TRIBOLIUM INFORMATION BULLETIN

Number 24

1984

EDITORS

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Number 24

July, 1984

Bibliography

NOTE

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FOREWORD

It is a pleasure to announce the acceptance by M. Hani Soliman of the position as co-editor of TIB. He replaces the position left vacant by P. N. Bhat. We are indebted to DR. Bhat for all the help he provided in publishing TIB 22 and 23.

We owe thanks to Mrs. Carol Smith, Alexandra Sokoloff, Elaine Sokoloff and Michael Sokoloff, for assistance in the publication of TIB-24.

Stock Lists

Note: The present listing of stock lists does not necessarily reflect the availability of all stocks in the institutions listed. Each year the call for contributions requests that contributors bring their lists up to date. Some contributors do, and these are indicated by the name of the contributor at the end of his list. But in other cases the lists have been contributed once, long ago, and with no attempt to update them. These lists are included because the material may still exist in those laboratories and may have special value to an investigator just beginning research or may give an idea to federal agencies where a given species can be found. The lists derived from previous issues of Tribolium Information Bulletin are followed by (Ed.). Those laboratories should be contacted to determine whether those cultures are still in existence.

Stock Lists

BERKELEY, CALIFORNIA
UNIVERSITY OF CALIFORNIA,
DONNER LABORATORY AND LAWRENCE RADIATION LABORATORY

Tribolium confusum

1. "+" - a wild type strain derived from Genetics Department, University of California, Berkeley.
2. Black - an autosomal semi-dominant body color mutant. From 1.
3. Miniature - an autosomal recessive body size mutant. From 1.
4. Short elytra - an autosomal dominant elytron size mutant. Low viability in adults, indicating a recessive Lethal gene.
5. Blistered elytra - an autosomal recessive mutant. Low viability.

Tribolium brevicornis

Wild type derived from Genetics Department, University of California, Berkeley.

(Ed.)

BRIDGEPORT, CONNECTICUT
UNIVERSITY OF BRIDGEPORT,
DEPARTMENT OF BIOLOGY

Tribolium confusum

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

(Ed.)

Stock Lists

BURLINGTON, NORTH CAROLINA
CAROLINA BIOLOGICAL SUPPLY COMPANY

Tribolium castaneum

1. black	Chicago
2. jet	
3. pearl	
4. wild	McGill
5. high body weight	
6. low body weight	

Tribolium confusum

1. wild	Carolina

(Ed.)

BURLINGTON, VERMONT 05401
UNIVERSITY OF VERMONT
DEPARTMENT OF ZOOLOGY

Tribolium castaneum
unsaturated fatty acid sensitive (cos)

Tribolium confusum
Chicago
black

Tribolium madens

Tribolium brevicornis

All stocks were derived from University of Rhode Island

(Ed.)

Stock Lists

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)
    2. antennapedia, black (ap, b)
    3. black-Chicago (b) via San Bernardino
    4. weird (wd) via San Bernardino

D. C. Englert

CARLISLE, PENNSYLVANIA
DICKINSON COLLEGE, DEPARTMENT OF BIOLOGY

Tribolium confusum

I. Wild type strains
    1. Six strains started from females captured in a feed bin in New York City, 1955.
    2. Three strains, one each from T. Park, Chicago; J. Stanley, Montreal; S. Smith, Sault Ste. Marie, Canada.
    3. One strain consisting of several above strains mixed together about three years ago.
    4. One strain started with individuals taken from (1) above, which has been freed of eye mutations.

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

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

Stock Lists

Oryzaephilus surinamensis

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

(Ed.)

CHARLOTTESVILLE, VIRGINIA
UNIVERSITY OF VIRGINIA,
DEPARTMENT OF BIOLOGY

Tribolium castaneum

I. Wild type strains

1. Chicago	University of Chicago
2. Purdue University Foundation	via Stony Brook
3. Synthetic	San Bernardino

II. Mutant strains

1. McGill black	University of Chicago via Stony Brook

(Ed.)

CHICAGO, ILLINOIS
UNIVERSITY OF CHICAGO
DEPARTMENT OF BIOLOGY

I. Wild type strains

A. *Tribolium castaneum*
   1. "Chicago"
   2. *b*I (an inbred strain derived from Chicago)
   3. *b*II (Same)
   4. *b*III (Same)
   5. *b*IV (Same)

B. *Tribolium confusum*
   1. "Chicago"
   2. *c*I (an inbred strain derived from from Chicago)
   3. *c*II (Same)
   4. *c*III (Same)
   5. *c*IV (Same)

C. *Tribolium madens*

D. *Latheticus oryzae*

Stock Lists

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

I. Wild type strains

A. *Callosobruchus maculatus*

B. *Oryzaephilus surinamensis*

C. *Tribolium castaneum*

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

D. *Tribolium confusum*

1. "Chicago" (originally from Thomas Park)
2. *bI* (derived from "Chicago")
3. *bII* (derived from "Chicago")
4. *bIII* (derived from "Chicago")
5. *bIV* (derived from "Chicago")

II. Mutant

A. *Tribolium confusum* ebony (an autosomal recessive body color mutant)

(Ed.)

CORAL GABLES, FLORIDA
UNIVERSITY OF MIAMI,
DEPARTMENT OF BIOLOGY

I. Wild type strains

1. *Tribolium confusum* Chicago
2. *Tribolium castaneum* Chicago

II. Mutant

T. confusum - Ebony - Sokoloff
T. castaneum - Jet - from chicago wild
T. castaneum - Chicago black - Sokoloff
T. castaneum - Sooty - Sokoloff
T. castaneum - Dark sooty - from Sooty

(Ed.)

Stock Lists

CORVALLIS, OREGON
OREGON STATE UNIVERSITY
DEPARTMENT OF ZOOLOGY

I. Wild type strains

  A. *Tribolium castaneum*
    1. Oregon (synthetic)

  B. *Tribolium confusum*
    1. Oregon (synthetic)

II. Mutant strains

  A. *Tribolium castaneum*
    1. ap^D,s
    2. b,mc,p
    3. bb
    4. dve,pd
    5. mc^c,s
    6. nd,s
    7. p,lod
    8. Rd,s
    9. r^D,s
    10. sa-2,+/s
    11. Sa-2,s
    12. ser,py,r
    13. wd,s

  B. *Tribolium confusum*
    1. b^u
    2. b, spl
    3. ble^u
    4. dep
    5. dj
    6. e^c
    7. msg^{AS}
    8. r^u
    9. thu
    10. thu^u

Peter S. Dawson

DAVIS, CALIFORNIA
UNIVERSITY OF CALIFORNIA
DEPT. OF ANIMAL SCIENCE

I. *Tribolium castaneum*

A. Wild Type Strains

1. BC1--Berkeley, 1967
2. DC1--Davis, collected 1969
3. DC2--Davis, collected 1978

B. Mutant Strains

1. BC2(s)--sooty; Berkeley , 1967
2. SCp--pearl; San Bernardino, 1969
3. Dsp--sooty, pearl; derived from BC2(s) x SCp

C. Selected and/or Inbred Lines

1. BC1#2, lines 1,2,4,6,8--selected for high pupa weight for 23 gen.
2. BC1#2, lines 3,5,7,10--selected for high pupa weight for 30 gen.
3. BC1#2, line 9--selected for high pupa weight for 52 gen.
4. BC1#2, lines 1c, 2c--unselected controls for above lines
5. BC1#2, line 9R--derived from line 9 above; selected for 52 gen;relaxed for 10 gen., resumed selection for 10 gen, relaxed until present
6. BC1#2BM-- selected for high pupa weight from single pair founder
7. DCp, lines 1,2--pearl, Davis background; selected for high pupa weight
8. DCp, line 9--unselected control for above lines
9. BC1#2L, lines 1,2,3--selected for low pupa weight for 25 gen.
10. BC1#2L, line 1c--unselected control for above lines
11. ACS--homozygous for slow allele at est-1 locus
12. ACF--homozygous for fast allele at est-1 locus
13. $B_2C_2D_2$
14. $A_1B_1C_0D_2$ } lines homozygous for various esterase loci
15. $B_0C_1D_1$
16. BCI#14, lines 1,2,3--inbred sooty lines, from Berkeley

Stock Lists

II. Tribolium confusum

A. Wild Type Strains

1. BF1--Berkeley , 1967
2. CF1--Chicago; obtained from Sokoloff, 1979
3. DF1 thru DF4--Davis; collected 1967, '69, '69, '78

B. Mutant Strains

1. SFp--pearl, San Bernardino , 1969
2. MFb--black, McGill; obtained from Sokoloff, 1979
3. MFe--ebony, McGill background

III. Tribolium audax

A. Wild Type Strain

1. +/+ obtained from Sokoloff, 1979

IV. Tribolium madens

A. Wild Type Strain

1. +/+ obtained from Sokoloff, 1979

(Ed.)

DENTON, TEXAS
TEXAS WOMAN'S UNIVERSITY
DEPARTMENT OF BIOLOGY

I. Wild type strains and origin

A. Tribolium confusum (Chicago Standard)

B. Tribolium castaneum (Brazil C1)

(Ed.)

FLUSHING, NEW YORK 11367
QUEENS COLLEGE OF THE CITY UNIVERSITY OF NEW YORK
DEPARTMENT OF BIOLOGY

Tribolium castaneum	Purdue University
Purdue wild type	

Stock Lists

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

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.)

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

Tribolium castaneum

I. Wild type strain

   1. Chicago

II. Mutant strains

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

(Ed.)

HUNTSVILLE, TEXAS
SAM HOUSTON STATE UNIVERSITY
BIOLOGY DEPARTMENT

Tribolium castaneum

I. Wild type strains

A. Purdue University Foundation
B. Huntsville, Texas wild type - source of squint-like (sl).

II. Mutant stains

A.	Bar eye (Be)	Berkeley , 1962
B.	black (b^D)	Carbondale, Ill., 1961
C.	light ocular diaphragm (lod^D)	Carbondale, Ill., 1961
D.	maroon (m)	Purdue + Foundation , 1962
E.	microcephalic (pearl) (mc, p)	Chazy, New York , 1959
F.	paddle (pd)	Chicago , 1955
G.	peach (r^{ph})	Carbondale, Ill., 1961
H.	pygmy (py)	Chazy, New York , 1960
I.	pink, ivory (p^{Pk}, i)	Chazy, N. Y.: Purdue + Foundation
J.	ring (rg)	Purdue + Foundation , 1961
K.	rose (rs)	Purdue + Foundation , 1964
L.	ruby (rb)	Carbondale, Ill., 1961
M.	ruby, jet (rb, j)	Carbondale, Ill., 1961
N.	ruby, peach (rb, r^{ph})	Purdue + Foundation , 1956
O.	sooty (s)	Chazy, New York , 1960
P.	squint (sq)	Huntsville, Texas , 1973
Q.	squint-like (sql)	

(Ed.)

IMMACULATA, PENNSYLVANIA
IMMACULATA COLLEGE, CANCER RESEARCH UNIT

I. Wild type strains

1.	*Alphitobius diaperinus*	PIL
2.	*Alphitobius laevigatus*	PIL
3.	*Gnathocerus cornutus*	PIL
4.	*Gnathocerus maxillosus*	PIL
5.	*Latheticus oryzae*	Berkeley
6.	*Tenebrio molitor*	PIL
7.	*Tenebrio obscurus*	PIL
8.	*Tribolium anaphe*	Berkeley
9.	*Tribolium brevicornis*	Berkeley
10.	*Tribolium castaneum*	Berkeley
11.	*Tribolium confusum*	Berkeley
12.	*Tribolium destructor*	Berkeley
13.	*Tribolium madens*	Berkeley

II. Mutant Strain

1. Tribolium confusum melanotic stink glands (msg)

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

(Ed.)

IRVINE, CALIFORNIA
UNIVERSITY OF CALIFORNIA, DEPARTMENT OF ORGANISMIC BIOLOGY

Tenebrio molitor

(Ed.)

ITHACA, NEW YORK
CORNELL UNIVERSITY, DEPARTMENT OF ANIMAL SCIENCE

Tribolium castaneum

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

(Ed.)

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

I. Wild type strains

1. *Tribolium confusum* from Dr. H. Ducoff, University of Illinois.

2. *Tribolium confusum* infected with *Nosema whitei*.

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

(Ed.)

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

Tenebrio molitor

(Ed.)

KENT, OHIO
KENT STATE UNIVERSITY, DEPARTMENT OF BIOLOGICAL SCIENCES

I. Wild type strains

A. *Tribolium castaneum*

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

B. *Tribolium confusum*

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

C. *Oryzaephilus surinamensis*

From infested flour.

(Ed.)

KINGSTON, R. I. 02881
UNIVERSITY OF RHODE ISLAND
DEPARTMENT OF ZOOLOGY

Tribolium castaneum	
Purdue Foundation	via Purdue
Black Foundation	via Purdue
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.)

Stock Lists

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 inbreeding.

(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).

A. E. Bell.

Stock Lists

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

Tribolium castaneum

I. Mutant strains

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

(Ed.)

LAURINGBURG, NORTH CAROLINA
ST. ANDREWS COLLEGE

Tribolium confusum

A wild stock that is infected with Nosema whitei.

(Ed.)

LEXINGTON, KENTUCKY
AGRICULTURAL EXPERIMENT STATION
UNIVERSITY OF KENTUCKY

Tribolium castaneum

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

1. IS - From a cross of CSI ~~SCI~~-10 x E1 inbred lines, maintained in population cages with extremely large population size and random mating for 28 generations.

(Ed.)

LIVERMORE, CALIFORNIA
BIOLOGICAL FRONTIERS INSTITUTE

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

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

(Ed.)

LORETTO, PENNSYLVANIA
ST. FRANCIS COLLEGE, BIOLOGY DEPARTMENT

I. Wild type strain

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

(Ed.)

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

I. Wild type strain

1. *Tribolium confusum*	Chicago via Berkeley

(Ed.)

MADISON, WISCONSIN
UNIVERSITY OF WISCONSIN

1) Wild type strain

WIS-1 *Xyleborus ferrugineus*, from Costa Rica.

2) "Germfree" strain

WIS-2 *Xyleborus ferrugineus*, derived from WIS-1.

Note

This insect as the wild type exists in obligatory symbiosis with filamentous fungi, yeasts and bacteria. The insect reproduces by arrhenotokous parthenogenesis with unfertilized (haploid, n=7) eggs yielding male progeny, and fertilized (diploid, n=14) eggs yielding female progeny. Females can be kept alive for 9-12 months and will retain fertility over most of their life. Thus, many experiments may be conducted with a given individual. The insect only decodes its larval genome into the phenotype if given a non-^{7} sterol. Imaginal phenotypic charagteristics are decoded only when a dietary ^{7} sterol is provided the larva. No other insects are known to provide this combination of attributes to researchers in the areas of cell determination versus differentiation, and other aspects of organismal development.

A new stock line can be started from a single virgin female by allowing her to produce male progeny which she will tend until they are adults, then will mate with a son, and then will produce mostly diploid female progeny which can be used to continue the created line.

(Ed.)

MADISON, NEW JERSEY
FAIRLEIGH DICKINSON UNIVERSITY
FLORHAM-MADISON CAMPUS
BIOLOGY DEPARTMENT

Blattela germanica, wild-type (VPI strain); Blackbody; red; ruby; rose; pallid; Prowing T (9;10)
Periplaneta americana, wild-type and white eye; wild-type from Hackensack (New Jersey) Meadowlands
Blatta orientalis
Supella longipalpis
Symploce hospes
Leucophaea maderae
Nauphoeta cinerea
Diploptera punctata
Gromphadorhina portentosa
Pycnoscelus surinamensis, several parthenogenetic forms
Pycnoscelus indicus, bisexual

Also mutant and translocation-bearing strains of several spp.

We also maintain a spider beetle species (as yet unidentified). It has been kept in the laboratory for about three years.

(Ed.)

MANHATTAN, KANSAS
DEPARTMENT OF ENTOMOLOGY
KANSAS STATE UNIVERSITY

LEPIDOPTERA

Phycitidae

Cadra cautella (Walk.), almond moth, from USDA, Manhattan, Kansas, 1971.
Plodia interpunctella (Hbn.), Indian-meal moth, Kansas.

Gelechiidae

Sitotroga cerealella (Oliv.), Angoumois grain moth, Kansas, about 1970.

A. Sitotroga cerealella (Oliv.), Red-eyed Angoumois grain moth, from stock cultures, 1967.

COLEOPTERA

Anobiidae

Lasioderma serricorne (F.), Cigarette beetle, Kansas, 1966.
Stegobium paniceum (L.), Drugstore beetle, from USDA, Richmond, Virginia, 1971.

Bostrichidae

Rhyzopertha dominica (F.), Lesser grain borer, Kansas.

Bruchidae

Callosobruchus maculatus (F.), Cowpea weevil, Kansas, 1971.

Stock Lists

Cucujidae

Cryptolestes ferrugineus (Steph.), Rusty grain beetle, Kansas.
Cryptolestes pusillus (Schon.), Flat grain beetle, Kansas.
Oryzaephilus surinamensis (L.), Saw-toothed grain beetle, Kansas.
Oryzaephilus mercator (Fauv.), Merchant grain beetle, from USDA, Savannah, Georgia, 1964.

Curculionidae

Sitophilus granarius (L.), Granary weevil, Kansas.
Sitophilus oryzae (L.), Rice weevil, Kansas, 1955.
Sitophilus zeamais Mots., Maize weevil, from Stuttgart, Arkansas, 1955.
Sitophilus zeamais Mots., Maize weevil, from Veracruz, Mexico, 1964.

Dermestidae

Megatoma piceus (Oliv.), Black carpet beetle, Kansas.
Trogoderma inclusum LeC., Larger cabinet beetle, from USDA, Manhattan, Kansas.
Trogoderma sternale Jayne, Manhattan, Kansas, 1971.
Trogoderma variabile Ballion, Kansas.

Ostomatidae

Tenebroides mauritanicus (L.), Cadelle, Kansas.

Ptinidae

Gibbium psylloides (Czemp.), Spider beetle, Chicago, Ill., 1966.

Silvanidae

Ahasverus advena (Waltl.), Foreign grain beetle, Manhattan, Kansas, 1969.

Tenebrionidae

Palorus ratzeburgi (Wissm.), Small-eyed flour beetle, Kansas, 1965.
Tenebrio molitor L., Yellow mealworm, Kansas.
Tenebrio obscurus F., Dark mealworm, Manhattan, Kansas, 1971.
Tribolium castaneum (Hbst.), Red flour beetle, Kansas.
Tribolium confusum J. du V., Confused flour beetle, Kansas.

(Ed.)

Stock Lists

MANHATTAN, KANSAS 66502

U.S. GRAIN MARKETING RESEARCH LABORATORY

Tribolium castaneum

I. Insecticide-resistant 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 R. W. Wilkin.
5. TC 95, nonspecific. From B. R. Champ.
6. DDT C, DDT-resistent, collected in South Africa, 1959. From D. G. Blackman.

II. Mutant strains

1.	au, lod, p-aureate, light ocular diaphragm, pearl (III, III, II)	from San Bernardino, 1981
2.	sa, c-short antennae, chestnut (VII, VII)	"
3.	pd, py, ptl-paddle, pygmy, platinum (I, I, I)	"
4.	mc, j-microcephalic, jet (V,V)	"
5.	Dch-Dachs (II)	"
6.	rb-ruby (V)	"
7.	mas-missing abdominal sternites (II)	"
8.	s-sooty (IV)	"
9.	sq-like-squint-like (VIII?)	"
10.	mxp-maxillopedia (II)	"
11.	Mo-Microphthalmic (VI)	"
12.	fas-3a-fused antennal segments (V)	"
13.	p-pearl (II)	"
14.	b, ap-black, antennapedia (III, VIII)	"
15.	b, apt-black, alate prothorax (III, IX)	"
16.	h, s-hazel, sooty (IV, IV)	"
17.	b-black (III)	"
18.	b^t-tawny (III)	"
19.	Chr-Charcoal (III)	"
20.	b^d-dusky (III)	new mutant, Manhattan, 1983
21.	Rmal-Resistance to malathion (VI)	"

R. W. Beeman

MIDLAND, MICHIGAN
THE DOW CHEMICAL COMPANY, BIOPRODUCTS DEPARTMENT

Tribolium confusum

Wild strain maintained in laboratory more than 20 years.

(Ed.)

MILWAUKEE, WISCONSIN 53201
THE UNIVERSITY OF WISCONSIN
ZOOLOGY DEPARTMENT

Wild type strains

1. Purdue Foundation +
2. Purdue Foundation *b*

Selected strains

1. Late: a population subjected to selection for a long larval period. Origin in Purdue Foundation +.
2. High chaetae: a population subjected to selection for increased pregenital chaetae number. Origin in Purdue Foundation *b*.
3. Low chaetae: a population subjected to selection for decreased pregenital chaetae number. Origin in Purdue Foundation *b*.

(Ed.)

MORGANTOWN, WEST VIRGINIA
WEST VIRGINIA UNIVERSITY
BIOLOGY DEPARTMENT

Wild type strains

1) *Tribolium castaneum* - Purdue via Kingston, R.I.
2) *Tribolium confusum* - Chicago via San Bernadino
3) *Tribolium madens* - San Bernadino

Mutants

1) *Tribolium castaneum*
    a) Black Foundation - Purdue via Kingston, R.I.
    b) Unsaturated fatty acid sensitive (cos) via Kingston, R.I.

(Ed.)

MOSCOW, IDAHO
UNIVERSITY OF IDAHO, DEPARTMENT OF ENTOMOLOGY

A. Tribolium brevicornis

Wild Type

Idaho	Parma, ID	1976

B. Tribolium castaneum*

Wild Type

Georgia	Savannah Lab, USDA	1971
Idaho	Local	1959
Kansas	Manhattan, KS, USDA	1971
Kansas State Univ.	Kansas State Univ.	1971

Mutant

Georgia Blind, sooty	Savannah Lab, USDA	1971

*Each of these strains is probably represented as six distinct substrains.

(Ed.)

MUNCIE, INDIANA
BALL STATE UNIVERSITY, DEPARTMENT OF PHYSIOLOGY AND HEALTH SCIENCE

Tribolium castaneum, large stock, from Purdue University.

Tribolium castaneum, foundation stock, from Purdue University.

(Ed.)

Muscatine, Iowa 52761
Muscatine Community College
152 Colorado St.

Tribolium castaneum

Wild type -- Purdue Foundation

Mutant

antennapedia -- Carbondale, Ill
black -- from Purdue Foundation +

(Ed.)

NATICK, MASSACHUSETTS
U.S. ARMY NATICK LABORATORIES, PIONEERING RESEARCH LABORATORY

I. Wild type strains

Lepidoptera:

Anagasta kuhniella - USDA Lab., Georgia, 1969
Cadra cautella " " " "
Plodia interpunctella " " " 1964
Sitotroga cerealella " " " 1969
Tineola bisselliella - Univ. New Hampshire, Durham, N.H.,1965

Coleoptera:

Anthrenus flavipes - USDA Lab., Georgia, 1967
Attagenus megatoma " " " 1957
Cryptolestes pucillus - Kansas State Univ., Manhattan, Kansas, 1971
Dermestes maculatus - USDA Lab., Georgia, 1968
Gibbium psylloides - Kansas State Univ., Manhattan, Kansas, 1971
Lasioderma serricorne - USDA Lab., Georgia, 1968
Oryzaephilus surinamensis - USDA Lab., Georgia, 1968
Palorus ratzeburgi - Kansas State Univ., Manhattan, Kansas, 1971
Rhyzopertha dominica - USDA Lab., Georgia, 1969
Sitophilus granarius - " " " 1968
Sitophilus oryzae " " " 1968

Tenebrio molitor - Univ. New Hampshire, Durham, N.H., 1965
Tenebroides mauritanicus - USDA Lab., Georgia, 1968
Tribolium audax - Univ. California, Riverside, Calif., 1971
Tribolium brevicornis - Univ. California, Riverside, Calif., 1971
Tribolium castaneum - USDA, Georgia, 1956
Tribolium confusum - USDA, Georgia, 1969
Tribolium destructor - Univ. California, Riverside, Calif.
Tribolium madens - " " " "
Trogoderma variable - NLABS, Natick, Mass., 1968

Mutant:

Tribolium confusum - Ebony strain, A. Sokoloff, 1968

(Ed.)

NORMAN, OKLAHOMA
UNIVERSITY OF OKLAHOMA, DEPARTMENT OF ZOOLOGY

Coleoptera

Tribolium castaneum (Tenebrionidae) wild type, Chicago; Univ. of Chicago.

(Ed.)

Stock Lists

NORTON, MASSACHUSETTS 02766
WHEATON COLLEGE, DEPARTMENT OF BIOLOGY

Tribolium confusum

Wild Type (Chicago)

Tribolium castaneum

Black (Chicago)

(Ed.)

NORTHRIDGE, CALIFORNIA
SAN FERNANDO VALLEY STATE COLLEGE
DEPARTMENT OF BIOLOGY

Tenebrio molitor infested with gregarines.

(Ed.)

NOTRE DAME, INDIANA
UNIVERSITY OF NOTRE DAME
DEPARTMENT OF BIOLOGY

I. Wild type strains

1.	CFI-11	Berkeley, 1965
2.	CFI-22	Berkeley, 1965
3.	CFI-11 x CFI-22	Berkeley, 1965
*4.	ND-11	Park, Univ. of Chicago, 1954

*Since 1956, maintained at the Air Force Weapons Laboratory, Kirtland, A.F.B., New Mexico.

(Ed.)

PITTSBURGH, PENNSYLVANIA
DUQUESNE UNIVERSITY
DEPARTMENT OF BIOLOGICAL SCIENCES

I. Wild type strains

1. Tribolium confusum (Chicago) used as internal host for *Hymenolepis diminuta*. Via Sokoloff (Ed.)

POCATELLO, IDAHO
IDAHO STATE UNIVERSITY, DEPARTMENT OF BIOLOGY

I. Wild type strains

Tribolium castaneum--Synthetic strain marked with sooty from Berkeley.

Tribolium confusum--Synthetic strain from Berkeley.

(Ed.)

PULLMAN, WASHINGTON 99163
WASHINGTON STATE UNIVERSITY
DEPARTMENT OF ENTOMOLOGY

Tribolium confusum - synthetic wild type
Tribolium castaneum - sooty

(Ed.)

RICHLAND, WASHINGTON
BATTELLE-NORTHWEST, BIOLOGY DEPARTMENT

I. Wild type strains

1. *Tribolium confusum* Duval (Chicago Standard)	Univ. of Chicago
2. *Tribolium castaneum* Herbst (Brazil *c*I)	Univ. of Chicago

II. Mutant strain

1. *Tribolium castaneum* Herbst (Sooty)	Univ. of Calif., Berkeley

(Ed.)

RIVERSIDE, CALIFORNIA
UNIVERSITY OF CALIFORNIA, DEPARTMENT OF ENTOMOLOGY

A. *Cryptolestes turcicus*	PIL via Berkeley
B. *Gnathocerus cornutus*	PIL via Berkeley
C. *Tribolium anaphe*	PIL via Berkeley
D. *Tribolium destructor*	PIL via Berkeley
E. *Tribolium madens*	PIL via Berkeley
F. *Tribolium brevicornis*	

(Ed.)

STOCK LISTS

SALT LAKE CITY, UTAH
UNIVERSITY OF UTAH, DEPARTMENT OF ZOOLOGY AND ENTOMOLOGY

I. Wild type strains

1. *Tribolium confusum*	Park, Chicago	1962
2. *Tribolium castaneum*	J. Laurie, Utah	1962
3. *Tenebrio molitor*	W. P. Larsen, via S. Muliak, Utah	1961
4. *Oryzaephilus* sp.	wild, Utah	1962

II. Mutant strain
  1. melanotic stink glands

(Ed.)

SAN BERNARDINO, CALIFORNIA
CALIFORNIA STATE COLLEGE, NATURAL SCIENCES DIVISION

I. *Tribolium anaphe*
  1. Wild
  2. Splprps

II. *Tribolium audax*

III. *Tribolium brevicornis*

spl		
wild	Riverside	1969
wild	Idaho	1975
wild	San Bernardino	1977

IV. *Tribolium castaneum*

Wild type strains

1. Chicago $^{+}/+$	Park	1955
2. Consejo $^{+}/+$	Spain	1968
4. Davis $^{+}/+$	Davis, CA	1961
6. Florida $^{+}/+$	Bell	1970
8. McGill $^{+}/+$	Stanley	1958
10. FIL $^{+}/+$		(?)
12. Sacramento $^{+}/+$		1961

Stock Lists

IV. *T. castaneum* (continued)

14. Texas +/+		1958
16. Veracruz +/+	Mexico	1963
17. Virginia +/+		
19. Syn +/+ (1) has *s*	Prepared	1958
20. Syn +/+ (2) (no body color)	Prepared	1958
23. New York +/+ UPF		1976
24. San Bernardino +/+		1976
25. CS-4 (from New York		1976

Mutant

Sex-linked

26. dve - divergent elytra	Chazy	1959
30. pd - paddle	Park	1955
34. pte platinum eye	Berkeley	1965
36. py pygmy	Chazy	1959
38. r- red	Chazy	1959
39 r^D red	Berkeley	
54. pd, r-1 paddle, red		
55. py, r pygmy, red		
57. py, r M^r pygmy, red, red modifier		
59. r, sp red, spotted		
61. pd, pte paddle, platinum eye		

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	Mc Gill, via New York	1976
86. b black	NASA	1959
88. b black synthetic (Chicago-McGill)		
90. Chr Charcoal III		1967
91. lod p light ocular diaphragm, pearl III, II		
94. msg melanotic stink glands		
96. mt mottled		
98. b^t tawny	PIL	1965
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		

IV. *T. castaneum* (continued)

139. mc microcephalic V	Chazy	1959
140. mc-1 microcephalic-1 (eyeless	Hayward	1967
143. fas-3a fused antennal segments 3a V	Berkeley	1963
148. m maroon V	Purdue	1970
150. rb ruby		1962
156. Mo Microphthalmic VI	Chazy	1959
162. sa=ca short antenna VII	Cold Spring Harbor	1960
165. c chestnut	Purdue	1962
168. ju-7 juvenile urogomphi	Purdue	
170. ble blistered elytra	Berkeley	1962
173. c, ${}_{S}$Rd	Corvallis	1975
180. ap_{D} antennapedia VIII	Berkeley	1962
186. sq squint VIII	Chazy	1959
189. apt alate prothorax IX		
192. ptl prothoraxless IX	Chazy	1959
194. ppas partially pointed abdominal sternites	Berkeley	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 mesothoraci projections		
238. mxp maxillopedia II	Berkeley	1965
240. Npp Non-punctate prothorax		
245. pec pectinate		
252. sc scar	Purdue	
259. w white	Purdue	
261. fas-8 fused antennal segments-8		
271. giant		
278. la long abdomen		
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, lgith ocular daphragm 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 - jet, Nonpunctate prothorax, pearl II, V, ?		
313. p, Mo, apt - pearl, Microphthalmic, alate prothorax II, VI		
315. p, mas - pearl, missing abdominal segments II, IX		
316. p, kn - pearl, knobby prothorax ?, II		
317. p, aa - pearl, abbreviated appendages ?, II		
322. p, fas-4, b - pearl, fused antennal segment-4, black II, ?, III		

Stock Lists

IV. T. castaneum (continued)

415. mxp, s - maxillopedia, sooty II, IV
416. au, s - aureate sooty III, IV
417. h, s - hazel, sooty
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, Microphthalmic, sooty ?, VI, IV
444. i, lod, Mo - ivory, light ocular diaphragm, Microphthalmic II, III, VI
445. i, ppas - ivory, partially pointed abdominal sternites II, ?
448. Chr, ap - Charcoal, antennapedia III, VIII
450. ble, au - blistered elytra, aureate VII, III
454. p^{ellis}, p^{pk}
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
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	1961

Mutant strains

apt - alate prothorax
apt, fas-2 - alate prothorax, fused antennal segments-2
b - black
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
b^2, b-McGill - black, synthetic
b^z - black (Zagreb)
b^z, r^z - black, red

Stock Lists

V. T. confusum

Mutant strains (continued)

b-Chicago, b-McGill - black

b-Donner - black

b-Georgia - black

b-McDonald, b-ssm - black

b-McGill - black

b-McGill (from N.Y.) - black

b-McGill, b^y-syn - black

b-McGill, fas - black, fused antennal segments

b-McGill, p - black pearl

b-ssm, spl - black, split

b-syn +/+ - black synthetic

b-Yugoslav - black Yugoslavia

ble - blistered elytra

ble, e - blistered elytra, ebony

carmine, p - carmine, pearl

cas - creased abdominal segments

claret

cru - crumpled

dpe - dirty pearl eye

dj - disjoined

dj, e - disjoined, ebony

dt (see umb) - dent (=umbilicus)

dt, p - dent, pearl

e (from N.Y.) - ebony New York

e, fas-3 - ebony, fused antennal segments-3

e - ebony (McGill background)

e^{1+H} - ebony

e-2 - ebony-2

e-2, fas-1 - ebony, fused antennal segments-1

ele - elongated elytra

ele, fas-2 - elongated elytra, fused antennal segments-2

es - eyespot

es, fas - eyespot, fused antennal segments

es, fas, msg - eyespot, fused antennal segments, melanotic stink glands

es, fas, sti - eyespot, fused antennal segments, sternites incomplete

eu, fas-2 - extra urogomphi, fused antennal segments-2

fas-2 - fused antennal segments-2

fas-2, lod, msg, p - fused antennal segments-2, light ocular diaphragm, melanotic stink glands, pearl

fas-2, lod, p - fused antennal segments-2, light ocular diaphragm, pearl

fas-2, msg - fused antennal segments-2, melanotic stink glands

fas-3-Yugoslavia - fused antennal segments-3

fro - frosted

lod, rus - light ocular diaphragm, ruby spot

msg, rus - melanotic stink glands, ruby spot

msg, twa - melanotic stink glands, twisted abdomen

ov-like - overshot-like

p - pearl

p-Slough - pearl

r - red

Stock Lists

V. T. confusum (continued)

r, sh - red, short elytra
r^d - red
r^z - red
rby - ruby
rus - ruby spot
rus, s - ruby spot, sooty
s - sooty
sh (Berkeley) - short elytra
sh, sp, twa - short elytra, split, twisted abdomen
sp - split
sp-1 - split-1
twa - twisted abdomen
thu - thumbed
thu XL - thumbed extra-large
umb - umbilicus
Winnipeg (body color) - black

VI. Tribolium destructor
1. wild

VII. Tribolium freemani

VIII. Tribolium madens
1. +/+

A. Sokoloff

Stock Lists

SANTA FE, NEW MEXICO
SANTA FE PREPARATORY SCHOOL

I. Wild type strain

A. *Tribolium castaneum*	Chicago via Berkeley
B. *Tribolium confusum*	McGill via Berkeley

(Ed.)

SAVANNAH, GEORGIA
STORED-PRODUCT INSECTS RESEARCH AND DEVELOPMENT LABORATORY

I. Wild type strains

A. *Lepidoptera*

1. *Anagasta kuehniella* (Zeller)	N.C. State at Raleigh, N.C.
2. *Cadra cautella* (Walker)	Tifton, Ga.
3. *Cadra figulilella* (Gregson)	Unknown
4. *Ephestia elutella* (Hübner)	Richmond, Va.
5. *Plodia interpunctella* (Hübner)	Modesto, Calif.
6. *Sitotroga cerealella* (Olivier)	Manhattan, Kansas
7. *Tineola bisselliella* (Hummel)	Savannah, Ga.; Ottawa, Can., and Durham, N.H.

B. *Coleoptera*

1. *Anthrenus flavipes* LeConte	Savannah, Ga.; and Durham, N.H.
2. *Attagenus megatoma* (Fab.)	CSMA strains
3. *Callosobruchus maculatus* (Fab.)	Fresno, California
4. *Cathartus quadricollis* (Guérin-Méneville)	Unknown
5. *Cryptolestes pusillus* (Schönherr)	Tifton, Ga.
6. *Dermestes maculatus* De Geer	Madison, Wisconsin
7. *Gibbium psylloides* (Czenpinski)	Unknown
8. *Lasioderma serricorne* (Fab.)	Unknown
9. *Oryzaephilus mercator* (Fauvel)	Unknown
10. *Oryzaephilus surinamensis* (L.)	Manhattan, Kansas
11. *Rhyzopertha dominica* (Fab.)	Unknown
12. *Stegobium paniceum* (Linnaeus)	Madison, Wisconsin
13. *Sitophilus granarius* (L.)	Manhattan, Kansas
14. *Sitophilus oryzae* (L.)	Arkansas; California; Kansas; Louisiana; Minnesota; and Texas
15. *Sitophilus zeamaize* Motschulsky	Estill, S.C.
16. *Stegobium paniceum* (L.)	Madison, Wisconsin
17. *Tenebrio molitor* (L.)	Manhattan, Kansas; and Durham, New Hampshire
18. *Tenebroides mauritanicus* (L.)	Savannah, Ga.
19. *Tribolium castaneum* (Herbst)	Unknown
20. *Tribolium confusum* Jacquelin duVal	Manhattan, Kansas
21. *Tribolium madens* Charpentier	Tifton, Ga.

Stock Lists

22.	*Trogoderma glabrum* (Herbst)	Madison, Wisconsin; Riverside, Calif.
23.	*Trogoderma inclusum* LeConte	Madison, Wisconsin; Riverside, Calif.
24.	*Trogoderma variabile* Ballion	Fresno, Calif; Riverside, Calif.

II. Mutant strains

A. *Plodia interpunctella*

1.	Scaleless (scl)	Savannah, Ga.
2.	Melanic (m)	Savannah, Ga.

B. *Tribolium castaneum*

1.	Black mutant	Ocilla, Ga.
2.	Black mutant	Savannah, Ga.

C. *Tribolium confusum*

1.	Fused antennal segments	Savannah, Ga.
2.	Short elytra	Savannah, Ga.
3.	Crumpled elytra	Savannah, Ga.
4.	Blade elytra	Savannah, Ga.
5.	Umbilicus	Savannah, Ga.
6.	Red eye pupae	Savannah, Ga.

D. New mutants

1. *T. confusum*, peg-leg (pl) - an autosomal recessive with appendages extremely reduced in length. Savannah, Ga.
2. *T. confusum*, separated elytra (sep) - elytra divergent from proximal end. Savannah, Ga.
3. *T. confusum*, creased elytra (cr) - elytra creased and distal portion divergent. Savannah, Ga.

(Ed.)

Stock Lists

SCHENECTADY, N.Y.
UNION COLLEGE
DEPARTMENT OF BIOLOGICAL SCIENCES

I. Inbred *T. castaneum* (Univ. of Chicago CIVa)

(Ed.)

SOUTH LANCASTER, MASSACHUSETTS
ATLANTIC UNION COLLEGE, BIOLOGY DEPARTMENT

Tribolium castaneum

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

II. Mutant strains
    1. red (r^{D})
    2. red (r)
    3. red (r^{Ho})
    4. red modifier (M^{r})
    5. McGill black ($McGb$)
    6. Chicago black (Cb)
    7. black (B^{S}-1), Brazil black
    8. sooty (s)
    9. jet (j)
    10. chestnut (c^{S})

(Ed.)

Stock Lists

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

I. Wild type strains

A. Laboratory strains

1. *Tribolium castaneum* - McGill	Montreal, Canada via University of California
2. *Tribolium castaneum* - Seton Hall	South Orange, New Jersey
3. *Tribolium castaneum* - inbred - 60 generations	
4. *Tribolium confusum*	Fordham University

B. Base Populations for quantitative studies(*Tribolium castaneum*)

1. Foundation *b* - marked with black(*b*) body color obtained via Purdue University, Lafayette, Indiana

2. Foundation *p* - marked with pearl (*p*) eye color obtained via Purdue University, Lafayette, Indiana.

II. Mutant strains

A. *Tribolium castaneum*

1. ca	via University of California
2. fas-3	via California State College
3. paddle	via California State College
4. red^{ho}	via California State College
5. Short antennae(*Sa*)	Purdue + Foundation, 1960
6. white	via California State College

(ed.)

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

Anthonomus grandis

A. Wild type strains

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

Stock Lists

B. Mutant strains	
1. yellow (*y*)	A & M strain
2. slate (*e*)	Acala, Mexico
3. ebony (*e*)	A & M strain
4. pearl (*p*)	A & M strain
C. Insecticide resistant	
1. Endrin Resistant ca. 20 g/weevil	Auburn University

(Ed.)

Storrs, Connecticut 06268
College of Liberal Arts and Sciences
The Biological Sciences Group

1. *Tribolium brevicornis*
    - a. Riverside +/+ (2 vials)

2. *Tribolium castaneum*
    - a. Chicago +/+
    - b. Veracruz +/+
    - c. Berkeley synthetic +/+ (marked with sooty)
    - d. *b* - Chicago (black)
    - e. *mc*, *p* (microcephalic, pearl)
    - f. *py* (pigmy)
    - g. Davis Low Body Weight
    - h. Davis High Body Weight

3. *Tribolium confusum*
    - a. Chicago +/+
    - b. Yugoslavia +/+
    - c. Inbred (GroupL CFI-B; Culture: 8d; Generation: 123)
    - d. *b*, *p* (black, pearl)
    - e. *dj*, *e* (disjoined, ebony)
    - f. *sh* (Berkeley) - (short elytra)

(Ed.)

ST. BERNARD, ALABAMA
ST. BERNARD ABBEY

I. Wild Type strains

A. *Tribolium castaneum*

1. Chicago	via San Bernardino

B. *Tribolium confusum* via San Bernardino

1. New York

II. Mutant strains

A. *Tribolium castaneum*

1. McGill black	via San Bernardino
2. jet	via San Bernardino
3. Sooty	via San Bernardino
4. Chicago black	via San Bernardino

B. *Tribolium confusum*

1. pearl	via San Bernardino
2. McGill black	via San Bernardino

(Ed.)

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

I. Wild type strains

A. Dermestidae

Attagenus megatoma (F.)	Madison, Wis., 1975 Savannah, Ga., 1974
Attagenus elongatulus (Casey)	Madison, Wis., 1977
Dermestes maculatus DeGeer	Zool. Dept. U. Minn., 1975 Madison, Wis., 1977
Trogoderma variable Ballion	field collected, Minn., 1972

Cucujidae

Cathartus quadricollis (Guerin-Meneville)	Savannah, Ga., 1974
Oryzaephilus surinamensis (L.)	Savannah, Ga., 1975

Silvanidae

Ahasverus advena Waltl.	field collected, Minn., 1977[2]

Tenebrionidae	
Cyaneus angustus (LeConte)	Winnepeg, 1974
	field collected, Minn., 1977[2]
Tribolium castaneum Herbst	Corvallis, Ore., 1976
Tribolium confusum duVal	unknown[1]
Bruchidae	
Acanthoscelides obtectus (Say)	Winnepeg, 1974
Anobiidae	
Lasioderma serricorne (Fab.)	Savannah, Ga., 1975
Bostrichidae	
Rhizopertha dominica (F.)	Manhattan, Ka., 1977
Curculionidae	
Sitophilus granarius (L.)	unknown[1]
Sitophilus oryzae (L.)	unknown[1]
Sitophilus zeamais Motsch.	Madison, Wis., 1978
B. Lepidoptera	
Pyralidae	
Anagasta kuehniella (Zeller)	Savannah, Ga. 1974
Plodia interpunctella (Hübner)	Manhattan, Ka., 1972
Gelechiidae	
Sitotroga cerealella (Oliver)	Savannah, Ga., 1975

II. Mutant strains

Tribolium castaneum, weird egg (*wd*)	Corvallis, Ore., 1976
Attagenus elongatulus Wisconsin Black (*bk*)	Madison, Wis., 1977[3]

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[1] subcultured in the present laboratory for more than 25 years.

[2] collected on shelled corn held in farm storage more than 1 year.

[3] obtained from wild type *A. elongatulus* Madison 1975 by A. Barak.

(Ed.)

Stock Lists

ST. PAUL, MINNESOTA
UNIVERSITY OF MINNESOTA
DEPARTMENT OF GENETICS & CELL BIOLOGY

Tribolium castaneum

Synthetic strains (all marked with sooty)

1. C -- stabilized selected line for pupa weight, 95 generations of selection, originated from crosses of CSI-5 and CSI-10
2. CSI-5 inbred line Berkeley, 1963
3. CSI-10 inbred line Berkeley, 1963
4. R -- randomly selected for 100 generations, from CSI-5 x CSI-10
5. Relaxed lines -- selected for heavier pupa weight for 50 generations, then maintained as a population cage with discrete generations for 75 generations.
6. S -- selected for heavier pupa weight for 3 generations, from CSI-5 x CSI-10
7. T -- selected for heavier pupa weight for 50 generations, then relaxed for 23 generations, then selected for 52 more generations

[All selection lines include two replicates designated by subscripts 1 and 2 (e.g., S_1 and S_2).]

(Ed.)

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

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

B. Purdue Foundation, p

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

(Ed.)

TEMPE, ARIZONA
ARIZONA STATE UNIVERSITY, DEPARTMENT OF ZOOLOGY

I. Synthetic strains

A. *Tribolium castaneum*
1. Berkeley, 1964 via San Bernardino

B. *Tribolium confusum*
1. Berkeley, 1958 via San Bernardino

II. Mutant strains

A. *Tribolium castaneum*
1. melanotic stink glands (*msg*), Berkeley, 1964 via San Bernardino

B. *Tribolium confusum*
1. melanotic stink glands (*msg*), Berkeley, 1962 via San Bernardino

TIFTON, GEORGIA
ABRAHAM BALDWIN AGRICULTURAL COLLEGE

(Ed.)

Tribolium castaneum

A. Wild type strain
1. Chicago

B. Mutant strains
1. black
2. squint

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

Stock Lists

URBANA, ILLINOIS 61801
UNIVERSITY OF ILLINOIS AT URBANA CHAMPAIGN
DEPARTMENT OF PHYSIOLOGY AND BIOPHYSICS

Tribolium castaneum

1. Wild type	(maintained since 1960)

Tribolium confusum

1. Wild type from Oklahoma	Dawson, 1967
2. Mutant, ebony	Dawson, 1967
3. Mutant, McGill black	Sokoloff, 1966

Tribolium brevicornis

1. Wild type	Yang, 1970

(Ed.)

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

Coleoptera

Anobiidae
  Lasioderma serricorne (F.)
  Stegobium paniceum (L.)

Anthribidae
  Araecerus fasciculatus (Deg.)
    Poor condition, may be dead

Bostrichidae
  Rhyzopertha dominica (F.)

Bruchidae
  Acanthoscelides obtectus (Say)

Cleridae
  Necrobia rufipes (Deg.)

Cucujidae
  Cryptolestes ferrugineus (Steph.)
    Poor condition, may be dead
  Cryptolestes pusillus (Schon.)
  Cryptolestes turcicus (Grouv.)

Curculionidae
  Sitophilus granarius (L.)
  Sitophilus oryzae (L.)

Dermestidae

Anthrenus flavipes LeC.
Weak culture
Attagenus megatoma (F.)
Trogoderma inclusum LeC.
Trogoderma variabile Ballion

Ostomidae

Lophocateres pusillus (Klug.)
Tenebroides mauretanicus (L.)

Ptinidae

Gibbium psylloides (Czemp,)

Silvanidae

Ahasverus advena (Waltl)
Oryzaephilus mercator (Fauv.)
O. mercator dead
O. surinamensis available

Tenebrionidae

Alphitobius diaperinus (Panz.)
Gnathocerus maxillosus (F.)
Palorus ratzeburgi (Wissm.)
Tribolium audax Halstead
Tribolium castaneum (Herbst)
Tribolium confusum Duv.
Tribolium destructor Uytt.
Weak culture, may be diseased

Lepidoptera

Pyralidae

Ephestia elutella (Hubn.)
Plodia interpunctella (Hubn.)

(Ed.)

BELGIUM

GEMBLOUX
INSTITUT AGRONOMIQUE DE L'ETAT
ZOOLOGIE GENERALE

Tenebrio molitor L., Gembloux strain, race F, obtained originally from G.S. Fraenkel, University of Illinois, Urbana, and selected over a period of 25 years for rapid development and maximum weight of 120 mg. by Prof. J. Leclercq, Faculté des Sciences Agronomiques de l'Etat, Gembloux, Belgium.

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

Tenebrio molitor

Wild type

Stock Lists

Tribolium confusum Berkeley, 1965

Two inbred and a wild type

(Ed.)

BRAZIL

CAMPINAS, SÃO PAULO
INSTITUTE AGRONOMICO, SEÇAO DE ENTOMOLOGIA

Anobiidae

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

Bostrichidae

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

Bruchidae

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

Curculionidae

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

Silvanidae (Cucujidae)

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

Tenebrionidae

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

(Ed.)

PIRACICABA, STATE OF SÃO PAULO
CENTRO DE ENERGIA NUCLEAR NA AGRICULTURA
DEPARTMENT OF RADIOENTOMOLOGY

Insect collections - Wild Strain
All of these insects are under controlled
conditions of around 28°C and 75% RH
(when the machine is not broken...)

1- *Tribolium confusum* 1970
2- *Zabrotes subfasciatus* 1968
3- *Acanthoscelides obtectus* 1968

CENTRO DE ENERGIA NUCLEAR NA AGRICULTURA
DEPARTMENT OF RADIOENTOMOLOGY (CONT'D)

4- Callosobruchus analis (?)	1975
5- Tenebrio molitor	1970
6- Araecerus fasciculatus	1968
7- Laemophloeus ferrugineus	1968
8- Lasioderma serricorne	1972
9- Ephestia cautella (?)	1975
10- Sitotroga cerealella	1971
11- Sitophilus oryzae	1968
12- Sitophilus zeamais	1968
13- Rhyzopertha dominica	1971
14- Oryzaephilus surinamensis	1968
15- Periplaneta americana	1972

(Ed.)

COLOMBIA

Universidad Nacional de Colombia
Dpto. de Biología.
Apdo. Aereo # 23227
Bogotá, D. E. Colombia, S.A.

Tribolium _castaneum_ Herbst. Stock list

CEPAS SILVESTRES

Nombre	Origen
Apulo	Grahero de la poblacion de Apulo (Cundinamarca, Colombia). Febrero de 1982
Bogotá	Harina contaminada almacenada en los sótanos del Instituto Nacional de Salud (Bogotá,D.E.,) Noviembre de 1978.
Bucaramanga	Laboratorio de cría de _Trichogamma_ sp. en Bucaramanga(Santander) Colombia Mayo de 1981.
Cartagena	Bodegas del terminal marítimo de Cartagena (Bolívar), Colombia. Abril de 1980

CEPAS MUTANTES

Antenapedia	Cepa Cartagena. Feb. de 1981.
Antena bifurcada	Cepa Bogotá. Abril de 1980.
Antena fusionada	Cepa Bogotá. Diciembre de 1980.
Apéndices diminutos (ma)	Cepa Bogotá. Febrero de 1981.
Charcoal	Cepa Bogotá. Diciembre de 1979.
Elitros rudimentarios	Cepa Bogotá. Marzo de 1981.
Negro (Black?)	Cepa charcoal. Noviembre de 1982.
Ojo estrecho (sq?)	Cepa Bogotá. Febrero de 1980.
Ojo pardo (c?)	Cepa Bogotá. Septiembre de 1980.
Ojo perlado (p?)	Mezcla Bog., Buc.,Car., (BBC). Febrero de 198
Ojo platinado (pte)	Cultivo mixto. Junio de 1981.
Ojo rosa (p^k?)	Cepa Cartagena. Agosto de 1980.
Patas deformadas (dfl?)	Cepa Bogotá. Enero de 1980.
Patas retorcidas (pl?)	Cepa Cartagena. Enero de 1981.

Fernando Núñez Del castillo

CZECHOSLOVAKIA

INSTITUT OCHRONY ROSLIN
PRACEWNIA BADANIA BIKOSNIKOW FREZEXHSWALNI
POZEN, UL. MICZURINA 20

- *Sitophilus granarius* L.
- *S. oryzae* L.
- *Rhizopertha dominica* F.
- *Trogoderma granarium* Ev.
- *Tribolium confusum* Duv.
- *T. destructor* Uytt.
- *Tenebrio molitor* L.
- *Oryzaephilus surinamensis* L.
- *O. mecator* Fauv.
- *Carpophilus hemipterus* L.
- *Stegobium paniceum* L.
- *Acanthoscelides obtectus* Say
- *Anagasta kuhniella* Zell.
- *Cadra cautella* Wlk.
- *Plodia interpunctella* Hubn.

(Ed.)

Stock Lists

DENMARK

LYNGBY
STATENS SKADEDYRLABORATORIUM
(DANISH PEST INFESTATION LABORATORY)

Alphitobius diaperinus
Anobium punctatum
Anthrenus museorum
Anthrenus vorax
Attagenus alfieri
Attagenus piceus
Dermestes frichii
Hylotrupes bajulus
Lasioderma serricorne
Oryzaephilus mercator
Oryzaephilus surinamensis
Rhizopertha dominica
Sitophilus granarius
Sitophilus oryzae
Stegobium (Sitodrepa) *paniceum*
Tenebrio molitor
Tenebrioides mauritanicus
Thylodrias contractus
Tribolium confusum
Tribolium destructor
Trogoderma granarium

(Ed.)

EASTERN NIGERIA

PORT HARCOURT
THE NIGERIAN STORED PRODUCTS RESEARCH INSTITUTE

I. Wild type strains

1.	*Dermestes maculatus* De Geer	Port Harcourt Strain, 1966
2.	*Cryzaephilus mercator* Fauv.	Port Harcourt Strain, 1966
3.	*Sitophilus zea-mais* Motschulsky	Kano Strain, 1965 (Ex Kano Lab. Stock) November, 1965
4.	*Tribolium castaneum* Hbst.	Kano Strain, 1965 (Ex Kano Lab. Stock) October, 1965

Stock Lists

5.	*Tribolium confusum* DuVal.	Kano Strain, 1965 (Ex Kano Lab. Stock) December, 1965
6.	*Trogoderma granarium* Everts	Kano Strain, 1965 (Ex Kano Lab. Stock) November, 1965

(Ed.)

EGYPT

GIZA
PLANT PROTECTION DEPARTMENT, MINISTRY OF AGRICULTURE

I. Wild type strains

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

(Ed.)

FRANCE

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

A - Wild type strains :

1. *Sitophilus granarius L.*

   Jura (France)

   AG strain

   Sitophilus oryzae L.

2. FB strain (La Réunion)
3. SFr strain (LYON)
   (56 500 ± 3 000 ovarian symbiotes)
4. W strain (Villeurbanne)

   (22 700 ± 1 500 ovarian symbiotes)
5. *Sitophilus zea-maïs Mots.*

   obtained from P.I.L. Slough

Stock Lists

VILLEURBANNE (LYON) RHÔNE
INSTITUT NATIONAL DES SCIENCES APPLIQUÉES, (CONT'D)

B - Selected lines of Sitophilus oryzae

6. SS/Sfr strain :
   Aposymbiotic strain (0 ovarian symbiote)
   obtained from Sfr
7. LL strain (slow development)
   (42 000 ± 3 000 ovarian symbiotes)
8. RR strain (Fast development)
   (88 000 ± 5 000 ovarian symbiotes)

(Ed.)

BIOLOGISCHES INSTITUT I
(ZOOLOGIE) DER ALBERT-LUDWIGS-UNIVERSITÄT
D 78 FREIBURG IM BREISGAU
KATHARINENSTRASSE 20

Wild type strains:			
1. Oryzaephilus surinamensis	Freiburg		
2. Tribolium castaneum	from	San	Bernardino
3. Tribolium confusum	"	"	"
Mutants:	"	"	"
A. Tribolium castaneum	"	"	"
4. alate prothorax (apt)	"	"	"
5. Bar eye (Be)	"	"	"
6. black (b^{s-I}) (Brazil background)	"	"	"
7. black (b^s) (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),	"	"	"
17. weird eggs (wd)			
B. Tribolium confusum			
18. black-3 (b-3)	"	"	"
19. ebony (e)	"	"	"
20. ebony-2 (e_2)	"	"	"
21. McGill black (McGb)	"	"	"

(Ed.)

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

Coleoptera

Bruchidae

Acanthoscelides obtectus (Say)	?	1974

Cucujidae

Cryptolestes turcicus Grouv.	Munich,	1966

Ptinidae

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

Silvanidae

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

Tenebrionidae

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

Lepidoptera

Phyticidae

Ephestia kuehniella (Zell.)	Munich,	1966

(Ed.)

INSTITUT FUER FLUGMEDIZIN der DFVLR
GODESBERGER ALLEE 70,
5300 BONN 2

I. Wild type strains derived from crop imports from Africa and Far East selected against rough anomalies

A. *Tribolium castaneum*, not inbred

B_1 *Tribolium confusum*, not inbred

B_2 *Tribolium confusum*, inbred by 12 single pair passages

II. C. *Tribolium castaneum*, a highly inbred tribe (C_1) from Prof. Bell (Purdue University, Lafayette, Indiana) which showed more than 50% different anomalies during first generations in our laboratory.

C_1 *Tribolium castaneum*, wild type strain

C_2 *Tribolium castaneum*, mixed mutations strain.

(Ed.)

GUATEMALA

DIV. DE CIENCIAS AGRICOLA Y ALIMENTOS
INCAP
CARRETERA ROOSEVELT, ZONA II
GUATEMALA, GUATEMALA

I. Wild type strains
Tribolium castaneum Davis, CA, 1974

II. Mutants
Tribolium castaneum (sooty) Guatemala, 1977

(Ed)

INDIA

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

Wild type strain

1. *Tribolium castaneum* from local godowns.

(Ed.)

HISSAR, HARAYANA
PUNJAB AGRICULTURAL UNIVERSITY, DEPARTMENT OF GENETICS

I. Wild type strains (*Tribolium castaneum*)

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

II.. Mutant strains (*Tribolium castaneum*)

S-8	*Py*	via Sokoloff, Berkeley
S-12	*P*	via Sokoloff, Berkeley
S-20	*Mo*	via Sokoloff, Berkeley
S-24	Squint	via Sokoloff, Berkeley
S-26	*sa*	via Sokoloff, Berkeley
S-28	*mc*	via Sokoloff, Berkeley
S-35	*py r*	via Sokoloff, Berkeley
S-53	jet	via Sokoloff, Berkeley
S-71	*sa*	via Sokoloff, Berkeley
S-74	*ju*	via Sokoloff, Berkeley
S-81	*Be s*	via Sokoloff, Berkeley
S-90	*py r Mr*	via Sokoloff, Berkeley
S-100	*b Mo*	via Sokoloff, Berkeley
S-154	*Be Fta*	via Sokoloff, Berkeley
S-248	*Fta c ca*	via Sokoloff, Berkeley
S-253	*lod p*	via Sokoloff, Berkeley
S-304	*msg*	via Sokoloff, Berkeley
S-313	*ser py r*	via Sokoloff, Berkeley
S-325	*Fta*	via Sokoloff, Berkeley
S-333	*Spa*	via Sokoloff, Berkeley
S-341	*r*	via Sokoloff, Berkeley
S-346	*Fas-3*	via Sokoloff, Berkeley
S-483	*pd*	via Sokoloff, Berkeley

(Ed.)

KARNAL, HARYANA
NATIONAL DAIRY RESEARCH INSTITUTE
DIVISION OF DAIRY CATTLE GENETICS & BREEDING

Wild type strains

A. *Tribolium castaneum*

	Source/date
1. NDRI - 1	Karnal, 1976
2. IZT - 1	Bareilly, 1976
3. Purdue + Foundation	Purdue 1976
4. Purdue *b* foundation (black)	Purdue 1976
5. Purdue *s* foundation (sooty)	Purdue 1976
6. Purdue *p* foundation (pearl)	Purdue 1976
7. McGill	Purdue 1975
8. Texas	Via San Bernardino, 1976
9. Veracruz	Via San Bernardino, 1976
10. Virginia	Via San Bernardino, 1976
11. Davis	Via San Bernardino, 1976
12. Sacramento	Via San Bernardino, 1976
13. Kyoto	Via San Bernardino, 1976
14. Jerez	Japan, 1976
	Spain, 1976

Mutants

Tribolium castaneum

1. black (Chicago) b	Via San Bernardino, 1976
2. pygmy (py)	Via San Bernardino, 1976
3. pearl eye (p)	Via San Bernardino, 1976
4. red eye (r)	Via San Bernardino, 1976

Tribolium castaneum

1. CSI-8	Via Berkeley, 1976
2. CSI-6	Karnal, 1977

(Ed.)

JABALPUR, MADHYA PRADESH
J.N. AGRICULTURAL UNIVERSITY
COLLEGE OF VETERINARY SCIENCE & A.H.
DEPARTMENT OF ANIMAL BREEDING & GENETICS

1. Random Stocks: R-1, R-2, R-3, R-4, R-5, R-6, R-7, R-8, R-9, R-10. PAU-1 (HSR-Wild).

2. Inbred Lines: I-1, I-2, I-3, I-4, I-5, I-6, I-7, I-8, I-9, I-10.

   These stocks have been inbred for 19 generations.

3. Mutant stocks:
   S-1 Chi-wild
   S-8 py
   S-10 p
   S-12 Chi b/b, Chi +/b, Chi +/+
   S-53 jet
   S-100 b Mo
   S-248 Fta c Ca
   S-304 msg
   S-313 ser py r
   S-333 Spa
   S-341 r

(Ed.)

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

T. castaneum

Wild strain of local origin

(Ed.)

Stock Lists

Patna- 14
Bihar Veterinary College
Rajendra Agricultural University

Tribolium castaneum

Wild type
- Izatnagar

Mutant

- Chicago black
- pygmy
- paddle
- red, paddle
- jet

Mani Mohan

INDONESIA

BIOTROP
Seameo Regional Center for Tropical Biology
Bogor, P.O. Box 17, Indonesia

Tribolium castaneum

Wild type strains

No.	Origin	Laboratory medium
BIO 27-1	chicken feed; Ciawi, W. Java	wheat flour
BIO 23-1	shelled peanut; Tajur, W. Java	" "
BIO 114	Sago flour; Bogor	" "
BIO 138	Rice bran Pasuruan, E. Java	milled rice
BIO 178	Milled rice; Madium, E. Java	" "
BIO 180	Mixture of milled rice and soy; bean residue; Kalasan, Central Java	" "
BIO 182	Milled rice; Bantul, Central Java	" "
BIO 187	Milled rice; Semarang " Java	wheat flour
191	Milled rice; Tegal, Central Java	milled rice
BIO 195	Milled rice; Semarang " "	" "
BIO 153	Milled rice; Madura island	wheat flour
BIO 238	Milled rice; Jakarta	wheat flour
BIO 263	Milled rice; Bangka island	wheat flour

Rafael I. Pranata

Stock Lists

Tel Aviv University
Department of Aoology
Tel Aviv
Israel

A. Tribolium castaneum

1. Wild type strains

CS++ (Berkeley) Obtained from San Bernardino Stock Center.
CS++ (McGill) Obtained from San Bernardino Stock Center.
3 strains collected from different stored products in Israel.

2. Mutant strains

Visible mutants
bb (Chicago) obtained from Stony Brook. N.Y.
eu++ (extra urogomphi, ++body color)
eubb (extra urogomphi, bb body color)
pearl (p) Obtained from San Bernardino Stock Ceneter
mc (microcephalic) Originated from a single mutant of p.
paddle (pd) Obtained from San Bernardino Stock Center
pdbb (paddle antenna, bb body color)
pygmy (py-r) Obtained from San Bernardino Stock Center

Electrophoretic mutants
bEs (slow esterase-], bb body color) selected from bb
bPs (Acph-1 slow, est-1 null, bb body color) selected from eubb
PF (Fast Acid phosphatase, ++body color) Selected from eu++.

B. Tribolium confusum

1. Wild type strains

CF++ (Chicago) Obtained from San Bernardino Stock Center
1 strain collected in Israel.

2. Mutant strains

CFbb (McGill) Obtained from Stony Brook, N.Y.
CFmsg Prothoracic, (melanotic stink glands) Obtained from San Bernardino Stock Center
CFmsg strong (melanotic stink glands) Obtained from San Bernardino Stock Center.
CF pearl, Obtained from San Bernardino Stock Center.
CFXL, (extra large) Obtained from San Bernardino Stock Center.

C. Tribolium brevicornis

Riverside++ Obtained from San Bernardino Stock Center.

David Wool.

Stock Lists

ITALY

PAVIA
UNIVERSITY PAVIA, CENTRO DE GENETICA

1. *Tribolium confusum* Duval, wild strain obtained from Professor A. Kock, Biological Institut, Regenesburg.
2. id. id., strain of recent colonization from specimens collected in Pavia; small, difficult colony.

(Ed.)

JAPAN

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

1) Wild type strains and geographic origin

Tribolium audax H. ....derived from Dr. D.G.H. Halstead Slough Lab.
Tribolium castaneum (H.) ...Japan
Tribolium castaneum (H.)
  TCP.A (PH_3-resistance) ...derived from Dr. R.G. Winks, Stored Grain Research Lab, Division of Entomology, CSIRO.
  CTC$_4$ (PH_3-susceptible) ...derived from Dr. R.G. Winks.
Tribolium confusum D. ......Japan
Tribolium freemani H. ......captured in Japan (contaminated imported corn from Brazil)

H. Nakakita.

OKAYAMA
LABORATORY OF APPLIED ENTOMOLOGY
COLLEGE OF AGRICULTURE
OKAYAMA UNIVERSITY

1. Wild type strains

COLEOPTERA

1.	*Alphitobius diaperinus*	Miyazaki
2.	*Callosobruchus chinensis*	Okayama
3.	*Callosobruchus maculatus*	
4.	*Gnathocerus cornutus*	Miyazaki
5.	*Lasioderma serricorne*	Okayama
6.	*Latheticus oryzae*	Miyazaki
7.	*Oryzaephilus surinamensis*	Miyazaki
8.	*Palorus ratzeburgii*	Miyazaki
9.	*Palorus subdepressus*	Miyazaki

10. *Rhyzopertha dominica*	Miyazaki
11. *Sitophilus oryzae*	Okayama
12. *Sitophilus zeamais*	Okayama
13. *Tenebrio molitor*	Okayama
14. *Tenebroides mauritanicus*	Okayama
15. *Tribolium castaneum*	Miyazaki
16. *Tribolium confusum*	Miyazaki
17. *Tribolium 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

10 wild type strains from different localities in Japan.
Black colored mutant derived from one of the geographical strains.

Callosobruchus maculatus

10 wild type strains from different localities in the world.

Callosobruchus analis
Callosobruchus phaseoli
Zabrotes subfasciatus
Acanthoscelides obtectus

(Ed.)

Stock Lists

MEXICO

CHAPINGO
CAMPO EXPERIMENTAL "EL HORNO"

Tribolium castaneum
Tribolium confusum

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

(Ed.)

MEXICO CITY, D.F. 20, MEXICO
INSTITUTO DE BIOLOGIA, UNAM.
DEPARTAMENTO DE ZOOLOGIA
APARTADO POSTAL 70-153

Wild Type

Tribolium castaneum
T. confusum **(sources not given. Ed)**

(Ed.)

THE NETHERLANDS

AMSTERDAM
ROYAL TRIPICAL INSTITUTE
DEPARTMENT OF AGRICULTURAL RESEARCH

Cryptolestes ferrugineus	P.I.L.
Cryptolestes pusilloides	P.I.L.
Cryptolestes capensis	P.I.L.
Latheticus oryzae	unknown
Gnathocerus maxillosus	Malawi, 1971
Gnathocerus cornutus	Malawi, 1971
Carpophilus dimidiatus	Malawi, 1971
Caryedon serratus	Senegal, 1970
Callosobruchus maculatus	unknown
Tribolium castaneum - Lindane resistant	Malawi, 1970
Tribolium castaneum - Lindane resistant + non-specific malathion resistance	

(Ed.)

Stock Lists

WAGENINGEN
AGRICULTURAL INSTITUTE
DEPARTMENT OF GENETICS

I. Tribolium castaneum

A. Wild type strains

1. California	Sokoloff, 1970
2. Netherlands	1975
3. Spain	Lopez-Fanjul, 1975

B. Mutants

1. black	Sokoloff, 1970
2. py, pd	Lopez-Fanjul,1975
3. sooty, fas2	Lopez-Fanjul,1975
4. jet, mc	Lopez-Fanjul,1975

(Ed.)

POLAND

Polish Academy of Sciences
Institute of Ecology
Dziekanow Lesny k/Warszawy 05092

1. Acanthoscelides obtectus }
2. Bruchus pisorum } wild type from Poland
3. Tribolium castaneum cI }
4. Tribolium castaneum cII } genetic strains from Chicago
5. Tribolium confusum bIV }

T. Prus

Stock Lists

PORTUGAL

LISBON
LABORATORIO DA DEFESA FITOSSANITARIA DOS PRODUTOS ARMAZENADOS
MINISTERIO DA ECONOMIA

The laboratory maintains the following cultures in the breeding room at 25° - 27° C and 65 - 70% R. H. The origin of the culture, the year of commencement and the culture media are given for each insect species.

Acanthoscelides obtectus (Say)--white bean	Coimbra, 1968
Anagasta kuhniella (Zell.)--bran and glycerine	Carcavelos, 1968
Cadra cautella (Walk.)--decorticated almonds	Algarve, Portugal, 1969
Callosobruchus maculatus (F.)--California black eye	Alcobaca, 1968
Gnathocerus cornutus (F.)--whole-meal flour and yeast	Portugal, 1969
Lasioderma serricorne (F.)--bran and dried yeast	Lisboa, 1964
Oryzaephilus surinamensis (L.)--broken wheat	Portugal, 1960
Plodia interpunctella (Hübn.)--bran and glycerine	Carcavelos, 1968
Rhyzopertha dominica (F.)--wheat	S. Tomé, W. Africa, 1969
Sitophilus granarius (L.)--wheat	Portugal, 1969
Sitophilus oryzae	Portugal, 1969
Sitotroga cerealella (Oliv.)--barley	Portugal, 1968
Tenebroides mauritanicus (L.)--broken maize, bran and dried yeast	Portugal, 1967
Tribolium castaneum (Herbst)--flour	Bissau (Guiné), 1957
Zabrotes subfasciatus--white bean	Lisboa, 1968

(Ed.)

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	Edinburgh, 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
14.	AN-I	high performance at	33°C
15.	AN-II	" " "	33°C
16.	AF-I	" " "	28°C
17.	AF-II	" " "	28°C
18.	AT-I	" " "	38°C
19.	AT-II	" " "	38°C
20.	BN-I	low performance at	33°C
21.	BF-I	" " "	28°C
22.	BF-II	" " "	28°C
23.	BT-I	" " "	38°C
24.	BT-II	" " "	38°C
25.	RN-I*	high cross performance at	33°C
26.	SN-I*	" " " "	33°C
27.	RN-II	" " " "	33°C
28.	SN-II	" " " "	33°C
29.	RF-I	" " " "	28°C
30.	SF-I	high cross performance at	28°C
31.	RF-II	" " " "	28°C
32.	SF-II	" " " "	28°C
33.	RT-I	" " " "	38°C
34.	ST-I	" " " "	38°C
35.	RT-II	" " " "	38°C
36.	ST-II	" " " "	38°C

* R & S corresponding lines were selected through a reciprocal recurrent selection.

37.	CTD-I	High peformance at different 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 segm. -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
58. wine r^{w}, I	Purdue,	1968
59. eye mutant, ?	Madrid,	1967
60. maroon *m*, V	Purdue,	1977
61. melanotic stink gland-like	Madrid,	1968
62. sooty *s*, IV	Sokoloff,	1977
63. chesnut *c*, VII	Sokoloff,	1977
64. microcephalic *mc*, V	Sokoloff,	1977
65. Microphthalmic *Mo*	Sokoloff,	1977
66. pink p^{pk}, II	Sokoloff,	1977
67. Bar eye *Be*, IV	Sokoloff,	1977
68. prothoraxless *ptl*, IX	Sokoloff,	1977
69. light ocular diaphragm *lod*,	Purdue,	1968
70. black *b*, III	Sokoloff,	1977

Tribolium confusum

A. Wild type strains

71. Coronada	La Coronada, Spain, 1976

B. Mutants type strains

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

(Ed.)

UNITED KINGDOM

AUSTRALIA

BRISBANE, QUEENSLAND
DEPARTMENT OF PRIMARY INDUSTRIES, ENTOMOLOGY LABORATORY

COLEOPTERA

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

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

C. *Sitophilus zeamais*--wild type

D. *Sitophilus granarius*--wild type

E. *Oryzaephilus surinamensis*
  1. Wild type strains
  2. Lindane resistant strains (impure)

F. *Lasioderma serricorne*--wild type

G. *Rhizopertha dominica*--wild type

H. *Mezium americanum*--wild type

LEPIDOPTERA

A. *Cadra cautella*--wild type

B. *Phthorimaea operculella*
  1. DDT-endrin resistant
  2. Red-eyed mutant (single autosomal recessive)

HYMENOPTERA

A. *Microchelomus* sp.--wild type

(Ed.)

BURNLEY, VICTORIA
VICTORIAN PLANT RESEARCH INSTITUTE, DEPARTMENT OF AGRICULTURE

COLEOPTERA

A. ***Tribolium castaneum***
   1. **Wild type strains**
   2. **Malathion specific resistant strain**
   3. **Malathion non-specific resistant strain**

B. *Tribolium confusum*
   1. Wild type strains
   2. Malathion specific strain

C. *Oryzaephilus surinamensis*
   1. Wild type strain
   2. Malathion resistant strain

D. *Gnathocerus cornutus* wild type strain

E. *Cryptolestes ferrugineus* wild type strain

F. *Sitophilus oryzae* wild type strain

G. *Sitophilus zeamais* wild type strain

H. *Sitophilus granarius* wild type strain

I. *Rhyzopertha dominica* wild type strain

LEPIDOPTERA

A. *Plodia interpunctella* wild type strain

B. *Ephestia figulilella* wild type strain

(Ed)

CANADA

EDMONTON, ALBERTA
UNIVERSITY OF ALBERTA, DEPARTMENT OF ANIMAL SCIENCE

A. Brazil	Purdue, 1965
B. Capetown	Purdue, 1965
C. Chicago	Chicago, 1965
D. Consejo	Madrid, 1965
E. Japan	Kyoto and Purdue, 1965
F. Kano	Scotland, 1965

G.	Kenya	Scotland, 1965
H.	Kingston	Scotland, 1965
I.	Lisbon	Portugal, 1965
J.	Purdue Foundation +	Manitoba, 1963
K.	Scotland	Edinburgh, 1965
L.	Seychelles	Scotland, 1965
M.	Surrey	England, 1965
N.	Veracruz	Berkeley, 1965

(Ed.)

DEPARTMENT OF ANIMAL AND POULTRY SCIENCE
UNIVERSITY OF GUELPH
GUELPH, ONTARIO, CANADA
N1G 2W1

Tribolium castaneum

Wild Type: derived from Purdue University Stock

Mutants:

1) pearl
2) platinum eye
3) pygmy
4) pygmy red
5) red
6) spotted red

Mutants all from Tribolium Stock Center, San Bernardino

(Ed.)

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

Tribolium castaneum

1.	Berkeley CSI-3F	Sokoloff, 1970
2.	Berkeley CS-synthetic, *sooty*	Sokoloff, 1970
3.	Berkeley CS-synthetic, *pygmy*	Sokoloff, 1970
4.	McGill *black*	Sokoloff, 1970
5.	Chicago *black*	Sokoloff, 1970
6.	Purdue Foundation	Scheinberg, 1967

(Ed.)

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

Tribolium castaneum

Purdue Foundation

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

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

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

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

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

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

(Ed.)

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

Tribolium confusum Duval

Strain: Laval

Origin: Quebec City

(Ed.)

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

Tribolium confusum Duval

Strain: Laval
Origin: Quebec City

(Ed.)

WINNIPEG, MANITOBA
CANADA DEPARTMENT OF AGRICULTURE, RESEARCH STATION

I. **Wild type strains**

A. **Coleoptera**

1.	*Acanthoscelides obtectus* (Say) Bruchidae	Winnipeg
2.	*Alphitobius diaperinus* Panzer Tenebrionidae	Saskatchewan
3.	*Cryptolestes ferrugineus* (Steph.) Cucujidae	Manitoba
4.	*Cryptolestes ferrugineus* (Steph.) Cucujidae	P.I.L. United Kingdom
5.	*Cryptolestes ferrugineus* (Steph.) Cucujidae	Australia
6.	*Cryptolestes turcicus* (Grouv.) Cucujidae	Ontario
7.	*Cryptolestes turcicus* (Grouv.) Cucujidae	P.I.L. United Kingdom
8.	*Cynaeus angustus* Leconte Tenebrionidae	Manitoba
9.	*Oryzaephilus mercator* (Fauvel) Silvanidae	Ontario
10.	*Oryzaephilus surinamensis* (L.) Silvanidae	Manitoba
11.	*Palorus subdepressus* Wollaston Tenebrionidae	Manitoba
12.	*Rhyzopertha dominica* (Fab.) Bostrichidae	Australia
13.	*Sitophilus granarius* (L.) Curculionidae	Manitoba
14.	*Sitophilus oryzae* (L.) Curculionidae	Montreal
15.	*Sitophilus zea-mais* Motschulsky Curculionidae	Japan
16.	*Stegobium paniceum* (L.) Anobiidae	Winnipeg
17.	*Tenebroides mauritanicus* (L.) Ostomidae	Manitoba
18.	*Tenebrio molitor* L. Tenebrionidae	Manitoba
19.	*Tribolium castaneum* (Herbst) Tenebrionidae	Manitoba
20.	*Tribolium destructor* Uytten. Tenebrionidae	Winnipeg
21.	*Tribolium confusum* (Du Val) Tenebrionidae	Ontario
22.	*Trogoderma variabile* Ballion Dermestidae	Alberta

II. Mutants

A. Coleoptera

1. *Tribolium confusum* Du val Winnipeg, Manitoba, 1963
ebony ($_e$ Smith and Loschiavo)

(Ed.)

UNITED KINGDOM
GREAT BRITAIN

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

Tenebrio molitor
Tenebrio obscurus
Blaps sp.
Tribolium sp.

(Ed.)

SCOTLAND, U.K.
UNIVERSITY OF DUNDEE
DEPARTMENT OF BIOLOGICAL SCIENCES

		Origin
1.	*Tribolium castaneum*	Libya
2.	*Latheticus oryzae*	Australia
3.	*Latheticus oryzae*	Ghana
4.	*Gnathocerus cornutus*	Egypt
5.	*Cathartus quadricollis*	Ghana

All above stocks have been kept in this laboratory at 27.5°C for three years.

(Ed.)

EDINBURGH
UNIVERSITY OF EDINBURGH
INSTITUTE OF ANIMAL GENETICS

Tribolium castaneum

A. Wild type strain

1. Chicago wild type

B. Mutant strains

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

Stocks obtained from Berkeley, California.

(Ed).

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

Tribolium castaneum Herbst.

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

Tribolium confusum J. duV.

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

(Ed.)

GLASGOW, SCOTLAND
UNIVERSITY OF GLASGOW
DEPARTMENT OF ZOOLOGY

Wild type Strains:

Wild strain of T. castaneum from the Infestation Department Ministry of Agriculture & Fisheries, Glasgow

T. castaneum
ppas partially pointed abdominal sternites

(Ed.)

LONDON
QUEEN ELIZABETH COLLEGE, DEPARTMENT OF BIOLOGY

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

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

(ed.)

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

Tribolium castaneum

A. Wild type

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

Tribolium confusum

- A. Wild type
  - 1. ebony (e^2)
  - 2. pearl (p)

All stocks derived from cultures at the Insectary of the Pest Infestation Control Laboratory, Slough, Bucks.

(ed.)

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 this 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 twenty 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 times of the year: _Thylodrias contractus_ Mots., _Dinarmus basilis_ (Rondani) (= _laticeps_ (Ashmead)), _Chaetospila elegans_ (Westw.), _Amphibolus venator_, Klug., and _Pyralis farinalis_ (L.).

PEST INFESTATION CONTROL LABORATORY
INSECTS HELD

ORDER Family (-subfamily) Genus (sub genus), species	COMMON NAME	COUNTRY OF ORIGIN	CULTURE MEDIUM	REARING TEMPERATURE °C
COLEOPTERA				
Anobiidae				
Lasioderma serricorne (F.)	_Cigarette beetle_		5	25
Stegobium paniceum (L.)	_Biscuit beetle_ (Bread beetle; Drugstore beetle)		5	25

Stock Lists

Anthribidae				
Araecerus fasciculatus (Deg.)	Coffee bean weevil (Cacao weevil)		25	25
Bostrichidae				
Prostephanus truncatus (Horn)	Larger grain borer		25	25
Rhyzopertha dominica (F.)	Lesser grain borer		1	30
Bruchidae				
Acanthoscelides obtectus (Say)	Dried bean beetle (American seed beetle)	W.Africa	27	30
Acanthoscelides obtectus (Say)	" " "	Portugal	27	30
Acanthoscelides obtectus (Say)	" " "	N.Germany	27	25
Callosobruchus analis (F.)	Chinese beetle		29	25
Callosobruchus chinensis (L.)	Cowpea weevil		30	25
Callosobruchus maculatus (F.)	Southern cowpea weevil	Sierra Leone	29	30
Callosobruchus maculatus (F.)		Burma	29	30
Callosobruchus phaseoli (Gyll.)		Malaya	28	25
Callosobruchus rhodesianus (Pic)		Swaziland	28	25
Caryedon serratus (Oliv.)	Groundnut seed beetle (Groundnut bruchid) (Groundnut borer)		19	30
Zabrotes subfasciatus (Boh.)	Mexican bean beetle		16	25
Cerylonidae				
Murmidius ovalis (Beck)		Ceylon	7b	25
Cleridae				
Necrobia rufipes (Deg.)	Copra beetle (Red-legged ham beetle)		24	30
Necrobia ruficollis (F.)		Bangladesh	24	30
Cucujidae				
Cryptolestes capensis (Waltl)			8	25
Cryptolestes ferrugineus (Steph.)	Rust red grain beetle		8	25/30
Cryptolestes pusilloides (Steel & Howe)		(Canada)	8	20
Cryptolestes pusillus (Schön.)	Flat grain beetle		6	25
Cryptolestes turcicus (Grouv.)			8	20
Cryptolestes ugandae Steel & Howe		(East Africa)	6	20
Curculionidae				
Sitophilus granarius (L.)	Grain weevil	(Russia)	1	25
Sitophilus oryzae (L.)	Rice weevil	Britain	1	25
Sitophilus zeamais Motsch.	Maize weevil		1	25
Dermestidae				
Anthrenocerus australis (Hope)	Australian carpet beetle	(Britain)	22	25/20
Anthrenus flavipes LeC.	Furniture carpet beetle		22	30
Anthrenus olgae Kalik		Poland	22	20
Anthrenus sarnicus Mroczkowski			21	20
Anthrenus verbasci (L.)	Varied carpet beetle	Britain	21	20
Attagenus brunneus Faldermann		(Spain)	21	30
Attagenus nr. fasciatus (Thunberg)		Botswana	12	25
Attagenus unicolor (Brahm) (=megatoma (F.))	Black carpet beetle		22	30
Attagenus pellio (L.)	Fur beetle	Britain	21	20
Attagenus rufiventris Pic		Botswana	11	25
Attagenus smirnovi Zhantiev		Kenya	11	20

Stock Lists

Dermestes ater Deg.	Black larder beetle	Britain	23b	25
Dermestes frischii Kug.	Hide beetle	(Nigeria)	23b	25
Dermestes haemorrhoidalis Küster		Britain	23b	25
Dermestes lardarius L.	Bacon beetle	Britain	23a	25
Dermestes maculatus Deg.	Leather beetle		23b	25
Dermestes peruvianus Castelnau		Britain	23a	25
Trogoderma angustum (Solier)		(Germany)	2	25
Trogoderma anthrenoides (Sharp)		U.S.A.	2	25/30
Trogoderma glabrum (Herbst)		U.S.A.	2	25
Trogoderma granarium Everts	Khapra beetle	(Britain)	2	30
Trogoderma grassmanii Beal		U.S.A.	11	25
Trogoderma inclusum LeC.	Larger cabinet beetle		6	25
Trogoderma irroratum Reitt.		Egypt	2	30
Trogoderma ornatum (Say)		U.S.A.	11	25
Trogoderma simplex Jayne		U.S.A.	2	25
Trogoderma sternale plagifer Casey		New Mexico	20	25
Trogoderma variable Ballion		U.S.A.	2	30
Languriidae				
Pharaxonotha kirschi (Reitt)	Mexican grain beetle	Portugal	11a	20
Mycetophagidae				
Typhaea stercorea (L.)	Hairy fungus beetle	Nigeria	3b	25
Nitidulidae				
Carpophilus dimidiatus (F.)	Corn-sap beetle	(Amer.)	17	25
Carpophilus hemipterus (L.)	Dried fruit beetle		16	25
Trogositidae				
Lophocateres pusillus (Klug)	Siamese grain beetle		6	30
Tenebroides mauritanicus (L.)	The Cadelle	Pakistan	9	30
Tenebroides mauritanicus (L.)	"	Britain	9	30
Ptinidae				
Gibbium psylloides (Czenp)	Hump beetle	Britain	11a	20
Mezium affine Boield.		Britain	11a	20
Mezium americanum (Lap.)	American spider beetle		11a	20
Niptus hololeucus (Fald.)	Golden spider beetle	Britain	11a	20
Pseudeurostus hilleri (Reitt.)		Britain	11a	20
Ptinus clavipes Pans.	Brown spider beetle	Britain	11a	20
Ptinus exulans Er.		Britain	11a	20
Ptinus pusillus Sturm			11a	20
Ptinus sexpunctatus Pans.			11a	20
Ptinus tectus Boield.	Australian spider beetle		20a	25
Stethomezium squamosum Hint.	African spider beetle	Britain	11a	20
Tipnus unicolor (P. & M.)		Kenya	11a	20
Trigonogenius globulus Sol.	Globular spider beetle	Ireland	11a	20
Trigonogenius particularis Pic		Kenya	13a	20
Silvanidae				
✓ Ahasverus advena (Waltl)	Foreign grain beetle	(W.Africa)	8	25
Cathartus quadricollis (Guer.)	Square necked grain beetle	W. Africa	8	25
Oryzaephilus mercator (Fauv.)	Merchant grain beetle		8	25
Oryzaephilus surinamensis (L.)	Saw-toothed grain beetle		8	25

Stock Lists

ORDER	COMMON NAME	COUNTRY OF ORIGIN	CULTURE MEDIUM	REARING TEMPERATURE °C
COLEOPTERA contd.				
Tenebrionidae				
Alphitobius diaperinus (Panz.)	Lesser mealworm		11	25
Alphitobius laevigatus (F.)	Black fungus beetle		5	25
Alphitophagus bifasciatus (Say)	Two banded fungus beetle	Britain	2b	25
Gnatocerus cornutus (F.)	Broad horned flour beetle		11	25
Gnatocerus maxillosus (F.)	Slender horned flour beetle		5	25
Latheticus oryzae Waterh.	Long headed flour beetle		5	30
*Palembus dermestoides (Fairm.)		Malaya	12	25
Palembus ocularis Casey		Jamaica	14	25
Coelopalorus foveicollis (Blair)		Trinidad	13	25
Palorus laesicollis (Fairm.)		Kenya	13	25
Palorus ratzeburgii (Wissm.)	Small eyed flour beetle		5	25
Palorus subdepressus (Woll.)	Depressed flour beetle	Turkey	5b	25
Sitophagus hololeptoides (Cast.)		Trinidad	12	25
Tenebrio molitor L.	Yellow mealworm		8a	25
Tenebrio obscurus F.	Dark mealworm		8a	25
Tribolium anaphe Hint.		Nigeria	11	25
Tribolium audax Halstead	American black flour beetle	Canada	11	25
Tribolium brevicornis LeC.		USA	26	25
Tribolium castaneum (Herbst)	Rust red flour beetle	Britain	26	25
Tribolium confusum J.du V.	Confused flour beetle		26	25
Tribolium destructor Uytt.	Dark flour beetle	(Holland)	11	25
Tribolium madens (Charp.)	Black flour beetle	(Yugoslavia)	11	25

*(= Martianus dermestoides Fairm.)

LEPIDOPTERA				
Pyralidae - Phycitinae				
Ephestia (Cadra) cautella (Walk.)	Tropical warehouse moth (Almond moth, dried currant moth)	(S. Africa)	6a	25
Ephestia (Cadra) cautella (Walk.)	" " " "	Cyprus	15	25
Ephestia (Ephestia) elutella (Hübn.)	Warehouse moth (Tobacco moth, Cacao moth)	Britain	6a	25
Ephestia (Cadra) figulilella Gregs.	Raisin moth	Cyprus	6a	25
Ephestia (Anagasta) kuehniella Zell.	Mediterranean flour moth (Mill moth)	Britain	6a	25
Plodia interpunctella (Hübn.)	Indian meal moth	Britain	6a	25
Pyralidae - Galleriinae				
Achroia grisella (F.)	Lesser wax moth		10	25
Corcyra cephalonica (Stainton)	Rice moth	(Burma)	6a	25
Galleria mellonella (L.)	Honeycomb moth		10	25
Galleria mellonella (L.)	" "	U.S.A.	4	25
Gelechiidae				
Sitotroga cerealella (Oliv.)	Angoumois grain moth		1	25
Tineidae				
Tinea columbariella Wocke			22	20
Tineola bisselliella (Humm.)	Common clothes moth		22	20
Tinea flavescentella Haw.		(Scotland)	22	20
Tinea metonella Pierce & Metcalfe		(East Africa)	22	20

Stock Lists

MUTANT STOCKS

	MUTATION	COUNTRY OF ORIGIN	CULTURE MEDIUM	REARING TEMPERATURE °C
Lasioderma serricorne (F.)	Black	U.S.A.	5	25
Rhyzopertha dominica (F.)	Black		1	30
Callosobruchus maculatus (F.)	Giant		28	30
Cryptolestes pusillus (Schön.)	V.dark	Trinidad	8	25
Dermestes maculatus Deg.	Black/Brown	Australia	23	25
Carpophilus dimidiatus (F.)	Pearl-eyed		8	25
Ahasverus advena (Waltl)	V. dark	Britain	8	25
Oryzaephilus surinamensis (L.)	Small	Burma	8	25
Tribolium castaneum (Herbst)	Giant		26	25
	V.dark	Britain		
	Bar-eyed?	Britain		
Tribolium confusum J.du V.	Black		26	25
	Pearl-eyed	Britain		
	Black & pearl-eyed			

Silvanidae (mutants)

Oryzaephilus mercator	pearl eye	Slough 1978
Oryzaephilus surinamensis	pearl eye	Slough 1978

Tenebrionidae (mutants)

Tribolium castaneum

sooty (s)	Berkeley 1977
black (b)	Berkeley 1977
tawny (b^t)	Berkeley 1977
jet (j)	Berkeley 1977

Tribolium confusum

red (r^y)	Berkeley 1977
eye spot (es)	Berkeley 1977
pearl eye (p)	Slough 1958
dirty pearl eye (dpe)	Berkeley 1977
ebony-2 (e_2)	Berkeley 1977
riboflavinless, pearl (p^r)	Vancouver 1977
black (b)	Berkeley 1977
melanotic stink glands (msg)	Berkeley 1977
ruby spot (rus)	Berkeley 1977
thumbed (thu)	Berkeley 1977
ebony (e)	New York 1977
blistered elytra (ble)	Berkeley 1977
disjoined (dj)	Berkeley 1977
umbilicus (umb)	Savannah 1977
claret	Berkeley 1978
ruby (rub)	Berkeley 1978

Also available occasionally:-

Amphibolus venator Klug
Chaetospila elegans (Westw.)
Dinarmus basilis Rondani (= laticeps (Ashmead))
Thylodrias contractus Mots.

Some strains which are periodically renewed from the field

Species and date of last addition:-

Sitophilus granarius (L.)	1970
Sitophilus oryzae (L.)	1970
Sitophilus zeamais Motsch.	1970
Oryzaephilus surinamensis (L.)	1976
Tribolium castaneum J.du V.	1975
Ephestia kuehniella Zell.	1975

CULTURE MEDIA

The letter "a" after a number (on previous pages) indicates that drinking water is added to the culture either in the form of damp blotting paper or as a corked tube of water containing a wick of blotting paper.

No.	FOOD	Weight Ratio (Ounces)
1.	Wheat	
2.	Wheat + wheatfeed	7:3
3.	"Farex" + Yeast + Honey + Glycerol	2:1:1:1
4.	Wheat + wheatfeed + glycerol on a damp pad of cotton wool	7:3:1
5.	Wheat + wheatfeed on a damp pad	7:3
6.	Wheatfeed + yeast	10:1
7.	Wheatfeed + yeast on a damp pad	
8.	Wheatfeed + yeast + glycerol	10:1
9.	Beetle culture (Family Bostrichidae)	
10.	Wheatfeed + rolled oats + yeast	5:5:1
11.	Wheatfeed + rolled oats + yeast + groundnuts	5:5:1:1
12.	Wheatfeed + rolled oats + yeast + groundnuts + cork	5:5:1:1
13.	Wheatfeed + rolled oats on a damp pad	2:1
14.	Rolled oats + yeast	10:1
15.	Rolled oats + yeast + sultanas	6:1:6
16.	Wheatfeed + rolled oats + yeast + glycerine + honey + brood comb	5:5:1:2:2:2
17.	Wheatfeed + fishmeal + yeast	8:4:1
18.	Wheatfeed + rolled oats + fishmeal + yeast	5:5:2:1
19.	Fishmeal + yeast	16:1
20.	Fishmeal + yeast + flannel	16:1
21.	Fishmeal + yeast + bacon ends	16:1
22.	Fishmeal + yeast + bacon ends + cheese	16:1
23.	Wholemeal flour + yeast	12:1
24.	Wheatfeed + rolled oats + flour + yeast	3:3:3:1
25.	Wheatfeed + grassmeal + yeast + shortex	20:10:1:2
26.	Groundnuts	
27.	Haricot beans	
28.	Butter bean	
29.	Cowpeas + dried green peas	1:1
30.	Maize	
31.	Wheatfeed + glucose + yeast + glycerol	8:2:1:2
32.	Wheatfeed + fishmeal + yeast + cholesterol	8:8:1:1

(Ed.)

Slough, Berks, 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 on 1 April 1983, following the amalgamation of the Tropical Products Institute and the Centre for Overseas Pest Research. The Director of the new 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. Its budget will total over £8 million 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 and 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 cash 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, TDRI will concentrate its activities in those areas where it has a comparative advantage in terms of experience, knowledge and cost-effectiveness. Close co-operation will continue with government organisations, universities and industry in developing countries, the UK, and other industrialised countries, and with multilateral and bilateral aid agencies.

Requests from developing country governments 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 organisations.

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°C 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 proejcts.

I. Wild type strains

A. Coleoptera

1. *Acanthoscelides obtectus* Bruchidae	Swaziland; Turkey
2. *Callosobruchus analis*, Bruchidae	MAFF Lab., Slough; Indonesia.
3. *Callosobruchus chinensis*, Bruchidae	Nepal; Kenya
4. *Callosobruchus maculatus*, Bruchidae	Brazil (2 strains); Nigeria (2 strains; Oman; Senegal; Sierra Leone; Turkey; Upper Volta; Yemen

5. *Caryedon serratus*, Bruchidae	Unknown
6. *Prostephanus truncatus*, Bsotrichidae	Mexico; Tanzania
7. *Sitophilus oryzae*, Curculionidae	Peru (pulse-feeding strain breeding on split peas)
8. *Sitophilus zeamais*, Curculionidae	Mexico
9. *Zabrotes subfasciatus*, Bruchidae	Uganda (collected from cowpeas and bred on cowpeas); Colombia

B. Lepidoptera

10. *Corcyra cephalonica*, Galleriinae	Malawi
11. *Ephestia cautella*, Phycitinae	Brazil
12. *Sitotroga cerealella*, Gelechiidae	Sudan

Chemical Control Section

(Stocks of some major beetle 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 programmes.)

I. Wild type strains

A. Coleoptera

13. *Acanthoscelides obtectus*, Bruchidae	Ethiopia
14. *Callosobruchus chinensis*, Bruchidae	India
15. *Sitophilus oryzae*, Curculionidae Insecticide-suspectible strain (reference strain)	via MAFF Lab. Slough
16. *Sitophilus oryzae*, Curculionidae Malathion and lindane resistant strain (A.76)	via MAFF Lab. Slough
17. *Tribolium castaneum*, Tenebrionidae Multiple insecticide-resistant strain (CTC 12)	Australia
18. *Tribolium castaneum*, Tenebrionidae Malathion-specific resistant strains (Kano C)	Nigeria
19. *Tribolium castaneum*, Tenebrionidae Insecticide-susceptible strain (reference strain)	MAFF Lab. Slough

Dr P F Prevett
Deputy Head of Department

NEW ZEALAND

PRIVATE BAG, AUCKLAND
ENTOMOLOGY DIVISION, D.S.I.R.

1. Wild type strains (all originating from stored products in New Zealand).
   Gnathocerus cornutus (F.) broadhorned flour beetle
   Oryzaephilus mercator (Fauvel) merchant grain beetle
   Stegobium paniceum (L.) drugstore beetle
   Tenebrio molitor (L.) yellow mealworm
   Tribolium confusum (duVal) confused flour beetle
2. Mutant strains: nil.
3. Notes: These cultures are maintained for experimental purposes.

(Ed.)

PRIVATE BAG, HAMILTON
MINISTRY OF AGRICULTURE & FISHERIES
RUAKURA ANIMAL RESEARCH STATION

Stock List: *Tribolium castaneum*

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

(Ed.)

YUGOSLAVIA

ZAGREB, KAČIĆEVA 9
INSTITUTE FOR PLANT PROTECTION
AGRICULTURAL FACULTY

I. Wild type strain

LEPIDOPTERA

Gelechiidae

***Sitotroga cerealella* (Oliv.)**

Phycitidae

***Anagasta kuhniella* Zell.**

Stock Lists

COLEOPTERA

Bostrichidae

Rhizopertha dominica (F.)

Bruchidae

Acanthoscelides obtectus (Say)

Cucujidae

Cryptolestes spp. (Species not yet identified, but *ferrugineus* and *pusillus* are present)

Curculionidae

Sitophilus zeamais Motsch.

Sitophilus oryzae (L.)
Sitophilus granarius (L.)

Dermestidae

Attagenus megatoma (F.)
Attagenus piceus (Oliv.)
Trogoderma granarium Everts

Ostomatidae

Tenebrioides mauritanicus (L.)

Ptinidae

Mezium spp. (species not yet identified)

Silvanidae

Oryzaephilus surinamensis (L.)
Oryzaephilus surinamensis (L.) v. bicornis
Oryzaephilus mercator (Fauv.)

Tenebrionidae

Gnathocerus cornutus (F.)
Palorus spp. (species not yet identified but *ratzeburgi* and *subdepressus* are present)
Tenebrio molitor L.
Tribolium castaneum (Herbst)
Tribolium confusum Duv.

All insects are originated from storehouses and mills from Croatia, Yugoslavia. They are reared in a lab under constant circumstances during 3-4 years. Only species *Trogoderma granarium* is of unknown origin, collected from imported foodstuffs. This species is not found in Yugostavia yet.

II. Mutants

Tribolium confusum

Chromosome III

Yugoslavian black (*=b^z*)--Yugoslavia 1969 (report of A. Sokoloff, TIB 13)

(Ed.)

West Indies

Kingston 10, Jamaica
Food Storage and Infestation Division,
Ministry of Industry and Commerce,
20 Hope Road

Wild type strains

Coleoptera:

1. *Lasioderma serricorne* (F)
2. *Rhyzopertha dominica* (F)
3. *Acanthoscelides obtectus* (Say)
4. *Callosobruchus chinensis* (L.)
5. *Cryptolestes pusillus* (Schon.)
6. *Sitophilus oryzae* (L.) Jamaican as well as T.S.P.C. London strains
7. *Tribolium castaneum* (Herbst)
8. *Tribolium castaneum* (Herbst) From T.S.P.C. London
9. *Oryzaephilus surinamensis* L.
10. *Carpophilus dimidiatus*
11. *Thorictodes heydeni* Reitter

Lepidoptera

1. *Ephestia cautella* Walker
2. *Corcyra cephalonica* Stainton (a) not available now

(Ed.)

NEW MUTANTS

Report of R. W. Beeman

T. castaneum

Translocations. These are dominant factors for semisterility isolated from irradiated cultures. All are associated with pseudolinkage between the indicated linkage groups, and are therefore reciprocal translocations or possibly more complex rearrangements. (Methods used in the production and detection of these rearrangements are described elsewhere in this issue.)

Translocation strain	Pseudolinkage (% Recombination ± SD)	Percent Hatch ± SD
T(2;4)1	*mas*-*s* (3.7±2.6)	43.2± 8.0
T(2;4)2	*mas*-*s* (2.1±1.7)	37.7± 4.3
T(2;4)3	*mas*-*s* (8.9±2.7)	19.0± 6.0
T(2;6)	*mas*-*Rmal* (21.2±3.3)	30.6± 6.2
T(6;8)	*Rmal*-*ap* (0±0)	36.3± 7.6
T(4;6)	*s*-*Rmal* (20.3±3.2)	22.8± 8.3
T(4;8)	*s*-*ap* (9.9±3.8)	45.4±10.4
T(Y;4)	♂-*s* (9.5±4.0)	39.4± 8.1

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*The relationship between size of eggs and some aspects of *Tribolium castaneum* biology.

The red flour beetle, *Tribolium castaneum* (Herbst) is a well-known insect of milled products. Many authors have attempted to determine the intrinsic rate of increase of *T. castaneum* and Howe (1958) showed that each female laid an average of 360 eggs, at a rate of 2-5 per day for approximately one hundred days. Sokoloff (1972) found that a small percentage of *T. castaneum* eggs were larger than normal. Isolation of these large eggs proved that they were viable, and that beetles developing from them appeared to be the same size as those from normal eggs. These experiments are an attempt to relate egg size to the weight of the larvae and adults hatching from them.

The insects used in the experiments came from a culture in the Department of Agricultural Biology, University of Newcastle upon Tyne. Three groups of 25 pairs of sexed adults were placed in 9 cm petri dishes, incubated at 30^{o}C and 55 ± 5% R.H. The food medium was a 19:1 mixture of whole meal flour and brewer's yeast passed through a 250 micrometer sieve. One week later, the eggs were collected by passing the medium through a

600 micrometer aperture sieve which separated the eggs from the adults. Previous authors (Khan and Selman 1981) used 500 micrometer sieve, but this was found to retain 20-35% of the large eggs. The egg medium was transferred to 500 and then 350 micrometer aperture sieves to collect and separate the large and small eggs.

Three replicates of 100 eggs of each size were taken. These eggs were washed in invertebrate saline solution to rid them of adhered food particles and transferred to kitchen foil for weighing and measuring. Newly hatched larvae, mature larvae, and adults were also weighed. The pupae were sexed by the method of Halstead (1963).

The results were shown in Table I. There is an insignificant difference between the two sizes of eggs for the percentage of eggs hatching. The eggs are significantly different in length, width and weight. Similarly, the weights of newly hatched and mature larvae are significantly different, large larvae hatching from large eggs and small larvae from small eggs. However, there is no significant difference between the weights of the male or the female adults developing from the eggs once the sexes have been separated. However, twice as many females as males develop from large eggs and twice as many males as females from small eggs. Thus on average large eggs develop into females and small eggs develop into males. The results support the findings of Milner (1970) and Khan (1981).

Table 1. The effect of egg size on the biology of _T. castaneum_

	Size of eggs		
Aspects of Biology	Large mean + S.D.	Small mean + S.D.	t value
Hatch (%)	79.33 ± 4.509	85.33 ± 2.517	3.00$^{N.S.}$(D.F.,2)
Length of eggs (mm)	0.67 ± 0.023	0.56 ± 0.025	10.63*** (D.F.,14)
Width of egg (mm)	0.42 ± 0.023	0.34 ± 0.012	11.18*** (D.F.,14)
Weight of egg (mg)	0.039 ± 0.005	0.031 ± 0.003	5.62*** (D.F.,14)
Weight of newly hatched larvae (mg)	0.026 ± 0.003	0.022 ± 0.002	2.99** (D.F.,14)
Weight of mature larvae (mg)	3.66 ± 0.224	3.44 ± 0.162	3.00** (D.F.,14)
Weight of adults (mg)			
	2.27 ± 0.079	2.22 ± 0.083	2.08$^{N.S.}$(D.F.,14)
	1.99 ± 0.110	1.97 ± 0.137	0.36$^{N.S.}$(D.F.,14)
Adult emergence (%)	65.67 ± 1.528	80.33 ± 3.055	12.20*** (D.F.,14)
Sex-ratio (Nos.)			
	40*.00 ± 3.606	26.33 ± 4.933	
	25.67 ± 2.309	54*.00 ± 3.000	

*Indicated the χ^2 value is significant

Halstead, A. G. H. 1963. External sex differences in stored products Coleptera. Bul. ent. Res. 54: 119-134.

Howe, R. W. 1958. The effects of temperature and humidity on the oviposition rate of *Tribolium castaneum* (HBST.) (Coleoptera. Tenebrionidae). Bull. ent. Res. 49: 301-310.

Khan, A. R. 1981. The combined action of organophosphorus insecticides and microsporidian on Tribolium castaneum. Knpubl. Ph.D. thesis, University of Newcastle upon Tyne.

Khan, A. R. and Selman, B. J. 1981. Some techniques fro minimising the difficulties in egg counting in *Tribolium castaneum* (Herbst.). Entomologist's Rec. J. Var., 92, 36-37.

Milner, R. J. 1970. The morphology and phathogenicity of Nosema whitei Weiser, a microsporidian pathogen of Tribolium castaneum Herbst. Unpubl. Ph.D. thesis, University of Newcastle upon Tyne.

Sokoloff, A. 1972. The biology of Tribolium, with special emphasis on genetic aspects. vol. 1, 300pp. Clarendon press, Oxford.

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*Efficient methods for the detection of radiation-induced chromosome rearrangements in T. castaneum.

While the literature on Tribolium genetics is extensive, no one has reported the induction of chromosome rearrangements in this genus. In view of the relevance of chromosome rearrangements to karyotype evolution, genetic control of pest populations, and other areas of study, we have attempted to fill this gap. Two observable phenotypes associated with rearranged chromosomes are inherited semisterility (due to the formation of aneuploid gametes during meiosis) and pseudolinkage (due to altered gene arrangements). Both are used routinely in Drosophila and other diptera to reveal the presence of rearrangements.

Each of the methods has drawbacks with respect to T. castaneum, but we nevertheless found both to be applicable to this species. The difficulty with the semisterility method is that eggs mature and are laid singly rather than in synchronized masses. The drawback of the pseudolinkage method is that crossing over occurs in both sexes. This implies that the efficiency of detection of rearrangements by pseudolinkage will be considerably less than 100%, and will depend upon which mutant markers are used.

To induce chromosome breakage, adult males 7-12 days old were exposed to 4kRad of gamma radiation from a Co^{60} source. Their sons were screened for the presence of chromosome rearrangements. All rearing and incubations were conducted at a constant temperature of 30°C and 60-80% r.h.

The semisterility method. In all cases, males suspected of carrying a rearrangement were paired singly with wild-type, virgin females, and the fertility of each female (% hatch of eggs laid after insemination) was measured. The most reliable results, as well as the most efficient progress, were achieved under the following conditions: The single pairs should be allowed to mate for 4 days, either in 13 x 100 mm test tubes containing a pinch of medium, or in 8 dram shell vials containing 1-2 g of medium. The tester females should have been reared from the egg stage in uncrowded cultures (<2000 eggs in 250 g of medium). An uncrowded condition is obtained by placing ca. 100 adults on 250 g of medium, then removing the adults after 2 days. The tester females should be at their maximum rate of egg production (15-20 eggs per day), i.e. 15-30 days post-eclosion, at the start of egg collection.
For egg collection, the female should be isolated in 1-2 g of 120 mesh medium for 3 days. The surface of the medium must be covered with coarsely ground wheat (during both mating and egg collection) to facilitate righting. The eggs are then collected on a 50 or 100 mesh sieve, counted, transferred to 2-3 g of 120 mesh medium, and incubated for 14 days. Percent hatch is then measured by collecting the larvae on

a 50 mesh sieve and counting them. Alternatively, the eggs can be transferred to 5 g of unsieved medium, incubated for 20 days, and the progeny collected on a 25 or 30 mesh sieve for counting. Under these conditions the vast majority of tester females produce 40-60 eggs with a hatchability (for wild-type x wild-type matings) ranging from 85-100%. The semisterility method for the recovery of rearrangements is extremely efficient, and in principle all rearrangements causing meiotic difficulties can be detected.

As a supplement to the method just described, we have also used a faster and simpler technique to screen for semisterility. In this method each male to be tested is confined with 2 females for 7 days. The 2 females are then transferred (together) onto 3 g of unsieved medium for 3 days. They are then removed and the medium is incubated for 20 days, after which time the progeny are collected on a 25 mesh sieve and weighed. The assumptions are that both females are inseminated, that the number of eggs laid by each female is relatively constant, and that the weight of 20-day-old progeny is proportional to their number. About 95% of the "semisterile" designations based on this simple method were subsequently confirmed by actual measurement of % hatch.

Of 386 irradiated sperm tested by the above methods 187 (48%) contained heritable, partially sterilizing mutations. About 100 of these were saved for pseudolinkage analysis.

The pseudolinkage method. This is a standard method used for *Drosophila* and other dipterans lacking recombination in one sex. In these dipterans all rearrangements involving 2 or more chromosomes can be detected. In contrast, in species with recombination in both sexes, interchromosomal rearrangements can be detected by pseudolinkage only if 2 of the breakpoints are located sufficiently near to markers on the 2 chromosomes. However, the fact that chromosome rearrangements (including reciprocal translocations) often suppress recombination in the affected chromosome arm, means that a reasonable efficiency of detection may be attainable, even in such species.

For pseudolinkage analysis we constructed a tester strain homozygous for recessive markers on 6 of the 9 autosomal linkage groups. The 6 markers (abbreviation and linkage group in parentheses) were: missing abdominal sternites (*mas*, II), aureate (*au*, III), sooty (*s*, IV), ruby (*rb*, V), malathion susceptibility (*Rmal*$^{+}$,VI) and antennapedia (*ap*, VIII). With this strain we could in principle detect interchromosomal rearrangements involving any 2 of 6 autosomes and the Y chromosome. X-linked rearrangements were not recovered in this work, since only males were irradiated, and only their sons were screened for the presence of rearrangements. Of 90 semisterile mutations screened so far, 8 (9%) show pseudolinkage (see "Section on New Mutants", this issue).

Rearrangement breakpoints as dominant Mendelian factors. Even among those rearrangements which do not show pseudolinkage between 2 or more chromosomes it may still be possible to map one of the breakpoints, since each breakpoint behaves like a dominant gene for semisterility during Mendelian crosses. Of 77 dominant semisterile mutations for which no pseudolinkage was detected using the mas, au, s, rb, Rmal$^+$, ap tester strain, 32 (42%) had one breakpoint which mapped close to one of the visible markers.

In summary, we have shown that chromosome rearrangements can be induced in a high percentage of irradiated sperm, and we have developed efficient detection methods based on semisterility and pseudolinkage. We have mapped at least one breakpoint in 40 different rearrangements, and have detected pseudolinkage in 8 of them. These 8 are probably reciprocal translocations. At least three of the rearrangements are tightly linked to the male sex, and can therefore be maintained indefinitely without selection. A more detailed description of the detection methods and of the rearrangements themselves will be published elsewhere.

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*On heterogeneity in bIV strain of Tribolium confusum Duval.

Introduction

Heterogeneity in respect to weight of individuals and rate of development was observed in insects - store product pests. Howe /1961/ pointed out that usually certain, not large fraction of population developed more slowly than the rest - reached maturity later but attained larger weight. This phenomenon can be observed at the moment of apearance and weight of pupae in sinchronised cultures. Similar phenomenon was reported by Prus /1976/ in research on cI strain of Tribolium castaneum /selected with some other genetic strains and tested in respect of primary characteristics in University of Chicago Park, Mertz and Petrusewicz 1961/. He noticed that there was a fraction of population with faster growth and which has one larval instar less than the rest of individuals. It could be found by observing appearance of exuvia in individual cultures. Analogous phenomenon was observed in bIV strain of Tribolium confusum comming from the same group of strains from University of Chicago. Strain bIV was the least productive of the genetic strains of Tribolium confusum and the strain cI of Tribolium castaneum investigated by Prus /1976/ has the highest productivity of the strains of T. castaneum /productivity was defined by authors as ability of population to build up and sustain a given level of abundance/.

The aim of this paper was to investigate and discribe the heterogeneity in bIV strain of T. confusum.

Methods

Separate cultures of 50 individuals were run starting from newly hatched larvae /0-2 hours after hatching/ till maturity. Each larva was placed into a separate vial with 1g of culture medium /95% wheat flour, 5% powdered backer yeast by weight/. These synchronised cultures were run in dark incubator at +29°C and 70% relative humidity. Every 2 days each vial content was sifted through fine mesh, developing larvae being separated, weighed with Cahn electrobalance model G and replaced into fresh medium. Besides the exuvium was looked for and its presence /or absence/ recorded. After emerging of pupae their sex was determined, and later on, emerging adults were mated in separate pairs, placed into 8g of standard medium and their weight being measured in three day intervals until 100th day of life.

Results

The group of 48 surviving individuals consisted of 7 males and 14 females having 6 larval instars in their development and 17 males and 10 females having 7 larval instars /Tab I/.

For comparison of groups the folowing criteria were used: maximum body weight, time of reaching maximum weight, body weight on 73rd day of postembrional life, duration of development. Statistical comparisons were made using the Student t-test.

Maximum body weight of 7-instar individuals was higher than that of 6-instar individuals within both sexes /Tab II/. Maximum body weight of males was lower than that of females /within both instar groups/.

Six-instar individuals reached maximum weight sooner than 7-instar individuals /Tab III/. There were no significant differences in time of reaching maximum weight between males and females within instar groups.

Body weight of 7-instar individuals on 73rd day of life was higher than that of 6-instar individuals /within both sexes/. Body weight of females was higher than that of males within both instar groups /Tab IV/.

There are no significant differences in the body weight of newly hatched larvae between the instar groups and sexes.

Resuming, growth curves for males and females of both the instar groups showed clear differences. The 6-instar group individuals grew faster and during first 16 days their weight was higher than that of the 7-instar group /Fig.1/. The weight increment was, however, stoped about 4 days earlier and the achieved maximum weights were lower than in the 7-instar group. This difference was maintained for the remaining life span of insects. In two instar groups the body weight of females was higher than that of males.

Six-instar females, about 6 days after eclosion, showed a short period of growth after which their body weight became closer to that of 7-instar females.

Clear differences in duration of subsequent developmental stages /Fig. 2/ as well as of the whole development since hatching until the eclosion /Tab V/ were observed. Six-instar individuals had their development shorter than 7-instar individuals. The 6-instar group showed higher diferences between sexes in duration of the subsequent developmental stages than the 7-instar group /Fig. 2/. Development of females in this group was more than one day shorter than that of males. Such difference within the 7-instar group was not observed /Tab V/.

Discusion

Average time of development of bIV strain of Tribolium confusum - with time of embryonal development /5.60 days/ added - equals 33.21 days. It is only about 1 day different from that reported by Park, Mertz and Petrusewicz /1961/: 32.24 days. The natural variability accounts for this. It suggests that during handling the cultures environmental conditions such as temperature, humidity etc. were close enough to those designed for the experiment not to change significantly time of development.

Park, Mertz and Petrusewicz /1961/ investigating time of development of eight strains of Tribolium ascertained that there is not any satisfactory evidence to suggest that sex is significantly related to duration of the postembrional period. Time of development of males was significantly /$p<0.05$/ shorter than that of females only in two strains, but the authors considered it as curiosites. Results of the present work suggests that such relation occurs but only within the 6-instar group: time of development of females was shorter than that of males. This difference is clear and significant /$p<0.001$/. From results by Prus /1976/ it appears that in cI T. castaneum the 7-instar group has time of development related with sex but, on the contrary to bIV T. confusum, the females develop longer than males /$p<0.05$/. There is also a difference although not tested statistically - in proportion of 6- and 7-instar individuals within females: in T. castaneum there were more 7-instar females whereas in T. confusum there were more 6-instar females.

These observations allow to suppose that the basis of this heterogeneity are reproductive strategies different in these two species /strains/. It may be thought that a specific strategy for bIV strain of T. confusum is to shorten the period of reaching maturity. This strain during its evolution produced a group of individuals with larval development by one instar shorter /6 instars/ than others. This shortening is at the expence of the body weight /which may have repercusion on fecundity/. It hastens however the process of comming new individuals to reproductive activity. The fact that females dominated in the 6-instar group, and within this group females had shorter development time than males, exerts also an influence on acceleration of reproduction in population /as females have greater influence on dynamics of reproduction than males/.

It is interesting to note that 6-instar females after eclosion have a short period of gaining weight - as if a period of additional growth - so they partly made up their deficiency of biomass /Fig. 1/.

In cI strain of T. castaneum /Prus 1976/ the 7-instar group is more numerous than the 6-instar group and shows differences in time of development between males and females: females developed more slowly - and reached higher weights than males. It permits to suggest that in cI T. castaneum a specific strategy is to reach high body weight even at the expense of time of development.

We might to venture an opinion that, for some reason, in bIV strain of Tribolium confusum a shortening period of reaching maturity is preferred what leads to formation of a group of individuals with fastened development.

Summary

A heterogenous character of bIV strain of Tribolium confusum was found by determining changes in body weight and duration of developmental stages in individual cultures. The population consisted of 6-larval instar and 7-larval instar group. The 6-instar group had shorter development and reached lover maximum weight than the 7-instar group. Six-instar females developed faster than 6-instar males.

The basis of this phenomenon may be a reproductive strategy of this strain.

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Howe, R. W. 1961. Developmental time and weight in Tribolium castaneum. Tribolium Information Bulletin, 4, 21-22.

Park, T., Mertz, D. B., Petrusewicz, K. 1961. Genetic strains of Tribolium: Their primary characteristics. Physiol. Zool.,34, 62-80.

Prus, T. 1976. On heterogeneity in cI strain of Tribolium castaneum Hbst. Tribolium Information Bulletin, 19, 97-104.

Table I. Proportions between the 6- and 7-instar groups and sexes in population of bIV strain of Tribolium confusum.

	6-instar	7-instar	sum
♂	7 /29.2%/	17 /70.8%/	24 /100%/
♀	14 /58.3%/	10 /41.7%/	24 /100%/
sum	21 /43.8%/	27 /56.2%/	48 /100%/

Table II. Comparison of maximum weight /µg/ within sexes and the instar groups in bIV strain of Tribolium confusum.

	6-instar	t-test	7-instar
♂	2667.3 ± 167.1 n = 7	t= 6.29 p<0.001	3259.8 ± 288.5 n = 17
t-test	t= 5.67 p<0.001	╳	t= 2.34 p<0.05
♀	3099.2 ± 159.0 n = 14	t= 6.47 p<0.001	3478.6 ± 97.3 n = 10

/mean values ± standard deviations/

Table III. Comparison of time of reaching maximum weight /days/ within sexes and the instar groups in bIV strain of Tribolium confusum.

	6-instar	t-test	7-instar
♂	16.28 ± 0.76 n = 7	t=12.95 p<0.001	20.00 ± 0.00 n = 17
t-test	t=0.97 no differ.	╳	t=1.50 no differ.
♀	16.00 ± 0.00 n = 14	t=13.55 p<0.001	19.60 ± 0.00 n = 10

/mean values ± standard deviations/

Table IV. Comparison of weight on 73rd day of life /µg/ within sexes and the strain groups in bIV strain of Tribolium confusum.

	6-instar	t-test	7-instar
♂	2005.71 ± 111.48 n = 7	t= 7.71 p<0.001	2418.00 ± 127.57 n = 17
t-test	t=11.25 p<0.001	╳	t= 7.35 p<0.001
♀	2582.50 ± 101.28 n = 14	t= 4.96 p<0.001	2835.00 ± 131.76 n = 10

/mean values ± standard deviations/

Table V. Comparison fo time of development /days/ within sexes and the instar groups in bIV strain of Tribolium confusum.

	6-instar	t-test	7-instar
♂	26.71 ± 0.76 n = 7	t= 7.97 p<0.001	29.00 ± 0.00 n = 17
t-test	t= 4.00 p<0.001	╳	t=0.00 no differ.
♀	25.31 ± 0.75 n = 14	t=18.40 p<0.001	29.00 ± 0.00 n = 10
averaged	25.80 ± 1.00 n = 21	t=14.66 p<0.001	29.00 ± 0.00 n = 27

/mean values ± standard deviations/

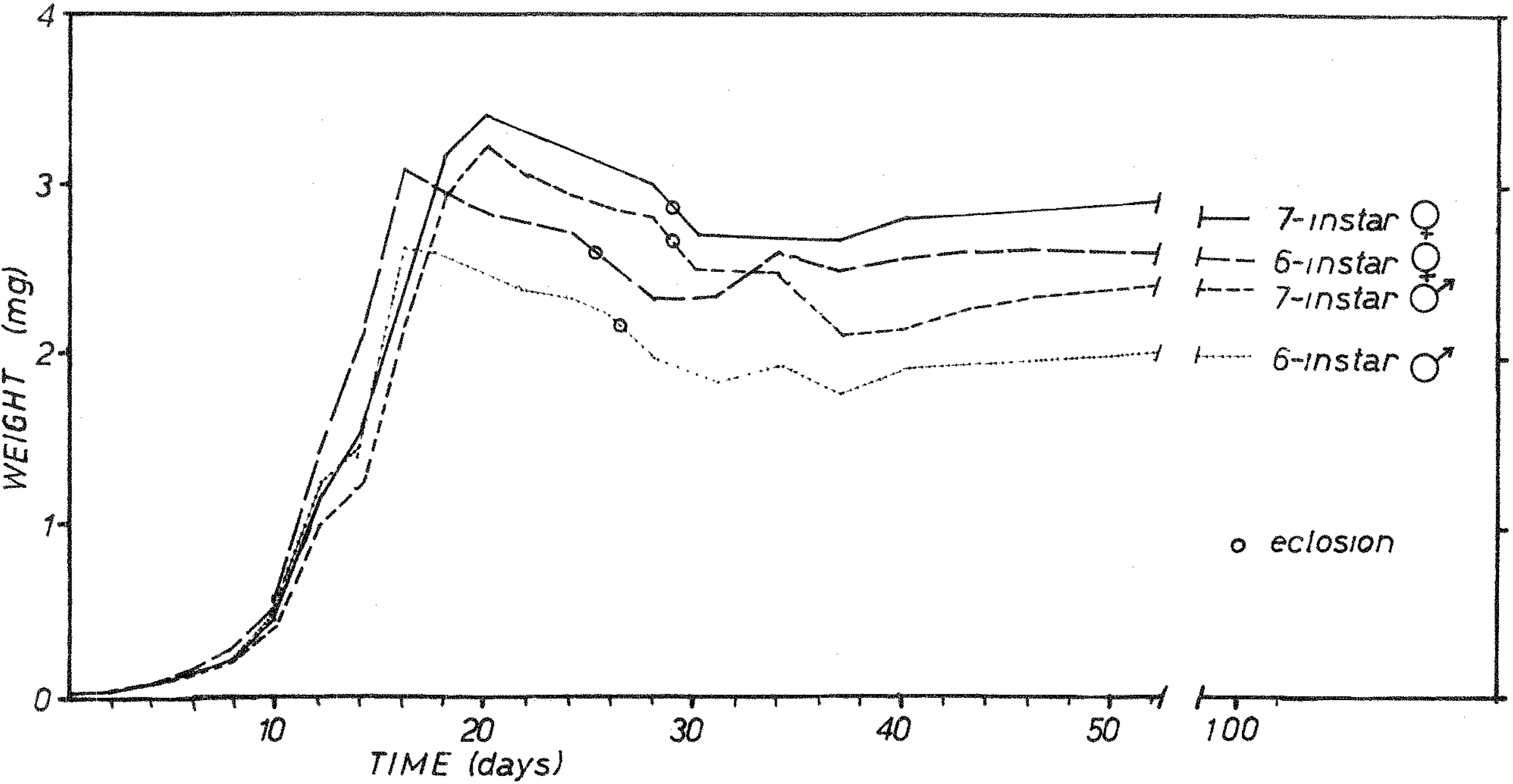

Fig. 1 The growth curves of the 6- and 7-larval instar groups of bIV strain of Tribolium confusum Duval.

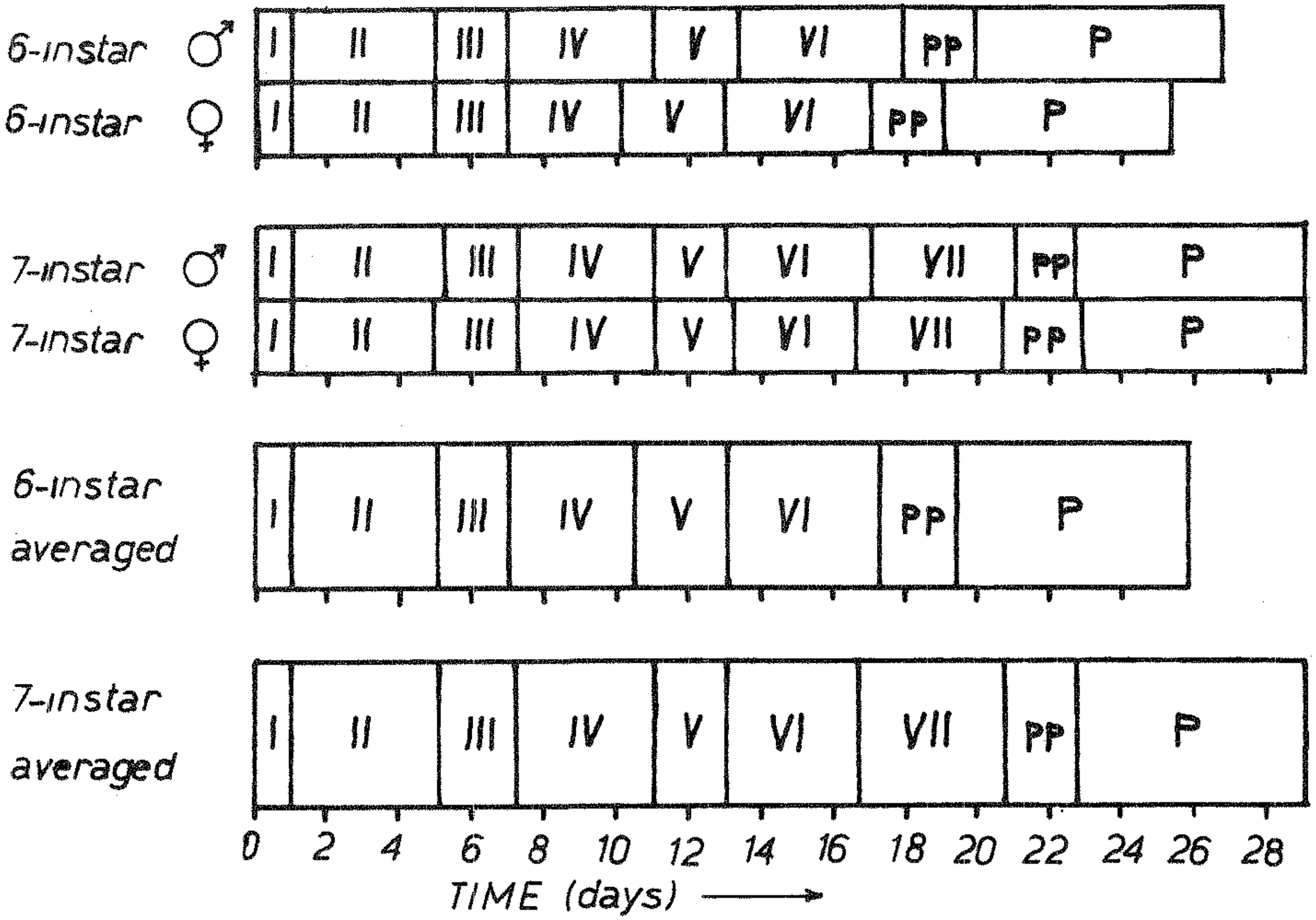

Fig. 2 Duration of succesive developmental stages in the 6- and 7-larval instar groups of bIV strain of Tribolium confusum Duval.

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*LINKAGE RELATIONSHIP OF AUREATE AND UMBILICUS IN *TRIBOLIUM CONFUSUM* DUVAL*

The linkage relationship of two mutations in *T. confusum* -aureate and umbilicus has been established. Aureate is linked with black in linkage group three. Aureate and black are approximately 28.47 ± .45 units apart in heterozygous males and 22.69 ± .42 units in heterozygous females. The results from backcrosses involving black and aureate are summarized in Table 1.

Umbilicus was also found associated with black on chromosome three. Umbilicus and black and approximately 36.9 ± .96 and 40.3 ± units apart in heterozygous males and females respectively. Backcross results from crosses between umbilicus and black are shown in Table 2.

The results from crossing black with the two newly established markers indicate that unequal crossing over also occurs in *T. confusum*. The recombination values differ by 5.78 ± .03% in the two sexes. In *T. castaneum* the distance between aureate and black has been reported as 39.79 ± 1.78% in the heterozygous black aureate male and 37.42 ± 1.27% in the heterozygous female (Sokoloff, 1977). The percent crossover distances for the two sexes in *T. castaneum* differ by 2.37 ± 0.51. The map unit difference in the two species may be the results of deletions, inversions or other chromosomal abnormalities.

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*Summary of Part I of a Master's Thesis "Contributions to the genetics of *Tribolium*".

TABLE 1. Backcross progeny from (A) *b* +/+ *au* females X *b au*/ *b au* male and (B) the reciprocal cross from 20 successful matings (numbers in parenthesis are decimal fractions of the total).

	cross	
Phenotype	A	B
b au	65 (.1053)	195 (.1446)
bz +	75 (.1216)	189 (.1401)
bz au	252 (.4084)	462 (.3425)
+ *b*	225 (.3647)	503 (.3729)
TOTAL	617	1349

* * *

TABLE 2. Backcross progeny from *T. confusum b* +/+ *umb* female X *b umb*/*b umb* male and the reciprocal cross from 4 successful matings (numbers in parenthesis are decimal fractions of the total).

	cross	
Phenotype	A	B
b umb	16 (.208)	42 (.106)
bz +	15 (.195)	104 (.263)
b +	15 (.195)	135 (.342)
bz umb	31 (.402)	114 (.289)
TOTAL	77	395

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*TRANSMISSION OF *T. CASTANEUM* MUTANTS IN *T. FREEMANI-T. CASTANEUM* HYBRIDS*

In 1981, Nakakita, et al. reported the successful hybridization between *T. freemani* Hinton and *T. castaneum* (Herbst). The purpose of this note is to report the phenotypic expression of *T. castaneum* mutants in *T. freemani-T. castaneum* hybrids.

The following mutations affecting body color (*b, Chr*), body weight/size (*py, Gi*), antenna (*Rd, Sa-2, Spa*), antenna and tarsi (*pd, Fta, Dch*), the ommatidia (*Be, Mo, r*) and the prothorax (*ptl*) were examined in this investigation. The mutants of *T. castaneum* were introduced into *T. freemani-T.castaneum* hybrids in both directions.

The expression and penetrance of the mutants in the *T. freemani-T. castaneum* hybrids were nearly identical to those witnessed in intraspecific crosses of *T. castaneum*. There were three slight variations: 1) the penetrance of *ptl* in the interspecific crosses was lower than that observed in intraspecific crosses of *T. castaneum*. 2) The penetrance of *Mo* was also lower in the interspecific crosses. The lowered penetrance of *ptl* and *Mo* may be due to the differences in the genetic background of the two species. 3) The body weight of beetles in intraspecific crosses increases almost two-fold in the presence of the *Gi* gene. In the interspecific crosses however, the increase in body weight was only a fraction of that observed in intraspecific crosses. There is little doubt that *Gi* causes an increase in body weight in matings with normal *T. castaneum*. In interspecific crosses however, the contribution of *Gi* does not appear as great.

REFERENCE

Nakakita, H., O. Imura and R.G. Winks. 1981. Hybridization between *T. freemani* Hinton and *T. castaneum* (Herbst), and some preliminary studies on the biology of *T. freemani* (Coleoptera:Tenebrionidae). Appl. Ent. Zool. 16:209-215.

*Summary of Part II of a Master's Thesis "Contributions to the genetics of *Tribolium*".

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* THE EXPRESSION OF *T. CASTANEUM* PYGMY AND GIANT MUTANT IN *T. FREEMANI-T. CASTANEUM* HYBRIDS*

Pygmy and Giant are mutations in *T. castaneum* (*T. cs*) which at a single step decrease and increase body weight in its' recipients respectively. The action of these genes was examined in the hybrids of *T. freemani* and *T. cs*. The experimental hybridization between these members of the *castaneum* species group have been reported by Nakakita, et al. (1981).

METHODS AND MATERIALS

T. cs py, *T. cs Gi* and normal *T. freemani* beetles were obtained from the *Tribolium* Stock Center at California State University in San Bernardino. All stocks were kept in a walk-in incubator at 70% relative humidity and 29 degree Celsius. Beetles were paired and placed in 3/4 oz. creamers containing five grams of whole wheat flour and brewer's yeast in a 19:1 ratio. Pair matings were made between the mutants of *T. cs* with *T. freemani* both ways. Twenty-five pupae of each strain were individually weighed to establish mean weights. The results from five replicates for each strain are shown in Table 1. The statistical method used in interpreting the data was the two-tailed Students' t test. The critical value was 2.01 with P<.05.

RESULTS-DISCUSSION

The pygmy gene causes a reduction in body weight in the *T. freemani-T. castaneum* hybrids as it does in pure *T. cs py* and normal *T. cs* strains. In crosses involving the *py* males the weight of the hybrid males was larger than that of the hybrids females. When the *py* female was involved, the weight of both hybrids was reduced. The weight of the hybrid females was greater than that of the hybrid males. The weight reduction caused by *py* is 3.5 milligrams (mg) when the weight of the *T. freemani-T. castaneum* male hybrids is compared with that of the pure *T. freemani* males. The *py* gene is responsible for lowering body weight by 1.2 mg when the weight of the *T. freemani-T. castaneum* hybrid females is compared to that of the normal *T. freemani* females. The comparisons of mean weight between males and female hybrids and between pure *T. freemani* and the hybrids were statistically significant upon application of the Students' t test.

The Giant gene increases the body weight of *T. cs* beetles by approximately two mg (Brownlee, 1984). Even though a weight increase was observed in the interspecific crosses, it was only a fraction of that seen in normal T. cs crosses. Perhaps the presence of Giant is more noticeable in beetles with low body weight. Although Gi does not increase body weight by two mg in the hybrids its' effect cannot be denied.

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Nakakita, H., O. Imura and R.G. Winks. 1981. Hybridization between T. freemani Hinton and T. castaneum (Herbst), and some preliminary studies on the biology of T. freemani (Coleoptera:Tenebrionidae). Appl. Ent. Zool. 16:209-215.

*Summary of part II of a Master's Thesis "Contributions to the genetics of Tribolium."

TABLE 1

AVERAGE WEIGHTS* OF 1) PURE *T. CASTANEUM* AND *T. FREEMANI* STRAINS AND 2) *T. FREEMANI- T. CASTANEUM* HYBRIDS FROM CROSSES INVOLVING THE PYGMY AND THE GIANT MUTANT

I STRAIN	(M)	(F)	STU t
T. cs +	2.2 ± .05	2.3 ± .05	1.96
T. freemani	5.4 ± .13	5.3 ± .14	.523
T. cs. Gi	4.3 ± .08	4.5 ± .08	1.73
T. cs. py	1.3 ± .05	1.4 ± .05	1.41

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II			
T. cs py (M)X *T. fr.* (F)	5.4 ± .05	4.1 ± .09	12.63**
T. cs py (F) X *T. fr.* (M)	1.7 ± .09	4.2 ± .08	20.76**
T. cs Gi (M) X *T. fr.* (F)	6.3 ± .08	5.7 ± .09	4.98**
T. cs Gi (F) X *T. fr.* (M)	4.7 ± .13	5.6 ± .20	3.77**

* Weights measured in mgs.
P<.05
Critical Value = 2.01
df = 48
M=Male
F=Female
**Significant

RESEARCH NOTE

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*Reproductive success of single *Tribolium castaneum* males when subjected to interstrain competition.

Gene frequencies in polymorphic populations of *Tribolium* may be altered by different types of mating behavior such as selective mating, aggressiveness of males, and receptiveness of females (Sinnock, 1970). The reproductive success of males is further complicated by sperm precedence. Schlager (1960) found that sperm transferred in later copulations took precedence over sperm already deposited by a previous male. If two males of different genotypes inseminate a female, the male to mate last leaves on the average 85.8% of the progeny (Sinnock, 1969). The proportion of sperm used from the first mating is affected by the mating speed of the second male (Wool and Bergerson, 1979). The genotype of a male may also affect its reproductive fitness. While studying the effects of single wild-type immigrants on populations of *Tribolium castaneum* initially homozygous for the antennapedia (*ap*) allele, a supplementary experiment was run to examine one-on-one competition between +/+ and *ap*/*ap* males.

The beetles used in this experiment were derived from a population of the Purdue wild-type (+) Foundation stock and a population of the mutant strain antennapedia (*ap*). All beetles were maintained in constant darkness in a Sherer-Gillett walk-in environmental chamber operating at a constant temperature of 32±1°C and a relative humidity of 70±5%. The culturing medium consisted of 95% whole wheat flour and 5% dried brewer's yeast.

All beetles were collected as eggs oviposited during a 24-hour period (Day 0). Pupae were separated by sex at Day 19, and kept as virgins until 14 days after adult emergence. Five replications were established, each consisting of 20 *ap*/*ap* females. One +/+ male and one *ap*/*ap* male were introduced to each group of females for 24 hours and then removed. The females of each replication were separated into 20 creamers and moved to a new creamer every day for 13 days. The numbers of + and *ap* offspring produced each day by each female were recorded.

The + male was more successful in terms of total progeny, leaving an average of 97.1 ± 5.24 offspring per day. This average was significantly greater than the average 38.2 ± 1.84 offspring per day left by the ap male ($P \leq 0.01$). For the five replications, an average of 3.4 ± 0.51 females were inseminated by the + male only, 1.6 ± 0.68 by the ap male only, and 12.6 ± 1.69 by both males. There was no significant difference between the numbers of females inseminated by each male. The + male left more offspring despite the fact that both males were able to inseminate almost all of the females.

The difference in reproductive success between the two males may be due to a number of factors including differences in mating speed, fertility, and aggressiveness. Wild-type males may be dominant in one-on-one competition, but the single + immigrants in our experimental populations had to compete with many ap males. Wool (1967) was unable to show frequency-dependent mating in populations of Tribolium, so the + immigrants probably gain no advantage by being the rare genotype. This competition experiment is currently being repeated using one + male and multiple ap males, to identify male insemination success under conditions comparable to those in our experimental populations.

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*Starvation Resistance in *Tribolium castaneum* Larvae

Investigations in this laboratory (Bell, 1981) have shown that two genetically distinct populations of *Tribolium castaneum* (Pearl and Black Foundation) show a significant response to natural selection for a limited food resource. The responses of interest in the present study are increases in intra-and inter-population competitive ability when competed against an unselected control population. This improvement in competitive ability is interesting because of the fact that it has never been shown before in these organisms.

The purpose of this investigation was to determine if the responses to selection noted above could be explained by differences existing in the population prior to selection. The interval of time in which a larva is able to survive in an environment lacking a food resource was examined. Two factors that may affect this interval are population type and egg size; both of which were included in the experimental design of this problem. Previously, these two factors had been analyzed as to their effects on hatching time (Langholff and Bell, 1983).

Materials and Methods

Eggs for this study were obtained from the following unrelated base or foundation populations of *Tribolium castaneum* which are maintained in our laboratory: (1) Purdue "+", (2) Black, and (3) Pearl. The Pearl and Black Populations are genetically marked with the pearl eye mutant (*p*) and the black body mutant (*b*), respectively. The Purdue "+" Population is genetically wild type. The base populations were cultured in standard media (95% whole wheat flour and 5% brewers yeast by weight), under optimal temperature, humidity, and light conditions (33°C, 70% relative humidity, and darkness). These conditions were used throughout this investigation.

From each of the base populations, a four-hour egg collection was taken from a mass mating of approximately 1000 adults. Then a random sample of 180 eggs from each popualtion was divided equally into three groups based on size (small, medium, or large). The size classifications were made subjectively at 10 x magnification. The largest 60 eggs were placed in the large group, the smallest 60 in the small group, and the remainder were classed as medium. Previous work in this laboratory indicated that this method provided adequate differentiation of size on the basis of weight (small = 33.9 ± 0.7 μg, medium = 37.9 ± 0.7 μg, large = 40.2 ± 0.7 μg). Direct classification of single eggs on an individual weight basis was not possible due to their small size and the accuracy of available scales. Within each combination of population type and egg size, the eggs were divided further into two groups in order to give two replications of the experiment.

After the size classification had been made, each egg was placed into a separate gelatin capsule (#00 Lilly). Each capsule had a small hole made by a needle in the top, allowing for the passage of air. The use of the capsules enabled the investigator to measure the variable of interest (survival time) on an individual basis. For this experiment, survival time was the interval of time from the laying of an egg until the death of the larva.

The observations taken during this experiment were analyzed using the following statistical model:

$$Y_{(ijk)l} = \mu + R_i + P_j + RP_{ij} + S_k + RS_{ik} + PS_{jk} + RPS_{ijk} + \varepsilon(ijk)l$$

where $Y_{(ijk)l}$ = analyzed variable of the ith replication, the jth population type, the kth egg size, and

μ = overall mean

R_i = the random effect of the ith replication, i = (1,2)

P_j = the fixed effect of the jth population type, j = (1,2,3)

s_k = the fixed effect of the kth egg size, k = (1,2,3)

$\varepsilon_{(ijk)l}$ = random error caused by the lth observation of the kth egg size in the jth population type in the ith replication, l = (1...30)

The analysis of variance (not shown) based on the above staitstical model indicated that all effects of replication were not significant (P<.25), so the experiment was analyzed in a manner analogous to that of a completely randomized design. The analysis of variance based on this new model is given in Table 1.

Table 1. Analysis of Variance for Survival Time

Source	df	Mean Squares
Population (P)	2	16.74**
Egg Size (S)	2	3.68**
P x S	4	0.85
Pooled Error	480	0.38

**P<.05

Results And Discussion

From the analysis of variance (Table 1), it was evident that only the main effects of population type and egg size were significant. Since there was no interaction between population type and egg size, the two variables were analyzed separately.

For population types and egg sizes, the mean survival times were compared using a Scheffe's multiple comparison test (Neter and Wasserman, 1974) and the results appear in Table 2.

Table 2. Comparison of Mean Survival Times

Population	Mean (days)	Standard Error	**
Pearl	7.955	0.0499	A
Black	7.329	0.0477	B
"+"	7.499	0.0485	C

Egg Size	Mean (days)	Standard Error	**
Small	7.434	0.0500	A
Medium	7.609	0.0472	B
Large	7.774	0.0489	B

**Identical letters indicate equivalent means (P<.05)

Table 2 indicates that the three populations differed significantly in survival under conditions of no food. The most resistant or longest surviving population was Pearl, followed by "+" and then Black. In Bell's (1981) paper, it was shown that prior to selection the three populations differed in competitive ability. The Pearl Population was found to be the most competitive followed by "+" and then Black. His results are consistent with the findings recorded here, based on survival time. Therefore, the results of this experiment are in accordance with the hypothesis that the initial ability of the popualtion to survive under limited food was what was acted upon by natural selection.

For egg sizes, it was found (Table 2) that the only significant difference was that small eggs have a shorter survival time in comparison to medium and large eggs. As previously reported (Langholff and Bell, 1983) Black eggs are smaller than Pearl and "+" eggs. The fact that the eggs of the Black Population are smallest may in part explain the short survival time for this population.

Summary

This investigation has shown that differences among populations and egg sizes have a significant effect on the survival of Tribolium castaneum larva. Also these differences may account for increases in competitive ability, for populations under natural selection for a limited food resource.

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* Reproductive parameters of Tribolium castaneum related to progeny testing*

A series of three experiments was carried out in order to determine the technical feasibility of using Tribolium castaneum as a pilot organism in selection experiments involving selection on the basis of progeny testing. Specifically, the experiments were designed to answer the following questions:

1. How many females can a male "service" without a decrease in fertility?

2. How does the age of the beetles at the time of mating affect their fecundity?

3. Will a non-virgin female remate with a different mate, so that her offspring will reflect the genetic make-up of the second male, and if so, how long an interval is necessary between matings?

A wild-type stock of Tribolium castaneum was used in all experiments. In addition, a stock homozygous for the recessive, sex-linked pygmy gene, (Sokoloff, 1966) was used in experiment 3. Stocks were maintained in incubators at 32°C and 71% relative humidity on a standard medium of 95% whole wheat flour and 5% brewers yeast.

For the first experiment, pupa were sampled from the wild-type base population at two week intervals for six weeks. Pupa were sexed and the sexes maintained separately. Six days after the last sampling, virgin beetles were single-pair mated in 10 different age-of-male/age-of-female combinations (see Table 1). Each combination was replicated 10 times. After 3 days, each pair was transferred to clean vials with measured amounts of fresh medium. Adults were removed after 24 hours, and all progeny were counted 13 to 14 days later.

The second experiment involved placing single, newly-emerged, virgin males in separate vials in combination with 1, 2, 4, 6, 8 or 10 females. After 3 days, all adults were separated and placed in clean vials with measured amounts of fresh medium for 24 hours. Offspring numbers were recorded 2 weeks later.

For experiment 3, two groups of newly-emerged, wild-type, virgin females were used. Group A females were mated with virgin, wild-type males for 24 hours, followed 2, 4 or 6 weeks later by a 24-hr mating period with virgin pygmy males. Group B females were mated first with pygmy males, and then remated to wild-type males. Seven to nine females were evaluated for each between-mating interval in each group. All of these females produced viable offspring from their first mating. The number of F1 daughters produced after the second mating ranged from 3 to 13, and all were backcrossed to pygmy males. The offspring of the backcross were scored in the pupal stage as wild-type or pygmy, in order to determine the genotype of their dams (F1), and hence, the genotype of their grandsires.

If no remating occurred, then the backcross progeny from group A should be 100% wild-type, indicating that their grandsires were the first mates offered to their granddam (i.e. the wild-type males). The backcross offspring from group B should be 50% wild-type and 50% pygmy if no remating had occurred, since the first males offered to their granddams were pygmy. If complete remating occurred then Group A offspring would be 50% pygmy and 50% wild-type, while the Group B offspring would be 100% wildtype.

In the first experiment, fecundity tended to decline with age (Table 1), but this decline was not significant (P<.05). The effects of the age of the male parent were not substantially different from the effects of the age of the female parent.

In the second experiment, male performance, as measured by the average number of offspring per female exposed, declined as the number of mates increased (Table 2). The average number of successful matings per male increased as the number of females exposed to him increased, but not proportionately. Three of the males produced no viable offspring at all. Since these males were exposed to 6, 8 or 10 females each, the data was also analysed with these males excluded. Even so, the average number of offpring per female exposed to fertile males declined as the number of mates increased. This decline was primarily a result of males not mating with some of the females available to them, rather than reduced sperm transfer to females.

In experiment 3, all F1 females in group A produced both wild-type and pygmy backcross progeny, while all group B females produced only wild-type backcross offspring. The ratio of wild type:pygmy backcross offspring in Group A was not significantly different from 1:1 for F1 females from dams that waited 4 or 6 weeks between remating. However, wild-type backcross offspring predominated (493 to 413) for grand-dams that only waited 2 weeks between remating. Thus, where remating did not occur for at least 4 weeks then all of the F1 offspring were sired by the second male. When remating occured after only two weeks, some offspring may have been sired by the first male, but only when the first male was wild type and the second male was pygmy. When the first mate was pygmy and the second, wild-type, complete remating occured. Possibly, sperm of pygmy males does not last as long as that of wild-type male, or pygmy males may produce less sperm.

In conclusion, males can apparently service several females over a 3-day period, but as the number of available mates increases, the proportion of females mated declines. Both males and females can mate up to six weeks of age without noticable reduction in subsequent fertility. Females can be successfully remated to new mates if their previous mates have been absent for at least 4 weeks. Eggs collected after their second mating will be sired by the second male.

Dr. Frankham of the University of MacQuarrie, Australia, suggested an alternative approach to the problem of remating. He clears residual live sperm and eggs from female Drosophila with a short exposure to freezing temperatues. Preliminary tests in our lab have indicated that a 5-min exposure to 1°F will clear viable eggs from female T. castaneum in eight days. Further studies are needed to determine whether remating will occur, and whether there are any long term effects on survival or fecundity.

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Table 1. Mean progeny number per mating for parents of different ages. Each mean is calculated from 10 single pair matings

		Age* of Male (in weeks)			
		0	2	4	6
Age* of Female (in weeks)	0	21.0	19.0	18.1	18.6
	2	19.1	23.7	–	–
	4	14.1	–	12.2	–
	6	21.4	–	–	16.9

*Age is counted from 3 days after emergence and is approximate

Table 2. Fecundities and average number of matings for single males paired with groups of females

No. of males tested	No. of females/ male	Number of Offspring Per Female			Number of matings/male	
		All Matings	Successful females only	Successful males only	All matings	Successful males only
5	1	36.8 (17.2)*	36.8 (17.2)	36.8 (17.2)	1.0	1.0
5	2	29.3 (12.3)	32.6 (8.0)	32.6 (8.0)	1.8 (.45)	1.8 (.45)
5	4	23.2 (16.3)	28.9 (12.6)	28.9 (12.6)	3.2 (.84)	3.2 (.84)
5	6	18.3 (17.3)	30.4 (10.8)	22.8 (16.4)	3.6 (2.9)	4.5 (2.4)
5	8	19.0 (19.0)	34.6 (10.4)	23.8 (18.4)	4.4 (3.2)	5.5 (2.4)
4	10	12.0 (15.5)	25.2 (13.0)	16.0 (16.0)	4.7 (3.8)	6.3 (2.5)

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*Standard error in parentheses

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*Genetic drift in large random mating control populations

Genetic drift has long been recognized as a significant factor in the evolution of natural populations. Its theoretical consequences in terms of gene frequencies were described by Wright (1945) and checked experimentally in numerous *Drosophila* studies. However, a *Tribolium* study (Rich, Bell and Wilson 1979) extending over 20 generations revealed that drift for the black (*b*) gene was significantly less then theoretically expected for small populations, due to natural selection within the randomly mated populations.

Genetic drift is of concern in quantitative genetics due to its possible influence on selection limits, predictability of selection responses, and the maintenance of control populations which are used by many investigators to separate genetic gains from environmental time trends. In a theoretical study of genetic drift for quantitative traits, Hill (1972) showed that the expected overall genetic mean of control populations does not change over generations. However, individual population means are expected to drift proportionally to the effective population size and the additive genetic variance.

In an early *Tribolium* study, Bray, Bell and King (1962) found no evidence of genetic drift for pupal weight in ten control populations reproduced over nine generations with 50 males and 50 females. And, Gall (1971) observed little divergence in pupal weight between three *Tribolium* control populations reproduced with 5 males and 20 females for 25 generations. On the other hand, Bell and Moore (1972) observed a significant divergence for pupal weight among eight control populations, each reproduced with 8 males and 24 females for twenty generations. More recently, Rich, *et al*. (1984) have studied genetic drift for two traits, pupal weight and reproductive fitness, in twelve replicate populations for each of four constant sizes (10, 20, 50 and 100 parents). Observed drift variances for both traits were significantly less than theoretical expectations. Stabilizing selection for an intermediate phenotype was suggested as the major force acting to counter genetic drift.

While genetic drift has not been systematically investigated in large (N>100) populations, the above results suggest that natural or unconscious selection in the reproduction of control populations could be a greater hazard than genetic drift in maintaining such populations without significant genetic trends for quantitative traits. A preliminary study of long term trends for three sub-populations of *Tribolium* provides some indirect evidence on this point.

Genetic Material

The genetic material for this study consisted of the Purdue "+" Foundation Population (F^+) of *Tribolium castaneum* and two sub-populations, Purdue *s* Foundation (F^s) and Purdue "+" Foundation maintained separately since 1964 and designated F^E. All had been maintained for about 280 generations as closed populations with a minimum of 250 randomly selected parents each generation.

The Purdue "+" Foundation identified as "+" because of its wild-type phenotype was synthesized in 1954 by the systematic combination of eight unrelated laboratory stocks and was maintained as a heterogenous control or base population with no artificial selection. Generations were maintained distinct and were cycled every 5-6 weeks. This population served as the base population for many of the early pupal weight selection studies reported from our laboratory (Bell, 1982). Generation means were not regularly observed for F^+ but during this early period (1954-1964) covering about 100 generations, sub-samples from F^+ uniformly revealed an average pupal weight of 225-230 dμg. There followed another period of about 100 generations when F^+ was routinely reproduced, but no observations were made on its pupal weight. On re-sampling F^+ since 1975 to monitor genetic gain for a long-term selection study, it's mean pupal weight has been consistently around 240-250 dμg. Apparently the genetic mean pupal weight had increased some 10% due to genetic drift and/or natural selection. The possibility of an improved environment was discounted since other populations did not show this increase. In addition, recent estimates suggest a significant decline in the h^2 of pupal weight in F^+ from near 60% initially to less than 30%.

The Purdue F^S Population was established from "sooty" (ss) segregants observed in the initial F^+ Population. Over several generations, the original F^+ Population was sub-divided into two populations, one homozygous for the wild-type body color (+) and the second homozygous for the "sooty" mutant (s). Therefore, the two populations were genetically similar or identical when established other than for the genetic marker "sooty." Thereafter, F^S was maintained as a closed population and reproduced each generation in the same manner as described for F^+.

The Purdue F^E Population was established in 1964 as a sub-sample of F^+ by Dr. D. C. Englert, Department of Zoology, Southern Illinois University. Thereafter, he maintained it continuously in his laboratory as a closed population, reproduced each generation by the mass transfer of about 250 adults. The F^E Population was re-introduced into our laboratory for the present study in 1981.

Experimental

As an experimental check for genetic drift which might have occurred among these large closed populations, a complete diallel crossing design was utilized with observations taken on a predominantly additive trait, pupal weight, and a heterotic trait, developmental rate or days to pupation.

From each of the three populations (F^+, F^S and F^E), consecutive 48-hour egg collections were taken in fresh medium. Three weeks later pupae were screened from these collections, sexed and held as virgins until sufficient numbers were available to complete the complete diallel.

The nine possible crosses, including reciprocals, for the three populations were made with 5 males and 5 females mass mated for each cross. These matings were acclimated for three days in a darkened climate controlled chamber at 30°C and 70% R.H. Two consecutive 24-hour egg collections were taken from each cross and cultured in 10 gr of standard medium (95% whole wheat flour and 5% dried brewers yeast). Commencing on Day 15, each mating was screened daily with observations recorded on (1) Days from egg to pupation, (2) number of pupae, and (3) mass weight of the pupae. An additional replication of this diallel was made in the same manner using a new sample of parents from each population.

Results

The observations from the two replications of the complete diallel were analyzed using the following statistical model,

$$Y_{ijklmn} = \mu + C_i + R_j + S_k + D_l + T_m + CR_{ij} + CS_{ik} + CD_{il} + CT_{im}$$

$$+ RS_{jk} + RD_{jl} + RT_{jm} + SD_{kl} + ST_{km} + DT_{lm} + \varepsilon(ijklm)_n$$

where Y_{ijklmn} = mean pupal weight or days to pupation

μ = overall mean

C_i = random effect of the ith collection $i = 1,2$

R_j = random effect of the jth replication $j = 1,2$

S_k = fixed effect of the kth sire line $k = 1,2,3$

D_l = fixed effect of the lth dam line $l = 1,2,3$

T_m = fixed effect of the mth day $m = 1,2$

$\varepsilon(ijklm)_n$ = the nth random within error

The analyses of variance for mean pupal weight and days to pupation based on the above statistical model are given in Table 1. The highly significant "Collection" effect shown in Table 1 for pupal weight was due to some unidentified environmental factor acting differentially in Collection 1 versus 2 in both replications. This significant environmental influence was not important in the present study since all crosses responded similarily. The highly significant effects shown for Sire and Dam lines were of interest in that they confirmed the suspicion that these three sub-populations had become genetically differentiated over time. For the more heterotic trait "days to pupation", this differentiation between populations due to the main or average influence of Sire and Dam lines, was of marginal significance. However, both traits revealed highly significant interactions between Sire and Dam lines to suggest that the populations had also become differentiated by non-additive or heterotic gene effects.

The genetic differentiation or drift between these three sub-populations is also evidenced in the diallel listing of over-all means (Table 2).

Table 1. Analyses of variance for mean pupal weight and days to pupation

Mean Squares by Traits

		Mean Pupal Weight		Days to Pupation	
Source	df	MS	F	MS	F
Collections (C)	1	8460.92	14.36**	47.72	6.28
Replication (R)	1	577.02	.98	2.45	.32
Sire Line (S)	2	18958.76	32.19**	.25	.03
Dam Line (D)	2	19996.78	33.95**	25.14	3.31
Day (T)	1	522.57	.89	5.23	.69
C x R	1	1367.91	2.32	6.83	.90
C x S	2	148.26	.25	2.03	.27
C x D	2	48.07	.08	5.62	.74
C x T	1	61.77	.11	14.37	1.89
R x S	2	419.94	.71	.26	.03
R x D	2	2009.28	3.41	1.38	.18
R x T	1	281.25	.48	.17	.02
S x D	4	4273.86	7.26**	73.71	9.70**
S x T	2	129.79	.22	6.01	.79
D x T	2	684.29	1.16	.02	.003
Within	533	589.06		7.60	
Total	559				

**(P<.01)

Table 2. Summary for pupal weight and days to pupation means for the diallel crosses including reciprocals

Dam Lines

Sire Lines	F^+	F^S	F^E	Overall
F^+	[a]252.42	272.91	245.28	256.87
	[b]20.02	18.92	19.22	19.37
F^S	269.55	263.00	257.12	263.23
	18.65	21.11	18.50	19.43
F^E	248.06	255.09	226.51	243.23
	18.97	19.50	19.91	19.47
Overall	256.68	263.67	242.97	
	19.23	19.83	19.20	

[a] pupal weight in dμg with approximate standard errors of 3.0 dμg

[b] days to pupation with approximate standard errors of 0.35 days

The differentiation among the three populations is demonstrated most clearly by their purebred values as underscored and listed on the diagonal. The population maintained in Englert's laboratory (F^E) revealed a mean pupal weight identical to the original Purdue + Foundation. On the other hand, both populations maintained continuously in our laboratory (F^+ and F^S) showed a 10-15% increase in mean pupal weight. The fact that the amount and direction of this genetic trend was nearly the same for F^+ and F^S suggests that in the reproduction of these populations either natural or unconscious selection for large pupal weight had occurred in addition to random drift.

In general the mean pupal weight of crosses were in between those of the parental lines, as expected for a trait determined largely by additive genes. Yet there was sufficient heterosis (2-6%) as measured by F_1 superiority over mid-parental values to cause the significant "Sire by Dam" interaction observed for pupal weight in Table 1.

For the more heterotic trait, days to pupation, the results are altogether different than those observed for pupal weight. In this case, the three populations had similar purebred values (note the diagonal means in Table 2) and similar overall means for the three Sire and Dam Lines. Consequently, these main effects in Table 1 were non-significant. However, in every case, the crossbreds were earlier or faster to pupation than the parental purebreds and this consistent heterosis of 5-10% for early pupation caused a highly significant "S X D" interaction(Table 1).

These results for days to pupation indicate that even though the population means did not diverge, genetic drift or inbreeding had occurred in terms of genetic divergence between populations as revealed by the heterosis in crosses. If one assumes an average effective population size (N_e) of 200 in the reproduction of these populations, an inbreeding coefficient (F) of about 50% would be expected theoretically after some 280 generations of random mating (assuming an average generation cycle of 5 weeks).

Summary

Genetic drift in terms of divergence of population means and heterosis in crosses for two quantitative traits, pupal weight and days to pupation, was observed in three foundation or control Tribolium populations which had been reproduced for about 280 generations as closed populations with about 250 randomly selected parents each generation. While genetic divergence between closed populations did occur as expected when measured by heterosis in crosses, population means were influenced to a greater degree by unconscious or natural directional selection than by random drift. These results are in agreement with the more extensive study of Rich, *et al.*(1984).

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*Vertical dispersion of Tribolium castaneum (Herbst) larvae in flour.

Vertical distribution of the adults in the flour medium was studied in both T. castaneum Herbst and T. confusum Duval (Dawson, 1964; Ghent, 1966; Mcleod & Dawson, 1982). In both species the adults remained on the surface in large numbers rather than tunnelling into a vial of fresh flour. Ghent (1966) also reported that for larvae the largest counts were obtained in the top quarter of the vial. T. castaneum larvae preferred to move downwards in the flour (Wijayagunasekara, 1979).

However, there is little other information on the vertical dispersion of T. castaneum larvae. These lead to the start of the present work on the vertical dispersion of T. castaneum larvae in flour.

All experiments were done in towers, made from five glass cylinders, each 19 mm inside diameter and 1 cm high. When the tower was assembled (with adhesive tape) the four lower sections were filled with 8 g of fresh flour with 5% brewer's yeast previously passed through a 250 micometer sieve. The uppermost section served as an air space in order to prevent a possible spill over of flour due to larval movement. Larvae were released at different positions in the flour column in different experiments. In the first set of experiments larvae were released on the 'top' of the flour column, at the 'middle' in the second set and at the 'bottom' of the flour column in the third set.

All units were kept in an incubator set at 30 ^{o}C (without relative humidity control and without light). After 24 hours each section of the unit was separated. The larvae were sifted out of the flour of each section separately by sieving the flour through a 250 micrometer sieve, and counted. Each set of experiments was conducted with different instar larvae taking one hundred larvae from each instar and replicated three times.

Four flour-filled sections of every unit were treated as four 'regions' and the distribution of larvae in the medium was expressed on a 'regional' basis. The uppermost region was arbitrarily assigned the number I, the lowest the number IV.

The results of the experiments and statistical analyses are shown in tables 1-4. In the present experiments higher proportion ($P<0.001$) of larvae were found in the lower regions (III + IV) compared with upper regions (I + II) when the larvae were initially released at the middle of the flour column (table 1) showing that larvae of all instars preferred to move downwards rather than upwards in the flour medium which agrees with the findings of Wijayagunasekara (1979). The present result differs from that of Ghent (1966) with T. castaneum larvae who reported that the upper two quarters included more than 77% of the larvae compared with lower two quarters of his experimental tower. This was probably due to the fact that in his experiments larval distribution were studied in a flour media containing all life stages 26 days after introducing 200 adults on the surface of the flour column and the distributional behaviour of the larvae was likely to be changed due to the presence of adults, position of eggs and duration.

A higher proportion of fourth, fifth and sixth instar larvae ($P<0.001$) remained in their initial 'bottom' regions of the flour column in comparison with their initial 'top' regions (table 2).

The differences in number of larvae moving to the corresponding third regions from their initial positions - 'top' and 'bottom' of the flour column were significant ($P<0.001$) for fifth (20% v.s. 5.33%) and sixth (30.67% v.s. 6.33%) instar. No larvae up to third instar reached the corresponding third regions from the initial 'top' or 'bottom' position (table 3). On the other hand, only a few fifth and sixth instar larvae reached the distal regions from their initial 'top' and 'bottom' positions (table 4).

In the present experiments the presence of higher numbers of larvae in the initial 'bottom' region could result from their response to gravity and the larvae of all instars preferred to settle down at the bottom of the experimental tower rather than to move upwards. In the present studies fifth and sixth instar larvae were also found to show greater mobility which was probably due to the interactions between them due to crowding and their faster rate of movement.

I wish to express my indebtedness to Dr. G. R. Port, Department of Agricultural Biology, University of Newcastle upon Tyne for his help and valuable suggestions during the studies and in preparation of the manuscript. I wish to thank the University of Rajshahi, Bangladesh for granting study leave. Financial support by the Commonwealth Scholarship Commission in the United Kingdom is gratefully acknowledged.

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TABLE 1

The numbers and percentage of T. castaneum larvae moving upwards (I + II) and downwards (III + IV) when initially released at the middle of the flour column.

Larval instar	Number of larvae moved		% total moved downwards	X^2
	upwards(I+II)	downwards(III+IV)		
First	2	298	99.33	292.05***
Second	6	294	98.00	276.48***
Third	66	234	78.00	94.08***
Fourth	77	223	74.33	71.05***
Fifth	83	217	72.33	59.85***
Sixth	98	202	67.33	36.05***

Three replicates per experiment for each instar; each replicate consisting of 100 larvae (N=300),

*** highly significant, $P<0.001$ (1 d.f.)

TABLE 2

The numbers and percentage of T. castaneum larvae remaining in their initial regions I and IV when released at the 'top' and 'bottom' of the flour column respectively.

Larval instar	Number of larvae remained in		% total remained in		X^2
	region I	region IV	region I	region IV	
First	271	298	90.33	99.33	1.28 N.S.
Second	254	293	84.67	97.67	2.78 N.S.
Third	248	280	82.67	93.33	1.94 N.S.
Fourth	179	274	59.67	91.34	19.92***
Fifth	60	232	20.00	77.33	101.31***
Sixth	43	212	14.33	70.67	112.00***

Three replicates per experiment for each instar; each replicate consisting of 100 larvae (N=300),

N.S. Not significant (1 d.f.)

*** highly significant, $P<0.001$ (1 d.f.)

TABLE 3

The numbers and percentage of *I. castaneum* larvae moving to the regions III and II when initially released at the 'top' and 'bottom' of the flour column respectively.

Larval instar	Number of larvae moved to		% total moved to		X^2
	region III	region II	region III	region II	
First	-	-	-	-	-
Second	-	-	-	-	-
Third	-	-	-	-	-
Fourth	5	1	1.67	0.33	$2.67^{N.S.}$
Fifth	60	16	20.00	5.33	25.47^{***}
Sixth	92	19	30.67	6.33	48.00^{***}

Three replicates per experiment for each instar· each replicate consisting of 100 larvae (N=300),

N.S. Not significant (1 d.f.)

*** highly significant, $P<0.001$ (1 d.f.)

TABLE 4

The numbers and percentage of *I. castaneum* larvae moving to the regions IV and I when initially released at the 'top' and 'bottom' of the flour column respectively.

Larval instar	Number of larvae moved to		% total moved to		X^2
	region IV	region I	region IV	region I	
First	-	-	-	-	-
Second	-	-	-	-	-
Third	-	-	-	-	-
Fourth	-	-	-	-	-
Fifth	8	2	2.67	0.67	$3.60^{N.S.}$
Sixth	51	12	17.00	4.00	24.14^{***}

Three replicates per experiment for each instar; each replicate consisting of 100 larvae (N=300),

N.S. Not significant (1 d.f.)

*** highly significant, $P<0.001$ (1 d.f.)

Mating Behavior of the Rock Outcrop Beetle, Collops georgianus (Coleoptera:Melyridae)

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Collops georgianus Fall is a soft-winged flower beetle (Melyridae) endemic to granitic rock outcrops of Georgia. It exhibits a sexual dimorphism in antennal structure shared by other members of the genus. The third antennal segments of the males are greatly enlarged (Fig. 1a,b) and are involved in a behavior which may preliminarily be termed courtship. I term it a preliminary designation because though I have observed this behavior in the field and in the laboratory hundreds of times, it has never once led to copulation. In every case the male and female depart from one another. Both this behavior and copulation have been observed in the field. The sexual dimorphism and the behavior have also been noted for other species by other authors (Horn 1870; McAtee 1916). McAtee has in fact termed it a "Collopid soul-kiss".

This "Collopid soul-kiss" involves the following. A male and female stand head to head. The male then places his antennae forward in parallel and the female grabs the swollen antennal segments with her mandibles (Fig. 1c,d). She pulls at them for some time (about 20 sec.) and then releases them. While she is tugging at the male, the male vibrates his forearms against the female's pronotum. After release, the male just stands there with his head down and antennae forward. The female wipes her antennae and mandibles with her forearms as though she got some substance from the male's antennal segments and is now tasting it. She then resumes the tugging and the male resumes moving his forearms against her pronotum. Again, the female will let go and wipe herself off. The process repeats itself several times. I've watched pairs do this for up to 7 minutes. It ends with the male and female parting. Sometimes the male will follow the female for a short time.

While a male and female are engaged thusly, another male will often come up to them and try to replace the first male. The first male ususally succeeds in forcing the intruding male away. I have also on occasion seen two males involved in this behavior with one acting as the female.

Clarification of the meaning of this behavior will I hope come from further study of the male antennal segments to determine whether glandular opennings exist and further behavioral studies to ascertain the role of these segments in the mating of individuals and in the egg-laying of females.

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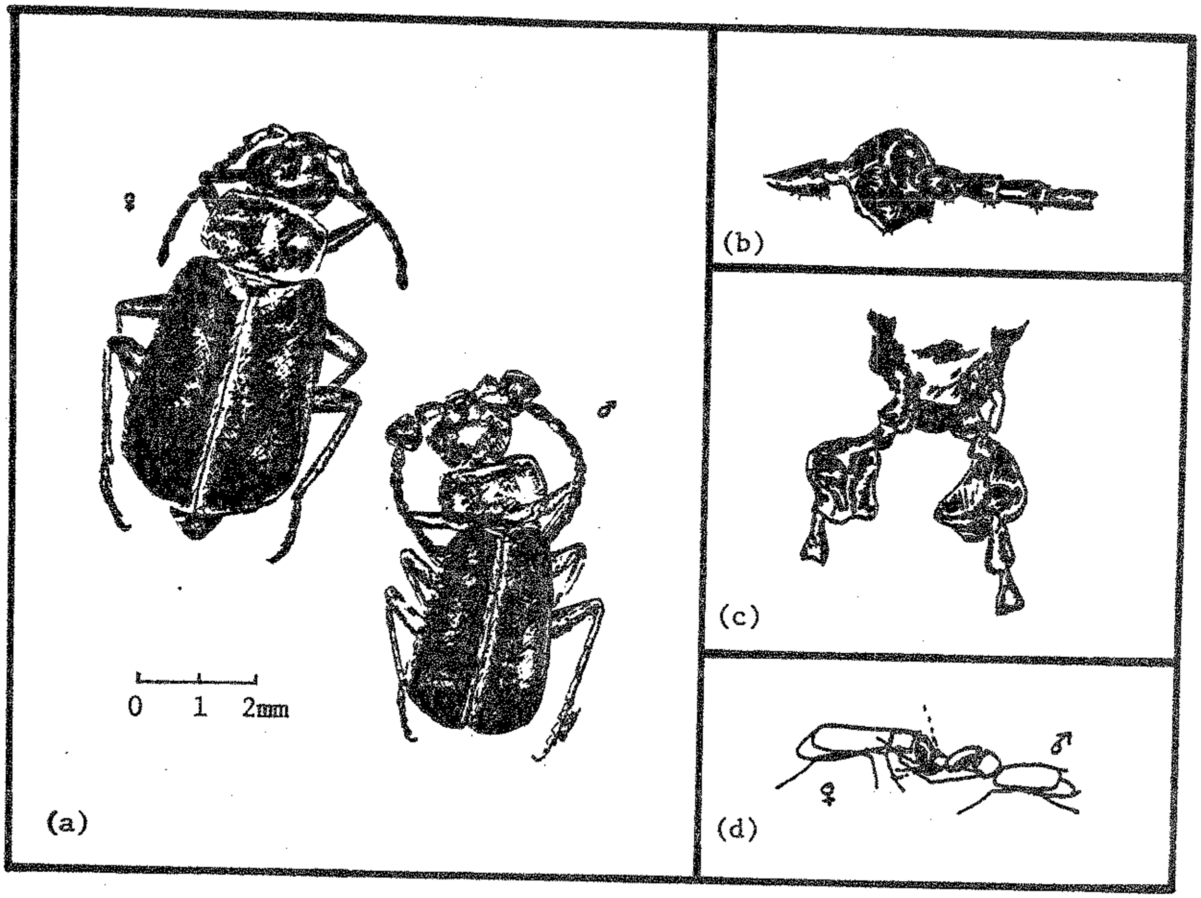
Fig. 1: *Collops georgianus* -- (a) female and male dorsal view; (b) close-up of male third antennal segment; (c) frontal view of male as seen by female; (d) female tugging at male antennal segments during "courtship" behavior.



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*Longevity of Tribolium castaneum as Influenced by Larval and Adult Feeding on VE

This study was aimed at determining the effect of the addition of 1% VE during development (in egg and larval stages) and/or adulthood on the longevity of the adults.

Materials and Methods:

The Tribolium castaneum strain used in this experiment was KJ (Kyoto, Japan) which is known to have reduced longevity in relation to other strains [Soliman and Lints (Gerontologia 21: 102-116, 1975)]. Four nutritional regimes were used: larvae fed on VE or no VE media and the emerged adults from each were either fed on medium with or without VE. The other experimental conditions were as described in the preceding note in this issue of TIB.

Results and Discussion:

Mean longevity: None of the means was significantly different from each other using T-test (Table 1).

Maximum longevity: The addition of VE to the medium increased the maximum longevity of the beetles. When no VE was provided the maximum longevity was the lowest among the four experimental conditions (Table 1), in contrast with, the highest maximum longevity when both larvae and adults were fed on VE. Feeding larvae only on VE increased the maximum longevity more than feeding adults only on VE. In other words, the presence of VE in the larval medium increased the maximum life-span of the emerged adults and further feeding of the adults with VE increased the maximum life-span even more.

Survival curve: Feeding larvae on VE increased early death up to day 56 (Fig. 1). Feeding larvae and adults on VE produced the highest early mortality and the lowest late mortality rates. These results (and those of T. audax males in the preceding note) seem to indicate that VE is needed in later life where it has the greatest beneficial effect as an antioxidant to protect against the damage to DNA and to stabilize cell membrane.

Mode of death: The mode of death (not presented here) was bimodal. The average proportion of the first distribution was about 1/3 and the second distribution 2/3 of all beetles within each experimental set. Very few beetles died between day 42 and 56 (which is also apparent from Fig. 1). The second distribution was the widest and has the lowest peak when VE was provided for both larvae and adults, and the reverse occurred when no VE was given to either stages.

Variability: The differences between the variabilities of the four experimental sets was tested using the squared-values of the coefficient of variability (Table 1). The highest variability was for the longevity of adults fed on VE and produced from larvae fed on VE also. All comparisons were significant except for the variabilities of the two experimental sets when larvae were not fed on VE.

Table 1. Mean and maximum longevity of adults of _Tribolium castaneum_ (Kyoto, Japan strain) under different nutritional regimes using 1% VE

Nutritional Regime					
Larva	Adult	N	Mean ± SE (days)	CV (%)	Maximum Longevity (days)
No VE	No VE	140	67.35±1.99	36.64	112
	VE	140	68.70±2.07	35.37	119
VE	No VE	70	66.20±3.34	41.86	126
	VE	70	67.20±3.75	49.75	130

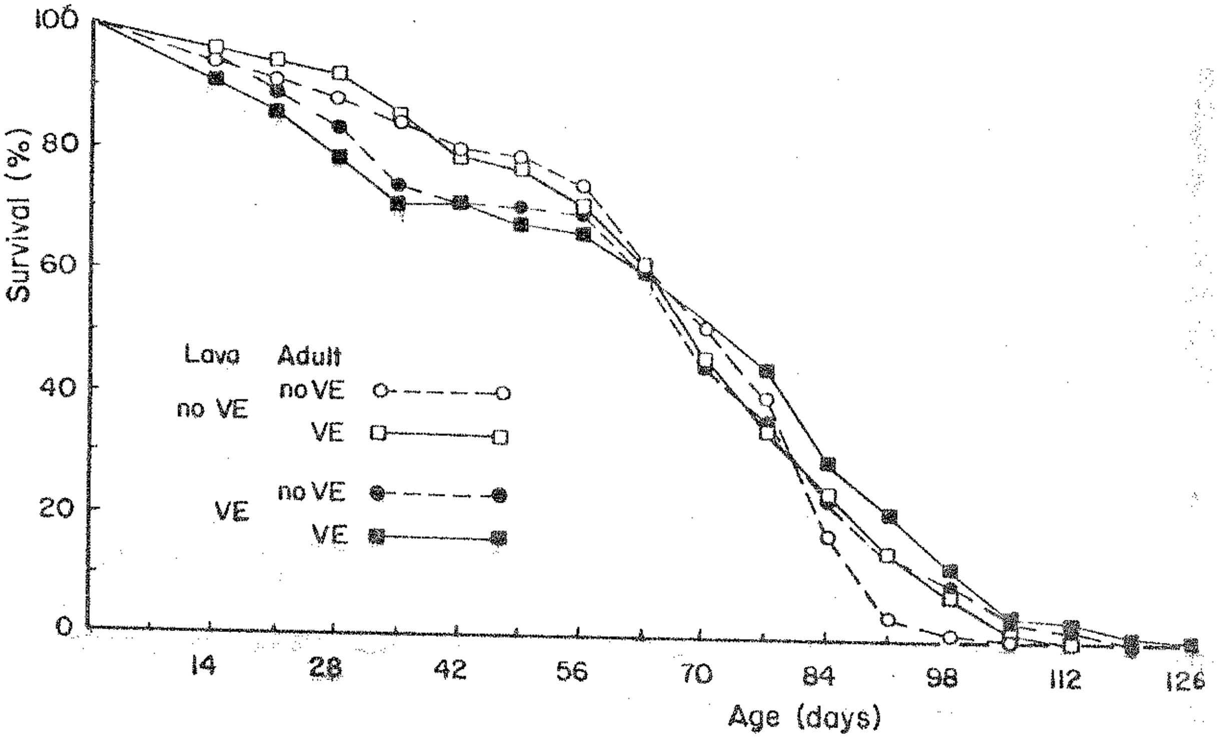

Fig. 1. Survival curves of _Tribolium castaneum_ as a result of feeding larvae and adults on 1% VE.

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*Effect of Sex and VE on Longevity of _T. audax_

The production and accumulation of free radicals and their deleterious effects have been implicated in speeding up the ageing process. Several investigators have suggested that α-tocopherol (VE) is a free-radical-reaction inhibitor (or antioxidant). In order to investigate the possible protective effect against DNA damage and membrane instability, VE (1% by weight) was added to the standard diet of _Tribolium_ (95% whole wheat flour and 5% dried yeast).

The experimental conditions were: 1g medium/_T. audax_ beetle (one day old), 10 (same sex) beetles/vial and incubated at 35°C and 70% relative humidity. Number of dead adults was recorded weekly.

The adults are presented in Table 1 and Fig. 1. There was no effect of VE on the mean longevity of the males. However, a possible beneficial effect of VE between age 84 and 119 days is indicated from Fig. 1. This effect of VE on older beetles was also observed for _T. castaneum_ in the following note in this issue of TIB.

The addition of VE to the diet resulted in a significant ($P < 0.001$) decrease in the mean longevity of the females. On the average, females lived longer than males ($P < 0.01$) without VE, but when the medium was supplemented with VE the males outlived the females ($P < 0.05$).

Maximum longevity of both sexes was not affected by the addition of VE (Table 1). Also, male homosexual behavior was negligible as indicated from Fig. 1.

Table 1. Mean and maximum longevity of males and females _Tribolium audax_ as influenced by the addition of VE

Sex	N	Mean ± SE (days)	C.V. (%)	Max. longevity (days)
		VE		
♀♀	60	73.86±3.37	35.4	126
♂♂	60	83.65±3.69	34.22	147
		No VE		
♀♀	40	93.98±4.27	28.75	126
♂♂	40	79.69±4.35	34.61	147

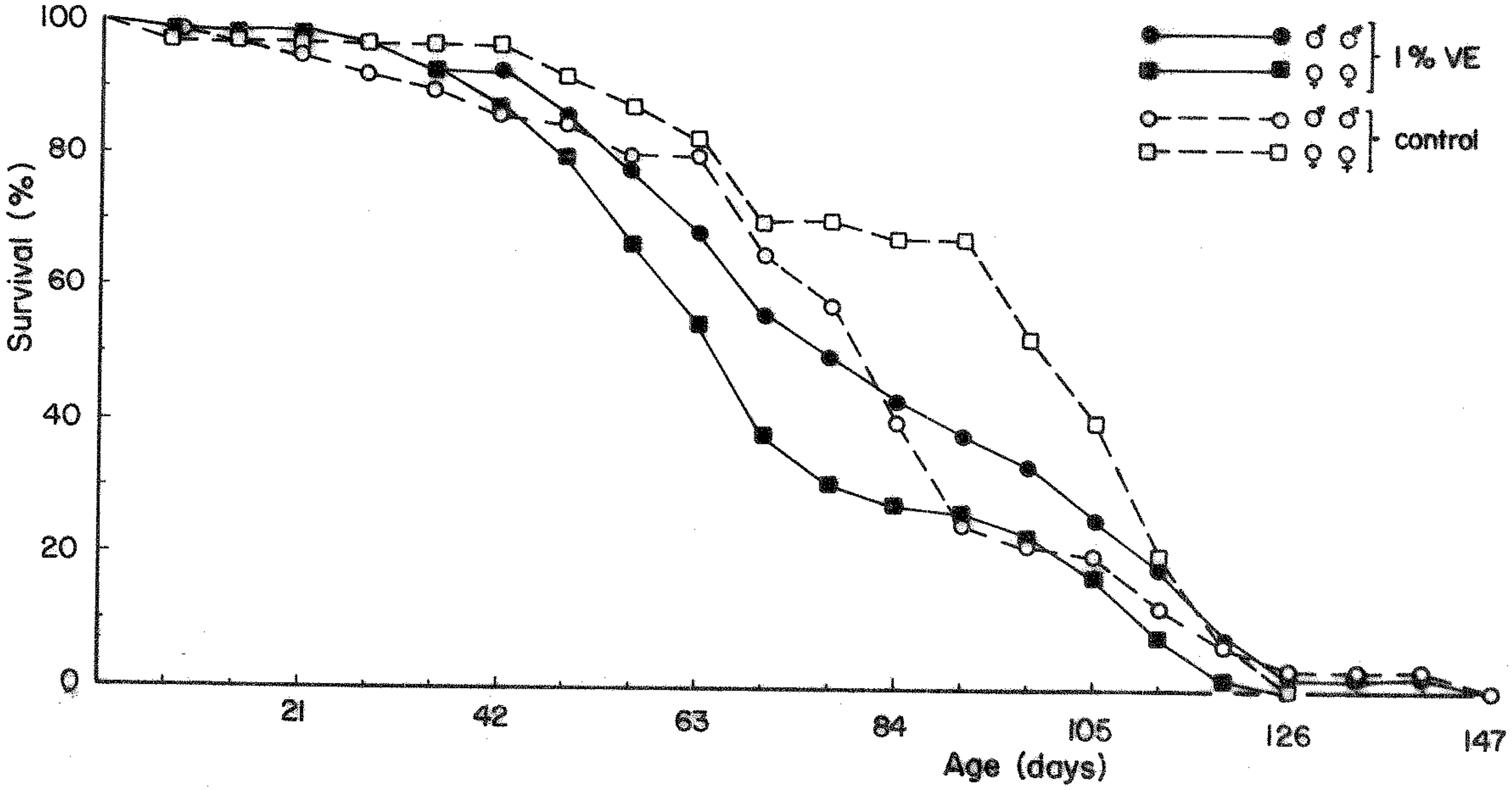

Fig. 1. Survival curves of males and females of Tribolium audax with and without the addition of 1% VE to the medium.

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*Effects of temperature, genotype and sex on variability of longevity in *Tribolium castaneum*

The effects of pre-imaginal temperature on the mean longevity of five strains of *T. castaneum* have been studied by Soliman and Lints (1982). All the main effects (temperature, sex and strain) and their first order interactions were significant and are summarized in Fig. 1 and Tables 1 and 2.

The coefficient of variability for both sexes of each strain raised at each preimaginal temperature is shown in Table 3. The analysis of variance on the squared values of the coefficient of variation (Table 4) shows a significant difference between the variabilities of the sexes ($P = 0.015$). Males have higher variability than females, a similar result to that of Mertz *et al*. (1965). Variability between the strains is not significant ($P = 0.087$) except for the two extreme strains (Duncan's multiple range test $P = 0.05$). The order of variability is Pygmy < Chicago < Large < Small < Viscosa.

Although the differences between the variabilities of the different temperatures are not significant, the order of variability is 25 < 30 < 25-30 < 35°C indicating increasing variability with increasing temperature. This could be a result of increasing developmental stability at lower temperatures.

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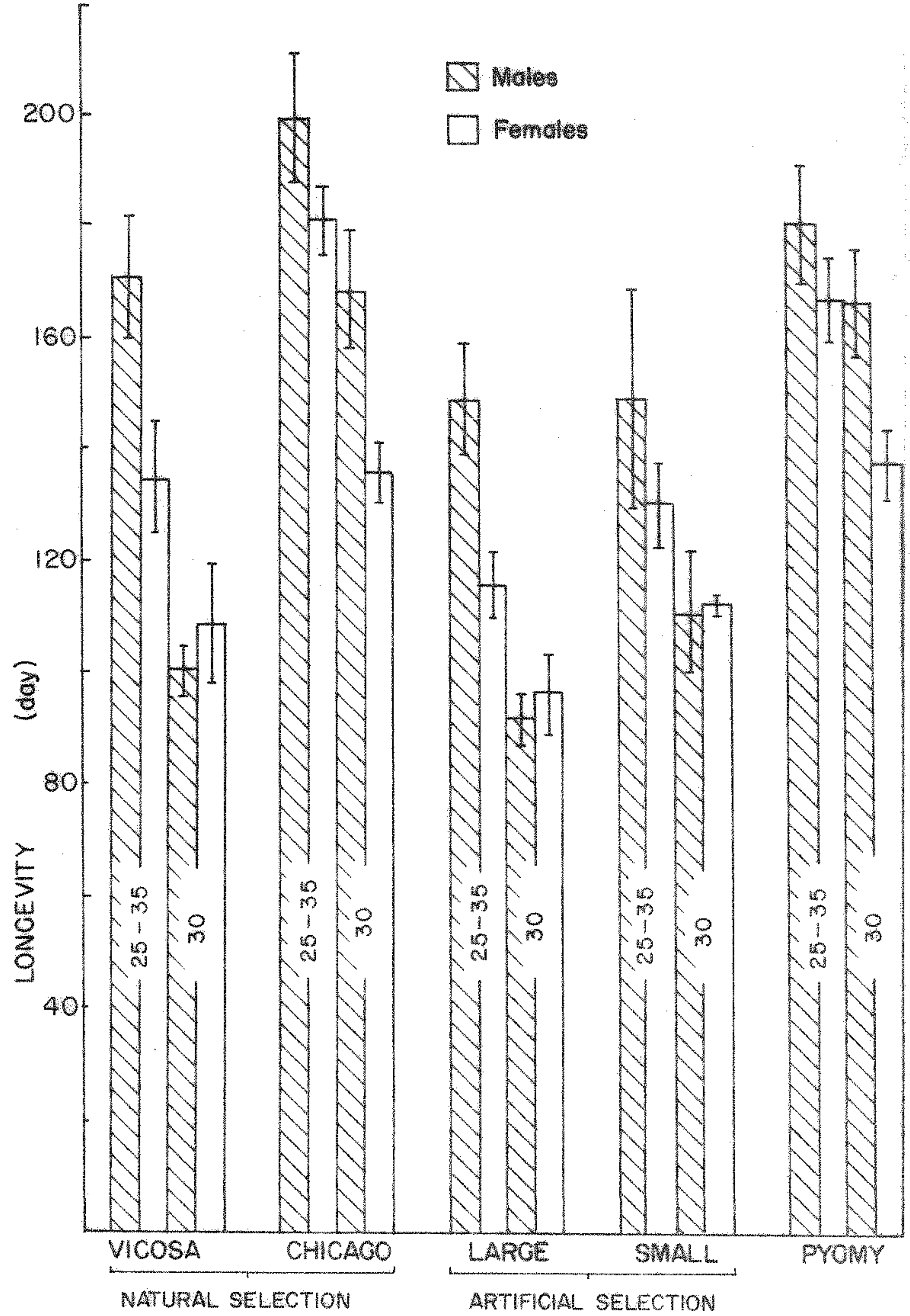

Fig. I. Comparison of mean longevity of five strains of *Tribolium castaneum* at constant 30°C and alternating 25-35°C with mean temperature of 30°C.

Table 1. Duncan's Multiple Range Test for the interaction between the mean adult longevity of five strains of *Tribolium castaneum* and four preimaginal temperatures.

	Temperature (°C)			
Strain	25	30	25-35	35
Vicosa	144.03 cg	104.67 bf	153.02 dg	100.81 bf
Chicago	167.39 dh	152.12 dg	190.25 ek	123.57 cfj
Large	135.97 cg	94.03 b	131.99 cgj	63.31 a
Small	132.20 cgj	111.36 bfj	139.63 cg	65.23 a
Pygmy	183.24 ehk	151.94 dg	173.55 dhk	112.28 bfj

Any two means with the same letter are not significantly different from each other at P=0.05.

Table 2. Duncan's Multiple Range Test for the interaction between the mean adult longevity of the two sexes and five strains of *Tribolium castaneum*.

	Sex	
Strain	Male	Female
Vicosa	130.58 bd	120.68 bc
Chicago	172.51 e	144.15 d
Large	110.69 ac	101.96 a
Small	113.86 ac	110.35 ac
Pygmy	165.25 e	145.26 d

Any two means with the same letter are not significantly different from each other at $P=0.05$.

Table 3. Coefficient of variability of five strains of *Tribolium castaneum* at four temperatures.

		Temperature (°C)			
Strain		25	30	25-35	35
Vicosa	♂♂	44.40	24.50	34.27	54.24
	♀♀	25.74	40.23	29.93	37.63
Chicago	♂♂	17.21	31.37	28.54	36.14
	♀♀	21.79	21.87	17.54	20.88
Large	♂♂	20.72	25.25	32.95	45.20
	♀♀	12.09	29.98	27.71	23.23
Small	♂♂	34.39	47.48	48.67	30.64
	♀♀	27.13	9.09	28.91	34.84
Pygmy	♂♂	19.71	25.69	27.84	37.68
	♀♀	17.63	20.52	19.26	23.03

Table 4. Analysis of variance of the Coefficient of Variation (CV^2)[1] of longevity.

Source of Variation	Degrees of Freedom	Mean Square	*F*	*P*
Sex	1	3,100,262	8.056	0.015
Strain	4	1,011,131	2.627	0.087
Temperature	3	664,201	1.726	0.215
Sex x Strain	4	110,730	0.288	0.880
Strain x Temperature	12	155,454	0.404	0.935
Sex x Temperature	3	169,980	0.442	0.727
Error	12	384,837		

[1] after Lewontin (1966)

Notes-Research

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* Selection for 21-day pupal weight in *Tribolium castaneum**

Introduction:

Under similar environmental conditions, the developmental rate of *Tribolium castaneum* can vary, so that pupation time may range between 15 and 21 days or more. Yamada (1975) found that pupa lose weight from the time of pupation to 20 days. Thus, pupal weight at a fixed age may be a function of developmental rate, as well as pupation weight. The objective of this study was to investigate the relationships among pupation time, weight at pupation and pupal weight at 21 days.

Materials and Methods:

T. castaneum from a wild-type stock originating at Purdue University were used in the study. The stock has been maintained at the University of Guelph since 1960, using a rotational crossbreeding system to minimize inbreeding.

One hundred pairs of parents from the base population were mated and eggs were collected over three consecutive periods (8 am to 4 pm, 4 pm to 12 pm, 12 pm to 8 am). Matings and egg collections were staggered over a 5-day period, so that 20 pairs of parents were mated on each day. Beginning on the fourteenth day after egg laying, each vial was checked daily for pupa. Any pupa were removed, sexed, identified and weighed to the nearest microgram. On the twenty-first day all pupa were reweighed. Individuals that were larvae or adults at this time were not weighed.

Two weeks after the 21-day weighings, the ten heaviest males and females, based on 21-day pupal weight, were mated together, as were the ten lightest males and females, producing a new set of twenty single pair matings for each block. Full-sib matings were avoided. Egg collections were made, and pupa weights recorded in a manner similar to that used in the previous generation.

Five weeks after the 21-day pupal weight measurements on the first generation, a second set of offspring were generated from the first generation. Sixty pairs of parents were chosen randomly and mated in 3 blocks of 20 pairs each. Egg collections and weighing procedures were identical to the first generation.

Throughout the study, all eggs, larva and pupa were maintained in incubators at 32°C and 70% humidity on a medium of 95% whole wheat flour and 5% dried brewers yeast. Mechanical problems caused the temperatures of the incubators to increase to 33°C part-way through the study.

Analyses:

Heritabilities for time of pupation, weight at pupation and 21-day pupal weight were determined from parent-offspring regressions. Only midparent-offspring regressions were meaningful for the offspring of parents selected on the basis of 21-day pupal weight. Sire-son and dam-daughter regressions were also estimated for the offspring of randomly selected parents. Regressions were estimated in two ways because the number of offspring per parent was not constant; mean offspring values were regressed on parent records and individual offspring records were regressed on parent records.

Significance of sex effects and effects of selection were determined from appropriate F-tests derived from analyses of variance on the three data sets. Models used included terms for sex, time of egg collection, block, and in the case of the data for the offspring of selected parents, a term for the direction of selection.

Genetic correlations were calculated from regression coefficients as follows:

$$r_G^2 = \frac{b_{x_o y_p} \cdot b_{y_o x_p}}{b_{x_o x_p} \cdot b_{y_o y_p}},$$

where $b_{x_o y_p}$ represents the regression of trait X measured in the offspring on trait Y measured in the parents, etc. Approximate standard errors were calculated according to the method given by Falconer (1960).

Results and Discussion:

Heritability estimates for time of pupation were generally small and not significantly different from zero (Table 1 and Table 2). In contrast, Englert and Bell (1970) reported realized heritabilities for developmental rate of 0.109 to 0.321. The discrepancy may reflect the reduced precision with which pupation time was identified in this study.

Heritability estimates for weight at time of pupation and 21-day pupal weight were between 0.19 and 0.34 with the exception of the sire-son regression for weight at pupation (Tables 1 and 2). Meyer and Enfield found heritabilities of about 0.2 to 0.3 for 21-day pupal weights. Jui and Friars (1974) also reported heritabilities of 0.3 for 21-day pupal weight.

In this study, the realized heritabilities for 21-day pupal weight were 0.13 and 0.20 for males and females, respectively in the upward direction, and 0.60 and 0.57, respectively, in the downward direction. Meyer and Enfield (1975) and McLeod (1983) also found that realized heritabilities were lower in the upward direction compared with the downward direction. However, Jui and Friars (1974) found higher realized heritabilities in the upward direction than for the downward direction for two of their populations with the least inbreeding. Consequently, no generatizations about realized heritabilities are possible.

Pupation was spread over several days for each population monitored, but was shifted forward for the two offspring populations (Figure 1), probably as a result of the slight increase in temperatures during the study. Pupation time was not significantly different (P>.05) in the two sexes. In all three populations, weight at pupation was lowest for individuals pupating 3 days after the earliest pupation time, and rose to a maximum for individuals pupating 5 or 6 days after the initiation of pupation (Figure 1). A similar pattern was reported by Yamada (1975) although the time scale in his study was somewhat compressed.

Genetic correlations between time of pupation and either of the measures of weight ranged between 0.12 and 2.53 (Table 3), suggesting that selection for either weight measure may also increase the time to pupation. Yamada (1975) suggested that selection of the heaviest pupa at a fixed age, such as 20 days, should increase the time to pupation, since earlier pupating individuals are lighter at the time of pupation and should experience a greater weight loss to 20 days. However, in this study, time of pupation was not significantly (P<.05) affected by selection for 21-day pupal weight. In fact, the average pupation time was lower in the high line than in the low line (17.22 vs 17.27 days for females, and 17.10 vs 17.45 days for males). Perhaps the estimate of time of pupation was too crude to detect any correalted response to selection for weight at 21 days. The apriori estimates of genetic correlations are subject to large sampling errors that results, in part from the small number of categories for time of pupation.

Genetic correlations between weight at pupation and weight at 21 days were not subject to the same problems as correlations involving time of pupation. The estimates were around 1.0 and were reflected by the positive correlated response to selection for 21 day weight. Weights at pupation were significantly higher (P<.05) for the offspring of parents selected for high 21-day weight than for offspring in the low line (2450 ugm vs 2233 ugm for females, and 2315 ugm vs 2089 ugm for males).

In conclusion, response to selection for 21 day pupal weight was primarily in changes of weight at pupation, rather than alterations in the developmental rate. However, this study indicates the need for more frequent checks for pupation in studies involving pupation rate.

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Table 1. Heritability estimates for pupa traits based on midparent-offspring regressions for offspring of selected parents.

	Trait		
	Pupation time[a]	Weight at pupation[a]	21-day Pupa weight[b]
Individual Records	-0.05 (0.03)[c]	0.29 (.01)	0.31 (.02)
Mean Records	0.01 (.07)	0.34 (.03)	0.31 (.03)

[a] Regressions were based on all offspring measured, including those individuals that had emerged by 21 days.

[b] Regressions were based only on individuals that were still pupa at 21 days.

[c] Standard errors are in parentheses.

Table 2. Heritability estimates for pupa traits for offspring of randomly-selected parents, based on individual records regressed on parent records.

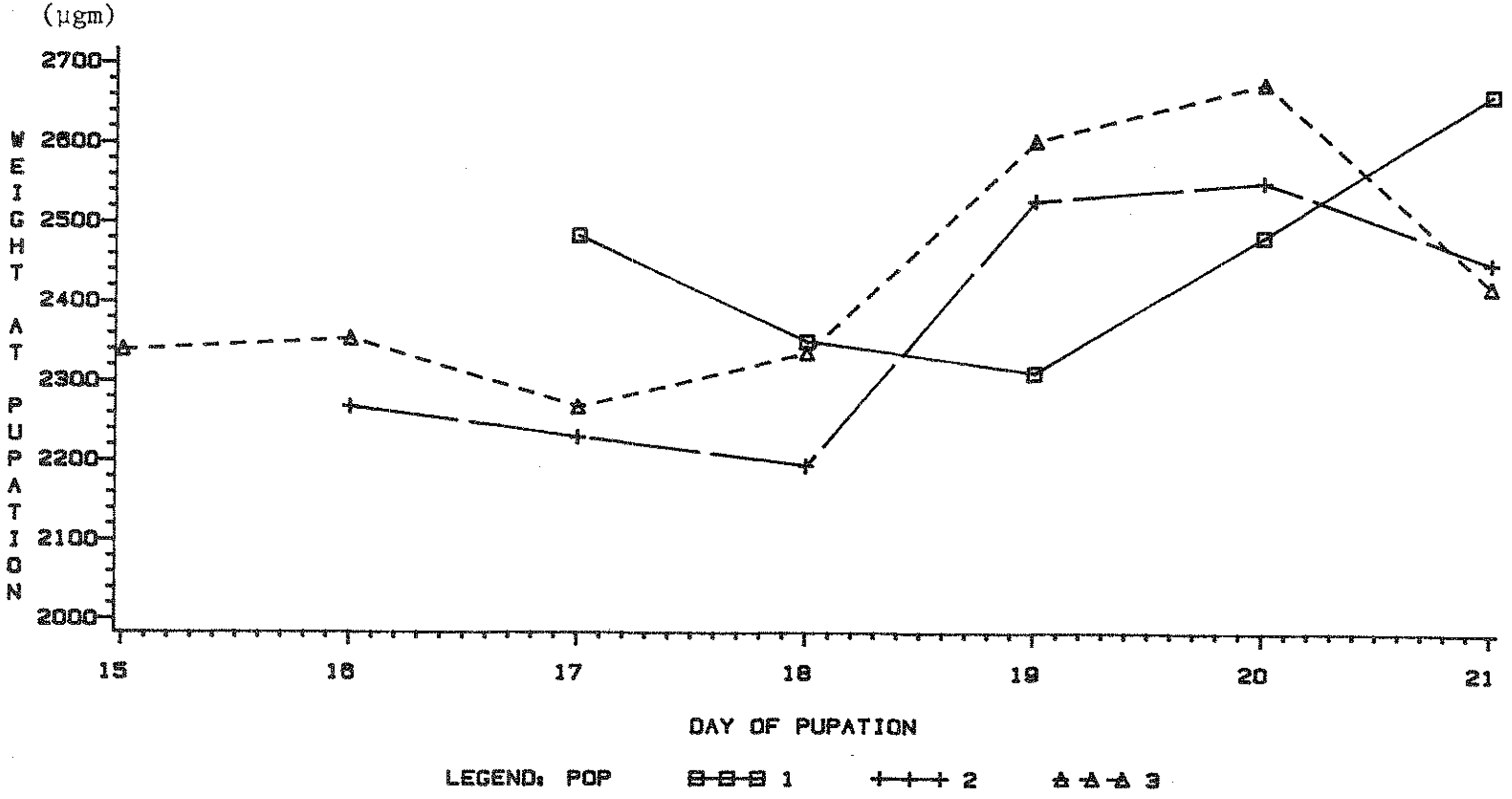
	Trait	
	Pupation Time	Weight at Pupation
Sire-son	-0.10 (.08)	-0.03 (.11)
Dam-daughter	0.15 (.11)	0.20 (.06)
Mid parent-offspring	0.00 (.00)	0.19 (.05)

Table 3. Genetic correlations between pupal traits based on midparent-offspring regressions for the offspring of selected parents.

		Trait	
	Trait	Weight at Pupation	Weight at 21 days
Individual Records	Time of pupation	1.30 (.08)[a]	1.52 (.86)
	Weight at pupation	-	1.00 (.0001)
Mean Records	Time of pupation	0.12 (.25)	2.53 (4.06)
	Weight at pupation	-	1.00 (.0001)

[a] Standard errors are given in parentheses

FIGURE 1: WEIGHT AT PUPATION AS A FUNCTION OF TIME OF PUPATION.



1=PARENTS, 2=OFFSPRING—SELECTED PARENTS,
3=OFFSPRING—RANDOMLY MATED PARENTS

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*Life history and new wild host legume of Callosobruchus chinensis (L.)

In Japan the most common and destructive pest of the azuki bean, Phaseolus angularis Wight, is the azuki bean weevil, Callosobruchus chinensis (L.). The weevils attack the bean in the field. The incidence of the weevils at the Natsu-azuki (the azuki cultivated in summer) field in north Okayama is recorded from the middle of July to mid-September. The weevils lay their eggs on the growing pods of the azuki between the end of July and the end of August. The incidence of the weevils at the Aki-azuki (the azuki cultivated in autumn) field is found from the middle of August and is continued for about three months. The weevils lay their eggs on the pods between mid-September and mid-October. In consequence fifteen per cent of beans are infested by the weevils before harvest. The weevils reproduce in the stored beans and under favorable conditions there may be as many as five or six generations in a year.

So far no wild host legume for the azuki bean weevil has been recorded in Japan. Dr. M. Muramatsu, Plant Cytogenetics and Breeding, College of Agriculture, Okayama University, collected the seeds of Phaseolus trilobatus Schreb in the suburbs of Kōchi-city on the 15th of October in 1982 and stored the seeds in the laboratory. Next year many azuki weevils emerged from the seeds.

To determine the weevil host range in the field the ripe seeds of many kinds of wild legumes were collected in Okayama and the rearing experiments on these seeds were carried out in the laboratory. As the result of the experiments it was found that the weevil feeds and develops on the following four wild legumes: Amphicarpala edgeworthii Benth; Dunbaria villosa (Thunb.); Phaseolus trilobatus Schreb; and Pueraria lohata (Willd).

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