

Coleoptera

Bruchidae--Acanthoscelides obtectus (Say)

Cucujidae--Cryptolestes turcicus Grouv. Munich, 1966

Ptinidae
Gibbium psylloides (Czemp) Regensburg, 1960
Ptinus tectus (Boi.) Munich, 1972

Silvanidae

Oryzaephilus mercator (Fauv.)	Munich,	1966
O. surinamensis (L)	?	1971

Munich (cont'd)

Tenebrionidae

Gnathocerus cornutus (F.)	MUNICH,	1966
Tribolium castaneum	?	1971
T. confusum Duv.	Munich,	1960
T. destructor Uyttenb.	"	1957

Lepidoptera

Phycitidae--Ephestia kuehniella (Zell.)	"	1966

E. Naton.

GERMANY

D-80333 munchen
Institut fur Zoologie
Luisenstrasse 14

WILD TYPE

Tribolium castaneum

MUTANTS provided by A. Sokoloff

Tribolium castaneum
- Bar eye, sooty (Be, s)
- Black, microcephalic pearl (b,mc,p)
- Microcephalic (mc)
- Microcephalic aureate (mc, au)
- Microphthalmic (Mo)
- Squint (sq)

Tribolium confusum
- Diminished eye (dim)

Marcus Friedrich

ISRAEL

TEL AVIV, ISRAEL
TEL AVIV UNIVERSITY
DEPARTMENT OF ZOOLOGY

Note: TSC=tribolium Stock Center, San Bernardino, Calif.).

A. Tribolium castaneum

1. Wild type strains

CTC-12 (insecticide resistant) Slough, England, 1977
Kano C (malathion resistant) Slough, England, 1977

2. Visible mutant strains
T.castaneum
bb (black) Stony Brook, N.Y.
eu++ (extra urogomphi, normal body color, derived from
mc--microcephalic derived from PP x bb, 1979
pd--paddle--From TSC, 1977
p--pearl. TSC, 1977
py--pygmy. TSC, 1979
electrophoretic mutants
bEs (slow esterase, b)--Derived from CSbb, 1977
bPs (slow phosphatase)--derived from EUbb, 1980
+PF (fast phosphatase)-- derived from eu++, 1981

B. Tribolium confusum
Wild type strains
Chicago --from TSC.
Ishaaya -- Israel, before 1972
Mutant strains
bb --via Stony Brook, 1970
XL (extra large) from TSC, 1979

c. T. brevicornis
++ Riverside via TSC, 1979

d. T. freemani
++ Japan, 1982

David Wool

JAPAN

NATIONAL FOOD RESEARCH INSTITUTE
MINISTRY OF AGRICULTURE, FORESTRY AND FISHERIES
2-1-2 KANNONDAI, YATABE-MACHI
TSUKUBA-GUN, IBARAKI-KEN 305

Psocoptera
 Liposcelidae
  Liposcelis bostrychophilus Badonel Wild
  Liposcelis entomophilus (Enderlein) Wild
 Trogiidae
  Lepinotus reticulatus Endelein Wild

Coleoptera
 Anobiidae
  Lasioderma serricorne (Fabricius) Wild
  Stegobium paniceum (L.) Wild
 Ptinidae
  Gibbium equinoctiale boieldieu Wild
 Bostrichidae
  Rhyzopertha dominica (Fabricius) Wild
  Dinoderus minutus (Fabricius) Wild
 Cucujidae
  Cryptolestes turcicus Wild
  Cryptolestes pusilloides (Steel & Howe Wild
 Silvanidae
  Oryzaephilus surinamentsis (L.) Wild
 Tenebrionidae
  Alphitobius diaperinus (panzer) wild
  Gnathocerus cornutus (Fabricius) Wild (Okayama str.)
  Palorus ratzeburgi (Wissmann) Wild
  Tribolium castaneum (Herbst) Wild
  T. confusum Jacquelin du Val Wild
  T. freemani Hinton Wild
  Tenebrio molitor L.
 Bruchidae
  Callosobruchus chinensis (L.) Wild
 Anthribidae
  Araecerus fasciculatus Degeer Wild
 Rhynchophoridae
  Sitophilus zeamais Motschulsky Wild
  Sitophilus oryzae (L.) Wild

Lepidoptera
 Pyralidae
  Ephestia cautella (Walker) Wild
  E. kuhniella (Zeller) Wild
  Plodia interpunctella Wild
  Corcyra cephalonica Wild
 Gelechiidae
  Sitotroga cerealella (Olivier) Wild

H. Nakakita H. Ikenaga

OKAYAMA
LABORATORY OF APPLIED ENTOMOLOGY
COLLEGE OF AGRICULTURE
OKAYAMA UNIVERSITY

1. Wild type strains

COLEOPTERA

1. Alphitobius diaperinus	Miyazaki
2. Callosobruchus chinensis	Okayama
3. C. maculatus	
4. Gnathocerus cornutus	Miyazaki
5. Lasioderma serricorne	Okayama
6. Latheticus oryzae	Miyazaki
7. Oryzaephilus surinamensis	Miyazaki
8. Palorus ratzeburgii	Miyazaki
9. P. subdepressus	Miyazaki
10. Rhysopertha dominica	Miyazaki
11. Sitophilus oryzae	Okayama
12. S. zeamais	Okayama
13. Tenebrio molitor	Okayama
14. Tenebroides mauritanicus	Okayama
15. Tribolium castaneum	Miyazaki
16. T. confusum	Miyazaki
17. T. freemani	

HYMENOPTERA

1. Anisopteromalus calandrae	Okayama
2. Choetospila elegans	Okayama
3. Lariophagus distinguendus	Okayama

Toshiharu Yoshida

INSTITUTE OF BIOLOGICAL SCIENCES
UNIVERSITY OF TSUKUBA
SAKURA-MURA, IBARAKI
300-31 JAPAN

Bruchidae

Callosobruchus chinensis

13 wild type strains from different localities in Japan and abroad

Black colored mutant derived from Shusenji strain.

cC Mainland China
fC Fukushima, Japan
hC Hirosaki, Japan
h1C Hirosaki, Japan

jC Kyoto, Japan, 1936
mC Morioka, Japan
nC Niigata, Japan, 1964
pC Punjab, India
sCbl Shusenji black mutant
tC Tokyo (Nishigahara, Nat. Inst. Agr.(, Japan
taC Tsukuba, Japan
taC2 Tsukuba, Japan
tsC Tsukuba, Japan
yC Taisha, Japan

C. maculatus
12 wild type strains from different localities in the world.
aQ U.S.A. (probably Louisiana).
bQ Burma
cQ Fresno Lab., USDA, Calif., U.S.A.
eQ Thailand
fQ Thailand
oQ Ohio, U.S.A.
rQ
tQ Tel Aviv, Israel (Dept. Plant Prot., Stored Prod. Res. Res. Lab.
kQ Kyoto, Japan
mQ Kansas State Univ., Manhattan, KS, U.S.A.
sQ Savannah Lab, USDA, georgia, U.S.A.

C. analis From United Kingdom
C. phaseoli From United Kingdom
Zabrotes subfaciatus From Africa
Acanthoscelides obtectus From California, U.S.A.
Hymenoptera
Braconidae
Heterospilus prosopidis from Hawaii, U.S.A.
Pteromalidae
Anisopteromalus calandrae, Japan
Chaetospila elegans from United Kingdom
Dinarmus basalis from India

K. fujii

PEOPLE'S REPUBLIC OF CHINA

Beijing
Beijing Agricultural University
Dept of Animal Science

Tribolium castaneum
  Wild type strains
    1. Base population for quantitative genetics, Guelph, 1987.
    2. Inbreeding line--Beijing, 1987
  Mutant strains: pygmy
    1. Base population maintained with no artificial selection and minimum of inbreeding--Guelph, 1987
    2. Inbreeding line--Beijing, 1987.

Lao zhang

SPAIN

MADRID
INSTITUTO NACIONAL DE INVESTIGACIONES AGRARIAS
DEPARTAMENTO DE GENETICA CUANTITATIVA Y MEJORA ANIMAL

tribolium castaneum

A. wild type strains

1.	Consejo	C.S.I.C. Madrid, Spain	1964
2.	Purdue	Purdue, USA.	1964
3.	edinburgh 1	Edinburgh, Scotland	1970
4.	Edinburgh 2	Edinburch, Scotland	1970
5.	Campanario	Campanario, Spain	1973
6.	Coronada	La Coronada, Spain	1976
7.	Andujar	Andujar, Spain	1975
8.	Jerez	Jerez, Spain	1975
9.	Osuna	Osuna, Spain	1975
10.	Carpio	Carpio, Spain	1975
11.	Jafo	Jafo, Israel	1975
12.	Beer-Sheba	Beer-Sheba, Israel	1975

B. Mutant type strains

13.	Black Purdue	Purdue, USA,	1964

C. Experimental lines

Originated from the "Consejo" strain and selected for egg laying performance through 42 generations

	selected for	Temperature (oC)
14. AN-I	high performance at	33
15. AN-II	" "	33
16. AF-I	" "	28
17. AF-II	" "	28
18. AT-I	" "	38
19. AT-II	" "	38
20. BN-I	low performance at	33
21. BF-I	" "	28
22. BF-II	" "	28
23. BT-I	" "	38
24. BT-II	" "	38
25. RN-I*	high cross performance at	33
26. SN-I*	" " " "	33
27. RN-II	" " " "	33
28. SN-II	" " " "	33
29. RF-I	" " " "	28
30. SF-I	" " " "	28
31. RF-II	" " " "	28
32. SF-II	" " " "	28
33. RT-I	" " " "	38
34. ST-I	" " " "	38
35. RT-II	high cross performance at	38
36. ST-II	" " " "	
37. CTD-I	high performance at diff. levels of selection	
38. CTD-II	" " " " " "	
39. DTD-I	" " " " " " "	
40. DTD-II	" " " " " " "	
41. ETD-I	" " " " " " "	
42. ETD-II	" " " " " " "	
43. FTD-I	" " " " " " "	
44. FTD-II	" " " " " " "	

D. mutants

45. antennapedia ap, VIII	Purdue, 1964
46. diferencial Df, IV	Purdue, 1964
47. fused antennal segments-2 fas-2 IV	Sokoloff, 1968
48. ivory i ?	Purdue, 1964
49. paddle, pd i	Purdue, 1964
50. pearl p II	Sokoloff, 1968
51. pegleg pg II	Purdue, 1968
52. pygmy py I	Purdue, 1968
53. rose rs I	Purdue, 1964
54. ruby rb ?	Purdue, 1964
55. short elytra sh VIII	
56. squint sq VIII	Purdue, 1964
57. white w ?	Purdue, 1964

w
58. wine r I Purdue, 1968
59. eye mutant ? Madrid, 1967
60. maroon m V Purdue, 1977
61. melanotic stink glands--like Madrid, 1968
62. sooty s Iv Sokoloff, 1977
63. chestnut c VII Sokoloff. 1977
64. microcephalic mc V Sokoloff, 1977
65. Microphthalmic Mo VI Sokoloff, 1977
Pk
66. pink p II Sokoloff, 1977
67. Bar eye Be IV Sokoloff, 1977
68. prothoraxless ptl IX Sokoloff, 1977
69. light ocular diaphragm lod III Purdue, 1968
70. black B III Sokoloff, 1977

Tribolium confusum

A. Wild type strains

71. Coronada La Coronada, Spain

B. Mutants

72. creased abdominal sternites cas II Sokoloff, 1968
73. ebony-2 e-2 II Sokoloff, 1968

Ma. C. Fuentes

UNITED KINGDOM

SLOUGH, BUCKS
MINISTRY OF AGRICULTURE, FISHERIES AND FOOD
THE INSECTARY OF THE PEST INFESTATION CONTROL LABORATORY

The object of this insectary is to provide constant supplies of storage insects and for this purpose the species listed are bred in controlled conditions. On request insects are sent, without charge to educational bodies if commercial firms are unable to supply them. The insects are maintained in constant temperature rooms at a relative humidity of 70%, except in the case of cockroaches where the relative humidity is 50%. As far as possible insects are bred free from disease. All new stocks pass through quarantine precautions before acceptance into the insectary.

Incorporated into the list is the name of the country from which the stock bred in the laboratory originated. However, it is only recently that records of this information have been kept, and since many species have been maintained in culture for over 20 years they are of unknown origin. Some species, such as Attagenus fasciatus were sent to us from entomologists working abroad; but other species such as Ephestia cautella, were obtained from infested produce brought to this country, so that there is only circumstantial evidence that produce and pests originated in the same country. In the latter case the name of the country is bracketed.

Limited stocks of the following species are cultured and may be available in small quantities at certain time of the year: Thylodrias contractus Mots., Dinarmus basilis (Rondani) (=laticeps (Ashmead)), Chaetospila elegans (Westw.), Amphibolus venator Klug., and Pyralis farinalis (L.).

INSCUL1.XLS

Genus, species, sub-species, strain.	Author	Order	Family	Country of origin	Year	Common name
Ahasverus advena	(Walt.)	Coleoptera	Sylvanidae	W. Africa	1956	Foreign Grain Beetle
Ahasverus advena S	(Walt.)	Coleoptera	Sylvanidae			Foreign Grain Beetle
Ahasverus advena S2252	(Walt.)	Coleoptera	Sylvanidae			Foreign Grain Beetle
Alphitobius diaperinus	(Panz.)	Coleoptera	Tenebrionidae			Lesser Mealworm
Alphitobius diaperinus Droxford susc.	(Panz.)	Coleoptera	Tenebrionidae	Hampshire	1984	Lesser Mealworm
Alphitobius diaperinus strain 39 susc.	(Panz.)	Coleoptera	Tenebrionidae			Lesser Mealworm
Alphitobius diaperinus Gooses foot R.	(Panz.)	Coleoptera	Tenebrionidae	Herefordshire	1983	Lesser Mealworm
Alphitobius diaperinus strain 44R.	(Panz.)	Coleoptera	Tenebrionidae	Gloucester	1988	Lesser Mealworm
Anthrenocerus australis	(Hope)	Coleoptera	Dermestidae	Britain	1933	Australian Carpet Beetle
Anthrenus flavipes	LeC.	Coleoptera	Dermestidae			Furniture Carpet Beetle
Anthrenus flavipes seminiveus	(Casey)	Coleoptera	Dermestidae			
Anthrenus picturatus hintoni	Mroczkowski	Coleoptera	Dermestidae	Russia	1977	
Anthrenus sarnicus	Mroczkowski	Coleoptera	Dermestidae	Wiltshire	1966	Guernsey Carpet Beetle
Anthrenus verbasci	(L)	Coleoptera	Dermestidae	Britain	1951	Varied Carpet Beetle
Attagenus brunneus Canada	Faldermann	Coleoptera	Dermestidae			
Attagenus brunneus Spain	Faldermann	Coleoptera	Dermestidae	Spain		
Attagenus cyphonoides	Reitter	Coleoptera	Dermestidae	Tashkent	1976	
Attagenus fasciatus cinnamomeus	Roth	Coleoptera	Dermestidae	Botswana	1965	
Attagenus insidiosus	Halstead	Coleoptera	Dermestidae	Kenya		
Attagenus pellio	(L)	Coleoptera	Dermestidae	Britain	1950	Fur Beetle
Attagenus refiventris	Pic	Coleoptera	Dermestidae	Botswana	1970	
Attagenus smirnovi	Zhantiev	Coleoptera	Dermestidae	Kenya	1962	
Attagenus unicolor canadensis	Casey	Coleoptera	Dermestidae		1980	

INSCUL1.XLS

Genus, species, sub-species, strain.	Author	Order	Family	Country of origin	Year	Common name
Attagenus unicolor japonicus	Reitter	Coleoptera	Dermestidae	N. America	1980	
Attagenus unicolor simulans	Solskij	Coleoptera	Dermestidae	U.S.S.R.	1976	
Attagenus unicolor unicolor	(Brahm)	Coleoptera	Dermestidae		pre. 1958	Black Carpet Beetle
Attagenus woodroffei Sweden	Halstead,Green.	Coleoptera	Dermestidae	Sweden	1978	
Attagenus woodroffei Finland	Halstead,Green.	Coleoptera	Dermestidae	Finland	1965	
Attagenus fasciatus fasciatus	(Thunberg)	Coleoptera	Dermestidae	New S. Wales	1972	
Callosobruchus maculatus	(F)	Coleoptera	Bruchidae			Southern Cowpea Weevil
Carpophilus dimidiatus	(F)	Coleoptera	Nitidulidae		pre. 1958	Corn Sap Beetle
Carpophilus dimidiatus pearl-eye	(F)	Coleoptera	Nitidulidae			Corn Sap Beetle
Carpophilus hemipterus	(L)	Coleoptera	Nitidulidae		1962	Dried Fruit Beetle
Coelopalorus foveicollis	(Blair)	Coleoptera	Tenebrionidae	Trinidad	1972	
Crypolestes ferrugineus	(Steph.)	Coleoptera	Cucujidae		1977	Rust Red Grain Beetle
Cryptolestes capensis	(Walt)	Coleoptera	Cucujidae		1961	
Cryptolestes ferrugineus C124	(Steph.)	Coleoptera	Cucujidae			Rust Red Grain Beetle
Cryptolestes pusilloides	(Steel and Howe)	Coleoptera	Cucujidae	Canada	1944	
Cryptolestes pusillus	(Schon.)	Coleoptera	Cucujidae			Flat Grain Beetle
Cryptolestes pusillus fuscus	Lefkovitch	Coleoptera	Cucujidae	Trinidad	1960	Flat Grain Beetle
Cryptolestes turcicus	(Grouv.)	Coleoptera	Cucujidae		pre. 1958	Turkish Grain Beetle
Cryptolestes turcicus red-eye mutant	(Grouv.)	Coleoptera	Cucujidae			Turkish Grain Beetle
Cryptolestes ugandae	Steel & Howe	Coleoptera	Cucujidae	E. Africa	1954	
Dermestes ater	Deg.	Coleoptera	Dermestidae	Britain	1953	Black Larder Beetle
Dermestes frischi	Kug.	Coleoptera	Dermestidae	Nigeria	pre. 1958	Hide Beetle
Dermestes haemorrhoidalis	Kuster	Coleoptera	Dermestidae	Britain	1962	Black Larder Beetle
Dermestes lardarius	L.	Coleoptera	Dermestidae	Britain	pre. 1958	Bacon Beetle
Dermestes maculatus	Deg.	Coleoptera	Dermestidae	Chittagong	1975	Leather Beetle

INSCUL1.XLS

Genus, species, sub-species, strain.	Author	Order	Family	Country of origin	Year	Common name
Dermestes maculatus black- brown	Deg.	Coleoptera	Dermestidae	Australia	1964	Leather Beetle
Dermestes maculatus Pearl-eye	Deg.	Coleoptera	Dermestidae	Australia	1964	Leather Beetle
Dermestes peruvianus	Cast.	Coleoptera	Dermestidae	Britain	1961	Peruvian Larder Beetle
Gibbium aequinoctiale	Boield.	Coleoptera	Ptinidae	Britain	1937	Hump Beetle
Gnatocerus cornutus	(F)	Coleoptera	Tenebrionidae		pre. 1958	Broad Horned Flour Beetle
Gnatocerus maxillosus	(F)	Coleoptera	Tenebrionidae		pre. 1958	Slender Horned Flour Beetle
Lasioderma serricorne	(F)	Coleoptera	Anobiidae		pre. 1958	Cigarette Beetle
Lasioderma serricorne black mutant	(F)	Coleoptera	Anobiidae	U.S.A.	1975	Cigarette Beetle
Latheticus oryzae	Waferth	Coleoptera	Tenebrionidae		pre. 1958	Long Headed Four Beetle
Lepisma saccharina (Silverfish)	(L.)	Thysanura	Lepismatidae	Britain	1978	Silverfish
Mezium affine	Boield	Coleoptera	Ptinidae	Britain	pre. 1958	
Mezium americanum	Lap.	Coleoptera	Ptinidae		1960	American Spider Beetle
Niptus hololeucus	(Fald.)	Coleoptera	Ptinidae	Britain	pre. 1958	Golden Spider Beetle
Oryzaephilus acuminatus	Halstead	Coleoptera	Silvanidae	Sri Lanka		
Oryzaephilus mercator	(Fauv.)	Coleoptera	Silvanidae		pre. 1958	Merchant Grain Beetle
Oryzaephilus surinamensis	(L.)	Coleoptera	Silvanidae		pre. 1958	Saw-toothed Grain Beetle
Oryzaephilus surinamensis 484R	(L.)	Coleoptera	Silvanidae			Saw-toothed Grain Beetle
Oryzaephilus surinamensis susc.	(L.)	Coleoptera	Silvanidae			Saw-toothed Grain Beetle
Oryzaephilus surinamensis small mutant	(L.)	Coleoptera	Silvanidae	E. Pakistan	1964	Saw-toothed Grain Beetle
Palorus cerylonoides	(Pascoe)	Coleoptera	Tenebrionidae	Indonesia		
Palorus ficicola 1168	(Pascoe)	Coleoptera	Tenebrionidae	Nigeria		
Palorus ficicola 1176	(Pascoe)	Coleoptera	Tenebrionidae	Nigeria		
Palorus genalis	Blair	Coleoptera	Tenebrionidae	Guyana		
Palorus ratzeburgii	(Wissm.)	Coleoptera	Tenebrionidae	Britain	1960	Small-eyed Flour Beetle
Palorus subdepressus	(Woll.)	Coleoptera	Tenebrionidae	Turkey	1956	Depressed Flour Beetle

INSCUL1.XLS

Genus, species, sub-species, strain.	Author	Order	Family	Country of origin	Year	Common name
Prostephanus truncatus	Horn	Coleoptera	Bostrichidae	Tanzania	1981	Larger Grain Borer
Pseudeurostus hilleri	(Reitt.)	Coleoptera	Ptinidae	Britain	1940	
Ptinus clavipes	Panz.	Coleoptera	Ptinidae	Britain	1954	Brown Spider Beetle
Ptinus exulans	Erichson	Coleoptera	Ptinidae	Britain	1971	
Ptinus pusillus	Sturm	Coleoptera	Ptinidae		pre. 1958	
Ptinus sexpunctatus	Panz.	Coleoptera	Ptinidae		pre. 1958	
Ptinus tectus Australian	Boield	Coleoptera	Ptinidae		1960	Australian Spider Beetle
Ptinus tectus Birkenhead	Boield	Coleoptera	Ptinidae	Britain	1975	
Rhyzopertha dominica Salisbury	(F)	Coleoptera	Bostrichidae	Britain	1979	Lesser Grain Borer
Rhyzopertha dominica 314R	(F)	Coleoptera	Bostrichidae	Trinidad	1972	Lesser Grain Borer
Rhyzopertha dominica 37	(F)	Coleoptera	Bostrichidae	Australia	1973	Lesser Grain Borer
Rhyzopertha dominica Feltons	(F)	Coleoptera	Bostrichidae	Britain	1979	Lesser Grain Borer
Rhyzopertha dominica Grimsditch	(F)	Coleoptera	Bostrichidae	Britain		Lesser Grain Borer
Rhyzopertha dominica 915 R	(F)	Coleoptera	Bostrichidae	Kuwait	1972	Lesser Grain Borer
Sitophagus hololeptoides	(Castelnau)	Coleoptera	Tenebrionidae	Trinidad	1972	
Sitophilus granarius	(L)	Coleoptera	Curculionidae	Russia		Grain Weevil
Sitophilus granarius Gainsborough R	(L)	Coleoptera	Curculionidae	Britain	1973	Grain Weevil
Sitophilus granarius Windsor	(L)	Coleoptera	Curculionidae	Britain	1970	Grain Weevil
Sitophilus oryzae Droxford	(L)	Coleoptera	Curculionidae	Britain		Rice Weevil
Sitophilus oryzae A76R	(L)	Coleoptera	Curculionidae	Nepal	1976	Rice Weevil
Sitophilus zeamais	Matsch.	Coleoptera	Curculionidae		pre. 1958	Maize Weevil
Sitophilus zeamais U.S.A.	Matsch.	Coleoptera	Curculionidae	U.S.A.	1982	Maize Weevil
Sphaericus gibboides	(Boield	Coleoptera	Ptinidae	Britain	1976	
Stegobium paniceum	(L)	Coleoptera	Anobiidae		1959	Biscuit Beetle
Stethomezium squamosum	Hint.	Coleoptera	Ptinidae	Britain		African Spider Beetle

INSCUL1.XLS

Genus, species, sub-species, strain.	Author	Order	Family	Country of origin	Year	Common name
Tenebrio molitor	L.	Coleoptera	Tenebrionidae		pre. 1958	Yellow Mealworm
Tenebrio obscurus	F.	Coleoptera	Tenebrionidae		pre. 1958	Dark Mealworm
Tipnus unicolor	(P.&M.)	Coleoptera	Ptinidae	Kenya	pre. 1958	
Tribolium confusum	J.du V.	Coleoptera	Tenebrionidae		1962	Confused Flour Beetle
Tribolium anapha	Hint.	Coleoptera	Tenebrionidae	Nigeria	1956	
Tribolium audax	Halstead	Coleoptera	Tenebrionidae	Canada	1969	American Flour Beetle
Tribolium brevicornis	LeC.	Coleoptera	Tenebrionidae	U.S.A.		
Tribolium castaneum CTC12	(Herbst.)	Coleoptera	Tenebrionidae	Australia		Rust Red Flour Beetle
Tribolium castaneum FSS11	(Herbst.)	Coleoptera	Tenebrionidae			Rust Red Flour Beetle
Tribolium castaneum black	(Herbst.)	Coleoptera	Tenebrionidae		1983	Rust Red Flour Beetle
Tribolium castaneum field	(Herbst.)	Coleoptera	Tenebrionidae	Britain	1975	Rust Red Flour Beetle
Tribolium destructor African	Uytt.	Coleoptera	Tenebrionidae	Ethiopia	1968	Dark Flour Beetle
Tribolium destructor Denmark	Uytt.	Coleoptera	Tenebrionidae	Denmark	1968	Dark Flour Beetle
Tribolium freemani	Hinton	Coleoptera	Tenebrionidae	Japan	1980	
Tribolium madens	(Charp.)	Coleoptera	Tenebrionidae	Yugoslavia	1959	Black Flour Beetle
Trigonogenius globulus	Sol.	Coleoptera	Ptinidae	Ireland	1961	Globular Flour Beetle
Trigonogenius particularis	Pic.	Coleoptera	Ptinidae	Kenya	1962	
Trogoderma angustum	(Solier)	Coleoptera	Dermestidae	Germany	1975	
Trogoderma anthrenoides	(Sharp)	Coleoptera	Dermestidae	U.S.A	1957	
Trogoderma glabrum	(Herbst.)	Coleoptera	Dermestidae	U.S.A.	1959	
Trogoderma granarium	Everts	Coleoptera	Dermestidae	Britain	pre. 1958	Khapra Beetle
Trogoderma granarium Bristol	Everts	Coleoptera	Dermestidae	Britain	1975	Khapra Beetle
Trogoderma grassmani	Beal	Coleoptera	Dermestidae	U.S.A.	1976	
Trogoderma inclusum	LeC.	Coleoptera	Dermestidae		pre. 1958	Larger Carpet Beetle
Trogoderma irroratum	Reitt.	Coleoptera	Dermestidae	Egypt	1959	

INSCUL1.XLS

Genus, species, sub-species, strain.	Author	Order	Family	Country of origin	Year	Common name
Trogoderma ornatum	(Say)	Coleoptera	Dermestidae	U.S.A.	1974	
Trogoderma sternale plagifer	Casey	Coleoptera	Dermestidae	New Mexico	1966	
Trogoderma variabile	Ballion	Coleoptera	Dermestidae	U.S.A.	1965	Warehouse Beetle
Trogoderma varium	(Mat.& Yoko.)	Coleoptera	Dermestidae	Korea	1970	
Typhaea stercorea Datchet	(L.)	Coleoptera	Mycetophagidae	Britain	1980	Hairy Fungus Beetle

INSCUL1.XLS

Genus, species, sub-species, strain.	Author	Order	Family	Country of origin	Year	Common name
Ephestia cautella	(Walker)	Lepidoptera	Pyralidae	Cyprus	1969	Tropical Warehouse Moth
Ephestia kuehniella	Zell	Lepidoptera	Pyralidae	Britain	1948	Mediterranean Flour Moth
Galleria mellonella	(L.)	Lepidoptera	Pyralidae	U.S.A.	1987	Way Moth/ Honeycomb Moth
Plodia interpunctella	(Hubert)	Lepidoptera	Pyralidae	Britain	1968	Indian-Meal Moth
Sitotroga cerealella 623	(Oliv.)	Lepidoptera	Gelechiidae	U.S.A.	1972	Angoumois Grain Moth
Sitotroga cerealella A68	(Oliv.)	Lepidoptera	Gelechiidae	Nepal	1981	Angoumois Grain Moth
Tinea pellionella	(L.)	Lepidoptera	Tineidae	Britain	1989	Case Bearing Clothes Moth
Tineola bisselliella	(Hummel)	Lepidoptera	Tineidae	Britain	1989	Webbing Clothes Moth
Plodia interpunctella 102	(Hubert)	Lepidoptera	Pyralidae	Tanzania	1977	Indian-Meal Moth

INSCUL1.XLS

Genus, species, sub-species, strain.	Author	Order	Family	Country of origin	Year	Common name
Liposcelis bostrychophila	Badonnel	Psocoptera	Lipscelidae			
Liposcelis subfuscus	Broadhead	Psocoptera				
Liposcelis paetus	Pearman	Psocoptera				
Lepinotus patruelis	Pearman					
Liposcelis subfuscus	Broadhead	Psocoptera	Lipscelidae			
Liposcelis paetus	Pearman	Psocoptera	Lipscelidae			
Lepinotus patruelis	Pearman	Psocoptera	Trogiidae			
Trogium pulsatorium	(L)	Psocoptera	Trogiidae			Larger Pale Booklouse

INSCUL1.XLS

Genus, species, sub-species, strain.	Author	Order	Family	Country of origin	Year	Common name
Blatta orientalis lab suscep.		Dictyoptera				Common Cockroach
Blatta orientalis West London		Dictyoptera				Common Cockroach
Blattella germanica resistant		Dictyoptera				
Blattella germanica suscep.		Dictyoptera				
Diploptera punctata		Dictyoptera				
Periplaneta americana lab suscep.		Dictyoptera				Ship Cockroach

SLOUGH, BUCKS, U.K.
TROPICAL DEVELOPMENT AND RESEARCH INSTITUTE (FORMERLY TPI)
STORAGE DEPARTMENT
OVERSEAS DEVELOPMENT ADMINISTRATION
PEST BIOLOGY AND INSPECTION SECTION

TROPICAL DEVELOPMENT AND RESEARCH INSTITUTE (TDRI)

The Tropical Development and Research Institute (TDRI) was formed 1 April, 1983, following the amalgamation of the Tropical Products Institute and the Centre for Overseas Pest Research. The Director of the Institute is Dr. Malcolm Thain who was formerly Director of the Tropical Products Institute.

The Institute, part of the Overseas Development Administration and funded from the aid programme, will provide technical assistance to developing countries. The budget will total over eight million pounds in the financial year 1983/84.

TDRI will continue to work on post-harvest technology and pest and vector management for the benefit of developing countries, by controlling the pests harmful to agriculture, stored products and public health, and by improved processing, storage and marketing of agricultural fisheries products.

The main emphasis of its work in scientific research and development, marketing, information, advice and training will centre on the improvement of food supplies in accordance with the major objectives of the British overseas aid programme. Work will also continue on certain non-food crops of particular importance to developing countries. These activities will be carried out, as at present, in the UK and overseas in countries throughout the developing world.

Since post harvest technology and pest and vector management are broad and varied subjects, TDRIwill concentrate its activities in those areas where it has a comparative advantage in terms of experience, knowledge and cost-effectiveness. Close cooperation will continue with government organizations, universities and industry in developing countries, the UK and other industrialized countries, and with multilateral and bilateral aid agencies.

Requests from developing country govenments qualifying for British aid will be channelled through the Overseas Development Administration, which may commission TDRI to carry out the work if it lies within the scope of its terms of reference, and if resources are available. In addition, TDRI may, subject to the claims on its resources commissioned by ODA, accept contracts for relevant work on behalf of developing countries from multilateral aid agencies and other organizations.

TDRI is based in London, although relocation to a new site outside the central London area is under consideration. It currently employs over 450 staff.

Requests for information, advice, investigations or training should be sent to:

The Director
Tropical Development and Research Institute
56-62 Gray's Inn Road
London WC1X 8LU
England (Telephone 01-242 5412)

All stocks are maintained at 27 degrees centigrade and 70% R.H. The stocks listed below are those currently maintained for ongoing research projects. Other storage pest species are kept in culture from time to time for training or short research projects.

I. Wild type strains

A. Coleoptera

Bostrichidae

1. Prostephanus truncatus -- Mexico, Tanzania

Bruchidae

1. Acanthoscelides obtectus -- Swaziland; Turkey
2. Callosobruchus analis -- MAFF Lab., Slough; Indonesia
3. Callosobruchus chinensis -- Nepal; Kenya
4. Callosobruchus maculatus -- Brazil, 2 strains; Nigeria, 2 strains; Oman; Senegal; Sierra leone; Turkey; Upper Volta; Yemen.
5. Caryedon serratus -- Unknown
6. Zabrotes subfasciatus -- Uganda (collected from cowpeas and bred on cowpeas); Colombia.

Curculionidae

1. Sitophilus oryzae -- Peru (pulse-feeding strain breeding on split peas)
2. S. zeamais -- Mexico

B. Lepidoptera

Galleriinae: Corcyra cephalonica -- Malawi

Gellechiidae: Sitotroga cerealella -- Sudan

Phycitinae: Ephestia cautella -- Brazil

CHEMICAL CONTROL SECTION

(stocks of some major beetles pests are maintained, under selection pressure with insecticide where necessary, in order to enable the FAO recommended methods for the detection and measurement of resistance to be carried out. Incoming strains from abroad are screened and the methods are demonstrated in training programs.)

Wild type strains

Coleoptera

Bostrichidae

Prostephanus truncatus--Strains tested for phosphine resistance: Botswana; Indonesia; Mali (8 strains) Nepal; Nigeria; Pakistan (2 strains) Singapore; Sri Lanka (4 strains); Tunisia; Zimbabwe.

Bruchidae

Acanthoscelides obtectus -- Ethiopia
Callosobruchus chinensis -- India

Curculionidae

Sitophilus oryzae -- Insecticide-susceptible strain (reference strain) -- via MAFF Lab, Slough
S. oryzae -- Malathion and lindane resistant strain (A.76) -- via MAFF Lab., Slough.

Tenebrionidae

Tribolium castaneum -- Multiple insecticide-resistant strain (CTC 12) -- australia
T. castaneum -- Malathion-specific resistant strains (Kano C) -- Nigeria
T. castaneum -- Insecticide-susceptible strain (reference strain) -- MAFF Lab, Slough

Dr. P. F. Prevett
Deputy Head of Department

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I. Wild type strains

A. Coleoptera

Anobiidae

1. Lasioderma serricorne — a. Unknown
2. Stegobium paniceum — a. ex-MAFF

Bostrichidae

1. Dinoderus distinctus — a. Tanzania
2. D. minutus — a. Indonesia
3. D. porcellus — a. Togo
4. Prostephanus truncatus — a. Costa Rica
   b. Mexico (3 strains)
   c. Nigeria
   d. Tanzania (4 strains)
   e. Togo
   f. Kenya
5. Rhyzopertha dominica — a. Ex-MAFF
   b. Angola*
   c. Kenya (3 strains)***
   d. Mali *
   e. Morocco *
   f. Nepal*
   g. Sri Lanka

Bruchidae

1. Acanthoscelides obtectus -- a. Colombia (2 strains)
   b. Uganda
   c. Zimbabwe
2. Callosobruchus analis -- a. MAFF Lab.
3. Callosobruchus chinensis -- a. Indonesia
4. Callosobruchus maculatus -- a. Uganda
5. Caryedon serratus — a. India
6. Zabrotes subfasciatus -- b. Uganda

Stock Lists

Curculionidae	
1. Sitophilus oryzae	
i. Normal strains	a. Ex-MAFF
	b. India
	c. Morocco
	d. Zimbabwe
ii. Pulse-feeding	a. Burma
2. S. zeamais --	a. Ex-MAFF
	b. India
Dermestidae	
1. Dermestes ater	a. Ex-MAFF
2. D. maculatus	a. Jamaica
3. Trogoderma granarium	a. India
	b. Sudan
Histeridae	
1. Teretriosoma nigrescens	a. Mexico
Lophocateridae	
1. Lophocateres pusillus	a. Philippines
Silvanidae	
1. Ahasverus advena	a. Ex-MAFF
2. Oryzaephilus sp.	a. Kenya (4 strains)
3. Oryzaephilus surinamensis	a. Ex-MAFF
Tenebrionida	
1. T. castaneum	a. Ex-MAFF
	b. Botswana‡
	c. Indonesia (2 strains)
	d. Kenya #
	e. Mali‡
	f. Mozambique
	g. Pakistan‡
	h. Philippines +
	i. Sri Lanka
	j. Thailand (3 strains)‡‡‡+
	k. Zimbabwe (2 strains)‡
2. Latheticus oryzae	a. Ex-MAFF
3. Gnatocerus cornutus	a. Ex-MAFF
4. Palorus subdepressus	a. Ex-MAFF

Key
‡ Number of strains which have to date been found to be Phosphine resistant.
+ Malathion resistance noted.
# Pirimiphos methyl resistance noted.

B. Lepidoptera

Pyralidae

1. Corcyra cephalonica	a. Ex-MAFF
2. ephestia cautella	a. Ex-MAFF
	b. Ethiopia
3. Ephestia elutella	a. Ex-MAFF

Gellechiidae:

1. Sitotroga cerealella	a. Sudan

CHEMICAL CONTROL SECTION

(stocks of some major beetles pests are maintained, under selection pressure with insecticide where necessary, in order to enable the FAO recommended methods for the detection and measurement of resistance to be carried out. Incoming strains from abroad are screened and the methods are demonstrated in training programs.)

Wild type strains

Coleoptera

Bostrichidae

Prostephanus truncatus--Strains tested for phosphine resistance: Botswana; Indonesia; Mali (8 strains) Nepal; Nigeria; Pakistan (2 strains) Singapore; Sri Lanka (4 strains); Tunisia; Zimbabwe.

Bruchidae

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T. castaneum -- Insecticide-susceptible strain (reference strain) -- MAFF Lab, Slough

Dr. Chris P. Haines

RESEARCH, TEACHING AND TECHNICAL NOTES

*DIRECTIONAL SELECTION FOR INCREASED PUPAE WEIGHT IN *TRIBOLIUM CASTANEUM* UNDER CROWDED AND UNCROWDED CONDITIONS

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ABSTRACT

The effects of environmental stress created by crowding on artificial selection for increased 24 day pupal body weight were investigated in *Tribolium*. The selections were carried out for seven generations (in four replicates) in population cages containing equal numbers of mating adults, but varying amounts of media (crowded or uncrowded). The importance of genotype-environment interaction in the response to selection was evaluated in generation seven by growing individuals selected under the two environmental conditions in both the selected environment and the alternate environment. Response to selection was found to be significantly ($p<0.01$) greater under crowded conditions in three of the four replicates. No significant interaction between the selection and testing environments was observed. This result indicates that the genes responsible for the selection response were likely the same in both the crowded and uncrowded environments.

INTRODUCTION

The question of whether parents should be selected and tested in the same environment in which their progeny are to perform is a problem which has received considerable attention. The fact that the phenotype of an organism is the product of both its genotype and its environment is widely accepted by quantitative geneticists. The controversial issue, however, is how important are the interaction effects between the genotype and the environment. Much of the work in this area was initiated by Hammond (1947), who stated: "The character required is best selected under environmental conditions which favor its fullest expression and that once developed, it can also be used in other environments provided that the other characters specially required by that new environment, are also present in the animal." This view was opposed, though, by Lush (1948), Lerner (1950) and Falconer and Latyszewski (1952). They recommended, on the basis of possible genotype-environment interactions, that breeders should maintain environmental conditions that are equivalent to those in which the progeny will be maintained. However, Lerner later qualified that statement by adding that this may not always be the best practice.

There has been extensive research dealing with selection response in *Tribolium castaneum*. The majority of this work, though, has consisted of selection within a single strain, or comparisons between different species or strains, in a single environment. In cases where the environment has been varied, temperature, humidity and nutritional levels have generally been the factors of interest. It has been shown that these factors significantly affect several traits such as body weight, reproductive performance and the number of pupae and larvae surviving to 23 days (Howe, 1956; Kidwell et al., 1964; Hardin and Bell, 1966; Orozco, 1976; Rich and Bell, 1980; Wade, 1990). One potentially stressful environmental factor that has been the subject of very little investigation, however, is the level of crowding.

In an attempt to further elucidate the possible effects of genotype-environment interactions on *Tribolium castaneum*, a selection experiment involving four replicates was used to evaluate whether there is an interaction between the environment in which parents are selected and the environment where progeny are grown. The two environments of interest here are crowded and uncrowded growing conditions.

MATERIALS AND METHODS

The foundation population used in these experiments originated as the F_3 generation of reciprocal crosses between two highly inbred lines. The contrasting environments chosen for this study were crowded (C) and uncrowded (U). All C population cages contained 15 g of fine sifted standard media (95% by weight sifted whole wheat flour, 5% by weight dried brewer's yeast), whereas the U population cages contained 45 g of the media. Preliminary tests indicated that the difference between these levels of media produced a significant difference in total progeny alive at 24 days (data not shown). The experiment consisted of four replicates, and all populations were maintained on a seven week generation cycle.

__Experiment 1- Selection in two environments__

Four lines were maintained for each replicate (see Table 1). 15 males and 15 females were placed in each population cage and allowed to mate and lay eggs for six days, after which time the adults were removed by passing the media through a coarse screen. The eggs were then allowed to develop for an average of 24 days. At the end of the developmental period, 50 pupae of each sex were removed and weighed to determine their 24 day pupal body weight. In the selected (S) populations, the top 20 of each sex (in terms of pupa weight) were selected, and 15 of those were used as parents for the next generation. The random (R) populations were handled exactly like the S populations, except that individuals were selected at random with respect to weight. Seven generations of selection were completed in the four replicates.

__Experiment 2- Evaluation of genotype-environment interaction__

The US and CS lines from generation seven of Experiment 1 were randomly sampled and subdivided into two environmentally different population cages (i.e., US into crowded and uncrowded, CS into crowded and uncrowded) for one generation of mating as described in Experiment 1. Twenty four day pupal body weights were taken as described in Experiment 1. The data for this experiment were analyzed separately by replicate in a two-way ANOVA with two selection environments and two testing environments.

RESULTS AND DISCUSSION

__Experiment 1__

The existence of environmental stress due to crowding was evident from the difference in the number of total progeny supported by both environments (see Table 2). Although every population was initiated with equal numbers of parents, the uncrowded conditions supported significantly more total progeny alive at 24 days than the crowded conditions. One possible explanation of this is that crowding in *Tribolium* can lead to a reduction in the number of immature individuals able to complete their life cycle. Any reduction in survival to adulthood such as this likely involves the elimination of some immature individuals through processes such as fratricide and cannibalism (Sokal and Huber, 1963; Sokal and Karten, 1964). Additionally, a decrease in the total number of eggs laid may have contributed to this difference. Orozco (1976) showed that environmental stress may also lead to a reduction in egg-laying in *Tribolium*.

Table 3 provides a comparison of the response to selection (measured as deviations from the randomly selected control) in both environments. Positive response to selection was found to be significant under both crowded and uncrowded conditions. This response was greater (although not significantly so) under crowded conditions in Reps 1-3, as well as for the pooled data. Additionally, the realized heritability was greater in Reps 1-3, and for the pooled data (the pooled difference approached significance, $p \approx .15$; see Table 4). If these differences are real and not simply sampling error, some mechanism must have been causing the crowded populations to respond to selection more efficiently than the uncrowded populations. The nature of this mechanism will be addressed below.

__Experiment 2__

The results of the analysis of variance for Experiment 2 support the earlier data that the response to selection was significantly greater under crowded conditions for both sexes in Reps 1-3 (see Tables 5 and 6). Additionally, disregarding the effect of the environment in which the selections were practiced, the crowded testing conditions produced a significantly greater mean in both sexes for Reps 1,3 and 4 (see Tables 5 and 7). These results imply that some factor was increasing the response to selection under crowded conditions. The most likely cause of this was either natural selection supplementing the artificial selection, or genotype-environment interaction due to the environmental stress. Because a significant interaction between the selection environment and the testing environment occurred only in the females of Rep 3 (see Table 5), it is apparent that genotype-environment interaction was not an important factor. This finding asserts the possibility that natural selection caused additional selection pressure for increased pupal body weight to be applied to the crowded populations. Because of the possibility of increased cannibalism under stressed conditions (see Experiment 1 results), and the difference in total progeny between the two environments (see Table 2), the most probable mechanism of natural selection in this case would have been cannibalism. For this to occur, the stress of crowding would increase selection pressure if larger individuals were cannibalizing smaller individuals, thereby increasing the mean body weight of individuals surviving to the pupal stage.

The lack of significant interaction between the selection environment and the test environment leads to the conclusion that the same genes for increased pupal body weight have produced the selection response in both environments. Thus, selections can be made in the environment that leads to the greatest genetic gain (in this case under stressed conditions), regardless of the environment in which the progeny will be maintained.

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Table 1: Description of lines.

Symbol	Description
US	Selected line maintained in the uncrowded environment.
UR	Random line maintained in the uncrowded environment.
CS	Selected line maintained in crowded environment with procedures identical to those described for US.
CR	Random line maintained in crowded environment with procedures identical to those described for CS.

Table 2: Comparison of total line progeny at 24 days in the two environments (data are averages ± SEM for generations 1-7).

Population	Uncrowded	Crowded	Difference
Selected	363 ± 21	158 ± 9	205 ± 17**
Random	390 ± 25	162 ± 11	228 ± 19**

** indicates significance at the 0.01 level of probability.

Table 3: Regression of response (deviation from control) on generations of selection.

Rep	Crowded	Uncrowded	Difference
1	38.5	16.3	22.2
2	42.7	37.8	4.9
3	40.5	-2.1	42.6
4	26.9	44.2	-17.3
Pooled (± SE)	37.2 ± 3.5**	24.0 ± 10.6*	13.2 ± 12.7

** indicates significance at the 0.01 level of probability.
* indicates significance at the 0.05 level of probability.

Table 4: Estimates of realized heritability.

Rep	Crowded	Uncrowded	Difference
1	.18	.08	.10
2	.21	.20	.01
3	.18	-.01	.19
4	.13	.17	-.04
Pooled (± SE)	.17 ± .04	.11 ± .02	.06 ± .04

Table 5: Analysis of variance showing F-statistics and significance levels for the four replicates.

	Males			
Source	Rep 1	Rep 2	Rep 3	Rep 4
Selection Environ.	6.9**	8.5**	95.5**	33.7**
Testing Environ.	23.5**	1.1	14.0**	10.2**
Interaction	1.0	0.1	0.8	1.9
	Females			
Source	Rep 1	Rep 2	Rep 3	Rep 4
Selection Environ.	21.3**	11.9**	87.1**	21.3**
Testing Environ.	15.3**	0.7	23.8**	6.2*
Interaction	3.5	2.0	5.3*	0.3

** indicates significance at the 0.01 level of probability.
* indicates significance at the 0.05 level of probability.

Table 6: Population means and differences for the two selection environments.

	Males		
Rep	Crowded	Uncrowded	Difference
1	2813	2728	85
2	2855	2775	80
3	2870	2579	291
4	2824	3031	-207
	Females		
Rep	Crowded	Uncrowded	Difference
1	2876	2717	159
2	2916	2802	114
3	2903	2632	271
4	2815	2994	-179

Table 7: Population means and differences for the two testing environments.

	Males		
Rep	Crowded	Uncrowded	Difference
1	2850	2692	158
2	2830	2800	30
3	2780	2669	111
4	2985	2871	114
	Females		
Rep	Crowded	Uncrowded	Difference
1	2864	2729	135
2	2846	2872	-26
3	2838	2696	142
4	2953	2857	96

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* Susceptibility of *Tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae) Larvae to Gamma Irradiation

Tribolium castaneum (Herbst) is one of the most destructive and major pests of stored food materials, and is cosmopolitan in distribution.The chemical control of the pest is limited because of the necessity to keep these stored products free from contamination. The extensive use of chemicals has resulted in the appearence of insects that are resistant, for example, some *Rhyzopertha dominica* (F.) are now resistant to phosphine (Bell *et al.*, 1977), *Sitophilus granarius* (L.) to pyrethrin (Prickett, 1980) and *T. castaneum* (Herbst) to methylbromide (Rajendran, 1992). These have led to the search for alternative pest control methods.

Irradiation methods recently provide new means of preserving a variety of foods and controlling insects on grains and cereal products (Burgess & Bennett, 1972; Brown *et al.* 1972; Dramola, 1980; Huda & Rezaur, 1982;. Dawes *et al.*, 1987; Hasan *et al.*, 1987, Navon *et al.*, 1988; Mehta *et al.*, 1990; Sengonca & Schade, 1991 and Saxena *et al.*, 1992). Radiation disinfestation can be recommended as a more effective pest control strategy which can be used to give instantaneous treatment without any residual problems (Patterson *et al.*,1975).

The present work was designed to investigate both the dose and age dependent mortality patterns in four *T. castaneum* strains, e.g. Raj1, CTC12, CR1 and FSS2.

Materials and Methods

The adults of different *T. castaneum* strains were extracted from laboratory culture and released on a thin layer of wholemeal flour previously passed through a 60-mesh seive in a petridish for oviposition. The eggs were collected on the following day and incubated in a petridish for hatching. After hatching, larvae were transferred to the food medium (Park and Frank,1948). When the larvae reached the desired ages they were irradiated. The doses were 0 (control), 2-, 3-, 4-, and 5-kr and the larvae were 1-,

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3-, 8-, 12- and 16-day old. After irradiation, they were retained in their original places. The sources of radiation used in the present experiments was the gamma Co^{60} irradiator and the rate of exposure was 12 kr/hr at 30 cm distance from the middle of the source pencil. Mature larvae were checked by sieving the medium through a 250 μm mesh seive for their pupation. After pupation, pupal recovery was noted carefully. The larval mortality was corrected (Abbott, 1925) and data were subjected to probit analysis (Busvine, 1971) to determine LD_{50} values together with the fiducial limits. The selection of radiation was based on its effectiveness against *Tribolium* spp. (Hasan *et al.*, 1989; Mehta *et al.*, 1990).

All the experiments were conducted in an incubator set at 30^0C.

Results and Discussion

The results presented here for *T. castaneum* strains show that gamma radiation affected all of them significantly (Table 1). The age-dependency of radio-sensitivity was also observed in all the strains of *T. castaneum* larvae (Table 2). The younger larvae were more radiosensitive than the older ones . The strain CR1 proved itself as the most and FSS2 the least sensitive strains. On exposure to 5-kr, larvae of all the strains became moribund and stopped feeding. All of them died within 7-9 days. The results indicated a close similarity in radiosensitivity of different stages in other species of the Coleoptera (Winstead *et al.*, 1989; Ghomomu, 1989).

The present study shows that the use of gamma radiation may be a useful tool in controlling *T. castaneum*. However, more future works are solicited.

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Table 1: The reponse of different strains of *T. castaneum* to gamma rays

Strain	Age (day)	$LD_{50} \pm SE$ (krad)	Fiducial limits	Slope (b)	X^2 (2 df)
	1	2.35 ± 0.17	2.01 - 2.77	6.72	12.41***
	3	2.42 ± 0.18	2.08 - 2.85	5.79	10.64*
Raj1	8	2.67 + 0.21	2.26 - 3.06	5.37	10.17*
	12	2.80 ± 0.29	2.23 - 3.45	4.36	15.12***
	16	3.21 ± 0.27	2.68 - 3.66	4.98	11.02***
	1	2.34 ± 0.16	2.02 - 2.72	6.61	10.43**
	3	2.38 ± 0.14	2.10 - 2.79	5.74	9.19**
CTC12	8	2.66 ± 0.17	2.33 - 2.96	5.30	6.16*
	12	2.73 ± 0.23	2.29 - 3.20	4.51	9.31**
	16	3.05 ± 0.22	2.60 - 3.51	4.45	8.50**
	1	2.18 ± 0.11	1.96 - 2.55	5.88	6.98**
	3	2.37 ± 0.17	2.05 - 2.75	6.29	9.90**
CR1	8	2.51 ± 0.18	2.17 - 2.92	5.30	8.71**
	12	2.64 ± 0.20	2.25 - 3.06	4.97	8.86**
	16	3.09 ± 0.25	2.61 - 3.55	4.63	9.57**
	1	2.36 ± 0.21	1.96 - 2.95	4.85	13.80***
	3	2.43 ± 0.22	2.00 - 3.05	4.72	15.09***
FSS2	8	2.76 ± 0.20	2.36 - 3.19	4.96	9.15**
	12	2.86 ± 0.18	2.51 - 3.21	4.87	6.47*
	16	3.40 ± 0.19	3.04 - 3.76	4.61	12.13***

Note: *$P < 0.05$, **$P < 0.01$, ***$P < 0.001$.

Table 2: Level of gamma rays resistance in *T. castaneum* larvae of various ages from different strains

Strain	Larval age (day)				
	1	3	8	12	16
Raj1 - CTC12	0.995	0.983	0.996	0.975	0.950
Raj1 - CR1	0.928	0.979	0.940	0.943	0.963
Raj1 - FSS2	1.000	1.004	1.034	1.021	1.059
CTC12- CR1	0.932	0.995	0.944	0.967	1.013
CTC12- FSS2	1.009	1.021	1.038	1.048	1.115
CR1 - FSS2	1.083	1.025	1.099	1.083	1.100

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*Comparison of Satellite DNAs in *Tribolium confusum* and *Tribolium anaphe*

Introduction

With the advent of modern techniques in molecular biology it has become possible to study genetic relationships between species readily. In the past, species were grouped together based on their morphologies and habitats. An example of this grouping methodology is found in the genus *Tribolium*. The beetles in this genus have been placed into species-groups based on morphological characteristics (Hinton, 1948). Today, it is possible to demonstrate the validity of these groupings and the evolution of these species through genetic analysis.

Recently, there has been increasing interest in studying the organization and characteristics of the genomic DNA of *Tribolium* species (Alvarez-Fuster *et al*, 1991; Beeman, 1987; Beeman *et al.*, 1989; Brown *et al.*, 1990; Plohl *et al.*, 1993; Stuart *et al.*, 1991; Tous *et al*, 1992). One method that has been used to characterize the genomes of a wide variety of eukaryotic species, including members of the *Tribolium* genus, is the study of tandemly repeated, highly abundant DNA sequences known as satellite DNA. Within the genus *Tribolium*, satellite DNAs have been identified and studied in *T. freemani* (Juan *et al*, 1993), *T. castaneum* (Brown *et al*, 1990) and *T. confusum* (Plohl *et al*, 1993).

It is assumed that closely related species, such as those in the same *Tribolium* species-group, would also have satellite DNAs that share a significant amount of homology. The amount of sequence homology in the satellite DNA might also assist in determining the position of the species in the phylogenic tree. The purpose of this study was to determine if the restriction enzyme sites that define *T. confusum* satellite DNA might also be present in the satellite DNA of *T. anaphe*, which is a member of the *confusum* species-group.

Materials and Methods

Chromosomal DNA was prepared using a modification of the procedure of Brown *et al.* (1990) from *T. confusum* and *T. anaphe* which were flash frozen in liquid nitrogen and ground to a fine powder . The DNA was digested with restriction endonucleases in a final volume of 10 µL utilizing buffers supplied by the manufacturer (Promega). Electrophoretic separation of the resulting DNA fragments was carried out on 4% MetaPhor™ agarose (FMC BioProducts) utilizing TAE buffer as recommended by the manufacturer. Gels were stained with ethidium bromide and the bands were photographed under UV illumination.

The relative mobilities of the *T. confusum* and *T. anaphe* DNA fragments as well as the 123 base pair DNA ladder (Life Technologies) which was used as a molecular size marker, were measured from photographs of the gels. The sizes of the satellite DNA fragments were estimated through extrapolation from semilog-graphs.

Results and Discussion

Genomic DNA isolated from *T. confusum* was digested with the restriction enzymes AluI, DdeI, and TaqI. Electrophoretic separation of the AluI, DdeI and TaqI digested DNA revealed the presence of a highly repetitive DNA fragment 158 base pairs in length. These results are in agreement with those obtained by Plohl *et al.* (1993).

When genomic DNA isolated from *T. anaphe* was subjected to digestion with the same series of enzymes, similar satellite DNA banding patterns were observed. However, the observed AluI, DdeI and TaqI DNA fragments had an apparent size of 171 base pairs in *T. anaphe*.

Since all three restriction enzyme sites are present in both species studied, there is preliminary evidence that these species share some homology in their satellite DNAs. Based on this preliminary data, it appears that Hinton's placement of *T. anaphe* in the *confusum* species-group is valid at the molecular level as well as the morphological level. Additional characterization of the satellite DNA present in *T. anaphe* is necessary to determine the exact size and sequence of the satellite monomers. This will allow for a direct comparison of the satellite DNAs at a molecular level with other members of the *confusum* species-group and *Tribolium* genus to better understand the relationships between these beetles.

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*Histological Evidence for Five Cell Types in the Male Accessory Reproductive Glands of Tribolium freemani (Coleoptera: Tenebrionidae)

Introduction

The general pattern for the reproductive accessory complex in the family Tenebrionidae appears to be two pairs of accessory glands which are attached to the seminal vesicles and the ejaculatory duct. The first set of glands, known as the tubular accessory glands (TAGs), are elongated glands with a single cell type and a uniformly staining soluble material within the lumen. The second set of glands are highly muscularized, have long thin cells, and contain light-opaque secretions. The second pair of glands has been variously identified as BAGs, PAGs, or RAGs. The morphology of the bean-shaped accessory gland (BAGs) of Tenebrio molitor and its individual cell types have been described (Dailey, et. al. 1980). Alphitobius diaperinus, the lesser mealworm, also has BAGs (Hopkins, et. al., 1993). The accessory gland of Tribolium brevicornis has been shown to be pear-shaped (PAGs) (O'Dell, et. al., 1990) and five cell types have also been identified in T. brevicornis (Sevener, et al., 1992). Rod-shaped (RAGs) glands have been identified in Tribolium castaneum (Murad and Ahmad, 1977), Tribolium anaphe (Hafeez and Gardiner, 1964) and Tribolium freemani (Rummel and Grimnes, 1991).

Preliminary whole mount staining of T. freemani glands revealed that some cells in the RAG absorb the non-polar dye Oil Red O (Rummel and Grimnes, 1991). The purpose of this study was to identify and describe the cell types located in the RAG of T. freemani through a more detailed histological study.

Materials and Methods

Colonies of T. freemani were raised in petri dishes on 19:1 mix of whole wheat flour and Brewer's yeast at a constant temperature of 30°C (Rummel and Grimnes, 1991). For whole mount studies, the adult glands were dissected in phosphate-buffered saline (PBS). The glands were stained in 0.3% Oil Red O (ORO) in 70% ethanol and subsequently destained and stored in 30% ethanol. For histological studies 8-10 day adult glands were dissected and fixed in 10% buffered formalin, dehydrated to xylene, and embedded in Paraplast. Sections (6 um) were stained in Mallory's Trichrome (Gray, 1964) which was modified to contain 25% of the normal level of Orange G.

Results and Discussion

In contrast to the TAG cells, which showed no appreciable staining, uptake of ORO in RAG cells appeared to be of five different intensities. Stained cells were seen in a band that ran from the posterior edge of the gland, near the ejaculatory duct attachment (EJD), and continued toward the anterior end of each RAG. Most of the staining cells were located on the non-TAG side, which is the dorsal side of the gland. Three distinct colors were seen: an orange-red stain near the EJD, a narrow band of bright red staining, and an intense deep red area forming a Y shape on the dorsal surface of the gland. The most anterior cells formed a cap of unstained (white opaque) cells, while the remainder of the gland was a light pink in color.

Analysis of the results of Mallory's-stained tissue shows that the TAG cells were uniformly stained but the cells of the RAG showed variable component absorption, resulting in 5 distinctly different colors (Figure 1). The differential staining was used to follow the progression of cell types throughout the gland. Cell type 1 was located in the anterior portion of the RAGs and stained a transparent blue. Cell type 2, which was on the outside wall of the RAG, stained yellow/orange. Cell type 3 was located on the posterior shoulder near the ejaculatory duct and had a clear cytoplasm with distinctly blue nuclei. Cell type 4 stained a light purple color and appeared in the body of the gland and as a fill around other cell types. Finally, cell type 5 stained a dark blue which appeared as clumps and as thin bands between other cell types of the RAG. In addition, some cells stained intensely red; this phenomenon was erratic but may represent a sixth cell type.

Secretory material elaborated from the cells of the RAG formed a distinct plug in the lumen of the gland which could be followed in subsequent sections. The colors seen in the cells were represented in the plug as separate blocks of material, indicating that the cell color was probably due to staining of secretory granules. Initial deformation of the elastic material located in the anterior ejaculatory duct suggests that T. freemani uses the RAG secretions to form the walls of its spermatophore in a process similar to that observed for T. molitor (Grimnes and Happ, 1986; Grimnes, et al.,1986)

Conclusions

No previous studies have focused on the differentiation between the cell types of T. freemani's reproductive accessory glands. Based on this study, we conclude that at least 5 distinct cell types exist in the RAG. This diversity is in keeping with the multiple cell types found in the analogous gland (BAG, PAG and RAG) in all other tenebrionid species examined thusfar. Further studies must be done with T. freemani to determine if the anomalous staining is a sixth cell type, if the pattern is age-related, and to determine the biochemical nature of the secretions and their functions.

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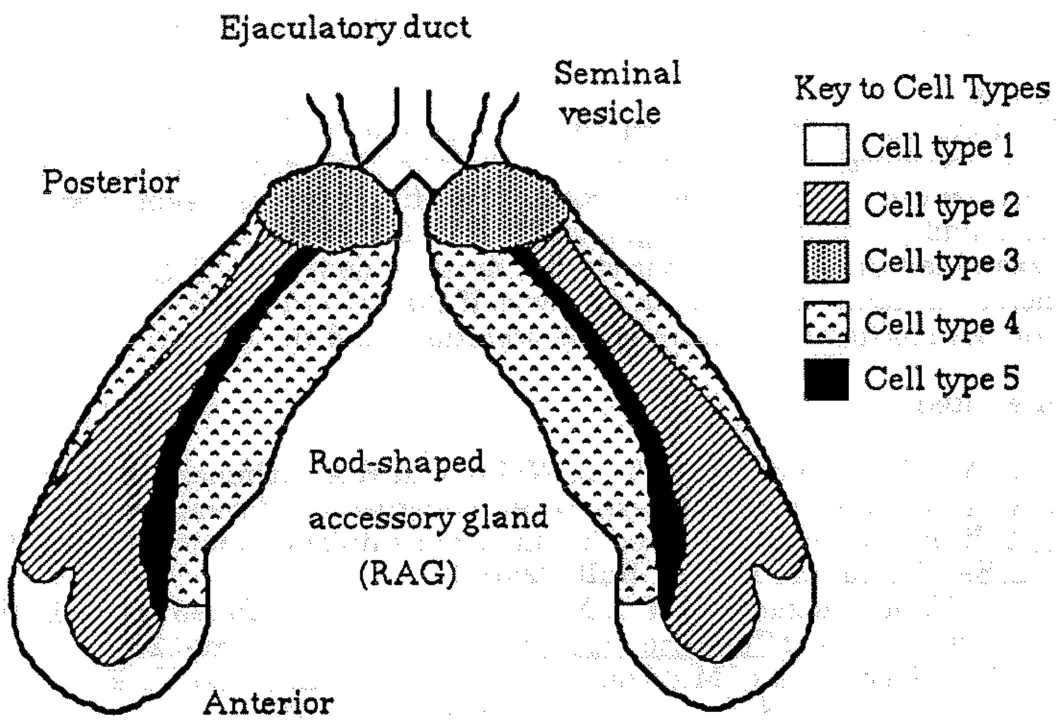

Figure 1. Dorsal view of Tribolium freemani accessory complex
TAGs on opposite side (not shown)

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BEHAVIOURAL RESPONSE OF *TRIBOLIUM CONFUSUM* DUVAL.LARVAE TO DHUTURA, *DATURA METEL* LIN.

ABSTRACT

Responses of larval *Tribolium confusum* Duval. to dhutura (*Datura metel* Lin.) were studied. Larvae of all instars were found to be repelled by the flour medium treated with dhutura leaf powder.

INTRODUCTION

Tribolium is one of the major pest of stored products and is widely distributed throughout the world. (Good, 1933; Cotton, 1947; Sokoloff, 1972, 1974). Both adults and larvae share the same habitat and are able to exploit a wide variety of stored commodities (Ziegler, 1977). Extensive use of insecticides has been a major cause of disruption and *Tribolium* has become resistant to some insecticides (Pieterse *et al*, 1972; Dyte *et al*,1975; Mensah and Watters, 1979). This problem has generated a sustained search for alternative means of control and in this respect, synergists, attractants and repellents have received considerable attention (Beroza, 1976).

The effectiveness of many local plant derevatives against insect pests has been reviewed by Jacobson (1958, 1975, 1990). The insect repellent and antifeedant properties of Nishinda (*Vitex negundo*), Biskatali (*Polygonum serrulatum)*, tobacco (*Nicotiana tabaccum*), Neem (*Azadirachta indica*), Turmeric (*Curcuma longa*), Caster (*Ricinus communis*), Royna (*Aphanamixix polystachya*) have been reported against stored product pests viz., *Tribolium castaneum* (Jilani and Malik, 1973; Qadri, 1973; Jilani *et al*, 1988; Parveen and Mondal, 1992). *Tribolium confusum* (Jacobson, 1958; Khanam *et al*, 1990; Mondal and Begum, 1991), *Trogoderma granarium* (Jotwani and Sircar, 1965), *Rhizopertha dominica* (Pereira and Wohlgemuth, 1982), *Sitophilus oryzae* (Ahmed *et al*, 1980; Golob *et al*, 1982; Kabir, *et al*., 1984;Mia *et al*., 1985; Khanam *et al*., 1991) and *Sitotroga cerealella*

(Abraham *et al.*, 1973). Moreover, different plant oils viz., cotton seed oil, peanut oil have also been reported as protectant of stored products against insect pests (Prodhan *et al.*, 1963; Pandey *et al.*, 1980; Shaaya and Ikan, 1980; Jilani *et al.*, 1988). Subsequently a number of workers have also been done with the repellency test of neem seed karnel and extracts of neem against different insect pests (Harper *et al.*, 1946; Nakanishi, 1975; Radwanski 1977a; Jacobson *et al.*, 1978).

Few workers have been reported the insecticidal properties of dhutura against different insect pests (Anon, 1952; Puttarudriah and Bhatta, 1953; Deshmukh and Borle, 1975). However, there is no information concerning the effectiveness of dhutura leaves as either repellent or attractant against stored product pests. This led to the present work.

MATERIALS AND METHODS

The experiments were conducted in ' choice chamber ' made from plastic petridish (8 cm diameter). The dishes were divided into two equal halves by a mark on the out side surface. By use of a partition each half of the dish could be loaded with either fresh or treated with dhutura leaf powder. The flour was treated by adding an appropriate weight of dhutura leaf powder and mixing thoroughly in an electric blender. The flour treated with dhutura at concentrations of 200, 400 and 800 ppm were used as test medium. After loading, the dish was agitated to make the food level even. The partition was removed and 50 test larvae were released on the centre of the dish. The dishes were placed in an incubator at 30 ^{c}. After 24 hours both fresh and treated media were separated by means of the partition and the insects from each half were collected by sieving through a 250 micrometer sieve and the numbers were counted. Experiments were replicated five times.

RESULTS AND DISCUSSION

The results of the experiments and statistical analyses are shown in table 1. *T confusum* larvae were repelled by dhutura. In dhutura treated media the responses differed significantly due to different larval instars ($P < 0.05$).

The present result is similar to those of the previous workers who reported the repellent action of various plant materials against different species of stored product insect pests (Pereira and Wohlgemuth, 1962; Jotwani and Sircar, 1965; Abraham *et al.*,1973; Jilani and Malik, 1973; Qadri, 1973;Ahmed *et al.*, 1980, Golob *et al.*, 1982; Kabir *et al.*, 1984; Mia *et al.*, 1985; Jilani *et al.*, 1988; Mondal and Begum, 1991; Parveen and Mondal, 1991; Khanam *et al*, 1991).

The present results indicate their possible use in the control of *Tribolium* in warehouses as repellents (Dethier, 1956). Bags or containers treated with repellent dhutura leaf may prevent *Tribolium* from attacking and infesting the food. Thus the use of dhutura leaf as repellent against *Tribolium* may prove to be important from the integrated pest management point of view.

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Table 1. Percentage of *T. confusum* larvae in medium treated with dhutura leaf powder at different concentrations.

Larval instar	Concentration (ppm)	Distribution in treated medium		X^2 (1 df)
		Total No.	% of total	
First	200	71	28.4	18.26***
	400	66	26.4	22.28***
	800	62	24.8	25.40***
Second	200	75	30.0	08.00**
	400	67	26.8	21.52***
	800	59	23.6	27.87***
Third	200	75	30.0	08.00**
	400	70	28.0	19.36***
	800	67	26.8	21.52***
Fourth	200	81	32.4	12.39***
	400	74	29.6	16.64***
	800	63	25.2	24.60***
Fifth	200	88	35.2	08.76**
	400	78	31.2	14.13***
	800	68	27.2	20.78***
Sixth	200	96	27.2	09.38**
	400	82	38.4	11.83***
	800	68	32.8	20.79***

Five replicates per test for each instar, each replicate consisting of 50 larvae (N= 250)

** Significant, $P < 0.01$;
*** Highly significant $P < 0.001$

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*Inheritance of body color in Tribolium--a review

Among the many mutants discovered in Tribolium castaneum, T. confusum and other species, some sex-linked and some autosomal mutations in both species affect body color. The purpose of this note is to bring this material into proper perspective to determine which of these mutations are homologous and which are analogous.

A. Sex-linked mutations.

The sex-linked mutations in both T. castaneum and T. confusum eliminate the chestnut pigment characteristic of normal beetles of both species from the elytra, but they do so in a different way: in T. castaneum the mutant spotted (sp) can be identified by the spots that appear on the elytra of teneral adults. The spots can be identified with least difficulty when the adults are a day or two old after eclosion from the pupal skin by the pigmentless spots on the elytra of these imagoes, which best can be described as colorless islands surrounded by pigmented areas. For illustration see Plate 2, Fig. H in Sokoloff, 1966).

As the chestnut body color darkens, the colorless areas begin to acquire color until several days or weeks later they become pigmented and of about the same color as the chestnut areas.

In T. confusum, the sex-linked dominant with recessive lethal effects Striped (St) produces a broad, longitudinal white stripe (see Plate 11, Fig. A in Sokoloff, 1966), which gradually will also darken until it disappears as the adults become sexually mature and beyond.

Whether sp in T. castaneum and St in T. confusum are homologous is open to speculation. The sp gene in T. castaneum is located about 45 units from red (r) , an eye color mutation. In T. confusum the St gene is located about 38 units from an eye color mutation which is also red, but as the name of this mutant (eyespot) indicates, the eye color mutations are differently expressed, and so are the spotted and Striped genes. Considerable more work is needed to settle the nature of these mutations.

More interesting are the mutants which modify the chestnut body color to a shade of black (as perceived by the unaided eye (or to a purplish color as registered under the dissecting microscope with artificial light (For more exact designation of these body colors see Sokoloff, 1966). The purplish black color is characteristic of a pair of genes located on chromosome III, (black and Charcoal) and two other genes located on Chromosomes IV and V, respectively mutants sooty (s), and jet (j). They have been recently used to identify homology between mutants occurring in T. castaneum and T. freemani by the hybridization method. This paper will soon be published in the J. of Heredity, but a short version of the results will be included at the end of this note.

B. Autosomal body color mutants in *T. castaneum*.

Four autosomal body color mutants and their alleles have been identified with their respective linkage groups in *T. castaneum*: *black* (*b*) and *Charcoal* (*Chr*) are located on linkage group III, *sooty* (*s*) on linkage group IV, and *jet* (*j*) on linkage group V. In this section of this paper we summarize the mode of Mendelian inheritance for those who may not be acquainted with their basic genetics.

1. Monohybrid crosses

a. *Black* (*b*), an autosomal semidominant, is a marker for linkage group III. Crosses between normal body color beetles referred to as wild type or *chestnut* (symbol +/+) and *black* (b/b), produce an F1 progeny (+/*b*) which are intermediate in color referred to as bronze. Crosses between two heterozygous beetles (+/*b* X +/*b*) produce the F2 progeny shown in the Punnett square in Fig. 1 From the Punnett square we can conclude that the genotypic ratio is equal to 1/4 +/+: 1/2 +/*b*: 1/4 *b*/*b*, and the appearance or phenotypic ratio is 1/4 chestnut: 1/2 bronze: 1/4 black. Backcrosses between the heterozygotes and the wild type homozygotes (+/*b* X +/+) yield a ratio of 1/2 bronze (+/*b*) and 1/2 chestnut (+/+), while backcrosses between the heterozygote and *black* (+/*b* X *b*/*b*) produce 1/2 bronze (+/*b*) and 1/2 black (*b*/*b*) (Sokoloff, 1966 for references).

b. *Charcoal* (*Chr*) is an autosomal dominant with recessive lethal effects located also on linkage group III. The phenotype of *Charcoal* is identical to the phenotype of +/*b*, i.e. bronze. Crosses between *Charcoal* and normal beetles (*Chr* X +/+) always yield equal proportions of *Charcoal* and chestnut beetles, and it is impossible to obtain a pure breeding stock of *Chr*. The explanation for this becomes clear when two *Chr* beetles are crossed to each other. This cross produces the progeny shown in the Punnett square in Fig. 2, i.e., a ratio of 2/3 *Charcoal* and 1/3 wild type beetles is obtained. There are no black beetles representing the *Chr*/*Chr* homozygous class. The homozygotes apparently die in the egg stage (Brown and Sokoloff, 1978). Crosses between *Chr*/+ and +/+ yield 1/2 *Charcoal* and 1/2 chestnut. Crosses between *Chr*/+ and homozygous *b*/*b* beetles yield 1/2 *Chr* +/+*b* beetles which are black and 1/2 ++/+*b* beetles that are bronze. The appearance of black beetles is due to pseudoallelism of *Chr* and *b* which are very close to each other (less that 0.1 crossover units).Crosses between heterozygous +/*b* and *Chr*/+ give the results in Fig. 3 which are similar to those obtained when two +/*b* are crossed. This is due to the non-complementation of *b* and *Chr* in the transposition (Brown and Sokoloff, 1978). Each of the genes (*b* or *Chr*) produces only half the amount of pigment which in the heterozygotes +/*b* and *Chr*/+ is only sufficient to produce beetles with bronze body color. On the other hand beetles with genotype *b*/*b* or *Chr*/*b* are able to produce enough pigment to produce a phenotypically black beetle.

c. The sooty (s) gene is an autosomal recessive which serves as a marker for linkage group IV. Its phenotypic appearance in homozygous condition is identical to bronze. As shown in Fig. 4, when a chestnut (+/+) and a sooty (s/s) beetle are mated, all the progeny (+/s) will be phenotypically chestnut. Crosses between F1s will produce 1/4 +/+ (chestnut); 1/2 +/s (also chestnut) and 1/4 bronze, for a total of 3/4 chestnut:1/4 bronze. Heterozygotes (+/s) mated to wild type (+/+) will produce all wild type or chestnut progeny (half of which will be genotypically +/+ and half will be +/s). In contrast, crosses between heterozygotes (+/s) and sooty (s/s) will yield 1/2 wildtype (+/s) and 1/2 bronze (s/s) progeny.
d. The jet (j) gene is also an autosomal recessive. It serves as a marker for linkage group V. Its phenotype is darker and easily distinguishable from black, Charcoal or sooty. Its behavior is typical for a Mendelian recessive gene. Diagrammatically its genetic behavior parallels the behavior of sooty in Fig. 4. All one has to do is to substitute the letters s by j in the Punnett square to illustrate the results which in the F2 will be 3 +/:1 j/j (i.e. 3 chestnut :1 jet).

2. Ratios in dihybrid crosses.
Because of similarities in phenotype and epistatic interactions, body color mutations in Tribolium provide interesting deviations from typical dihybrid F2 (9:3:3:1) ratios. Below is a brief review involving body color autosomal mutations.
a. Crosses between black and jet.
The F1 of crosses between black and jet are genetically +/b;+/j and phenotypically bronze. Crosses between F1s yield the following proportions of F1 gametes and the combinations of genotypes resulting from them shown in Fig. 5:
Because of semidominance of b and epistasis of b and j, the phenotypic ratio in F2 is:

3/16 +/;+/ =chestnut
6/16 +/b;+/ =bronze
4/16 b/b;+/ and b/b;j/j=black
3/16 +/;j/j =jet (Sokoloff, 1966).

b. Crosses between black and sooty.
The F1 are genetically +/b;+/s and phenotypically bronze. Their gametes and F2 will be as shown in Fig. 6.
Because of identical phenotype produced by +/b and s/s and epistasis of b over s the phenotypic ratio in the F2 becomes

3/16 +/;+/ = chestnut
6/16 +/b;+/ and 3/16 +/; s/s = 9/16 bronze
3/16 b/b;+/ and 1/16 b/b;s/s = 4/16 black
(Sokoloff, 1966).

c. Crosses between black and Charcoal.
As previously indicated, the genes b and Chr are linked and in close proximity to each other. The recombination values in back-crosses of Chr +/+ b male x + b/+ b female = 0.07 while the reciprocal cross gave a recombinant value of .014% because sex influences the frequency of recombination (Sokoloff, 1977). Furthermore, b and Chr complement each other so when crosses between +/b and Chr/+ are carried out the genetic ratio will be as shown in Fig. 8, or a phenotypic ratio of

1/4 +/+ = chestnut
1/2 Chr/+ and +/b = bronze, and
1/4 + Chr/b + = black.

When two black beetles of genotype + Chr/b + are mated, one obtains all black beetles of which 1/4 will die in the egg stage (genotype + Chr/+ Chr); 1/2 will be Chr +/+ b: 1/4 will be b +/b +. The phenotypic ratio will be 100% black, of which 2/3 will be black because of non-complementation of Chr and b, and 1/3 will be black because they are homozygous for the b gene. If large numbers of beetles are examined, it is possible to obtain a small number of chestnut beetles, the result of crossing over. (Brown and Sokoloff, 1978).

d. Crosses between Charcoal and jet.
The F1 progeny consist of equal numbers of Chr/+;+/j (bronze) and chestnut (+/+;+/j). Crosses of the bronze F1 to get F2, one obtains the genotypes shown in Punnett square 7.
One quarter of the beetles will die in the egg stage. Of the remaining 12/12, 3/12 or 1/4 will be phenotypically wild type, 6/12 (1/2) will be bronze, and 3/12 (1/4) will be jet. Crosses between the non-Charcoal beetles in F1 will be 3/4 chestnut:1/4 jet in the F2.

e. Crosses between Charcoal and sooty.
Crosses between Charcoal (Chr) and sooty (s/s) give two genotypes in F1: Chr +/+ s (bronze) and +/+:+/s (chestnut). Crossing the non-bronze (i.e. chestnut beetles to each other (+/+;+/s X +/+;+/s) and if one ignores the wild type alleles of linkage group III one obtains a typical Mendelian genetic ratio of 1/4 +/+; 1/2 +/s; 1/4 s/s, or a phenotypic ratio of 3/4 chestnut and 1/4 bronze. Crossing the bronze F1 beetles to obtain F2 one obtains the Punnett square in Fig. 11. One quarter of the progeny will die because of homozygosity of Chr. Of the survivors, 9/12 will be bronze either because of the presence of heterozygous Chr or homozygous s/s and 3/12 will be phenotypically wild type.

3. Identification of homologous genes in closely related species.
There are two reliable ways in determining whether mutations found in two species are homologous or analogous. One is by their linkage relationships and the relative position on the mutants in respect to marker genes. The other is by the use of the hybridization method. This method is an extension of tests of allelism. Two mutants are allelic when strain 1 and strain 2

of a given species, bearing a similar mutation, are crossed. The mutants are allelic if the F1 of this cross phenotypically resemble the mutant phenotype of the two parental strains. If the phenotype of the F1 is like the wild type, the two strains are not allelic. In the same way, at the interspecies level, two mutations will be homologous if crosses of, say, mutant X of species A with mutant Y of species B yield F1 progeny bearing the parental trait. If the F1 resembles the wild type of the two species, the two mutants are not homologous.

In *Tribolium*, the most closely related species are *T. castaneum* and the most recently discovered *T. freemani*. These two species when crossed, produce abundant hybrids all of which are sterile. Even though *T. castaneum* and *T. freemani* produce sterile hybrids, Spray and Sokoloff (submitted for publication) had an opportunity to use the hybridization test when a male mutant was discovered in *T. freemani*. The mutant in question had a bronze color. But the bronze phenotype is produced by several genes in *T. castaneum*: the *black* and *Charcoal* genes of linkage group III, in heterozygous form, and the gene *sooty* as a homozygote. By crossing this male with virgins of these mutants it was possible to determine, by a process of elimination, that the mutant male was heterozygous for *black* and rule out that the gene was homologous to *Chr* or *s*. This was subsequently confirmed when the heterozygous male was crossed with virgin *T. freemani* +/+ females. They produced males and females which were chestnut and bronze. Backcrosses of bronze females to the heterozygote gave bronze and black beetles. The latter were then selected to establish a black mutant stock. Thus, thanks to the hybridization test, we were able to establish homology not only for *black* but also for the *Charcoal* wild type allele present by the interaction of the *black* gene in the unknown mutant and the *Charcoal* heterozygotes of *T. castaneum* to produce black beetles in a manner similar to that illustrated in Fig. 3.
Thus, as indicated above, where marker genes are available in one species (A) and where hybridization is possible between species A and species B, homology can be established in two generations at most between similar mutants in species A and B.

Legends for Figures 1-8.

Fig.1. Upper row: P1 consisting of +/+ X b/b.
Second row F1 consisting of all +/b.
Third row F2 consisting of 1/4 +/+; 1/2 +/b; 1/4 b/b.
The Punnett square shows the gametes produced by both F1 parents and the F2. The phenotypic ratio will be 1/4 chestnut: 1/2 bronze: 1/4 black.

Fig.2. Gametes and F2 produced by Chr/+ X Chr/+ crosses. 1/4 of progeny (Chr/Chr) die. Therefore, the phenotypic ratio of the survivors is 2/3 bronze and 1/3 chestnut.

Fig.3. Gametes and progeny produced by Chr/+ X b/+ crosses. The phenotypic ratio is 1/4 chestnut: 1/2 bronze: 1/4 black.

Fig.4. Upper row: P1 cross +/+ X s/s.
Middle row: F1 (+/s).
Third row: F2 3/4 + (i.e. 1/4 +/+ + 1/2 +/s): 1/4 s/s.
Punnett square: Gametes of two heterozygous (+/s) F1 parents.
F2 phenotypic ratio is 3/4 chestnut: 1/4 bronze.

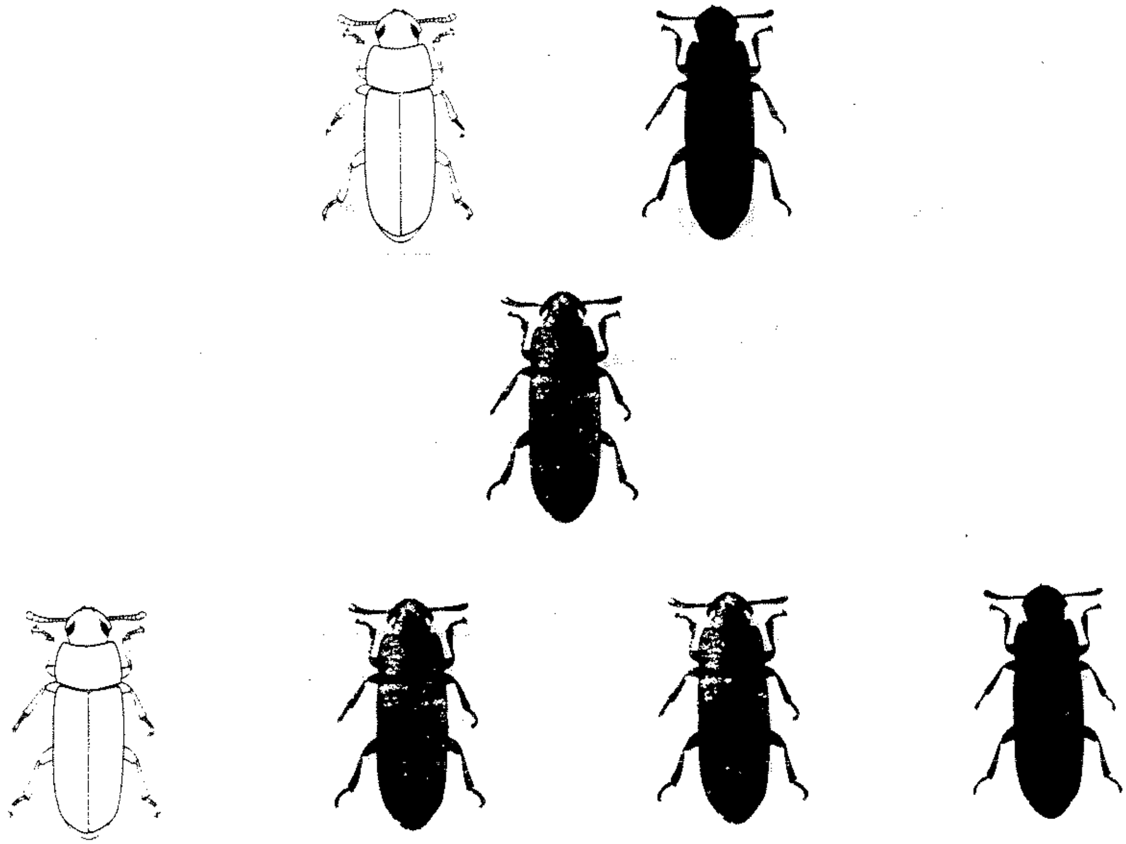
Fig. 5. Dihybrid ratio in F2 of crosses between b and j. The phenotypic ratio is 3/16 chestnut: 6/16 bronze: 4/16 black: 3/16 jet.

Fig. 6. F2 of b/b X s/s crosses. The phenotypic ratio of the F2 is 3/16 chestnut: 9/16 bronze: 4/16 black.

Fig. 7. F2 of crosses of Chr/+ X j/j: The phenotypic ratio of the F2 is: 1/4 +/+: 1/2 bronze: 1/4 jet.

Fig. 8. F2 of crosses of Chr/+ X s/s: The phenotypic ratio of the F2 is: will be 1/4 +/+: 3/4 bronze.

For more details see text.



	+	b
+	+/+	+/b
b	+/b	b/b

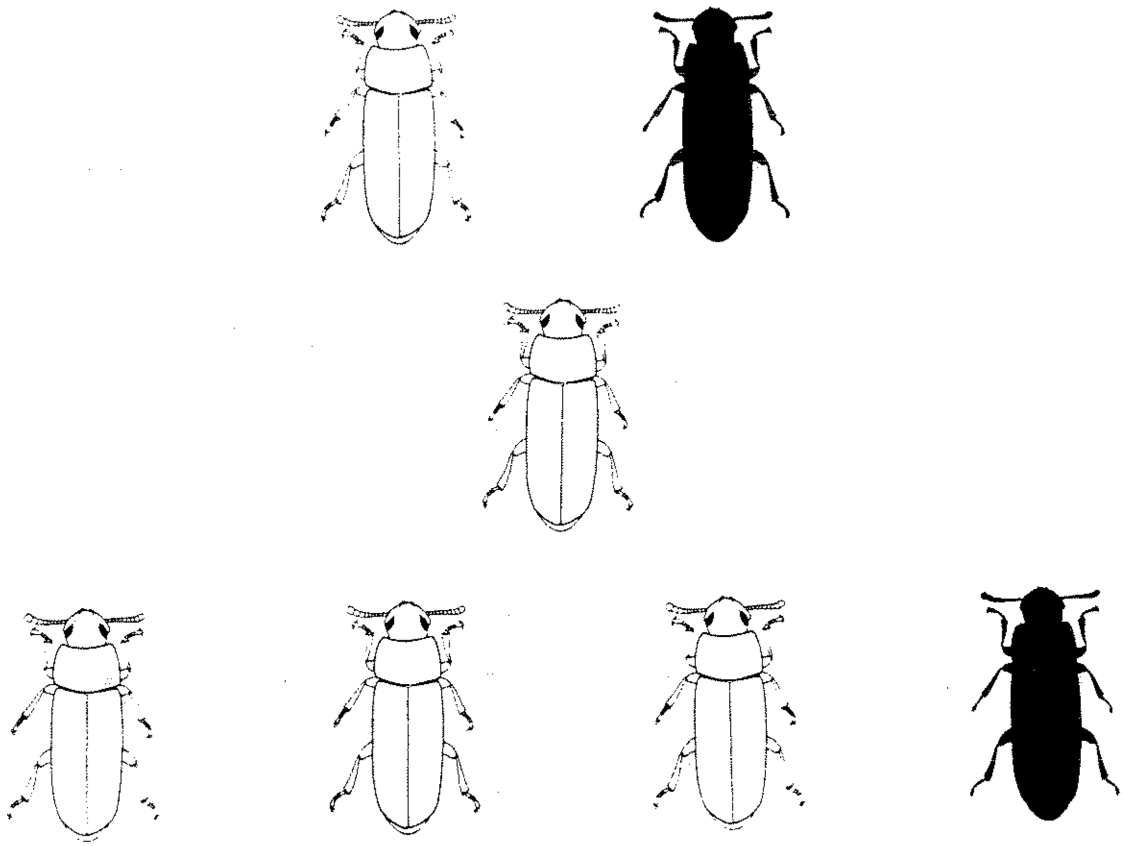
Fig.1

	Chr	+
Chr	Chr / Chr	Chr / +
+	Chr / +	+ / +

Fig.2

	++	b+
++	++ / ++	++ / b+
+Chr	+Chr / ++	+Chr / b+

Fig.3



	+	s
+	+ / +	+ / s
s	+ / s	s / s

Fig.4

	+ ; +	b ; +	+ ; j	b ; j
+ ; +	+/+ ; +/+	+/b ; +/+	+/+ ; +/j	+/b ; +/j
b ; +	+/b ; +/+	b/b ; +/+	+/b ; +/j	b/b ; +/j
+ ; j	+/+ ; +/j	+/b ; +/j	+/+ ; j/j	+/b ; j/j
b ; j	+/b ; +/j	b/b ; +/j	+/b ; j/j	b/b ; j/j

Fig.5

	+;+	b;+	+;s	b;s
+;+	+/+;+/+	+/b;+/+	+/+;+/s	+/b;+/s
b;+	+/b;+/+	b/b;+/+	+/b;+/s	b/b;+/s
+;s	+/+;+/s	+/b;+/s	+/+;s/s	+/b;s/s
b;s	+/b;+/s	b/b;+/s	+/b;s/s	b/b;s/s

Fig.6

	Chr ; +	Chr ; j	+ ; +	+ ; j
Chr ; +	Chr/Chr ; +/+	Chr/Chr ; +/j	Chr/+ ; +/+	Chr/+ ; +/j
Chr; j	Chr/Chr ; +/j	Chr/Chr ; j/j	Chr/+ ; +/j	Chr/+ ; j/j
+ ; +	Chr/+ ; +/+	Chr/+ ; +/j	+/+ ; +/+	+/+ ; +/j
+ ; j	Chr/+ ; +/j	Chr/+ ; j/j	+/+ ; +/j	+/+ ; j/j

Fig.7

	Chr ; +	Chr ; s	+ ; +	+ ; s
Chr ; +	Chr/Chr ; +/+	Chr/Chr ; +/s	Chr/+ ; +/+	Chr/+ ; +/s
Chr; s	Chr/Chr ; +/s	Chr/Chr ; s/s	Chr/+ ; +/s	Chr/+ ; s/s
+ ; +	Chr/+ ; +/+	Chr/+ ; +/s	+/+ ; +/+	+/+ ; +/s
+ ; s	Chr/+ ; +/s	Chr/+ ; s/s	+/+ ; +/s	+/+ ; s/s

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NOTE: THESE REFERENCES HAVE BEEN OBTAINED FROM THE AGRICOLA, BIOSIS AND CAB DATA BASES FOR THE YEARS 1992-1994. THEY HAVE BEEN ARRANGED ACCORDING TO TOPIC TO CONFORM WITH THE FORMAT EMPLOYED IN THE TIB SINCE ITS INCEPTION IN 1958. THE EDITOR HOPES THIS COMPILATION AND ITS FORMAT WILL BE USEFUL TO THE SUBSCRIBERS OF TIB. SUGGESTIONS FOR IMPROVEMENT ARE WELCOME

A. SOKOLOFF

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19. TERATOLOGY

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Edwards, D.K., Ph.D. Dispersal, survival and population dynamics. Periodic phenomena in insects. (5)
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Friedrich, Markus	Ph. D. student	eye development
Hausdorf, Bernhard	Ph. D. student	head gap genes
Klingler, Martin	Res. Associate	segm. mutants; transgenics
Schroder, Reinhard	Postdoc fellow	maternal organizers; anti-sense.
Tautz, Diethard	Professor	early development; evolution
Wolff, Christian	Ph.D. student	regulation of hunchback

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Cox, Dr. P.D.	Stored-product entomology
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Halstead, Dr. D.G.H.	Taxonomy, ecology, behavior (2, 5, 17)
Mills, Dr. K.A.	Fumigation, controlled atmospheres, gene-
Muggleton, Dr. J.	Insecticide resistance, population genetics
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Dales, M.J. B. Sc. PhD. Control of stored-product insects (Chemical dusts, botanicals, IGR's). aFumigation with carbon dioxide.

Donaldson, T. M.Phil. Farming systems, training, project management
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