TRIBOLIUM

INFORMATION BULLETIN

20

March 1977

Material contributed by workers on Tribolium and other Coleoptera

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SCHOOL OF NATURAL SCIENCES, CALIFORNIA STATE COLLEGE

SAN BERNARDINO, CALIFORNIA

TRIBOLIUM INFORMATION BULLETIN

Number 20

Editor: A. Sokoloff, School of Natural Sciences

California State College, San Bernardino

California

1977

NOTE

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TRIBOLIUM INFORMATION BULLETIN

Number 20

March, 1977

Foreword

I am indebted to Tod Coleman, Jim Gooch, Jim Schumacher and Carol Smith for assistance in the preparation of Tribolium Information Bulletin 20.

ANNOUNCEMENTS

The notes of the following authors published in TIB-19 may be quoted without contacting them, even though the notes were not asterisked:

Albers, J. and A. Sokoloff,	pp.84-85
Faustini, D.	86-89
Jillson, D.	90-94
Koruniç, Z. and A. Sokoloff	95-96
Prus, T.	97-104
Ryder, W.D., F.L. Waterhouse and R. McHugh	105-109
Sinha, R.N.	110
Sokoloff, A.	111-113
Soliman, M.H.	113-119
Sverdlov, E., D. Wool, and E. Cohen	120-125
Wright, V. R., E. de las Casas, and P.K. Harein	126-128
Yoshida, T.	128-129
Keim, B. H.	130-131
Taylor, C. D.	132
Vazquez, A. W.	133-143

Dr. V. K. Taneja, National Dairy Research Institute, Karnal (Haryana) India, is establishing a laboratory devoted to research on *Tribolium* genetics. He would appreciate receiving reprints from other workers on *Tribolium*, particularly those dealing with quantitative genetics.

The Biology of Tribolium with special reference to genetic aspects, Volume 3 by A. Sokoloff, Clarendon Press, Oxford, England, will appear in 1977. (Vol. 1, 1972, and Vol. 2, 1975 are still available)

Ms Ora Lee Matthews McCoy Watts
Department of Biology
University of Chicago
Chicago, Illinois 60637

Tribolium Supreme

O Tribolium Supreme!

Watch over and preserve our mein.

We need love and care, not degradation,

to help our mentors on standard deviation.

Our insect society is free of capitalism,

but we're still working on egg cannibalism.

Please keep us fertile , lay eggs in our midst.

Please, dear Supreme, teach us to coexist!

We will close at this hour

but keep praying for Flour Power!

Amen

Ms Ora Lee Matthews McCoy Watts
Department of Biology
University of Chicago
Chicago, Illinois 60637

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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 request 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

BALTIMORE, MARYLAND
THE JOHN HOPKINS UNIVERSITY
SCHOOL OF HYGIENE AND PUBLIC HEALTH

Tribolium confusum: bI and bIV
Tribolium castaneum: cI and cIV-a

Michael Nathanson

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.)

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.)

CARBONDALE, ILLINOIS
SOUTHERN ILLINOIS UNIVERSITY,
DEPARTMENT OF ZOOLOGY

I. Base populations

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

II. Mutant

1. antennapedia (ap)
2. black b via San Bernardino
3. black Brazil (b) via San Bernardino
4. black Chicago (b) via San Bernardino
5. black ex-NASA (b) via San Bernardino
6. black McGill (b) via San Bernardino
7. paddle (pd)
8. pearl (p)
9. pygmy (py)
10. pygmy, paddle, spotted (py pd sp)
11. pygmy, red, paddle (py r pd)
12. ruby, light ocular diaphragm (rb lod)
13. Short antenna (Sa)
14. spotted (sp)
15. squint (sq)

III. Selected populations

Early: a population subjected to selection for a short larval period. Origin in Purdue Wild Foundation.

Late: a population subjected to selection for a long larval period. Origin in Purdue Wild Foundation.

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

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

Stock Lists

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. bI (an inbred strain derived from Chicago)
3. bII (" " " " " ")
4. bIII (" " " " " ")
5. bIV (" " " " " ")

B. *Tribolium confusum*
1. "Chicago"
2. cI (an inbred strain derived from Chicago)
3. cII (" " " " " ")
4. cIII (" " " " " ")
5. cIV (" " " " " ")

C. *Latheticus oryzae*

II. Mutants

A. *Tribolium castaneum*
1. Chicago black

B. *Tribolium confusum*
1. Ebony
2. McGill Black

M. Wade.

COLLEGE PARK, MARYLAND
UNIVERSITY OF MARYLAND,
DEPARTMENT OF ZOOLOGY

I. Wild type strains

A. *Tribolium castaneum*

Stock Lists

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

Inbred strains.

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

B. Tribolium confusum

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

Inbred strains

2. CFI-11 — Berkeley, Calif., 1965

II. Mutant

1. T. confusum — Berkeley, Calif., 1959

ebony ($e^{L\&H}$)

(Ed.)

CORAL GABLES, FLORIDA
UNIVERSITY OF MIAMI,
DEPARTMENT OF BIOLOGY

I. Wild type strains

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

II. Mutant

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

(Ed.)

Stock Lists

CORVALLIS, OREGON
OREGON STATE UNIVERSITY,
DEPARTMENT OF ZOOLOGY

I. Wild type strains

A. *Tribolium castaneum*

1. Oregon — Urbana, 1966

B. *Tribolium confusum*

1. Oregon — Urbana, 1966

II. Mutant strains

A. *Tribolium castaneum*

1. *sa* - 2 (+l*s*) — Berkeley, 1966
2. *dve*, *pd* — Berkeley, 1967
3. *b*, *mc*, *p* — Berkeley, 1966
4. *Sa*$_D$ - 2, *s* — Berkeley, 1967
5. *ap*, *s* — Berkeley, 1966
6. *ser*, *py*, *r* — Berkeley, 1967
7. blob (*bb*) — Urbana, 1968
8. *aa*, *mc*, *j* — Corvallis, 1974
9. *r*^{U}, *s* — Berkeley, 1967
10. weird eggs (*wd*), *s* — Corvallis, 1972
11. nude eggs (*nd*), *s* — Corvallis, 1973

B. *Tribolium confusum*

1. *msg*^{AS} — Berkeley, 1967
2. *dj*/t — Berkeley, 1966
3. *thu* — Berkeley, 1966
4. *b*^{U} — Urbana, 1967
5. *thu*^{U} — Berkeley, 1966
6. *ble*^{U} — Urbana, 1967
7. *r*^{U} — Urbana, 1968
8. *dep* — Urbana, 1969
9. *b*, *spl* — San Bernardino, 1973
10. *e*^{c} — Corvallis, 1970

Stock Lists

DAVIS, CALIFORNIA
UNIVERSITY OF CALIFORNIA, DEPARTMENT OF ANIMAL HUSBANDRY

I. Wild type strains (*T. castaneum*)

BC1	*T. castaneum*	Berkeley, 1967
DCI	*T. castaneum*	Davis, 1969

II. Mutant strains

BC2 *T. castaneum*, sooty — Berkeley, 1967
BC114 *T. castaneum*, sooty, inbred from strain 14a — Berkeley, 1967
SCp *T. castaneum*, pearl eye — San Bernardino, 1969

III. Selected strains (all derived from BC1)

6-14 BC1-2, lines 1-8, 10, selected for large 21-day pupa for 23-36 generations, currently in generation 95.
15 BC1-2, line 9 selected for 58 generations; average 21-day pupa weight 6 mg, currently in generation 95.
16-18 BC1-2L, lines 1-3, selected for small 21-day pupa for 13 generations, currently in generation 90.
19-20 BC1-2, lines 1C, 2C, random selected control
21 BC1-2L, line 1C, random selected control

IV. Wild type strains (*T. confusum*)

BF1	*T. confusum*	Berkeley, 1967
DF1	*T. confusum*	Davis, 1967
DF3	*T. confusum*	Davis, 1969

V. Mutant strains

SFp (pearl eyes) — San Bernardino, 1969

J. Medrano

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)

H. E. Erdman

Stock Lists

DAVIS, CALIFORNIA
UNIVERSITY OF CALIFORNIA, DEPARTMENT OF ANIMAL HUSBANDRY

I. Wild type strains (*T. castaneum*)

BC1 *T. castaneum* Berkeley, 1967
DCI *T. castaneum* Davis, 1969

II. Mutant strains

BC2 *T. castaneum*, sooty Berkeley, 1967
BC114 *T. castaneum*, sooty, inbred from strain 14a Berkeley, 1967
SCp *T. castaneum*, pearl eye San Bernardino, 1969

III. Selected strains (all derived from BC1)

6-14 BC1-2, lines 1-8, 10, selected for large 21-day pupa for 23-36 generations, currently in generation 95.
15 BC1-2, line 9 selected for 58 generations; average 21-day pupa weight 6 mg, currently in generation 95.
16-18 BC1-2L, lines 1-3, selected for small 21-day pupa for 13 generations, currently in generation 90.
19-20 BC1-2, lines 1C, 2C, random selected control
21 BC1-2L, line 1C, random selected control

IV. Wild type strains (*T. confusum*)

BF1 *T. confusum* Berkeley, 1967
DF1 *T. confusum* Davis, 1967
DF3 *T. confusum* Davis, 1969

V. Mutant strains

SFp (pearl eyes) San Bernardino, 1969

J. Medrano

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)

H. E. Erdman

Stock lists

EAST LANSING, MICHIGAN
MICHIGAN STATE UNIVERSITY, BIOLOGY RESEARCH CENTER

Tribolium castaneum

I. Wild type strain

1. McGill — Chicago via Berkeley, 1964

II. Mutant strains

1. paddle — Chicago via Berkeley,
2. spotted — Berkeley,

(Ed.)

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.)

HAMPTON, IOWA
FARMERS HYBRID COMPANY

I. Wild type strain

1. Chicago — via Berkeley, 1965

II. Mutant strains

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

(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)	

A. A. Dewees

Stock Lists

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.)

Stock Lists

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.

Stock Lists

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

Tribolium castaneum

Purdue Foundation
Black Foundation via Purdue
Unsaturated fatty acid sensitive (cos) via Purdue

Tribolium confusum

Chicago Park, 1955
black via San Bernardino
pearl via San Bernardino

Tribolium madens via San Bernardino

Tribolium brevicornis via San Bernardino

Jillson, D. E.

LAFAYETTE, INDIANA 47907
PURDUE UNIVERSITY
ANIMAL SCIENCES DEPARTMENT

Tribolium castaneum

I. Wild Type strains

A. Base populations for quantitative genetics studies:

1. Foundation + - wild type population synthesized in 1954 1954 from a broad genetic base and maintained with no artificial selection and minimum of inbreeding.

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

3. Foundation b - synthesized in 1959 and marked with black (b), unrelated to Foundation +, broad genetic base, no selection, minimum inbreeding.

4. Foundation p - synthesized in 1959 and marked with pearl (p), unrelated to Foundations + and b, broad genetic base, no selection, minimum inbreeding.

Stock Lists

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

Jillson, D. E.

LAFAYETTE, INDIANA 47907
PURDUE UNIVERSITY
ANIMAL SCIENCES DEPARTMENT

Tribolium castaneum

I. Wild Type strains

A. Base populations for quantitative genetics studies:

1. Foundation + - wild type population synthesized in 1954 1954 from a broad genetic base and maintained with no artificial selection and minimum of inbreeding.

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

3. Foundation *b* - synthesized in 1959 and marked with black (*b*), unrelated to Foundation +, broad genetic base, no selection, minimum inbreeding.

4. Foundation *p* - synthesized in 1959 and marked with pearl (*p*), unrelated to Foundations + and *b*, broad genetic base, no selection, minimum inbreeding.

B. Laboratory stocks

5.	Arkansas	Fayetteville, 1954
6.	Brazil	Vicosa, 1958
7.	Capetown	South Africa, 1958
8.	Chicago	University of Chicago, 1954
9.	Carbondale	Illinois, 1958
10.	Columbia	South America, 1958
11.	Florida	Gainesville, 1958
12.	Georgia	Tipton, 1954
13.	Japan	Kyoto, 1958
14.	McGill	Montreal, Canada, 1958
15.	Minnesota	Minneapolis, 1958
16.	Texas	College Station, 1954
17.	Virginia	Blacksburg, 1954

II. Mutant strains

18.	antennapedia, ap	Purdue Sa Stock, 1962
19.	black, b^D	Carbondale, Illinois, 1964
20.	chestnut, c	Purdue + Foundation, 1961
21.	cordovan, b^{cd}	Purdue + Foundation, 1962
22.	corn oil sensitive, cos	Purdue + Foundation, 1966
23.	ivory, i	Purdue + Foundation, 1961
24.	jet, j^E	Purdue + Foundation, 1961
25.	maroon m	Purdue + Foundation, 1962
26.	paddle, pd	Chicago, 1955
27.	peach, r^{pn}	Carbondale, Illinois, 1964
28.	pearl, p^S	Fla. Inbred, (Purdue), 1963
29.	pygmy, py	Chazy, New York, 1960
30.	red, r^s	Purdue + Foundation, 1964
31.	ring, rg	Purdue + Foundation, 1961
32.	rose, rs	Purdue + Foundation,
33.	ruby, rb	Carbondale, Illinois, 1964
34.	Short antenna, Sa	Purdue + Foundation, 1960
35.	short antenna, sa_3	Purdue + Foundation, 1966
36.	sooty, s	Purdue + Foundation, 1956
37.	squint, sq	Chazy, New York, 1960
38.	wine r^w	Purdue + Foundation, 1963

(Ed.)

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.)

Stock Lists

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. Wild strains

1.	4 strains collected locally	Kentucky, 1970

III. Inbred Lines

1.	CSI-5	Berkeley via Minnesota
2.	CSI-10	Berkeley via Minnesota
3.	E-1	Edinburgh via Minnesota
4.	E-2	Edinburgh via Minnesota
5-9.	Five Inbred lines derived from different wild strains	Purdue

IV. Selected Strains

Several strains which have been selected for increased 21 day pupa weight.

R. Goodwill

Stock Lists

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 w ll 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.

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

I. Huber

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.

R. B. Mills

Stock Lists

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.

E. L. Lange

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.

Stock Lists

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.)

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 pusillus - 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.)

Stock Lists

NEW YORK CITY 11367
QUEENS COLLEGE, DEPARTMENT OF BIOLOGY

Tribolium castaneum

Wild Type — Purdue Foundation +

R.E. Calhoun

NORMAN, OKLAHOMA
UNIVERSITY OF OKLAHOMA, DEPARTMENT OF ZOOLOGY

Coleoptera

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

F.J. Sonleitner

NORTON, MASSACHUSETTS 02766
WHEATON COLLEGE, DEPARTMENT OF BIOLOGY

Tribolium confusum

Wild Type (Chicago)

Tribolium castaneum

Black (Chicago)

John C. Kricher

Stock Lists

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.)

Stock Lists

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

Roger Akre

RICHLAND, WASHINGTON
BATTELLE-NORTHWEST, BIOLOGY DEPARTMENT

I. Wild type strains

1. *Tribolium confusum* Duval (Chicago Standard) — Univ. of Chicago
2. *Tribolium castaneum* Herbst (Brazil cI) — 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*
1. Apt-Knp
4. rb - body color mutation chestnut in color
5. +/+
3. rb
7. rb, Apt-Knp

III. *Tribolium brevicornis*

spl		
wild	Riverside	1965
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. Pil +/+		(?)
12. Sacramento +/+		1961

IV. T. castaneum (continued)

14. Texas $^{+}/+$		1958
16. Veracruz $^{+}/+$	Mexico	1963
17. Virginia $^{+}/+$		1958
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

Inbred Stock

	Generation
CS1-A6	25
CS1-A10	35

Mutant

1. Sex-linked	Chazy	1959
26. dve - divergent elytra		
28. ma^{D} - miniature appendaged	Bell	1967
30. pd - paddle	Park	1955
32. pok - pokey	Berkeley	1962
34. pte - platinum eye	Berkeley	1965
36. py - pygmy	Chazy	1959
38. r - red	Chazy	
39. r^{D} - red	Berkeley	
40. r^{HD} - red	Berkeley	
41. r^{S} (Bell) - red		
42. r^{PH} - red		
47. te-1 - truncated elytra		
51. dve - divergent elytra		
54. pd, r - I. paddle, red		
55. py, r - pygmy, red		
57. py, M^{r}, r pygmy, red, red modifier		
59. r, sp red spotted		
61. pd. pte - paddle, platinum eye		
2. Autosomal		
63. p (from New York) II. pearl		1976
64. p^{PK} II. pearl	Chazy	1959
65. p II. pearl	Park	1955
66. p^{s} II. pearl		
68. Malta p II. pearl		
70. pg II. pegleg	Chazy	1959
72. p. pg II. pearl pegleg		
76. au III. black		
78. b^{n} III. black		
81. b^{S-1} — Brazil, p - black, pearl		
82. b — Chicago - black		1955

IV. T. castaneum (continued)

14. Texas $^+/+$		1958
16. Veracruz $^+/+$	Mexico	1963
17. Virginia $^+/+$		1958
19. Syn $^+/+$ (1) has $\bar{s}$	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

Inbred Stock

	Generation
CS1-A6	25
CS1-A10	35

Mutant

1. Sex-linked	Chazy	1959
26. dve - divergent elytra		
28. ma^D - miniature appendaged	Bell	1967
30. pd - paddle	Park	1955
32. pok - pokey	Berkeley	1962
34. pte - platinum eye	Berkeley	1965
36. py - pygmy	Chazy	1959
38. r - red	Chazy	
39. r^D - red	Berkeley	
40. r^{HD} - red	Berkeley	
41. r^S (Bell) - red		
42. r^{PH} - red		
47. te-1 - truncated elytra		
51. dve - divergent elytra		
54. pd, r - I. paddle, red		
55. py, r - pygmy, red		
57. py, M^r, r pygmy, red, red modifier		
59. r, sp red spotted		
61. pd. pte - paddle, platinum eye		
2. Autosomal		
63. p (from New York) II. pearl		1976
64. p^{PK} II. pearl	Chazy	1959
65. p II. pearl	Park	1955
66. p^s II. pearl		
68. Malta p II. pearl		
70. pg II. pegleg	Chazy	1959
72. p. pg II. pearl pegleg		
76. au III. black		
78. b^n III. black		
81. b^{S-1} — Brazil, p — black, pearl		
82. b — Chicago - black		1955

IV. T. castaneum (continued)

83. b - McGill UPF Background $\frac{BC}{(C)}$ (from New York)		1976
84. b - McGill black		1959
85. b - McGill (from New York) black		1976
86. b (ex NASA) black		1959
87. b - McGill background $\frac{BC}{(D)}$ (from New York) black		1976
88. b - syn (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^+ - tawny	PIL	1965
105. fas-2 - fused antennal segments-2 IV		
107. ap, ju - antennapedia, juvenile urogomphi		
113. S(U.S. Syn) - sooty IV		
114. S(from N.Y.) - sooty IV		
123. Be - Bar eye IV		
135. j - jet V		
136. j^{as} - jet V		
138. blind (has eyes) - Georgia via South Dakota		1976
139. mc - microcephalic V	Chazy	1959
microcephalic-1 V		
140. mc-1 (eyeless)	Hayward	1967
143. fas-3a - fused antennal segments-3 V	Berkeley	1963
148. m - maroon V	Purdue	1970
150. rb - ruby		1962
156. Mo - Microphthalmic	Chazy	1959
159. Sa-1 - Short antenna-1 VII	Berkeley	1961
162. sa=ca - short antenna	Cold Spring Harbor	1960
163. Ca, c - short antenna		
165. C - chestnut	Purdue	1962
168. ju-7 - juvenile urogomphi	Purdue	
170. ble - blistered elytra	Berkeley	1962
171. Fta - Fused tarsi and antennae VII		
173. c, Rd		
180. ap^S - antennapedia VIII	Berkeley	1962
186. Sq^D - squint VIII	Chazy	1959
189. apt - alate prothorax IX		
192. ptl - prothoraxless IX	Chazy	
194. ppas - partially pointed abdominal sternites	Berkeley	1963
196. mas - missing abdominal sternites	Berleley	1964
209. Rd - Reindeer	Oregon S.U.	1976
210. Be, Rd - Bar eye Reindeer		
211. Be, Chr - Bar eye Charcoal IV, III		
212. Chr, Rd - Charcoal Reindeer		
213. Be, Chr, Rd - Bar eye, Charcoal Reindeer		
221. bj - banjo	Chazy	1960

IV. *T. castaneum* (continued)

222.	bra - branched antenna		
226.	Cfl, lod, p - confusum-like, light ocular diaphragm pearl		1976
228.	Dch - Dachs	San Bernardino	1976
230.	fas-1 - fused antennal segments-1	Chazy	1959
233.	imp - incomplete mesothoracic projections		
238.	mxp - maxillopedia	Berkeley	1965
239.	lp, mxp		
240.	Npp - non		
245.	pec - pectinate		
252.	sc - scar	Purdue	
254.	ty		
259.	w - white		
261.	fas-8 - fused antennal segments-8		
264.	Sh - short elytra		
266.	rgt - reduced gin traps	Berkeley	1966
269.	Sq-like - squint-like		
271.	giant		
274.	Berkeley LH		
275.	Berkeley SH		
278.	la		
280.	Veracruz small		
288.	fas-9 - fused antennal segments-9	San Bernardino	1975
293.	au, fas-9, j, lod, ov-like, p - aureate, fused antennal segments 9, jet, light ocular diaphragm, overshot-light, pearl		
295.	p, pd - pearl, paddle II, I		
296.	b, p, pd - black, pearl, paddle III, II, I		
297.	p, sp - pearl, spotted II, I		
298.	p, py - pearl, pygmy II, I		
299.	i, p, py - ivory, pearl, pygmy II, II, I		
301.	au, lod, p - aureate, light ocular diaphragm, pearl III, III, II		
302.	au, mc, p - aureate, microcephalic pearl III, V, II		
303.	b, p - black, pearl III, II		
304.	au, lod, msg, p - aureate, light ocular diaphragm melanotic stink glands, pearl, III, III, III, II		
306.	b, p, pc - black, pearl, pointed elytra III, II, ?		
308.	mc, p - microcephalic pearl V, II		
310.	p, s - sooty II, IV		
312.	j, NPP, p - jet, nonpunctate prothorax, pearl V, ?, II		
313.	apt, Mo, p - alate prothorax, Microphthalmic, pearl IX, VI, II		
315.	MAS, p - missing abdominal segments, pearl IX, II		
316.	KNP, p - knobby prothorax, pearl ?, II		
317.	aa, p - abbreviated appendages, pearl ?, II		
322.	b, fas-4, p - black, fused antennal segment-4, pearl III, ?, II		

IV. T. castaneum (continued)

324. b^+, p - bent tibia, pearl ?, II
325. au, fas-8, lod, p - aureate, fused antennal segments-8, light III, ?, III, II ocular diaphragm, pearl
330. b, p, rju-2 - black, pearl, reduced juvenile III, II, V urogomphi-2
331. mas, p, sh - missing abdominal segments, pearl, III, II, ? short elytra
334. au, FTA, lod, p - aureate, Fused tarsi and antennae, III, VII, light ocular diaphragm, pearl III, II
339. pd, py, s - paddle, pygmy, sooty I, I, IV
340. pd, pte, py - paddle, platinum eye, pygmy I, I, I
351. py, r, ser - pygmy, red, serrate I, I, I
352. lod, py, r - light ocular diaphragm, pygmy, red III, I, I
353. i, lod, py - ivory, light ocular diaphragm, pygmy II, III, II
354. b, py, r - black, pygmy, red III, I, I
356. b, py - black, pygmy III, I
357. pd, py, sp - paddle, pygmy, spotted I, I, I
369. au, b - aureate, black III, III
372. apt, b - alate prothorax, black ?, III
373. b, Npp - black, Non punctate prothorax III, ?
374. b, Npp, ptl - black, nonpunctate prothorax, prothoraxless III, ?, IX
376. b, ppas - black, partially pointed abdominal segments III, IX
377. b, mc, p - black, microcephalic, pearl, III, V, II
378. b, sa - black, short antenna III, VII
379. ap, b - antennapedia, black VIII, III
381. b ptl - black, prothoraxless III, IX
390. j^{as}, j^{hle}, j^{syn}, p - synthetic jet, pearl V, II
391. j, ppas - jet, partially pointed abdominal segments V, IX
401. ims, s - incomplete mesosternites, sooty IV, IV
402. h, ptl, s - hazel, prothoraxless, sooty IV, IX, IV
403. mc,s - microcephalic, sooty V, IV
404. s, w - sooty, white IV, ?
406. ap, s - antennapedia, sooty VIII, IV
407. elb, s - albowed antenna, sooty VIII, IV
408. cas, s - creased abdominal segments, sooty, VIII, IV
409. r^D, s - red, sooty I, IV
410. fas-2, s - fused antennal segments-2, sooty IV, IV
412. Df, s - Deformed, sooty ?, IV
413. fas-6, s - fused-antennal segments-6, sooty ?, IV

IV. *T. castaneum* (continued)

415. mxp, s - maxillopedia, sooty
416. au, s - aureate sooty
417. h, s - hazel, tooty
418. Be, s - Bar eye, sooty IV, IV
420. Georgia blink, s - Ga. blind, sooty ?, IV
428. c, Npp - chestnut, nonpunctate prothorax VII, ?
429. Fta, Npp - Fused tarsi and antennae, Nonpunctate prothorax
430. au, Npp - aureate, nonpunctate prothorax
436. au, mc - aureate, microcephalic III, V
442. Df, Mo, s - 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
448. ap, Chr - antennapedia, Charcoal VIII, III
450. au, ble - aureate, blistered elytra III, VII
454. p^{ellis}, p^{pk}
460. r, Spa - red, Spatulate
462. mas, mc - missing abdominal segments, microcephalic IX, V
469. k, lod - ivory, light ocular diaphragm
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

Inbred strains

Cf 1-Alb	123
Cf 1-A5	112
Cf 1-A11b	116
Cf 1-B31	111
Cf 1-B3C	119
Cf 1-B8d	117
Cf 1-B11a	119

V. T. confusum

Inbred strains (continued)
Cf 1-C13 82
Cf 1-C14 82
Cf 1-C14' 77
Cf 1-C15 76

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-1, dim, r - black, diminutive, red
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, sh(Berkeley) - black, short
b, sh, sp - black, short, split
b, sp - black, split
b, sp, b-ssm - black, split
b-twa - black, twisted abdomen
b^2 - black
b^2, b-McGill - black, synthetic
b^z - black (Zagneb)
b^z, r^z - black, red
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-Yogoslav - black Yugoslavia
ble - blistered elytra
ble, e - blistered elytra, ebony
btt - bent tibia
carmine, p - carmine, pearl
cas - creased abdominal segments
cas, e-2, p - creased abdominal segments, ebony-2, pearl
claret
Cru - Crumpled
dpe - dirty pearl eye
dj - disjoined
dj, e - disjoined, ebony

V. *T. confusum* (continued)

dt (see umb) - dent (=umbilicus)
dt, es - dent, eyespot
dt, msg - dent, melanotic stink glands
dt, p - dent, pearl
e (from N.Y.) - ebony New York
e, fas-3 - ebony, fused antennal segments-3
e - ebony (McGill background)
e^{L+H} - ebony
e^2 - ebony
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-Yugoslav - fused antennal segments-3
fro - frosted
lod, rs - light ocular diaphragm
msg, rus - melanotic stink glands, ruby spot
msg, twa - melanotic slink glands, twisted abdomen
ov-like - overshot-like
p - pearl
p-slough - pearl
r - red
r, sh - red, short elytra
r^u - 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, som - split-1
sti - sternites incomplete
stl - stilted legs

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, G
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.

R. Davis

Gelechiidae

Sitotroga cerealella (Oliver) Savannah, Ga. 19

II. Mutant strains

Tribolium castaneum, weird egg (wd) Corvallis, Ore., 19

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

Phillip K. Harein
Ernesto De Las Casas
Florence V. Dunkel
Valerie F. Wright

Stock Lists

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

Tribolium castaneum

I. Wild type synthetic populations (all have been selected for pupa weight.)

1. G-0 — Davis, 1974
2. G-3 — Davis, 1974
3. G-9 — Davis, 1974
4. P — Purdue, 1974

II. Synthetic strains (all marked with sooty)

1. C -- stabilized selected line, 95 generations of selection, originated from crosses of CSI-5 and CSI-10.
2. CSI-5 — Berkeley, 1963
3. CSI-10 — Berkeley, 1963
4. R -- randomly selected for 90 generations, from CSI-5 x CSI-10.
5. Relaxed lines -- selected for pupa weight for 50 generations, then maintained as a population cage with discrete generations for 65 generations.
6. S -- selected for pupa weight for 110 generations, from CSI-5 x CSI-10.
7. T -- selected for pupa weight for 50 generations, then relaxed for 23 generations, then selected for 42 more generations.

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

F. D. Enfield

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.)

Tribolium confusum

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

Sokoloff, 1966

Tribolium brevicornis

1. Wild type — Yang, 1970

TIFTON, GEORGIA
ABRAHAM BALDWIN AGRICULTURAL COLLEGE

Tribolium castaneum

A. Wild type strain
   1. Chicago

B. Mutant strains
   1. black
   2. squint

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

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
2. Mutant, ebony — Dawson, 1967
3. Mutant, McGill black — Dawson, 1967

Sokoloff, 1966

Tribolium brevicornis

1. Wild type

Yang, 1970

TIFTON, GEORGIA
ABRAHAM BALDWIN AGRICULTURAL COLLEGE

Tribolium castaneum

A. Wild type strain
   1. Chicago

B. Mutant strains
   1. black
   2. squint

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

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

Tribolium castaneum

1. Wild type (maintained since 1960)

Stock List

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

DEPARTMENT OF HEALTH EDUCATION AND WELFARE
DIVISION OF MICROBIOLOGY (CONT'D)

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.) A.W. Vazquez

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 Belgium

Tribolium confusum

Two inbred and a wild type Berkeley, 1965

(Ed.)

BRAZIL

CAMPINAS, SÃO PAULO
INSTITUTE AGRONOMICO, SEÇAO DE ENTOMOLOGIA

Anobiidae

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

Bostrochidae

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

F.M. Wiendl

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. *Oryzaephilus 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

LYON, RHÔNE
LABORATORIRE DE ZOOLOGIE GÉNÉRALE, FACULTÉ DES SCIENCES

Tribolium castaneum

Wild type strain from Alès, France.

(Ed.)

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

A. Acanthoscelides obsoletus--wild type — France
B. Blabera fusca
C. Clitumnus extradentatus
D. Galleria mellonella — Saint Cyr au Mont d'Or
E. Oryzaephilus surinamensis--from imported dried apricots

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

F.	*Periplaneta americana*	Antibes
G.	*Psendococcus citri*	Infestation Control Laboratory, Surbiton
H.	*Sitophilus granarius*	P.I.L.,Slough
I.	*Sitophilus oryzae*	Lyon
J.	*Sitophilus saskii* - wild type	P.I.L.,Slough
K.	*Stegobium paniceum*	
L.	*Tenebrio molitor*	P.I.L, Slough
M.	*Tenebrio obscurus*	Ales
N.	*Tribolium castaneum* - wild type	(Ed.)

GERMANY

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

Wild type strains:

1. Oryzaephilus surinamensis	Freiburg (stored products)
2. Tribolium castaneum	from San Bernardino (not marked as to origin)
3. Tribolium confusum	" " " " "

Mutants:
A. Tribolium castaneum

4. alate prothorax (apt)	from San Bernardino
5. Bar eye (Be)	" " "
6. black (b^{S-1}) (Brazil background)	" " "
7. black (b^S) (Chicago background)	" " "
8. Dachs (Dch)	" " "
9. Fused tarsi and antennae (Fta)	" " "
10. Microphthalmic (Mo)	" " "
11. nude eggs (nd)	" " "
12. pygmy (py)	" " "
13. Short antenna-2 (Sa-2)	" " "
14. short antenna (sa), allele unknown	" " "
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)	" " "

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

E. Naton

INSTITUT FÜR FLUGMEDIZIN DER DFVLR
KOLNESTR 70
5300 BONN-BAD GODESBURG

I. Wild type strains derived from crop imports from Africa and Far East

A. Tribolium castaneum
B_1 Tribolium confusum
B_2 Tribolium confusum inbred over about 21 generations with passages over several single pair steps

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

W. Briegleb

GUATEMALA

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

I. Wild type stocks
SSP - Obtained from Dr. Gall at U.C. Davis
G - Originally came from Georgia

II. Mutants
sooty 1 - Obtained from Dr. Gall, U.C. Davis
sooty 2 - Mutant isolated from G strain
pearl eye - Obtained from Dr. Gall, U.C. Davis

J. Medrano

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 — via Sokoloff, Berkeley
5. Chicago wild — via Sokoloff, Berkeley
6. Brazil
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	Me	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

Stock Lists

S-71	sa	via Sokoloff, Berkeley
S-74	ju	via Sokoloff, Berkeley
S-81	Be s	via Sokoloff, Berkeley
S-90	py r M^r	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 1975
7. McGill	Via San Bernardino, 1976
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	Japan, 1976
14. Jerez	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

Inbred lines

Tribolium castaneum

1. CSI - 6 — Via San Bernardino, 1976

V.K. TANEJA

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.)

BAHADUR SHAH ZAFAR MARG, NEW DELHI-1
MAULANA AZAD MEDICAL COLLEGE, DEPARTMENT OF BIOCHEMISTRY

T. castaneum

Wild strain of local origin

ISRAEL (Ed.)

TEL AVIV, ISRAEL
TEL AVIV UNIVERSITY, DEPARTMENT OF ZOOLOGY

1. Stock list

Tribolium castaneum

Wild type strains:

++	Stony Brook, N.Y. (Purdue)
CTC-12	Slough, England (Orig. from Australia)

Mutants:

black (b)	Stony Brook, N.Y. (Chicago)
pearl (p)	Stock Center, San Bernardino
paddle (pd)	Stock Center, San Bernardino
red (r)	Stock Center, San Bernardino

Extra urogomphi (eu), derived from b in this laboratory

1) eu-b, (black body color)
2) eu +, (brown body color)

Mutants T. confusum

black (b)	Stony Brook, N.Y. (Chicago)
Extra Large (XL)	Savannah, Georgia U.S.A.

Dr. David Wool

ITALY

PAVIA
UNIVERSITY PAVIA, CENTRO DI GENETICA

1. Tribolium confusum Duval, wild strain obtained from Professor A. Koch, Zoologisches Institut, Regensburg.

2. id. id., strain of recent colonization from specimens collected in Pavia mill, difficult colony.

JAPAN

KYOTO
KYOTO UNIVERSITY, ENTOMOLIGICAL LABORATORY

Bruchidae

Callosobruchus chinensis

9 strains come from different localities in Japan. Black colored mutant derived from one of the geographical strains.

Callosobruchus maculatus

12 strains come from different localities in the world.

Louisiana, U.S.A.
Fresno Lab., U.S.D.A., Calif., U.S.A.
Savannah Lab., U.S.D.A., Georgia, U.S.A.
Ohio State Univ., Columbus, Ohio, U.S.A.
Kansas State Univ., Manhattan, Kansas, U.S.A.
Hong Kong
Chieng Mai, Thailand
Burma
Tel Aviv, Israel

Zabrotes subfasciatus

Curculionidae

Sitophilus zeamais

Sitophilus oryzae

Tenebrionidae

Tribolium confusum

Tribolium castaneum

S. Utida

OKAYAMA
OKAYAMA UNIVERSITY, FACULTY OF AGRICULTURE
LABORATORY OF APPLIED ENTOMOLOGY

I. Wild type strains
   1. *Alphitobius diaperinus* — Miyazaki
   2. *Alphitophagus bifasciatus* — Okayama
   3. *Callosobruchus chinensis* — 13 strains from different localities

4. Cryptolestes pusillus — Miyazaki
5. Gnathocerus cornutus — Miyazaki
6. Lasioderma serricorne — Miyazaki
7. Lastheticus oryzae — Miyazaki
8. Murmidius ovalis — Okayama
9. Neatus (Tenebrio) picipes — Okayama
10. Oryzaephilus mercator — Miyazaki
11. Oryzaephilus surinamensis — Miyazaki
12. Palorus ratzeburgii — Miyazaki
13. Palorus subdepressus — Miyazaki
14. Rhyzopertha dominica — Miyazaki
15. Sitophilus oryzae — Okayama
16. Sitophilis zeamais — Okayama
17. Stegobium paniceum — Okayama
18. Tenebrio obscurus — Okayama
19. Tenebrio molitor — Sapporo
20. Tenebroides mauritanicus — Okayama
21. Tribolium castaneum — Miyazaki
22. Tribolium confusum — Miyazaki

II. Mutant strains

Callosobruchus chinensis — Black mutant, Kyoto University

T. Yoshida

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.)

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	

Stock Lists

Tribolium castaneum (susceptible)	Malawi, 1971
Tribolium confusum (susceptible)	Malawi, 1971
Sitophilus oryzae (susceptible)	Malawi, 1971
Sitophilus zeamais I Lindane resistant	Malawi, 1971
Sitophilus zeamais II Lindane resistant	Malawi, 1971
Oryzaephilus surinamensis (small strain)	Thailand, 1972
Oryzaephilus surinamensis	unknown
Oryzaephilus mercator (small strain)	Thailand, 1970
Oryzaephilus mercator	Germany
Trogoderma granarium	Sudan, 1970
Necrobia rufipes	Ivory Coast, 1970
Sitotroga cerealella	unknown
Plodia interpunctella	China
Corcyra cephalonica	Ivory Coast
Ephestia cautella	Nigeria

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

P. Stam.

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.	Zamora	Zamora, Spain,	1976
12.	Jafo	Jafo, Israel,	1975
13.	Beer-Sheba	Beer-Sheba, Israel,	1975

B. Mutant type strains

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

		Selected for	Temperature
31.	SF-I	high cross performance at	28°C
32.	RF-II	" " " "	28°C
33.	SF-II	" " " "	28°C
34.	RT-I	" " " "	38°C
35.	ST-I	" " " "	38°C
36.	RT-II	" " " "	38°C
37.	ST-II	" " " "	38°C

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

38.	CTD-I	High performance at different levels of selection
39.	CTD-II	" " " " "
40.	DTD-I	" " " " "
41.	DTD-II	" " " " "
42.	ETD-I	" " " " "
43.	ETD-II	" " " " "
44.	FTD-I	" " " " "
45.	FTD-II	" " " " "

D. Mutants

46.	antennapedia <u>ap</u>, VIII	Purdue, 1964
47.	Diferencial <u>Df</u>, IV	Purdue, 1964
48.	fused antennal segm. -2 <u>fas-2</u>, IV	Sokoloff, 1968
49.	ivory <u>i</u>, ?	Purdue, 1964
50.	paddle <u>pd</u>, I	Purdue, 1964
51.	pearl <u>p</u>, II	Sokoloff, 1968
52.	pegleg <u>pg</u>, II	Purdue, 196
53.	pygmy <u>py</u>, I	Purdue, 196
54.	ring <u>rg</u>, I	Purdue, 1964
55.	ruby <u>rb</u>, ?	Purdue, 196
56.	short elytra <u>sh</u>, VIII	
57.	spotted <u>sp</u>, I	Purdue, 1964
58.	white <u>w</u>, ?	Purdue, 1964
59.	wine <u>r^w</u>, I	Purdue, 1968
60.	eye mutant, ?	Madrid, 1967
61.	elytra mutant, ?	Madrid, 1967
62.	melanotic stink gland-like	Madrid, 1968

Tribolium confusum

A. Wild type strains

63.	Infantes	Infantes, Spain, 197
64.	Coronada	La Coronada, Spain, 197

B. Mutants type strains

65.	creased abdominal sternites <u>cas</u>, II	Sokoloff, 196
66.	ebony-2 <u>e-2</u>, II	Sokoloff, 19

Stock Lists

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

D. Patterson

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 deve opmental time (Derived from Purdue Foundation).

Tribolium castaneum (Continued)

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

A. Lemonde

Stock Lists

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

Tribolium confusum Duval

Strain: Laval
Origin: Quebec City

L. Huot

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

I. Wild type strains

A. *Tribolium confusum* inbred lines

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

II. Mutant strains

A. *Tribolium confusum*

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

Stock Lists

B. Tribolium castaneum

1. red (r); chromosome I	Berkeley, 1965
2. pearl (p); chromosome I	Purdue, 1967
3. pearl riboflavinless (p^r) (formerly "ivory")	Berkeley, 1965
4. pink (p^{pk}); chromosome II	
5. light ocular diaphragn (p background); chromosome III	Berkeley, 1965
6. jet H.L.E.; chromosome V	Berkeley, 1867
7. Chestnut (c); chromosome VII	Berkeley, 1965
8. s; r^D; multichromosomal	Berkeley, 1965

(Ed.)

VANCOUVER, B.C.
UNIVERSITY OF BRITISH COLUMBIA, POULTRY SCIENCE GENETICS LABORATORY

Tribolium confusum

Wild type
1. U.B.C. wild type - Vancouver, B.C.

Mutants
1. Riboflavinless, pearl-eye (p^r) — C.W. Roberts

WINNIPEG, MANITOBA
CANADA DEPARTMENT OF AGRICULTURE, RESEARCH STATION

I. Wild type strains

A. Coleoptera

1. Acanthoscelides obtectus (Say) Bruchidae	Winnipeg
2. Alphitobius diaperinus Panzer Tenebrionidae	Saskatchewan
3. Cryptolestes ferrugineus (Steph.) Cucujidae	Manitoba
4. Cryptolestes ferrugineus (Steph.) Cucujidae	P.I.L.
	United Kingdom
	Australia
5. Cryptolestes ferrugineus (Steph.) Cucujidae	Ontario
6. Cryptolestes turcicus (Grouv.) Cucujidae	P.I.L.
7. Cryptolestes turcicus (Grouv.) Cucujidae	United Kingdom
	Manitoba
8. Cynaeus angustus Leconte Tenebrionidae	Ontario
9. Oryzaephilus mercator (Fauvel) Silvanidae	Manitoba
10. Oryzaephilus surinamensis (L.) Silvanidae	Manitoba
11. Palorus subdepressus Wollaston Tenebrionidae	Australia
12. Rhyzopertha dominica (Fab.) Bostrichidae	

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

B. Lepidoptera

3. Plodia interpunctella (Hbn.) Phycitidae — Winnipeg

II. Mutants

A. Coleoptera

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

L.B. Smith

UNITED KINGDOM
GREAT BRITAIN

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

Tenebrio molitor
Tenebrio obscurus
Blaps sp.
Tribolium sp.

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

B. Lepidoptera

3. Plodia interpunctella (Hbn.) Phycitidae — Winnipeg

II. Mutants

A. Coleoptera

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

L.B. Smith

UNITED KINGDOM

GREAT BRITAIN

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

Tenebrio molitor
Tenebrio obscurus
Blaps sp.
Tribolium sp.

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.

F.L. Waterhouse

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.)

Stock Lists

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 foodstuffs.

Tribolium confusum J. duV.

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

(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.)

Stock Lists

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.).

ORDER Family (-subfamily) Genus (sub genus), species.	COMMON NAME	COUNTRY OF ORIGIN OF STOCK	CULTURE MEDIUM	REAR. TEMP. °C
COLEOPTERA				
Anobiidae				
Lasioderma serricorne (F.)	Cigarette beetle		6	25
Stegobium paniceum (L.)	Biscuit beetle		6	25
Anthribidae				
Araecerus fasciculatus (Deg)	Coffee bean weevil		30	25
Bostrichidae				
Prostephanus truncatus (Horn)	Larger grain borer		30	25
Rhyzopertha dominica (F.)	Lesser grain borer		1	30
Bruchidae				
Acanthoscelides obtectus (Say)	Dried Bean beetle	W. Africa	27	30
Acanthoscelides obtectus (Say)	Dried Bean beetle	N. Germany	27	25
Acanthoscelides obtectus (Say)	Dried Bean beetle	Portugal	27	30
Callosobruchus analis (F.)			29	30
Callosobruchus chinensis (L.)	Cowpea weevil		29	25
Callosobruchus maculatus (F.)		Sierra Leone	29	30
Callosobruchus maculatus (F.)		Burma	29	30
Callosobruchus phaseoli (Gyll.)		Malaya	cowpeas	25

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.).

ORDER Family (-subfamily) Genus (sub genus), species.	COMMON NAME	COUNTRY OF ORIGIN OF STOCK	CULTURE MEDIUM	REAR TEMP °C
COLEOPTERA				
Anobiidae				
Lasioderma serricorne (F.)	Cigarette beetle		6	25
Stegobium paniceum (L.)	Biscuit beetle		6	25
Anthribidae				
Araecerus fasciculatus (Deg)	Coffee bean weevil		30	25
Bostrichidae				
Prostephanus truncatus (Horn)	Larger grain borer		30	25
Rhyzopertha dominica (F.)	Lesser grain borer		1	30
Bruchidae				
Acanthoscelides obtectus (Say)	Dried Bean beetle	W. Africa	27	30
Acanthoscelides obtectus (Say)	Dried Bean beetle	N. Germany	27	25
Acanthoscelides obtectus (Say)	Dried Bean beetle	Portugal	27	30
Callosobruchus analis (F.)			29	30
Callosobruchus chinensis (L.)	Cowpea weevil		29	25
Callosobruchus maculatus (F.)		Sierra Leone	29	30
Callosobruchus maculatus (F.)		Burma	29	30
Callosobruchus phaseoli (Gyll.)		Malaya	cowpeas	25

March, 1977

ORDER	COMMON NAME	COUNTRY OF ORIGIN OF STOCK	CULTURE MEDIUM	REARING TEMP. °C
Caryedon serratus (Oliv.) (= *gonagra* (F.))	Groundnut seed beetle		26a	30
Zabrotes subfasciatus (Boh.)			28	30
Cerylonidae				
Murmidius ovalis (Beck)		Ceylon	13	25
Cleridae				
Necrobia rufipes (Deg.)	Copra beetle		22	30
Cucujidae				
Cryptolestes capensis (Waltl)			10	25
Cryptolestes ferrugineus (Steph.)	Rust-red grain beetle		10	30
Cryptolestes pusilloides (Steel & Howe)		(Canada)	10	25
Cryptolestes pusillus (Schon.)	Flat grain beetle		10	25
Cryptolestes turcicus (Grouv.)			10	25
Cryptolestes ugandae (Steel & Howe)		(E. Africa)	10	25
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)	20	25
Anthrenus (*Anthrenus*) *flavipes* LeC. (= *vorax* Waterh.)	Furniture carpet beetle		20	30
Anthrenus (Nathrenus) *verbasci* (L.)	Varied carpet beetle	Britain	20	20
~~Anthrenus~~ (*Anthrenodes*) *sarnicus* Mroczkowski			32	20
Anthrenus (*Florilinus*) *olgae* Kalik		Poland	20	20

ORDER	COMMON NAME	COUNTRY OF ORIGIN OF STOCK	CULTURE MEDIUM	RE... T... °C
Attagenus brunneus Faldermann		Spain	19+ cholesterol	30
Attagenus Sp			17	20
Attagenus smirnovi Zhantiev		Kenya	17	25
Attagenus fasciatus (Thunberg)(= gloriosae) (Fabricius))		Botswana	18	25
Attagenus (unicolor Brahm) (= megatoma (F.) & piceus (Ol.) nec. Thb.)	Black carpet beetle		20	30
Attagenus pellio (L.)	Fur beetle	Britain	20	20
Dermestes ater Deg.	Black larder beetle	Britain	21a	25
Dermestes frischii Kug.	Hide beetle	(Nigeria)	21a	25
Dermestes haemorrhoidalis Kuster		Britain	21a	25
Dermestes lardarius L.	Bacon beetle	Britain	21a	25
Dermestes maculatus Deg.	Leather beetle		21a	25
Dermestes peruvianus Castelnau		Britain	21a	25
Trogoderma angustum (Solier)		Germany	2	25
Trogoderma anthrenoides (Sharp)		U.S.A.	2	30
Trogoderma glabrum (Herbst)		U.S.A.	2	30
Trogoderma granarium Everts	Khapra beetle	(Britain)	2	30
Trogoderma grassmanii Beal		U.S.A.	18	30
Trogoderma inclusum LeC.	Larger cabinet beetle		10	25
Trogoderma irroratum Reitt.		Egypt	2	30
Trogoderma ornatus (Say)		U.S.A.	19+ wheat	25
Trogoderma variabile Ballion (= parabile Beal)		U.S.A.	2	30
Trogoderma simplex Jayne		U.S.A.	18	30
Trogoderma sternale plagifer Casey		New Mexico	19	30
Languriidae				
Pharaxonotha kirschi (Reitt.)		Portugal	6a	20

ORDER	COMMON NAME	COUNTRY OF ORIGIN OF STOCK	CULTURE MEDIUM	REARING TEMP. °C
Mycetophagidae				
<u>Typhaea stercorea</u> (L.)	Hairy grain beetle	Nigeria	4	25
Nitidulidae				
<u>Carpophilus dimidiatus</u> (F.)	Corn-sap beetle		14	25
<u>Carpophilus hemipterus</u> (L.)	Dried fruit beetle		15	25
Trogossitidae				
<u>Lophocateres pusillus</u> (Klug.)	Siamese grain beetle		11	30
<u>Tenebroides mauritanicus</u>(L.)	The Cadelle	Pakistan	12	30
Ptinidae				
<u>Gibbium psylloides</u> (Czemp)	Hump spider beetle	Britain	17a	20
<u>Mezium affine</u> Boield.		Britain	17a	20
<u>Mezium americannum</u> Lap.	American spider beetle		17a	20
<u>Niptus hololeucus</u> (Fauld.)	Golden spider beetle	Britain	17a	20
<u>Pseudeurostus helleri</u> (Reitt.)		Britain	17a	20
<u>Ptinis clavipes</u> Panz.	Brown spider beetle	Britain	17a	20
<u>Ptinus exulans</u> Erichson		Britain	17a	20
<u>Ptinis pusillus</u> Sturm.			17a	20
<u>Ptinus sexpunctatus</u> Panz.			17a	20
<u>Ptinus tectus</u> Boield.	Australian spider beetle		19a	25
<u>Stethomezium squamosum</u> Hint.	African spider beetle	Britain	17a	20
<u>Tipnus unicolor</u> (P.&M.)		Kenya	17a	20
<u>Trigonogenius globulus</u> Sol.	Globular spider beetle	Ireland	17a	20
<u>Trigonogenius particularis</u> Pic		Kenya	18a	25

ORDER	COMMON NAME	COUNTRY OF ORIGIN OF STOCK	CULTURE MEDIUM	REAR TEMP °C
Silvanidae				
Ahasveras advena (Waltl)	Foreign grain beetle	(W. Africa)	10	25
Cathartus quadricollis (Guer.)	Square-necked grain beetle	W. Africa	10	25
Oryzaephilus mercator (Fauv.)	Merchant grain beetle		10	25
Oryzaephilus surinamensis (L.)	Saw-toothed grain beetle		10	25
Tenebrionidae				
Alphitobius diaperinus (Panz.)	Lesser mealworm		7 7	25 25
Alphitobius laevigatus (F.)	Black fungus beetle		7	25
Alphitophagus bifasciatus (Say)	Two banded fungus beetle	Britain	5	25
Gnathocerus cornutus (F.)	Broad-horned flour beetle		17	25
Gnathocerus maxillosus (F.)	Slender horned flour beetle		6	25
Latheticus oryzae Waterh.	Long headed flour beetle		6	30
Palembus ocularis Casey		Jamaica	18* maize	25
Palembus dermestoides (Fairmaire)		Malaya	18	25
Coelopalorus fovicollis Blair		Trinidad	24	25
Palorus laesicollis (Fairm.)		Kenya	24	25
Palorus ratzeburgii (Wissm.)	Small-eyed flour beetle			
Palorus subdepressus (Woll.)	Depressed flour beetle	Turkey	7	25
Sitophagus hololeptoides Canst		Trinidad	18	25
Tenebrio molitor L.	Yellow mealworm		10a	25
Tenebrio obscurus F.	Dark mealworm		10a	25
Tribolium anaphe Hint.		Nigeria	17	25
Tribolium audax Halstead		Canada	17	25

ORDER	COMMON NAME	COUNTRY OF ORIGIN OF STOCK	CULTURE MEDIUM	REARING TEMP. °C
Tribolium brevicornis LeC.		U.S.A.	23	25
Tribolium castaneum (Herbst)	Rust-red flour beetle	Britain	23	25
Tribolium confusum Duv.	Confused flour beetle		23	25
Tribolium destructor Uytt.	Dark flour beetle	(Holland)	17	25
Tribolium madens (Charp.)	Black flour beetle	Yugoslavia	17	25
DICTYOPTERA				
Blattellidae				
Blatella germanica (L.)	German cockroach		18a	27
Supella longipalpa (F.)	Brown banded cockroach		18a	27
Blattidae				
Blatta orientalis L.	Oriental cockroach		18a	27
Periplaneta americana (L.)	American cockroach		18a	27
Periplaneta australasiae (F.)	Australian cockroach		18a	27
DIPTERA				
Muscidae				
Musca domestica L.	Housefly	Britain	25	27
HYMENOPTERA				
Formicidae				
Monomorium pharaonis (L.)	Pharaoh's ant	Britain	33	27
Chalcididae				
Chaetospila elegans (Westw.)			9	25
LEPIDOPTERA				
Pyralidae - Pyralinae				
Pyralis farinalis (L.)	Meal moth		5	25
Pyralidae - Phycitinae				
Ephestia (Anagasta) kuehniella (Zell.)	Mediterranean flour moth	Britain	8a	25

ORDER	COMMON NAME	COUNTRY OF ORIGIN OF STOCK	CULTURE MEDIUM	REAR. TEMP. °C
Ephestia (Cadra) cautella (Walk.)	Tropical warehouse moth	(S. Africa)	8a	25
Ephestia (Cadra) cautella (Walk.)	Tropical warehouse moth	Cyprus	31a	30
Ephestia (Ephestia) elutella (Hubn.)	Warehouse moth	Britain	8a	25
Ephestia (Cadra) figulilella Gregs.	Raisin moth	Cyprus	31a	30
Plodia interpunctella (Hubn.)	Indian meal moth	Britain	8a	25
Pyralidae - Gallerinae				
Achroia grisella (F.)	Lesser wax moth		16a	25
Galleria mellonella (L.)	Honey comb moth		3	25
Gelleria melonella (L.)	Honeycomb moth		16a	25
Corcyra cephalonica Stainton	Rice moth	(Burma)	8	25
Gelechiidae				
Sitotroga cerealella (Oliv.)	Angoumois grain moth		1	25
Tineidae				
Tinea columberiella Wocke	Case bearing clothes moth		20	20
Tinea flavescentella Haworth		Britain	20	20
Tinea metonella (Pierce)			20	25
Tineola bisselliella (Humm.)	Common clothes moth			

MUTANT STOCKS	MUTATION	COUNTRY OF ORIGIN OF STOCK	MEDIA	TEMP
Anobiidae				
Lasioderma serricorne (F.)	Black	U.S.A.	6	25

MUTANT STOCKS	MUTATION	COUNTRY OF ORIGIN OF STOCK	MEDIA	TEMP.
Bostrichidae				
Rhyzopertha dominica (F.)	Black		1	30
Bruchidae				
Callosobruchus maculatus (F.)	Bens		29	30
Cucujidae				
Cryptolestes pusillus (Schon)	Black	Trinidad	10	30
Cryptolestes turcicus	Red eye	Winnipeg		
Curculionidae				
Sitophilus granarius	Red eye	CSIRO		
Dermestidae				
Dermestes maculatus Deg.	Black/Brown	Australia	21	25
Trogoderma granarium	Pearl eye	Britain		
Gelechiidae				
Sitotroga cerealella	1. Red eye	Nepal		
	2. Red eye	Kansas, U.S.A.		
Nitidulidae				
Carpophilus dimidiatus (F.)	Pearl-eyed		10	25
Pyralidae-Phycitinae				
Ephestia cautella	1. Yellow eye	U.S.A.		
	2. Brown	U.S.A.		
	3. Black	U.S.A.		
	4. White eye	U.S.A.		
Ephestia elutella	White eye	Britain		
Ephestia kuehniella	Red eye	Germany		
Plodia interpunctella	1. Scaleless	U.S.A.		
	2. Melanic	U.S.A.		
	3. Red eye	U.S.A.		
Silvanidae				
Ahasverus advena (Waltl)	Black	Britain	10	25
Oryzaephilus surinamensis (L.)	Small	Burma	10	25

Tenebrionidae

Tribolium castaneum (Herbst)	Very dark (black)		23	25
Tribolium castaneum (Herbst)	Bar eyed	Edinburgh	23	25
Tribolium castaneum (Herbst)	Giant		23	25
Tribolium castaneum	Sooty	Berkeley		
Tribolium confusum Duv.	Black		23	25
Tribolium confusum Duv.	Pearl-eyed		23	25
Tribolium confusum Duv.	Black and Pearl-eyed		23	25
Tribolium confusum	Yugoslav red	Berkeley		
Tribolium confusum	Ebony	" "		
Tribolium confusum	Ebony-2	" "		
Tribolium confusum	Ruby spot	" "		
Tribolium confusum	Blistered elytra	" "		
Tribolium confusum	Melanotic stink glands	" "		
Tribolium confusum	Thumbed	" "		
Tribolium confusum	Disjoin ed	" "		
Tribolium confusum	Dirty pearl eye	" "		
Tribolium confusum	Pearl, light ocular diaphragm	" "		
Tribolium confusum	Umbilicus	Savannah		
Tribolium confusum	Riboflavinless, pearl	Vancouver		

The following species are periodically renewed from the field:

	Date & Origin of Last Addition	Culture Medium	Temp. °C
COLEOPTERA			
Curculionidae			
Sitophilus granarius (L.)	1970	1	20
Sitophilus oryzae (L.)	1970	1	20
Sitophilus zeamais (Motsch.)	1970	1	20
Silvanidae			
Oryzaephilus surinamensis (L.)	May 1975 Nottingham	10	25
Ptinidae			
Ptinus tectus (Boield.)	May 1975 Bristol/Mills	19a	25
Tenebrionidae			
Tribolium castaneum (Herbst)	May 1975 Bristol	25	25

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

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

I. Wild type strains

COLEOPTERA

Anobiidae
Lasioderma serricorne — Cyprus, 1964

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

(Ed.)

NEW ZEALAND

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

1. Stock lists: *Tribolium castaneum*
Tribolium confusum

Wild type strains from local infestations

Other Coleoptera: *Dermestes maculatus*
Gnathocerus cornutus
Sitophilus granarius
Sitophilus oryzae
Stegobium paniceum
Tenebrio molitor

2. New Mutants: Nil

3. Notes: Culture maintained for general purpose only; supply to schools and colleges for teaching and research.

Pritam Singh

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.

H.H. Meyer

Stock Lists

YUGOSLAVIA

ZAGREB, KAČIĆEVA 9
INSTITUTE FOR PLANT PROTECTION
AGRICULTURAL FACULTY

I. Wild type strain

LEPIDOPTERA

Gelechiidae
Sitotroga cerealella (Oliv.)

Phycitidae
Anagasta kuhniella Zell.

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.)

Stock Lists

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)

Zlatko Korunić

NEW MUTANTS

Report of M. Hani Soliman

Tribolium audax

1. Brown (*br*). Discovered in 1974 in a population obtained from Dr A. Sokoloff. The *br* gene was found to be semi-dominant. The heterozygote "*br*/+" produces a chestnut body colour. The homozygote recessive "*br*/*br*" resembles the normal colour in *T. castaneum*, while the wild type is black.

   The heterozygote has a slightly faster developmental rate than the homozygote recessive which is as fast as the wild type. Although the wild type showed the highest viability and the homozygote recessive the lowest, the difference was not significant.

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*Survival Rate at Different Stages of Development in *Tribolium castaneum*.

An experiment was conducted to study rate of survival at different stages of development in *Tribolium castaneum*. Material and culture methods used in this experiment were the same as reported by (Bhat and Bhat Tribolium Inform. Bull. Vol 17: 82-87).

The eggs were collected from PAU-I foundation strain, 36 females, on 7th, 8th, 9th, 10th and 11th day of life. These eggs were counted and kept for hatching and subsequent adult survival. Table 1 details the various parameters and adult survival. The hatchability was 95.27%. Sokoloff and Ho (1962) have given an average hatchability of eggs as 80.23% and percentage of eggs hatching as adult as 77.0%. The percentage of larvae forming adults was around 90%, indicating a 10% mortality after the larvae are formed. There was no significant difference in hatchability between days. Survival of larvae based on the total number of eggs set was 88.57% and based on the number hatched was 92.95%. Percentage survival of pupae was 84.70 based on eggs set. The percentage calculated on the basis of number of eggs hatched was 89.16% and based on survived larvae was 95.91%. There was no significant drop in rate of survival from larvae to pupae, there was a significant drop in survival by 15.30 from egg to pupa. Percentage survival of adults based on the number of eggs set was 80.40%, a significant drop by 19.60%. Based on the number of eggs hatched was 84.39%, a drop in survival by 10.82% and based on number of survived larvae was 90.77%, a drop in survival by 9.23%, based on surviving adult pupa was 94.64%, a small drop by 5.36%. It is obvious that the most sensitive period of development was from egg to pupa especially from hatched egg to larva. Sokoloff *et al*. (1966) also showed that the most critical period in the life cycle was from hatching to larval development.

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TABLE 1: PERCENTAGE SURVIVAL AT VARIOUS STAGES OF DEVELOPMENT FROM EGG TO ADULT

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Days	No. of egg set	No. of hatched	% hatchability	No. of larvae	% survival of larvae	% survival from (3)	No. of pupae	No. of pupae (Males)	No. of pupae (Females)	Survival of pupae	% survival of pupae from (5)	No. of adults	No. of adults (Male)	No. of adults (Female)	% survival of adults	% survival of adults from (8)	χ^2 for sex ratio
7	463	435	93.95	409	83.33	94.02	389	191	198	84.01	95.11	370	178	192	79.91	97.6	0.126
8	440	414	94.9	391	88.86	94.44	385	179	206	87.50	98.45	364	168	196	82.72	94.5	2.120
9	456	437	95.83	387	84.66	88.55	364	184	120	79.82	94.05	346	171	175	75.87	92.3	0.044
10	426	407	95.53	377	88.12	92.62	361	174	186	84.74	95.75	346	164	182	81.22	96.3	0.234
11	481	466	96.88	443	92.09	95.06	427	213	214	89.18	96.83	396	200	196	82.32	92.2	0.232
X(5)	2266	2159	95.27	2007	88.57	92.95	1926	941	984	84.70	95.91	1822	881	941	80.40	94.64	

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*Estimation of Genetic Variation and Heritability of Ovariole Number in Tribolium Castaneum

Tribolium castaneum has been extensively used by a large number of workers to study the quantitative genetic theory. Genetic variation and heritability has been investigated for growth and larva weight (Hardin 1962; Yamada and Bell 1964) for pupal weight (Bray et al., 1962, Bhat, 1965). Ovariole number though strongly connected with fitness has not been studied so far.

Material and culture methods used in this experiment were the same as reported by (Bhat and Bhat in Tribolium Inform. Bull. Vol. 17: 82-87).

A large population of pupae from the PAU-I foundation strain was sexed and 300 females and 100 males were drawn at random. The females were dept in three culture bottles each containing 100 pupae when they were 9 days old, in one group left antenna was cut in the second group right antenna was cut while in the 3rd group, both left and right were cut for identification. Three females were alloted to each male at random, in this way thirty sire families were established in one replicate and similarly another replicate was made up with thirty sire families. Each family was kept in a small vial with standard medium. Individuals were allowed to mate for 10 days. On the 10th day the females were separated in single vials, each vial containing properly labelled single female. 48 hour egg collection of each female was taken. The pupae were sexed and separated. The female pupae were watched for emergence. The adult females were dissected and ovariole number per ovary and per individual was recorded. For genetic analysis a statistical model involving sires, dams within sires and progeny within dams and sires was used.

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The mean ovariole number per ovary was 5.86 $\pm$ 0.59, with a coefficient of variation of 10%. The mean ovariole number per female was 11.51 $\pm$ 0.76, with a coefficient of variation of 6.5%.

Replicate differences were not significant. Table I details the analysis of variance of ovariole number. The sire and dam component were both negative, consequently the estimate of heritability from sire variance was small and negative ($h^2 = -0.073$).

Estimate of genetic variance by the intrasire regression of daughter on dams was $\sigma^2 A = 0.04$, and heritability was 0.14. The results are detailed in Table II.

A large number of experiments have been reported with _Tribolium castaneum_ to study the genetic variation and heritability for growth and larval weight (Hardin, 1962, Yamada and Bell 1964) for population time (Englert 1964) for pupal weight (Bray, 1962, Bhat 1965). All these workers have reported varying estimates of genetic components for these traits.

So far there has been no report on the genetic variation of ovariole number in _Tribolium castaneum_.

Robertson (1957) reported a mean ovariole number of 21.6 with a coefficient of variation of 13.3 in _Drosophila melanogaster_. A range of 16.4 to 24.5 was observed in various stocks. He reported the cumulative heritability of ovariole number as 0.46 after 10 generations of two way selection. Starting with a mean ovariole number of 44 in the first generation in 10 generations the ovariole number increased to 62. An appreciable genetic reduction in ovariole number reduced egg production. The estimate of genetic variance in our case was small and negative by half sib analysis and small by intra sire, regression. Dickerson (1959) suggested that this situation could arise from two possible reasons. Firstly the estimates of variance components could be negative from sampling, a necessary and sufficient condition for that to hold would be that size should have been small. In this case the sample size per sire was fairly large, about 7.81 progeny per male were scored. Second possibility is that the genetic variation with respect to this trait was really small and not different from zero. This observation is supported by the fact that the range between two extreme in this trait is as small as 4 ovarioles.

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TABLE I ANALYSIS OF VARIANCE FOR OVARIOLE NUMBER IN TRIBOLIUM CASTANEUM

Source of variation	D.F.	S.S.	M.S.
Between sires	54	2.9204	0.064
Between dames within sires	90	7.7360	0.086
Between progeny within dams within sires	286	107.7800	0.377

$K_1 = 2.97$, $K_2 = 2.95$, $K_3 = 7.81$

$6^2e = 0.377$, $6^2d = -0.097$, $6^2S = -0.005$,

$h^2 = -0.073$

TABLE II: ANALYSIS OF VARIANCE OF INTRA SIRE REGRESSION OF DAUGHTER ON DAM

Source of variation	Dams Variation			Dam Daughter covariance	
	D.F.	S.S.	M.S.	S.S.	M.S.
Between sires	50	39.7800	0.7956	3.2733	0.0655
Within sires	84	6.9240	0.0824	1.1450	0.0136

Dam variance

$6^2e = 0.0824$, $6^2S = 0.266$

Dam daughter covariance

$6^2e = 0.0136$, $6^2s = 0.0194$,

$6^2A = 0.0388$, $h^2 = 0.1458$

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*The map position of Charcoal

Charcoal (Chr), an autosomal dominant with recessive lethal effects, is a body color mutation resembling, but distinct from, black. Previously, Sokoloff (1977) determined that black (b), aureate (au) and light ocular diaphragm (lod)are linked, and the frequency of recombination frequencies are: b - au = 39.79 + 1.78, au - lod = 27.67 + 1.62 and b - lod = 13.97% when the heterozygotes are males and b - au = 37.43 + 1.27; au - lod = 18.32 + 1.21 and b - lod = 21.05 + 1.51% when the heterozygotes are females.

We now report that Charcoal (Chr) is in the vicinity of b. This is suggested by the recombination frequencies (Chr - au = 44.11 + .50; Chr - lod = 17.67 + .38; and au - lod = 28.08% for heterozygous males and Chr - au = 41.28 + .49; Chr - lod = 20.03 + .40 and au - lod = 22.19 + .42% for heterozygous females) and by the tests of allelism: Chr/+ X b/b give black and bronze F_1, and backcrosses of Chr+/+b ♀ X +b/+b ♂ produced 8/11,853 = 0.07% recombinant bronze beetles and the reciprocal cross gave 2/14,583 or 0.014% recombinants. It is suggested that the order of these pseudoalleles is Chr - b - lod - au.

This investigation was supported by U.S. Army Research Office grant DRXRO-CB-14447-L.

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*A case of pseudoallelism involving body color genes in Tribolium castaneum

The third linkage group of Tribolium castaneum is identified with black, an autosomal semidominant gene which was probably the second mutant discovered in this flour beetle. A recent study (Sokoloff, 1977) has established that black (b) and the autosomal recessive mutants aureate (au) and light ocular diaphragm (lod) are linked. The distances between b and au = 39.79 ± 1.78 units; au - lod = 27.67 ± 1.62 units and b - lod = 13.97 units in the males, and b - au = 37.43 ± 1.27 units; au - lod = 18.32 ± 1.21 units and b - lod = 21.05 ∓ 1.51 units in the females. The order of the three genes is the same in the two sexes: b - lod - au.

A more recent study with Charcoal (Chr), (an autosomal dominant with recessive lethal effects) has determined that it, too is linked with au and lod. The recombination values are: Chr - au = 44.11 ± .50 units; Chr - lod = 17.67 ± .38 units; and au - lod = 28.08 ∓ .45 in the males, and Chr - au = 41.28 ± .49 units; Chr - lod = 20.03 ± .40 units; and au - lod = 22.19 ± .42 units in the females. The order of these genes is, therefore, Chr - lod - au in the two sexes, the differences in recombination values being attributed to differences in genetic background.

These linkage data suggest that Chr and b are either alleles of each other, or pseudoalleles. We have carried out experiments which suggest that b and Chr are pseudoalleles.

Crosses between Chr/+ and b/b produce two types of beetles: one group is phenotypically as dark as the black strain, and indistinguishable from b/b beetles. The other group is genetically +/b and phenotypically these beetles are bronze, a color characteristic of the heterozygotes +/b which is expected.

Using every precaution to prevent contamination, we crossed Chr+/+b females back to black males. We obtained 8/11,853 bronze beetles giving a recombination value of 0.07 per cent. While in the reciprocal cross, Chr+/+b ♂ X b/b ♀ we obtained 2/14,583 bronze beetles, or a recombination value of 0.014%.

Hence the two genes, b and Chr cannot be considered alleles (occurring in the same locus) but they must be considered pseudoalleles.

We do not have three point crosses to give the exact order of these four genes, but the linkage data so far obtained suggests

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A more recent study with Charcoal (*Chr*), (an autosomal dominant with recessive lethal effects) has determined that it, too is linked with *au* and *lod*. The recombination values are: *Chr* - *au* = 44.11 ± .50 units; *Chr* - *lod* = 17.67 ± .38 units; and *au* - *lod* = 28.08 ∓ .45 in the males, and *Chr* - *au* = 41.28 ± .49 units; *Chr* - *lod* = 20.03 ± .40 units; and *au* - *lod* = 22.19 ± .42 units in the females. The order of these genes is, therefore, *Chr* - *lod* - *au* in the two sexes, the differences in recombination values being attributed to differences in genetic background.

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Crosses between *Chr*/+ and *b*/*b* produce two types of beetles: one group is phenotypically as dark as the black strain, and indistinguishable from *b*/*b* beetles. The other group is genetically +/*b* and phenotypically these beetles are bronze, a color characteristic of the heterozygotes +/*b* which is expected.

Using every precaution to prevent contamination, we crossed *Chr*+/+*b* females back to black males. We obtained 8/11,853 bronze beetles giving a recombination value of 0.07 per cent. While in the reciprocal cross, *Chr*+/+*b* ♂ X *b*/*b* ♀ we obtained 2/14,583 bronze beetles, or a recombination value of 0.014%.

Hence the two genes, *b* and *Chr* cannot be considered alleles (occurring in the same locus) but they must be considered pseudoalleles.

We do not have three point crosses to give the exact order of these four genes, but the linkage data so far obtained suggests that the order of the genes is probably *Chr* - *b* - *lod* - *au*, with *Chr* and *b* very close to each other.

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Pattern of sorbic acid sensitivity in *Tribolium confusum* embryos.

Sorbic acid is a short chain di-unsaturated fatty acid which produces no significant chronic or acute toxic effects when taken orally by small mammals (Tanase, 1974, Gaunt, et al., 1975). It is used as a broad spectrum fungistat in many foodstuffs including cereal products and is inexpensively synthesized. Sorbic acid is also ovicidal for stored product Coleoptera at levels approved for human consumption (Boush et al., 1968, Burkholder et al., 1973, Baker and Mabie, 1973). In our studies to determine the insecticidal mode of action of this food additive, it was found that the *Tribolium confusum* embryo is sensitive to sorbic acid only during the first 24 hours after oviposition. Further information on the pattern of its sensitivity during this period was desired.

Oxygen consumption measurements were obtained with an 8 flask recording Gilson differential respirometer. Eggs were obtained within a 2 hour period from surface sterilized adults and maintained in the respirometer at 30°C and 93% R.H. Under these conditions the period of embryogenesis is 115-120 hours. Sorbic acid was added to the autoclaved whole wheat flour containing 5% yeast. Sample size was 200 eggs/flask with 2 replications at each concentration.

At concentrations of 0.25% and 0.50% sorbic acid, mortality was not observed unless eggs were laid directly in the treated flour (Fig. 1). Only then did significant ($P<.001$) mortality occur after an 18 hour exposure with 0.50% and after a 24 hour exposure with 0.25%. There was no difference in the pattern of sensitivity with 4.60% and 8.00%. These higher concentrations caused 100% mortality when eggs were exposed at (1) oviposition and for only 2 hours thereafter and (2) 18 hours after oviposition for the remainder of embryogenesis.

At levels of sorbic acid which produce 100% mortality, no metabolic activity was detected in embryos. At levels of sorbic acid which produce 50-75% mortality, embryos began to respire at a rate similar to controls, but a significant difference ($P<.001$) was detected at 84 hours postoviposition (Fig. 2). At sublethal exposures there was no detectable difference between the test and control patterns of O_2 consumption.

These results suggest that 4.6% sorbic acid is acutely toxic to *T. confusum* embryos on contact. The toxic effect of 0.25% is detectable when monitored by O_2 consumption late in embryogenesis. However, in both mortality patterns, exposure must occur in the first 24 hours after oviposition and the most critical time during this period is the 2 hours immediately after (and including) oviposition. Events occurring during this period that may be interrupted by sorbic acid are synthesis of the vitelline membrane which confers water impermeability, closing of the micropyle, blastoderm formation and drying (polymerization) of the exochorion.

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Figure 1. Pattern of mortality of <u>Tribolium confusum</u> embryos exposed to sorbic acid.

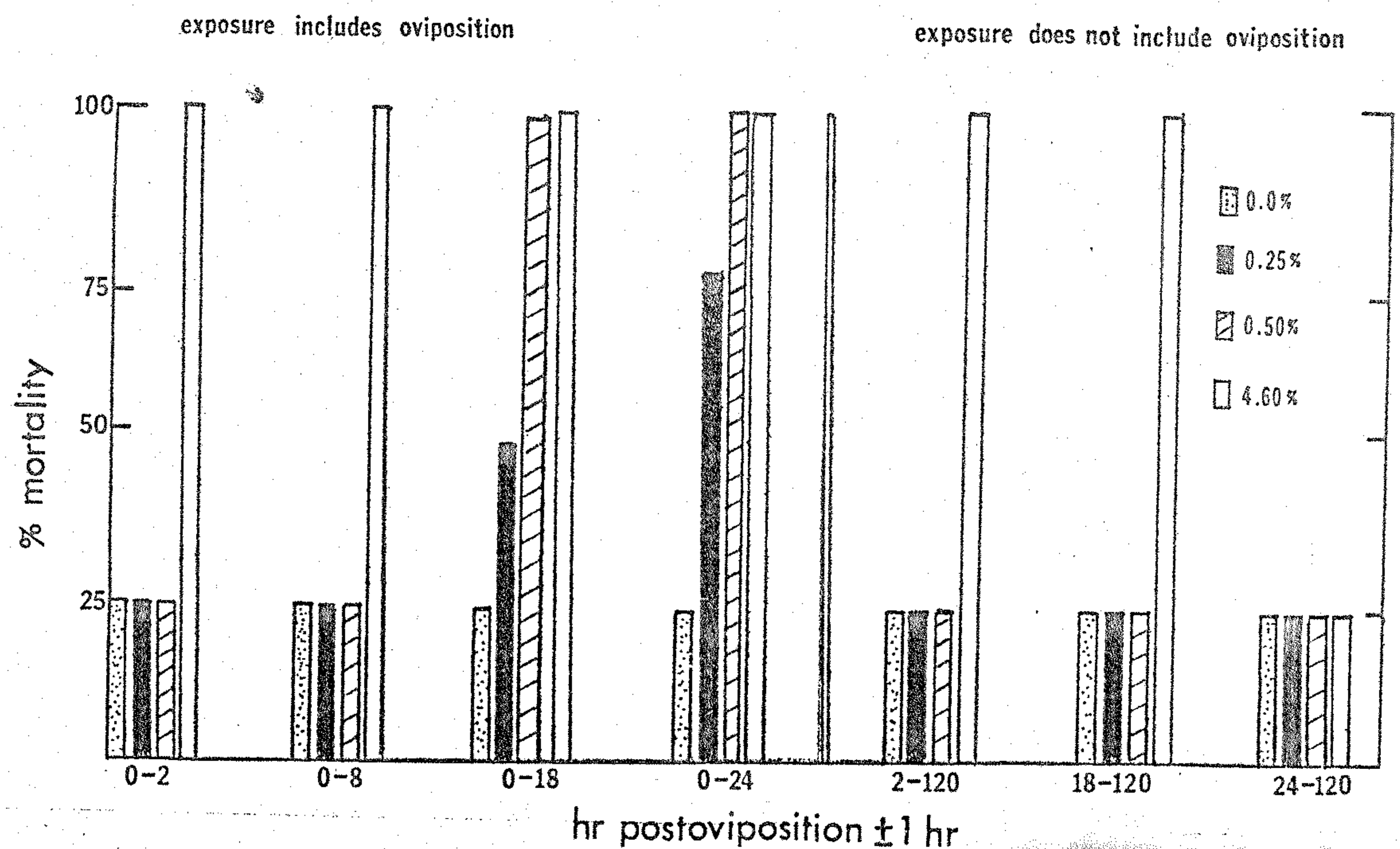


Figure 1. Pattern of mortality of Tribolium confusum embryos exposed to sorbic acid.

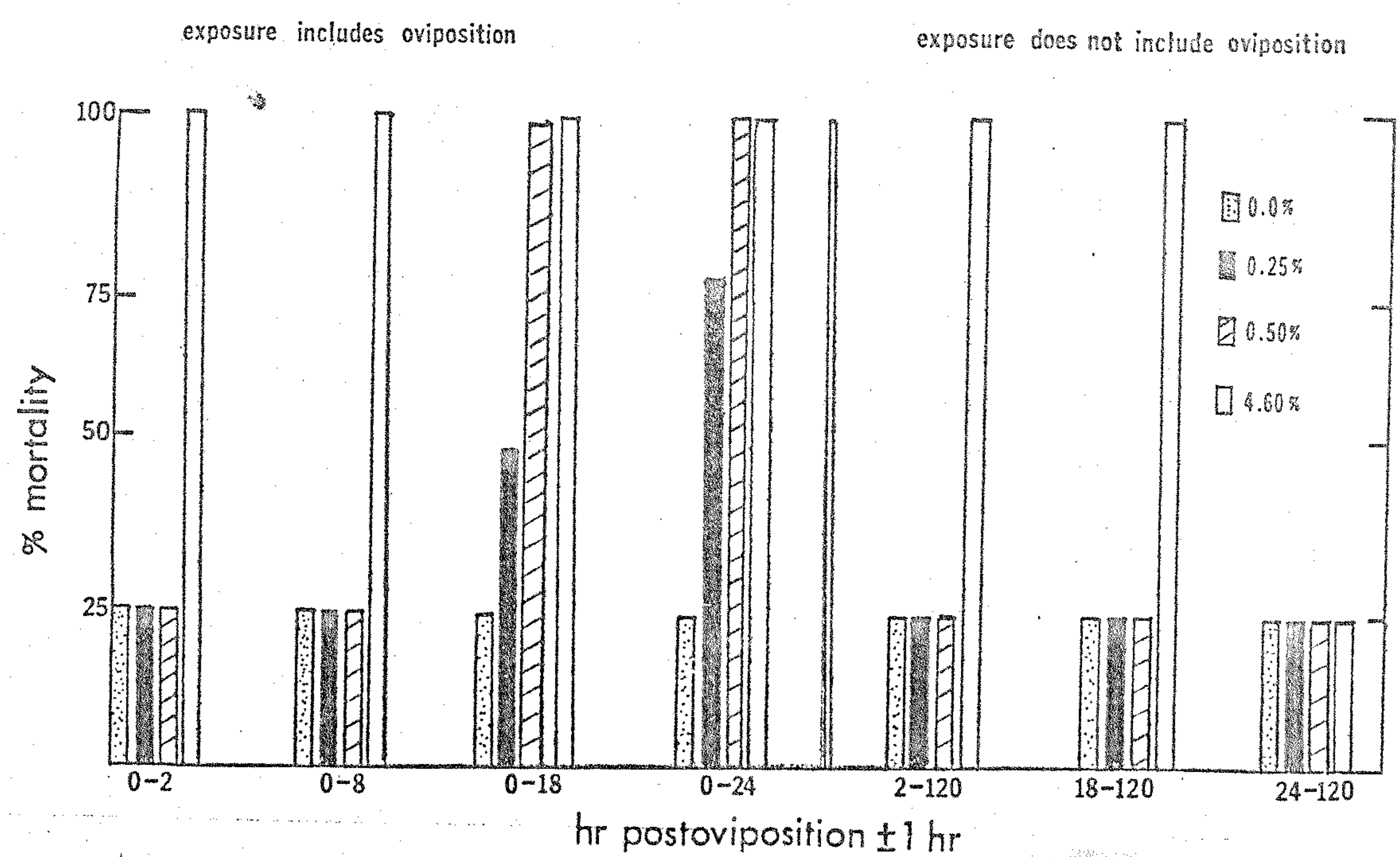
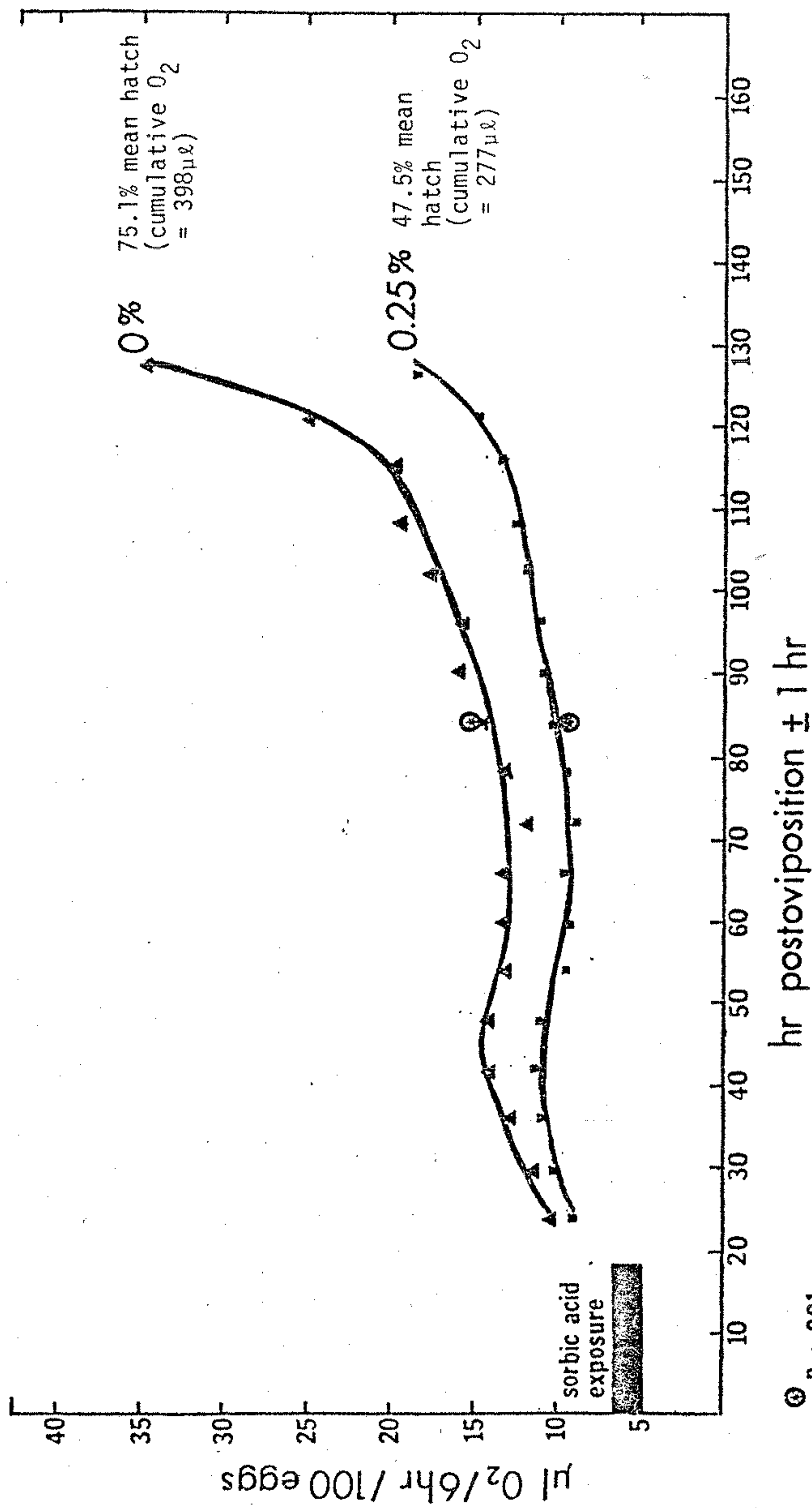


Figure 2. O_2 consumption of *Tribolium confusum* embryos exposed to sorbic acid. $30^{\circ}C$. 93% R.H.



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*Comparison of natural selection for three deleterious genes in *Tribolium castaneum*

Three autosomal dominant mutations in *Tribolium castaneum*, each lethal when homozygous, were examined to determine their rate of elimination from laboratory populations under extreme competitive conditions. The three mutations used were Short antenna (*Sa*), Deformed (*Df*), and bar eye (*Be*). For detailed descriptions of the three mutations, consult Sokoloff (1966).

Four populations were initiated for each of the mutant strains, using 10 pairs of mating adults possessing the desired heterozygous genotype. The four populations were examined as follows:

Population 1 -- Censused at 40-day intervals for 240 days, with all contents of the population box being replaced after censusing.

Population 2 -- replication of Population 1.

Population 3 -- Censused at 120-day intervals for 240 days; all contents replaced after censusing.

Population 4 -- Censused at 40-day intervals for 80 days; all contents except wild-type adults being replaced after censusing.

All populations except Population 4 were run concurrently. Population 4 was introduced toward the end of the study. Each population was reared in a plastic population box (13x17.5x6cm) containing 100g of the stand culturing medium (95% whole wheat flour, 5% dried brewer's yeast). Culturing conditions of 33° ± 2° C and 65 ± 5% R. H. were maintained in darkened Labline Incubators (Model 844B). New culture medium was introduced only after the 200-day census, when it became obvious that severe starvation would terminate the study prematurely. The contents of each population box was censused for the number and genotype of live and dead adults and the number of pupae. Larvae and eggs were not censused. After the census was completed, all contents were returned to the box. In Population 4, all contents except the living wild-type adults were returned to the box.

The gene frequencies recorded for each of the mutant strains are presented in Table 1. When the study was terminated at 240 days, Be had been eliminated from each of the populations subjected to natural selection; Df had been eliminated from two of the populations and was present at a frequency of 0.01 in the third, but Sa was still evident at a reasonably high frequency. In each of the three mutant strains, gene frequency counts at 120 days were quite similar for the three populations exposed to natural selection, suggesting that the frequent handling and censusing *per se* of Populations 1 and 2 had no adverse or favorable effects upon the fate of the gene frequencies. However, in the Sa strain, Population 3, when compared to Populations 1 and 2 exhibited a lower gene frequency when censused at 240 days. It is not known whether the handling plus addition of new medium at 200 days was responsible for this discrepancy or whether some other factor was operating. The addition of fresh medium at 200 days did not prevent or decrease the rate of elimination of either the Df or the Be genes.

Under selection against a recessive lethal with discrete generations, the gene frequency expected at the end of the study period (240 days equivalent to 6-7 generations) would be 0.12 - 0.11, and elimination of the gene from the effects of selection against the homozygote alone would be slower as the gene frequency gets smaller. With overlapping generations, the decrease in gene frequency would be slightly slower, but not of a sufficient magnitude to alter the eventual outcome by many generations (Crow and Kimura, 1970).

In the present study, the elimination of Be came quite rapidly, with the frequency of this gene being reduced to below 0.1 within the first 80 days of exposure to natural selection, while Df did not fall below that figure until the 200-day census, and when the study was terminated, Sa was still present above the 0.1 frequency.

Tables 2, 3 and 4 present the census figures for the live and dead adults and pupae recorded during the study. An increase in the number of live adults after new medium was introduced was observed only for the Sa and Df strains, indicating that even the wild-type genotype in the Be strain was unable to adjust to the severe competitive conditions created. Although the Sa strain did not "rebound" as well as the Df strain after new medium was introduced, the sudden increase in gene frequency is of interest. Since there was complete overlap of generations, it is not known whether this increase was the result of an increase in Sa/+ progeny or an increase in the ability of the Sa/+ parents under extremely adverse conditions to survive better when these conditions were temporarily reversed.

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Dawson (1970), in a study also using the *Sa* gene, observed a decline in gene frequency which did parallel that expected of a homozygous recessive lethal in populations with discrete generations except for populations which had a recessive lethal coupled to *Sa*. His study, however, was performed under conditions in which fresh medium was introduced into each new generation. The conditions of the present study would provide the maximum competitive environment necessary for the genotypes in question. Since conditioning of the culture medium had been shown to have an effect upon fecundity, survivorship of eggs and developmental rate in some genotypes (Karten, 1965), it is highly likely that the *Sa*/+ individuals may have been better able to adapt and respond to the changing medium conditions during the last 40 days of the study, thus, the increase observed in gene frequencies.

While sex ratios of the surviving adults had not been taken, another possible answer for the increase of *Sa* following addition of the new medium might be that the majority of the *Sa*/+ beetles present were females. It has been shown both by Krause *et al.* (1962) and Dawson (1970) that the *Sa*/+ males are drastically reduced in mating success, which would increase selection against *Sa* initially, but when coupled with an adaptation to medium conditioning could enhance its retention on a short term basis.

The rapid elimination of the *Be* gene from all populations, including the one subjected to artificial selection, is the consequence of a combination of a serious decrease in viability of the *Be*/+ genotype and the inability of the male to successfully mate as observed by us. This latter has been demonstrated to be a key factor in the rapid elimination of mutant genes in *Drosophila melanogaster* populations (Merrell, 1965). While there is no direct evidence, this is probably also true of the *Df*/+ males although when artificial selection is practiced, the population size appears unaffected (Table 3).

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Table 1. Gene frequencies for three mutant strains of *Tribolium castaneum* subjected to natural selection.

Days	Sa/+				Df/+				Be/+			
	Pop.1	Pop.2	Pop.3	Pop.4	Pop.1	Pop.2	Pop.3	Pop.4	Pop.1	Pop.2	Pop.3	Pop.4
0	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
40	0.36	0.34	no census	0.33	0.40	0.38	no census	0.41	0.30	0.19	no census	0.3[illegible]
80	0.31	0.28	no census	0.39	0.29	0.26	no census	0.38	0.09	0.08	no census	0.2[illegible]
120	0.30	0.27	0.31	--	0.21	0.19	0.21	--	0.03	0.06	0.005	--
160	0.24	0.25	no census	--	0.18	0.18	no census	--	0.005	0.01	no census	--
200	0.15	0.17	no census	--	0.01	0.01	no census	--	0.00	0.00	no census	--
240	0.29	0.22	0.18	--	0.01	0.00	0.00	--	--	--	0.00	--

Table 4. Number of live adults, dead adults and pupae recorded during each census period for the Be/+ populations.

Days	Population 1			Population 2			Population 3			Population 4		
	LA	DA	P	LA	DA	P	LA	DA	P	LA	DA	P
0	20	0	0	20	0	0	20	0	0	20	0	0
40	112	7	10	46	18	9		no census		46	8	36
80	924	58	138	162	36	169		no census		59	26	49
120	1611	208	242	689	127	125	1126	91	21	--	--	--
160	826	1142	8	596	378	82		no census		--	--	--
200	24	1967	23	17	916	14		no census		--	--	--
240	12	2019	16	7	941	9	31	1412	18	--	--	--

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*Size as a Factor in the Infection of Tribolium spp and Eleodes sp by Hymenolepis diminuta

Introduction

Tribolium spp have been established as a successful host for the rat tapeworm, Hymenolepis diminuta. The tapeworm ova are passed out of the rat host with the fecal matter. When they are ingested by a suitable species of beetle, the eggs hatch in the intestine. The onchospheres then penetrate the intestinal wall and enter the haemocoel where they develop into cysticercoids. Factors affecting the incidence of infection in beetles has been investigated. Role of sex of the beetles in infection has been studied by Mankau et al 1971, where they reported a significantly higher rate of infection in the female beetles compared to the males. A comparative study of the two sexes in three different species of Tribolium showed that in T. confusum and T. castaneum a significantly greater percentage of female beetles became infected compared to the males and that the females of those two species harboured significantly greater numbers of cysticercoids per beetle than the males. T. brevicornis showed no significant difference between the sexes in the percentage of infected beetles or in the number of cysticercoids harboured by each beetle (Mankau 1977). The role of age of beetles on the incidence of Hymenolepis infection in T. confusum beetles had been reported by Kelly et al (1967) where they observed that old females had a significantly smaller burden of cysticercoids when compared to young or middle-aged females, whereas middle-aged males generally had a higher incidence only where compared with young or old males, concluding that age resistance to H. diminuta cysticercoids in T. confusum occurs only in the females.

The purpose of the present study was to determine whether or not the differences in size and weight between a pygmy mutant strain and the normal strain of T. castaneum has a significant effect on the number of H. diminuta cysticercoids harboured by the beetles. Also whether Eleodes, a commonly found beetle in So. California could serve as an intermediate host for H. diminuta and if so, whether its relatively huge size would harbour a proportionate number of cysticercoids per gram of body weight.

Methods and Materials

60 beetles of normal strain and 60 of the mutant pygmy strain of *Tribolium castaneum* species were obtained from Dr. Alex Sokoloff, Director, Tribolium Stock Center, California State College at San Bernardino. 30 *Eleodes dentipes* sp beetles were collected from the Riverside-San Bernardino area. The beetles were denied food for 3 days prior to the infection. They were grouped in petri dishes, each containing 10 *Tribolium* beetles/dish. *Eleodes* were separated in groups of five.

Hymenolepis diminuta inoculum was obtained by removing tapeworms from an infected white rat (Carolina Biological Supply, Inc.). Gravid proglottids were placed in mammalian ringer's solution and teased apart to liberate the ova. Ova concentration was determined by direct count under a dissecting microscope. A suspension of approximately 200-240 ova per drop was used to infect the beetles by placing a drop of the inoculum on an oatmeal flake 3-4 mm in diameter. The inoculum was absorbed into the oatmeal flake and 5 such flakes were placed in each of the petri dishes containing the beetles, providing approximately 100-1,200 ova per dish. The petri dishes were covered and taped to prevent dessication of the ova. Most of the oatmeal was consumed in the first two days and subsequently the beetles were fed their regular diet of 95% unbleached wheat flour and 5% brewer's yeast. After 7 weeks all the beetles were dissected under a dissecting scope and the cysticercoids counted.

Results

Thirteen of the initial 135 beetles died during the experiment. 63% of the remaining 119 beetles were infected. The survivors consisted of 58 *T. castaneum* (normal), 52 *T. castaneum* (pygmy) and 9 *Eleodes*, showing 71, 64 and 10 percent infection respectively.

Incidence of *H. diminuta* cysticercoids per infected beetle was highest in *T. castaneum* (N) with 3.4 per beetle, followed by *T. castaneum* (P) with 2.9 per beetle, with *Eleodes* harbouring 2 cysticercoids, both found in the single infected beetle.

Table 1. Rate of infection and incidence of H. diminuta cysticercoids in experimentally infected T. castaneum (N), T. castaneum (pyg.) and Eleodes.

Beetle	Mortality	Survivors	Infected	% infection	Total cysticercoids	Cysticercoids per beetle	Cysticercoids per gm of bo. wt.
T. castaneum(R)	2	58	41	71	138	3.4	1.36
T. castaneum(pgy)	8	52	33	64	95	2.9	2.37
*Eleodes	3	9	1	10	2	2.0	
Total	13	119	75	63	235	3.1	

*3 were missing within the first week

Discussion

The average number of cysticercoids harboured per infected T. castaneum (N) beetle (3.4) appear not to be significantly greater than those found in the mutant, T. castaneum (P) (2.9). This is remarkable, since the pygmy mutant weighs only half as much as the normal T. castaneum beetle. This therefore indicates that the difference in size and weight between T. castaneum (N) and T. castaneum (P), has no significant effect on the incidence of H. diminuta cysticercoids.

In a similar study (Mankau 1977) using 3 different species of Tribolium beetles, namely T. castaneum, T. confusum and T. brevicornis, it was found that the average number of cysticercoids harboured by T. castaneum was greater than in T. brevicornis even though the latter species weighed 8-10 times more than T. castaneum.

The number of cysticercoids per gram of body weight of the beetles was significantly higher in the pygmy mutant (2.37) compared to the T. castaneum (N) (1.36).

Although only one out of the 30 Eleodes sp beetles used in the experiment became infected, it nevertheless is significant information. This beetle is commonly found in the fields and backyards of southwestern United States and no doubt serves as a source of food for wild rats and mice. The cysticercoids recovered from these beetles were normal in appearance and development and therefore it is evident that they can serve as effective intermediate hosts for Hymenolepis diminuta.

It is possible that the extremely large mouthparts in Eleodes sp is related to the very low infection rate. Voge and Berntzen (1961) in their study of "in vitro" hatching of H. diminuta oncospheres have shown that the rupture of the egg shell of the ova is necessary for the successful hatching and continued development of cysticercoids. This rupture is normally caused by the mandibles of the beetle. An interesting case was reported by Mankau and Morse (1973) where in an experiment, where T. confusum were infected with H. diminuta ova, and obtained 77% infection with mature infective cysticercoids, one beetle was found to contain approximately 450 ova, with the egg shell intact, but harboured no cysticercoids. When the mouth parts of the beetle was examined it was found to have a defective mandible, affecting its ability to properly puncture the membrane of the onchospheres.

The large mouth parts of the Eleodes beetle could have permitted the passage of the onchospheres without rupture of the membranes thereby preventing subsequent development into cysticercoids.

We hope to test the above hypothesis by removing the cutting edges of the mandibles of Tribolium beetles prior to their infection with H. diminuta cysticercoids to see if it affects proper development of cysticercoids.

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Natural selection on adult body weight in *Tribolium castaneum* *

This is a study of changes in adult body weight accompanying seventy generations of a husbandry regime in which discrete generations are imposed on populations of the Chicago Black strain of *Tribolium castaneum*. The regime, described fully in Sokal and Sonleitner (1968), consists of allowing the offspring of three days of adult oviposition to mature and in turn reproduce for three days in fress medium. To examine the genetic consequences of long term exposure to this regime, adult dry weight was assayed under controlled conditions in populations extracted from ongoing discrete regime lines at generation 70 and in the laboratory stock Chicago Black cultures from which the discrete lines had originated. The stock cultures had been husbanded so as to permit overlapping generations for at least fifteen years. In a separate experiment the effect of population density on adult dry weight was also examined.

Materials and Methods

All experiments were carried out at 29.5°C and 70% relative humidity in medium consisting of 95% sifted whole wheat flour and 5% brewer's yeast. The experiments were performed in 8g of medium in 8 dram shell vials at a population density prescribed by the particular experimental design. Adults were dried for 24 hours at 100°C and mass weighed by replicate. All adults assayed were one generation removed from their particular husbandry regime, the interim generation being at a low density considered optimal for *Tribolium* development.

Results

Vials were seeded with 20 eggs collected from batches of either discrete or stock origin adults that had been mass mated. Five replicates were run for each group. Forty days after the cultures were initiated (about ten days after adult eclosion) each replicate was mass weighed. The stock regime group, at 1022 ug/adult, was found to be significantly heavier (P 0.01) than the 936 ug/adult weight found in the discrete regime group.

Another experiment was run to determine the effects of population density on the dry weights of the two strains. Replicate vials were each seeded with 50 eggs and compared to those seeded with 400 eggs for both strains. Mean adult weights at the lower density were 972 ug for the stock group and 860 ug for the discrete group. At the higher density they were 903 ug and 796 ug, respectively. A two-way analysis of variance reveals the effects of density and previous husbandry to be highly significant (P 0.001) but not their interaction. In both cases adults raised at high density weigh about 93% as much as those raised at low density.

Conclusion

Lowered adult body weight is a consequence of long term exposure to the discrete generation regime. This is apparently genetic in origin and is probably a result of selective forces generated by this husbandry regime. McCauley (1977) presents a series of assays on other quantitative traits affected by the discrete regime and also presents the demographic consequences of selection on these traits. In that paper a model of the selective forces generated by the novel regime is presented.

The lack of an interaction between the effects of husbandry regime and population density indicates that there was no selection on the factors determining the genotype X environment interaction in this character.

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New strategy to maximize the egg-laying of virgin female in *Tribolium castaneum* with reciprocal recurrent selection.

Starting from a population of the *T. castaneum* "Consejo" kept in laboratory without selection and with a minimum of consanguinity, it was designed an experience which consisted in the use of the reciprocal recurrent selection (rrs) and two different pressures of selection - 20% and 2%, respectively - with three replications and standard conditions in the growing and operation of insects; the quantitative character selected was the egg-laying of virgin females between the days 7th to 9th after emergence. On seeing the obtained result after five generations of selection, during which the lines kept at 2% of selection had to be given up on account of the loss of vigour and high mortality and in order to find out a suitable strategy which could make compatible the effects of the strong pressure of selection in short time with a graduated adaptation of the studied populations to the environment, new lines were extracted derived from the lines kept until that moment at 20% of selection, advancing with all those until the 9th generation.

The respective analysis of variance for mean on generations of reciprocal crosses show a significant advantage of the pressure of selection of the 2% in front of the one of 20% in the first generation of rrs, although in the following generations the reproduction capacity deteriorates slowly. From this, we deduce that these pressures selected a priori don't allow to study which should be the optimum.

Two new experiences which complete the previous information are still in their period of achievement and they consist in two new strategies where, besides the rrs and previous selection pressures, other ways of selection move simple participate at alternative intervals.

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*Ultrastructural Characterization of a Single Gene Effect on the Egg Surface of *Tribolium castaneum*.

The "weird gene" (wd) of *Tribolium castaneum* is completely recessive and produces the easily detected phenotype illustrated in Figure 1. Eggs of homozygous females (wd/wd) fail to acquire the usual coating of flour particles. We previously speculated that this results from the absence of an outer "sticky" coating (Dawson and Riddle, 1975). The present report confirms this and describes the precise anatomical basis of the difference between the normal and weird phenotypes as well as some ultrastructural aspects of the egg shell.

Eggs from a pure breeding line of the weird gene and normal eggs from the outbred Oregon Synthetic stock were examined. For scanning electron microscopy (SEM), the flour was removed from normal eggs by washing in a dilute solution of zepharin. Washed eggs retain at least some of their stickiness. For transmission electron microscopy (TEM), washed and unwashed eggs were examined. The results confirmed that no egg component was removed by the washing procedure. Stanley and Grundmann (1966) also found the outer "gummy" layer to be resistant to detergent except within the first few hours after oviposition.

All eggs were fixed in 5% glutaraldehyde in 0.1 M sodium cacodylate buffer at pH 7.0 for 3½ days at $4^{\circ}C$. The eggs were then rinsed in 0.2 M cacodylate and postfixed in cacodylate buffered 2% osmium tetroxide for 2 hours. Dehydration was carried out in a graded series of ethanols. For TEM the eggs were stained *en bloc* with uranyl acetate and embedded in Araldite under vacuum. Thin sections were cut with a diamond knife, serially stained in uranyl acetate and lead citrate, and viewed in an RCA 3H electron microscope. For SEM the eggs were critical point dried, mounted on double-sticky tape, coated with gold-palladium, and viewed with an International Scientific Instruments Mini-SEM.

The three dimensional surface structure of a normal egg is illustrated in Figures 2 and 4. Even at low magnification (Fig. 2), a textured appearance is discernible with SEM which is not detectable with the light microscope. At a higher magnification, (Figure 4), the topography is resolved into a reticular network, irregular in height and structure. Compare with this the featureless appearance of eggs produced by homozygous (wd/wd) females (Figures 3,5).

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Comparison of transmission electron micrographs of transverse thin sections (Figures 6,7) show that the textured appearance of normal eggs is due to an outer layer which is absent in weird eggs. Being the most external layer, it is presumably responsible for the sticky quality of normal eggs and will be labelled as the "sticky layer". Absence of the sticky layer is the only apparent structural defect in the weird egg. The sticky layer varies in height from 0.1 µm to 6 µm and is vaculoated but does not have a frothy appearance as in some beetle eggs (Sweeny et al., 1968).

The remaining structure of the egg shell is composed of three layers: vitelline membrane, endochorion and exochorion. The most medial, the vitelline membrane, is not shown since the preparative procedure caused its separation from the remaining egg shell. The crystalline endochorion appears variously as striated parallel to the egg surface, normal to the egg surface (most common), and cross hatched, and thus, is similar in appearance to the crystalline layer of T. confusum (Furneaux and Mackay, 1970). The adjacent margins of both the vitelline membrane and endochorion are differentiated into bands by a difference in electron density in our micrographs. The endochorion margin also appears to lack the regular structure of the crystalline layer. The structural location suggests that these bands could represent the wax layer(s).

The exochorion is heterogeneous and does not exhibit a regular substructure. Often seen in the exochorion are circular structures which are electron dense with electron lucent cores. Occasionally, the cores of these structures are contiguous with each other and also with electron lucent channels through the crystalline layer.

In normal eggs, but not in weird, the exochorion has an irregular wave pattern in transverse section (Figure 6). This difference may simply be due to physical forces acting on the egg surface, however. Furneaux and Mackay (1970, 1976) do not distinguish between exochorion and the sticky layer. However, since a single gene substitution is responsible for the complete absence of one and not the other, it seems clear that the two layers are chemically distinct as well as structurally distinct. It should also be noted that the exochorion of Stanley and Grundmann (1966) is equivalent to what we label the sticky layer.

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Ultrastructural Characterization of a Single Gene Effect on the Egg Surface of *Tribolium castaneum*

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Legends

Figure 1: Light micrograph of normal and weird eggs. Normal eggs are covered with flour.

Figure 2: SEM of normal egg with flour removed. The bar represents 50 µm.

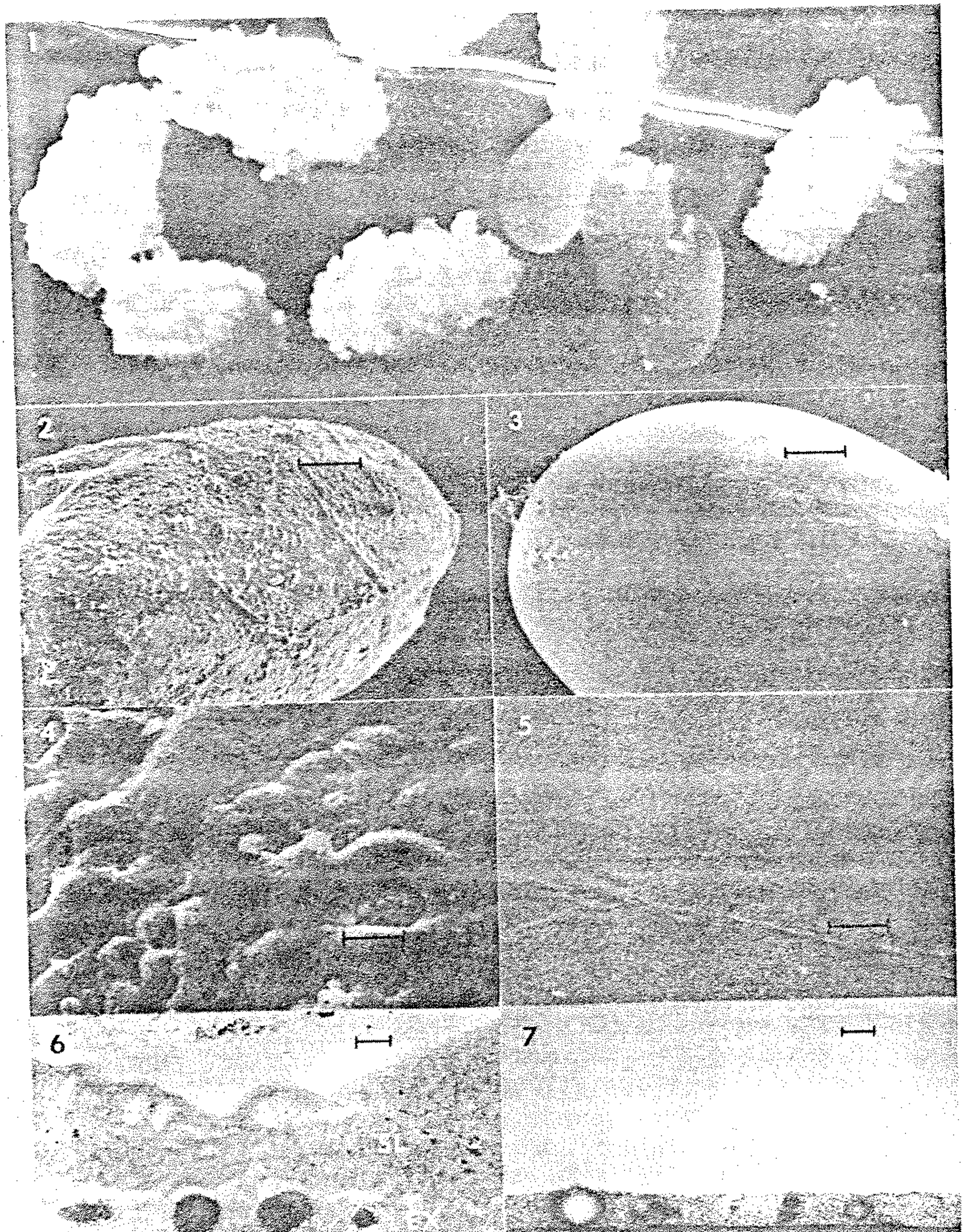
Figure 3: SEM of weird egg. The bar represents 50 µm.

Figure 4: SEM of normal egg with flour removed. The bar represents 5 µm.

Figure 5: SEM of weird egg. The bar represents 5 µm.

Figure 6: TEM of transverse section of normal egg. SL, sticky layer; EX, exochorion; EN, endochorion; CL, crystalline layer. The bar represents 0.1 µm.

Figure 7: TEM of weird egg. The bar represents 0.1 µm.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*Variability for dispersal behavior in a wild population of *Tribolium castaneum*

Introduction

The quantitative study of dispersal behavior in *Tribolium* was greatly facilitated by Prus (1963), who suggested a simple apparatus in which the act of dispersal can easily be separated from other types of movement. Since then it has been demonstrated (Prus, 1966; Żyromska-Rudzka, 1966; Ogden, 1970a) that the rate of dispersal depends upon the species, genetic strain, sex, density (of larvae or adults) and degree of conditioning of the flour. The differences between strains (Prus, 1966), and the results of selection experiments (Ogden, 1970b), indicate that the variation in dispersal activity has a genetic component.

So far all of the studies on dispersal behavior were performed on laboratory stocks, in which departure of dispersing individuals is usually not allowed. The present work deals with variability for this trait in a natural population. On the basis of the results some speculations are offered about the role of dispersal in the ecology of *Tribolium* in nature.

Methods

1. Population. The population of *Tribolium castaneum* used in this study was derived from beetles that were collected three months prior to the start of the experiment in a grain storage silo near Tel Aviv. These individuals were mated freely, and the beetles used in the experiments were collected as pupae from among their progeny.

2. Experimental apparatus. Dispersal was studied in an apparatus based on the one designed by Prus (1963). The beetles to be tested are placed, in a measured amount of flour, in a small vial (A) which is connected through its top, by means of a polyvinyl tubing, to a small, empty vial (B). A thin thread, 30 cm long, leaves the surface of the flour in vial A, goes through the tube, and enters vial B.

Beetles found on the bottom of vial B are scored as dispersants. In Prus' apparatus, the thread ends in vial B with a loop, and does not reach the bottom. In our apparatus, the tip of the thread is connected to a thin metal filament that does reach the bottom. It seems to us that our design is more reliable for scoring dispersing beetles, because, on one hand, the beetles do not have to jump or fall off the thread in order to reach the bottom, while, on the other hand, they cannot climb back once they get down.

3. Experimental design. To start the experiment, 19 pairs were chosen at random. From among the progeny of each pair, termed a family, two replicate groups of 30 beetles each (15 males and 15 females) were tested.

In each replicate, dispersal was measured when the beetles were 10, 20, 30 and 48 days old. The beetles were introduced into vial A, with 8 g of fresh flour (95% whole wheat flour, 5% brewer's yeast), 4 days before each run. All tests were carried out under similar conditions, including non-conditioned flour, absence of larvae or pupae, low but constant adult density and after enough time had elapsed to let the beetles get used to the new environment.

Males and females were marked differentially, with a dot of quickdrying nitrocellulose paint on the elytra. We found that the marking had no effect on viability, fecundity or the tendency to disperse.

On the day of the experiment, the thread leading to the bottom of vial B was inserted into the flour in vial A. Dispersants were defined as beetles found on the bottom of vial B after 24 hours. They were scored by sex, marked, and returned to vial A. The marking was such that we could know the performance of each beetle in each run. Four days prior to each run dead beetles were replaced by sibs of the same sex and age.

The experiments were run in a dark incubator with a temperature of 29°C and relative humidity 70%. the different families were distributed on the shelves at random, and the two replicates of each family were started several days apart, according to the availability of beetles.

4. Analysis of data. The comparison of dispersal activity according to family, replicate, sex and age was done using a program for Analysis of Variance, Factorial design (BMD 02V), available at the Library of the Computation Center, The Hebrew University. The analysis was carried out on the transformation

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arcsin m/n, where m = number of dispersants and n = total of beetles in vial A.

Results

1. Differences between families and between ages. The numbers of dispersing beetles, listed according to family, replicate and age are given in Table 1. The analysis of variance (Table 2) shows that while no difference exists between the means of the two replicates, the differences between families and between ages are highly significant.

The dependence of dispersal rate on age is shown in Figure 1. The mean rate of dispersal is highest at the age of 20 days, and its level at 48 days is very low. In order to find out whether it is only the low rate at 48 days which is responsible for the difference between ages, a second analysis of variance was carried out, this time excluding the data of 48 days. The results again show significant differences between families and between ages.

The analysis of variance also shows a significant contribution to the variation in dispersal activity of the interaction Age x Family, suggesting that the age of maximum probability to disperse varies from family to family.

Figure 1 can be supplemented by the results of a separate experiment, performed with 5-days old adults from the same population. Dispersal rate of these beetles was 13%. We conclude that on the average the tendency to disperse is low right after eclosion, reaches a maximum at the age of 2-3 weeks and declines sharply thereafter.

2. Differences among sibs. The following test was performed in order to find out whether differences exist also between individuals, within families:

If all members of a family (sibs in our case) have the same tendency to disperse, then at age i the propability for dispersal of any individual will equal p_i, the rate of dispersal of that family at that age. The determination as to whether a particular individual will move to vial B or not will depend only on p_i. Under such conditions, 60 individuals, which are tested 3 times (at 10, 20 and 30 days), are expected to form the four following groups, according to the number of times each beetle moves to vial B:

$$N_o = 60(q_{10} \cdot q_{20} \cdot q_{30})$$

$$N_1 = 60[(p_{10} \cdot q_{20} \cdot q_{30}) + (q_{10} \cdot p_{20} \cdot q_{30}) + (p_{10} \cdot p_{20} \cdot q_{30})]$$

$$N_2 = 60[(p_{10} \cdot p_{20} \cdot q_{30}) + (p_{10} \cdot q_{20} \cdot p_{30}) + (q_{10} \cdot p_{20} \cdot p_{30})]$$

$$N_3 = 60(p_{10} \cdot p_{20} \cdot p_{30})$$

where N_j denotes the number of beetles that have moved j times to vial B (N_j=60), and $q_i=1-p_i$.

If, on the other hand, some individuals in a given family have a higher tendency than others to disperse, the dispersing beetles at each age will not form a random sample of the entire family. The same individuals will tend to move into vial B every time, others will tend not to move at all, and the distribution of individuals according to the number of times they are found in vial B will deviate from the expected values given above.

Table 3 gives the observed and expected numbers of dispersing and non-dispersing beetles, for 17 of the families of the wild population (families 10_2 and 17 were omitted because of errors in scoring). A X^2 test on the totals shows that the deviations between "observed" and "expected" is found in the categories of "0 times" (16 families" and "3 times" (11 families), strongly suggests that all individuals of the same family cannot be considered identical with respect to their tendency to disperse.

3. Differences between sexes. Because the marking of a dispersing beetle obliterated its original marking according to sex, the comparison between the two sexes with respect to their rate of dispersal can be done, at each age, only with the beetles that have dispersed at that age for the first time. At 10 days the 402 dispersing beetles (at this age all dispersants do so for the first time) included 214 males and 188 females. At 20 days 129 males dispersed for the first time, compared to 123 females, and at 30 days the values were 51 males and 43 females. In none of the ages was the difference between the sexes statistically significant, but the excess of dispersing males was consistent.

Discussion

The main purpose of the present work was to see whether variability, with respect to the tendency to disperse, exists in natural populations of Tribolium. We decided to measure dispersal under optimal conditions, where it can be described as spontaneous, and not as a reaction to an environmental factor. Spontaneous dispersal is probably an adaptation to life in unstable or unpredictable habitats (Southwood, 1962). If the environment is going to become inhospitable, it is better not to wait until conditions actually deteriorate. There will be an advantage to a certain amount of dispersal when conditions are still good, and the chances of the dispersants to survive the process of wandering and to find a suitable habitat are not reduced by a lowered physical state.

Our results indicate that variability for dispersal behavior indeed exists, at least in the one population studied by us. The fact that the variation between families is much higher than within families (Table 2) strongly suggests that a large part of the variation is genetic. In addition, each family, although characterized by its own average rate of dispersal, seems to segregate for dispersants, that tend to disperse at every opportunity, and non-dispersants, that do not disperse at all (Table 3).

The problem of the forces which are responsible for maintaining this variability is interesting, but it cannot be solved without a better knowledge of the genetic basis of dispersal behavior and the dynamics of Tribolium populations in nature. A recent simulation study (Roff, 1975) has shown that, in a heterogenous environment, a variety of genetic models can account for the maintenance of variation within a local population, with respect to dispersal behavior.

For the last several thousand years Tribolium has been associated completely, or almost completely, with human facilities, such as flour mills and grain storage sites. Life in these habitats, and in particular as the war against Tribolium intensifies, must include many cases of establishment of new populations on one hand, and extinction of local populations on the other hand. The variability for dispersal ability can well be an adaption to this way of life.

The dependence of dispersal rate on age is also consistent with the assumption that spontaneous dispersal is mostly colonizatory. Natural selection is expected to time colonization to a pre-reproductive stage (Lewontin, 1965), and the findings in many migrating insects support this expectation (Dingle, 1972). In Tribolium, efficient reproduction starts in the second week of adult life (e.g. Young, 1970). Our finding that dispersal activity reaches a peak at the age of 2-3 weeks suggests that also in Tribolium natural selection favored dispersal at an age in which reproductive potential is at its maximum. It may also be that the slight delay in dispersal activity enables dispersing females to leave some progeny behind, and still maintain the major fraction of their reproductive activity for the new habitat, or at least to become fertilized before entering a period in which no mates may be available.

Acknowledgement

This research was supported by the Leslie Lavy Research Fund.

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Table 1

Number of dispersing beetles, listed according to family, replicate and age. Thirty beetles were tested each time.

Family No.	10 days rep. 1	10 days rep. 2	20 days rep.1	20 days rep. 2	30 days rep. 1	30 days rep. 2	48 days rep. 1	48 days rep. 2
1	18	15	15	16	15	22	0	4
2	20	12	18	15	16	24	3	4
3	12	13	14	19	14	10	4	0
4	19	16	10	15	7	8	1	3
5	10	9	10	6	12	7	2	-
6	10	7	20	5	6	4	2	2
7	15	14	17	17	6	4	-	0
8	13	14	4	19	10	12	2	0
9	1	13	9	11	1	3	1	6
10	4	3	17	3	0	4	1	5
11	15	12	9	14	15	12	-	5
12	3	2	10	5	0	4	0	0
13	4	6	10	14	4	8	1	2
14	10	9	11	11	12	2	5	1
15	3	7	14	4	6	5	0	0
16	12	11	13	21	9	14	1	6
17	13	12	12	12	11	5	1	2
18	13	14	13	14	14	8	2	0
19	9	9	11	4	0	7	0	6
Total	204	198	237	225	158	163	26	46

Table 2

Analysis of variance for rates of dispersal

(at 10, 20, 30 and 48 days).

Source of variation		df	SS	MS	F
Ages (A)		3	2126.553	708.851	83.6***
Replicates (R)		1	0.421	0.421	0.06
Families (F)		18	1594.618	88.590	10.4***
Interaction:	AxR	3	5.947	1.982	0.2
	AxF	54	921.697	17.068	2.0**
	RxF	18	238.829	13.268	1.6
Residual		54	457.803	8.478	

*** 0.001 > p

** 0.01 > p > 0.001

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** 0.01 > p > 0.001

Table 3

Observed and expected numbers of beetles that moved 0, 1, 2 or 3 times (out of 3 possibilities) to vial B, for 17 of the 19 families. For method of calculation of expected values see text. Expected totals were calculated from average frequencies of dispersing beetles at each age.

	Number of times							
	0		1		2		3	
Family No.	obs.	exp.	obs.	exp.	obs.	exp.	obs.	exp.
1	5	5.00	18	19.51	28	24.97	9	10.51
2	5	4.20	15	18.33	30	25.73	10	11.73
3	12	9.45	21	24.60	20	20.45	7	5.50
4	14	11.18	25	27.04	14	18.37	7	3.40
5	23	19.04	22	26.77	10	12.33	5	1.86
6	27	20.90	15	27.37	17	10.54	1	1.18
7	15	11.19	21	27.35	20	18.72	4	2.74
8	15	12.89	26	26.02	11	17.30	8	3.79
9	32	28.62	20	25.07	6	6.00	2	0.31
11	12	11.19	27	25.27	13	18.88	8	4.66
12	40	39.19	17	18.69	3	2.06	0	0.06
13	25	24.00	26	26.80	7	8.40	2	0.80
14	22	19.91	23	26.81	13	11.66	2	1.63
15	31	28.58	19	24.38	10	6.48	0	0.55
16	18	9.89	14	25.22	18	19.89	10	5.00
18	12	11.49	27	25.46	14	18.58	7	4.45
19	31	27.82	18	24.87	11	6.77	0	0.52
Total	339	281.9	354	457.0	245	240.7	82	40.8

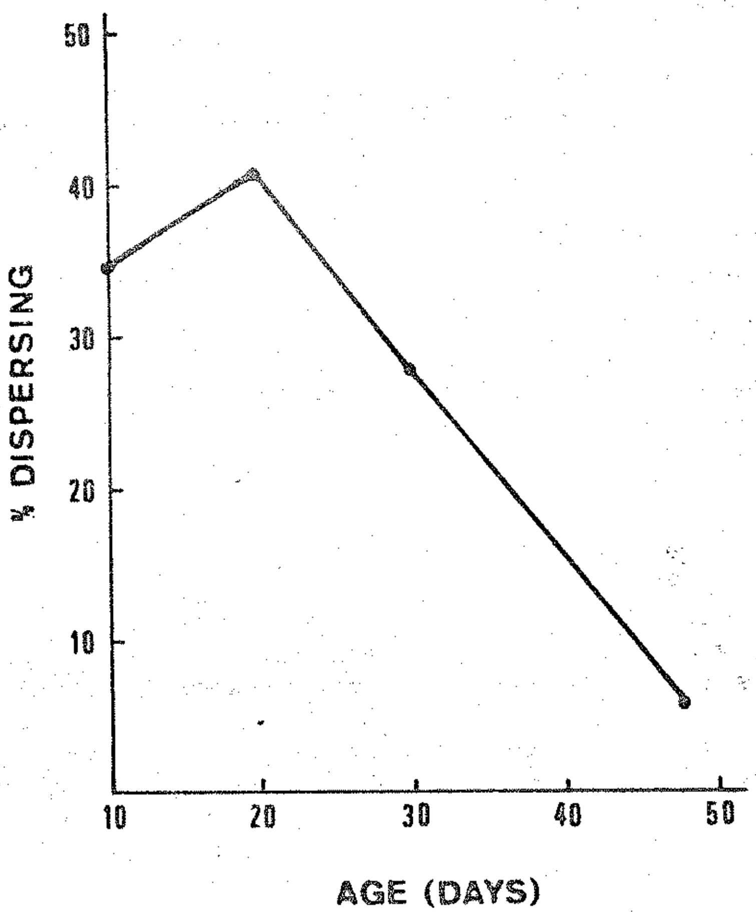

Fig. 1. The relation between dispersal rate (averages of the different families) and age.

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*Stage and syndrome of lethality in *Tribolium castaneum* homozygous for *Fta*.*

The *Fta* allele of *Tribolium castaneum* (see Sokoloff 1966) exerts its lethal homozygous effect in the egg stage (Sokoloff, pers . com.). Embryonic lethals potentially represent valuable tools in the study of early steps in development such as specification of the basic body pattern (see Sander 1976). In order to ascertain stages and syndrome of *Fta*-dependent lethality we studied development in eggs from heterozygous parents (Tab. 1).

	(a) 32°C	(b) 29°C	(c) 20°C	(d) 20°C	(e) total
number of eggs	1099	921	559	1099	3678
%failure before germ band	3,4	5,6	17,0	7,2	7,1
%legless larvae	25,5	23,9	19,1	24,2	23,7
%normal larvae	71,2	70,6	63,9	68,6	69,1
%legless/total larvae	26,4	25,3	23,1	26,1	25,6

Tab. 1 Developmental results from eggs incubated at different temperatures, parents heterozygous for *Fta*. a-c offspring of 3 pairs each, d offspring from mass culture tested to see whether deviation noted in c was due to lower temperature.

The percentage of eggs which failed to reach the germ band stage (Tab. 1) was somewhat lower in most test samples than in the wild-type controls. Eggs which continued development produced either normal larvae or larvae with extremely reduced appendages. All appendages from antennae to urogomphi were uniformly affected but apart from this the larvae looked quite normal. Closer observation of leg development revealed normal-looking leg buds in the early germ band stage, but these failed to grow thereafter. At the larval level of differentiation the knob-like legs were found to consist of only the more or less well developed coxa; there were some coxal bristles and muscles but none of the more distal leg structures. Some of the malformed larvae hatched but apparently were unable to feed properly; none reached the 2nd larval stage. The percentages presented in Tab. 1 indicate

1) The authors are indebted to Dr. A. Sokoloff for providing the *Fta* strain and for valuable advice, and to the Deutsche Forschungsgemeinschaft for financial support (SFB 46).

that, independent of rearing temperature, lethality caused by the Fta allele in the homozygous state is entirely due to the very uniform syndrome of arrest of appendage growth at the late germ band stage. Similar malformations were also observed in assumedly homozygous offspring from parents heterozygous for the allele Sa-2 (Kuld 1976); Krause et al. (1963) had already established the egg stage as the period where lethality of this allele is expressed.

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*Subpopulations of Tribolium castaneum (Hbst.) resulting from routine culture maintenance.

The "Idaho" strain of T. castaneum was started in 1959 from a relatively small initial number of individuals and maintained on an irregular but active subculturing basis until mid-1962. Subsequent subculturing was sporadic until 1966 when the strain was nearly lost by neglect. It was recovered from a very few individuals (ca. 10) at which time a more routine culture maintenance was established; reculturing at 3-5 week intervals from 1-3 lines. From mid-1968 to July 1971 new cultures were established, usually at weekly intervals but occasionally at intervals of 2 weeks. No records were kept as to whether parent adults were 1, 2, 3, or 4 weeks old. Since July 1971 cultures have been started on a weekly basis from parents approximately 2 weeks old. At ca. 90°F and 50% R.H. This has resulted in a 6 week sequence of cultures.

By mid-1973 it became apparent that this culture system had produced 6 subcultures, as indicated by mean pupal weights (100 male, 100 female individually weighed to ± 1 microgram) statistically distinct at the 1% level. Segregation into substrains was probably to be expected, but that this was noted in terms of pupal weight was less to be anticipated. Although there are differences in the extremes of variation from the overall mean, these differences are small. Each substrain has shown the "capability" to have approximately the same high or low mean pupal weight. The differences seem to derive from the frequency of high or low mean weights and not the capability to attain maximal or minimal values. Male and female mean pupal weights usually varied in the same direction, but often not to the same degree. Weekly means varied randomly within a ± 15% or greater range from the overall mean. Sequential subculture mean pupal weights, however, apparently do not vary randomly. A possible explanation for this observation is currently being studied.

Other T. castaneum strains (Georgis, Georgia Blind-sooty, Kansas and Kansas State University) have been similarly maintained since mid-1971. Although some pupal weight data have been obtained from these strains they have not been analyzed. Subjective evaluation indicates that each is now represented by 6 subpopulations.

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Observations on a natural population of Tribolium brevicornis LeC.

In 1859 John Le Conte discovered a beetle in Ft. Tejon, California which he named Aphanotus brevicornis. Hinton (1948) included this species in the genus Tribolium. In addition to Tribolium brevicornis the brevicornis species group of Tribolium includes:

Species	Locality
T. brevicornis Le C	California
T. linsleyi Hinton	Mexico
T. parallelus (Casey)	Western N. America
T. gebieni Uyttenb	?
T. carinatum Hinton	Argentina
T. carinatum dubium Hinton	Argentina
T. uezumii Nakane	Honshu, Japan

Linsley (1944) pointed out that T. (Aphanotus) brevicornis is a species which is often found in bee nests. His literature survey included the observations of Davidson (1893) who recorded Aphanotus brevicornis from Xylocopa bee nests; Nininger (1916) who extracted these beetles from nests of carpenter bees and Hicks (1929) who reported Aphanotus brevicornis from nests of the bee Anthidium mormonum fragariellum. Linsley himself (1943) had found that cells of Xylocopa orpifex found on an old log of an incense cedar, Libocedrus decurrens were infested with Aphanotus brevicornis.

Other than Le Conte's paper, the only citations which give a geographic location for Tribolium brevicornis are those of Okumura and Strong (1965) (who found this species in Alpine and Mono Counties in California, infesting chicken feed, honeycomb and oat seeds) and Strong (1970) who trapped this flour beetle in nine unspecified localities in California.

T. brevicornis is maintained in stock at the University of Idaho, Moscow, Idaho, and at a few other laboratories including the Tribolium Stock Center, California State College, San Bernardino, California. The stock at the University of Idaho was found in Parma, Idaho. The one at the Tribolium Stock Center was kindly supplied by Dr. R. G. Strong, University of California, Riverside. This strain was derived from a sample collected at Bishop (Strong, personal communication, 1977).

We report now the discovery of a natural population of Tribolium brevicornis. This population was originally discovered by one of us (A.S.) in April, 1977 under the bark of an alder tree which lay on the bank of the Waterman Canyon Creek just outside of the northern limits of the City of San Bernardino, about a mile north from the junction of California State Highway 18 and the Old Waterman Canyon Road.

The log in question had been cosmetically removed from the top of a dead alder tree by the County Highway Department. The bark of the log was cracked in numerous places, but much of it was still firmly attached, so that, by hand, pieces of bark could be removed only with difficulty. Under a fairly loose piece of bark were found two beetles in close contact. The third beetle was found under another piece of bark 30 centimeters away. Aside from these beetles there was a branch and twig boring beetle (Bostrichidae), a rather flat cucujid (?), a snail and an unidentified bee.

The three beetles were brought back to the laboratory, examined under the microscope, and placed in standard flour beetle medium since they appeared Tribolium-like. Every few days the flour was sifted and checked for the presence of eggs. Occasionally a piece of apple was placed on the surface in case the beetles required moisture. Except for their small size, these beetles largely resembled Tribolium brevicornis (see Table 1). These beetles began to lay eggs, and from the eggs emerged larvae with distinct dark bands on the tergites. Subsequently one of the beetles died. The other two were weighed, individually, and their weight determined at about 4.8 mg. At a later date (June 27) the original vials containing eggs were examined. By then there were large larvae, pupae, and a few adults which were about three times heavier than their parents.

On the same date we returned to Waterman Canyon, and under the bark of the stump of the same tree and in another area of the original downed trunk we found five additional beetles. These, however, were much larger than the original ones found. (see Table 1).

A sample of T. brevicornis was obtained from the U. of California at Riverside culture, and 10 males and 10 females weighed individually. The mean value for the 10 males was 11.57 $\pm$ .63 mg. and a coefficient of variation of 17.30%, and for females 11.82 $\pm$ .63 mg. with a coefficient of variation of 16.73%.

Thus, judging by the female sample, the laboratory population is considerably more uniform in size (than the population collected in nature), even though the beetles were derived from a culture in which the flour was already badly used up.

The interesting thing about this sample, of course, lies in the fact that the weight of females varies considerably, the largest females being about three times heavier (14 mg) than the smallest females (4.5 mg).

A further report on this natural population of Tribolium brevicornis will be made at a later date.

Table 1. Individual weights (in mg) of beetles derived from a natural population at Waterman Canyon (left) and from a laboratory population.

Sex	Waterman population	Laboratory population
♀♀ *1	4.5	13.0
*2	4.5	10.0
3	9.4	8.1
4	14.0	10.3
5	10.7	10.5
6	11.0	14.0
7		13.5
8		12.2
9		12.8
10		13.8
♂♂ 1	8.4	14.9
2	--	12.7
3	--	10.7
4	--	11.6
5	--	9.3
6	--	13.7
7	--	12.7
8	--	10.6
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	10		13.8
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	2	--	12.7
	3	--	10.7
	4	--	11.6
	5	--	9.3
	6	--	13.7
	7	--	12.7
	8	--	10.6
	9	--	8.8
	10	--	10.8

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*The effect of culturing together on adult longevity of Tribolium audax.

Adults 2-6 days old were reared on one gram of flour/beetle in various numbers: 1, 2, 4, 10, 20, 40 with corresponding number of replications of 40, 20, 10, 4, 2, 1. (Actual number in each experimental unit= 40 beetles). 1, 2, or 4 beetles were raised in vials (1 cm in diameter and 3 cm high); 10 and 20 beetles were raised in vials (2cm in diameter and 3 cm high); and 40 beetles in $\frac{1}{4}$ pint milk bottle (5cm in diameter and 10 cm high). Males and females were reared separately. Constant conditions of 35° C and 60% R.H. were maintained throughout the experiment. The medium consisted of 95% whole wheat flour and 5% dried yeast. Table 1 shows the effect of rearing together on the mean longevity of adults. It is evident that individually reared beetles have higher longevity than beetles reared together, even though the amout of bood/beetle is the same. Males seem to live longer than females when they are raised individually or in pairs and shorter when 4, 10, 20, or 40 beetles are raised together. This indicates that males are more sensitive to the presence of other males than females. There was no evidence of cannibalism. It is possible that the size of the container may be a contributing factor.

Table 1. Longevity of *T. audax* as influenced by number of beetles cultured together.

Number of beetles cultured together	Sex	Mean longevity (days)	Coefficient of variation (%)
1	Male	96.6	37.1
	Female	93.8	35.0
2	Male	91.32	30.1
	Female	89.30	28.7
4	Male	84.18	33.8
	Female	87.68	27.9
10	Male	81.55	35.8
	Female	93.98	29.0
20	Male	67.73	40.1
	Female	68.63	41.5
40	Male	73.68	34.3
	Female	84.88	35.1

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*Rate of egg production in fecundated and virgin females of *Tribolium castaneum*

The foundation population (NDRI-1) of *Tribolium castaneum* was used to study the rate of egg laying in fecundated and virgin females. This population was collected from areas around Karnal (Haryana) and had been maintained in the laboratory over a period of 9 months in mass culture at $32^{\circ}C \pm 1.0^{\circ}C$. Culture media used consisted of 95% wheat flour and 5% yeast.

100 newly emerged virgin females and 50 males were collected. Each such female was assigned randomly to the two groups and were kept in a 5g glass vial with 2g media. Males were assigned at random to each female in group one, while the females in the group 2 were not provided with any males. The egg production in the two groups was recorded from 8th day onwards over a period of 21 days. 24 hrs. egg collection was recorded every day at 10.00 A.M. The average daily egg production in the two groups have been shown graphically in Fig. 1. An increase in egg production was noted till 12th to 13th day in both the groups with a decline, thereafter. Significant difference in the rate of egg production between the two groups were noted for 1st, 2nd, and 3rd week production. The total weekly egg production averages in fecundated and virgin females were 82.47 ± 3.02, 19.80 ± 1.76; 69.07 ± 2.73, 18.15 ± 2.36 and 64.33 ± 2.86, 22.71 ± 4.34 respectively for 1st, 2nd and 3rd week. The rate of egg production was highest in first week followed by a decline thereafter, which was not significant.

The average daily egg production in the fecundated and virgin females in 1st, 2nd and 3rd week was 11.78, 2.83; 9.87, 2.59 and 9.19, 3.24 respectively. Females with males (pair mated group) showed two to five fold increase in egg production compared to virgin group. It can, therefore, be concluded that males are necessary for complete egg laying. This is inconformity with the findings of Ruano and Orozco (1966), Orozco et al (1970) and Bhat and Bhat (1974).

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2. Ruano, R.G. and Orozco, F. 1966. Individual effect of the male on egg laying rate of fecundated females in *Tribolium castaneum*. Tribolium Inf. Bull. 9: 107-109

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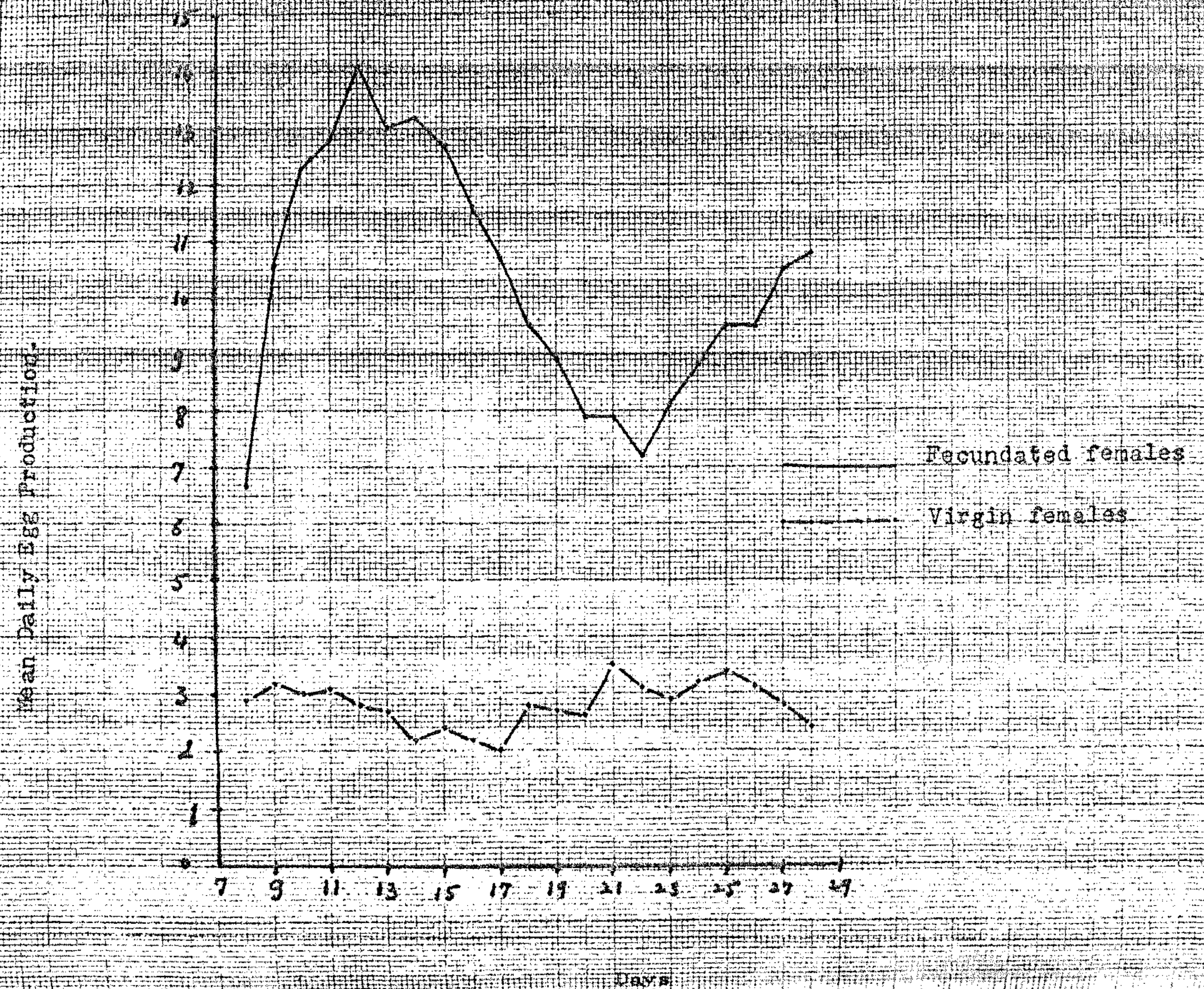
FIGURE [illegible]


Mean Daily Egg Production
Days
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Clustering of nuclear pores to "nuclear sieves" in some Oedionchina fleabeetles.

The phylogenetically young subtribe Oedionychina of the fleabeetles possesses unusual cytological features like unequal mitosis in spermatogonia, the lowest known number of spermatocytes I per cyst, and spermatozoa per bundle (4 and 16, respectively), size of spermatocytes and spermatozoa unusual for Coleoptera (about 50 μm across, and over 4 mm, respectively), and large, presumably heterochromatic sex chromosomes, that in the male segregate from a distance-bivalent or -multivalent condition (1). The Oedionychina genera fall in two categories in relation to the structure of the nuclear envelope of spermatocyte I, and of the epinuclear material synthetized during diplotene (2,3). Omophoita shows a more conventional structure with an even and probably random distribution of nuclear pores, and a layer of polysomes separated from the outer nuclear membrane by an intermediate layer about 400 Å thick. The nucleus is surrounded by a continuous layer of epinuclear material. In Oedionychus and related genera, all nuclear pores are clustered to nuclear sieves: shallow, cup-like invaginations of nuclear envelope. The sieves are filled with polysomal aggregates kept at a distance of about 400 A from the outer nuclear membrane. The sieves with their contents are called nuclear sieve complexes (NSC). Epinuclear material is formed only at the NSCs, being thus discontinuous.

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*The Effect of Propagule Sex Ratio Upon the Number and Sex Ratio of the Adults Produced in a 37 Day Interval by *Tribolium castaneum*

In some experiments it is necessary to begin each generation with a sample of adults chosen at random from a much larger adult population. Deviations in the sex ratios of these propagules can result in large fluctuations in the population density from generation to generation. For this reason, it became necessary in our work to determine the effect of propagule sex ratio upon the number and sex ratio of the adults produced by that propagule during a 37 day interval.

A series of populations was established with groups of 16 adults whose sex ratio had been determined at the pupal stage (Park, 1934). The sex ratio of these propagules of 16 adults was varied from 4 ♀♀ and 12 ♂♂ to 12 ♀♀ and 4 ♂♂ (see Table). Five replicates were established for each sex ratio treatment. After 37 days the populations were censused for adults and the adults were preserved in 95% ethanol. Within three days of preservation, the adults were sexed with the aid of a dissecting microscope by the technique of everting the genitalia (Stanley and Grundmann, 1965).

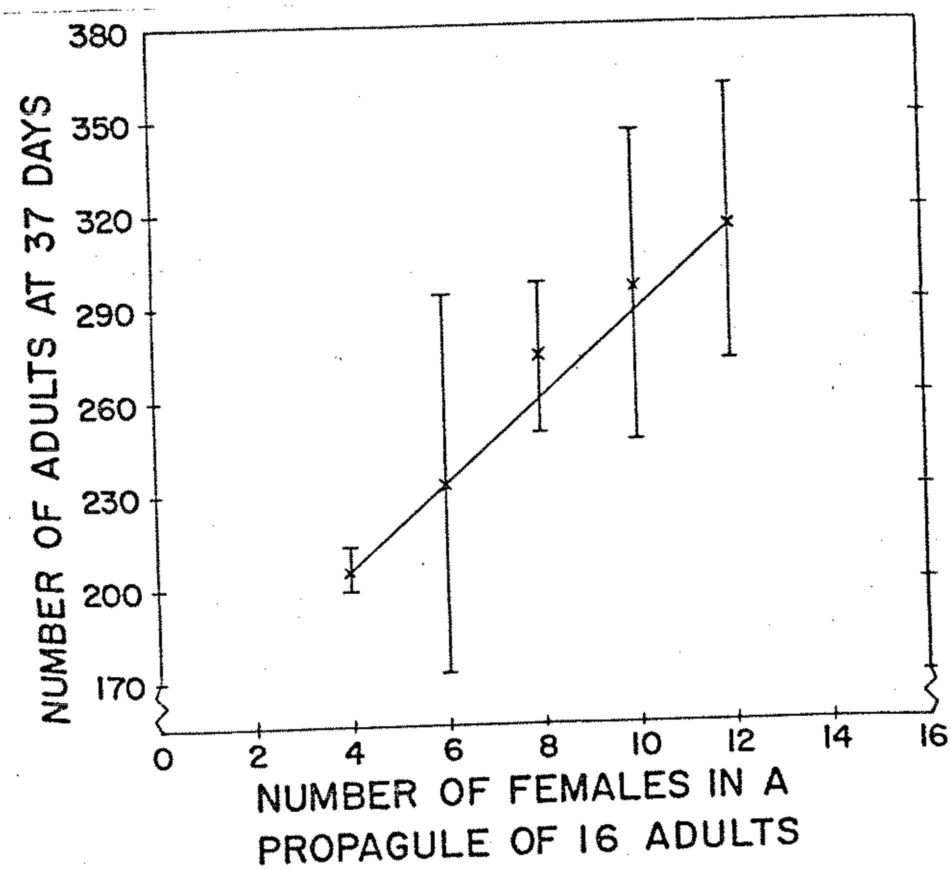
The results of this sex ratio-productivity assay are presented in Figure 1. The net result of increasing the number of females in a propagule by one is to increase the number of adults at day 37 by approximately 14. This result was arrived at by determining the slope of the line drawn in Figure 1. (The X's represent the treatment means and the brackets are one standard deviation about the mean.)

The sex ratio of the founding propagule was found to have no effect upon the sex ratio of the adults produced by that propagule. In no case did the sex ratio of the populations at 37 days differ significantly from a one-to-one ratio of males to females.

TABLE

SEX RATIO TREATMENTS

4 females + 12 males	5 replicates
6 females + 10 males	5 replicates
8 females + 8 males	5 replicates
10 females + 6 males	5 replicates
12 females + 4 males	5 replicates
	25 vials total



FIGURE

References:

Park, T. 1934. Observations on the general biology of the flour beetles *Tribolium confusum* Duval. *Quarterly Review of Biology* 9:36-54.

Stanley, M.S.M. and Grundmann, A.W., 1965. Observations on the morphology and sexual behavior of *Tribolium confusum*. J. of Kansas Entomological Society 38:10-18.

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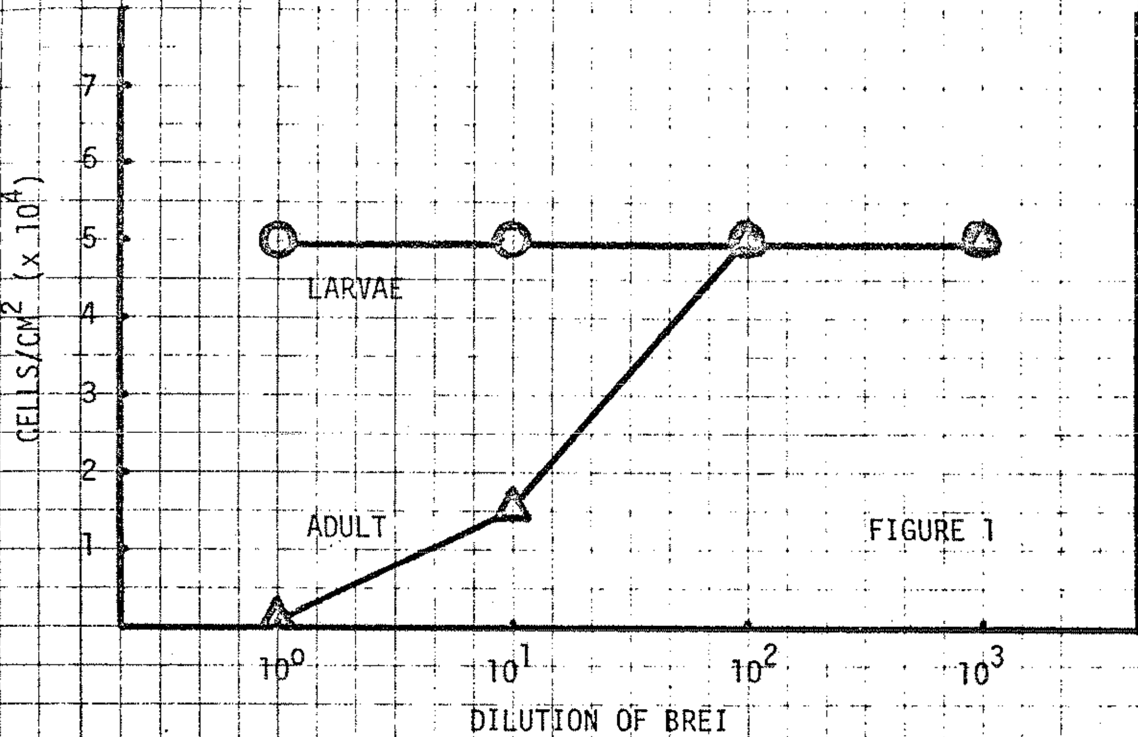
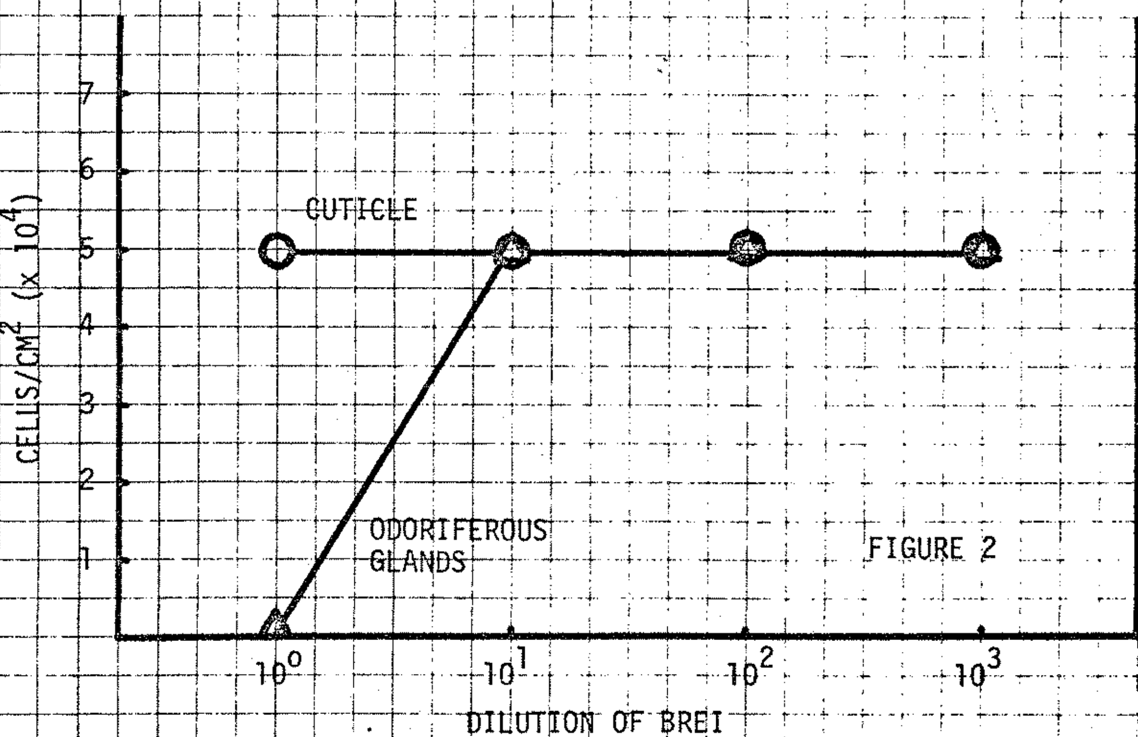
Tribolium confusum brei *in vitro*.

While developing a tissue culture technique to determine quantities of mycotoxin carried within stored product insects, it was observed that adult *T. confusum* prepared as a sterile brei were highly toxic to mammalian cell lines while a brei of larvae had no toxicity (Figure 1). The brei were prepared by grinding 1 g (about 400) insects with mortar and pestle. The sample was extracted with a 10% solution of dimethylsulfoxide in phosphate buffered saline (PBS). After centrifugation the supernatant was passed through a series of millipore filters (1.2-0.3μ). Several dilutions of the sterile filtrate in PBS were added to cultures of African green monkey kidney cells (VERO) at the time of passage. The number of cells/culture flask was estimated with an ocular reticule as the mean of 10 random cell counts/flask 24 hours after passage.

Two major differences between adults and larvae of *T. confusum* are the presence of sclerotized cuticle and the odoriferous, quinone-producing glands in the adult. Both are absent in the larva. Dissected cuticle consisting of elytra, head and appendages from 100 adults was prepared as a sterile brei. The paired, abdominal odoriferous glands were dissected at the same time and prepared separately. The addition of these brei to cultured VERO cells resulted in Figure 2. The cuticle preparation had no toxicity for the cells. However the odoriferous gland preparation caused 100% destruction of the cells as an undiluted brei (10^0). One tenfold dilution prevented this toxicity. Two tenfold dilutions were nedessary to prevent toxicity from the 1 g brei. The effect of the adult odoriferous glands masks any other toxic material that might be present within the adult in small quantity. Therefore the larva is a better test organism for this purpose.





Figures 1 and 2. Estimated number of cells 24 hrs. post-inoculation. Control = $5 \times 10^4/cm^2$.

NOTES — TECHNICAL

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Automated cultivation of a chain of polymiktic generations of flour beetles.

To achieve a chain of separate, polymiktic generations of *Tribolium* in an automated manner the following construction is used. Cylindrical chambers occluded with sieves, each for one generation, are stored together. The mesh-width of the sieves is sufficient to allow freshly hatched larvae of the beetles to pass through. The generation succession is achieved by special arrangement of the food and/or substrate within the chambers. Main components of this arrangement are:

1. Difficult decomposable wheat-groats suspended in Perlon-wool for maintaining the adult beetles.
2. A layer of a nourishment powder the beetles prefer for depositing eggs, behind the sieve of the next chamber.

The set of cylinders is aerated with 40% oxygen, 60% nitrogen in the direction F_n to p.

With n chambers we hope to achieve a pure F_{n-1}. The other generations may be in part mixed together, yet it is hoped to prevent this by a proper reduction of feeding. The system works already for three generations and is projected for use in a free-flyer experiment of the NASA.

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Some Modifications to Culturing Techniques for *Tribolium*

Over the past couple of years, we have developed several modifications to standard culturing techniques (Sokoloff, TIB; Vol. 3, 1960) which have significantly increased the ease and efficienty of collecting certain types of data in quantitative genetics studies with *Tribolium castaneum*. Workers in Quantitative genetics or in other fields may find these modifications useful also.

We now use 30 ml. polyproplyene beakers for rearing individual families or small groups of individuals. These beakers are lightweight, inexpensive, autoclavable and can be stacked for storage when not in use. We use plastic medicine cups for covers to these beakers which permits stacking of the beakers containing *Tribolium*. We have found this to be very convenient when storing sexed individuals for subsequent mating.

A raised circular center portion in the base of the medicine cup is easily removed by placing a few drops of wylene in the center of an inverted cup. This makes it possible to construct a large number of inexpensive screens to fit these beakers. When we wish to collect eggs from the same females in a number of consecutive time periods, we place the female with flour in the screen (30 mesh) which is then inserted in a beaker. At the end of the egglaying period the flour can be shaken through the screen and the screen with the female can be placed in a fresh beaker for a second egglaying period.

In some recent experiments, we have been weighing individual larvae on day 14, checking daily for pupation and then weighing pupae on day of pupation. If this daily check of pupation is to be meaningful, all larvae must be checked in a relatively short period of time. We have been able to do this by placing the larvae, after weighing, into one of the wells of a falcon tissue culture plate. The type of plate we have been using for larvae have 96 wells and are made of transparent polysterene. Each well measures 6 mm. in diameter and has a curved bottom. Because of this curbed bottom, pupae generally rest dorsal side down. The sex of the pupae is then easily determined, without handling, by placing the tray on the stage of a dissecting microscope. For the purpose of adding flour to the wells, the tray is covered with a piece of 40 mesh wire cloth and flour is deposited on the screen. Flour can then be transferred fairly uniformly to each well with small paint brush. Exact measurement is not necessary since the flour is provided in excess and replaced daily. The flour is removed in a similar manner, by vacuujing through the screen. We have used a piece of flexible tubing and a one-holed-rubber stopper fitted with glass tubing to reduce the opening of the vacuum cleaner for this purpose. It takes a little practice to become proficient at removing the flour without transferring larvae from one well to the next. However it takes one experienced worker, depending upon how many larvae have pupated, between 15-90 minutes to check 20 trays (1920 larva) and replace the flour. We have fashioned lids for these trays from flexible tissue culture plates and a piece of plate glass so each well is individually covered. For storage of large populations until individual selection can be performed, we have been placing pupae, after weighing, in similar plates with flat bottoms (wells are slightly larger). This reduces the effort needed to locate the selected individuals as well as the storage space required.

The items mentioned above are probably available from a number of suppliers. We have purchased them through University Medical Stores. However, listed below is one source for each of the items:

Wire cloth	Small Parts, Inc. 6901 N.E. Third Ave. Miami, Florida 33138
Medicine cups	Solo Cup Company Urbana, Illinois 61801
Tissue culture plates	Cooke Laboratory Products 900 Slaters Lane Alexandria, Virginia 22314
Polyproplyene beakers	Cole-Parmer 7425 North Oak Park Ave. Chicago, Illinois 60648

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A SIMPLE TECHNIQUE TO IMMOBILISE TRIBOLIUM ADULTS

Tribolium great activity and mobility can cause considerable technical difficulties in laboratory operations, e.g. adult sexing, antennae clipping, etc; mostly if the number of individuals subjected to these operations is large.

Adults can be efficiently immobilised by employing adhesive labels commonly used in offices, thus making laboratory manipulations easy enough. One of these labels can be fixed on a slide or on any other surface easy to handle under a binocular microscope. The adhesive surface of the lable should be maintained in an upwards position. The insect will then be placed on the adhesive side where it will be trapped (Fig. 1-4). Preferably, the imago will be adhered to the label by its dorsal side in order to avoid damaging its extremities. Adults should be clean of flour and dust in order to make a better and longer use of the adhesive material. It is also convenient that this adhesive material be constituted by a thin film, because if the insect was fixed using its own weight, no excess of gum, which could hurt it, will be sticked on its body when it be taken off the label.

Insects can be taken off the label by using a soft forceps made from steel hoop (thickness 0.1 mm) (Fig. 1-1) or with an appropriate needle. Brushes are not recommended as they will not lift the insect but only displacing it on the adhesive side, with the risk of it becoming damaged.

For antennae clipping, steel forceps with very thin tips can be used (Fig. 1-2). As they will clip by pressure rather than tearing off they will give a better result than using a small scalpel. In this way it is not necessary a very great adhesive strength nor an excess of pressure of the insect on the label. These forceps are of the type used by watchmakers (5 PEER rustless steel or 4ROYAL electronic, SWITZERLAND). Adults can be sexed by using a thin brush to touch the profemus.

Although immobilising pupae is seldom necessary, the same adhesive labels can also be used for this purpose. Special care must be taken in order to avoid damaging the elytra.

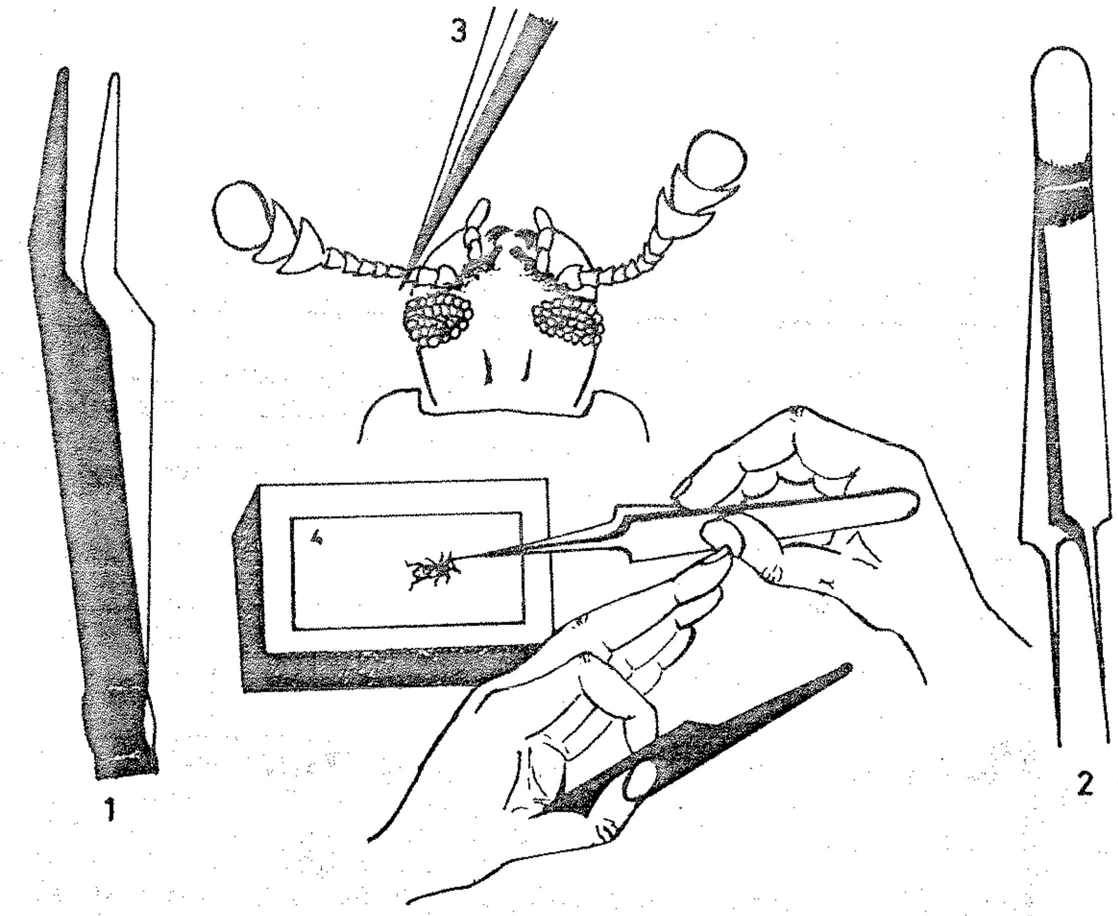

Fig. 1. Antenna clipping technique

The insect remains fixed and motionless on the adhesive side of the label (4) which is mounted on a slide. The insect can be placed on and removed off the label by using a flexible soft forceps (1) which can be handled with the left hand. The antennae can be clipped at the third segment level (3) with a watchmaker's forceps (2) handled with the right hand. To prevent the right hand from shaking it can rest on the left hand free fingers. A binocular with magnifying power from 6 to 16 is enough to carry out this operation.

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A NEW DYE FOR USE IN COLORING TRIBOLIUM EGGS

Introduction

Some studies involving *Tribolium* eggs require that the eggs be marked by a dye of some sort to differentiate them from newly laid eggs or eggs of other species. The dye customarily used for this purpose is Neutral Red, a substance first used by Rich (1956). It has become necessary, however, to explore the use of additional dyes in order to differentiate the eggs of more than 2 species or strains. While conducting preliminary experiments in a cannibalism study, we have found a second suitable dye as well as one with deleterious effects on the adult beetles.

Materials and Methods

Three dyes, Neutral Red (certified), Brilliant Cresyl Blue, and Janus Green B, were selected for use in an egg viability study of 3 species of *Tribolium*. The species chosen were *T. castaneum* (Chicago black), *T. confusum* (Chicago), and *T. madens* (wild-type). All 3 dyes are certified by the Biological Stain Commission for use as supravital stains for blood.

The medium on which the flour beetles were raised consisted of stoneground wheat flour, yeast (5% by weight), and dye (1% by weight). All were sifted through a 4XX sieve, and the wheat and yeast were sterilized at 60°C for 24 hours. Eight grams of mixed medium were then parcelled out in 8 dram vials and placed in an acclimatizing incubator for one week.

Thirty-six vials were set up for each species: 9 replicates for each of 3 dye mixtures and an undyed control. To each vial were added 20 randomly chosen beetles from stock populations. The vials were then incubated at 30°C and 70% r.h. for 3 days.

The original intention was to collect 50 eggs from each vial on the 4th day and tally the number of hatchings. The fecundity of *T. madens* was overestimated, however, as fully ½ of the vials yielded less than 50 eggs. All of the Janus Green B vials were included in the under 50 egg group. A similar problem was encountered when collecting eggs from the Janus Green B vials of the other 2 species.

Results

Janus Green B had a marked effect on the fecundity of all 3 species. Only 3 of 9 green *T. confusum* vials yielded 50 eggs, and not one of the green *T. castaneum* vials yielded that number. Of the latter, 3 vials yielded 1 egg, 1 vial yielded 2 eggs, and 2 vials yielded no eggs. The probability that this is the result of the sex ratio of the randomly chosen adults is extremely small (P less than 0.025).

Those green eggs which did successfully hatch did so earlier than eggs laid in the other treatments. While no statistical test was conducted to compare mean development time of the eggs, the difference was marked. We can conclude that beetles in the Janus Green B flour ceased ovipositing soon after being introduced into that medium.

Behavioral abnormalities were also noted among the beetles in the green flour. There was a tendency for the beetles to cluster at the top of the flour column rather than tunnel through it. Movement was lethargic. Some of the beetles were dead. These traits were not noticed in the other vials, and for this reason the Janus Green B dyed flour was excluded from any statistical comparison with the control.

Both the Neutral Red and Brilliant Cresyl Blue compared well with the undyed control. A two way anova was performed on the percentage of eggs hatched (using the arcsin square root transformation). No significant dye effect was evident, and there was no significant species-dye interaction. There was a highly significant (P less than 0.001) difference noted in the egg viability between species: *T. castaneum* was the most viable and *T. confusum* the least viable. This last fact is of interest in its own right but is not of any importance insofar as the experimental test of the dyes is concerned.

We can conclude that Brilliant Cresyl Blue provides an alternative to Neutral Red for dyeing Tribolium eggs, while Janus Green B is not suitable. In cases where it is necessary to distinguish 2 kinds of eggs, these dyes permit naked-eye separation.

Rich, Earl R. (1956). Egg cannibalism and fecundity in *Tribolium*. Ecology 37: 109-120.

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Wheatley, P.E., B.Sc., A.R.C.S., D.T.A., Director, Control by contact insecticides.

GUATEMALA

Guatemala City
Instituto de Nutricion de Centro America y Panama
Division de Cirnaias de Alimentos del INCAP

Bressoni, R.
Medrano, J., Ph.D., Biochemical genetics.

INDIA

+Delhi
University of Delhi
Department of Zoology

Saxena, K.N., Reader in Zoology. (12,13)

+Gorakhpur, U.P.
University of Gorakhpur
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Chaudhry, H.S., M.Sc., D. Phil. Developmental Biology, Cytology and Endocrinology. (3,4,13)
Das, A.B., M.Sc., Ph.D. (Illinois) Insects Taxonomy and Acarology. (17)
Khere, M.K., M.Sc., D. Phil. Insects Norphology and Development. (1,3)
Krishna, S.S., M.Sc., Ph.D. Morphology and Nutritive Physiology of Insects. (1,10)
Shukla, G.S., M.Sc., Ph.D. Morphology and Excretory Physiology of Insects. (1,13)
Sinha, T.B., M.Sc., Ph.D. Insect Taxonomy and Acarology. (17)

+Hissar, Harayana
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Gill, Kulbir S., Ph.D. Associate Professor.

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Bhat, Pushkar, Head of Division (7)
Bhat, Prin P., Ass't. Professor

+Jabalpur, Madhya Pradesh
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Shrivastava, P.N., B.V.Sc. & A.H. Research Assistant.

+Muzaffarpur
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*Srivastava, U.S., Professor and Head of the Department. (3)

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*Pant, N.C., Ph.D. (10)

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Department of Biochemistry

Lyall (Kapoor), R.P.D., Research Scholar. Interest: General morphology and insect physiology, particularly the effect of physical factors such as temperature and relative humidity on the survival value of *T. castaneum*. (12)

INDONESIA

Denpasar, Bali
Universitas Udayana
Fakultas Kedoteran Hewan & Peternakan

Darmadja, D. (7)

IRELAND

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Cunningham, E.P.

ISRAEL

Tel-Aviv
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Wool, David, Ph.D. Ecological genetics. (5,7)
Cohen, Ephraim, Ph.D. Insect hormonre. (12,13)
Ela, Englander, graduate student
Levi, Orna, graduate student
Manheim, Ora, graduate student
Paz, Michael, graduate student
Sverdlov, Eliyahu, graduate student

ITALY

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Universita, Instituto Lazzaro Spallazani
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Milani, R. Professor.
*Springhetti, Antonio, Ph.D. Vitamin Tests. (13)

JAPAN

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Pref. Institute of Agricultural and Forest Science
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Kiritani, K., D. Agr. Head, Population ecology. (5)

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Inouye, T., research associate. (2,5,16)
Kuno, E., research associate, Ph.D. (5,16)
Takafuji, A., research associate, Ph.D. (5)
Takahasji, F., associate professor, Ph.D. (2,5,13,18)
Utida, Syunro, Professor of entomology. Population ecology in general and billogy of stored product insects. (5,7)

+Misima, Shizuoka-ken
National Institute of Genetics

Yamada, Yuko, Ph.D. (7)

Okayama
Okayama University
Faculty of Agriculture
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Yoshida, T., Dept. Agric. Population ecology and biology of stored product insects. (2,5,13)

Yamaguchi University
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Chiba, Yoshihiko

NETHERLANDS

Amsterdam
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Department of Agricultural Research
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Schulten, G.G.M., Ph.D. Entomologist, storage pests. (12)
Klashorst, van de, G., B.Sc. Assistant Entomologist, storage pests. (12)

+Wageningen
Laboratory for Research on Insecticides

Oppenoorth, F.V., Ph.D. Acting Director. Physiology and genetics of insect resistance. (8,15)

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Stam, P. (7,16)

NEW ZEALAND

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Singh, P., Ph.D. Rearing. (5,12)
Watt, J.C. Ph.D. Systematics. (17)

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Ruakura Agricultural Research Centre

Baker, R.L., M. Agr. Sci., Ph.D. Quantitative genetics and animal breeding. (7)
Carter, A.H., M.A., Ph.D., Leader of genetics section. (7).
Clarke, J.N., M. Agr. Sci., Ph.D. Quantitative genetics and animal breeding. (7)
Meyer, H.H., M.S., Ph.D. Quantitative genetics and animal breeding. (7)

+Palmerston North
Department of Scientific and Industrial Research
Grasslands, Division

Rumball, William, M.Sc. Methods of analyzing and predicting selection response. (7)

POLAND

Warsaw
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PORTUGAL

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Laboratorio da Defesa Fitossanitaria dos Produtos Armazenados (L.D.F.P.A.)
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Brigada de Estudos da Defesa Fitossanitaria dos Produtos Ultramarinos (B.E.D.F.P.U.)

Ministerio do Ultramar
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Baeta Neves, C.N., Prof. of entomology of the Institute of Agronomy for higher studies. Director of the L.D.F.P.A. head of the B.E.D.F.P.U. (5,12)

SPAIN

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Laboratorio de Genetica de Poblaciones

Alvarez, Laveron, Carmen; Prto. Agr. Population genetics. (7)

*Barrera, Antonio; Prto. Agr. Population genetics. (7)
Campo, Jose Luis; Dr. Ing. Agr. Popul. Genet. and Poul. Breeding. (7)
Carbonell, milio; Dr. Ing. Agr. Population Genetics. (7)
Carceles, Francisco; Prto. Agr. Poultry Breeding. (7)
*Diez-Barra, Rafael; Prto. Agr. Population Genetics. (7)
*Dobao, Teresa; Ing. Agr. Biochemical Genetics. (7)
*Fuentes, Ma. Teresa; Ing. Agr. Biochemical Genetics. (7)
*Gallego-Diaz, Jose; Ing. Agr. Population Genetics. (7)
*Lopez-Fanjul, Carlose; Dr. Ing. Agr. and Ph.D. Popul. Genetics. (7)
Malpica, Jose Maria; Dr. Ing. Agr. Biochemical Genetics. (7,13)
Martinez Vassallo, Javier; Ing. Agr. Biochemical Genetics. (7,13)
Odriozola, Miguel; Dr. Ing. Agr. Animal Breeding. (7)
*Orozco, Fernando; Dr. Ing. Agr. and Ph.D. Head of Department Population Genetics and Poultry Breeding. (7)
Rodriganez, Jaime; Ing. Agr. Animal Breeding. (7)
*Ruando, Ramiro G.; Ldo. Veterinario. Population Genetics. (7)
*Silvela, Luis; Dr. Ing. Agr. and Ph.D. Population Genetics. (7)
*Tagarro, Ma. Pilar; Prto. Agr. Population Genetics. (7)
* Actually working with Tribolium.

+Madrid
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Sanchez-Monge, Enrique, Dr. Ing. Agr. Professor. (7)

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Nuez, F., Prof. Enc. Lab. Mejora Genetica. (7)

UNITED STATES

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Donner Radiation Laboratory

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Hayes, T.L., Ph.D. (4)
Yang, T.C.H., Ph.D., Radiation biophysicist. (9)

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*Pease, R.F.W., Ph.D. Scanning electron microscope. (4)

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Bentley, Boyd, B.S., Staff Research Assistant
Benyi, K., Ph.D. Candidate, Animal Breeding
Gall, Graham A.E., Ph.D., Auantitative and biochemical genetics (7)
Gross. S.J., Ph.D. Candidate, Quantitative genetics. (7)

+Irvine, California
University of California
Department of Organismic Biology

Zeikus, Regina D., Teratology in the beetle *Tenebrio molitor*. (19)

+Northridge, California
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Moore, Joseph, Ph.D. Associate Professor. (11)

San Bernardino, California
California State College
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Department of Biology
Tribolium Stock Center

Brown, Eric, Student Assistant
*Coleman, Tod, Technical Assistant
*Faustini, Daryl, Graduate Student
*Mankau, Sarojam K., Ph.D. (11)
Newfelt, Sharon, Student Assistant
Newby, Felicia, Student Assistant
Schumacher, Jim, Student Assistant
Shetler, Michael, Student Assistant
Smith, Penny, Student Assistant
*Sokoloff, Alexander, Ph.D. (5, 7)
Spedding, James, Student Assistant
*Yamada, Ellen, Graduate Student

+Bridgeport, Connecticut
University of Bridgeport
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Raghuvir, N.N., Ph.D. Effects of ultra-violet on *Tribolium confusum*.

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Biology Research Laboratory

Agee, H.R., Research Entomologist
Ashley, T.T., Ass't. Prof., Univ, of Florida
Calkins, C.O., Research Entomologist
Callahan, P.S., Research Entomologist
Chambers, D.L., Research Entomologist - Laboratory Director
*Coffelt, J.A., Research Entomologist
Doolittle, R.E., Research Chemist
*Ferkovich, S.M., Research Entomologist
Greany, P.D., Ass't Prof., Univ. of Florida
*Hagstrum, D.W., Research Entomologist
Hamilton, E.W., Research Entomologist

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Huettel, M.D., Ass't Prof., Univ. of Florida
Leppla, N.C., Research Entomologist
*Marzke, F.O., Research Entomologist
Mayer, M.S., Research Entomologist
Mitchell, E.R., Research ntomologist
McLaughlin, J.R., Ass't. Prof., Univ. of Florida
*Oberlander, H., Research Physiologist
Sharp, J.L., Ass't. Prof., Univ. of Florida
*Silhacek, D., Research Chemist
*Sower, L., Research Entomologist
Spencer, N.R., Research Entomologist
Stanley, J.M., Agricultural Engineer
Tingle, F.L., Research Entomologist
Tumlinson, J.H., Research Chemist
Turner, W.K., Agricultural Engineer
*Vick, K., Research Entomologist
Webb, J.C., Agricultural Engineer.

*Working with stored-products insects.

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Naval Aerospace Medical Institute
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Beischer, D.E., Ph.D. Biomagnetics. (13)

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University of Georgia, United State Department of Agriculture
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Tindell, L.D., Ph.D., Population genetics.

Decatur, Georgia
Agnes Scott College
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Wistrand, H. (5,7)

Savannah, Georgia
United States Department of Agriculture
Stored-Product Insects Research and Development Laboratory

Arbogast, Richard T., Ph.D. Ecology. (5)
Baker, J.E., Ph.D. Physiology and nutrition. (10,13)
Brower, J.H., Ph.D. Radiation biology and genetics. (7,9)

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DIRECTORY - GEOGRAPHICAL

Savannah, Georgia (continued)

Bruce, W.A., Ph.D. Physiology. (13)
Bry, R.E., B.S. Mothproofing. (12)
Cline, L.D., M.S. Biology. (5)
Davis, Robert, Ph.D. Acarology and Ecology. (5)
Dennis, N.M., M.S. Insecticide formulations. (8)
Gillenwater, H.B., B.A. Fumigation. (8)
Highland, H.A., Ph.D. Insect-resistant packaging. (8)
Jay, E.G., Ph.D. Controlled atmospheres and temperatures. (13)
Kirkpatrick, R.L., M.S. Physical energy control. (9)
LeCato, G.L., Ph.D. Ecology. (5)
Leesch, J.G., Ph.D. Toxicology. (13)
Lum, P.T.M., Ph.D. Biology. (5)
Mullen, M.A., Ph.D. Physiology and ecology. (5,13)
Press, J.W., M.S. Biology. (5)
Redlinger, L.M., M.S. Chemical control. (8)
Simonaitis, R.A., Ph.D. Insecticide residues. (8)
Street, M.W. B.A. Light and sound. (13)
Su, H.C.F., Ph.D. Sex attractants. (13)
Tilton, E.W., M.S. Radiology. (9)
Vardell, H.H., M.S. Physical control and genetics. (7,9)
Zehner, J.M., Ph.D. Insecticide residues. (8)
Zettler, J.L., Ph.D. Physiology and toxicology. (13)

Savannah, Georgia
Armstrong State College
Biology Department

Davenport, L.B., Jr., Ph.D. Head of Department.

+Tifton, Georgia
Coastal Plain Experiment Station
Peanut and Southern Corn Insects Investigations

Redlinger, L.M. Investigations Leader.

Moscow, Idaho
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Howard W. Smith, Ph. D.

+Pocatello, Idaho
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Minshall, G. Wayne (5)

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Southern Illinois University
Department of Zoology

*Englert, DuWayne C., Ph.D. Associate Prof. Population genetics
(7)

Carbondale, Illinois (Continued)

*Fogle, Thomas A., B.S. Teaching Assistant. Population genetics. (7)
*George, Rachel, M.Sc. Teaching Assistant. Physiological genetics. (7)
Grinde, Katherine E., B.A. Graduate Fellow. General genetics. (7)
Kline, John P., M.S. Graduate Assistant. Population genetics. (7)
Lees, Judith A., B.A. Medical School Lab Preparation. General genetics. (7)

Chicago, Illinois
University of Illinois at Chicago Circle
Department of Biological Sciences

Cawthon, David A., B.A. Technician and graduate student. (5)
Craig, David D., M.S. Graduate student. (5)
Mertz, David B., Ph.D. Professor. (5)
Wagner, Janice, B.A. Graduate student. (5)
Wu, Ai-Chu, B.S. Graduate student. (5)

+Chicago, Illinois
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Lloyd, Monte, Ph.D., Population ecology
Park, Thomas, Ph.D., Professor

+Oak Park, Illinois
Oak Park River Forest High School
Biological Sciences Research Project

Geisert, Paul, Director, Biological Sciences Research Project (5)

Urbana, Illinois
University of Illinois
Department of Dairy Science

Grossman, M., Ph.D. Population and quantitative genetics. (7)

Urbana, Illinois
University of Illinois
Department of Physiology and Biophysics

Blakely, E., M.S. (Biophysics) - Radiation biology; cell culture. (40

Urbana, Illinois (Continued)

Chiu, M., M.S., (Physiology) - Radiation biology. (9)
Ding, G., M.S., (Microbiology) - Radiation biology; aging. (9,13)
Ducoff, H.S., Ph.D., Professor of Physiology and Biophysics and of Bioengineering - Radiation biology (repair mechanisms, life-span changes_: disease-resistance in insects. (9,13)
Garner, M., B.S., - Radiation biology. (9)
Lai, P., M.S., (Chemistry) - Radiation biophysics (repair mechanisms); cell culture. (3,9)
Plummer, S., B.S. - Radiation biology; aging. (9,13)
Wanna, S., M.S., (Biology) - Radiation biology; mathematical biology. (9,16)

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Fujii, K., Ph.D. (7)

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Bell, A. Earl, Ph.D. Professor (5,7)
Carbonell, Emilio, Dr. Ing. Agron., INIA Fellow. (5,7)
Gajic, Zivorad, Ph.D., Fulbright Research Scholar. (5,7)
Melhorn, Pamela L., B.S., Genetics Research Technician
Miles, Deborah A., B.S., Genetics Research Assistant
Muir, William M., M.S., Graduate Assistant
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Rich, Stephen, B.S., Graduate Assistant
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Chiu, M., M.S., (Physiology) - Radiation biology. (9)
Ding, G., M.S., (Microbiology) - Radiation biology; aging. (9,13)
Ducoff, H.S., Ph.D., Professor of Physiology and Biophysics and of Bioengineering - Radiation biology (repair mechanisms, life-span changes_: disease-resistance in insects. (9,13)
Garner, M., B.S., - Radiation biology. (9)
Lai, P., M.S., (Chemistry) - Radiation biophysics (repair mechanisms); cell culture. (3,9)
Plummer, S., B.S. - Radiation biology; aging. (9,13)
Wanna, S., M.S., (Biology) - Radiation biology; mathematical biology. (9,16)

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Partida, Gregory J., Ph.D. Assistant Professor. (12)
White, Stephen, Undergraduate Hourly Employee. (12)

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Goodwill, Robert, Ph.D., Population and quantitative genetics. (7)
Tan, Sam, B.S. Technician
Walker, Roger, B.S., Graduate Student, Population and quantitative genetics. (7)

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Nathanson, Michael (5)

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Kinney, T.B., Jr., Ph.D., Population genetics (located at Lafayette, Indiana). (7)
Lepore, P.D., Ph.D. Biochemical genetics. (7,13)
Sarvella, P.A., Ph.D. Cytological genetics. (4,7)
Tindell, L.D., Ph.D. Population genetics (located at Athens, Georgia). (7)

+Natick, Massachusetts
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Florentine, G.J., Ph.D. Research entomologist. Sensory physiology of insects. (13)
Gingrich, J., 1LT, Ph.D. Research entomologist. Effect of ultraviolet on cockroaches. (13)
Pratt, J.J., Jr., PhD. Group Head. Toxicology, insect nutrition, behavior of rodents. (2,10,13) - Retired
Smith, L.W., Jr., Ph.D. Research entomologist. Insect behavior and ecology. (2,5). Director.

Entomology Group

Cohen, S., M.S. Biologist. Genetics. (7)
Raisbeck, B., Ph.D. Biologist. Insect Tissue Culture. (3)
Roth, L.M., Ph.D. Group Head. Behavior and reproduction in cockroaches. (2,13)

Norton, Massachusetts
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Kircher, J.C.
Keim, Barbara Howell (5)

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Kissinger, D.G., Ph.D. Taxonomy, genetics and development of Curculionidae. (3,5,17)

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Slatis, Herman M., Ph.D. Population genetics. (7)

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De Las Casas, Ernesto, Ph.D. Research Associate. Micro-organisms associated with stored grain insects. (5,11,12)
Dunkel, F.V., Ph.D. Postdoctoral Fellow. Effect of food additives on stored grain insects and protozoan associates. (5,12)th
Harein, P.K., Ph.D. Professor. Stored product insect management. (12)
Wright, Valerie F., M.S. Research Assistant. Relationship of insects, fungi and mycotoxins in stored products.

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Braskerud, Ove A., B.A., Associate Scientists, Population genetics. (7)
Comstock, Ralph E., Ph.D. Professor. Population genetics. (7)
Enfield, Franklin D., Ph.D. Professor. Population genetics. (7)
Hartung, Nancy Z., B.A., Graduate Student, Population genetics. (7)
Kaufman, Pamela K., Ph.D., Postdoctoral Fellow, Population genetics. (7)

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Bell, Max E., Ph.D. Ecology. (5)

Kirksville, Missouri (Continued)

Bywaters, James H., Ph.D. Genetics. (7)
Dimit, James E., M.A. Ecology. (5)
Hanks, David L., Ph.D. Microbiology. (11)
Jay, Austin E., Ph.D. Physiology. (13)
Kangas, Donald E., Ph.D. Limnology and ecology. (5)
Mock, Orin B., Ph.D. Endocrinology. (13)
Rosebery, Dean A., Ph.D. Wildlife.
Sells, Gary D., Ph.D. Physiology. (3)
Shaddy, James H., Ph.D. Entomology. (12)

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Huber, Ivan, Ph.D. Population biology and systematics of cockroaches; Genetic control of the German cockroach. (1,5,7,17)

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Krause, Eliot, Ph.D. Genetics and Population genetics. (7)

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Tschinkel, Walter, Ph.D. (13,17)

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Calhoon, Robert E. (7,15,16)

DIRECTORY - GEOGRAPHICAL

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Waddington, C.H., C.B.E., Sc.D., D.SC., F.R.S. Professor. (7)

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Boyer, John F., Ph.D. (5)

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McCauley, David E., B.S., Graduate student, Ecological genetics.
Sokal, Robert R., Ph.D., Professor, Ecological genetics. (5,7)
Wasserman, Steven, G.A., Graduate student, Behavioral ecology.
Wieland, Judith, B.A., M.A., Graduate student, Ecological genetics.

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Chang, T.H., Ph.D. Insect tissue culture. (3)
Flint, Hollis M., Ph.D. Insect radiation sterilization. (9)
Klassen, Waldemar, Ph.D. Insect genetics. (7)
LaChance, Leo E., Ph.D. Insect genetics, radiobiology. (7,9)
Riemann, John G., Ph.D. Insect cytology. (4)
Wagoner, Dale E., Ph.D. Insect genetics. (7)

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Kannowski, Paul B., Ph.D. (2, 5, 13) Pheromones and behavior.

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Schurr, Karl, Ph.D. (9,12,13)

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Murray, J.J., Ph.D. Ecological genetics. (5,7)

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*Stanley, M.S.M., Ph.D. Development of *Tribolium confusum*. (3)

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Hatch, Melville H. (17)

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