TRIBOLIUM INFORMATION BULLETIN

Number 17

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California State College, San Bernardino

California

1974

NOTE

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TRIBOLIUM INFORMATION BULLETIN

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March, 1974

Notes - Research (continued)

Notes - Technical

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Bibliography (continued)

Foreword

It is hoped that Tribolium Information 17 will be as useful to others as previous issues of this bulletin have been. In spite of the general scarcity of grant funds available from federal agencies it is apparent from the bibliography and the research notes that Tribolium continues to be researched as intensely as it was some 20 years ago when the editor began his investigations on flour beetles.

While the condition of the Tribolium Information Bulletin may be termed good, the same cannot be said for the condition of the Tribolium Stock Center. The section on Cellular Biology of the National Science Foundation from which the Stock Center recieved its support has decided not to provide further support to the Tribolium Stock Center as well as the majority of insect stock centers. (Fuller details will be available in the Genetics supplement for 1974).

Except for the timely appearance of a research grant to the Editor which will enable him to maintain some of the more valuable mutant stocks, and an institutional grant which provides for student help to maintain other stocks, the Tribolium Stock Center would be in serious difficulty. The responsibility for maintenance of genetic stocks has now been shifted to the section on Systematics, Biology of the National Science Foundation.

It is hoped that this subsection dealing with Biological Resources will recognize that in these times of scarcity a shift

in priorities, particularly toward greater support of centers for maintenance of mutant stocks of useful experimental organisms, is imperative.

For the preparation of TIB 17 I am indebted to Janice Brown, Pat Cavataio, Susan Clark, and Jim Gooch.

The publication of TIB-17 was made possible by Army Research Office Grant RDRD LP-11790-LS.

ANNOUNCEMENTS

Triboliumists are advised of the following International Conferences or Congresses, to be held October 7-11, 1974:

1. The first International Working Conference on Stored-Product Entomology will be held in Savannah, Georgia, U.S.A. October 7-11, 1974. The Conference will cover all phases of stored-product entomology and will include symposia, panel discussions, and submitted papers. Facilities will be available for informal get-togethers as they are required. A Proceedings will be published following the Conference.

Anyone desiring further information should contact:

Organizers
First International Working Conference on Stored-Product Entomology
c/o Stored-Product Insects Research and Development Laboratory,
ARS-USDA
P.O. Box 5125
Savannah, Georgia 31403
U.S.A.

2. The First World Congress on Genetics Applied to Livestock Production will be held in Madrid, Spain, October 7-11, 1974. The Congress will be held in the Palacio Nacional de Congresos y Exposiciones of Madrid, on the Avenida del Generalisimo, 29, tel. 270 56 00/09, 270 28 01/05 and 270 58 00.

The Palacio, considered as one of the most modern and best equipped halls in all Europe, is essentially made up of three different units according to need, although they are entirely intercommunicable: Congress Area, Exhibition Area and Parking Area.

For further details contact the General Secretariat, located on Departamento de Genetica, Facultad de Veterinaria, Ciudad Universitaria, Madrid-3, Spain, tel. 243 94 59 (Prof. Dr. Carlos Luis de Cuenca). All inquiries regarding information, registration, scientific works and other data should be relayed to the address.

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 elytrum 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.

BRIDGEPORT, CONNECTICUT
UNIVERSITY OF BRIDGEPORT,
DEPARTMENT OF BIOLOGY

Tribolium confusum

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

(Ed.)

Stock Lists

BURLINGTON, NORTH CAROLINA
CAROLINA BIOLOGICAL SUPPLY COMPANY

Tribolium castaneum

1.	black	Chicago
2.	jet	
3.	pearl	
4.	wild	McGill

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. paddle (pd)
2. spotted (sp)
3. pygmy, red, paddle (py r pd)
4. pygmy (py)
5. red (r)
6. pygmy, red (py r)
7. pygmy, paddle, spotted (py pd sp)
8. pearl (p)
9. white (w)
10. ruby, light ocular diaphragm (rb lod)
11. Short antenna (Sa)
12. chestnut (c)
13. antennapedia (ap)
14. squint (sq)

III. Selected populations

Early: a population subjected to selection for a short larval peroid. 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

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

Tribolium castaneum

"Chicago" - a wild type strain (originally from Thomas Park)
"Brazil" (also known as cI) - a wild type strain (originally from Rio de Janiero)
cII - an inbred strain (derived from "Brazil")
cIII - an inbred strain (derived from "Chicago")
cIV-a - an inbred strain (derived from "Chicago")

Tribolium confusum

"Chicago" - a wild type strain (originally from Thomas Park)
"Ebony" - an autosomal recessive body color mutant
bI - an inbred strain (derived from "Chicago")
bII - an inbred strain (derived from "Chicago")
bIII - an inbred strain (derived from "Chicago)
bIV - an inbred strain (derived from "Chicago")

COLLEGE PARK, MARYLAND
UNIVERSITY OF MARYLAND,
DEPARTMENT OF ZOOLOGY

I. Wild type strains

A. Tribolium castaneum

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

Inbred strains.

4. E 2 (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

2. 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.)

CORVALLIS, OREGON
OREGON STATE UNIVERSITY,
DEPARTMENT OF ZOOLOGY

I. Wild type strains

A. Tribolium castaneum

1. Berkeley Berkeley, 1966
2. Chicago Urbana, 1966
3. del Valle Maryland, 1966
4. Oregon Urbana, 1967
5. Vivarium Urbana, 1967

Stock Lists

B. *Tribolium confusum*

1.	Berkeley	Berkeley, 1966
2.	Chicago	Urbana, 1966
3.	Kansas	Kansas, 1966
4.	Oklahoma	Urbana, 1966
5.	Oregon	Urbana, 1967

II. Mutant strains

A. *Tribolium castaneum*

1.	sa-2 (+/s)	Berkeley, 1966
2.	dve, pd	Berkeley, 1967
3.	fas-3a	Berkeley, 1967
4.	b, mc, p	Berkeley, 1966
5.	bal, c (+/s)	Berkeley, 1966
6.	pd	Urbana, 1966
7.	Be	Berkeley, 1966
8.	mc	Berkeley, 1967
9.	aa (+/p)	Berkeley, 1967
10.	ctp, ju	Berkeley, 1966
11.	Mo	Berkeley, 1966
12.	b^D	Berkeley, 1966
13.	ap^D, s	Berkeley, 1966
14.	j^D	Berkeley, 1966
15.	p, s, ap^D	Berkeley, 1966
16.	Fta, c	Berkeley, 1966
17.	ser, py, r	Berkeley, 1967
18.	Spa (+/c)	Berkeley, 1966
19.	r^2, s	Berkeley, 1967
20.	sq	Berkeley, 1967
21.	h^s	Urbana, 1967
22.	sh^s	Berkeley, 1967
23.	p, lod	Berkeley, 1967
24.	Sa-2, s	Berkeley, 1967
25.	r^u	Urbana, 1968

B. *Tribolium confusum*

1.	sh,h_{AS}	Berkeley, 1966
2.	mag^s	Berkeley, 1967
3.	we	Berkeley, 1966
4.	$dj,_s p,lod$	Berkeley, 1966
5.	thu^s, e	Berkeley, 1966
6.	dj	Berkeley, 1966
7.	e	Urbana, 1966
8.	thu	Berkeley, 1966
9.	p	Berkeley, 1966
10.	p_u lod	Berkeley, 1966
11.	h^u	Urbana, 1967
12.	thu^u	Berkeley, 1966
13.	ble^u	Urbana, 1967
14.	r^u	Urbana, 1968
15.	dep	Urbana, 1969
16.	sh^c	Corvallis, 1970

P. S. Dawson

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.
15 BC1-2, line 9 selected for 48 generations; average 21-day pupa weight 6-10 mg.
16-18 BC1-2L, lines 1-3, selected for small 21-day pupa for 30 generations.

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

G. A. E. Gall

DENTON, TEXAS 76204
TEXAS WOMAN'S UNIVERSITY
DEPARTMENT OF BIOLOGY

A. Wild type strains

1.	Tribolium confusum	Chicago
2.	Tribolium castaneum	Chicago

B. Mutant strains

1.	Tribolium castaneum "sooty"	San Bernardino

H. E. Erdman

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.)

EAST LANSING MICHIGAN
MICHIGAN STATE UNIVERSITY, DEPARTMENT OF ZOOLOGY

Tribolium confusum

I. Wild type strain

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

II. Mutant strains

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

Tribolium castaneum

Wild type strain
black strain

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

Attagenus megatoma	black carpet beetle
Cadra cautella	almond moth
Cylas formicarius elegantulus	sweet potato weevil
Ladioderma 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	

HAMPTON, IOWA
FARMERS HYBRID COMPANY

I. Wild type strain

1.	Chicago	via Berkeley, 1965

Stock Lists

II. Mutant strains

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

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)

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^D)	Berkeley , 1962
B.	black (b)	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 anaphae	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

I. Wild type strains

Purdue Foundation	Via Purdue
Black Foundation	Via Purdue
Pearl Foundation	Via Purdue

II. Mutant strains

Unsaturated fatty acid sensitive (cos)	
Melanotic stink glands (msg)	Berkeley, 1964

Tribolium confusum

T. confusum, Chicago	Park, 1955

R. F. Costantino

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

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^{ph}	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.)

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.

Stock Lists

COLEOPTERA

Anobiidae

Lasioderma serricorne (F.), Cigarette bettle, 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.

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.

Stock Lists

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

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

Stock Lists

MOSCOW, IDAHO
UNIVERSITY OF IDAHO, DEPARTMENT OF ENTOMOLOGY

A. Tribolium castaneum - large and small selections, sooty marked, obtained from Berkeley last October.

B. Tribolium madens from the Boise Valley area, Idaho, started in November, 1967.

C. Tribolium confusum - probably of local origin, held under weekly subculturing for about three years.

D. Tribolium castaneum - of local origin, subcultured largely at weekly intervals for about five years, started from a very few individuals surviving neglect of cultures previously, somewhat sporadically, maintained for several years in the laboratory.

(Ed.)

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

Tribolium castaneum, large stock, from Purdue University.

Tribolium castaneum, foundation stock, from Purdue University.

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

Stock Lists

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

NORMAN, OKLAHOMA
UNIVERSITY OF OKLAHOMA, DEPARTMENT OF ZOOLOGY

Coleoptera

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

F. J. Sonleitner.

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 interned 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.)

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. Wild type strains

A. Tribolium castaneum

1.	Arkansas	Bell, 1970
2.	Brazil	ex Park via Howard Erdman, 1963
3.	Capetown	Bell, 1970
4.	Chicago	Park, 1955
5.	Columbia	Bell, 1970
6.	Consejo	Spain, 1968
7.	Davis	Davis, Calif., 1961
8.	Georgia	Bell, 1970
9.	Florida	Bell, 1970
10.	Japan	Bell, 1970
11.	McGill	Stanely, 1958
12.	Sacramento	1961
13.	Texas	1958
14.	Veracruz, Mexico	1963
15.	Virginia	1958

B. Tribolium confusum

1.	Chicago	Park, 1955
2.	Davis	1961
3.	McGill	Stanley, 1958
4.	New York	1961
5.	Pennsylvania	McDonald, 1963
6.	Sacramento	1961
7.	San Bernardino	1968

C. Tribolium audax

1.	PIL	Slough, 1971

D. Tribolium anaphe

1.	PIL	Slough, 1963

E. Tribolium brevicornis

1.	Riverside	Calif., 1965

Stock Lists

F. Tribolium destructor
1. PIL — Slough, 1963

G. Tribolium madens
1. PIL — Slough, 1963
2. PIL — Slough, 1971

H. Latheticus oryzae
1. Kansas — 1970
2. Savannah — Georgia, 1970
3. Tifton — Georgia, 1970

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

J. Cryptolestes turcicus
1. PIL — Slough, 1963

K. Stegobium paniceum — San Bernardino, 1969

L. Trogoderma inclusum — USDA Lab., Fresno, 1968

II. Synthetic strains

A. Tribolium castaneum

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

2. Berkeley. Synthetic strain from seven laboratory strains not marked with body color genes. Prepared in 1964.

B. Tribolium confusum
1. Berkeley. Synthetic strain form six wild type laboratory strains not marked with body color genes. Prepared in 1958.

III. Inbred lines

A. Tribolium castaneum

1. Started 1971 from synthetic strain now in the 9th generation of brother-sister mating and not marked with sooty.

B. Tribolium confusum
1. Started October, 1958, from the Berkeley synthetic strain (now in 90-99 generation of brother-sister mating, not marked with body color genes).

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

2. Started in 1964 from the Berkeley synthetic strain, (now in 56-58 generation of brother-sister mating, not marked with body color genes.)
   a. CFI-13
   b. CFI-14
   c. CFI-15
   d. CFI-23
   e. CFI-24

IV. Mutants

A. Tribolium castaneum

Chromosome I

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

Chromosome II

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

Chromosome III

32.	aureate (au)	Berkeley, 1965
33.	McGill black (mcGb)	Stanley, 1964
34.	Chicago black (Cb)	Park, 1955
35.	Synthetic (McGb/Cb)	Chazy, New York, 1958
36.	black (b^{S-1}) (Brazil background)	Berkeley, 1963
37.	black (b^{S}) (Chicago background)	Chazy, New York, 1960

38. light ocular diaphragm (lod)
(pearl background)
39. light ocular diaphragm (lod^{d}) Dewees, 1971
40. melanotic stink glands (msg) Berkeley, 1964
41. scar (sc) Purdue, 1964
42. tawny (bt) PIL, 1965

Chromosome IV

39. cut prothorax (ctp) Berkeley, 1962
40. elongated juvenile urogomphi (eju) Berkeley, 1965
41. fused antennal segments-2 (fas-2) Berkeley,
42. incomplete mesosternum (ims) Berkeley, 1962
43. juvenile urogomphi (ju) Berkeley, 1962
44. reduced juvenile urogomphi (rju) Berkeley, 1963
45. Spatulate (Spa) Berkeley, 1964
46. deformed legs (dfl) Chazy, New York, 1959
47. sternites incomplete (sti) Berkeley, 1963
48. fas-2s
49. mahogany (my)

Chromosome V

50. jet (j) Park, 1955
51. microcephalic (mc) Chazy, New York, 1959
52. fused antennal segments-3 (fas-3) (=agg) Berkeley, 1961
53. fused antennal segments-3a (fas-3a) Berkeley, 1963
54. j spl mc
55. maroon (m) Eddleman, 1970

Chromosome VI

56. Microphthalmic (Mo) Chazy, New York, 1959

Chromosome VII

57. Short antenna (Sa)
58. Short antenna (Sa-1) (=Gn) Berkeley, 1959
59. Short antenna (Sa-2) (=Ds) Berkeley, 1962
60. Short antenna (Sa-3) (=Cua) Chazy, New York, 1959
61. short antenna (sa) (=ca) 1961
62. chestnut (c) (ex Eddleman) Berkeley, 1962
63. blistered elytra (ble) Berkeley, 1962
64. short antenna (sa-2) (=vg) Berkeley, 1962
65. Fused tarsi and antennae (Fta)
66. Fta ble
67. sa c
68. Fta c
69. Sa c
70. Fta ca c
71. ble c

Stock Lists

Chromosome VIII

72. antennapedia (ap^D) Berkeley, 1962
73. antennapedia (ap^S) (=fas-6) Berkeley, 1963
74. squint (sq) Chazy, 1959

Chromosome IX

75. missing abdominal sternites (mas) Berkeley, 1964
76. prothoraxless (ptl) Chazy, New York, 1959
77. prothoraxless-1 (ptl-1) Berkeley, 1965
78. partially pointed abdominal sternites (ppas) Berkeley, 1963

Chromosome X

79. abbreviated appendages (aa) Cold Spring Harbor, N. Y., 1961
80. abbreviated appendages-1 (aa-1) Chazy, New York, 1960 (=csp1)

Multichromosomal

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

81. py pd; p I, II
82. sp; p I, II
83. py; b I, III
84. py r; lod I, III
85. sp; j I, V
86. pd; Mo I, VI
87. sp; p; j I, II, V
88. p; lod II, III
89. p; b II, III
90. p; b; Mo II, III, VI
91. p; b; mc II, III, V
92. p; mc II, V
93. b; Mo III, VI
94. j; Mo V, VI
95. ju ctp c IV, VII
96. Mo; sa VI, VII
97. b (p) apt III, (II), ?
98. mc apt V, ?
99. apt j V, ?
100. Mo (c) nas VI, (VII), IX
101. (p) b mas (II), III ?
102. p Bamp/+ II, III ?
103. Bamp/+ap^D III ?, IX
104. Bamp/+ ptl^{Hoy} III ?, IX
105. b max III, ?

Stock Lists

106. j max V, ?
107. au Npp IV, ?
108. ap Npp VIII, ?
109. Be au IV
110. Fta ppas VII, ?
111. mc ppas V, IX
112. fas-3a ptl^{Hoy} III, IX
113. b ap^{s} III, VIII
114. au ctp IV
115. j ppas V, IX
116. ppk V, IX
117. rb m ?; V

Unassigned (but possibly in II)

118. creased abdominal sternites (cas) Berkeley, 1963
119. abnormal abdominal sternites (aas) Berkeley, 1965
120. akimbo (akb) Berkeley, 1964
121. alate prothorax (apt) Berkeley, 1964
122. antennae and tarsi fused (atf) Berkeley, 1961
123. ballooned (bal) Berkeley, 1963
124. banjo (bj) Chazy, New York, 1960
125. bead (bd) Bell, 1967
126. bent tibia (bt) Berkeley, 1961
127. Blunt abdominal and metathoracic projections (Bamp) (possibly in III) Berkeley, 1965
128. bowed femur (bf) Berkeley, 1963
129. bowleg Bell, 1967
130. bumpy (by) Bell, 1966
131. Charcoal (Chr) Berkeley, 1966
132. deflected epimera (dep) Berkeley, 1964
133. deformed femur (dff) Berkeley, 1964
134. deformed tibia (dft) Berkeley, 1964
135. dented Bell, 1967
136. diminutive appendages (dim) Berkeley, 1966
137. elbowed antennae-1 (elb-1) Berkeley, 1964
138. elongated elytra (ele) Berkeley, 1964
139. elytra and tarsi affected (eta) Berkeley, 1963
140. extra urogomphi (eu) (black) Chazy, New York, 1960
141. fused antennal segments-1 (fas-1) Chazy, New York, 1959
142. Fused antennal segments-4 (Fas-4) Berkeley, 1963
143. Fused antennal segments-5 (Fas-5) Berkeley, 1963
144. jagged antecoxal piece (jac) Berkeley, 1964
145. knobby prothorax (knp) Berkeley, 1966
146. lopped median groove (lmg) Berkeley, 1964
147. maxillopedia (max) Berkeley, 1965
148. minature appendages (ma^{D} r) Bell, 1967
149. Multi-urogomphi (Mu) Bell, 1966
150. Nonpunctate prothorax (Npp) Berkeley, 1965
151. padded prothorax (pdp) Berkeley, 1965

Stock Lists

152.	pectinate antennae (pec)	Berkeley, 1964
153.	reduced gin traps (rgt)	Berkeley, 1965
154.	reduced pleurosternal suture (rps)	Berkeley, 1965
155.	reduced tarsi and antennae (rta)	Berkeley, 1966
156.	rough (ro)	Berkeley, 1964
157.	ruby (rby)	Berkeley, 1962
158.	rugose elytra (rue)	Berkeley, 1966
159.	scalloped prothorax (scp)	Berkeley, 1965
160.	short median abdominal projection (smp)	Berkeley, 1966
161.	short split spinasternum (sss)	Berkeley, 1965
162.	split (sp)	1963
163.	split-back (sb)	Bell, 1966
164.	stumpy (stu)	Berkeley, 1965
165.	Tetra urogomphi (Tu)	Berkeley, 1965
166.	tiny (ti) (=ty)	1962
167.	umbilicus (umb)	Berkeley, 1964

B. Tribolium confusum

Chromosome I

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

Chromosome II

18.	pearl (p)	PIL, via Stanley, 1960
19.	pearl (p^S)	Berkeley, 1962
20.	ebony-2 (e_2)	PIL, via Stanley, 1960
21.	creased abdominal sternites (cas)	Berkeley, 1963
22.	dirty pearl eye (dpe) (=fro)	Berkeley, 1963
23.	e_2p	PIL, via Stanley, 1960
24.	p cas	

Chromosome III

25.	Yugoslavian black (=b^z)	Yugoslavia, 1969

Stock Lists

26.	McGill black (McGb) (=b^{Ho})	Stanley, 1960
27.	black-3 (b-3)	Berkeley, 1964
28.	ruby spot (rus)	Chazy, New York, 1960
29.	melanotic stink glands (msg)	Berkeley, 1962
30.	rus msg	
31.	b rus	
32.	b msg	

Chromosome IV

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

Chromosome V

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

Chromosome VI

40.	disjoined (dj)	Berkeley, 1963

Unassigned (but possibly in III)

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

Multichromosomal

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

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

C. Tribolium anaphe

None

D. Tribolium audax

None

E. Tribolium brevicornis

1. creased abdominal sternites (cas)
2. split (spl)
3. fused antennal segments (fas)

F. Tribolium destructor

None

G. Tribolium madens

1.	fused antennal segments-1 (fas-1)	Berkeley, 1964
2.	split (spl)	Berkeley, 1964
3.	bent tibia (btt)	Berkeley, 1964

H. Latheticus oryzae

None

I. Oryzaephilus surinamensis

None

Stock Lists

J. Cryptolestes turcicus

Chromosome I

1. red (r) PIL, 1963

K. Stegobium paniceum

None

A. Sokoloff

SANTA FE, NEW MEXICO
SANTA FE PREPARATORY SCHOOL

I. Wild type strain
A. Tribolium castaneum — Chicago via Berkeley
B. Tribolium confusum — McGill via Berkeley

(Ed.)

SAVANNAH, GEORGIA
STORED-PRODUCT INSECTS RESEARCH AND DEVELOPMENT LABORATORY

I. Wild type strains

A. Lepidoptera

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

B. Coleoptera

1.	Anthrenus flavipes LeConte	Savannah, Ga.; and Durham, N.H.
2.	Attagenus megatoma (Fab.)	CSMA strains
3.	Callosobruchus maculatus (Fab.)	Fresno, California
4.	Cathartus quadricollis (Guérin-Méneville)	Unknown
5.	Cryptolestes pusillus (Schönherr)	Tifton, Ga.
6.	Dermestes maculatus De Geer	Madison, Wisconsin
7.	Gibbium psylloides (Czenpinski)	Unknown
8.	Lasioderma serricorne (Fab.)	Unknown
9.	Oryzaephilus mercator (Fauvel)	Unknown
10.	Oryzaephilus surinamensis (L.)	Manhattan, Kansas
11.	Rhyzopertha dominica (Fab.)	Unknown
12.	Stegobium paniceum (Linnaeus)	Madison, Wisconsin
13.	Sitophilus granarius (L.)	Manhattan, Kansas
14.	Sitophilus oryzae (L.)	Arkansas; California; Kansas; Louisiana; Minnesota; and Texas

Stock Lists

15.	Sitophilus zeamaize Motschulsky	Estill, S.C.
16.	Stegobium paniceum (L.)	Madison, Wisconsin
17.	Tenebrio molitor (L.)	Manhattan, Kansas; and Durham, New Hampshire
18.	Tenebroides mauritanicus (L.)	Savannah, Ga.
19.	Tribolium castaneum (Herbst)	Unknown
20.	Tribolium confusum Jacquelin duVal	Manhattan, Kansas
21.	Tribolium madens Charpentier	Tifton, Ga.
22.	Trogoderma glabrum (Herbst)	Madison, Wisconsin; Riverside, Calif.
23.	Trogoderma inclusum LeConte	Madison, Wisconsin; Riverside, Calif.
24.	Trogoderma variabile Ballion	Fresno, Calif; Riverside, Calif.

II. Mutant strains

A. Plodia interpunctella

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

B. Tribolium castaneum

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

C. Tribolium confusum

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

D. New mutants

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

R. Davis

Stock Lists

SOUTH LANCASTER, MASSACHUSETTS
ATLANTIC UNION COLLEGE, BIOLOGY DEPARTMENT

Tribolium castaneum

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

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

(Ed.)

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

I. Wild type strains

A. Laboratory strains
1. Tribolium castaneum – McGill — Montreal, Canada via University of California
2. Tribolium castaneum – Seton Hall — South Orange, New Jersey
3. Tribolium castaneum – inbred – 20 generations
4. Tribolium confusum — Fordham University

B. Base Populations for quantative studies (Tribolium castaneum)

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

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

Stock Lists

II. Mutant strains

A. Tribolium castaneum

1.	ca	via University of California
2.	fas-3	via California State College
3.	paddle	via California State College
4.	red ^{n0}	via California State College
5.	Short antennae (Sa)	Purdue + Foundation, 1960
6.	white	via California State College

Eliot Krause

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

Anthonomus grandis

A. Wild type strains

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

B. Mutant strains

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

C. Insecticide resistant

1.	Endrin Resistant ca. 20 g/weevil	Auburn University

W. Ivey

(Ed.)

STONY BROOK, NEW YORK
STATE UNIVERSITY OF NEW YORK, DIVISION OF BIOLOGICAL SCIENCES

Tribolium castaneum

I. Wild type

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

II. Mutants

1.	Sooty (s)	
2.	paddle (pd)	University of Chicago

3. pearl (p) — University of Chicago
4. McGill black (McGb) University of Chicago Stock — University of California
5. McGill black (McGb) with UPF genetic background obtained by backcrossing to UPF for nine generations. — University of Kansas

Tribolium confusum

I. Wild type
1. Chicago (Sonleitner) — University of Chicago
2. New York — University of Chicago

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

Robert R. Sokal

ST. BERNARD, ALABAMA
ST. BERNARD ABBEY

I. Wild Type strains

A. Tribolium castaneum
1. Chicago — via San Bernardino

B. Tribolium confusum
1. New York — via San Bernardino

II. Mutant strains

A. Tribolium castaneum

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

B. Tribolium confusum
1. pearl — via San Bernardino
2. McGill black — via San Bernardino
3. Ebony (Smith) — via San Bernardino

Stock Lists

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

Stock list of stored product insects

Tribolium confusum
Sitophilus oryzae (large strain)
Sitophilus granarius
Oryzaephilus surinamensis
Trogoderma parabili
Rhyzopertha dominica
Plodia interpunctella
Ephestia spp.
Attagenus megatoma

Ernesto De las Casas
Phillip K. Harein

ST. PAUL, MINNESOTA 55101
UNIVERSITY OF MINNESOTA
DEPARTMENT OF GENETICS AND CELL BIOLOGY

Tribolium castaneum

A. Synthetic populations

All selected populations originated from a cross of inbred lines CSI-5 and CSI-10 obtained in 1963 from the Tribolium stock center (marked with sooty).

1. S lines - populations selected for 85 generations for increased pupa weight.

2. C lines - stabilized selected populations for 21 day pupa weight (85 generations).

3. R lines - random bred and random selected for 60 generations.

4. T lines - populations selected for 21 day pupa weight for 52 generations followed by 30 generations of relaxed selection.

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.

Stock Lists

TEMPE, ARIZONA
ARIZONA STATE UNIVERSITY, DEPARTMENT OF ZOOLOGY

I. Synthetic strains

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

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

II. Mutant strains

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

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

Harry E. Wistrand

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
UNIVERSITY OF ILLINOIS, DEPARTMENT OF ZOOLOGY

I. Wild type strains

A. Tribolium castaneum

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

B. Tribolium confusum

1. Berkeley	Berkeley, 1966

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

II. Inbred lines

A. Tribolium castaneum

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

B. Tribolium confusum

1.	CFI-1	Berkeley, 1966
2.	CFI-2	Berkeley, 1966
3.	CFI-3	Berkeley, 1966
4.	CFI-5	Berkeley, 1966
5.	CFI-7	Berkeley, 1966
6.	CFI-8	Berkeley, 1966
7.	CFI-11	Berkeley, 1966
8.	CFI-12	Berkeley, 1966
9.	CFI-13	Berkeley, 1966
10.	CFI-14	Berkeley, 1966
11.	CFI-15	Berkeley, 1966
12.	CFI-16	Berkeley, 1966
13.	CFI-18	Berkeley, 1966
14.	CFI-19	Berkeley, 1966
15.	CFI-20	Berkeley, 1966
16.	CFI-21	Berkeley, 1966
17.	CFI-22	Berkeley, 1966
18.	CFI-23	Berkeley, 1966
19.	CFI-24	Berkeley, 1966

III. Mutant strains

A. Tribolium castaneum

1.	sa-2 (+/s)	Berkeley, 1966
2.	i	Purdue, 1967
3.	w	Purdue, 1967
4.	b, mc, p	Berkeley, 1966
5.	bal, s	Berkeley, 1966
6.	pd	Urbana, 1966
7.	Be	Berkeley, 1966
8.	mc	Berkeley, 1967
9.	aa (+/p)	Berkeley, 1967

10.	$\underline{r^{Ho}}$	Berkeley, 1966
11.	Mo	Berkeley, 1966
12.	b	Berkeley, 1966
13.	$\underline{ap^{D}}$, s	Berkeley, 1966
14.	j	Berkeley, 1966
15.	r (+/py)	Berkeley, 1966
16.	Fta/+, c	Berkeley, 1966
17.	c	Berkeley, 1966
18.	Spa/+, +/c	Berkeley, 1966
19.	p	Berkeley, 1967
20.	sq	Berkeley, 1967
21.	msg	Berkeley, 1967
22.	$\underline{sh^{s}}$	Berkeley, 1967
23.	p, lod	Berkeley, 1967
24.	Sa-2, s	Berkeley, 1967
25.	rg	Berkeley, 1967
26.	fas-3a	Berkeley, 1967
27.	$\underline{r^{D}}$, s	Berkeley, 1967
28.	dve, pd	Berkeley, 1967
29.	h	Urbana, 1967
30.	rs	Purdue, 1967
31.	rb	Purdue, 1967
32.	j, m	Purdue, 1967
33.	ctp, ju	Berkeley, 1967

(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	Dawson, 1967
2.	Mutant, ebony	Dawson, 1967
3.	Mutant, McGill black	Sokoloff, 1966

Tribolium brevicornis

1.	Wild type	Yang, 1970

Stock Lists

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.)

BELGIUM

GEMPLOUX
INSTITUT AGRONOMIQUE DE L'ETAT, ZOOLOGIE GENERALE

Tenebrio molitor

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

(Ed.)

LOUVAIN
F.A. GANSSENS 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, SAO PAULO
INSTITUTE AGRONOMICO, SECAO DE ENTOMOLGIA

Anobiidae

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

Bostrochidae

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

Bruchidae

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

Stock Lists

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.)

CANADA

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

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.)

GUELPH, ONTARIO
UNIVERSITY OF GUELPH, DEPARTMENT OF ANIMAL AND POULTRY SCIENCE

Tribolium castaneum

Wild type - mass mated stock derived from Purdue University Foundation Stock.

R. Fairfull

Stock Lists

GUELPH, ONTARIO
UNIVERSITY OF GUELPH, DEPARTMENT OF ZOOLOGY

A. Sitophilus granarius (L)
   1. GG strain, dark, heavy and symbiotic
   2. MW strain, paler, lighter and aposymbiotic
   3. Two new strains as yet unclassified

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

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

(Ed.)

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

Tribolium castaneum

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

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

Tribolium castaneum

Purdue Foundation

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

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

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

Stock Lists

TSLW - A populations 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

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

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

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.	Ahasverus advena (Waltl) Silvanidae	Manitoba
3.	Alphitobius diaperinus Panzer Tenebrionidae	Saskatchewan
4.	Anthicus floralis L. Anthicidae	Manitoba
5.	Cryptolestes ferrugineus (Steph.) Cucujidae	Manitoba
6.	Cryptolestes ferrugineus (Steph.) Cucujidae	PIL United Kingdom
7.	Cryptolestes ferrugineus (Steph.) Cucujidae	Australia

Stock Lists

8.	Cryptolestes turcicus (Grouv.) Cucujidae	Ontario
9.	Cryptolestes turcicus (Grouv.) Cucujidae	PIL United Kingdom
10.	Cynaeus angustus Leconte Tenebrionidae	Manitoba
11.	Oryzaephilus mercator (Fauvel) Silvanidae	Ontario
12.	Oryzaephilus surinamensis (L.) Silvanidae	Manitoba
13.	Rhyzopertha dominica (Fab.) Bostrichidae	Australia
14.	Sitophilus granarius (L.) Curculionidae	Manitoba
15.	Sitophilus oryzae (L.) Curculionidae	Montreal
16.	Sitophilus zea-mais Motschulsky Curculionidae	Japan
17.	Stegobium paniceum (L.) Anobiidae	Winnipeg
18.	Tenebroides mauritanicus (L.) Ostomidae	Manitoba
19.	Tenebrio molitor (L.) Tenebrionidae	Manitoba
20.	Tribolium castaneum (Herbst) Tenebrionidae	Manitoba
21.	Tribolium confusum (DuVal)	
22.	Tribolium madens Charp. Tenebrionidae	Manitoba
23.	Trogoderma variabile Ballion Dermestidae	Alberta

B. Lepidoptera

1.	Nemapogon granella (L.) Tineidae	Ontario
2.	Plodia interpunctella (Hbn.) Phycitidae	Winnipeg
3.	Pyralis farinalis L. Pyralidae	Manitoba

II. Mutant strain

A. Coleoptera

Tribolium castaneum Herbst Tenebrionidae (Black body color from lab stock) — Winnipeg

Tribolium confusum DuVal — Winnipeg, Manitoba, 1963

L.B. Smith

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

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
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.)

Stock Lists

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.

Note: Dr. M. A. Hafeez is at present in London. Fate of above stocks is unknown.

(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	
F.	Periplaneta americana	
G.	Pseudococcus citri	Antibes
H.	Sitophilus granarius	Infestation Control Laboratory, Surbiton

Stock Lists

I.	Sitophilus oryzae	P.I.L., Slough
J.	Sitophilus sasakii--wild type	Lyon
K.	Stegobium paniceum	P.I.L., Slough
L.	Tenebrio molitor	
M.	Tenebrio obscurus	P.I.L., Slough
N.	Tribolium castaneum--wild type	Alès

(Ed.)

GERMANY

MUNICH
BAYER, LANDESANSTALT FÜR BODENKULTUR
PFLANZENBAU U. PFLANZENSCHUTZ

Coleoptera

Cucjidae

Cryptolestes turcicus (Grouv.)	Munich, 1966

Curculionidae

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

Ptinidae

Gibbium psylloides (Czemp.)	Regensburg, 1960

Silvanidae

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

Tenebrionidae

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

Lepidoptera

Phyticidae

Anagasta Kuehniella (Zell.)	Munich, 1966

(Ed.)

Stock Lists

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

Tenebrio molitor
Tenebrio obscurus
Blaps sp.
Tribolium sp.

(Ed.)

DUNDEE, ANGUS
UNIVERSITY OF DUNDEE, DEPARTMENT OF NATURAL HISTORY

Only the stock unique to this laboratory is listed.
Wild stock

1. Tribolium castaneum - Kenya. Collected in December, 1967, from stored maize in the Nairobi district.

(Ed.)

DUNDEE
DUNDEE UNIVERSITY
DEPARTMENT OF BIOLOGICAL SCIENCES

	Origin
Tribolium castaneum	Sleugh
T. confusum	
T. madens	
T. destructor	
T. brevicornis	
T. castaneum - M..S.G	Sokoleff
T. castaneum - M.S.G.	Sleugh
T. confusum - Black mutant	Sleugh
T. confusum - Pearl Eye	Sleugh
Eppestion cautella	Sleugh
Gnathocerus maxillosus	Sleugh
G. cornutus - Sleugh, New Zealand	Egypt
Latheticus oryzae - Normal and Dark	Sleugh
Sitophilus zeamais	Sleugh

F. L. Waterhouse

ENDINBURGH
UNIVERSITY OF ENDINBURGH, INSTITITE OF ANIMAL GENETICS

Tribelium 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.)

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

Tribelium castaneum Herbst.

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

Tribelium confusum J. duV.

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

(Ed.)

GLASGOW, SCOTLAND
UNIVERSITY OF GLASGOW
DEPARTMENT OF ZOOLOGY

Wild type Strains:

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

T. castaneum
ppas partially pointed abdominal sternites

LONDON
QUEEN ELIZABETH COLLEGE, DEPARTMENT OF BIOLOGY

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

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

(ed.)

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

Tribolium castaneum

A. Wild type

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

Tribolium confusum

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

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

(ed.)

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

ORDER Family (-subfamily) Genus (sub genus), species.	COMMON NAME	COUNTRY OF ORIGIN OF STOCK	CULTURE MEDIUM	REARING TEMPERATURE °C
Cucujidae				
Cryptolestes capenis (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			35	20
Anthrenus (Florilinus) olgae Kalik			20	20
Attagenus sp? (alfieri of Hinton 1945)		Kenya	17	25
Attagenus fasciatus (Thunberg) (=gloriosae (Fabrioius)		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

ORDER Family (-subfamily) Genus (sub genus), species.	COMMON NAME	COUNTRY OF ORIGIN OF STOCK	CULTURE MEDIUM
Gelechiidae			
Sitotroga cerealella (Oliv.)	Angoumois grain moth		1
Tineidae			
Tinea columberiella Wocke	Case bearing clothes moth		20
Tinea flavescentella Haworth		Britain	20
Tineola bisselliella (Humm.)	Common clothes moth		20
Tenea Pellionella (L.)			20
COLEOPTERA			
Anobiidae			
Lasioderma serricorne (F.)	Cigarette beetle		6
Stegobium paniceum (L.)	Biscuit beetle		6
Antribidae			
Araecerus fasciculatus (Deg.)			39
Bostrichidae			
Rhyzopertha dominica (F.)	Lesser grain borer		1
Bruchidae			
Acanthoscelides obtectus (Say)	Dried Bean beetle	W. Africa	27
Callosobruchus analis (F.)			29
Callosobruchus chinensis (L.)	Cowpea weevil		29
Callosobruchus maculatus (F.)		Sierra Leone	29
Callosobruchus rhodesianus (Pic)			29
Caryedon serratus (Oliv.) (=gonagra (F.))	Groundnut seed beetle		26a
Zabrotes subfasciatus (Boh.)			28
Cerylonidae			
Murmidius ovalis (Beck)		Ceylon	13
Cleridae			
Necrobia rufipes (Deg.)	Copra beetle		22
Necrobia ruficollis (F.)			40

Stock Lists

I. Wild type strains

ORDER Family (-subfamily) Genus (sub genus), species.	COMMON NAME	COUNTRY OF ORIGIN OF STOCK	CULTURE MEDIUM	REARING TEMPERATURE °C.
DICTYOPTERA				
Blattidae				
Blatta orientalis L.	Oriental cockroach		18a	27
Blattella germanica (L.)	German 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
Braconidae				
Bracon hebetor Say		America	31	25
LEPIDOPTERA				
Pyralidae - Pyralinae				
Pyralis farinalis (L.)	Meal Moth		5	25
Pyralidae - Phycitinae				
Ephestia (Anagasta) kuehniella (Zell.)	Mediterranean flour moth	Britain	8a	25
		Britain	8a	25
Ephestia (Cadra) cautella (Walk.)	Tropical warehouse moth	(S. Africa)	8a	25
Ephestia (Ephestia) elutella (Hubn.)	Warehouse moth	Britain	8a	25
Ephestia (Cadra) calidella (Guen.)		Cyprus	34a	30
Ephestia (Cadra) figulilella Gregs.		Cyprus	34a	30
Plodia interpunctella (Hubn.)	Indian meal moth	Britain	8a	25
Pyralidae - Galleriae				
Achroia grisella (F.)	Lesser wax moth		16a	25
Galleria mellonella (L.)	Honeycomb moth		16a	25
Paralipsa gularis (Zell.)			26	25

ORDER Family (-subfamily) Genus (sub genus), species.	COMMON NAME	COUNTRY OF ORIGIN OF STOCK	CULTURE MEDIUM	REARING TEMPERATURE °C
Dermestes peruvianus Castelnau		Britain	21a	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 variabile Ballion (=parabile Beal)		U.S.A.	2	30
Trogoderma simplex Jayne		U.S.A.	18	30
Trogoderma sternale plagifer Casey		New Mexico	32	30
Mycetophagidae				
Typhaea stercorea (L.)	Hairy grain beetle	Nigeria	4	25
Nitidulidae				
Carpophilus dimidiatus (F.)	Corn-sap beetle		14	25
Carpophilus hemipterus (L.)	Dried fruit beetle		15	25
Carpophilus marginellus			23a	25
Trogossitidae				
Lophocateres pusillus (Klug.)	Siamese grain beetle		11	30
Tenebroides mauritanicus (L.)	The Cadelle	Pakistan	12	30
Ptinidae				
Gibbium psylloides (Czemp)	Hump spider beetle	Britain	17a	20
Mezium affine Boield.		Britain	17a	20
Mezium americanum Lap.	American spider beetle		17a	20
Niptus hololeucus (Fald.)	Golden spider beetle	Britain	17a	20
Pseudeurostus hilleri (Reitt.)		Britain	17a	20
Ptinus clavipes Panz.	Brown spider beetle	Britain	17a	20
Ptinus pusillus Sturm.			17a	20
Ptinus sexpunctatus Panz.			17a	20
Ptinus tectus Boield	Australian spider beetle		19a	25
Stethomezium squamosum Hint.	African spider beetle	Britain	17a	20
Tipnus unicolor (P. & M.)		Kenya	17a	20
Trigonogenius globulus Sol.	Globular spider beetle	Ireland	17a	20
Trigonogenius particularis Pic		Kenya	18a	25

ORDER Family (-subfamily) Genus (sub genus), species.	COMMON NAME	COUNTRY OF ORIGIN OF STOCK	CULTURE MEDIUM	REARING TEMPERATURE °C
Silvanidae				
Ahasverus advena (Waltl)	Foreign grain beetle	(West Africa)	10	25
Cathartus quadricollis (Guer.)	Square-necked grain beetle	W. Africa	10	25
Oryzaephilus mercator (Fauv.)	Merchant grain beetle		10	25
Oryzaephilus surinamemsis	Saw-toothed grain beetle		10	25
Tenebrionidae				
Alphitobius diaperinus (Panz.)	Lesser mealworm		7	25
Alphitobius laeviagatus (F.)	Black fungus beetle		7	25
Alphitobius viator Muls. & God.		Sierra Leone	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
Palorus laesicollis (Fairm.)		Kenya	24	25
Palorus ratzeburgii (Wissm.)	Small-eyed flour beetle		6	25
Palorus subdepressus (Woll.)	Depressed flour beetle	Turkey	7	25
Tenebrio molitor L.	Yellow mealworm		10a	25
Tenebrio obscurus F.	Dark mealworm		10a	25
Tribolium anaphe Hint.		Nigeria	17	25
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
Languriidae				
Pharaxonotha kirschi (Reitt.)			6a	25

The letter "a" after a number 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.

CULTURE MEDIA

No.	Food	Weight Rat (Ounces)
1.	Wheat	
2.	Wheat + wheatfeed	7:3
3.	Wheat + wheatfeed + glycerol	7:3:1
4.	Wheat + wheatfeed + glycerol on a damp pad of cotton wool	7:3:1
5.	Wheat + wheatfeed on a damp pad	7:3:1
6.	Wheatfeed + yeast	10:1
7.	Wheatfeed + yeast on a damp pad	10:1
8.	Wheatfeed + yeast + glycerol	10:1:3
9.	Wheatfeed + yeast + glycerol on a damp pad	10:1:3
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 + dates	6:1:6
16.	Wheatfeed + rolled oats + yeast + glycerine + honey + brood comb	
17.	Wheatfeed + fishmeal + yeast	5:5:1:2
18.	Wheatfeed + rolled oats + fishmeal + yeast	8:4:1
19.	Fishmeal + yeast	5:5:2:1
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	16:1
24.	Wheatfeed + rolled oats + flour + yeast	12:1
25.	Wheatfeed + grassmeal + yeast + shortex	3:3:3:1
26.	Groundnuts	20:10:1
27.	Haricot beans	
28.	Butter beans	
29.	Cowpeas + dried green peas	
30.	Liver + sugar and water	1:1
31.	Moth culture (Sub-family Phycitinae)	
32.	Fishmeal + Yeast + dried cockroaches	
33.	Liver, swiss roll and honey	
34.	Wheatfeed + glucose + yeast	
35.	Wheatfeed + fishmeal + yeast + cholesterol	5:2:1
36.	Crushed dog biscuit + yeast	8:8:1:1
37.	Bread and butter	20:1
38.	Sweet biscuits	
39.	Maize	
40.	Wood sawdust + bones	

1. Resistant strains

A. Tribolium castaneum (Tenebrionidae)

1. DDT resistant	South Africa, 1960
2. Non-specific resistant	Australia, 1968
3. Lindane specific resistant	Zambia, 1970
4. Malathion specific resistant	Nigeria, 1963
5. Insecticide susceptible	Unknown, 1970

II. Mutants

MUTANT STOCKS	MUTATION	COUNTRY OF ORIGIN OF STOCK	MEDIA	TEMP.
Bostrichidae				
Rhyzopertha dominica (F.)	Black		1	30
Bruchidae				
Callosobruchus maculatus (F.)	Giant		29	30
Cucujidae				
Cryptolestes pusillus (Schön)	Black	Trinidad	10	30
Dermestidae				
Dermestes maculatus Deg.	Black/ Brown	Australia	21	25
Nitidulidae				
Carpophilus dimidiatus (F.)	Pearl-eyed		10	25
Silvanidae				
Ahasveras advena (Waltl)	Black	Britain	10	25
Oryzaephilus surinamensis (L.)	Small	Burma	10	25
Tenebrionidae				
Latheticus oryzae Waterh.	Dark		6	30

MUTANT STOCKS	MUTATION	COUNTRY OF ORIGIN OF STOCK	MEDIA	TEMP.
Tribolium confusum Duv.	Black		23	25
T. confusum	Pearl-eyed	Malta	23	25
T. confusum	Pearl-eyed	Britain	23	25
T. confusum	Pearl-eyed		23	25
T. confusum	Black and Pearl-eyed		23	25

(Ed.)

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

LEPIDOPTERA

Phycitidae

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

(Ed.)

Stock Lists

INDIA

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

Wild type strain

1. Tribolium castaneum from local godowns.

(Ed.)

HISSAR, HARAYANA
PUNJAB AGRICULTURAL UNIVERSITY, DEPARTMENT OF GENETICS

I. Wild type strains (Tribolium castaneum)

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

II. Mutant strains (Tribolium castaneum)

S-8	Py	via Sokoloff, Berkeley
S-12	P	via Sokoloff, Berkeley
S-20	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
S-71	sa	via Sokoloff, Berkeley
S-74	ju	via Sokoloff, Berkeley
S-81	Bes	via Sokoloff, Berkeley
S-90	Py r Mr	via Sokoloff, Berkeley
S-100	b Mo	via Sokoloff, Berkeley
S-154	Be Fta	via Sokoloff, Berkeley
S-248	Fta c ca	via Sokoloff, Berkeley
S-253	lod p	via Sokoloff, Berkeley
S-304	Msg	via Sokoloff, Berkeley
S-313	ser py r	via Sokoloff, Berkeley
S-325	Fta	via Sokoloff, Berkeley
S-333	Spa	via Sokoloff, Berkeley
S-341	r	via Sokoloff, Berkeley
S-346	Fas-3	via Sokoloff, Berkeley
S-483	pd	via Sokoloff, Berkeley

(Ed.)

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

T. castaneum

Wild strain of local origin

(Ed.)

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

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

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

These stocks have been inbred for 19 generations.

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

ISRAEL

TEL AVIV, ISRAEL
TEL AVIV UNIVERSITY, DEPARTMENT OF ZOOLOGY

1. Stock list

Tribolium castaneum:

Wild type
++ (Purdue)

Mutants
black (bb)
sooty (ss)
extra urogomphi (eu)

Tribolium confusum

Mutants
black (mcGill) (bb)

Two other strains listed in TIB-15 were lost by infection.

All strains except eu were obtained from Dr. R. R. Sokal's laboratory, Stony Brook, N.Y. USA in 1970. The CS bb and CS ss stocks were recently contaminated by wild type beetles and therefore contain some wild-type genetic background.

Dr. David Wool

ITALY

PAVIA
UNIVERSITY PAVIA, CENTRO DE GENETICA

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

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

JAPAN

KYOTO
KYOTO UNIVERSITY, FACULTY OF AGRICULTURE
ENTOMOLOGICAL LABORATORY

1. Wild type

Bruchidae

Callosobruchus chinensis	Kyoto 11 other districts in Japan
Callosobruchus maculatus	Louisiana, U.S.A. California, U.S.A. (Fresno, Lab., U.S.D.A.) Burma Israel Thailand
Zabrotes bifasciatus	Hong Kong

Tenebrionidae

Tribolium castaneum	Kyoto
Tribolium confusum	

2. Mutant strain
Black mutant from a strain of Callasobruchus Chinensis

MISIMA, SIZUOKA-KEN
NATIONAL INSTITUTE OF GENETICS

No stock list available.

(Ed.)

MIYAZAKI
MIYAZAKI UNIVERSITY, DEPARTMENT OF BIOLOGY

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

(Ed.)

OKAYAMA, JAPAN
OKAYAMA UNIVERSITY
FACULTY OF AGRICULTURE
LABORATORY OF APPLIED ENTOMOLOGY

Wild type

Alphitobius diaperinus	Miyazaki
Callosobruchus chinensis	Hiroshima Kyoto
Gnathocerus cornutus	Miyazaki
Lasioderma serricorne	Miyazaki
Latheticus oryzae	Miyazaki
Oryzaephilus mercator	Miyazaki
Oryzaephilus surinamensis	Miyazaki
Palorus ratzeburgi	Miyazaki
Palorus subdepressus	Miyazaki
Rhizopertha dominica	Miyazaki
Sitophilus oryzae	Miyazaki
Sitophilus zeamais	Miyazaki
Stegobium paniceum	Miyazaki
Tenebrio obscurus	Miyazaki
Tribolium castaneum	Miyazaki
Tribolium confusum	Miyazaki

T. Yoshida

MEXICO

CHAMPINGO
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, THE NETHERLANDS
ROYAL TRIPICAL INSTITUTE
DEPT. AGRIC. RES.

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	
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

NEW ZEALAND

NELSON
DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH
ENTOMOLOGY DIVISION

Stegobium paniceum--from infested rat food pellets at Otago University, Dunedin
Oryzaephilus surinamensis--from infested rat food pellets at Otago University, Dunedin
Gnathocerus cornutus--from infested rat food pellets at Otago University, Dunedin
Sitophilus oryzae--from spaghetti in galleys of overseas ships at Port Nelson
Sitophilus zeamais--from rice in galleys of overseas ships at Port Nelson

(Ed.)

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

Tribolium castaneum

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

A. R. Quartermain

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

Tribolium castaneum

1. Heavy and light population resulting from 18 generations of selection for increased and decreased pupal weight.
2. Strong, moderate and weak populations resulting from 20 generations of within-family selection for increased pupal weight at three selection intensities.

(Ed.)

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
LABORATORIO DE GENETICA DE POBLACIONES

Tribolium castaneum

A. Wild type strains

1. Consejo	CSIC, 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

B. Mutant type strains

6. 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
7.	AN - I	high performance	at	33° C
8.	AN - II	high performance	at	33° C
9.	AF - I	high performance	at	28° C
10.	AF - II	high performance	at	28° C
11.	AT - I	high performance	at	38° C
12.	AT - II	high performance	at	38° C
13.	BN - I	low performance	at	33° C
14.	BN - II	low performance	at	33° C
15.	BF - I	low performance	at	28° C
16.	BF - II	low performance	at	28 C
17.	BT - I	low performance	at	38° C
18.	BT - II	low performance	at	38° C
19.	RN - I*	high cross performance	at	33° C
20.	SN - I*	high cross performance	at	33° C
21.	RN - II	high cross performance	at	33° C
22.	SN - II	high cross performance	at	33° C
23.	RF - I	high cross performance	at	28° C
24.	SF - I	high cross performance	at	28° C
25.	RF - II	high cross performance	at	28° C
26.	SF - II	high cross performance	at	28° C
27.	RT - I	high cross performance	at	38° C
28.	ST - I	high cross performance	at	38° C
29.	RT - II	high cross performance	at	38° C
	ST - II	high cross performance	at	38° C

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

31 - 38 Inbred lines with 26 generations of full sibbing.

39.	ATD-I	High performance at different levels of selct.
40.	ATD-LL	" " " " " " "
41.	BTD-I	" " " " " " "
42.	BTD-II	" " " " " " "
43.	CTD-I	" " " " " " "
44.	CTD-II	" " " " " " "
45.	DTD-I	" " " " " " "
46.	DTD-II	" " " " " " "
47.	ETD-I	" " " " " " "
48.	ETD-II	" " " " " " "
49.	FTD.I	" " " " " " "
50.	FTD-II	" " " " " " "

D. Mutants

		Source and date
51.	antennapedia ap, VIII	Purdue, 1964
52.	Bar eye Be, IV	Purdue, 1968
53.	Black b, III	Sokoloff, 1964
54.	chestnut c, VII	Purdue, 1964
55.	cordeban cd, III	Purdue, 1964
56.	Diferencial Df, IV	Purdue, 1964
57.	fussed antennal segm. -2 fas-2, IV	Sokoloff, 1968
58.	ivory i, ?	Purdue, 1964
59.	jat j, V	Purdue, 1964
60.	juvenile urogenphy ju, IV	Purdue, 1964
61.	light ocular diaph. lod, III	Purdue, 1964
62.	maroon m, V	Purdue, 1964
63.	microcephalic mc, V	Purdue, 1964
64.	paddle pd, I	Purdue, 1964
65.	pearl p, II	Sokoloff, 1968
66.	pegleg pg, II	Purdue, 1968
67.	pink p^{pk}, II	Purdue, 1968
68.	pygmy py, I	Purdue, 1968
69.	red r, I	Purdue, 1968
70.	ring rg, I	Purdue, 1964
71.	rose, rs, I	Purdue, 1964
72.	ruby rb, ?	Purdue, 1964
73.	Short antenna Sa, VII	Purdue 1. 1964
74.	short elytra sh, VIII	Purdue, 1964
75.	sooty s, IV	Purdue, 1964
76.	spotted sp, I	Purdue, 1964
77.	squint sq, VIII	Purdue, 1964
78.	white w, ?	Purdue, 1964
79.	wine r^{w}, I	Purdue, 1968
80.	eye mutant ?	Madrid, 1967
81.	elytra mutant ?	Madrid 1967
82.	melanotic stink gland-like ?	Madrid, 1968

Tribolium confusum

A. Wild type strains

83.	Campanario	Campanario, Spain, 1973
84.	Santa Maria	Santa Maria, Spain, 1973
85.	Mandayona	Mandayona, Spain, 1973

B. Mutant type strains

86.	black b, III	Sokoloff, 1968
87.	creased abdoedral sternites cas, II	Sokoloff, 1968
88.	ebony-2 e_{-2}, II	Sokoloff, 1968

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.)

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

CZECHOSLOVAKIA

INSTYTUT ORHRONY ROSLIN
PRACEWNIA BADANIA BIKOSNIKOW FRZEKHSWALNI
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 Hub.

New Mutants

Tribolium castaneum

squint-like (sql) Report of A. A. Dewees. This is an autosomal recessive of good penetrance, expressivity, and viability found at an estimated gene frequency of approximately .14 in a sack of contaminated white flour. Tests of allelism indicate that the gene is not an allele of squint (sq) but it has the identical phenotype. Ommatidia are absent in the adult but the ocular diaphragm is visible through the exoskeleton and has a considerably reduced or absent ocular foramen giving rise to the squint-eye appearance. Linkage studies are presently under way.

NOTES - RESEARCH

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Feeding and ovipósition preference in T. audax, T. madens, T. castaneum, T. confusum and T. brevicornis

As part of a laboratory experiment in the Population Genetics and Ecology course we introduced 50 unsexed beetles of each of the above species into three plastic choice chambers such as those designed and illustrated by Inouye (196_). The choice chambers contained equal quantities of two media: corn plus yeast (C Y); soy plus yeast (S Y) and standard medium, i. e. wheat plus yeast (W Y). The media were separated by a plastic divider. Sizable holes in this divider allowed free passage of the beetles from one side of the chamber to the other. The beetles were counted and placed on the surface of the two flours in the middle of the chamber. The chambers were placed in an incubator maintained at 32° C., and about 60 per cent R. H. for a period of 48 hours. After this period the contents of each side of the chamber were aspirated into a vial, the material was then sifted with a coarse screen to remove the adults and a fine screen to isolate the eggs. The adults were then sexed and counted and the number of eggs laid in each medium was recorded.

The results are summarized in Table 1. A preliminary analysis of these limited data leads to the following conclusions:

For adult medium preference,

1. Given the choice of WY and SY all the species except T. brevicornis are found more often in WY than in SY. T. brevicornis adults were found about equally distributed in the two media.

2. Given the choice of CY and WY, T. confusum, T. madens and T. audax (all in the confusum species group) seem to prefer the corn plus yeast over the wheat plus yeast medium. T. castaneum, on the other hand, is found more often in the wheat plus yeast medium. T. brevicornis is found about equally frequently in these two media.

3. Given the choice of CY and SY, T. audax, T. madens, T. castaneum and T. confusum adults seldom are found in soy plus yeast. T. brevicornis, on the other hand, is found equally frequently in the two media.

By itself, the occurrence of the adults in a medium at a given instant (in this case when the two media are separated) does not necessarily mean a preference for that particular medium. A stronger case can be advanced if the number of eggs found in the medium corresponds to the prevalence of adults.

According to the data in Table 1:

4. Given the choice of WY and SY T. castaneum, T. audax and T. madens prefer to lay their eggs in wheat than in soy. T. confusum accepts both media as an oviposition site, while T. brevicornis seems to prefer

soy to wheat medium as an egg-laying site.

5. Given the choice of WY and CY, T. castaneum prefers wheat, T. audax and T. confusum clearly prefer corn to wheat, and T. madens and T. brevicornis use the two media about equally frequnetly as an oviposition site.

6. Given the choice of CY and SY it is clear that T. audax, T. madens, T. castaneum and T. confusum females prefer CY to deposit their eggs The data for T. brevicornis, on the other hand, reinforces the conclusion that the preferred medium by females of this species appears to be soy.

A previous study (Sokoloff, 1972 and Sokoloff and Cavataio, 1972) showed that T. brevicornis is unusual in that it can survive for as long as nine months without food or water. This study shows that T. brevicornis, in contrast to the other species, can exploit soy flour in spite of the presence of toxic substances which affect the developmental rate of Tribolium castaneum and T. confusum.

(For review see Sokoloff, Franklin, Overton and Ho, 1966).

Table 1. Food choice and oviposition of 5 species of Tribolium.

	T. brevicornis			T. madens			T. audax		
Media	♂	♀	eggs	♂	♀	eggs	♂	♀	eggs
WY	11	10	41	14	25	51	22	13	222
SY	16	10	67	5	6	12	3	5	27
WY	10	11	48	6	14	49	10	7	39
CY	12	13	36	15	12	58	14	16	188
CY	13	11	57	28	20	87	25	24	278
SY	14	13	106	2	0	0	0	0	0

	T. castaneum			T. confusum		
Media	♂	♀	eggs	♂	♀	eggs
WY	17	24	225	12	12	38
SY	0	1	9	1	7	49
WY	13	16	175	7	8	61
CY	6	12	15	12	20	117
CY	14	26	31	13	36	186
SY	0	1	3	1	0	3

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Life-span productivity in Tribolium for two single cross hybrids and parental inbreds.

The flour beetle Tribolium has become widely recognized as an excellent biological model for testing new concepts in ecology and genetics. Most selection studies to date with Tribolium have examined polygenic traits determined largely by additive gene effects. (e.g. developmental rate, larval weight at a fixed age, and pupal weight). In general, the results are in agreement with selection theory based on an additive gene model (Bell, 1969).

A major problem area today in population genetics concerns non-additive gene effects resulting from dominance and/or epistasis. The nature and utilization of this portion of the total genetic variation in a population is not well understood from either a theoretical or an experimental basis.

For Tribolium to serve effectively in model experiments relating to non-additive gene effects, appropriate polygenic traits are essential. Drawing from earlier experience with Drosophila (Bell, et al. 1955; Brown and Bell 1961) we have investigated certain components of fitness in Tribolium castaneum as possible models of nonadditive gene effects.

Our first study in this area examined life-span egg production, viability, and fertility of two unrelated single cross hybrids (C♀ x B♂ and Va♀ x K ♂) and their respective parental inbred lines B, C, K and Va. Newly emerged males and females of the various genotypes were assigned in single pairs to individual creamers containing 2g of egg collection medium (95% whole wheat flour + 5% brewers' yeast mixture screened through a 0.21mm mesh). Daily egg collections were made for the first three weeks followed by periodic observations thereafter. Eggs were counted at 15X magnification and incubated for subsequent hatchability observations. All sterile matings were excluded from the results as summarized in Figure 1.

Even though the numbers observed for each genotype were small certain results were clearly manifested. Non-additive gene effects in terms of heterosis (F_1 - MP) were observed for three components of life-span productivity: (1). The hybrids reached sexual maturity or initiated egg lay some 3 days earlier than their inbred parents; (2). Hybrid egg lay was more than twice that of inbreds and the peak rate of lay was sustained longer, and (3). The hybrids lived longer than their parental inbreds. Among the former, 81% were still productive at the end of the 90 day test period while only 26% of the inbreds survived.

Another trait in Tribolium which has potential as a non-additive gene model is biomass, an aggregate trait which combines body weight

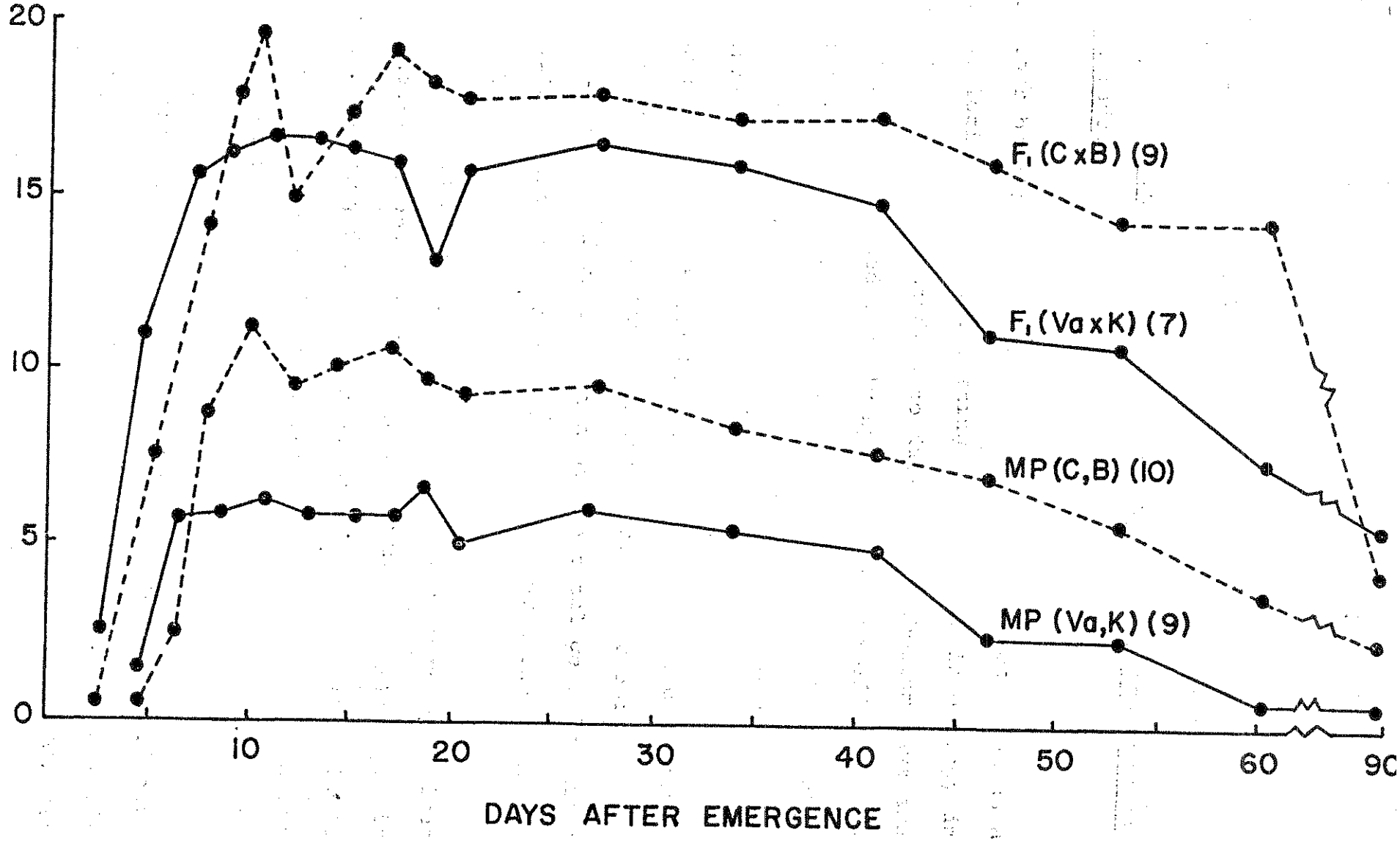

Figure 1. Daily rate of egg lay for fecundated females contrasting single cross (F_1) hybrids and mid-parental (MP) inbreds (Plotted as 2-day averages for the first 20 days and on a weekly basis thereafter. Number observed shown for each genotype).

with the fitness trait "number of offspring". Krause and Bell (1972) investigated biomass in two unrelated heterogeneous base populations (Purdue black and pearl) and found that 75-80% of the phenotypic variance for the fitness component was determined by rate of egg lay. Genetic effects on 24-hr. egg lay were largely non-additive.

More recently, Orozco and Bell (1974) found considerable additive genetic variance (h^2=0.36 ± .03) for 4-day virgin egg lay in the Consejo Base Population of Tribolium when performance was measured in an optimum environment (33°C). However estimates for additive gene effects were considerable smaller (h^2=.25 ± .03) for egg lay under severe stree (28°C), and non-additive effects assumed significant proportions (15%).

The above studies suggest that egg lay in Tribolium can serve as a useful biological model of non-additive gene effects. In addition, the introduction of optimum and stress testing environments provides an interesting genotype x environment model.

Literature Cited

Bell, A. E. 1969. The nature of selection responses in Tribolium. Jap. J. Genetics 44:299-309.

Bell, A. E., C. H. Moore and D. C. Warren 1955. The evaluation of new methods for the improvement of quantitative characteristics. Cold Spring arbor Symposium on Quant. Biol. 20:197-212.

Brown, W. P. and A. E. Bell 1961. Genetic analysis of a plateaued population of Drosophila melanogaster. Genetics 46:407-425.

Krause, E. and A. E. Bell 1972. A genetic study of biomass in Tribolium. I. Path coefficient analysis of base populations. Can. J. Genet. Cytol. 14:181-193.

Orozco, F. and A. E. Bell 1974. A genetic study of egg laying of Tribolium in optimum and stress environments. Can. J. Genet. Cytol. (In Press).

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Effect of Presence of Males on Egg Production in Tribolium castaneum.

A number of authors Ruano and Orozco (1956), Espejo and Orozco (1966), Kummer (1960) have shown that presence of males is essential for egg production in insects. Tagarro and Rico (1966) studied the effect of removing the male on egg laying rate of fecundated females of Tribolium castaneum. They mated a number of females to an individual male immediately after emergence and separated them on the 7th day. The egg production of individual female was recorded for 4 days. There was no significant drop in the rate of laying during this period.

Ruano and Orozco (1966) reported egg production of fecundated females of Tribolium castaneum as 67 ± 11 eggs and virgin females 18 ± 7 eggs for a period of 4 days between 7th and 11th day after emergence. Their findings indicated that presence of male affected the number of eggs laid by each female.

Espejo and Orozco (1966) reported that in Tribolium castaneum when fecundated females were deprived of their males the egg laying rate was maintained at a high level for a long period of time, the reduction in number of eggs was very slow. While when virgin females were mated they achieved immediately a very high egg laying rate, as high as in females mated from the beginning.

Kummer (1960) studied the effect of presence of male or male secretions on rate of egg laying in Drosophila melanogaster. The main conclusions of his experiments were that the process of couplation alone was not important, in fact both the secretion of paragonia and that of the testes were essential if full egg production by females had to be achieved. From these experiments there was an indication that presence of males might be necessary for complete egg production in females. In view of this an experiment was planned to study the effect of presence of males on egg production in females of Tribolium castaneum.

Material and Methods

The foundation population (PAU-I) of Tribolium castaneum was used in these experiments. This population was maintained in the laboratory for over a period of two years in mass cultures.

Culture media used consisted of 95% wheat flour and 5% yeast with vitamin mixture (A_1B_2 & D_3). The whole wheat flour was sieved through a filter of (0.7 mm pore size) sterilized in an even for one hour at 150°C, yeast and vitamin mixture was then added to the sterilized flour. This mixture was mixed in a shaker at high speed, bottled and kept sealed in refrigerator for use.

The larvae were collected from the foundation population and kept in fresh media. The cultures were maintained at 32°C ± 1°C and 70% relative humidity. Fifty newly emerged virgin females (0-4 hours old) were collected. Each female was randomly alloted to a replicate. Such two replicates were generated. Males were assigned to each female at random in replicate (II). The females of replicate (IV) were not provided with any males. The animals were raised on the egg media. The pair matings in replicate (II) and virgin females in replicate (IV) were raised on in P.V. 5g glass vials in 2g media.

Twenty four hour egg collection was recorded every day at 10 A.M. The eggs were transferred to new vial daily. The egg production was recorded for 31 days. On 31st day males were separated from replicate (II) and provided to virgin females in replicate (IV).

The egg collection was recorded daily for a further period of 10 more days. After 10 days egg production was recorded for a period of 24 hrs. every third day upto 60 days.

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Results

It was observed that those females which were provided with males as pair mates, produced nine eggs per day in the first week as against 2.8 eggs by virgin females (Table 1 and Fig. 1). Both the groups showed increase in egg production upto the 5th week. Females with males (pair mated group) showed three-fold increase in egg production compared to the virgin group. After a period of 31 days (after 5th week) the situation was reversed, the egg production in virgin group which was provided now with males shot up by three-folds (16.60) in the 6th week and then levelled off around the average egg production of pair mated group. The egg production in the pair mated group whose males were removed fell steadily and levelled off, around the level of egg production of virgin group (after three to four weeks) while the virgin group increased their production within a period of twenty four hours.

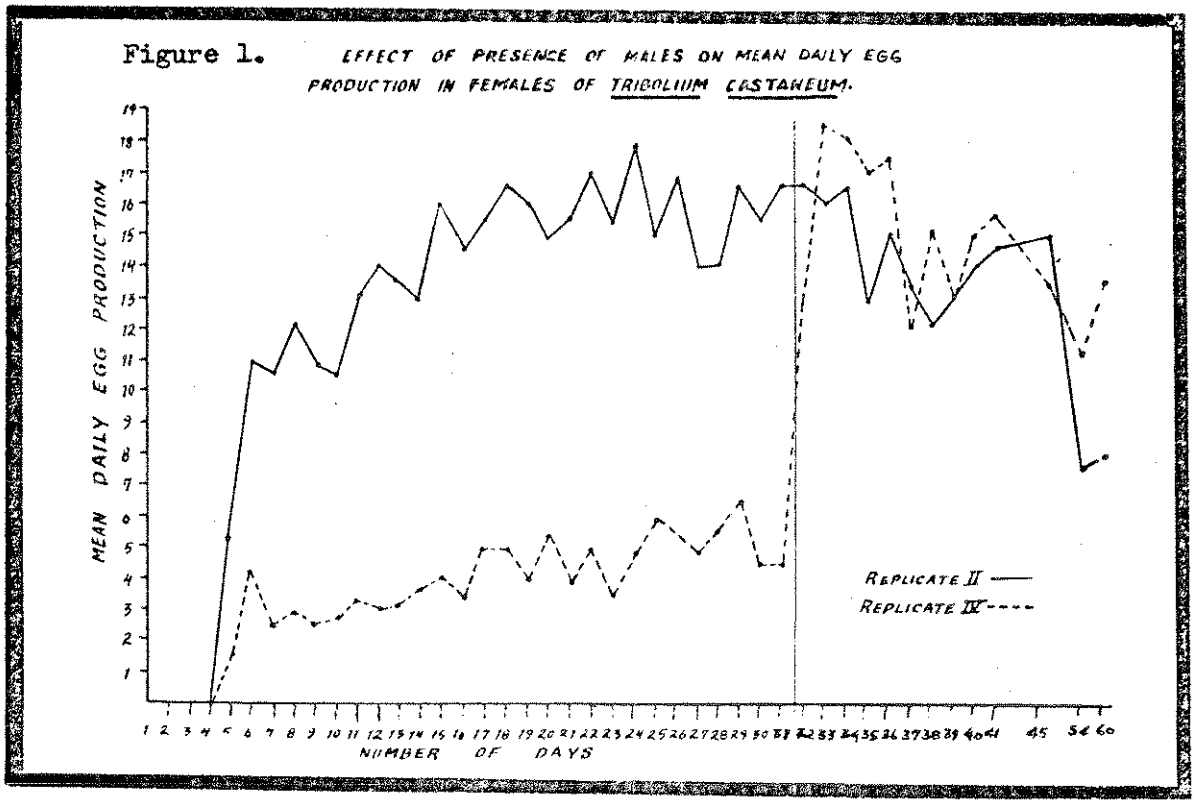

Figure 1. EFFECT OF PRESENCE OF MALES ON MEAN DAILY EGG PRODUCTION IN FEMALES OF TRIBOLIUM CASTANEUM.

Discussion

It was observed that there was a significant difference in egg production between two treatments (pair mated/virgin group). The difference was three-fold under similar set of controlled environmental conditions. The only conclusion which can be drawn was that males are necessary for complete egg laying. This was in conformity with the finding of Ruano and Orozco (1966) who reported a three-fold difference in virgin and pair mated group, even though their findings were based on the average of 4 day production between 7th and 11th day of egg laying. Tagarro and Rico (1966) could however not find any significant difference between the two sets in contradiction of Ruano and Orozco (1966) from the same laboratory. They observed that if matings were done after emergence and kept for 7 days and recorded for 4 days after separation, they found no significant drop in egg production. It may be observed here

Table 1. Effect of presence of males on egg production of females in Tribolium castaneum.

No. of replicates	No. of eggs produced each week									
	1	2	3	4	5	6	7	8	9	10
1. (i) II (Males provided)	9.00	11.60	13.31	15.79	16.20					
(ii) II (Males removed)						12.27	13.70	15.00	7.7	7.9
2. (i) IV (Virgin females)	2.80	2.93	4.56	4.81	4.10					
(ii) IV (Males provided)						16.60	14.63	13.40	11.3	13.7

that it takes 96 hours for the first egg to be formed (Bhat, 1970). Consequently mating immediatley after imergence is of no consequence. The peak egg production in Tribolium castaneum was reported to be from 7th to 11th day (Bhat, 1971), it would not be unusual to expect no fall in egg production time. It took roughly three to four weeks for egg production to fall to the level of virgin group.

It was observed that the physical presence of male was not important, but copulation followed by injection of semen was important because after the males were removed from the pair mated group in the 6th week, there was no immediate decrease in egg production of this group. It took almost three to four weeks for a significant drop in egg production to be registered. It was argued that if only the physical presence of males was important for enhancing egg production then the egg production would drop immediately after the separation , instead decrease in egg production was very slow, hence physical presence of male as a factor was not important and the injection of semen was necessary for enhancing egg production. These results are in conformity with those of Kummer (1960) who reported that both the secretion of paragonia and that of testes were essential if full egg production by females had to be achieved in Drosophila melanogaster.

It was further observed that virgin group when provided with males showed an immediate rise in egg production within 24 hours and then levelled off at the level of pair mated group, indicating that something must have transferred from the males to the virgin females and enhanced the egg production. Similar results have been reported by Espejo and Orozco (1966).

References

Bhat, Pran P. 1970. Epigenetic studies of the egg in Tribolium castaneum. Tribolium Inform. Bull. 13:66-67.

Bhat, Pran P. 1971. Epigenetics of the egg and reproductive performance in Tribolium castaneum. Ph. D. Thesis Punjab Agricultural University, Ludhiana, Punjab, India.

Espejo, M. and Orozco, F. 1966. Effect of removing of putting males to fecundated or virgin females, respectively, on the egg laying rate during a long period of time in Tribolium castaneum. Tribolium Inform. Bull., 9:80-83.

Kummer, H. 1960. Experimentalle untersuchungenzue wirkung von fortpflanzungs-faktoren aufdie lebensdauer von Drosophila melanogaster—Weibchen zeitschrift fur vergleichende physiologie., 43:642-679.

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

Tagarro, Map and Rice, M. 1966. Effect of removing the male on egg laying rate laying rate of fecundated females in Tribolium castaneum. Tribolium Inform. Bull., 9:120-121.

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The egg production curve in flour beetle Tribolium castaneum.

The egg production curve was studied on the basis of average daily production per surviving female. The curve is generally J-shaped and clearly divisible into two portions. One characterized by an initial increase upto the 8th day followed by a stable and persistent plateau which is essentially linear. Regression functions were fitted to both the portions of the curve from 4th to 7th and 8th to 31st day. There was a linear increase from 4th to 7th day by 3.82 eggs per day. From 8th to 31 day of life the value of regression coefficient was 0.118. The egg production from 5th to 10th day was correlated with total life production in the following order: 5th to 7th, 6th to 8th, 7th to 9th, 8th to 10th, 5th to 10th, 6th to 10th and 7th to 10th. In addition rank correlations were also estimated. The value of product moment and rank correlation coefficients was highest between 8th to 10th day period and the life time production. These were also the peak days of egg production. Each ovariole produced 1.02 eggs per day.

The total number of eggs produced over the life time period was correlated with ovariole number. The product moment correlation coefficient was estimated as 0.59 which was significantly different from zero. It was concluded on the basis of this study that egg production on days 8, 9 and 10th could fairly represent the egg production on life time basis.

Introduction

Flour beetles of the genus Tribolium constitute important primary and secondary pests in all kinds of cereal products. For this reason, they have attracted the attention of investigators with a broad spectrum of interests. Since Chapman (1924) used and stressed the usefulness of Tribolium in population studies, Tribolium castaneum has received considerable attention from geneticists, ecologists, morphologists and students of evolution because of the interesting material available in beetles and their suitability to various phases of research.

Egg production is highly variable and slight changes in environment greatly influence its expression. Studies on the egg production curve have been reported by Robertson (1957), Narain (1962) in Drosophila melanogaster and by Bhat (1961) in Drosophila ananassae. The shape of the curve has generally been described as that of an inverted J. Regression equations were fitted by these authors to see if the larger part of the curve was generally linear. The egg production per day was of the order of 32.1 with peak egg production on 4th, 5th and 6th day of emergence in both species.

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** Head of Division, Animal Genetics, I.V.R.I. (India)

Material and Methods

The foundation population of Tribolium castaneum used in these experiments was obtained from the Department of Genetics, P. A. U., Hissar. The line used in this study was P. A. U. -1 foundation population, maintained in the laboratory for over a period of two years in mass cultures.

The animals were raised in whole wheat medium which consisted of 95% wheat flour and 5% yeast and vitamin mixture (A_1, B_2 and D_3). The whole wheat flour was sieved through a sifter (0.7 mm pore size) sterilized in an oven for one hour at 250°C. Yeast and vitamin mixture were in a shaker at high speed, bottled and kept sealed in a refrigerator until ready for use.

The larvae were collected from thefoundation population of Tribolium castaneum and kept in fresh medium. The cultures were maintained in the temperature cabinet at 32 $\pm$ 1°C and 70% relative humidity.

The pupae were collected and sexed. These were watched for the emergence of the virgin adults. The freshly emerged adults were whitish in colour and could be easily identified; Hundreds of such females (0-4 hours old) were collected. Each female was randomly alloted to a replicate. Three such replicates were generated. Males were assigned to each female at random in three replicates (I, II and III).

The animals raised on the media wire sieved through a filter with a pore size of 0.125 mm.

The pair matings (one male and one female) were raised on in P.V. 5 g glass vials in 2 g media.

24 hours egg collection was recorded every day at 10:00 a.m. by shifting the contents of each vial through a sieve with the pore size of 0.125 mm. Since the grain size of media was 0.125 mm, the media would pass through with ease and the eggs would remain in the sieve, the egg size being 0.30 mm. They could not pass through. The eggs were transferred to a thick black paper, counted and recorded. The animals were then transferred to new vials daily. The egg production was recorded daily for 31 days.

Results

Daily egg production in three replicates (I, II and III) each of 20 females were studied for a period of 31 days. The results are detailed in table 1.

Table 1. Mean daily egg production for first twelve days of life and subsequently based on weekly totals in Tribolium castaneum.

Number of replicates		Number of Days of Life											
		1	2	3	4	5	6	7	8	9	10	11	12
I	$(\bar{X})$					2.9	11.0	11.7	10.6	11.4	11.1	8.8	12.4
II	$(\bar{X})$					5.3	11.1	10.6	12.1	10.9	10.5	12.9	14.0
III	$(\bar{X})$				2.2	12.0	8.2	16.2	15.0	14.0	13.3	16.2	14.0
	$(\bar{X})$				0.7	6.8	10.2	12.3	12.6	11.9	11.5	13.0	13.6

		Number of Weeks				
		1	2	3	4	5
I	$(\bar{X})$	8.60	10.91	13.47	13.19	14.60
II	$(\bar{X})$	9.00	11.60	13.31	15.79	16.20
III	$(\bar{X})$	9.70	14.50	14.01	11.10	14.10
	$(\bar{X})$	7.5	12.30	14.57	14.30	15.23

The beetles on an average laid 381.14 ± 27.9 eggs for a period of 31 days. The egg production curve, drawn on the basis of average daily production per surviving female, is presented in figure 1.

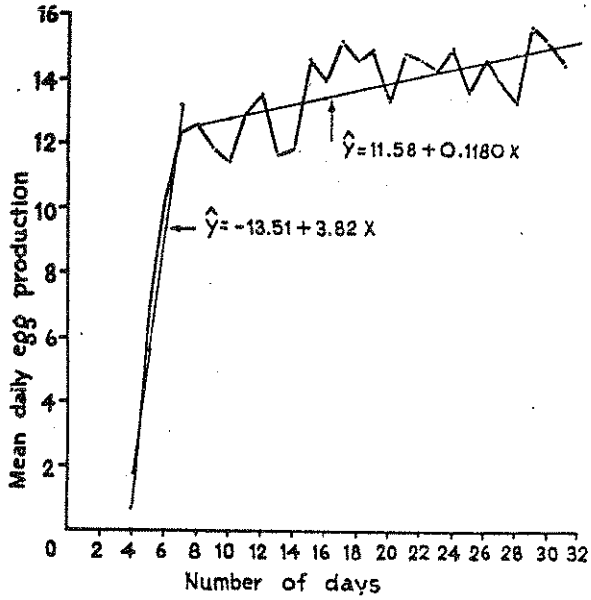

Fig.1. Mean daily egg production in Tribolium castaneum

From this figure and table 1 it was observed that in one replication eggs were laid during the fourth day and in other two, on the fifth day.

The egg production increased progressively during the first few days, reaching the peak on the 8th day. The average egg production per female per day was found to be 12.6, 11.9, 11.5, 13.0 on 8th, 9th, 10th and 11th day of egg laying. Thereafter, the production fluctuated between 14.30 to 15.23 eggs per day. The properties of egg production curve were studied. The curve is generally J shaped and clearly divisible into two portions. One characterized by an initial increase upto the 8th day, followed by a fluctuant curve which was essentially linear. Regression lines were fitted to both portions of the curve, from 4th to 7th day and 8th to 31st day. The regression equations are detailed below:

Days	Regression coefficient	Regression equation
4 - 7	3.820	$Y = -13.51 + 3.820\ x$
8 - 31	0.118	$Y = 11.58 + 0.118\ x$

Y = Number of eggs per female per day.
X = Number of days.

The curve shows a linear increase from 4th to 7th day by 3.82 eggs per day. From 8th to 31st day of life, the value of regression coefficient was 0.118 suggesting only slight change in egg production after the 8th day of life.

The egg production from 5th to 10th day was correlated with total life time production in the following order: 5th to 7th, 6th to 8th, 7th to 9th, 8th to 10th, 5th to 10th, 6th to 10th, and 7th to 10th day. The results are detailed in table 2.

Table 2. Product moment and rank correlation coefficients between various periods and life time production in Tribolium castaneum.

S.No.	Period (days)	Correlation coefficient	Rank correlation
1.	5, 6, 7	0.538**	0.585
2.	6, 7, 8	0.677**	0.690
3.	7, 8, 9	0.714**	0.575
4.	8, 9, 10	0.777**	0.837
5.	5 to 10	0.694**	0.742
6.	6 to 10	0.731**	0.799
7.	7 to 10	0.743**	0.781

** p 0.01

The 8th, 9th and 10th day of period had the highest (0.777) correlation coefficient with the life time production. It appears that during this period eggs laid will fairly estimate the life time egg production of these females.

At the end of the experiment the females were sacrificed and ovariole number was recorded. A total of 8124 eggs were laid by twenty two females for 31 days. The total number of ovarioles for these 22 females was 255. The total number of eggs for thirty one days produced by each ovariole was calculated to be 31.84 eggs. Total number of eggs produced by each ovariole per day was 1.02 eggs which work out to about one egg produced by one ovariole in a period of twenty four hours.

The total number of eggs produced over the life time period was correlated with ovariole number. The product moment correlation coefficient was estimated as 0.59 which was significantly different from zero.

Discussion

The egg production curve showed an initial progressive increase during the first few days reaching the peak on the 8th day. Thereafter, the production fluctuated between 14.3 to 15.2 eggs per day. Like most production curves, it is slightly J shaped. The initial rise in egg production was quickly followed by a fluctuant curve which was essentially linear. The regression coefficient of egg production on days from 4th to 7th day was 3.82 and from the 8th to 31st day was 0.118. The egg production increased at the rate of 3.82 eggs per day from 4th to 7th day and thereafter at the rate of 0.118 eggs per day.

Sonleitner (1965) reported fecundity and fertility in Tribolium castaneum at 3 days intervals upto 18th day of age. The number of eggs reported per day in the first week was 17.7, in the second week 21.3 and the maximum number of eggs produced per day was 23.2 eggs.

In these experiments the number of eggs produced per day in the first week and second week was 11.9 and 13.0 and the maximum number of eggs per day was 15.23. It seem that the stock used by Sonleitner (1965) was of higher egg producing potential. The results are in aggreement with those of Ruano and Orzoco (1966). They reported 16.8 eggs in females which were provided with males. Fuentes and Ruano (1967) studied the effect of different temperatures on egg production in Tribolium castaneum. Maximum number of eggs were laid by females between 32° to 36°C.

The egg production from 5th to 10th day period of life was correlated with total life production (based on 31 days) in the various orders (Table 2). Combined 8th, 9th and 10th day egg production had the highest product moment and rank correlations with life time production. These were also the peak days of egg production.

Similar results were reported in Drosophila melanogaster by Robertson (1957) and Narain (1962) and in Drosophila ananasse by Bhat (1961). These authors reported rank order correlations between first 10 days and life time production. It was suggested that egg production wasmaximum on 4th, 5th, and 6th day and this could predict the total life time production. Since in Tribolium castaneum the product moment correlation and rank correlation was highest between the period 8th, 9th and 10th day and the total life time production, it could easily be used as an index to predict the life time production. The value of regression coefficient after the 8th day of life was small, which suggests that there is very little increase in egg production after the initial stability is reached.

References

Anderson, R. L. & Bancroft, T. A. 1952. Statistical theory in research. New York. McGraw-Hill.

Bhat, Pran P. 1971. Epigenetics of the egg and reproductive performance in Tribolium castaneum. Ph.D. thesis Punjab Agricultural University, Ludhiana, Punjab.

Bhat, Pushkar Nath 1961. Two way selection for a metric character in Drosophila and correlated response in other non-selected metric characters. M.V.Sc., thesis, Agra University, Agra.

Chapman, R. N. 1924. Nutritional studies on the confused flour beetle Tribolium confusum (Duval). J. Gen. Physiol. 11, 565-585.

Fuentes, C. and Ruano, R. G. 1967. Egg laying rate of virgin females of Tribolium castaneum at different temperatures. Tribolium Information Bulletin 10:96-107.

Narain, P. 1962. Effect of age of female on the rate of egg production in Drosophila melanogaster. DIS 36:96-97.

Robertson, F. W, 1957. Studies on quantitative inheritance X. Genetic variation of ovary size in Drosophila J. Genet. 55:410-427.

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

Sonleitner, Frank J. 1965. Effect of hypothermy and tarsusclipping on fecundity and longevity of Tribolium castaneum. Tribolium Information Bulletin 9:154-155.

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Bioenergetics in Tribolium Populations.

The bioenergetics of Tribolium populations were studied at three temperatures. Single-species populations containing either 52 T. confusum or 52 T. castaneum adults and mixed species populations containing 26 T. confusum and T. castaneum adults were reared at 25°, 30°, and 35° C. Caloric values of food consumed; caloric values of eggs, larvae, pupae, and adults; and caloric expenditures for respiration were determined at 10, 20, 30, 40, and 50 days.

Single-species population data indicated that T. castaneum consumed more food and had consistently higher total caloric values in living components (sum of egg, larva, pupa, and adult caloric values) at all temperatures. Respiration caloric values indicated that T. castaneum was metabolically more active. These data from single species populations indicate that T. castaneum is inately "superior" at all temperatures (higher metabolic rate, more rapid increase in population biomass). Furthermore, the differences between T. castaneum and T. confusum increased with increasing temperature.

Mixed-species population data indicated that interspecific interactions modify the outcome observed for single species. Effects of interspecific interactions were determined by subtracting biomass caloric values of single-species populations from biomass caloric values of single-species populations. T. castaneum was the predicted survivor in populations reared at 35° and 30° C. In populations reared at 35° C, both species had lower caloric values when reared together. T. castaneum had higher caloric values, whereas T.confusum had lower caloric values when mixed species values were compared to single species values in populations reared at 30°C. Experiments conducted at 25° C were not of sufficient duration to predict the surviving species. There was the suggestion however, that T. confusum gained in caloric biomass accumlation at the expense of T. castaneum in mixed-species populations.

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*A preliminary study of the decreased sexual competitiveness of X-irradiated males of T. castaneum.

Loss of sexual competitiveness frequently has been observed in male insects irradiated for sterile-male release tests for control of harmful insects. Thus if "sterilized" males are tested in a 4 : 1 : 1 ratio with normal males and females, 80% reduction in the number of viable progeny should be expected; actually, the reduction often is less than 50%. Most insect species for which sterile-male release measures have been proposed are relatively short-lived and/or lacking in somatic cell turnover in the adult stage. It is not known whether or not the decline in competitiveness represents a manifestation of the same injury which leads to (or hastens) death after higher doses, nor whether some recovery eventually occurs. Indeed, there have been few attempts to elucidate the mechanisms involved, although there is some evidence (Nair and Bhakthan, 1969) that there is damage to the flight muscles of irradiated flies. Apart from practical implications, the phenomenon is of great interest because it appears to represent the expression of radiation injury to nonproliferative tissues, which are regarded as highly radioresistant. If decreased competitiveness occurs in sublethally-irradiated males of groups such as Coleoptera, Hemiptera, or Orthoptera, it may be possible to dissociate this manifestation of injury from the lesions involved in acute lethality, which in these groups appears to stem from damage to proliferative cells, viz., the cells which renew the lining of the midgut (Ducoff, 1972). It may also be possible to detect and score recovery of competitiveness with the passage of time.

We have, accordingly, initiated a series of experiments to determine competitiveness of male Tribolium at various times after exposure to ionizing radiation under various conditions and patterns of exposure. Various numbers of irradiated males are placed with 1 nonirradiated male and 1 nonirradiated female for 3 successive 2-day periods at 30°; the adults are removed and the vials of flour-yeast medium with deposited progeny are incubated for several weeks, until the larvae are large enough for convenient counting. The productivity, P, of a given type of mating is the mean number of viable progeny/female/day. Using a slight modification of the method of Fried (1971), the total productivity, P_T, of a test mating is:

$$P_T = \frac{P_N + R\,C\,P_R}{1 + R\,C},$$

in which P_N and P_R are the respective mean productivities, in single-pair matings, of nonirradiated and of irradiated males; 1 and R represent the respective number of nonirradiated and of irradiated males in a test mating; and C is the competitiveness of the irradiated males. Competitiveness, then, is readily calculated, as

$$C = \frac{P_N - P_T}{R(P_T - P_R)}.$$

Using T. castaneum exposed to 8100 R of 280 kVp X-rays and test ratios of 3 and of 6 irradiated males/1 nonirradiated male and 1 nonirradiated female, we find that males tested during the first week after exposure were about 50% competitive, but males tested for the first time in the sixth week were only 20% competitive. All acute deaths following midlethal irradiation occur within the first 4 weeks, so a significant amount of injury remains, presumably in nonproliferative tissues. (Work supported by USPHS grant CA 13779).

Literature cited

Ducoff, H. S., 1972. Causes of death in irradiated adult insects. Biological Review (Camb. Phil. Soc.) 47:211-240.

Fried, M., 1971. Determination of sterile-insect competitiveness. J. Econ. Entom. 64:869-872.

Nair, K. K. and N. M. G. Bhakthan, 1969. Preliminary studies on the ultrastructural damage in the flight muscles of gamma-irradiated housefly. Internat. J. Radiat. Biol. 16:397-399.

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Sire, Dam and Age Effects on Offspring Number in Tribolium castaneum.

Progeny wereobtained from eighty-five single pair matings of Tribolium selected at random from a large population maintained with a minimum of inbreeding, by sampling eggs from the parents for forty-eight hours following the time when they reached 35 days of age. Pupae from all matings were separated by sex and classed by family size in five groups (15-22, 23-30, 31-38, 39-46 and 47-54 offspring per family). Male and female progeney from each class were selected at random and mated as pupae in a five by five mating plan, from the low class to the high class for sires and from the low class to the high class for dams with one mating per cell. Ten replicates were obtained by sampling eggs from different sets of parents in the mating plan at 28, 33, 34, 35, 40, 41, 42, 47, 48 and 49 days of age to establish replicates one to ten respectively.

The effects of sire, dam, age and their first order interactions were tested for significance using X^2_r values from Friedman'2 Way Analysis of Variance by Ranks (Bradley 1968).

The simple effect of sire family size on offspring number is not significant (Table 1, $\alpha > 0.250$); however, the sire by dam family size interaction is significant (Table 1, $\alpha < 0.050$). The interaction of sire and dam family size on offspring number is due to the lowest two dam family sizes (15-22, 23-30) in each sire family size class. As sire family size levels increase from S_1 to S_5, the relationship of the mean number of offspring in the lower two dam family size classes changes. The value of the mean offspring family size for the second lowest dam family class (23-30) minus the lowest dam family class (15-22) changes from negative to higher positive values (ie. -15.4, +5.0, +9.5, +9.7, +13.9) across sire classes.

Dam family size has a highly significant effect on offspring number (Table 1, $\alpha < 0.010$). Mean offspring family size rises across the lower three dam family size classes (Table1, D_1, D_2, D_3, 0.025); with the middle class (31-38, D_3) as the pivotal point, the mean offspring family size plateaus (Table 1, D_3, D_4, D_5, $\alpha > 0.950$).

The effect of age of parents at time of mating on offspring number was highly significant (Table 1, $\alpha < 0.0005$). The mean size of offspring family increases rapidly from maturity to a peak at approximately thirty-five days of age, then drops off slowly to the end of reproductive life.

Some non-mutant specimens of T. castaneum of different age groups were dissected; in newly emerged soft bodied adults I found persistent pupal ventral muscles (as well as tergal muscles) overlying loosely all the ventrites and underneath them the normal adult ventral muscles in the mobile ventrites 3-5 as well as some small and sometimes asymmetrical bundles in the anterior connate ventrites 1 & 2, like those of the last 3 ventrites (Fig. 4). In older adults, neither the persistent pupal nor the peculiar adult muscles of the connate ventrites were found. Similar features were seen also in young adults of Tenebrio obscurus; these phenomena will be discussed further in a study of abdominal structure in adult Coleoptera, now in progress.

Table 1.

Values and Significance Levels for the Effects of Sire, Dam and Age on Offspring Number

Comparison	d.f.	χ_r^2
S_1, S_2, S_3, S_4, S_5	4	5.34
D_1, D_2, D_3, D_4, D_5	4	14.14***
D_1, D_2, D_3	2	8.15**
D_3, D_4, D_5	2	0.60
A_1, A_2, A_3, A_4, A_5 A_6, A_7, A_8, A_9, A_{10}	9	183.18***
A_2, A_3, A_4, A_5, A_6 A_7, A_8, A_9, A_{10}	8	17.6 **
Dam x Age Interaction	4	4.45
Sire x Age Interaction	4	3.68
Sire x Dam Interaction	4	10.16*

* $P(\alpha) \leq 0.05$; ** $P(\alpha) \leq 0.025$; *** $P(\alpha) \leq 0.01$

NOTE: For N>10 and/or k>3, χ_r^2 is distributed as χ^2. k = d.f. + 1, N = number of replicates, $P(\alpha)$ = Probability of type 1 error.

S_1 = 15-22 Sire Family Size Class, S_2 = 23-30 Sire Family Size Class, S_3 = 31-38 Sire Family Size Class, etc.

D_1 = 15-22 Dam Family Size Class, D_2 = 23-30 Dam Family Size Class, D_3 = 31-38 Dam Family Size Class, etc.

A_1 = Parental age of 28 days at time of sample mating, A_2 = Parental age of 33 days at time of sample mating; A_3 = Parental age of 34 days at time of sample mating, etc.

Table 2. Average Offspring Family Size for each Dam Family Size within each Sire Family Size with the Overall Means of each Class.

		DAM FAMILY SIZE					
		15-22 (D_1)	23-30 (D_2)	31-38 (D_3)	39-46 (D_4)	47-54 (D_5)	Mean Offspring Family Size for Each Sire Class
	15-22 (S_1)	29.9	14.5	27.7	22.0	27.9	24.36
SIRE	23-30 (S_2)	21.2	26.2	34.3	33.1	29.5	28.86
FAMILY	31-38 (S_3)	24.0	33.5	26.7	27.5	31.2	27.92
SIZE	39-46 (S_4)	17.5	27.2	30.3	24.7	30.1	26.04
	47-54 (S_5)	16.3	30.2	35.1	31.7	30.4	29.14
Mean Offspring Family Size for Each Dam Class		21.78	26.32	30.82	28.80	29.42	

Table 3. Average Offspring Family Size for each Age of Parents at Time of Mating

	Age of Parents at Time of Mating									
	(A_1) 28	(A_2) 33	(A_3)34	(A_4) 35	(A_5)40	(A_6)41	(A_7)42	(A_8)47	(A_9)48	(A_{10})49
Mean Offspring Family Size for Each Parental Age	13.96	34.64	35.20	35.36	29.96	28.56	25.80	22.24	19.80	27.88

Speaking of the ventral longitudinal muscles of the ventrites 1 & 2, it is possible that these muscles are normal and functional in teneral adults, providing the insect with some flexing capacity while the ventrites are still soft enough. As soon as they have become more or less sclerotised, which is marked with the changes in the color of the ventrites from amber to reddish-brown, all the pupal and ventral longitudinal adult muscles of the ventrites 1 & 2 may be absorbed since they are no more effective. Such muscles might be termed transient ventral longitudinal muscles.

None of the dissected specimens of ppas mutants were newly emerged adults and the ventral longitudinal muscles in any of the first 2 ventrites of ppas mutants are not similar in form to those of the corresponding segments of the newly emerged non-mutants, which rater resemble those of the ventrite 3.

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References

Bradley, James V. 1968. Distribution-Free Statistical Tests, Prentice-Hall, Inc. Englewood Cliffs, N. J., pp 138-141.

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*Comparison of Methods of Counting Tribolium Eggs.

Introduction

Genetic experiments with Tribolium, particularly selection experiments, often involve counting large numbers of eggs. Therefore, it would be advantageous to mechanize counting. To increase the efficiency, while maintaining a high degree of accuracy, hand counting, as the standard, was compared with machine counting, using one of two automated "bacteria colony" counters, in two experiments.

Materials and Methods

Varying numbers of eggs, ranging from about 5 to about 125, were sifted from flour medium and placed at random into 24 vials. The eggs in each vial were counted eight times, twice (determinations 1 and 2) by each of two operators (operators 1 (O_1) and 2 (O_2)) using each of two methods (method 1 (M_1), hand; and method 2 (M_2), machine).

Experiment 1:

For each hand count, the contents (eggs and residual flour particles) of each vial were poured into a linear egg counting stage (Muir and Grossman, 1973); the eggs were counted under a microscope, and the contents returned to the same vial. (With some experience, operators can usually distinguish eggs from flour particles.) The machine counter was a BioTran Automated Colony Counter,[1] Model CIII, including a CV-10 viewing monitor. For this method, the operator placed the contents of each vial into a plastic petri dish and placed it on the Counter. He then made two determinations before the contents were returned to the vial. After each determination, the petri dish was shaken slightly, and again placed on the Counter for another reading. By using the viewing monitor, the operator took care that the eggs were not clustered at the perimeter of the dish and were not touching each other. The specification of the machine is that it will count all particles as small as 0.2 mm in diameter.

Experiment 2:

The second experiment was similar to the first, with about the same range in numbers of eggs per vial. Counting by hand involved two steps; first, counting the eggs in each vial, using the linear egg counting stage under a microscope, then counting the number of flour particles for a count of total (eggs + flour) particles. The flour particles that were counted were those judged by the operator to be of sufficient size to be counted also by the machine. The machine counter was the Petri-Scan Bacteria Colony Counter.[2] Its specification is that all particles over 0.25 mm in diameter will be counted.

Statistical Analysis:

Because eggs or flour particles might have been lost while transferring them to and from a vial, a linear factor, called sequence, was included in the analysis. The sequence of the eight counts per vial differed in the two experiments, so they were analyzed separately.

Square-roots of egg and total particle numbers were analyzed because the square-root transformation tended to make the error variances homogeneous according to Bartlett's test (Ostle, 1963).

Results and Discussion

Experiment 1:

The BioTran counted significantly ($P < .05$) more eggs (or total particles) than the hand counting method (Tables 1 and 2). However, this difference was not consistent over vials, as indicated by the significant ($P < .01$) vial by method (V x M) interaction.

[1] BioTran, Model CIII is manufactured by New Brunswick Scientific Co., Inc., 1130 Somerset Street, New Brunswick, N.J. 08903.

[2] Petri-Scan is manufactured by American Instrument Company, Box 477, Barrington, Ill. 60010.

To study whether the counting methods have a constant difference over the range of numbers of eggs counted, a linear regression analysis of machine counts on hand counts was performed on the transformed data. The correlation between methods of counting was .99, and the linear regression coefficient of the transformed data for machine count on hand count was .953 ± .033, not significantly ($P > .05$) different from 1.00 (Figure 1). This indicates that for every additional 100 eggs counted by hand, this machine counted about 91 eggs. The machine count was higher than the hand count up to about 80-85 eggs, after which the two methods counted about the same number of eggs.

Variation between determinations by operator 1 using the machine (.0335) was not significantly different from that between determinations by operator 2 using the machine (.0473) (Table 2), and there was no significant interaction between methods and operators. Thus the machine may be used by either operator with the same accuracy and also with the same precision.

Experiment 2:

The Petri-Scan counted significantly ($P < .01$) fewer total particles than the hand counting method (Tables 1 and 2). This difference was not consistent over vials as evidenced by the significant ($P < .01$) interaction of vials (quantity of eggs or particles) with counting method.

Linear regression analyses of machine counts on hand counts were performed on the mean $\sqrt{\text{eggs}}$ (Figure 2) and mean $\sqrt{\text{total particles}}$ (Figure 3). In both analyses the correlation between methods of counting was about .96. The linear regression coefficients were .783 ± .043, and .733 ± .045, respectively. This indicates that for every additional 100 eggs or total particles counted by hand, the Petri-Scan counted, respectively, about 61 or about 54 total particles. Both regression coefficients were significantly ($P < .01$) different from 1.00.

There appeared to be a significant difference ($P < .01$) between operators in the number of total particles counted; operator 1 counted an average of about 35 particles per vial, while operator 2 counted an average of only about 33.5 particles per vial. This difference may reflect the variation in judgement of the operators as to what sized particle was to be counted by the hand method.

Table 1. Least-squares means of square-root of egg and total particle counts per vial for each method by experiments.

	Experiment 1			Experiment 2					
	$\sqrt{\text{Eggs}}$	$\sqrt{\text{Total Particles}}$		$\sqrt{\text{Eggs}}$	$\sqrt{\text{Total Particles}}$		$\sqrt{\text{Total Particles}}$		
Vial No.	Method 1 Hand	Method 2 BioTran	Difference (1 - 2)	Method 1 Hand	Method 2 Petri-Scan	Difference (1 - 2)	Method 1 Hand	Method 2 Petri-Scan	Difference (1 - 2)
1	7.0521	6.8361	.2160	7.6807	6.9616	.7192	8.3034	6.9616	1.3418
2	4.1819	4.2709	- .0890	4.3582	4.0277	.3304	4.7395	4.0277	.7118
3	6.5741	6.5187	.0554	6.8368	5.9213	.9156	7.4135	5.9213	1.4922
4	5.1228	5.3136	- .1908	9.7045	7.2787	2.4258	10.1681	7.2787	2.8894
5	8.9719	8.9405	.0314	7.2786	5.5407	1.7380	7.6801	5.5407	2.1394
6	7.9213	7.9989	- .0776	3.7393	3.1831	.5562	3.8707	3.1831	.6876
7	4.1828	4.3008	- .1180	12.6277	10.2648	2.3630	13.7588	10.2648	3.4940
8	8.8728	9.0662	- .1934	6.8163	5.6507	1.1656	7.7633	5.6507	2.1126
9	6.5763	6.7071	- .1308	6.0142	5.2903	.7240	6.8373	5.2903	1.5470
10	5.9154	5.9368	- .0214	6.7820	5.0979	1.6840	7.4485	5.0979	2.3506
11	4.0615	3.9673	.0942	5.3614	4.0423	1.3192	6.0821	4.0423	2.0398
12	2.4494	2.4986	- .0492	6.1657	4.8622	1.3036	7.3404	4.8622	2.4782
13	9.0666	8.8972	.1694	5.9776	4.7349	1.2426	6.4761	4.7349	1.7412
14	6.1643	6.2641	- .0998	2.5968	1.9920	.6048	3.2394	1.9920	1.2474
15	6.4222	6.5760	- .1538	5.3538	4.9442	.4096	5.9694	4.9442	1.0252
16	5.8722	6.1400	- .2678	3.1218	2.4062	.7156	3.7378	2.4062	1.3316
17	5.3847	5.2667	.1180	6.8344	5.6052	1.2292	7.6440	5.6052	2.0388
18	4.3298	4.5530	- .2232	5.9146	4.7168	1.1978	6.5744	4.7168	1.8576
19	9.9740	9.6414	.3326	4.5774	4.3896	.1878	5.1328	4.3896	.7432
20	4.4700	5.8914	-1.4214	6.0205	5.2191	.8014	6.4417	5.2191	1.2226
21	10.6846	10.7684	- .0838	4.9238	3.6582	1.2656	5.2420	3.6582	1.5838
22	7.5816	8.4842	- .9026	6.2191	6.0791	.1400	6.6171	6.0791	.5380
23	5.4772	5.8716	- .3944	5.4313	4.4929	.9384	5.5899	4.4929	1.0970
24	2.1769	2.6457	- .4688	5.2683	4.7757	.5122	5.6521	4.7757	.8764
$\bar{X}$	6.2286	6.3898	- .1612	6.0677	5.0473	1.0204	6.6551	5.0473	1.6078
$\sigma_{\bar{X}}$	.45704	.44131	.07474	.41977	.33926	.12343	.44523	.33926	.15120

Table 2. Analysis of variance of square-root of egg and total particle counts for each experiment.

Experiment 1			Experiment 2			
		Mean Squares			Mean Squares	
Source	d.f.	$\sqrt{\text{Eggs}}$	Source	d.f.	$\sqrt{\text{Eggs}}$	$\sqrt{\text{Total Particles}}$
Sequence (S)	1	.2755**	Sequence (S)	1	7.9060**	10.6200**
Method (M)	1	1.2462*	Method (M)	1	49.9725**	124.0922**
Operator (O)	1	.0352	Operator (O)	1	.2066	.8021**
M x O	1	.0340	M x O	1	.0004	.2125
O x Det (D)/M_1	1	.0077	Det (D) x M	1	3.6746**	3.1012**
D/(O_1 x M_2)	1	.0335	D x O	1	2.1438**	2.2239**
D/(O_2 x M_2)	1	.0473	D x M x O	1	.0497	.0380
Vials (V)	23	38.4810**	Vials (V)	23	27.2340**	28.9819**
V x S	23	.0284	V x S	23	.3295**	.3421**
V x M	23	.2681**	V x M	23	.7312**	1.0974**
V x O	23	.0232	V x O	23	.0566	.0624
V x M x O	23	.0246	V x M x O	23	.0430	.0619
V x O x D/M_1	23	.0081	V x D x M	23	.3276*	.3274*
V x D/(O_1 x M_2)	23	.0242	V x D x O	23	.0496	.0610
V x D/(O_2 x M_2)	23	.0229	V x D x M x O	23	.0879	.1032
Total	191		Total	191		

** Significant at 1% level of probability.
* Significant at 5% level of probability.

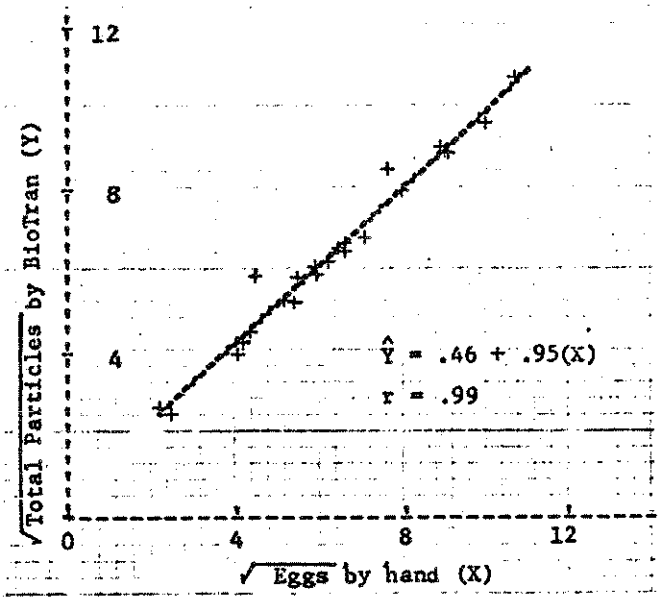

Figure 1. Regression of $\sqrt{\text{total particles}}$ counted by the BioTran on $\sqrt{\text{eggs}}$ counted by hand.

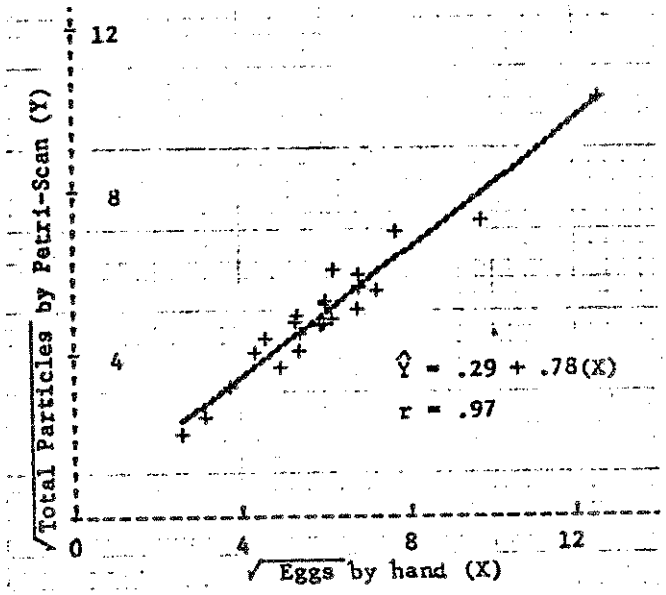

Figure 2. Regression of $\sqrt{\text{total particles}}$ counted by the Petri-Scan on $\sqrt{\text{eggs}}$ counted by hand.

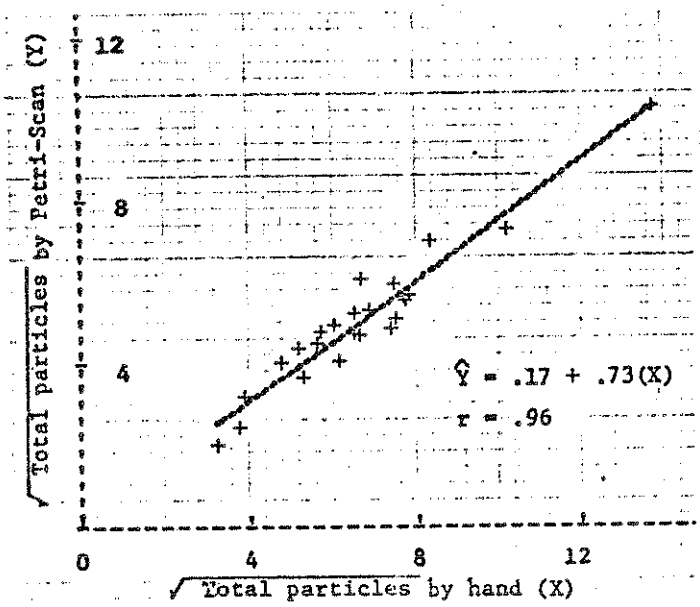

Figure 3. Regression of $\sqrt{\text{total particles}}$ counted by the Petri-Scan on $\sqrt{\text{total particles}}$ counted by hand.

Conclusions

Counts using the BioTran machine agree with hand counts better than do counts using the Petri-Scan machine. Over a range of eggs, numbering from 5 to 125, the BioTran counted 91% of the eggs counted by the hand method. Operators probably will not differ in their counts, no matter which method they use, if they are experienced in distinguishing eggs from flour particles.

Although there may be some bias in machine counting, using the machine increases efficiency by reducing operator fatigue, allowing larger quantities of eggs to be counted, and allowing a change in operators without significantly affecting the results.

Acknowledgments

The BioTran Automated Colony Counter was provided through the courtesy of Mr. Ted Shields, Sales Engineer, New Brunswick Scientific Co., Inc. The Petri-Scan was provided through the courtesy of Mr. William T. Robinson, Sales Engineer, American Instrument Company. We thank Dr. H. W. Norton for his assistance in the analysis of the data, and Clyde Anderson for his technical assistance.

References

1. Muir, W. M. and M. Grossman, 1973. A linear egg counting stage for use with Tribolium. T.I.B. 16:113-114.

2. Ostle, B., 1963. Statistics in Research. Iowa State University Press, Ames, IA.

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*The Influence of the ppas Mutation on the Abdominal Musculature of Tribolium castaneum.

Sokoloff (The Genetics of Tribolium and Related species, Academic Press, New York; 1966) has pointed out that ppas mutants of Tribolium castaneum have homeotic features in that the subsequent ventrites tend to become similar to the 1st ventrite, having a middle projection corresponding to the intercoxal process of the 1st ventrite and also having an anterior articulating membrane. These features suggested that some kind of abnormalities might be expected in the ventral musculature of the ppas mutants.

Through the kindness of Dr. A. Sokoloff I received some adult ppas mutants and through Mr. G. Hosie of the Infestation Department, Ministry of Agriculture Fisheries, Glasgow, some non-mutant specimens of Tribolium castaneum; I dissected nearly 20 random specimens (of both sexes and different ages) of ppas, and some non-mutants for comparison.

As seen in Fig. 1, the non-mutant ones have the first 3 ventrites connate and first 2 in fully mature specimens lack the ventral longitudinal muscles which are present in the ventrites 3, 4, 5; these muscles in a segment actually move the segment one behind. The ventral longitudinal muscles of nearly all the dissected specimens of the ppas mutants differed more or less from those of the normal type and the homeotic modification of the ventrite 2 was well expressed. In one of them (Fig. 3) the ventrites 2-4 showed the modification in decreasing degree posteriorly. As far as the musculature is concerned, this specimen in comparison with the other ppas mutants has the extremest muscular abnormality, with median ventral longitudinal muscles in the ventrites 1 & 2, similar to those normally in front of the ventrite 1, while the ventrite 3 has lost them, as is the normal condition of the ventrites 1 & 2; this specimen also lost the ventral lateral oblique muscles altogether. Many intermediate types were found between this extremest mutant and non-mutant type. In these intermediate types, the abnormalities involved are modifications, often asymmetrical, in the orientation and position of the ventral muscles. The modifications in their orientation are changes in the direction and location of the muscles so that the normally longitudinal muscles have become oblique or vice versa and the normal positions of the muscles have also been displaced. The structural modifications are the coalescence and lenghtening of the muscle bundles e.g. (Fig. 2). From these observations it appears that in ppas mutant of this species, the ventral musculature shows homeotic tendencies towards the abdominal base. This tendency is more evident in the extremest ppas mutant (Fig. 3) than the intermediate mutants.

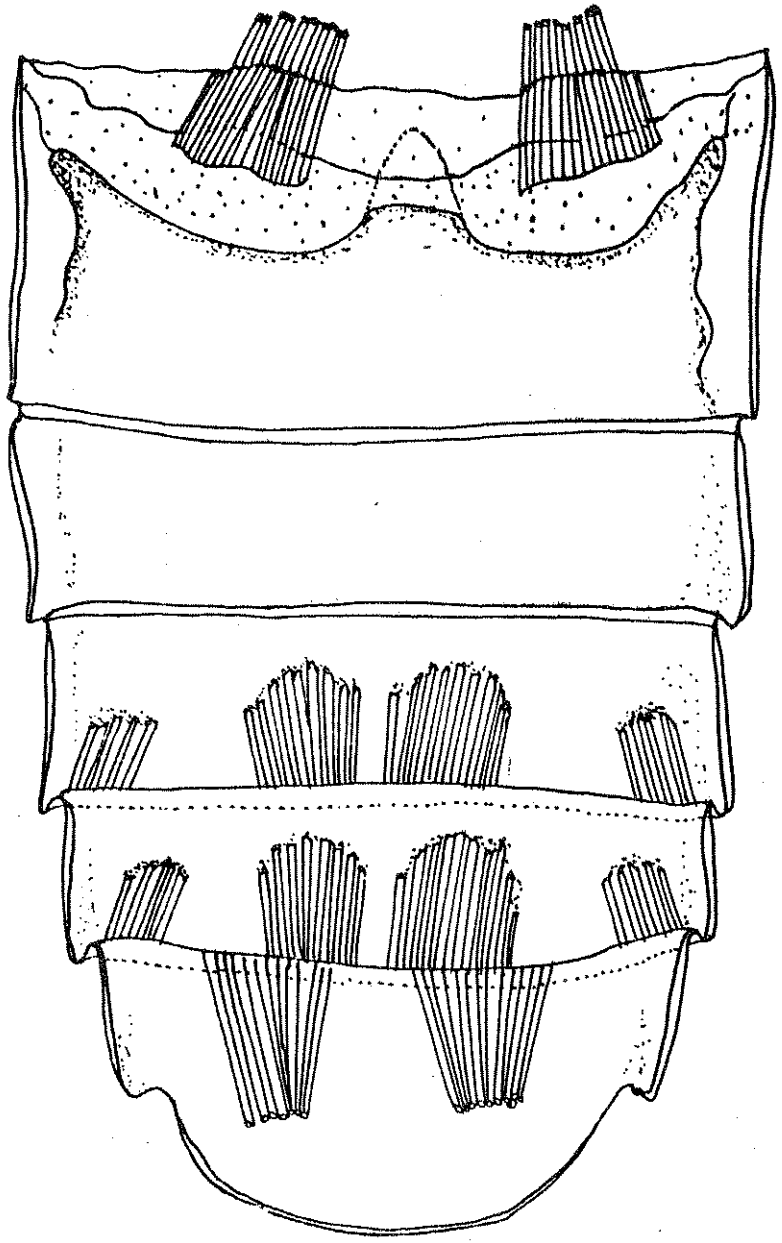

Fig. 1. The ventral abdominal musculature of a fully mature non-mutant Tribolium castaneum.

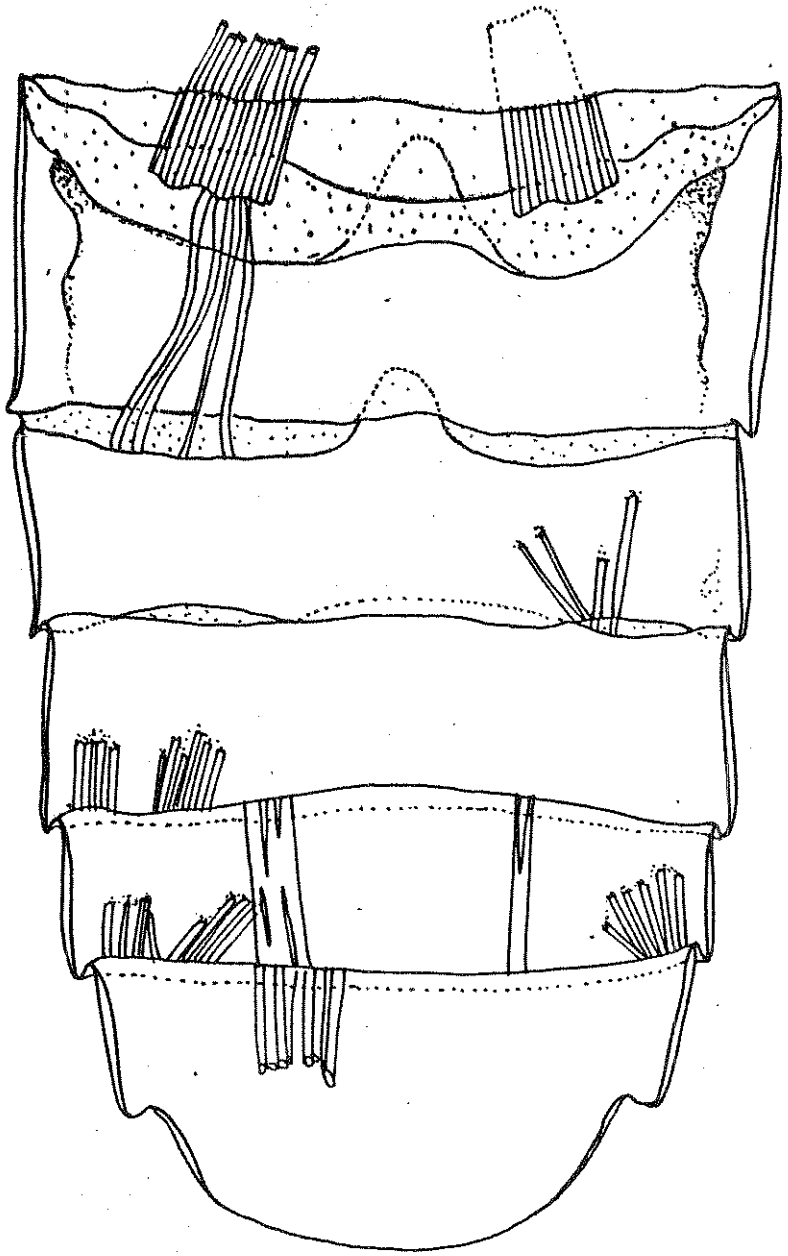

Fig. 2. The ventral abdominal musculature of a fully mature intermediate ppas mutant of T. castaneum.

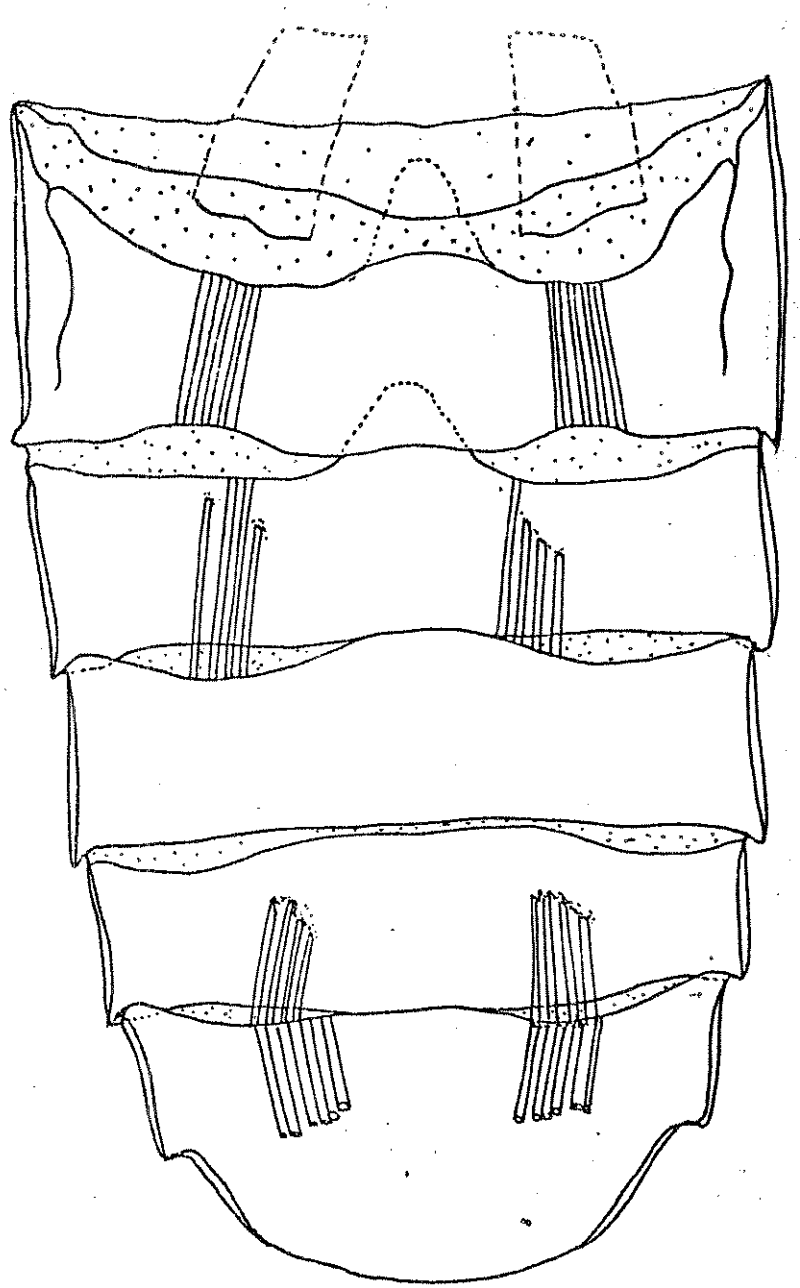

Fig. 3. The ventral abdominal masculature of an extreme ppas mutant of T. castaneum.

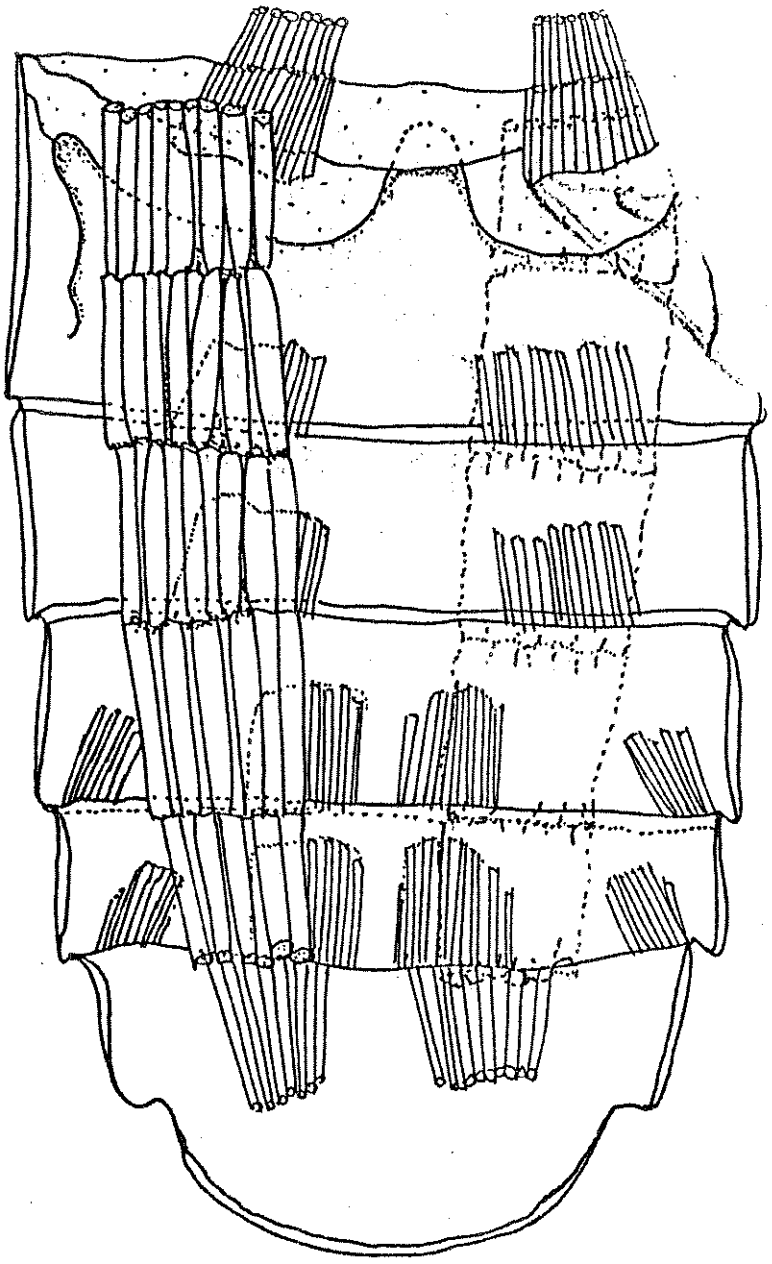

Fig. 4. The ventral abdominal masculature of a newly emerged non-mutant adult T. castaneum; The thick loosely overlying persistent pupal muscles are ommitted on the right hand side, notice the transient ventral muscles in the ventrites 1 & 2.

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*Dietary and Density Dependant Factors in the Induction of Population Autocide of Flour Beetles, Tribolium confusum.

The response of the adult Tribolium confusum Jacquelyn duVal to stress imposed by malathion and crowding was investigated. Stress imposed by malathion concentrations of 1.0 ppm or greater with population densities of 75 or more adult beetles per 3 grams of flour was adequate to initiate the production of gas with resulting death of all beetles. A color change in the flour (white to pink) was a secondary effect resulting from the presence of quinone gas.

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*Selection for changes in developmental period in Tribolium castaneum (Chicago Black strain).

In conjunction with other ongoing research it became necessary to investigate the amount of genetic variation in egg to adult developmental period maintained in the Chicago Black strain of Tribolium castaneum. This paper will report on the results of five generations of artificial selection for both fast and slow developmental period.

Materials and Methods

The Chicago black (bb) beetles were obtained from stocks maintained in our laboratory. Throughout the experiment they were reared on sifted whole wheat flour mixed with 5% brewers yeast at 25°C and 70% R. H. Four egg farms were set up and 400 one-day old eggs from each farm were used to set up each of the four lines that made up generation 0. The cultures were always raised in 40 grams of flour in half-pint Mason jars. After 22 days the cultures were sifted and all pupae removed to separate vials corresponding to their respective cultures. If any, larvae remained, the cultures were sifted again every four days until all had pupated. The vials containing pupae were checked daily and all emerging adults were removed to holding vials. At the end of generation 0 two of the lines were each subdivided into fast and slow lines by taking the 10% fastest and slowest from each line and allowing them to mate with their cohorts for a day in 40 grams of fresh flour. The other two lines were designated controls. All the emerged adults from the particular control line were mixed and 10% taken at random to form the parents of the next generation. Thus generation 1 consisted of two fast lines, two slow lines, and two control lines.

Table 1. - Egg to adult developmental time -- mean and variance and sample sizes

		Fast Lines		Slow Lines		Control Lines	
Generation		1	2	1	2	1	2
0.	F	25.741	25.687	25.741	25.687	25.740	25.646
	6^2	1.446	0.839	1.446	0.839	1.370	0.956
	n	352	367	352	367	319	356
1.	F	25.803	25.446	26.304	26.720	25.978	26.152
	6^2	2.385	0.568	1.474	3.888	0.451	1.193
	n	213	195	253	300	178	223
2.	F	26.073	25.301	26.784	27.405	26.007	26.100
	6^2	2.70	0.527	2.204	4.676	0.453	0.715
	n	96	153	139	159	140	110
3.	F	25.387	25.457	26.939	29.031	26.329	26.584
	6^2	0.588	0.606	2.548	4.367	0.939	1.787
	n	150	164	164	97	213	154
4.	F	24.984	25.380	28.321	31.312	25.386	26.201
	6^2	0.842	2.649	2.466	10.450	0.754	2.424
	n	185	108	131	138	44	169
5.	F	25.005	25.056	28.738		25.463	26.258
	6^2	0.816	2.179	3.235		1.300	2.894
	n	186	144	103		123	155

It should be noted that all new generations were started at least 5 days after the last adult emerged to insure that the youngest adults were mature. This regime was continued for the rest of the experiment except that due to a population decline the parents of subsequent generations consisted of the 20 fastest, slowest, or randomly selected beetles. This kept population size at about 150. It was hoped that maintaining the population so low eliminated any changes in developmental period due to density effects.

Results and discussiion

A summary of the data is given in table 1. Note that only four generations were run in slow line number 2. As can be seen from generation 0 the bb strain has a developmental period averaging a little less than 26 days. The distribution is faintly bimodal; a major mode occurring on day 26 and a very much smaller mode 2-3 days later. This is very similar to the distribution for this strain found by Kence (1973). Previous selection experiments on developmental period in T. castaneum have shown a relatively rapid response to selection for slower development and a less dramatic response for faster development, Dawson (1965, 1966). Wool (1969), on the other hand, found that he could select for faster developmental time in bb rather easily but found no response to selection for slower developmental period.

In the work reported on in this paper the response to selection was highly asymmetric. The response to selection for slow development was apparent after one generation and by the end of the experiment the mean had shifted an average of nearly four days. The response to selection for fast development was neither as rapid nor as clear cut. There was a trend toward faster development but this was not found statistically significant. A single classification analysis of variance was performed by grouping all mean developmental times into either control, fast, or slow. The results were significant (F_s= 22.743, $P < .001$), showing that selection had differentiated the groups. Further analysis revealed no significant difference in Fast vs. Control (F_s2.388, $P < .10$) and a large difference in Slow vs. Control (F_s=28.946, $P < .001$).

The individual population variances (see Table 1) were similarly grouped and Druskal-Wallis tests performed separately on each selected group vs. the control group. As was the case with the means there was no difference between the Fast and the Control (adj H = .0309, $P < .5$) and a highly significant difference between the Slow and the Control (adj H = 12.444, $P < .005$). Thus it seems that selection for slower developmental period acts not only by shifting the mean of the population but by increasing its variance.

The response to slow selection can be explained by Kence's (1973) work in which he hypothesizes a polymorphism in number of larval instars which results in the bimodality in developmental period. He assumes that in bb the morph for higher number of instars in maintained at low levels. The results reported here tend to support these assumptions.

Literature Cited

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

Dawson, P. S. 1965. Developmental rate and competitive ability in Tribolium (I). Evolution 20:104-115.

Kence, A. 1973. The effects of variation in larval development on laboratory populations of Tribolium and houseflies. Ph.D. Thesis, State University of New York at Stony Brook. 184 pp.

Wool, D. 1969. Selection for fast and slow development in pure cultures of T. castaneum strains. Tribolium Inf. Bull. 11:108-112.

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*Multifactor Ecological Effects on the Fitness of Tribolium Populations.

This research was done to gain information on the effects of nutrients, radiation, and competition studied singly or in combinations on the productivity of Tribolium castaneum and Tribolium confusum populations. The response of Tribolium populations to stress in a laboratory situation may supply explanations for their responses in nature.

The results indicated a progressive reduction in productivity for the P_1 adults of T. castaneum and T. confusum as the gamma (^{60}Co) exposures increased. The sterilizing dose for each species was between 3 and 6 kR at 36 ± 2 C and 56 ± 10% relative humidity. With stress from radiation or competition T. castaneum consistantly was reproductivity fitter than T. confusum; whereas, the opposite was true without the stress.

A progressive reduction in productivity for both species was noted as the percent of cottonseed flour increased. The life cycle from egg to adult was apparently prolonged on cottonseed flour. The flour beetles were not consuming the cottonseed flour because of palatability and/or consistancy. Dissection of the dead adults revealed empty and shriveled digestive systems.

As the gamma radiation dose increased and the proportion of cottonseed flour increased, the numbers of F_1 progeny of T. castaneum and T. confusum decreased. The radiation effects obscured the flour effects in modifying the fitness of Tribolium, although the flour proportions did contribute to the overall productivity decreases.

The 9 kR exposure was the LD_{100} for parental adutls of T. castaneum on 100% cottonseed flour and T. confusum on all flour proportions. An increase in F_1 mortality was observed with increased population density.

Fitness parameters, such as productivity and lethality, for single- and mixed-species populations of T. castaneum and T. confusum varied inversely to the gamma radiation exposure and/or the proportion of cottonseed flour.

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*Larval length and width measurements as an index of growth in Tribolium castaneum.

Many indices have been devised to quantify the growth process of Tribolium. Measurements include the duration of metamorphosis (Park, et. al, 1961), adult, pupal and larval weight (Bell, 1969) and estimation of biomass (King and Dawson, 1972). In our laboratory we have quantified growth by length and width measurements, similar to Brindley (1930) with T. confusum. There are several reasons for choosing these measurements:

(1) Ocular micrometer readings are easy to obtain and record and are only slightly more time consuming than sexing pupae, (2) It is an inexpensive system and maintenance is minimal as opposed to weight measurements which require the maintenance of sensitive balances, (3) It offers the opportunity of quantitatively assessing on an individual basis, and (4) most importantly, the system provides an accurate means of describing growth during the very early stages of Tribolium development. The following study is presented as an example of the kind of information that can be obtained via these measurements and in fact suggests that only one measurement is needed (length or width) to monitor Tribolium development.

The genetic material used during this study were two populations of T. castaneum, the unsaturated fatty acid sensitive population (cos/cos) described by Costantino and Rowe (1972) and the Purdue Foundation population (+/+). Eggs from both the sensitive and normal populations were collected over a 24 hour period and distributed in groups of 25 to creamers containing diet 0 (percentage composition: wheat flour 95, and brewers yeast 5), diet 3 (percentage composition: wheat flour 92, brewers yeast 5, and corn oil 3), and diet 5 (percentage composition: wheat flour 90, brewers yeast 5, and corn oil 5) and maintained at 33±1°C in low (35±5%) and high (77±3%) relative humidity. Seventy-two hours after egg collection, larvae from all environmental combinations were counted and eight randomly chosen individuals were measured (Scully, 1972). In order to assure accurate measurement, larvae were placed in the freezer compartment of a refrigerator for approximately two minutes prior to measurement. This inhibited movement of the larvae for several minutes and did not affect viability. In all cases, larvae were measured with an ocular micrometer to the nearest .005 of a millimeter; the total magnification was x .8. (Actual number of millimeters = recorded number of millimeters divided by .8). The results of each day represent an independent sample of individuals.

Tables 1a and b contain the mean and standard error of the mean for measurements of larval length and width as recorded for low relative humidity. The length parameter exhibits a greater range of values during early development than does width. This difference in phenotypic variance suggests that larval length may be a more informative measure of the developmental growth of a population than is width.

The analysis of variance for the first nine days of these data is presented in Tables 2a and b. The analysis performed on length measurements agrees with that performed on width. All components are statistically meaningful. Because growth occured over the observation period the differences due to Days were significant. The concentration of corn oil significantly affected larval growth as did the genotype of the population. The Days by Oil interaction is an indication that the response to the concentration of corn oil changes with time while the Days by Genotype interaction reflects how differently both populations grow with respect to time. The Oil by Genotype interaction points out the different phenotypic responses of both genotypes.

Table 1 (A) Mean length of larvae and standard error of the mean of populations of T. castaneum grown at low relative humidity on different concentrations of corn oil media. Each mean represents an independent sample of 8 individuals. Given in millimeters (total magnification x .8; observed number of millimeters = actual number of millimeters / .8). (B) Mean width of larvae and standard error of the mean of the same populations cultured under the same conditions.

(A)

Days After Hatching	Sensitive Diet			Normal Diet		
	0	3%	5%	0	3%	5%
1	0.775±.016	0.787±.016	0.756±.011	0.781±.019	0.800±0	0.781±.009
2	0.800±.021	0.775±.027	0.731±.016	0.835±.024	0.819±.033	0.762±.016
3	0.940±.034	0.945±.043	0.831±.027	1.045±.028	1.025±.031	0.955±.050
4	1.110±.012	1.010±.033	0.935±.027	1.035±.024	1.100±.027	1.055±.034
5	1.294±.072	1.006±.013	1.000±.008	1.417±.046	1.400±.041	1.256±.065
6	1.500±.026	1.255±.047	0.985±.036	1.490±.037	1.375±.082	1.370±.042
7	1.695±.075	1.210±.018	1.085±.051	1.860±.095	1.935±.069	1.910±.073
8	1.905±.084	1.400±.104	1.110±.050	2.145±.058	2.150±.128	1.875±.067
9	2.760±.118	1.430±.093	1.314±.114	3.060±.189	3.065±.066	3.025±.155
10	3.280±.170	1.806±.148	1.336±.066	3.600±.192	3.435±.135	2.970±.110

(B)

Days After Hatching	Sensitive Diet			Normal Diet		
	0	3%	5%	0	3%	5%
1	.131±.013	.137±.012	.136±.011	.150±.009	.131±.013	.131±.009
2	.169±.013	.150±.013	.144±.006	.169±.009	.162±.008	.156±.011
3	.180±.008	.160±.007	.162±.012	.185±.008	.175±.008	.185±.011
4	.200±.000	.165±.100	.170±.008	.190±.007	.205±.012	.190±.012
5	.200±.012	.167±.012	.172±.009	.217±.008	.244±.013	.189±.011
6	.230±.008	.200±.007	.170±.008	.225±.017	.240±.019	.240±.010
7	.285±.013	.185±.011	.190±.012	.270±.011	.250±.013	.280±.008
8	.300±.010	.210±.007	.175±.015	.325±.015	.280±.022	.315±.017
9	.450±.027	.240±.010	.221±.018	.510±.022	.495±.019	.475±.032
10	.495±.017	.275±.013	.221±.010	.540±.025	.500±.019	.455±.020

Table 2 A) Analysis of variance of larval length of the sensitive and normal genotypes cultured in low relative humidity.

Source of Variation	Degrees of Freedom	Mean Squares	F-ratio
Days (D)	8	22.622	378.0*
Oil (O)	2	6.234	104.1*
Genotype (G)	1	10.860	346.9*
D X O	16	0.878	14.7*
D X G	8	2.322	38.8*
O X G	2	3.129	52.3*
D X O X G	16	0.517	8.6*
Residual	378	0.060	
Total	431		

*Significant at the 0.05 level of probability.

B) Analysis of variance of larval width of the sensitive and normal genotypes cultured in low relative humidity.

Source of Variation	Degrees of Freedom	Mean Squares	F-ratio
Days (D)	8	0.445	263.5*
Oil (O)	2	0.132	78.4*
Genotype (G)	1	0.450	266.7*
D X O	16	0.017	10.2*
D X G	8	0.052	30.8*
O X G	2	0.086	50.6*
D X O X G	16	0.010	6.0*
Residual	378	0.002	
Total	431		

*Significant at the 0.05 level of probability.

Table 3. Correlation coefficients of mean larval length and width.

	Low Relative Humidity			High Relative Humidity		
Diet	0	3	5	0	3	5
Genotype						
(cos/cos)	.992	.981	.962	.989	.670	.989
(+/+)	.989	.973	.991	.994	.991	.980

The correlation coefficients of mean larval length with larval width (Table 3) in all cases but one are greater than .95 indicating a strong linear relationship between these measurements. Predictions of larval width based on measured larval length should be good and the volume of a particular organism easily estimated. The exception in this study is very likely attributable to sampling error.

In summary, it appears as if larval length and width measurements provide easily acquirable yet accurate information on the growth of Tribolium larvae. Analysis based on length yields similar information as analysis based on width. The linear correlation coefficients of mean length and mean width are on the order of .95 justifying the use of only one of the parameters as a measure of growth. It is suggested that larval length be measured as this parameter is the most sensitive to changes in time and to environmental differences.

Literature Cited

Bell, A. E. 1969. The nature of selection responses in Tribolium. Jap. J. of Gen. 44:299-309.

Brindley, T. A. 1930. The growth and development of Ephestia kühniella Zeller (Lepid.) and Tribolium confusum Duv. (Coleopt.) under controlled conditions of temperature and relative humidity. Ann. Ent. Soc. Am., 23:741-757.

Costantino, R. F. and P. M. Rowe. 1972. Genetic analysis of a population of Tribolium. IV. Gene expression modified by corn oil and relative humidity. Heredity, 29:247-252.

King, C. E. and P. S. Dawson. 1972. Population biology and the Tribolium model. In Evolutionary Biology 5:113-227.

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

Scully, A. M. M. 1973. The Colonizing Ability of Some Populations of Tribolium castaneum. M. S. Thesis. University of Rhode Island, Kingston, R. I.

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A strain of small Oryzaephilus mercator Fauvel from Thailand.

Introduction

The occurrence of a strain of small Oryzaephilus surinamensis (L.) in the Far East and its biology has been described by Aitken (1966). Results from crosses between the small and a normal sized strain showed that the inheritance of size was under polyfactorial control and that size was inherited through both parents, the female parent having a greater influence. In 1970 some small Oryzaephilus mercator Fauvel were collected from a shipment of polished rice imported from Thailand to Holland.

This strain was cultured on rolled oats at 25°C and 70% R.H. since its collection.

The inheritance of size of this strain has been studied.

Experiments and results

End 1972 pronota were measured of 50 males and 50 females of the strain of small beetles (called S) and of a laboratory strain of normal size (called L) according to the method described by Aitken (1966).

Strain L was cultured for a large number of generations on rolled oats at 25°C and 70% R.H.

Crosses were made between strains S and L and a number of back crosses were carried out. Of the progeny of the various crosses the pronota of 50 females were measured. The results are shown in Table I. They are similar to those found by Aitken (1966). Differences in size between both strains are obvious, also when they are bred on a nutrient-rich food rolled oats. The size of the F_1 of interstrainal crosses lays between that of the parental strains.

In both sexes of the F_1 there is a bias towards the large condition which is more pronounced when the female parent is of the large strain. The progeny of the F_1 inter se cross is smaller than of the F_1 hybrids but a larger size is reached when the female grandparent was large.

The influence of the female parent is also reflected in the progeny of the various back crosses.

Discussion

Some preliminary experiments showed that the developmental periods of the S and L strain with rolled oats as food at 25°C and 30°C and 70% R. H. were the same. The fertility and fecundity of the hybrids also does not seem to be impaired. The question arises therefore how a small strain originates and how it maintains its identity.

It is supposed that the small strain in the long run is better adapted to a poor diet than strains of normal size and so a small strain can exist.

On a more nutritious food like rolled oats however, it is likely that a small strain will be gradually swamped by a strain of normal size. To prove this assumption experiments have to be carried out on the productivity and competition of both strains on deficient diets.

Table I

Lenght of pronota in strains S and L, inter strain crosses and back crosses bred on rolled oats at 25°C and 70% R.H.

Strain or cross	mean length mm. ♂♂	♀♀	standard deviation ♂♂	♀♀
L	0.73	0.71	0.041	0.032
L x S	0.69	0.68	0.030	0.022
L x S inter se	0.66	0.66	0.043	0.027
L x (L x S)	0.71	0.69	0.034	0.029
S x (L x S)	0.64	0.64	0.026	0.030
(L x S) x L	0.72	0.71	0.031	0.028
(L x S) x S	0.65	0.63	0.036	0.030
S	0.59	0.59	0.019	0.028
S x L	0.67	0.67	0.024	0.026
S x L inter se	0.64	0.64	0.033	0.031
L x (S x L)	0.68	0.67	0.030	0.027
S x (S x L)	0.63	0.62	0.033	0.035
(S x L) x L	0.70	0.69	0.029	0.028
(S x L) x S	0.64	0.64	0.039	0.027

Literature

Aitken, A. D. 1966. A strain of small Oryzaephilus surinamensis (L.) (Coleoptera Silvanidae) from the far East. J. Stored Prod. Res. 2:45-55.

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*Selection against homzygotes in a variable environment. A preliminary experiment with Tribolium.

Introduction

Some data from Nature and a few experimental results reported so far indicate that even changes of very short duration relative to generation time may produce important genetic changes in populations. For example, Band and Ives (1961, and later publications summarized by Band 1972), reported a positive correlation between the range of diurnal temperature fluctuation and the frequency of lethal and semi-lethal chromosomes in a natural population of Drosophila melanogaster. Beardmore (1961) concluded from his study of bristle number in Drosophila populations that a diurnal change in temperature was highly effective in maintaining genetic variance. Beardmore and Levine (1963) reported that larval viability of a population after 19 generations in a diurnally-fluctuating environment was higher than three other populations maintained in 3 different but constant conditions over the same period. Long (1970) compared populations after many generations in one constant and three fluctuating environments with a period of 1, 32 and 96 days respectively. Using a multiple index of fitness, he was able to show that the population from the diurnally-changing conditions had the highest fitness.

Increased fitness is often related to an increase in the proportion of heterozygotes, which are also more homeostatic and may survive in a wilder range of environmental conditions. On the other hand, many natural populations are inbred - and inbreeding tends to increase the proportion of homozygotes in the population.

It, therefore, seemed of interest to expose populations, for a length of time, to variable environment under very close inbreeding, and compare their fitness with populations of the same initial genetic constitution under the same mating system, but maintained in a constant environment.

Materials and Methods

A wild type strain of Tribolium castaneum, originally obtained from Dr. R. R. Sokal's laboratory in Stony Brook, L. I., N. Y., was used in this experiment. Offspring of two randomly-chosen pairs of adults (selected from the stock in the pupal stage) were pair-mated in vials containing 1 g. of medium (flour and brewer's yeast in the ratio 100:5). Each pair founded one replicate line for the experiment, by ovipositing for 7 days.

Ten of these lines were maintained in a standard (constant) environment (30°C, 70% RH) denoted C, and 30 lines in a variable environment, denoted V. These were exposed to a series of treatments.

The experiment lasted 6 generations. Every generation, beginning when first detected, offspring pupae were recovered from the vials twice weekly, separated by sex, and held separate until adults emerged.

To minimize the loss of experimental lines from occasional sterility of parent adults, 3 replicate pairs chosen at random, were set up for 7 days oviposition each line if enough offspring were available. From these, 1 fertile pair was chosen to continue the line.

Six treatments were decided upon arbitrarily ("no treatment" being one of the list, Table 1) and were given to the V lines in generations 1-5 twice every week, beginning with the termination of oviposition and ending when pupation began. No treatments were given at generation 6.

Calculations: Two parameters, associated with fitness and likely to be affected by inbreeding, were calculated. (1) Productivity (defined as the number of pupae obtained from a pair of adults ovipositing for 7 days in 1 g. of medium). This parameter is the combined result of parent fecundity and offspring survival to pupation. (2) Median developmental period of offspring from egg to pupa. Developmental period data were analyzed without transformation. Square-root transformation of pupal counts were used in the analysis of productivity.

Results

The mean productivity of the experimental groups is illustrated in fig. 1 (left). It is instructive to compare the productivity of C lines to that of V lines at generation 6 in which all lines were maintained in the constant environment. In this generation the mean productivity of V lines was significantly higher than the C lines ($P < 0.05$ by t test).

The median developmental periods of V and C are illustrated in fig. 1 (right). The developmental period of the V group was generally longer than that of the C group. However, in generation 6, when all lines were tested in the constant environment, the average median for V was shorter than for C, although the difference between them was just barely significant.

At generation 3, hybrid lines were made by crossing between C lines. (C x C). At generation 4, the following single-pair crosses were made: Cx C, V x V, and C x V. In addition, the offspring of the cross in the preceding generation were sibmated (A) and cross-mated (B). For each cross, several replicates (8 to 16) were made. All

crosses were maintained in the constant environment. Examination of the data reveals a significant difference in productivity between group B (cross-mated) and their best parents C_I ($P < 0.01$), but no such difference in group A. Productivity of B was almost as high as in the beginning of the experiment. (fig. 2a).

There were no significant differences in developmental period between hybrids in the different crosses, but it was shorter than that of the inbred lines ($P < 0.01$). (fig. 2b).

Discussion

The results indicate that the sib-mated V lines, with a history of 5 generations of exposure to unpredictable short-term treatments, were more fit (as indicated by their higher productivity and shorter developmental time) than the C lines, which were of the same origin and practiced the same mating system but maintained in the constant environment, in which C and V were compared at generation 6.

Sib-mating, with subsequent sampling of but one pair of offspring to continue a line, could be expected to lead to rapid homozygotization of the genome in each line, exposing deleterious alleles to selection pressures. Moreover, even homozygosity per se should be more deleterious in a suboptimal variable environment than in a favourable constant one, because homozygous individuals may lack the physiological flexibility to adapt to variable conditions (Lerner, 1954). Therefore, populations living in variable environments should include a higher proportion of heterozygous individuals than in constant environments. We conclude that homozygous individuals were less likely to be included as parents in the V lines than in the C lines, and therefore were selected against in the variable environment. This process has reduced the rate of homozygotization in the V lines, resulting in their better fitness. This conclusion is supported by the fact that outcrossing at generation 5 (fig. 2) has restored productivity to its originally high level, and that hybridization reduced developmental time of all crosses compared to the inbred lines.

Table 1. Experimental treatments for the V group. To obtain the complete sequence of experimental history, the generations should follow each other in sequence. No treatments were given during the oviposition and pupation periods.

Treatment symbols:
0 no treatment
1 cold treatment: 2°C for 1 hour
2 heat treatment: 38°C for 24 hours
3 starvation treatment: 24 hours without food, at 30°C
4 competition treatment: 7 days competition with adult males of T. confusum (black mutant)
5 competition treatment - same as 4 but for 10 days.

	WEEKS 1	2	3		4	
Gen. 1	Oviposition: No treatment	1	0	2	0	0	Pupation: No treatment
Gen. 2		3	0	3	3	2	
Gen. 3		0	0	4		0	
Gen. 4		0	2	1	1	3	
Gen. 5		0	5			0	
Gen. 6		0	0	0	0	0	

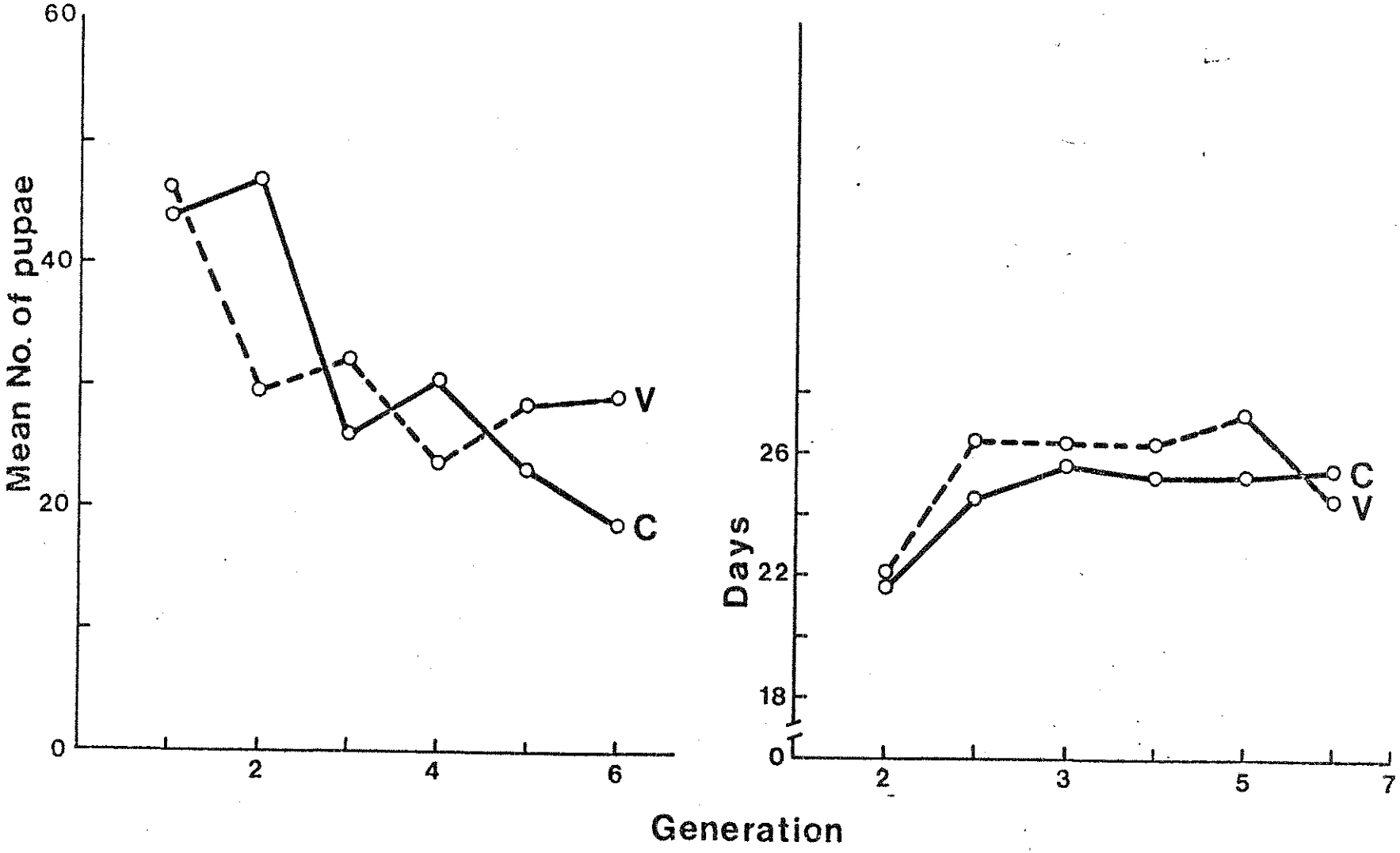

Fig. 1. (left) Mean productivity of the 2 experimental groups
(right) Average median egg-to-adult developmental period (in days) of the V and C groups.

(Variable environment: broken lines
Constant environment: solid line)

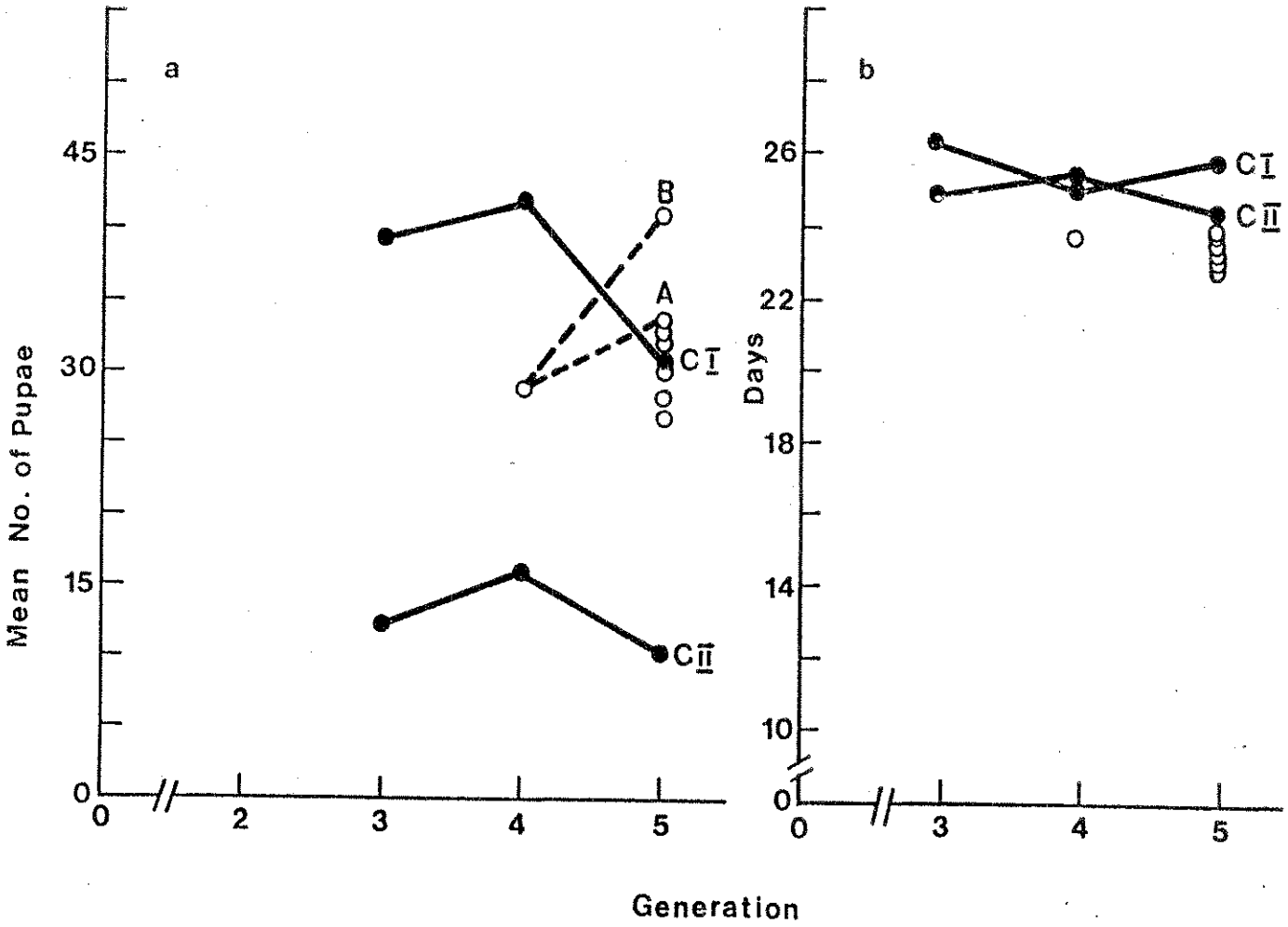

Fig. 2. Productivity (a) and developmental period (b) of the hybrid lines compared with their inbred parents C_I and C_{II}, at generations 3 - 5. Solid circles - inbred lines. Open circles - hybrids. A and B are the sib-mated (A) and cross-mated (B) offspring of the hybrids obtained at generation 4. (See text).

REFERENCES

Band, H. T. and P. T. Ives, 1961. Correlated changes in environment and lethal frequency in a natural population of Drosophila melanogaster. Proc. Nat. Acad. Sci. 47:180-185.

Band, H. T., 1972. Minor climatic shifts and genetic changes in a natural population of Drosophila melanogaster. Amer. Natur. 106:102-115.

Beardmore, J. A., 1961. Diurnal temperature fluctuation and genetic variance in Drosophila populations. Nature 189:162-163.

Beardmore, J. A., and L. Levine, 1963. Fitness and environmental variation. 1. A study of some polymorphic populations of Drosophila paeudoobscura. Evolution 17:121-129.

Lerner, I. M., 1954. Genetic Homeostasis. John Wiley & Sons, Inc.

Long, T., 1970. Genetic effects of fluctuating temperature in populations of Drosophila melanogaster. Genetics 66:401-416.

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The influence of the male on female egg-laying of "Tribolium castaneum".

A series of experiments were carried out in order to study the influence of the male of Tribolium castaneum on the egg laying of the female to whom it has been mated. Some preliminar work on this subject has been reported by Orozco et al. (1971).

Insects from the Consejo population (Orozco and Bell, 1974) were used, and they were kept at 33°C and 70% relative humidity. All matings were individually made.

The following effects were considered:

L_V = Egg laying of virgin females.

L_F = Egg laying of fecundated females.

L_M = Egg laying of virgin females in the presence of a male which was separated from the female by means of a wire netting placed in the corresponding vial.

L_D = Egg laying of females mated to males previously irradiated in a caesium bomb at the following dosages: D_1 = 16 Krds, D_2 = 20 Krds, D_3 = 30 Krds. All dosages completely sterilized the males.

L_C = Egg laying of females mated to Tribolium confusum males. These matings were all unviable.

Three types of experiments each with several replications were carried out. In each experiment virgin and fecundated females were compared with females submitted to other treatments as shown in Table 1.

Table 1. Effects tested in each experiment.

Experiment	Effects tested							Number of replications
	L_V	L_F	L_{D_1}	L_{D_2}	L_{D_3}	L_M	L_C	
I	x	x	x		x			3
II	x	x				x		2
III	x	x		x		x	x	4

Table 2 presents the egg laying average figures for the four treatments of experiment I (both by replications and for the pooled data), together with the mean squares of the corresponding analyses of variance.

Table 2. Four-days average egg laying with its standard error and mean squares from analyses of variance of Experiment I.

		Rep. 1	Rep. 2	Rep. 3	Pool
average values per treatment	L_F	76.38±1.39	48.83±1.98	73.23±2.15	66.15±1.29
	L_{D_1}	53.97±1.57	30.82±1.38	42.37±1.79	42.39±1.07
	L_{D_3}	56.03±1.58	31.76±1.76	41.87±1.90	43.22±1.18
	L_V	37.67±1.45	21.26±1.61	22.20±1.82	27.04±0.93
mean squares of ANOV	Replicates	-	-	-	49,481.21**
	Treatments	25,179.10**	21,055.51**	56,644.50**	76,220.59**
	R x T	-	-	-	2,737.36**
	Residual	223.71	258.16	323.14	266.81

** ($P < 0.01$)

No differences were found between doses of irradiation and the lay of the females mated to those irradiated males was intermediate between those of virgin and fecundated females with differences in both cases highly significant ($P < 0.01$). The significant effect found for the replication x treatment component of variance in the pooled analysis is of a quantitative type rather than a qualitative one since the same pattern was found in the four replicates for the performance of the four treatments.

Table 3.- Four-days average egg laying with its standard error and mean squares from the analyses of variance of Experiment II.

		Rep. 1	Rep. 2	Pool
average values for treatment	L_F	57.23±2.04	36.75±1.48	46.99±1.45
	L_M	34.25±1.57	15.94±0.89	25.58±1.14
	L_V	25.37±1.69	15.16±0.95	20.33±1.06
mean squares of ANOV	Replicates	-	-	38,034.44**
	Treatments	27,033.24**	14,671.42**	39,754.49**
	R x T	-	-	1,950.17**
	Residual	315.65	136,95	227,83

** ($P < 0.01$)

Table 3 is as Table 2 but for the data from experiment II. In this case the egg laying of virgin females separated from the male by a wire screen placed in the vial was in both replicates far below the lay of fecundated females. However, although the difference $L_M - L_F$ was not significant in replicate 2, it was highly significant ($P < 0.01$) but small (8.88 eggs) in replicate 1. In the pooled analysis the difference $L_M - L_F = 5.25$ eggs was not significant even at the 0.10 level, but in this case the highly significant effect for the interaction replication x treatment reflects the contradictory results obtained in both replications.

The average laying figures for the four replicates of experiment III and their pool are presented in Table 4, with the mean squares for the corresponding analyses of variance. All the effects in these analyses were highly significant ($P < 0.01$). The reason for the significance of the interaction are the small differences in ranking order between L_V, L_C and L_M when considering the four replications.

The treatment L_F was always superior to L_{D2} and the performance of L_{D2} always larger than those for the other three treatments, with highly significant differences ($P < 0.01$) in each replication and also in the pooled analysis. Comparing L_C and L_M with L_V does not produce important differences in some replicates but in other cases it gives significant differences even though they are smaller than those observed with respect to L_F and L_D. Table 5 presents all the set of differences for the pooled analysis and from them it can be deduced that the performances of L_V, L_C and L_M are not significantly different. Only in the first replication of this experiment III, L_M and L_C were larger than L_V; but given the results in the other three replications and in the pooled analysis, it seems reasonable to state that L_F L_D $L_C = L_M = L_V$.

Table 4.- Two-days average egg laying with its standard error and mean squares from the analyses of variance of Experiment III.

		Replications				Pool
		1	2	3	4	
average values for treatment	L_F	33.02±0.78	33.56±0.72	31.88±0.94	31.70±0.97	32.54±0.43
	L_{D_3}	30.01±0.86	19.97±0.83	19.22±0.57	22.02±0.90	22.83±0.45
	L_M	19.84±0.83	12.79±0.80	11.11±0.46	9.73±0.59	13.53±0.42
	L_C	16.21±0.70	9.73±0.51	10.26±0.51	12.11±0.76	12.07±0.32
	L_V	10.33±0.71	11.03±0.73	14.03±0.67	11.01±0.92	11.62±0.38
means square of ANOV	Replicates	-	-	-	-	2,403.00**
	Treatments	8,971.75**	9,558.62**	7,800.71**	8,035.50**	32,012.54**
	R x T	-	-	-	-	784.68**
	Residual	60.30	51.44	46.90	63.63	55.35

** ($P < 0.01$)

REFERENCES

Orozco, F., Espejo, M. and Carbonell, E. 1971. Influencia de diversos factores en la puesta del Tribolium castaneum. IV. Influencia del macho. Anales INIA, 1:93-108.

Orozco, F. and Bell, A. E. 1974. A genetic study of egg laying of Tribolium in optimal and stress environments. Can. J. Genet. Cytol. (Submitted).

Sokoloff, A. 1972. The Biology of Tribolium, with special emphasis on genetic aspects, Vol. 1. Oxford University Press.

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Cannibalism among different developmental forms of the black and pearl foundation Tribolium populations.

Wool (1969) had recognized that cannibalism is an important factor in the regulation of competing Tribolium populations. Kence (1971) and Miller and Kence (1973) studying cannibalism between different genotypes at the black locus observed preferential cannibalism of one genotype over the others. However, Sellin and Krause (1973) using mixed cultures of Short antennae (Sa-2) and wild type could not detect any preferential cannibalism although random observations previously supported Kence's findings.

Park et. al. (1965) have shown that cannibalism can occur at many stages of the beetle's development: larva-egg, larva-pupa, adult-larva, adult-pupa and adult-egg. To investigate the cannibalism preferences of different developmental forms, a preliminary study involving black and pearl foundation populations was made. Krause and Bell (1972) had found these populations differed in a number of basic traits, in particular, the pearl larva were 50% larger than the black at 13 days. Competitive situations between larva-pupa, adult-pupa and adult-larva were investigated under various amounts of media.

Material and Methods

Different stages of development were collected from mass matings of 10 male and 10 females. Five bottles each of the black (black body color) and pearl (pearl eye color) foundation populations of Tribolium castaneum were maintained on standard media (95% sifted whole wheat flour and 5% dried Brewer's yeast) in an incubator set at 91±1°F and 70±2% R.H. These matings were transferred into fresh media every 24 hours to maintain similar age limits of the developmental forms used: larva (13 days), pupa (18 days) and adults (25 days).

Table 5.- Differences between treatments and their significance for the pool analysis of experiment III. (Newman Keuls sequential test).

	L_V	L_C	L_M	L_{D_3}
L_F	20.92**	20.47**	19.01**	9.71*
L_{D_3}	11.21**	10.76**	9.30**	
L_M	1.91	1.46		
L_C	0.45			

** ($P > 0.01$)

From the analysed experiments it may be concluded that:

a) Given the well known fact that the virgin females lay less eggs than the fecundated ones (about one third) it has been shown clearly that females mated to irradiated sterile males perform intermediate.

b) However, the lay of females mated to males of another species (Tribolium confusum) was not enhanced and their lay was equal to the virgin ones.

c) Finally, when females were near a male of the same species but physical copulation was prevented, it seemed that the egg laying was not increased, at least to a great extent. This result is not very conclusive even with the obtainment of two positive cases out of the six tested, although this may reflect the complexity of the treatment.

If males of Tribolium confusum copulate with females of Tribolium castaneum as indicated by Sokoloff (1972) it is necessary to think that the estimulation to lay from the copulation itself with males of the same species is different and positive.

In this way the increase in egg laying could be due to two facts: first the copulation and corresponding physiological factors and afterwards the fertilization of the eggs.

The possible stimulus for increasing lay due to the presence of the male near the female through some influence of pherormonae is therefore in some doubtful state after the results obtained in experiments I and III. The slight increase in two replicates is not enough to conclude that this estimulus is a positive one.

Six combinations of competitive cannibalism were observed between the black and pearl populations: larva (predator) - pupa (prey); adult (predator) - pupa (prey); adult (predator) - larva (prey). Each combination maintained in 3/4 oz. creamer consisted of 25 prey and 10 predators which were kept together for four days. Four creamers were used for each combination, resulting in a total of 100 potential prey. The number of prey surviving were used as a measure of cannibalism. To differentiate cannibalism from livability, a control group of 100 beetles were observed simultaneously. Three replicates of the experiment were used, each under different environmental conditions: no media, little media (just enough media to cover the bottom of the creamer) and excess media (10 q. per creamer).

Chi-square tests were used to compare the various parameters studied.

Results and Discussion

The results of the various predator-prey combinations between different developmental forms, between genotypes within a single species and between various environmental regimes are shown in Table 1a. With exception, the excess media regime results in no appreciable cannibalism as compared with the more stressful conditions of little or no media. Since beetles are a tunneling organism, the excess media regime provides both sufficient food and decreases the chance encounter between predator and prey.

Kence (1973) observed genotypic differences in cannibalistic behavior between larva and pupa. In our study (Table 1a) the survival of the pupa were significantly lowered from that of the controls (Table 1b), particularly in the no and little media environments. The controls here serve as a measure of livability of the prey under the various environments. With exception, similar lowering of pupal survival was observed (Table 1a) when adults were used as predators. However, with the larva-pupa situations, the pearl were the better cannalibalizers while the black adults are better cannibalizers than the pearl in reference to pupa survival.

When adults were used as predators and larva as prey (assuming the larva are the prey, although conceivably it could be reversed), decreases in larval survival was observed on both no and little media regimes. However, in reference to the no media regimes, the controls (Table 1b) had poor viability, probably due to the necessity of food for complete development. Again the black adults had better appetites.

Ideally, it would be desirable to study preferential cannibalism of one genotype versus the other. An error in the experimental design became evident in analyzing the data when no information from the control combination of black predator on black prey and pearl on pearl were obtained. This limits the interpretations in

reference to preferential cannibalism. From this preliminary study, it seems that the pearl larva, which are larger in size, are better cannibalizers of the black pupa. However, size differences are probably not the only causes of observed difference in response between the genotypes since black adults are better cannibalizers of pearl larva and pupa than the reverse combination.

Table 1a. Number of prey surviving (of 100 organisms) exposed to different predator-prey combinations under various environmental regimes

		Environment regimes		
Predator	Prey	No media	Little media	Excess media
Black larva	Pearl pupa	52	90	94
Pearl larva	Black pupa	13	84	93
Black adults	Pearl pupa	8	13	65
Pearl adults	Black pupa	45	26	99
Black adults	Pearl larva	1	81	90
Pearl adults	Black larva	13	98	100

Table 1b. Number of survivors (of 100 organisms) corresponding respectfully to the prey (in Table 1a.) exposed to various environmental regimes.

	Environment regimes		
	No media	Little media	Excess media
Pearl pupa	98	92	93
Black pupa	98	95	98
Pearl pupa	97	100	98
Black pupa	100	99	93
Pearl larva	8	100	99
Black larva	40	99	100

Summary

Preferential cannibalism was observed, particularly, under the stressful conditions of little of no media. The pearl larva were better cannibalizers of the black pupa than the reverse combination. Part of this differential response may be accounted for by the pearl larva being larger in size. In addition, the black adults were observed to be better cannibalizers of both the pearl pupa and larva.

Literature Cited

Kence, A. 1971. Genetic differences in palatability of pupa and voracity of larvae of *Tribolium castaneum*. TIB 14:79-80.

Krause, E. and A. E. Bell 1972. A genetic study of biomass in *Tribolium* I. Path coefficient analysis of base populations. Can. J. Genet. Cytol. 14:181-193.

Miller, S. G. and A. Kence 1973. Preferential cannibalism of pupae in hybrid populations of Tribolium castaneum. TIB 15:92-93.

Park, T. et al. 1965. Cannibalistic predation in populations of flour beetles. Physiol. Zoo. 38:289-321.

Sellin, L. and E. Krause. 1973. The effect of cannibalism in mixed cultures of short-antennae and wild type strains of T. castaneum. TIB15:93-96.

Wool, D. 1969. The effect of larval age range on survival of two Tribolium castaneum strains in mixed cultures through pupal cannibalism. Res. Pop. Ecol. 11:40-44.

NOTES - TECHNICAL

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A container for studying oviposition rate in the absence of egg cannibalism.

Sonleitner (1961) described a plastic replica of a shell vial (similar in construction to the fractionable shell vial of Ghent, 1966) which he used to study oviposition rate of beetles on the surface of the flour medium. A single pair of beetles confined in such a device exhibits an oviposition rate only slightly less than that of a single pair in 4 grams of medium in a shell vial. Because all eggs are oviposited below the subsurface mesh, they are safe from cannibalism. Thus the device enables one to study the oviposition rate of single pairs under fairly normal conditions but in the absence of egg cannibalism. Controlled numbers of eggs may be fed to the pair by introducing them onto the surface of the medium above the mesh. Such introduced eggs should be marked (Sonleitner, 1961) so that they may be distinguished from those produced by the pair.

Such a tower is made from several short sections of lucite tube (1 inch in diameter 1/16th inch wall thickness, ½ inch long.) The bottom section is cemented to a small square of plexiglass which serves as a base. The top section has a piece of OOXX bolting cloth cemented across its lower end. When the bottom section is overfilled with medium and the top section placed over it and fastened in place with Scotch tope, the bolting cloth should be buried just beneath the surface of the medium. The beetles are then placed in the top section on the surface of the medium. Eggs are recovered by taking the tower apart and sifting the medium in the bottom section.

Ghent, A. W. 1966. Studies of behavior of the Tribolium flour beetles. II. Distributions in depth of T. castaneum and T. confusum in fractionable shell vials. Ecology 47(3): 355-367.

Sonleitner, F. J. 1961. Factors affecting egg cannibalism and fecundity in populations of adult Tribolium castaneum Herbst. Physiol. Zool. XXXIV(3): 233-255.

ANATOMY & HISTOLOGY

Arbogast, R. T., Roppel R. M. and Carthon, M. 1972. Hygrorecepters of adult sawtoothed grain beetles, Oryzaephilus surinamensis (L.) Can. J. Zool. 50:1147-1153.

Barlet, J. 1972. On thorax of certain Myxophaga Crowson (Coleoptera). Inst. Roy. Sci. Natur. Belg. Bull. 48:6 p. Aug. 31.

Chang, V. C. S. and Jensen, L. 1973. Antennal morphology of New Guinea sugarcane weevil, Rhabdoscelus obscurus. Entomol. Soc. Amer. Ann. 66:117-121.

El-Halfawy, M. 1972. Differentiation of sexes in Tribolium confusum Duv. Agric. Res. Rev. 50:65-66.

Forsyth, D. J. 1972. Structure of pygidial defence glands of Carabidae (Coleoptera). Zool. Soc. London Trans. 32:249-309.

Gokan, N. and Nakahira, A. 1972. Surface structure of pronotum in soybean beetle, Anomala rufocuprea Motschulsky. Kontyu 40:206-208.

Gundevia, H. S. and Ramamurty, P. S. 1972. On intraganglionic neurohormal organs in ventral nerve cord of Hydrophilus olivaceus. Experientia 28:1049-1050.

Kobylnyk, R. W. 1973. Lethal and sublethal effects produced by three lasers on two Trogoderma species. II. Histological changes. Can. Entomol. 105:513-525.

Monga, D. 1972. Spermatheca and associated accessory gland in Callosobruchus maculatus (F.) Zool. Pol. 22:71-79.

Pajni, H. R. and Chhibba, K. K. 1972. Structure of rostrum in Calandra oryzae (L.) Int. J. Insect Morphol. Embryol. 1:219-223.

Ponomarenko, A. G. 1972. On nomenclature of wing venation in beetles. Entomol. Obozr. 51:768-775.

Provansal, A. and Grillot, J. P. 1972. Perisympathetic organs in Holometabola insects. I. Coleoptera. Soc. Entomol. France Ann. 8:863-913.

Ryan, M. F. 1973. Sensory recepters of Tribolium larvae. Phys. Zool. 46:238-244.

Steinmann, H. 1972. A comparative anatomy of insect head. IV. Muscles and nerves of sympathical system. Rovartani Kozlemenyek 25:481-491.

BEHAVIOR STUDIES

Arbogast, R. T. 1973. Light responses of Tribolium castaneum and Tribolium confusum: variation with age and sex. J. Stored Prod. Res. 9:31-35.

Bathon, H. 1973. On form vision in hiding orientation of ground beetles; studies on Carabus problematicus Thoms., Agonum assimile Payk., Abax ater Vill., and Bembidion litorale Oliv. Tierpsychol. 32:337-352.

Bauer, T. 1972. An instinct movement as an ecological regulation mechanism in ground beetle. Naturwissenschaften 59:649.

Darchen, R. 1973. Attempt at interpretation of caste determination in Trigona and Melipona. Acad. Sci. C. R. Ser. D. 276:607-609.

Edona, V. I. 1972. Basic studies on walking rhythm in epilachna beetle, J. Anim. Morphol. Physiol. 19:135-139.

Eisenstein, E. M. 1972. Learning and memory in isolated insect ganglia. Adv. Insect Physiol. 9:111-181.

Evans, M. E. G. 1972. Jump of click beetle: A preliminary study. J. Zool. 167:319-336.

Fields, G. J., and McMullen, R. D. 1972. Aggregation sites and behavior of two species of Hippodamia in south-central British Columbia. Entomol. Soc. Brit. Columbia J. 69:25-27.

Frantsevich, L. I., and Mokrushev, P. A. 1971. Perception of visual movements in scarabaeid beetles. In International Congress of Entomology, 13th Moscow, 1968. Trudy 2:14.

Hamilton, W. D. 1972. Altruism and related phenomena, mainly in social insects. Annu. Rev. Ecol. Syst. 3:193-232.

Hlavac, T. F. 1972. Prothorax of Coleoptera: orgin, major features of variation. Psyche 79:123-149.

Kennedy, J. S. 1972. Emergence of behaviour. J. Aust. Entomol. Soc. 11:168-176.

Kuznetsova, I. A. 1971. Photoperiodic adaptations of insects as limiting factors in intraregional resettlement. In International Congress of Entomology, 13th, Moscow, 1968. Trudy 2:162.

Ledous, A., and Dargagnon, D. 1973. Formation of castes in ant Aphaenogaster senilis Mayr. Acad Sci. C. R. Ser. D. 276:551-553.

Loschiavo, S. R. 1973. Effect of fungi and moisture on locomotory behavior of rusty grain beetle, Cryptolestes ferrugineus. Can Entomol. 105:485-490.

Marzke, F. O., Street, M. W., Mullen, M. A. and McCray, T. L. 1973. Spectral responses of six species of stored-product insects to visible light. J. Ga. Entomol. Soc. 8:195-200.

Mazokhin-Porshniakov, G. A. 1971. Tropisms, taxis and olfactory orientation in insects. In Vsesoiuznyi Simposium po Khemoretseptsii Nasekomykh, 1St, Vilma, 1971. Khemoretseptsiia nasekomykh; materialy P 7-11.

Meyer-Rochow, B. 1972. Communication in aggregation forming saw-flies and leaf beetles. Z. Tierpsychol. 30:451-455.

Mletzko, G. 1972. Orientation rhythmics of Carabidae. 2. day active ground beetles. Zool. Anz. 188:174-184.

Moore, I. 1972. Rove beetles taking flight directly from surface of fresh and salt water: an escape mechanism. Wasmann J. Biol. 30: 169-170.

Morimoto, N. 1972. Recent studies on insect aggregations. New Entomol. 21:1-14.

Mullen, V. T. 1973. Social behavior in confined populations of horned passalus beetle. Ga. Entomol. Soc. J. 8:115-123.

Niemitz, C., and Krampe, A. 1972. An investigation of orientation behaviour of larvae of Necrophorus vespillo. Z. Tierpsychol. 30: 456-463.

Nordlund, D. A. and Brady, U. E. 1973. Stimulation of eclosion of adult Plodia interpunctella with carbon dioxide. Annals. Ent. Soc. Am. 66:1366-8.

Perttunen, V. 1972. Humidity and light reactions of Stitophilus granarius (L.) Sitophilus oryzae L., Rhizopertha dominica F. and Acanthoscelides obtectus Say. Suom Hyonteistieteellinen Aikak Ann. Entomol. Fenn. 38:161-176.

Pierart, P. 1973. Ethological genetics (behavioral genetics in relation to ecology). Nat. Belg. 54:181-220.

Pinto, J. D. 1973. Sexual behavior in genus Pleuropoma LeConte: a new mating display in blister beetles. Can. Entomol. 105:957-969.

Reinig, H. J. 1973. Capability of direction-finding by whirligig beetle Gyrinus sbustriatus Steph. J. Comp. Physiol. 84:281-298.

Salita, L. J. 1972. Gallery orientation in Cerambycid larvae. Entomologist. 105:300-304.

Sargent, T. D. 1973. Behavioral adaptations of cryptic moths. VI. Further experimental studies on bark-like species. Lepidopterists Soc. J. 27:8-12.

Sheiman, I. M. 1973. Training of Tenebrio molitor larvae at various stages of post-embryonal development. Zh. Obshch. Biol. 34: 470-475.

Shorey, H. H. 1973. Behavioral responses to insect pheromones. Annu. Rev. Entomol. 18:349-380.

Smith, L. B. 1972. Wandering of larvae of Cryptolestes ferrugineus among wheat kernels. Can. Entomol. 104:1655-1659.

Soans, A. B. and Soans, J. S. 1972. A convenient method rearing tiger beetles in laboratory for biological and behavioural studies. Bombay Natur. Hist. Soc. J. 69:209-210.

Stein, W. 1972. Investigations on flight and flight behaviour of curculionids. Z. Angew Entomol. 71:368-375.

Stein, W. 1973. Laboratory investigations about flight behaviour and flight activity of Sitona species. Anz. Schadlingsk Pflanzenschutz 46:44-46.

Storch, R. H. 1973. Effect of photoperiod on Coccinella transverso-guttata. Entomol. Exp. Appl. 16:77-82.

Villacis, J., Sosa, M. C. and Ortega, C. A. 1972. Behavior of Sitotroga cerealella Olivier and Sitophilus zeamais Motschulsky in ten types of corn with contrasting characteristics. Rev. Peruana Entomol. Agr. 15:153-164.

Wojtusiak, R. J. 1971. Achievements of Polish entomology in field of ethology. Pol Pismo Entomol. 41:733-746.

CYTOLOGY AND ELECTRON MICROSCOPY

Ashrafi, Shahid H. and Roppel, Richard M. 1973. Radiation-induced partial sterility related to structurally abnormal sperms of Plodia interpunctella. Ann. Entomol. Soc. Amer. 66:1309-14.

Ashrafi, Shahid H. and Roppel, Richard M. 1973. Radiation-induced alteration of testes of larvae of the Indian meal moth, Plodia interpunctella. Ann. Entomol. Soc. Amer. 66:1324-28.

Baccetti, B. 1972. Insect sperm cells. Adv. Insect Physiol. 9:314-397.

Bram, R. A., and Anthony, D. W. 1973. Scanning electron microscopy of cultured cells of Aedes aegypti. J. Invertebrate Pathol. 21:107-111.

Dasgupta, J. and Chakravarti, A. 1973. Chromosome numbers in twelve species of indian carabidae and Tenebrionidae. Cur. Sci. 42:102.

Ennis, T. J. 1972. Low chromosome number and post-reductional XO in Gelus californicus. Can. J. Genet. Cytol. 14:851-857.

Fromme, H. G., Pfautsch, M., Pfefferkorn, G. and Bystrický, V. 1972. Critical point drying: a preparation method for scanning electron microscopy. Microsc. Acta. 73:29-37.

Gokan, N. and Nakahira, A. 1972. Electron microscope studies on surface structure of elytra in chafers. 1. Relation between fine structure and appearance in subfamily Sericinae. Kontyu 40:303-308.

Howden, H. F., and Ling, L. E. C. 1973. Scanning electron microscopy: low-magnification pictures of uncoated zoological specimens. Science 179:386-388.

Satir, P., and Gilula, N. B. 1973. Fine structure of membranes and intercellular communication in insects. Annu. Rev. Entomol. 18:143-166.

Sharma, G. P., Handa, S. M. and Sharma, S. 1973. Karyotype and sex-mechanism in four species of tenebrionid beetles. Cur. Sci. 42:216-217.

Takenouchi, Y. 1972. An additional finding of chromosomes in a parthenogenetic weevil. Cyrtepistomus castaneus Roelofs. Cis 13:5-6.

Takenouchi, Y. and Shiitsu, T. A survey of chromosomes in eleven species of Chrysomelid beetles. Kontyu 40:297-302.

Tombes, A. S. 1972. Scanning electron microscopy of endocrine tissue of Hypera punctata (Fabricius). Int. J. Insect Morphol. Embryol. 1: 201-202.

Tombes, A. S. and Roppel, R. M. 1972. Ultrastructure of spermatheca of granary weevil, Sitophilus granarius. Int. J. Insect Morphol. Embryol. 1:141-152.

Tremblay, E., and Caltagirone, L. E. 1973. Fate of polar bodies in insects. Annu. Rev. Entomol. 18:421-444.

ECOLOGY AND POPULATION ECOLOGY

Aboul-Nasr, S. 1973. Ecological studies on insects infesting wheat grains in Egypt. Z. Angew Entomol. 73:203-212.

Adkisson, P. L. 1972. Photoperiodism and seasonal discrimination by an insect. In Problemy Fotoperiodizma i Diapauzy Nasekomykh P. 102-111.

Arbogast, R. T. 1973. Light responses of Tribolium castaneum and Tribolium confusum: variation with age and sex. J. Stored Prod. Res. 9:31-35.

Arbogast, R. T. and Carthon, M. 1973. Light, tactile, and humidity responses of adult Oryzaephilus surinamensis. Environ. Entomol. 2:931-5.

Arobogast, R. T. and Flaherty, B. R. 1973. Light responses of Tribolium castaneum and Tribolium confusum: Variation with age and sex. J. Stored Prod. Res. 9:31-35.

Ataeva, M. 1972. Wintering of some Coccinellidae on southern slopes of Gissar Range and in Gissar Valley of Tajikistan. Izv Akad Nauk Tadzh SSR 2:63-66.

_____ 1972. Biology and ecology of Epilachna chrysomelina in Tajikistan. Izv Akad Nauk Tadzh SSR 1:85-86.

Baker, Je 1973. Growth responses of larvae of rice weevil maize weevil, maize weevil, and granary weevil on a meridic diet. J. Econ. Entomol. 66:681-683.

Beatson, S. H. and Dripps, J. S. 1972. Long-term survival of cockroaches out of doors. Envir. Hlth. 80:340-341.

Boles, H. P. and Ernst, R. L. 1972. Reactions of red flour beetle, Tribolium castaneum to some newly developed whole wheat products. Entomol. Soc. Amer. N. Cent. Br. Proc. 27:71-75.

Bottrell, D. G., White, J. R., Moody, D. S. and Hardee,D. D. 1972. Overwintering habitats of boll weevil in rolling plains of Texas. Environ. Entomol. 1:633-638.

Butler, G. D., and Dickerson, W. A. 1972. Life cycle of convergent lady beetle in relation to temperature. J. Econ. Entomol. 65: 1508-1509.

Bystrak, P. G. and Messersmith, D. H. 1973. A new host record for Forcipomyia crinita Saunders. Entomol. News 84:17-21.

Charykuliev, D. and Nepesova, M. 1972. On Sarcophagidae flies as predators of darkling beetles in Turkmenia. Akad. Nauk. Turkm. Ssr. Izv. Ser. Biol. Nauk. 5:71-73.

Cherepanov, A. I. 1972. Morphology and biology of long-horned beetle Chlorophorus gracilipes Fald. Akad Nauk Sssr Sibirsk Otd Biol. Inst. Tr. 11:55-62.

Coombs, C. W. and Woodroffe, G. E. 1973. Evaluation of some of the factors involved in ecological succession in an insect population breeding in stored wheat. J. Anim. Ecol., 42:305-322.

Cornic, J. F. 1973. Studies on feeding habits of three species of Carabid beetles and their variation in an apple orchard. Ann. Soc. Entomol. Fr. 9:69-87.

Dabrowska-Prot, E. and Luczak, J. 1972. Mosquito reduction by five spider species in conditions of competition of predator pairs. Wiad Parazytol. 18:779-781.

El-Halfawy, M. S., Nakhla, J. M. and Isa, N. H. 1972. Effect of food on fecundity, longevity and development of southern cowpea weevil, Callosobruchus maculatus F. 1972. Agric. Res. Rev. 50:67-70.

El-Kifl, A. H. 1971. Biological and Ecological studies on Bruchidius incarnatus Boh. Coleoptera: Bruchidae. Soc. Entomol. Egypte Bull. 55:141-162.

Emden, H. F. van 1972. Host plants in population dynamics of insects. Roy. Entomol. Soc. London Sump. 6:181-199.

Escalante, G. J. A. 1972. Biological data on Hippodamia convergens Guerin in areas of Cusco. Rev. Peruana Entomol. Agr. 15:237-239.

Farrell, J. A. K. 1973. Effects of initial body weight and feeding on fecundity and longevity of adult Costelytra zealandica. N.Z.J. Sci. 16:53-57.

Filipeck, P. 1971. Biology and ecology of Tribolium confusum Duv. and Tribolium castaneum Hbst. Poznan Inst. Ochrony Roslin Prace Nauk. 13:25-66.

Franek, M. 1973. Effect of some environmental factors on changes of temperature and habitat conditions inside rearing containers in laboratory cultures of granary weevil, Sitophilus granarius L. Pol. Pismo. Entomol. 43:189-200.

Freitag, R. 1973. Kraft mill fallout and ground beetle populations. Atmos Environ. 7:587-588.

French, J. R. J. and Roeper, R. A. 1972. Interactions of ambrosia beetle, Xyleborus dispar, with its symbiotic fungus Ambrosiella hartigii. Can. Entomol. 104:1635-1641.

Galewski, K. 1973. Stadial differentiation in larvae of Dytiscidae Pol. Pismo Entomol. 43:15-25.

Gerber, G. H. 1973. Courtship and copulation in Lytta nuttalli. Can. Entomol. 105:719-724.

_____ 1973. Reproductive behaviour and physiology of Tenebrio molitor. I. Initiation of mating in young adults and effects of adult density. Can. Entomol. 105:807-811.

Ginzburg, L. R. 1973. A mathematical model of an interaction of two populations. III. On compatibility of populations. Zh. Obshch. Biol. 34:464-469.

Graham, K. 1972. Entomological, ecological and evolutionary implications of photodynamic action. Can. J. Zool. 50:1631-1636.

Gressitt, J. L. and Davis, C. J. 1972. Seasonal occurrence of Hawaiian Cerambycidae. Hawaii Entomol. Soc. Proc. 21:213-221.

Grimble, D. G., Knight, F. B. and Nord, J. C. 1971. Associated insects reared from galls of Saperda inornata on trembling aspen in Michigan. Great Lakes Entomol. 4:53-57.

Gromova, A. A. 1973. Activity of feeding of Leptinotarsa decemlineata after hibernation at different levels of its population density. Zool. Zh. 52:613-614.

Grum, L. Egg production of some Carabidae species. Acad Polon Sci. Bull. Ser. Sci. Biol. 21:261-268,

Hagstrum, D. W. and Leach, C. E. 1973. Role of constant and fluctuating temperatures in determining development time and fecundity of three species of stored-products Coleoptera. Entomol. Soc. Amer. Ann. 66:407-410.

Hagvar, E. B. 1972. Changes in coleopterous fauna associated with maturational stages of fungus Geccinum testaceoscabrum. Norsk Entomol. Tidsskr. 19:39-42.

Hawke, S. D. 1973. Ecology and behavior of desert burrowing cockroach, Avenivaga sp. Oecologia 11:263-279.

Huffaker, C. B. and Laing, J. E. 1972. "Competitive displacement" without a shortage of resources? Res. Population Ecol. 14:1-17.

Hukusima, S. and Komada, N. 1971. Biononics of Propylaca japonica Thunberg. Gifu Univ. Fac. Agr. Res. Bull. 31:137-145.

Hurpin, B. 1973. Laboratory investigations of fecundity factors in Oryctes monoceros Ol. and Oryctes rhinoceros L. Ann. Soc. Entomol. Fr. 9:89-117.

Iperti, G., Brun, J. and Daumal, J. 1972. Possible rearing of coccidiphagous and aphidiphagous cocineliids preying on alternative food: Eggs of anagasta kuhniella Z. Ann. Zool. Ecol. Anim. 4:555-567.

Ivashchenko, I. I. 1972. On presence of sex attractants in some species of Scarabaeidae. Nauch Doki Vyssh. Shk., Biol. Nauk. 9:23-26.

Jolivet, P. 1973. Know host plants of timarcha Latreille: some considerations on possible reasons of selective trophism. Soc. Entomol. France Bull. 78:9-25.

Jourdheuil, P. 1971. Remarks on the biology of the Cantharidae. In International Congress of Entomology, 13th, Moscow, 1968. Trudy 2:152.

Karnavar, G. K. 1973. Prolonged starvation on survival and fecundity in Trogoderma granarium. Curr. Sci. 42:609-610.

Kirkpatrick, R. L. and Tilton, E. W. 1973. Elevated temperatures to control insect infestations in wheat. J. Ga. Entomol. Soc. 8:264-8.

Klein, M. G., Ladd, T. L. and Lawrence, K. O. 1972. Influence of height of exposure of virgin female Japanese beetles on captures of males. Environ. Entomol. 1:600-601.

Klekowski, R. A., Prus, T. and Zyromska-Rudzka, H. 1967. Elements of energy budget of Tribolium castaneum (Hbst.) in its developmental cycle. In Petrusewicz, K., (Ed.) Secondary Productivity of Terrestrial Ecosystems. Warsaw.

Larochelle, A. 1972. Observations on mating periods of some ground beetles. Entomol. Soc. Wash. Proc. 74:274.

_____ 1973. Notes on periods of egg production of some ground beetles. Entomol. News 84:139-140.

Latheef, M. A. 1973. A sampling plan for studies on population dynamics of Leptinotrase decemlineata on tomato, Entomol. Entomol. Exp. Appl. 16:365-372.

Lowrie, R. C. 1973. Displacement of Aedes polynesiensis Marks by Aedes albopictus Skuse through competition in larval stage under laboratory conditions. J. Med. Entomol. 10:131-136.

_____ 1973. Effect of competition between larvae of Aedes albopictus Marks. J. Med. Entomol. 10:23-30.

Luff, M. L. and Davies, L. 1972. Ecological observations on some Carabidae. Entomol. Mon. Mag. 108:46-51.

Lum, P. T. M. and Brady, U. E. 1973. Levels of pheromeone in female Plodia interpunctella mating with males reared in different light regimens. Ann. Entomol. Soc. Amer. 66:821-3.

Lum, P. T. M., Flaherty, B. R. and Phillips, R. H. 1973. Fecundity and egg viability of stressed female Indian meal moths, Plodia interpunctella. J. Ga. Entomol. Soc. 8:245-8.

McCambridge, W. F. and Knight, F. B. 1972. Factors affecting spruce beetles during a small outbreak. Ecology 53:830-839.

Malyk, M. R. and Robinson, A. G. 1971. A study of voracity, fecundity and developmental rates of some common lady beetle predators of aphids on cereal crops in Manitoba. Manitoba Entomol. 5:89-95.

Mertz, D. B. 1972. Tribolium model and mathematics of population growth. Annu. Rev. Ecol. Syst. 3:51-78.

Mertz, D. B. and Cawthon, D. A. 1973. Sex differences in the cannibalistic roles of adult flour beetles. Ecology 54:400-1402.

Mordkovich, V. G. 1971. Faunistic and ecological elements amoung population of Tenebrionidae in chestnut soils in different regions of mountains of southern Siberia. In International Congress of Entomology, 13th, Moscow, 1968. Trudy 1:180-181.

Mullen, M. A. 1973. Low frequency sound affecting the development of the Indian meal moth. J. Ga. Entomol. Soc. 8:320-1.

Nair, K. S. S., and Desai, A. K. 1972. Some new findings on factors inducing diapause in Trogoderma granarium Everts. J. Stored Prod. Res. 8:27-54.

Nayar, J. K. and Sauerman, D. M. 1973. A comparative study of growth and development in Florida mosquitoes. 4. Effects of temporary crowding during larval stages on female flight activity patterns. J. Med. Entomol. 10:37-42.

Ntifo, S. E. A. 1973. Developmental period and mortality of Gnathocerus maxillosus under various conditions of temperature and humidity. J. Stored Prod. Res. 9:51-59.

Osborne, D. J. 1972. Mutual regulation of growth and development in plants and insects. Roy. Entomol. Soc. London Symp. 6:33-42.

Paarmann, W. 1973. Importance of larval stages for reproduction periodicity of ground beetles Broscus laevigatus Dej. and Orthomus atlanticus Fairm. Oecologia 13:81-92.

Park, T., Mertz, D. B., Grodzinski, W. and Prus, T. 1965. Cannibalistic predation in populations of flour beetles. Physiol. Zool. 38:289-321.

Petrusewicz, K., Prus, T. and Rudzka, H. 1963. Density and size of medium in populations of Tribolium. Ekol. Polska 11:603-608.

Pierre, J. G. 1973. Behavior of four species of insects in rapeseed stocks. Inform. Tech. Cetiom. 30:38-45.

Press, J. W. and Flaherty, B. R. 1973. Hatchability of Plodia interpunctella eggs exposed to a carbon dioxide atmosphere: Relationship of egg age to exposure time. J. Ga. Entomol. Soc. 8:210-3.

Price, P. W. 1073. Parasitoid strategies and community organization. Environ. Entomol. 2:623-626.

Prus, T. 1961. The effect of homotypic and heterotypic conditioning of medium upon the net fecundity of Tribolium castaneum Herbst. and T. confusum Duval. Ekol. Polska 9:245-257.

_____ 1963. Search for methods to investigate mobility in Tribolium Ecology 44:801-803.

_____ 1966. Emigrational ability and surface numbers of adult beetles in 12 strains of Tribolium confusum Duval and T. castaneum Herst. Ekol. Polska 14:547-588.

_____ 1968. Some regulatory mechanisms inpopulations of Tribolium confusum Duval and T. castaneum Herbst. Ekol. Polska. 16:336-374.

Prus, T. B. and Park, T. 1973. The relation of yeast and flour to the cannibalism of eggs by Tribolium larvae. Ekol. Polska 21:163-171.

Rahalkar, G. W., Tamhankar, A. G. and Adeesan, C. 1972. Influence of prior exposure of male khapra beetle to female sex pheromone on their mating ability. Experientia 28:1123-1124.

Raske, A. G. 1973. Notes on biology of Tetropium parvulum in Alberta. Can. Entomol. 105:757-760.

Rothschild, M. 1972. Secondary plant substances and warning colouration in insects. Roy. Entomol. Soc. London Symp. 6:59-83.

Roussy, L. 1973. Precarious situation of entomological fauna in our rural areas. Gaz. Apic. 74:99-100.

Sandner, H. 1971. Achievements of Polish entomology in field of ecology. Pol. Pismo. Entomol. 41:747-761.

Schmitz, R. F. 1972. Behavior of Ips pini during mating, oviposition, and larval development. Can. Entomol. 104:1723-1728.

Schuler, W. 1973. Situation dependent differences and Batesian mimicry. Naturwissenschaften 60:205.

Sinha, R. N. 1973. Population dynamics of stored-product mites. Oecologia 12:315-327.

Smith, B. C., Starratt, A.N. and Bodnaryk, R. P. Entomol. Soc. Amer. Ann. 66:452-456.

Stanic, V., Shuloy, A., Ikan, R., Green, N., Warthen, D., and Jacobson, M. 1973. Olfactory responses of Khapra beetle toward synthetic alkanol and alkenol acetates. J. Econ. Entomol. 66:261-262.

Takahashi, F. 1972. Stage structure in population of Tribolium confusum duval with reference to its equilibrium density. Kontyu 40:194-202.

Taylor, C. E. and Sokal, R. R. 1973. Some new experiments on competition between housefly strains. Egypt J. Genet. Cytol. 2: 102-120.

Toop, W. 1972. Colonization of a city park by Coleoptera. Pedobiologia 12:336-346.

Tyschchenko, V. P. 1972. Resemblance of basic mechanism of photoperiodic reactions in insects and plants. In Problemy Fotoperiodizma i Diapauzy Nasekomykh P. 112-137.

Urbani, E. 1972. A survey of morphological, cytochemical and biochemical studies on oogenesis of Dytiscidae and other Coleoptera. Riv. Biol. 65:299-320.

Urs, K. C. D. 1973. Effect of moisture on growth rate and development of two strains of Tenebrio molitor L. J. Stored Prod. Res. 8: 291-297.

Ushatinskaya, R. S. 1972. Daily, seasonal and perennial cycles in insect development and their ecological and physiological causes. J. Interdisciplinary Cycle-Res. 3:193-195.

Vick, K. W. 1973. Effects of interspecific matings of Trogoderma glabrum and Trogodermia inclusum on oviposition and remating. Entomol. Soc. Amer. Ann. 66:237-239.

Wasserman, M. 1970. Egg-to-adult survival: an invalid measurement for determining preadult viability. Am. Nat. 104:404-407.

Weires, R. W., Radcliffe, E. B., Barnes, D. K., and Stucker, R. E. 1972. Interactions of insect populations on five alfalfa varieties. Entomol. Soc. Amer. N. Cent. Br. Proc. 27:138-140.

Wightman, J. A. 1973. Effect of environment on Costelytra zealandica. 2. Effect of temperature and soil moisture on duration and survival of egg stage. N. Z. J. Sci. 16:41-52.

Winlarska, W. 1973. On biology of Lema cyanella L., Pol. Pismo Entomol. 43:373-382.

Wool, D. 1973. Size, productivity, age and competition in Tribolium populations subjected to long-term serial transfer. J. Anim. Ecol. 42:183-200.

Yeo, P. F. 1972. Floral allurements for pollinating insects. Roy. Entomol. Soc. London Symp. 6:51-57.

Yoshida, T. 1970. Seasonal abundance of Indian meal moth, Plodia interpunctella. J. Food Hyg. Soc. Japan 11: Suppl. 33-39.

Zuberi, R. I., Effendi, G. H., and Ashrafi, S. H. 1972. A study of aerobic bacteria and fungi associated with Blattella germanica, Tribolium confusum, and Poekilocerus pictus. Pakistan J. Sci. Indus Res. 15:64-66.

GENERAL

Anonymous, 1973. Laboratory colonies of insects, mites and ticks in Canada, Bull. Entomol. Soc. Can. 5:1-15.

Brower, John H. 1973. Reproduction and development of twelve species of stored-product insects on kenaf seed. Florida Entomol. 56: 49-51.

Wilcox, J. A. 1972. Entomology projects for elementary and secondary schools. N. Y. State Mus. Sci. Serv. Bull. 422:44p.

GENETICS AND PHENOTYPIC VARIATION

Ahmad, M. K. 1972. Notes on variation of elytral pattern in Adonia variegata Goeze. Pak J. Zool. 4:225-228.

Anonymous, 1973. Abstracts of papers presented at XIII International Congress of Genetics, University of California, Berkeley, U.S.A. August 20-29, Genetics 744:313P.

_____, 1973. Gynandromorphism in Aedes triseriaturs. J. Med. Entomol. 10:52.

Alekseyev, A. N. 1971. Immunity in insects. Entomol. Fev. 50:420-426.

Bains, S. S., Kaur, B. and Atwal, S. 1971. Relative varietal resistance in some new wheats to attack of Trogoderma granarium everts. Bull. Grain.Technol. 9:197-202.

Barker, J. S. F. 1973. Natural selection for coexistence or competitive ability in laboratory populations of Drosophila. Egypt J. Genet. Cytol. 2:288-315.

Barr, A. R. and Narang, S. L. 1972. Inheritance of enlarged tergum in Culex pipiens. J. Med. Entomol. 9:560-563.

Bell, A. E. 1973. Simultaneous selection for two correlated traits in Tribolium. Genet. Res. 21:29-46.

_____, 1972. More on reciprocal recurrent selection. Proc. 21st ational Breeders Roundtable 18-51.

_____, 1972. Divergent two-trait selection in Tribolium. Natl. Breeders Roundtable Proc. 21Th:106-135.

_____, 1973. Simultaneous selection for two correlated traits in Tribolium. Genet. Res. 21:29046.

Bell, A. E. and M. J. Burris. 1973. Simultaneous selection for two correlated traits in Tribolium. Genetical Research 21:29-46.

Bell, A. E. and J. J. Colaianne. 1973. Natural selection in Tribolium populations under severe intraspecific competition. Proc. XIII Inter. Congress Genetics, P. 19.

Bell, A. E. and Moore, C. H. 1972. Reciprocal recurrent selection for pupal weight in Tribolium in comparison with conventional methods. Egypt. J. Genet. Cytol. 1:92-119.

Biemont, J. C. 1973. Different responses of fertility of Acanthoscelides obtectus from two brother-sister and father-daughter consanguine crossings. C. R. Hebd Seances Acad. Sci., Ser. D. Sci. Nat. 276:2593-2595.

Boles, H. P., Ernst, R. L., and Bolte, L. C. 1972. Resistance of hard winter wheats to attack by rice weevil, Sitophilus oryzae. Entomol. Soc. Amer. N. Cent. Br. Proc. 27:111-114.

Brower, John H. 1973. Melanic Plodia interpunctella: A useful tool for the sterile-male technique. Environ. Entomol. 2:1128.

Carbonell, E. and Fuentes, M. C. 1973. Correlaciones geneticas de la puesta de Tribolium castaneum en diversos medios ambientes. Anales Inst. Nac. Invest. Agra. Serie General No. 2:73-82.

Chakraborty, D. P. and Mathew, G. 1972. Effect of host plant nutrition on susceptibility of seeds of several exotic wheat varieties to Sitophilus oryzae. Bull. Grain Technol. 10:116-119.

Clark, A. M. 1973. Patterns of genetic mosaicism in antennae and legs of Habrobracon juglandis. Develop. Biol. 32:432-445.

Clarke, C. A., Sheppard, P., and Smith, A. G. 1973. Genetics of fore and hindwing colour in crosses between Danaus chrysippus from Australia and from Sierra Leone. Lepidopterists Soc. J. 27:73-77.

Coffelt, J. A. 1973. A black mutation of Lasioderma serricorne. J. Stored Prod. Res. 9:65-70.

Colainne, J. J. 1972. Natural selection through intense intraspecific competition in laboratory populations of Tribolium castaneum. Ph.D. Thesis, Purdue University Library.

Crystal, M. M. 1973. Chemosterilization of screwworm flies: modification of action by temperature. Environ Entomol. 2:145-147.

Cuthbert, F. P. and Jones, A. 1972. Resistance in sweetpotatoes to Coleoptera increased by recurrent selection. J. Econ. Entomol. 65:1655-1658.

Dawson, P. S. 1971. The blob mutant of Tribolium castaneum. Can. J. Genet. Cytol. 13:801-810.

_____ 1972. Sex and crossing over in linkage group IV of Tribolium castaneum. Genetics 72:525-530.

_____ 1973. Linkage group IV of Tribolium castaneum. Cytol. 14:675-680.

_____ 1973. Life history strategy and developmental time in flour beetles. Genetics 74:s59.

Dewees, A. A. 1973. Modification of recombination frequency in Tribolium castaneum. Genetics 74:s62-s63.

Dyte, C. E. 1972. Resistance to synthetic juvenile hormones in a strain of flour beetle, Tribolium castaneum Nature, Lond. 238:48-49.

Enfield, F. D. 1972. Patterns of response to 70 generations of selection for pupa weight in Tribolium. Natl Breeders Round-table Proc. 21th:52-70.

_____ 1973. Long term response to selection in Tribolium: gene action and gene numbers Proc. XIII Int. Gen. Congress,s72.

_____ 1974. Recurrent selection and response plateaus. Proc. 1st World Congress on Genetics Applied to Livestock Production.

Frey, J. J. 1972. A statistical investigation of genetic effects in single and three-way cross Tribolium hybrids. Ph.D. Thesis, Purdue University Library.

Friars, G. W. 1973. Realized genetic parameters following selection in Tribolium castaneum in to environments. Ann. Genet. Sel. Anim. 5:135-142.

Goodwill, R. and Enfield, F. D. 1971. Heterozygosity in inbred lines of Tribolium castaneum. Theor. and App. Genetics 41:5-12.

Gordon, H. T. and Gordon, B. R. 1971. Milkweed bug mutants on sun-flower seed: viability and eye-color interactions. J. Hered. 62:315-316.

Goszczynska, K. 1972. Genetic analysis of DDT resistance in housefly, Musca domestica L. Warsaw Panstw Zakl Hig Rocz 23: 301-309.

Gray, T. H. and Dyer, E. D. A. 1972. Flight-muscle degeneration in spruce beetles, Dendroctonus rufipennis. Entomol. Soc. Brit. Columbia J. 69:41-43.

Hamalainen, M. and Clayhills, T. 1972. An interesting colour form of Coccinella septempunctata L. Suom. Hyonteistieteellinen Aikak Ann. Entomol. Fenn. 38:158-159.

Hamalainen, M. and Markkula, M. 1972. Possibility of producing Coccinella septempunctata L. without a diapause. Suom. Hyonteistieteellinen Aikak Ann. Entomol. Fenn. 38:193-194.

Hillman, R. 1973. Effects of inhibition of protein synthesis on phenotype of Abnormal-abdomen. Genet. Res. 21:229-238.

Hinton, H. E. 1973. Physiological clour change in elytra of hercules beetle, Dynastes hercules. J. Insect Physiol. 19:533-549.

Iqbal, M. P. 1973. Linkage groups and recombination in malaria mosquito. J. Hered 64:133-136.

Jenkins, J. N., McCarty, J. C., Parrott, W. L., Lindig, O. H. and McLaughlin, R. E. 1972. Genetic characteristics of an ebony, pearl strain of boll weevil. J. Econ. Entomol. 65:1621-1623.

Jost, E. 1972. Function of sperm in incompatible crosses of mosquito Culex pipiens L. Experientia 28:1374-1375.

Kashiwagi, M. and Utida, S. 1972. A new mutant in Callosobruchus chinensis. Appl. Ent. Zool. 7:95-96.

Katakura, H. 1973. New information on distribution and geographic polymorphism of two Epilachna beetles, Epilachna vigintioctomaculata and Epilachna pustulosa, in Hokkaido. Konchu 41:234-23.

Kence, A. 1973. Effects of variation in larval development. Ph.D. dissertation, State University of New York at Stony Brook. 184 pp.

King, C. E. and Dawson, P. S. 1973. Habitat selection by flour beetles in complex environments. Physiol. Zool. 46:297-309.

Krause, E. and A. E. Bell. 1972. A genetic study of biomass in Tribolium. I. Path coefficient analysis of base populations. Canad. J. Genet. Cytol. 14:181-193.

Kress, D. D. and Enfield, F. D. 1971. Correlated response in male and female sterility to selection for pupa weight in Tribolium. Theor. and App. Genetics 41:197-202.

Kreutzer, R. D. and Kitzmiller, J. B. 1972. Hybridization between two species of mosquitoes: Anopheles punctipennis Say. and Anopheles Ludlow. J. Hered 63:191-196.

Lanier, G. N., Birch, M. C., Schmitz, R. F., and Furniss, M. M. 1972. Pheromones of Ips pini: variation in response among three populations. Can. Entomol. 104:1917-1923.

Larochelle, A. 1972. Wing-dimorphism in Pterostichus patruelis Dejean and Pterostichus femoralis Kirby. Entomol. Soc. Wash. Proc. 74:329.

Lees, D. R. 1973. Atmospheric pollution and industrial melanism. Heredity 30:227-232.

Lesniak, A. 1972. Use of objective colorimetry in ecological and genetic studies on luminosity of colouring of insects. Ekol. Pol. Ser. B. 18:41-43.

Lima-de-faria, A. 1973. Amplification of ribosomal DNA in Acheta. III. release of DNA copies from chromomeres. Hereditas 73:163-183.

Lorimer, N., Hallinan, E. and Rai, K. S. 1972. Translocation homozygotes in yellow fever mosquito, Aedes aegypti. J. Hered. 63:159-166.

Meyer, H. H. and Enfield, F. D. 1973. Selection intensity effects on realized heritability. Proc. XIII Int. Gen. Congress, s181.

Miyazaki, T. 1972. A hybrid dragonfly bred from egg laid by Sympetrum pedemontanum elatum Selys. Tombo 15:26-27.

Nishio, Y. 1972. Abdomen shape of Cicindela japana Motschulsky. Kontyu 40:284-289.

Nord, J. C., and Knight, F. B. 1971. Geographic variation of Saperda inornata Say. in eastern North America. Great Lakes Entomol. 4:39-52.

Novozhenov, IU I and Korobitsyn, N. M. 1972. Aberrant variation in natural insect populations. Zhur. Obshch Biol. 33:315-324.

Nowosielski-Slepowron, B. J. A. and Strevens, D. E. A. 1973. Mortality of four species of Tribolium and of Gnathocerus macillosus (F) after freezing. analyzed by weighted regression lines. Physiol. Zool. 46:85-93.

O'donald, P. 1973. Evolution of dominance in polymorphic batesian mimicry. Theor. Popul. Biol. 4:173-192.

Orozco, F. 1972. Influence of fitness deterioration on selection limits. Ann. Genet. Sel. Anim. 4:569-592.

Orozco, F., Campo, J. L. and Ruano, R. G. 1973. Influencia de diversos factores en la puesta del Tribolium castaneum. VII. Influencia de pequenas variaciones de valoracion. Anales Inst. Nac. Invest. Agrarias. Serie General No. 2:53-71.

Orozco, F., Campo, J. L. and Tagarro, P. 1973. Influencia de diversos factores en la puesta del Tribolium castaneum. VI. Puesta en funcion de la edad durante el primer mes. Anales Inst. Nac. Invest. Agra. Serie General No. 2:37-52.

Pero, R. 1973. Amplification of ribosomal DNA in Acheta. IV. number of cistrons for 28S and 18S ribosomal RNA. Hereditas 73:195-210.

Rana, B. S., and Murty, B. R. 1971. Genetic analysis of resistance to stem borer in sorghum. Indian J. Genet. Plant Breeding 31: 521-529.

Randall, W. K. 1971. Willow clones differ in susceptibility to cottonwood leaf beetle. Southern Conf. Forest Tree Impr. Proc. 11 Th: 108-111.

Reiser, P. L. 1972. Comparative research on Carabus menetriesi Humm. Nachrichtenbl. Bayer Entomol. 21:58-61.

Ross, M. H. 1973. Genetic variability in German cockroach. IX. Genetics of narrow abdomen and Elo black-body. J. Hered 64:143-146.

_____ 1973. Additional data for linkage group X of the German cockroach. J. Hered. 64:44-45.

_____ 1973. Notch-pronotum, shriveled-wing and cubitus interruptus mutants of German cockroach.

Ross, M. H. and Cochran, D. G. 1973. German cockroach genetics and its possible use in control measures. Patna J. Med. 47:325-337.

Sakai, R. K., Baker, R. H., and Iqbal, M. P. 1972. Genetics of ebony a nonlethal recessive melanotic mutant in a mosquito. J. Hered. 63:275-279.

Scudder, G. G. E. 1972. Industrial melanism: a possibility in British Columbia. Entomol. Soc. Brit. Columbia J. 69:46-48.

Sharova, I. K. H. and Sedov, A. M. 1972. Geographical variability of Pterostichus melanarius. Zool. Zh. 51:1411-1412.

Singh, V., Mathur, B. N. and Sharma, S. K. 1972. A note on relative susceptibility of some barley varieties to Trogoderma granarium Everts. Madras Agr. J. 59:42-43.

Singh, J. and Talluri, B. R. 1972. Studies on relative resistance of some varieties of pea to Callosobruchus chinensis (L.). Bull. Grain Technol. 10:37-40.

Sokal, R. R. and Fujii, K. 1972. Effects of genetic background on ecology of selection in Tribolium populations. Evolution 26: 489-512.

Soliman, M. H. 1972. Correlated response to natural selection in laboratory populations of Tribolium castaneum. Can. J. Genet. Cytol. 14:971-978.

_____ 1973. 'geographic' variation in sensitivity of X-irradiation in Tribolium. I. Differences in adult emergence due to species, strain, and age at pupation. Radiat. Res. 54:510-520.

_____ 1973. 'Geographic' variation in sensitivity to X-irradiation in Tribolium II. Incidence of developmental abnormalities. Radiat. Res. 54:521-530.

Stam, P. 1972. Effect of initial linkage disequilibrium and natural selection in pooled populations Experiments with Tribolium and simulation. Wageningen Landbouwhogesch Mededel 24, 62P.

Stein, W. 1973. Inheritance of wing dimorphism in Apion virens. Angew Entomol. 74:62-63.

Stepshin, V. P. 1973. Antennopedix: a new homoeotic mutation in Drosophila melanogaster. Sov. Genet. 6:12-1218.

Steyskal, G. C. 1972. Meaning of term "sibling species". Syst. Zool. 21:446.

Suomalainen, E. 1973. Genetic polymorphism and evolution in parthenogenetic animals. I. Polyploid Curculionidae. Genetics 74:489-508.

Sved, J. A. 1972. Heterosis at level of chromosome and at level of gene. Theor. Popul. Biol. 3:491-506.

Sverdlov, E. and Wool, D. 1973. An effect of inbreeding on adult survival under starvation in T. castaneum. Tribolium Inform. Bull. 16:97-99.

Taimr, L. 1973. Sterile-male technique and its role in integrated insect control. Biol. Ser. B. Zool. 28:147-155.

Thompson, V. 1973. Spittlebug polymorphic for worning coloration. Nature 242:126-128.

Urs, K. C. D. 1973. Effect of moisture on growth rate and development of two strains of Tenebrio molitor L. J. Stored Prod. Res. 8: 291-297.

Utida, S. 1972. Density dependent polymorphism in the adult of Callsobruchus maculatus. J. Stored Prod. Res. 8:111-126.

Van Duyn, J. W., Turnipseed, S. G. and Maxwell, J. D. 1972. Resistance to soybeans to Mexican bean beetle: iI. Reactions of beetle to resistant plants. Crop Sci. 12:561-562.

Vogt, H. 1972. Remarkable striation-mutation of an Olibvus. Entomol. Bl. 68:164-166.

Wagoner, D. E. 1973. Genetic manipulation used against a field population of house flies. 1. Males bearing a heterozygous translocation. Environ Entomol. 2:128-134.

Von Brostel, R. C., Smith, R. H., Whiting, A. R. and Grosch, D. S. 1971. Mutational and physiologic responses of Habrobracon in biosatellite. II. In U.S. National Aeronautics and Space Adm., Sci. and Tech. Inf. Off. the Experiments of Biosatellite II. P. 17-39.

Winkler, S. 1973. Resistance phenomena of Melolontha melolontha? Entomol. Z. 83:13-15.

Wool, D. 1973. Quantitative evaluation of temporal similarity in abundance of animal species. Res. Popul. Ecol. 15:90-98.

Wool, D. and Levi, O. 1973. The length of embyonic development in the eu mutant of T. castaneum. Tribolium Inform. Bull. 16:105-108.

Wool, D. and Mendlinger, S. 1973. The eu mutant of the flour beetle, Tribolium castaneum. Environmental and genetic effect on penetrance. Genetica. Vol. 44:496-504.

Yadava, R. P. S., Rattray, J. B. M. and Musgrave, A. J. 1972. Fatty acid profiles of two microbiologically different strains of granary weevil; Sitophilus granarius L. Compar. Biochem. Physiol. 43:383-391.

Yamada, Yukio. 1973. Fifty percent time to pupation as a measure of developmental time in Tribolium. Canad. J. Genet. Cytol. 15:223-226.

_____ 1973. Fifty per cent time to pupation as a measure of developmental time in Tribolium. Can. J. Genet. Cytol. 15: 223-226.

Zaslavskii, V. A. 1973. Geographic races of Chilocorus bipustulatus. 2. Commonness of mechanism of photoperiodic control of development in different geographic populations. Zool. Zh. 52:64-68.

INSECT TISSUE CULTURE AND EMBRYOLOGY

Anderson, D. T. 1972. Development of heminetabolous insects. In Counce, S. J. ed. Developmental Systems: Insects 1:95-163.

_____ 1972. Development of holometabolous insects. In Counce, S. J. ed. Developmental Systems: Insects 1:165-242.

Beck, S. D. 1972. Growth and retrogression in larvae of Trogoderma glabrum. 3. Ecdysis and form determination. Entomol. Soc. Amer. Ann. 65:1319-1324.

Cleret, J. J. 1971. Quantitative study and genetic comparisons of development of eye in Jaera nalbifrons forsmani Bocuuet. Soc. Linn Normandie Bull. 102:114-147.

Cloarec, A. 1971. Formation of the compound eye of Ranatra linearis L. during larval development. Soc. Sci. Bretagne Bull. 46:215-223.

Counce, S. J. 1973. Causal analysis of insect embryogenesis. In Counce, S. J., ed. Developmental Systems: Insects 2:1-156.

Daniels, N. E. and Chedester, L. D. 1972. Developmental studies of convergent lady beetle. Agricultural Experiment Station Tex. Agric. Exp. Stn. Prog. Rep. 3109, 3 P.

Demal, J. and Leloup, A. M. 1972. Organ culture of insects. Invertebr. Tissue Cult. 2:3-39.

Doane, W. W. 1973. Role of hormones in insect development. In Counce, S. J., ed. Developmental Systems: Insects 2:291-479.

Hedin, P. A., Miles, L. R., Thompson, A. C. and Gueldner, R. C. 1972. Constituents of boll weevil. V. Factors inhibiting larval development. J. Econ. Entomol. 65:1231-1235.

Ivanova-Kasas, O. M. 1972. Polyembryony in insects. In Counce, S. J. ed. Developmental Systems: Insects 1:243-271.

Jura, C. 1972. Development of apterygote insects. In Counce, S. J., ed. Developmental Systems: Insects 1:49-94.

Kuthe, H. W. 1973. Protein incorporation pattern in early organogenesis of Dermestes frischi. Wilhelm Roux' Arch Entwicklungsmech Organismen 172:58-65.

Lawrence, P. A. 1973. Development of spatial patterns in integument of insects. In Counce, S. J., ed. Developmental Systems: Insects 2:157-209.

Lum, P. T. M. and Flaherty, B. R. 1973. Influence of continuous light on oocyte maturation in Bracon hebetor. Ann. Entomol. Soc. Amer. 66:355-357.

BIBLIOGRAPHY

Meyer, H. W. 1973. Differentiated orientation performance and spatial organization of insect eye. Fortschr Zool. 21:294-306.

Oberlander, H. 1972. Hormonal control of development of imaginal disks. Results Probl. Cell Differ 5:155-172.

Press, J. W., Flaherty, B. R. and Arbogast, R. T. 1973. Oocyte maturation in Tribolium castaneum after repetitive sublethal carbon dioxide exposures. Ann. Entomol. Soc. Amer. 66:480-81.

Rempel, J. G. and Church, N. S. 1965. The embryology of Lytta viridana LeConte (Coleoptera: Meloidae) I. Maturation, fertilization and cleavage. Can. J. Zool. 43:915-925.

Schafer, R. 1973. Postembyronic development in antenna of cockroach, Leucophaea maderae: growth, regeneration, and development of adult pattern of sense organs. J. Exp. Zool. 183:353-363.

Stanley, M. S. M. and Grundmann, A. W. 1970. The embryonic development of Tribolium confusum. Ann. Ent. Soc. Amer. 63:1248-1256.

Takami, T. 1972. In vitro development of insect embryos. Invertebr. Tissue Cult 2:137-159.

Ushatinskaia, R. S. 1973. Sensitivity of Hyphantria cunea Drury to damaging physical and chemical influences at different stages of posterbryonic development. I. Sensitivity to high temperatures and potassium cyanide. Ontogenez 4:175-180.

Zakhvatin, Y. A. 1972. Nucleocytoplasmic ratio in early embryogenesis of insects. Sov. J. Develop. Biol. 2:488-492.

INSECTICIDES AND INSECTICIDE RESISTANCE

Aijaz, R. Baig, M. M. H., Khan, N. and Lord, K. A. 1971. Comparative effect of petkolin-M and ddt on rate of oxygen consumption of adult Tribolium castaneum H. Pakistan J. Sci. Indus. Res. 14: 228-231.

Ali, A., Khan, R. A. and Naqvi, S. N. H. 1972. Formulation of petkolin dust and its evaluation against stored grain pests. Sci. Indus. 9:57-61.

Anonymous, 1973. Insect control: strategies for future. Environ. Ser. Coop. Ext. Serv. Coll. Agric. Home Econ. Ohio State Un. Iv. Ohio Agric. Res. Dev. Cent. 4: 15 P.

_____, 1973. Safe use of pesticides, twentieth report of WHO Expert Committee on Insecticides. World Health Organ Tech. Rep. Ser. 513: 54 P.

Baker, J. E. 1973. Tribolium confusum: food additives as ovicides. J. Econ. Entomol. 66:765-767.

Baker, J. E. and Mabie, J. M. 1973. Tribolium confusum: Food additives as ovicides. J. Econ. Entomol. 66:765-7.

Bitran, E. A., Lazzarini, S. and Mendonca, P.P. de 1971. Phosphine effect on rice weevil in warehouses and silos. Biologico 37: 195-198.

Bond, E. J. 1973. Response of three insects to sublethal doses of phosphine. J. Stored Prod. Res. 8:307-313.

_____ 1973. Increased tolerance to ethylene dibromide in a field population of Tribolium castaneum. J. Stored Prod. Res. 9:61-63.

Bond, E. J. and Upitis, E. 1972. Persistence of tolerance to methyl bromide in Sitophilus granarius (L.) after cessation of selection. J. Stored Prod. Res. 8:221-222.

Borkovec, A. B., Woods, C. W. and McHaffey, D. G. 1972. Chemosterilants against boll weevil. I. Aziridines. J. Econ. Entomol. 65:1543-1547.

Bry, R. E., Boatwright, R. E., Lang, J. H. and Cail, R. S. 1973. Protesting woolen fabric against insect damage with resmethrin. Soap/Cosmetics/Chemical Specialties 49:40, 42, 44.

Bry, R. E., Lang, J. H. and Boatwright, R. E. 1973. Candidate repellents for mothproofing: Preliminary investigations with black carpet beetle larvae. J. Ga. Entomol. Soc. 8:306-9.

Bry, R. E., Lang, J. H. and Brown, S. A. 1973. Protection of woolen carpeting against black carpet beetle larvae damage: Investigation of six compounds. J. Econ. Entomol. 66:546-8.

Bry, R. E., Lang, J. H. and Cail, R. S. 1973. Influence of aging on Gardona residues when Gardona is applied to woolen cloth during drycleaning. J. Ga. Entomol. Soc. 8:75-9.

Cherry, E. T. 1973. Boll weevil population suppression with late-season insecticide applications. Tenn. Farm Home Sci. Prog. Rep. 86:11-13.

Cochran, D. G. 1973. Inheritance and linkage of pyrethrins resistance in German cockroach. J. Econ. Entomol. 66:27-30.

_____ 1973. Inheritance of malathion resistance in German cockroach. Entomol. Exp. Appl. 16:83-90.

Cogburn, R. R. 1973. Insect resistance of stored rice studied. Rice J. 76:72-73.

Cooper, C. V. and Gillenwater, H. B. 1972. Preliminary evaluation of six candidate fumigants against stored-product insects. Ga. Entomol. Soc. J. 7:250-253.

Dale, D. 1973. Insect antifeedants. Pesticides 7:16-17.

DeMilo, A. B., Borkovec, A. B. and McHaffrey, D. G. 1972. Chemosterilants against boll weevil. 2. s-triazines. J. Econ. Entomol 65:1548-1550.

Ebeling, W. 1973. Dust desiccants: effect of prolonged exposure of films on insecticidal efficacy. J. Econ. Entomol. 66:280-282.

Edwards, C. A. and Thompson, A. R. 1971. Control of wireworms with organophosphorus and carbamate insecticides. Pestic. Sci. 2:185-189.

Ellis, C. R. 1972. Susceptibility of two strains of Sitophilus granarius to 1, 2-debromoethane. 2. Strain difference in uptake and metabolism of radiolabeled fumigant. J. Econ. Entomol. 65:1573-1577.

_____ 1972. Susceptibility of two strains of Sitophilus granarius to 1, 2-dibromoethane. 3. Effect of total lipid on strain susceptibility. J. Econ. Entomol. 65:1579-1582.

Fuente, J. M. de la 1972. Residues of agricultural pesticides and their effect on environment. Rev. Peruana Entomol. Agr. 15:333-336.

Gartner, J. B and Turgeon, A. J. 1971. Major changes proposed in pesticide laws. Ill Turfgrass Conf. 12th:3-4.

Graham, K., Wrangler, E. and Aasen, L. H. 1972. Susceptibility of mealworm to photodynamic injury by methylene blue. Can. J. Zool. 50:1625-1629.

Grassl, R. F. 1973. Insecticidal baits tested for controlling Trogoderma variabile and Tribolium audax in nests of alfalfa leafcutting bees. Proc. Wash. State Entomol. Soc. 34:354-355.

Hanker, I. 1973. Penetration, excretion and metabolism of DDT-14C and effects of temperature in susceptible and resistant larvae of Leptinotarsa decemlineata Say. Acta. Entomol. Bohemoslav. 70:243-253.

Hanna, J. G. 1973. Pesticides inspection report, 1972. Conn. Agr. Exp. Sta. Bull. 734:. 14 P.

Harein, P. K. and Rao, H. R. G. 1972. Dichlorvos and Gardona as protectants for stored wheat Against agranary weevil infestations in laboratory studies. J. Econ. Entomol. 65:1402-1405.

Highland, H. A. and Merritt, P. H. 1973. Synthetic pyrethroids as package treatments to prevent insect penetration.

Highland, H. A. and Secreast, M. 1973. Barriers in synergized-pyrethrins-treated paper bags to prevent migration of piperonyl butoxide into cornmeal, flour, and CSM. Technical Bull. No. 1475 of Agricultural Research Service, US Dept. of Agriculture, 14P.

Highland, H. A., Secreast, M. and Byrd, R. V. 1973. Barrier coatings enhance insect resistance of multiwalls. Paper, Film and Foil Converter, Sept. 1 page, Anonymous. (Based on a manuscript entitled "Effect of insecticide barriers in stored, empty, insect-resistance kraft bags.").

Hill, E. G., Fishwick, F. B. and Thompson, R. H. 1973. Pesticide residues in foodstuffs in Great Britain: organochlorine residues in imported cereals, nuts, pulses and animal foodstuffs. Pestic. Sci. 4:33-39.

Hill, E. G. and Thompson, R. H. 1973. Pesticide residues in food-stuffs in Great Britain: a further report on the bromide contents of imported foods and feedingstuffs. Pestic. Sci. 4:41-49.

Howe, R. W. 1973. Susceptibility of immature and adult stages of Sitophilus granarius to phosphine. J. Stored Prod. Res. 8:241-262.

Ilic, B. 1973. Comparative study of hydrogen phosphide preparations used in grain fumigation. Anz. Schadlingskd Pflanzenschutz 46: 117-121.

Johnson, G. A. 1973. DDT-induced chromosomal damage in mice. J. Hered. 64:7-8.

Kalkan, M. 1973. Studies on effectiveness of phostoxin pellets against various stages of bean weevil, granary weevil and confused flour beetle. Bitki Korum Bul 13:49-54.

Katiyar, V. N. and Lemonde, A. 1972. Biological effects of some organophosphate and carbamate insecticides on confused flour beetle. J. Econ. Entomol. 65:939-942.

Kawahara, T. 1972. Absorption of chlorinated hydrocarbons by turnip planted in pot, and their translocation in plant. Tokyo Agr. Chem. Insp. Sta. Bull. 12:52-56.

LeCato, G. L. 1973. Mortality of red flour beetle adults fed insecticide-treated Indian meal moths. Environ. Entomol. 2: 726-727.

Lin, (Chi) 1972. Determination of rice weevil, resistance to insecticides and development of substitutive chemicals. Taiwan Agr. Quart 8:115-123.

Lloyd, C. J. 1973. Toxicity of pyrethrins and five synthetic pyrethroids, to Tribolium castaneum and susceptible and pyrethrin-resistant Sitophilus granarius (L.). J. Stored Prod. Res. 9: 77-92.

Lohren, U. 1972. Effect of different insecticides on corn mould beetle. Deut. Tierarztl Wochensch. 79:504-506.

McDonald, L. L. and Press, J. W. 1973. Toxicity of eight insecticides to Indian meal moth adults. J. Ga. Entomol. Soc. 8:200-202.

McFarlane, J. A. and Dobie, P. 1972. The susceptibility of t'ef to infestation by some pests of stored grain. J. Stored Prod. Res. 8:177-182.

McGauchey, W. H. 1972. Diatomaceous earth for confused flour beetle and rice weevil control in rough, brown and milled rice. J. Econ. Entomol. 65:1427-14.28.

Mel'nikov, N. N. 1973. Pesticides and environmental protection. Khim. Sel'skom. Khoz. 11:31-34.

Milward, A. F., Rudge, A. J. B. and Taylor, J. K. 1973. The use of pesticides in bakeries. Baking Inds. J. 4pp.

Miner, F. D. and Dumas, B. A. 1972. Insecticide tests for alfalfa weevil control. Arkansas Agricultural Experiment Station Ark. Farm Res. 21:2.

Minton, N. A. and Gillenwater, H. B. 1973. Methyl bromide fumigation of Pratylenchus brachyurus in peanut shells. J. Nematol. 5:147-9.

Monro, H. A. U., Upitis, E. and Bond, E. J. 1972. Resistance of a laboratory strain of Sitophilus granarius (L.) to phosphine. J. Stored Prod. Res. 8:199-207.

Mostafa, S. A. S. Kamel, A. H., El-Nahal, A. K. M. and El-Borollosy, F. M. 1972. Toxicity of carbon bisulphide and methyl bromide to eggs of four stored product insects. J. Stored Prod Res. 8:193-198.

Neubecker, F. 1973. Phostoxin for control of infestation in elevators, warehouses and flour mills. Tec. Molitoria 24:76-80.

Oldfield, J. F. T. 1972. General review of problems of pesticide residues. I I R B J (Int. Inst. Sugar Beet Res.) 6:15-18.

Omana, M. M. 1972. Effect of nutrition on susceptibility of Tribolium castaneum Herbst tot toxicity of different insecticides. Agric. Res. J. Kerala 10:32-37.

Pieterse, A. H., Schulten, G. G. M. and Kuyken, W. 1972. A study on insecticide resistance in Tribolium castaneum in Malawi. J. Stored Prod. Res. 8:183-191.

Pingale, S. V. 1972. Fumigation of wheat loaded in ships with different fumigants. Bull. Grain Technol. 10:267-270.

Pirani, F. 1973. Malathion for grain protection and its application in wheat. Molini Ital. 24:102-104.

Plasch, G. 1973. Study of pesticide residues in flour mill laboratory. Getreide Mehl. Brot. 27:15-18.

Quinlan, J. K. 1972. Malathion aerosols applied in conjunction with aeration to corn stored in a flat storage structure. Entomol. Soc. Amer. N. Cent. Br. Proc. 27:63-65.

_____ 1972. Malathion surface sprays for controlling insect populations in stored shelled corn. Entomol. Soc. Amer. N. Cent. Br. Proc. 27:65-67.

Rauscher, H. 1973. Physical and chemical aspects of use of hydrogen phosphide in fumigation of pests of stored products. Prakt Schadlingsbekampfer 25:25-29.

Sardar, M. A. 1972. Laboratory evaluation of malathion and vapona for control of red flour beetle, Tribolium castaneum, in wheat. Pakistan J. Sci. Indus. Res. 15:239.

Sarmiento, J. and Perez-Herazo, A. 1972. Aspersion of insecticides against internal infestation by Sitophilus oryzae L. in stored corn. Rev. Peruana Entomol. Agr. 15:344-347.

Sato, K. 1973. Studies on characteristics of action of fumigants. I. fifty percent knock down dose of hydrogen phosphide to adsuki bean weevil, Callosobruchus chinensis L., calculated from uptake amounts of oxygen by weevil. Botyu-kagaku 38:22-29.

Schesser, J. H. 1972. Boxcar research with dichlorvos aerosol. Entomol. Soc. Amer. N. Cent. Br. Proc. 27:56-57.

Sithanantham, S. Kuppuswamy, S. Swamippan, M. Anandakrishnan, K. B. and Subramaniam, T. R. 1972. Evaluation of "minifume" as a fumigant for storage pests. Madras Agr. J. 59:559-560.

Smith, D. C. 1973. Pesticide residues in total diet in Canada. III. 1971. Pestic. Sci. 4:211-214.

Sonnet, P. E. 1973. Synergism of synthetic mixed isomers of juvenile hormone. J. Econ. Entomol. 66:793-794.

Storey, C. L. 1972. Effects of air movement on biological effectiveness and persistence of malathion in stored wheat. Entomol. Soc. Amer. N. Cent. Br. Proc. 27:57-62.

Su, H. C. F., Speirs, R. D. and Mahany, P. G. 1972. Toxicity of citrus oils to several stored-product insects: laboratory evaluation. J. Econ. Entomol. 65:1438-1441.

Terry, P. H., Borkovec, A. B. and McHaffey, D. G. 1972. Chemosterilants against boll weevil. 3. Phosphorus amides. J. Econ. Entomol. 65:1550-1552.

Udeaan, A. S. and Bindra, O. S. 1971. Malathion residues in wheat grains in relation to dosages applied, storage period and receptacles used for storage. Bull. Grain Technol. 9:13-19.

Upitis, E. 1973. Some aspects of inheritance of tolerance to methyl bromide by Sitophilus granarius (L.) J. Stored Prod. Res. 9:13-17.

Vardell, H. H., Cagle A. and Cooper, E. 1973. Phosphine residues on soybeans fumigated with aluminum phosphide. J. Econ. Entomol. 66:800-1.

Vardell, H. H., Cagle, A., and Cooper, E. 1973. Fumigation with phosphine against stored-product insects in bagged flour in plywood overpacks. J. Econ. Entomol. 66:1209-10.

Vardell, H. H., Gillenwater, H. B. Eason, G. and Cagle, A. 1973. White-fringed beetles: Dichlorvos applied as a postharvest treatment to protect wheat. J. Econ. Entomol. 66:225-7.

Vardell, H. H. , Gillenwater, H. B., Whitten, M. E., Cagle, A., Eason, G. and Cail, R. S. 1973. Dichlorvos degradation on stored wheat and resulting milling fractions. J. Econ. Entomol. 66:761-3.

Venugopal, M. S. 1972. Studies on sterility inducing effects of two antibiotics and sulphanilamide on red flour beetle Tribolium castaneum F. Hindustan Antibiot Bull. 15:7-8.

Vincent, L. E., and Lindgren, D. L. 1972. Toxicity of phosphine to life stages of four species of dermestids. J. Econ. Entomol. 65:1429-1431.

Watanabe, T. 1972. Analytical method of several carbamate pesticide residues by oscillographic polarography. Tokyo Agr. Chem. Insp. Sta. Bull. 12:57-62.

Webster, J. A. 1972. Developing resistance to cereal leaf beetle: Morphological basis, problems and progress. Entomol. Soc. Amer. N. Cent. Br. Proc. 27:98-102.

Wilkin, D. R. 1973. Resistance to lindane in Acarus siro from an English cheese store. J. Stored Prod. Res. 9:101-104.

Wilkin, D. R. and Hope, J. A. 1973. Evaluation of pesticides against stored product mites. J. Stored Prod. Res. 8:323-327.

Wurster, C. F. 1973. DDT proved neither essential nor safe. Bioscience 23:105-106.

Zettler, J. L., McDonald, L. L., Redlinger, L. M. and Jones, R. D. 1973. Plodia interpunctella and Cadra cautella resistance in strains to malathion and synergized pyrethrins. J. Econ. Entomol. 66:1049-50.

IRRADIATION AND USE OF ISOTOPES

Bhatti, J. A. and Shipp, E. 1972. Mating competition of irradiated and normal males with normal females of Queensland fruit flay, Dacus tryoni. Nucleus 9:107-110.

Brower, J. H. 1973. Gamma radiation sensitivity of corn sap beetle, Carpophilus dimidiatus. Ga. Entomol. Soc. J 8:55-58.

_____ 1973. Gamma radiation sensitivity of malathion-resistant strains of the Indian meal moth. J. Econ. Entomol. 66:461-62.

_____ 1973. Radiation sensitivity of sucessively irradiated generations of Tribolium castaneum and Sitophilus oryzae (L.) J. Stored Prod. Res. 9:43-49.

_____ 1973. Comparative gamma radiation sensitivity of Tribolium madens and Tribolium castaneum. J. Stored Prod. Res. 9:93-100.

_____ 1973. Sensitivity of Tenebrio molitor and T. obscurus to gamma irradiation. J. Econ. Entomol. 66:1175-9.

_____ 1973. Low-dosage gamma radiation effects on the reproductive capacity of Callosobruchus maculatus. Ann. Ent. Soc. Amer. 66:117-9.

_____ 1973. Depressed flour beetle: Sensitivity to gamma irradiation. J. Econ. Entomol. 66:1318-20.

_____ 1973. Weight loss of wheat infested with gamma-radiated Sitophilus oryzae (L.) and Rhyzopertha dominica (F.). J. Stored Prod. Res. 9:37-41.

Brower, J. H., Hossain, M. M. and Tilton, E. W. 1973. Radiation sensitivity of successively irradiated generations of Tribolium castaneum and Sitophilus oryzae. J. Stored Prod. Res. 9:43-49.

Brower, J. H. and Mahany, P. G. 1973. Gamma radiation sensitivity of the cadelle, Tenebroides mauritanicus and the flat grain beetle, Cryptolestes pusillus. J. Ga. Entomol. Soc. 8:174-184.

Brower, J. H., Miller G. L. and Edenfield, J. E. 1973. Gamma radiation sensitivity of the corn sap beetle, Carpophilus dimidiatus. J. Ga. Entomol. Soc. 8:55-58.

Brower, J. H. and Scott, H. C. 1972. Gamma radiation sensitivity of spider beetle, Gibbium psylloides. Can. Entomol. 104:1551-1556.

Brower, J. H., and Tilton, E. W. 1972. Gamma-radiation effects on Trogoderma inclusum and Trogoderma variabile. J. Econ. Entomol. 65:250-254.

Brower, J. H. and Tilton, E. W. 1972. Comparative gamma radiation sensitivity of sawtoothed grain beetle and merchant grain beetle. Environ. Entomol. 1:735-738.

Brower, J. H. and Tilton, E. W. 1973. Weight loss of wheat infested with gamma-radiated Sitophilus oryzae (L.) and Rhyzopertha dominica (F.). J. Stored Prod. Res. 9:37-41.

Brower, J. H. and Tilton, E. W. 1973. Comparative gamma radiation sensitivity of Tribolium madens and T. castaneum. J. Stored Prod. Res. 9:93-100.

Brower, J. H. and Tilton, E. W. 1973. Development and fecundity of the Indian meal moth, Plodia interpunctella, reared on diets of irradiated nutmeats. Int. J. Appl. Rad. Isotopes 24:327-331.

Brown, G. A. 1973. Sensitivity of red flour beetle eggs to gamma radiation as infulenced by treatment age and dose rate. Ga. Entomol. Soc. J. 8:153-157.

Brown, G. A., Brower, J. H. and Tilton, E. W. 1972. Gamma radiation effects on Sitophilus zeamais and Sitophilus granarius. J. Econ. Entomol. 65:203-205.

Brown, G. A. and Davis, R. 1973. Sensitivity of red flour beetle eggs to gamma radiation as influenced by treatment age and dose rate. J. Ga. Entomol. Soc. 8:153-7.

Browner, J. H. 1973. Gamma radiation sensitivity of cadells, Tenebroides mauritanicus and flat grain beetle, Cryptolestes pusillus. Ga. Entomol. Soc. J. 8:174-184.

Chawla, S. S. 1973. Sensitivity of Oryzaephilus surinamensis to cesium-137. I. Irradiation of eggs: effects on hatching, survival, and fecundity. Can. Entomol. 105:283-288.

_____ 1973. Sensitivity of Oryzaephilus surinamensis to Cesium-137. II. Irradiation of larvae, pupae and adults. J. Econ. Entomol. 66:605-608.

Cogburn, R. R., Tilton, E. W. and Brower, J. H. 1973. Almond moth: Gamma Radiation effects on the life stages. J. Econ. Entomol. 66:754-51.

Dinther, J. B. M van and Monsink, F. T. 1971. Use of radioactive phosphorus in studying egg predation by carabids in cauliflower fields. Ghent Rijksfac Landbouwetensch. Meded. 36:283-293.

Dobie, P. 1973. An investigation into use of an X-ray technique in study of pre-emergent stages of Sitophilus oryzae (L.) developing in Manitoba wheat. J. Stored Prod. Res. 9:7-12.

Ducoff, H. S. 1972. Causes of death in irradiated adult insects. Cambridge Phil. Soc. Biol. Rev. 47:211-240.

Erdman, H. E. 1973. Effects of chronic 60Co radiation, dose rate, temperature, and cohabitation on population performance of flour beetles. Environ. Entomol. 2:41-48.

_____ 1973. Comparative species radiation sensitivities of flour beetles to chronic gamma radiation. J. Econ. Entomol. 66: 251-252.

Fesus, I. 1972. Detection and estimation of internal pest infestation in seeds by application of X-ray techniques. EPpo Bull. 3:65-76.

Gintsburg, G. I. 1972. Incorporation of H3-thymidine into cytoplasm of oocytes during various periods of their growth. Sov. J. Develop. Biol. 2:63-69.

Griffiths, T. D. and Ducoff, H. S. 1973. Suppression by hypoxia of dose-fractionation recovery in Tenebrionid beetles. Int. J. Radiat. Biol. 24:203-206.

Hossain, M., Brower, J. H. and Tilton, E. W. 1972. Sensitivity to an acute gamma radiation exposure of successively irradiated generations of cowpea weevil. J. Econ. Entomol. 65:1566-1568.

Iperti, G. and Buscarlet, L. A. 1972. Contribution to study of a migration of Adoniaii notata Schn. by marking with stable iridium-191. Ann. Zool. Ecol. Anim. 4:249-254.

Martinsen, D. L. and Kimeldorf, D. J. 1972. Prompt detection of ionizing radiations by carpenter ants. Biol. Bull. 143:403-419.

Kirkpatrick, R. L. 1973. Gamma, infra-red and microwave radiation combinations for control of Rhyzopertha dominica in wheat. J. Stored Prod. Res. 9:19-23.

Kirkpatrick, R. L., Brower, J. H. and Tilton, E. W. 1973. Gamma, infra-red, and microwave radiation combinations for control of Rhyzopertha dominica in wheat. J. Stored Prod. Res. 9:19-23.

Kirkpatrick, R. L., Brower, J. H., Tilton, E. W. and Brown, G. A. 1973. Gamma and microwave radiation to control the rice weevil in wheat. J. Ga. Entomol. Soc. 8:51-55.

PoChedley, D. S. 1971. Variations in resistance of meal worm, Tenebrio molitor, eggs to X-rays. In International Congress of Entomology, 13th, Moscow, 1968. Trudy 2:30-31.

Revetti, L. M. 1972. Irradiation of grains. I. Irradiation of corn. Agron. Trop. 22:497-507.

Riemann, J. G. 1973. Ultrastructure of sperm in F1 progeny of irradiated males of Mediteranean flour moth, Anagasta kuehniella. Entomol. Soc. Amer. Ann. 66:147-153.

Singh, H. and Liles, J. N. 1972. Sex differences in radiosensitivity of Rhyzopertha dominica adults. J. Econ. Entomol. 65:1213.

Soliman, M. H. 1973. Lethality: dependence on developmental rate in X-irradiated pupae of Tribolium. Experientia 29:550-551.

Stermer, R. A. 1972. Automated X-ray inspection of grain for insect infestation. Amer. Soc. Agr. Eng. Trans. ASae 15:1081-1085.

Tamhankar, A. J., Rahalkar, G. W. and Adeesan, C. 1972. Male response to female sex pheromone: A probable factor determining mating competitiveness of radiation-sterilized Trogoderma granarium males. Entomol. Exp. Appl. 15:392-394.

Tilton, E. W. 1973. Progeny production by Sitophilus oryzae and Tribolium castaneum reared for several generations on irradiated diets. Ga. Entomol. Soc. J. 8:168-173.

Tilton, E. W. and Brower, J. H. 1973. Utilization of irradiated sperm from successive matings by the female cowpea weevil. J. Econ. Entomol. 66:545-546.

Tilton, E. W. and Brower, J. H. 1973. Status of U.S. Dept. of Agriculture research on irradiation disinfestation of grain and grain products, p. 295-306, In IAEA, Vienna, Radiation Preservation of Food.

Tilton, E. W. and Brower, J. H. 1973. Progeny production by Sitophilus oryzae and Tribolium castaneum reared for several generations on irradiated diets. J. Ga. Entomol. Soc. 8:168-73.

Ullmann, S. L. 1973. Oogenesis in Tenebrio molitor: histological and autoadiographical observations on pupal and adult ovaries. J. Embryol. Exp. Morphol. 30:179-217.

Wohlgemuth, R. 1973. Studies on effect of ionizing radiations on viability of adult grain weevil. Z. Angew Entomol. 74:7-24.

NUTRITION

Baker, J. E. and Mabie, J. A. 1973. Feeding behavior of larvae of Plodia interpunctella. Environ. Entomol. 2:627-32.

Baker, J. E. and Mabie, J. M. 1973. Growth and Development of larvae of the granary weevil, Sitophilus granarius, on natural and meridic diets. Can. Entomol. 105:249-256.

Baker, J. E. and Mabie, J. M. 1973. Growth responses of larvae of Sitophilus granarius on a meridic diet. Ann. Entomol. Soc. Amer. 66:723-6.

Calkins, C. P. 1973. Food preferences of a false wireworm, Eleodes suturalis. Environ. Entomol. 2:105-108.

Cline, L. Daniel. 1973. Rearing the lesser grain borer on ground dog biscuits to obtain mature larvae and pupae. Ann. Entomol. Soc. Amer. 66:551-2.

Dadd, R. H. 1973. Insect nutrition: current developments and metabolic implications. Annu. Rev. Entomol. 18:381-420.

Davis, G. R. F. 1972. A growth factor in brewer's yeast for saw-toothed grain beetle, Oryzaephilus surinamensis (L.). Compar Biochem. Physiol. 43:927-963.

_____ 1973. Quantitative dietary requirements of saw-toothed grain beetle, Oryzaephilus surinamensis, for L-leucine. J. Insect Physiol. 19:273-276.

_____ 1973. Quantitative requirements of saw-toothed grain beetle, Oryzaephilus surinamensis, for dietary L-isoleucine and L-valine. J. Insect Physiol. 19:1657-1661.

Iperti, G. 1972. Suitability of eggs of Anagasta kuhniella Z. as food for an aphidiphagous cocinellid: Adonia 11-notata Schn. Entomophaga 17:437-441.

Jay, E. G., Musen, H. L. and Pearman, G. C. 1973. Damage to stored soybeans by the cowpea weevil, Callosobruchus maculatus. J. Ga. Entomol. Soc. 8:164-7.

Jay, E. G. and Pearman, G. C. 1973. Carbon dioxide for control of an insect infestation in stored corn. J. Stored Prod. Res. 9:25-29.

Kamano, S. 1973. Studies on artificial diets and laboratory rearing methods suitable for successive generations of rice stem borer. Chilo suppressalis Walker. Tokyo Nat. Inst. Agr. Sci. Bull. Ser. C. 27:1-51.

Kittur, S. U. 1972. Preference of Sitotroga cerealella Oliv. to rice varieties during storage. Indian J. Agr. Sci. 42:621-622.

LeCato, G. L. 1973. Multiplication of Oryzaephilus spp. and Tribolium spp. on 20 natural product diets. Environ. Entomol. 2:176-179.

LeCato, G. L. and Flaherty, B. R. 1973. Tribolium castaneum progeny production and development on diets supplemented with eggs or adults of Plodia interpunctella. J. Stored Prod. Res. 9:199-203.

LeCato G. L. 1973. Saw-toothed grain beetle: Population growth on peanuts stimulated by eating eggs or adults of the Indian meal moth. Ann. Entomol. Eoc. Amer. 66:1365.

LeCato, G. L. and McCray, T. L. 1973. Multiplication of Oryzaephilus spp. and Tribolium spp. on 20 natural product diets. Environ. Entomol. 2:176-79.

LeCato, G. L., Press, J. W. and McDonald, L. L. 1973. Mortality of red flour beetle adults fed insecticide-treated Indian meal moths. Environ. Entomol. 2:726-32.

Levinson, H. Z. 1973. Action of overdosed biotin on reproduction of hide beetle, Dermestes maculatus. Insect Physiol. 19:551-558.

Metcalfe, D. R., Loschiavo, S. R. and McGinnis, A. J. 1972. Evaluation of cereal cultivars for feeding value with confused flour beetle, Tribolium confusum. Can. Entomol. 104:1427-1431.

Mills, R. B. 1973. Development of Sitophilus zeamais Motsch. in WURLD wheat. J. Stored Prod. Res. 8:271-274.

Opyrchalowa, J. 1972. Insect nutrition. Ochrona Roslin 16:9-11. (Continued).

Ozols, G. E. and Bicevskis, M. J. 1971. Attractiveness of boring meal extracts to beetles Ips typographus L. in natural conditions. In Vsesoiuznyi Simposium po Khemoretseptsii Nasekomykh 1St., Vilma, 1971. Khemoretseptsiia nasekomykh; materialy P.195-197.

Reiss, J. 1973. Toxicity of molds to larvae of Tenebrio molitor. J. Invertebrate Pathol. 21:112-113.

Roy, P. 1973. Lipid requirements for Tribolium castaneum. Indian J. Entomol. 34:35-41.

Sarin, K. 1972. On food utilization and nutrients by Alphitobius diaperinus. Zool. Jahrbucher Abt. Allg. Zool. Physiol. Tiere. 76:408-415.

Schoonhoven, A. V. and Horber, E. 1972. Developement of maize weevil on kernels of Opaque-2 and Floury-2, nearly isogenic corn inbred lines. Crop Sci. 12:862-863.

Sehgal, S. S. and Agarwal, H. C. 1973. Quantitative dietary requirements of beetle Trogoderma for cholesterol and choline. J. Insect Physiol. 19:419-425.

Villacis, S. J., Sosa, M. C. and Ortega, C. A. 1972. Nutritional and reproductive effects of 5 types of corn in development of Sitophilus zeamais Motschulsky. Rev. Peruana Entomol. Agr. 15:147-152.

Waldbauer, G. P. and Bhattacharya, A. K. 1973. Self-selection of an optimum diet from a mixture of wheat fractions by larvae of Tribolium confusum. J. Insect Physiol. 19:407-418.

Walder, J. M. M. 1973. Influence of foods on longevity and oviposition of Zabrotes subfasciatus. Rev. Agric. 48:45-46.

PARASITES AND SYMBIONTS OF COLEOPTERA

Anonymous 1972. Sleeping sickness of gypsy moth. New Jersey Agricultural Experiment Station Re: Search 5:2-3, 13.

Bailey, L. 1972. Preservation of infective microsporidan spores. J. Invertebrate Pathol. 20:252-254.

Baudoin, J. and Maillard, Y. P. 1972. Research on Gregarina of Coleoptera Hydrophilidae. Protistologica 8:53-63.

Burges, H. D. 1973. Enzootic diseases of insects. N.Y. Acad. Sci. Ann. 217-31-49.

Caceres, C. I, E. and Tantalean, Z. G. de 1972. Insects of Lima connected with cystercoid larva of Hymenolepis diminuta. Rev. Peruana Entomol. Agr. 15:142-147.

Doane, J. F. 1973. Parasitism of Agriotes obscurus Linn. by Hexamermis sp. Schweiz Entomol. Ges. Mitt. 45:299-300.

Drea, J. J., Dysart, R. J., Coles, L. W. and Loan, C. C. 1972. Microctonus stelleri, a new parasite of alfalfa weevil introduced into United States. Can. Entomol. 104:1445-1456.

Geest, L. P. S. van der and Laan, P. A. van der 1971. World teaching facilities in insect pathology. In Burges. H. D. Microbial control of insects and mites P. 725-732.

Geest, L. P. S. van der and Laan, P. A. van der 1971. Sources of special materials. In Burges, H. D. Microbial control of insects and mites P. 741-749.

Geest, L. P. S. van der, and Laan, P. A. van der 1971. Insect pathogens available for distribution. In Burges, H. D. Microbial control of insects and mites. P. 733-739.

George, C. R. 1972. Irreversible malnutrition in Tribolium castaneum attributable to parasitization by Nosema whitei. J. Stored Prod. Res. 8:227-228.

Heyneman, D. and Voge, M. 1971. Host response of flour beetle, Tribolium confusum, to infections with Hymenolipis diminuta, Hymenolepis microstoma, and Hymenolepis citelli. J. Parasitol. 57: 881-886.

Kvicala, B. A. 1973. A beetle-transmitted virus disease of cowpea in Cuba. Plant Prot. Bull 21:27-29, 39.

Lum, P. T. M. and Baker, J. E. 1973. Development of mycetomes in larvae of Sitophilus granarius and S. oryzae. Ann. Entomol. Soc. Amer. 66:1261-3.

Martin, G. 1973. Proof of a symbiotic intracytoplasmic microorganism of Oniscoidea Armadillidium vulgare Latr. Whose presence accompanies intersexuality or total feminization of genetic males of thelygenic. Acad. Sci. C R Ser. D. 276:2313-2316.

Milner, R. J. 1972. Survival of Nosema whitei spores stored at 4 degrees C. J. Invertebrate Pathol. 20:356-357.

_____ 1973. Nosema whitei, a microsporidan pathogen of some species of Tribolium. IV. The effect of temperature humidity and larval age on pathogenecity for T. castaneum. Entomophaga. 18:305-315.

Press, J. W., Flaherty, B. R. Davis, R. and Arbogast, R. T. 1973. Development of Xylocoris flavipes on eggs of Plodia interpunctella killed by gamma radiation or by freezing. Environ. Entomol. 2: 335-6.

Puissegur, C. 1972. Cystogenesis of hemocoelic Gregarines in carabs of Pyrences and Corbieres. Bull. Biol. France Belg. 106:101-122.

Quiot, J. M. 1973. Infection of Coleoptera cell cultures by Oryctes virus. Hebd. Seances Acad. Sci. Ser. D. Sci. Nat. 296:3229-3231.

Remillet, M. and Van Wacrebeke, D. 1972. Particularities of heterogonic cycle of two Tylenchida nematodes parasites of Nitidulidae. Acad. Sci. C. R. Ser. D 275:1507-15-9.

Thompson, J. V. and Fletcher, L. W. 1972. A pathogenic strain of Bacillus cereus isolated from cigarette beetle, Lasioderma serricorne. J. Invertebrate Pathol. 20:341-350.

Ubelaker, J. E., Cooper, N. B. and Allison, V. F. 1970. Possible defensive mechanism of Hymenolepis diminuta cysticercoids to hemocytes of beetle Tribolium confusum. J. Invertebrate Pathol. 16:310-312.

Voge, M. 1973. The post embryonic developmental stages of cestodes. In Ben Dawes (Ed.) Advances in Parasitology 11: . Academic Press N.Y.

Waerebeke, D. van 1973. Morphology and Biology of Heterogonema ovomasculis n. sp., parasite of Nitidulidae. Nematologica 19:80-92.

Wafa, A. K., Ali, A. M. Keddis, M. E. 1971. Toxicity of acaricides to certain tetranychid mites under various degrees of temperatrues and relative humidities. Emtomol. Soc. Egypt Bull. Econ. Ser. 5:107-113.

Weiser, J. 1973. Production of spores of Nosema plodiae Kellen et Lindegren in Mamestra brassicae L. after different infective dosage. II. Comparison with Nosema heterosporum Kellen et Lindegren. Vestn. Cesk Spol.Zool. 37:234-237.

PESTS

Abrahamson, L. P. and Newsome, L. 1972. Tree age influences trunk borer infestations in cottonwood plantations. Forest Sct. 18: 231-232.

Alexandrescu, S. 1972. Control of coloradto beetle by ultra low volano aircraft treatment. Inst. Cercet Pentru Prot. Plant An. 8:265-270.

Ankersmit, G. W. 1973. Studies on sterile-male technique as a means of control of Adoxophyes orana. 1. Problems of mass rearing (crowding effects). Neth. J. Plant Pathol. 79:54-61.

Anonymous, 1972. Colorado beetle. Advis. Leafl. Minist. Agric. Fish Food 71: 5 P.

_____ 1972. Control of insect infestation in cereals and foods. Tec. Molitoria 23:743-751.

_____ 1972. Pest control in food industry and protection of foods. Indus. Aliment 11:85-95.

_____ 1972 Household insect pests and their control, 13th ed. N.S.W. Dep. Agric. Entomol. Branch Insect Pest Bull. 47: 30 P.

_____ 1972. Insects Pests. Agric. Gaz. N.S.W. 83:265-266.

_____ 1972. Control of insects attacking stored grain and peas and seed treatment for small grains cooperative extension service. Wash. State Univ. Ext. Em. 3314: 3P.

_____ 1973. Silverfish and firebrats, how to control them. USDA Leafl. 412. 6 P.

_____ 1973. Sterilizing insects saves grain. U.S. Agricultural Research Service Agric. Res. 21:3-5.

Bains, S. S. 1972. Protection of grain against Trogoderma granarium and Sitophilus oryzae. Bull. Grain Technol. 10:283-287.

Bazzi, B. 1971. Application of Cidial for control of parasitic insects of stored grains; metabolism, residues and technical, commerical, hygienic, sanitary implications. Milan. Ist. Ric. Agr. Contrib. 11:27-29.

Bengston, M. 1972. Control of grain storage insects on farms. Queensland Agr. J. 98:553-555.

Benson, J. F. 1973. Biology of Lepidoptera infesting stored products, with special reference to population dynamics. Cambridge Phil. Soc. Biol. Rev. 48:1-26.

Beratlief, C. 1973. Resistance of animal pests against control substances. Natura 25:23-29.

Bills, G. T. 1973. Biological fly control in deep-pit poultry houses. Br. Poult. Sci. 14:209-212.

Blakitnaia, L. P. and Bogdan-Blakitnaia, L. R. 1972. Grain storage pests. Zashch. Rast. 11:46-47.

Brower, J. H. 1973. Reproduction and development of twelve species of stored-product insects on kenaf seed. Fla. Entomol. 56:49-51.

Carruth, L. A. and Olton, G. S. 1972. Household pests. Arizona University Cooperative Extension Service. Ariz. Univ. Ext. Bull. A. 72: 21 P.

Chatterji, S and Sarup, P. 1959. Biology of Thorictodes heydeni Reitt. a pest of stored cereals and their products in India. Indian J. Ent. 21:282-283.

Chu, Y. I. 1972. Studies on Lycosa pseudoannulata Boesenberg et Strand I. External feature and habits. Chung-hua Chih Wu Pao Hu Hsueh Hui Plant Prot. Bull 14:169-174.

Clark, R. P. 1973. Current pesticide legislation. Hyacinth Control J. 11:4-5.

Cogsburn, R. R. 1973. Stored-product insect populations in port warehouses of Gulf Coast. Environ. Entomol. 2:401-407.

_____ 1973. Stored-product insect populations in boxcars delivering flour and rice to Gulf Coast ports. Environ. Entomol. 2:427-431.

Cole, W. E. 1973. Crowding effects among single-age larvae of mountain pine beetle, Dendroctonus ponderosae. Environ. Entomol. 2: 285-293.

Coombs, C. W. 1973. Evaluation of some of factors involved in ecological succession in an insect population breeding in stored wheat. J. Anim. Ecol. 42:305-322.

Dantas da Silva, V. 1972. Trogoderma granarium Everts in Mozambique. Rev. Agr. 14:31-36.

De Palma, L. 1973. Gas fumigants: technical and economical aspects. Molini Ital. 24:56-59.

Dolinski, M. G., Hanic, W. and Loschiavo, S. R. 1971. Triticale as a new host for stored grain insects. Manitoba Entomol. 5:54.

Faber, W. 1972. Drug store beetle and cigarette beetle. Deut. Muller-zeitung 70:112-114.

Faber, W. 1972. Pests in grain storage and flour mills and efforts to control them. Muhle Mischfuttertech. 109:820, 823-825.

Falknas, P. O. 1972. Are we stopping Colorado potato beetle? Lantmannen 83:14-15.

Frankenhuyzen, A. van 1972. Cherry-stone beetle, Anthonomus rectirostris L. Natura 69:97-99.

Fraser, R. 1973. Pest control in mills. Milling 155:30-31, 34-36.

Freude, H. 1972. Reports of study group from Munich on Coleoptera. Nachrichtenbl Bayer Entomol. 21:70-73.

Freyberg, G. 1972. Pest control and stored product protection with phosphin, today more up-to-date than ever before. Muhle Mischfuttertech. 109:244.

Furniss, M. M. and Furniss, R. L. 1972. Scolytids on snowfields above timberline in Oregon and Washington. Can. Entomol. 104: 1471-1478.

Gillenwater, H. B., Eason, G., and Bauman, E. B. 1972. Gas-propelled aerosols and micronized dusts for control of insects in aircraft. 4. Potential for controlling stored-product insects. J. Econ. Entomol. 65:1450-1453.

Gloria, B. R. 1972. Preliminary information on main pests of stored grain on Peruvian Coast. Rev. Peruana Entomol. Agr. 15:219-224.

Gojmerac, W. L. 1973. No practical control for some insect pests. Hoards Dairyman 118:774.

_____ 1973. Controlling pantry pests. A Coop. Ext. Programs Univ. Wis. 1984: 2 P.

Golebiowska, Z. and Nawrot, J. 1971. Detection methods of latent infestation of grain by storage pest. Zeszyty Probl. Postepow Nauk Roln 113:281-305.

Golebiowska, Z. 1972. Protection of cereal storehouses against pests. Noew Roln. 21:8-9.

Gorokhov, V. V. 1971. On possibility of using insects in control of molluses. Vses Inst. Gelmintol. K. I. Skryabina Tr. 18:79-87.

Gospondinov, G. 1973. Harm on bread baking qualities of wheat done by different grain pest species. Rastenievud Nauk 10:125-133.

Hagstrum, D. W. and Leach, C. E. 1973. Infestation of flour by Tribolium castaneum: rate of adult dispersal in relationship to sex, mated condition, and other factors. Entomol. Soc. Amer. Ann. 66:384-387.

Harris, P. 1972. Insects in population dynamics of plants. Roy. Entomol. Soc. London Symp 6:201-209.

Haskell, P. T. 1973. Fourteenth Internationsl Congress of Entomology, Canberra, August 22-30, 1972. PAns Pest Artic News Sumn. 19:140-147.

Heinrich, W. O. 1973. Integrated control: Ideas which become real. Biologico 39:85-92.

Hofsten, C. G. von 1973. Colorado potato beetle beaten through cooperation. Lantmannen 84:13-14.

Hunter, F. A., Tulloch, J. B. M. and Lambourne, M. G. 1973. Insects and mites of maltings in the East Midlands of England. J. Stored Prod. Res., 9:119-141.

IAkovenko, V. A. 1973. Features of gluten albumen of wheat damaged by Blissus leucopterus. Izv. Vyssh Uchebn Zaved, Pishch Tekhnol. 4:17-19.

Ilic, B. and Popovic, N. 1972. Experiments on diffusion of phosphorus-hydrogen into various types of packing at various temperatures. Agrohemija 3/4:153-166.

Irwin, D. G.,Smith, L. W. and Pratt, J. J. 1972. Effects of carbon dioxide and mitrogen on secretion of parabenzoquinones by Tribolium castaneum. J. Stored Prod. Res. 8:213-219.

Jay, E. G. 1973. Carbon dioxide for control of an insect infestation in stored corn. J. Stored Prod. Res. 9:25-29.

Kashyap, N. P. 1972. Feasibility of employing sterile technique for control of stored grain pest. Bull. Grain Technol. 10:131-132.

Kathuria, D. S., Das, S. K. and Misra, V. K. 1970. Pests of some important seeds and their methods of control. Plant Prot. Bull. 22:7-14.

Kerck, K. 1972. Ethyl alcohol and structure of trunk as a component of primary attraction for Xyloterus domesticus L. Naturwissenschaften 59: 423.

Kinkade, M. L. 1973. Dietary and density dependent factors in induction of population autocide of flour beetles, Tribolium confusum. Environ. Entomol. 2:75-76.

Klein, J. 1972. Newer methods of protection against grain pests. Malomipar Termenyforgalom 19:83-86.

Kokovic, S. V. 1972. Control of potato beetle. Agrohemija 3/4:167-169.

Krysan, J. L. and Guss, P. L. 1973. Histochemistry of esterases in eggs of Diabrotica undecimpunctata howardi. Entomol. Soc. Amer. Ann. 66:315-320.

Ksiazck, J. 1972. Control of Colorado potato beetle in 1972. Nowe. Roln. 21:6-7.

Kurir, A. 1972. Second note on bionomy of Hylecoetus dermestoides L. Holzforsch Holzverwertung 24:127-135.

Lang, J. H. and Bry, R. E. 1972. Preliminary investigations of tetramethrin as a protectant of woolen cloth against damage by black carpet beetle larvae. Ga. Entomol. Soc. J. 7:260-264.

Laudani, H. 1973. Development of an insect-resistant cotton bag. USDA Tech. Bull 1463, 47 P.

LeCato, G. L. and Davis, R. 1973. Preferences of the predator, Xylocoris flavipes for species and instars of stored-product insects. Fla. Entomol. 56:57-59.

Lipa, J. J. 1972. Use of light trapa in control of insect pests. Ochrona Roslin 10:12-14.

_____ 1972. Use of color trapa for determination of insect populations or control of insect pests. Ochrona Roslin 16:12-13.

Maelzer, D. A. 1972. Biological control of insect pests. Fruit World Market Grower 73:32, 40.

Metwally, M. M., Sehnal, F. and Landa, V. 1972. Reduction of fecundity and control of khapra beetle by juvenile hormone mimics. J. Econ. Entomol. 65:1603-1605.

Mills, R. B. 1972. Susceptibility of gelantinized wheat products to stored-product insects. Annu. Wheat News 18:90-92.

_____ 1972. Host-plant resistance applied to stored-product insects. Entomol. Soc. Amer. N. Cent. Br. Proc. 27:106-107.

Moore, I. 1973. Beneficial insects: neglected 'good guys'. Environ. Southwest 454, 5-7.

Nakamura, S. 1973. Insect fauna and seasonal prevalence of Dermestes ater in cocoon and silk stored as by-product. Sanchi Kenkyu Acta. Sericol. 87:87-92.

Nawaot, J. 1971. Fertility of bean weevil in containers of different color. Poznan Inst. Ochrony Roslin Prace Nauk. 13:145-153.

Nelson, S. O. 1973. Insect-control studies with microwaves and other radiofrequency energy. Bull. Entomol. Soc. Am. 19:157-163.

Niemczyk, E. 1972. Biological control in orchards. II. Ochrona Roslin 16:10-11.

Panwar, J. S. 1972. Check these storage losses. Intensive Agr. 10: 20-21.

Petty, H. B. 1973. 25 years of insect control. Crops Soils. 25:4-5.

Pickarczyk, K. 1971. Determination of periods of occurrence of more important developmental stages of potato beetle in different regions of Poland. Poznan Inst. Ochrony Roslin Prace Nauk. 13: 169-190.

Piltz, H. 1972. Control of stored food pests in grain and storage areas. Deut . Muller-zeitung 70:130-133.

_____ 1972. Pest control of stored cereals and in warehouses. Prakt Schadlingsbekampfer 24:4-6.

Pleshanova, G. I. 1972. Ptinid beetles as pests of stored food and products in eastern Siberia. Akad Nauk Sssr Sibirsk Otd. Biol. Inst. Tr. 11:79-80.

Rauscher, H. 1972. Protection of stocks in our time. Muhle Misch-futtertech. 109:238, 241.

Schurr, K. 1972. Insects as a major protein source in sewage lagoon biomass useable as animal food. Entomol. Soc. Amer. N. Cent. Br. Proc. 27:135-137.

Sifuentes, J. A. 1972. Guide of recommendations for control of Agricultural pests in Mexico 1972. Algodon Mex. 69:49-51.

Silva, V. D. da 1972. New finds of some injurious insects in stored products. Rev. Agr. 14:29-32.

Simmonds, F. J. 1972. Approaches to biological control problems. Entomophaga 17:251-264.

Singh, K. 1972. Studies on loss in weight caused by Ditophilus oryzae Linn. to various high yielding varieties of wheat. Bull. Grain Technol. 10:271-275.

Smith, R. F. 1973. War against pests use of natural enemies, resistance, and ecological techniques is basis of an integrated control. FAo Rev. 6:50-53.

Soderstrom, E. L. 1973. Interspecific competition of almond moth, Indian meal moth, and raisin moth in malathion-treated and untreated almonds. J. Econ. Entomol. 66:741-744.

Srinath, D. 1973. Influence of some Aspergillus species on population of Sitophilus oryzae L. Curr. Sci. 42:683-684.

Taft, H. M., Hopkins, A. R., James, W., and Moore, R. F. 1973. Boll weevils: time if entry into hibernation sites and variations in survival and emergence. J. Econ. Entomol. 66:254-256.

Tamhankar, A. J., Rahalkar, G. W. and Adeesan, C. Male response to female sex pheromone: A probable factor determining mating competitiveness of radiation-sterilized Trogoderma granarium males. Entomol. Exp. Appl. 15:392-394.

Teschner, D. 1972. Problems of modern insect control. Acta. Fytotechnica 23:83-100.

Thygesen, T. 1972. Colorado potato beetle comes to Denmark. Nye Dan Landbrug 3:16-19.

Turnipseed, S. G. 1973. Management of insect pests of soybeans. Tall Timbers Conf. Ecol. Anim.Control. Habitat Manage Proc. 4:189-203.

Viktorov, G. A. 1973. Behavior of parasite-entomophagous insects and its significance for biological pest control. Usp Sovrem. Biol. 74:482-493.

Whitney, H. S. and Cobb, F. W. 1972. Non-staining fungi associated with bark beetle Dendroctonus brevicomis on Pinus ponderosa. Can. J. Bot. 50:1943-1945.

Wilson, D. E. and Janzen, D. H. 1972. Predation on Scheelea palm seeds by bruchid beetles: seed density and distance from parent palm. Ecology 53:954-959.

Yerrington, A. P. 1973. Effects on content and construction on insect resistance of rice packages. Rice J. 76:22-24.

PHYSIOLOGY AND BIOCHEMISTRY

Aliniazee, M. T. 1973. Oxygen toxicity in Tribolium species. Environ. Entomol. 2:293-295.

Andersen, S. O. 1973. Amino-acid composition of cuticles from Tenebrio molitor with special reference to action of juvenile hormone. Insect Biochem. 3:171-180.

Anonymous, 1971. Symposium: chemistry and activity of insect pheromones. In International IUpac Congress of Pesticide Chemistry, 2 D, Tel-Aviv, 1971. Pesticide Chemistry; Proceedings 3:67-162.

_____, 1972. Decoding insect messages. Ohio Agr. Res. Develop. Center Res. Bull. 1061:13-14.

Arbogast, R. T. and Carthon, M. 1972. Effect of starvation and desiccation on water balance and humidity response of adult Oryzaephilus surinamensis. Entomol. Exp. Appl. 15:488-498.

Armitage, P. 1973. Structure and function of insect muscle. Cold Spring Harbor Symp. Quant Biol. 37:379-387.

Barth, R. H. and Lester, L. J. 1973. Neuro-hormonal control of sexual behavior in insects. Annu. Rev. Entomol. 18:445-472.

Bate, C. M. 1973. Mechanism of pupal gin trap. I. Segmental gradients and connexions of triggering sensilla. J. Exp Biol. 59:95-107.

_____ 1973. Mechanism of pupal gin trap. II. closure movement. J. Exp. Biol. 59:109-119.

_____ 1973. Mechanism of pupal gin trap. III. Interneurones and origin of closure mechamism. J. Exp. Biol. 59:121-135.

Baust, J. G. 1973. Mechanisms of cryoprotection in freezing tolerant animal systems. Cryobiology 10:197-205.

Bell, E. W. 1973. Potential juvenile hormone activity: preparation of fatty beta-methylenedioxyphenyl derivatives. J. Agric. Food Chem. 21:925-926.

Brand, J. M., Duffield, R. M.,MacConnell, J. G. and Blum, M. S. 1973. Caste-specific compounds in male carpenter ants. Science 179: 388-389.

Bridges, R. G. 1972. Choline metabolism in insects. Adv. Insect Physiol. 9:51-110.

Bullard, B. 1973. How many myosins per cross-bridge? iI. Flight muscle myosin from blowfly, Sarcophaga bullata. Cold Spring Harbor Symp. Quant. Biol. 37:423-428.

Burk, T. and Bell, W. J. 1973. Cockroach aggregation pheromone: inhibition of locomotion. Kans. Entomol. Soc. J. 46:36-41.

Canonica, L. 1973. Structure, biogenesis and chemistry of hormones in mutation. Inform. Fitopatol. 23:11-14.

Cloudsley-Thompson, J. L. 1973. Factors influencing supercooling of tropical Arthropoda, especially locusts. J. Nat. Hist. 7:471-480.

Daneholt, B. 1972. Giant RNA transcript in a balbiani ring. Nat. New Biol. 240:229-232.

David, J. and Rougier, M. 1972. Physiology of explanted dorsal vessel of insects. Invertebr. Tissue Cult. 2:211-244.

De Kort, C. A. D. and Bartelink, A. K. M. 1972. Biochemical maturation of flight mucle mitochondria in Colorado beetle, Leptinotarsa decemlineata Say. Compar Biochem. Physiol. 43:1009-1017.

Delachambre, J., Provansal, A. and Grillot, J. P. 1972. Proof of liberation of a tanning factor assimilable to bursicule by perisympathetic organs in Tenebrio molitor L. Acad Sci. C R Ser D 275:2703-2706.

Devaki Nandanan, M. 1973. Properties and distribution of extra-digestive lipase in beetle, Trogoderma. Insect Biochem. 3:223-230.

DeWitt, J. R. and Armbrust, E. J. 1972. Photoperiodic sensitivity of alfalfa weevil during larval development. J. Econ. Entomol. 65:1289-1292.

Durer, H. and Villiger, W. 1972. Iridescent colors of Euchroma gigantea (L.): electron microscopic examination of elytra. Int. J. Insect Morphol. Embryol. 1:233-240.

Dutkowski, A. 1972. Role of suboesophageal ganglion in regulation of RNA synthesis in some insect tissues. In Studies on Cytochemistry and Cytophysiology of Lipid and Nucleotide Metabolism of the Animal Cell P. 65-71.

El-Asmar, M. F., Osman, O. H. and Ismail, M. 1973. Fractionation and lethality of venom from scorpion Buthus minax. Toxicon. 11:3-7.

Evans, M. E. 1973. Jump of click beetle - energetics and mechanics. J. Zool. 169:181-194.

Ferenz, H. J. 1973. Juvenile hormone-initiated sexual maturity in males of Pterostichus nigrita f. Experientia 29:356.

Flaherty, B. R., Press, J. W. and Lum, P. T. M. 1973. Fecundity of Plodia interpunctella adults after ezposure to sublethal dosages of carbon dioxide. J. Ga. Entomol. Soc. 8:141-5.

Garcin, J. E. 1972. Variations of total lipid fraction and relative water content in Pimelia bipunctata Fab. in function of sex and physiological state. Acad Sci C R Ser D 275:1655-1658.

Gokan, N. 1973. Compound eyes of lamellicorn leaf-chafers and relation between their structures and activities. Konchu 41:106-125.

Griffiths, D. J. G. 1973. Action of black widow spider venom at insect neuromuscular junctions. Toxicon 11:369-374.

Halstead, D. G. H. 1973. Preliminary biological studies on pheromone produced by male Acanthoscelides obtectus. J. Stored Prod. Res. 9: 109-117.

Hamalainen, M. and Markkula, M. 1972. Effect of type of food on fecundity in Coccinella septempunctata L. Suom Hyonteistieteellinen Aikak Ann. Entomol. Fenn. 38:195-199.

Hedin, P. A., Miles, L. R., Thompson, A. C. and Gueldner, R. C. 1972. Constituents of boll weevil. VI. Effect of free fatty acid content on larval development. J. Econ. Entomol. 65:1284-1286.

Henrick, C. A. 1973. Alkyl 3,7, 11-trimethyl-2, 4-dodecadienoates a new class of potent insect growth regulators with juvenile hormone activity. J. Agr. Food Chem. 21:355-359.

Herfs, A. 1973. On body coloring of Porcellio scaber Latr. Anz. Schadlingsk Pflanzenschutz 46:83-86.

Hinton, H. E. and Jarman, G. M. 1973. Physiological colour change in elytra of hercules beetle, Dynastes hercules. J. Cell Physiol. 19: 533-549.

Huignard, J. and Lamy. M. 1972. Study of development of proteins of spermatophore after mating in Acanthoscelides obtectus. Acad. Sci. C. R. Ser. D. 275:1067-1070.

Ilan, J. 1973. Protein synthesis and insect morphogenesis. Annu. Rev. Entomol. 18:167-182.

Janda, S. 1972. Defensive secretions of bombardier beetles. Ziva 20:223-224.

Johnson, H. M., Bukovic, J. A., Eisenberg, W. V. and Vazquez, A. W. 1973. Antigenic properties of some insects involved in food contamination. Ass. Offic. Anal.Chem. J. 56:63-65.

Joly, P. 1973. Regulation of moulting in insects. Acrida 2:Xix-xxxiii.

Kogan, M. 1973. Automatic recordings of masticatory motions of leaf-chewing insects. Entomol. Soc. Amer. Ann. 66:66-69.

Kolbe, W. 1973. Isovaleric acid in defensive secretion of Zyras humeralis Grav. Entomol. Bl. 69:57-60.

Korolev, A. M. 1971. Primary processes of odor reception. In Vsesoiuznyi Simposium po Khemoretseptsii Nasekomykh, 1St, Vilma, 1971. Khemoretseptsiia nasekomykh; materialy P. 29-42.

Kort, C. A. D de 1973. The significance of L-proline for oxidative metabolism in the flight muscles of the colorado bettle, Leptinotarsa decemlineata. Insect Biochem 3:11-17.

Krysan, J. L. and Guss, P. L. 1973. On regulation of lipolysis in an insect egg: observations in vitro. Biochim. Biophys. Acta. 296:466-470.

Kumar, K. 1973. Studies on alimentary canal of Odoiporus longicollis. IV. Rate of passage of food. Zool. Beitr. 19:53-57.

Kuthe, H. W. 1972. Investigations on localization and synthesis of egg proteins during early development of Dermestes frischi. Wilhelm Roux' Arch Entwicklungsmech Organismen 170:165-174.

Lambert, B., Egyhazi, E., Kaneholt, B. and Ringborg, U. 1973. Quantitative micro-assay for RNA/DNA hybrids in study of nucleolar RNA from Chironomus tentans salivary gland cells. Exp. Cell Res. 76:369-380.

Lambert, B., Daneholt, B., Edstrom, J. E., Egyhazi, E. and Ringborg, U. 1973. Comparison between chromosomal and nuclear sap RNA from Chironomus tentans salivary gland cells by RNA/DNA hybridization. Exp. Cell Res. 76:381-389.

Lamprecht, G. 1973. Carrying out frequency multiplication and masking of running activity by Carabus species through light cycles. J. Insect Physiol. 19:1579-1590.

Lanier, G. N., Birch, M. C., Schmitz, R. F. and Furniss, M. 1972. Pheromones of Ips pini: variation in response among three populations. Can. Entomol. 104:1917-1923.

Leigh, J. B. 1973. Effects of ATP analogs on low-angle X-ray diffraction pattern of insect flight muscle. Cold Spring Habor Symp. Quant. Biol. 37:443-447.

Levinson, H. Z. 1973. Dual function of assembling scent of female khapra beetle Trogoderma granarium. Naturwissenschaften 60: 352-353.

Lhoste, J. and Rauch, F. 1972. A contribution to action of juvenile hormone on Tenebrio molitor L. Rev. Zool. Agric. Pathol. Veg. 71:109-117.

MacConnell, J. G. 1973. New results of chemistry of insect pheromones. Angew Chem. 85:647-657.

Martelli, M. 1973. Hormones in growth of insects. Inform. Fitopatol. 23:9.

McGinnis, A. J. and Loschiavo, S. R. 1973. Repellency of wheat germ extracts prepared with peroxide-containing either to adults of Tribolium confusum. Can. Entomol. 105:133-137.

McKebben, G. H., Gueldner, R. C., Hedin, P. A., Hardee, D. D. and Davich, T. B. 1972. Release characteristics of polymeric attractant and repellent compositions. J. Econ. Entomol. 65: 1512-1514.

Meinwald J., Opheim, K. and Eisen, T. 1973. Chemical defense mechanisms of arthropods. XXXVI. Stereospecific synthesis of gyrinidal, a norsesquiterpenoid aldehyde from gyrinid beetles. Tetrahedron Lett. 4:281-284.

Meyer-Rochow, V. B. 1973. Dioptric cyctem of eye of Cybister. Roy. Soc. London Proc. Ser. B Biol. Sci. 183:159-178.

Mitlin, N. 1973. Uric acid in nucleic and amino acid synthesis in boll weevil, Anthonomus grandis. J. Insect Physiol. 19:1569-1574.

Mody, N. V. 1973. Pecan weevil sex attractant: bioassy and chemical studies. J. Insect Physiol. 19:2063-22071.

Moore, J. L. 1973. Hemolymph carbohydrate measurements. Proc. Wash. State Entomol. Soc. 34:355-356.

Nair, K. S. S. 1973. Termination of diapause in Trogoderma granarium Everts. J. Stored Prod. Res. 8:275-290.

Nawrot, J. 1972. Resistance of eggs and imago of sawtoothed grain beetle to low temperatures. Ochrona Roslin 16:18-19.

Nettles, W. C. 1973. Metabolism of sugars to polyols in boll weevil. J. Insect Physiol. 19:1677-1687.

Newcombe, C. L. 1973. Effects of mechanical shock on chemistry of insects. Proc. Annu. Tech. Meet. Inst. Environ. Sci. 19th:218-222.

Nuorteva, M. 1972. Rate of movement of food through alimentary canal in Hylobius abietis L. Suom. Hyonteistieteellinen Aikak Ann. Entomol. Fenn. 38:113-118.

Pant, R. 1973. Studies on accumulation of citrates in insects. Curr. Sci. 42:592-595.

Pardue, M. L., Gerbi, S. A., Eckhardt, R. A. and Gall, J. G. 1972. Cytological localization of DNA complementary to ribosomal RNA in polytene chromosomes of Diptera. In Animal Ribosomes: Experimental Studies of the Last Five Years P. 59-81.

Pasteels, J. M. 1973. Distribution and activities of defensive alkaloids of Coccinellidae. J. Insect Physiol. 19:1771-1784.

Peakin, G. J. 1973. Measurement of costs of maintenance in terrestrial poikilotherms: a comparison between respirometry and calorimetry. Experientia 29:801-802.

Pearce, F. L. 1973. Absence of nerve growth factor in venoms of bees, scorpions, spiders and toads. Toxicon 11:309-310.

Pearson, K. G. 1973. Function of peripheral inhibitory axons in insects. Amer. Zool. 13:321-330.

Pinet, J. M. and Bernard, J. 1972. Attempt to explain the mode of action of humidity and temperature on an insect receptor. Ann. Zool. Ecol. Anim. 4:483-495.

Press, J. W., Flaherty, B. R. and Arbogast, R. T. 1973. Oocyte maturation in Tribolium castaneum after repetitive sublethal carbon dioxide exposures. Entomol. Soc. Amer. Ann. 66:480-481.

Priesner, E. 1973. Species specificity and function of some insect pheromones. Fortschr. Zool. 22:49-135.

Randall, P. J., Lloyd-jones, J. G., Cook, I. F., Rees, H. H. and Goodwin, T. W. 1972. Fate of C-25 hydrogen of 28-insofucosterol during conversion into cholesterol in insect Tenebrio molitor. Chem. Commun. 23:1296-1298.

Reddy, G. and Krishnakumaran, A. 1972. Relationship between morphogenetic activity and metabolic stability of insect juvenile hormone analogues. J. Insect Physiol. 18:2019-2028.

Reedy, M. K. 1973. How many myosins per cross-bridge? i. Flight muscle myofibrils from blowfly, Sarcophaga bullata. Cold Spring Harbor Symp. Quant Biol. 37:397-421.

Rice, M. J., Galun, R. and Finlayson, L. H. 1973. Mechanotransduction in insect neurones. Nat. New Biol. 241:286-288.

Rogers, W. P. 1973. Juvenile and moulting hormones from nematodes. Parasitology 67:105-113.

Rosenberg, E. 1973. A receptor protein for juvenile hormone analogue 10, 11-epoxy-6, 7-trans-2, 3-transfarnesylpropenylether from epidermis cells of pupae of Tenebrio molitor L. Z Naturforsch 28C:453-456.

Rudinsky, J. A. 1973. Multiple functions of Douglas fir beetle pheromone 3-methyl-2-cyclohexen-1-one. Environ Entomol, 2: 579-585.

Sacchi, L, Griolo, A. and Cima, L. 1972. Influence of light on accumulation of ommochromes in Musca domestica L. Riv. Parassitol. 33: 231-235.

Sarin, K. 1973. Digestive enzymes in immature and adult stages of Alphitobius diaperinus. Konchu 41:10-17.

Schanbscher, F. L., Lee, C. K., Hall, J. E., Wilson, I. B., Howell, D. E. and Odell, G. V. 1973. Composition and properties of tarantula Dugesiella hantzi venom. Toxicon 11:21-29.

Shafizadeh, F. 1973. Longilobol, a new sesquiterpene triol from Artemisia longiloba beetle. Tetrahedron Lett. 24:2171-2174.

Shamshurin, A. A. 1972. Insect hormones. Priroda 4:53-63.

Schmialek, P. 1973. Epidermis of pupae of Tenebrio molitor L. as target opgan for juvenile hormone analogue 10, 11-spoxy-6, 7-trans-2, 3-trans-farnesylpropenylether. Z. Naturforsch 28C:173-177.

Singh, J. P. 1973. Studies on nature of excretory material of Aulacophora beetle. Zool. Beitr. 19:43-51.

Socha, R. 1973. Inhibition of insect development by simultaneous action of prothoracic gland hormone and juvenile hormone. J. Insect Physiol. 19:1449-1453.

Stengel, M. and Schubert, G. 1972. Influence of pars intercerebralis and corpora cardiaca of ovipositing female onoogenesis of prealimentary female of Melolontha melolontha L. Acad Sci. C. R. Ser. D. 275:1653-1654.

Stengel, M. and Schubert, G. 1972. Role of pars intercerebralis and corpora cardiaca ofovipositing female of Melolontha melolontha L. in migratory behavior of prealimentary female. Acad Sci. C. R. Ser. D. 275:2161-2162.

Su, H. C. F., Mahany, P. G. and Brady, U. E. 1973. Synthesis and bioassay of the Indian meal moth sex pheromone. J. Econ. Entomol. 66:845-6.

Tannert, W. 1973. Identification and function of a gathering indicating and a danger indicating odorous substance in Blaps mucronata, Latr., 1804. Biol. Zentralbl. 92:230.

Thomas, D. and Gouranton, J. 1973. Duration of formation of intranuclear protein crystals of middle intestine of Tenebrio molitor. J. Cell Physiol. 19:515-522.

Thomas, D. 1973. Study with labeled amino-acids, of proteinaceous intranuclear crystals synthesis in Tenebrio molitor L. Microsc. 16:287-298.

_____ 1973. Duration of formation of intranuclear crystal proteins of middle intestine of Tenebrio molitor. J. Insect Physiol. 19:515-522.

Thompson, A. C., Henson, R. D., Gueldner, R. C. and Hedin, P. A. 1973. Constituents of boll weevil, Anthonomus grandis Boheman. VIII. Lipids and fatty acids in subcellular particles of pharate pupae. Compar Biochem. Physiol. 45:233-239.

Thompson, S. N. 1973. A review and comparative characterization of fatty acid compositions of seven insect orders. Compar Biochem. Physiol. 45:467-482.

Treherne, J. E. and Pichon, Y. 1972. Insect blood-brain barrier. Adv. Insect Physiol 9:257-313.

Tursch, B., Braekman, J. C., Daloze, D., Hootele, C., Losman, D., Karlsson, R. and Pasteels, J. M. 1972. Chemical ecology of arthropods, VI. Adaline, a novel alkaloid from Adalia bipunctata L. Tetrahedron Lett. 3:201-202.

Tursch, B., Daloze, D., Pasteels, J. M., Cravador, A. Braekman, J. C., Hootele, C. and Zimmermann, D. 1972. Two novel alkaloids from American ladybug Hippodamia convergens. Soc. Chim. Belg. Bull. 81:649-650.

Urs., K. C. D. 1973. Effect of moisture on lipid content and composition of two strains of Tenebrio molitor L. J. Stored Prod. Res. 8:299-305.

Vac, J. P., Bakke, A., and Renwick, J. A. A. 1972. Pheromones in Ips: occurrence and production. Can. Entomol. 104:1967-1975.

Wehner, R. 1973. Coordinate system of visual field of arthropods. Fortschr. Zool. 21:258-593.

Wheeler, J. W., Happ, G. M., Araujo, J. and Pasteels, J. M. 1972. Gamma-dodecalactone from rove beetles. Tetrahedron Lett. 46:4635-4638.

Wheeler, J. W., Oh, S. K., Benfield, E. F., and Neff, S. E. 1972. Cyclopentanoid norsesquiterpens from gyrinid beetles. Amer. Chem. Soc. J. 94:7589-7590.

Wigglesworth, V. B. 1973. Signifigance of Apolysis' in moulting of insects. Roy. Entomol. Soc. London Proc. Ser. A Gen. Entomol. 47:141-149.

Yinon, U. 1970. Electrophysiological and behavioural response of a stored product beetle to light. J. Stored Prod. Res. 6:195-198.

Young, J. C. 1973. Identification of linalool produced by two species of bark beetles of genus Ips. J. Insect Physiol. 19: 1615-1622.

Zelazny, B. and Neville, A. C. 1972. Quantitative studies on fibril orientation in beetle endocuticle. J. Insect Physiol. 18:2095-2121.

Zlotkin, E. 1973. Toxic effects of phenoloxidase from haemolymph of tenbrionid beetles. J. Insect Physiol. 19:1057-1065.

Zwilling, R., Medugorac, I. and Mella, K. 1972. Evolution of endopeptidases. XIv. Nontryptic cleavage specificity of a BAee hydrolyzing enzyme from Tenebrio molitor. Compar. Biochem. Physiol. 43:419-424.

SPECIATION

Angus, R. B. 1973. Pleistocene Helophorus from Borislav and Starunia in western Ukraine, with a reinterpretation of M. Lomnicki's species, dexcription of a new siberian species, and comparison with Bri. Roy Soc. London Phil Trans Ser B. Biol. Sci.23:299-326.

Ashworth, A. C. and Brophy, J. A. 1972. Late Quarternary fossil beetle assemblage from Missouri Coteau, North Dakota. Geol. Soc. Amer. Bull. 83:2981-2988.

Ass, M. J. 1973. Claws of Arthropoda, their origin, evolution and function. Dtsch. Entomol. Z. 20:127-152.

Astaurov, B. L. 1972. Parthenogenesis and polyploidy in animal evolution. Biol. Zh. Arm. 25:3-11.

Blackith, R. E. 1973. Clues to Mesozoic evolution of Eumastacidae. Acrida 2:V-xviii.

Buckhold, B. Slater, J. V., Silver, I. L., Yang, T. and Tobias, C. A. 1971. Some effects of spaceflight on the flour beetle, Tribolium confusum. In U. S. National Aeronautics and Space Adm., Sci. and Tech. Inf. Off. The Experiments of Biosatellite II. P. 79-95.

Carlson, C. W. 1973. Amino acid compositions of cytochrome C from four Hymenopteran species: evolutionary significance. Syst. Zool. 22:77-83.

Cornell, J. F. 1972. Eyeless beetles of North Carolina with notes on their ecology and evolution. Elisha. Mitchell Sci. Soc. J. 88:260-265.

Crowson, R. A. 1973. On a new superfamily Artematopoidca of polyphagan beetles with definition of two new fossil genera from Baltic Amber. J. Nat. Hist. 7:225-238.

Galewski, K. 1972. Female external genital apparatus in European species of Haliplidae and their significance for species identication. Acad Polon Sci. Bull. Ser. Sci. Biol. 20:783-788.

Heie, O. E. 1972. Some new fossil aphids from Baltic amber in Copenhagen collection. Steenstrupia 2:247-262.

Hink, W. F. 1972. A catalog of invertebrate cell lines. Invertebr. Tissue Cult. 2:363-387.

Klausnitzer, B. and Klausnitzer, H. 1972. Lady beetles. Neue Brehm-bucherei. 51, 88 P.

Koponen, M. 1973. Subfossil forest insects from Piilonsuo Moor in southern Finland. Acta Entomol. Fenn. 29, 84 P.

Kryzhanovskii, O. L. 1973. Directions of evolution in Histeridae. Zool. Zh. 52:870-875.

Kukalova-peck, J. 1972. Unusual structures in Paleozoic insect orders Megasecoptera and Palaeodictyoptera, with a description of a new family. J. Psyche. 79:243-268.

Lewis, S. E. 1973. A new species of fossil Tropidia from Ruby River Basin of southwestern Montana. Entomol. Soc. Amer. Ann. 66: 487-488.

Matis, E. G. 1972. Types of life cycles of Cassidinae from Kazakhstan and middle Asia and some features of their evolution. Zool. Zh. 51:1659-1664.

McAlpine, J. F. 1973. A fossil ironomyiid fly from Canadian amber. Can. Entomol. 105:105-111.

McAlpine, D. K. 1972. Insects and continental drift. Australian Natur. Hist. 17:274-278.

Norberg, R. A. 1972. Evolution of flight in insects. Zool. Scr. 1:247-250.

Opler, P. A. 1973. Fossil lepidopterous leaf mines demonstrate age of some insect-plant relationships. Science 179:1321-1323.

Quilty, P. G. 1972. A middle Cambrian Xiphosuran (?) from western Tasmania. R. Soc. Tasmania Pap Proc. 106:21-23.

Rodendorf, B. B. 1972. Devonian eopterids were not insects but Eumalacostraceans. Entomol. Rev. 51:58-59.

Smart, J. 1972. Insect and plant: progressive palaeoecological integration. Roy. Entomol. Soc. London Symp. 6:143-155.

Southwood, T. R. E. 1972. Insect/plant relationship - an evolutionary perspective. Roy. Entomol. Soc. London Symp. 6:3-30.

Stormer, L. 1972. Arthropods from Lower Devonian of Alken an der Mosel, Germany. 2. Xiphosura. Senekenbergiana Lethaca 53: 1-29.

Szarski, H. 1973. Protein diversity and mechanism of evolution. Kosmos, Ser. A. Biol. 22:249-254.

Tarrier, M. 1972. On convergent development of varied lines of Dysmictocarabus solieri Dej. green gilt. Entomops 25:25-28.

Tyshchenko, V. P. 1973. Origin and evolution of photoperiodism in insects. Zh. Obshch. Biol. 24:538-558.

Vepsalainen, K. 1972. Gerris thoracicus f. fuscinotum Reuter - a teneral phenomenon. Notulae Entomol. 52:113-114.

STATISTICAL METHODS

Stark, R. W. 1973. Systems analysis of insect populations. N. Y. Acad. Sci. Ann. 217:50-57.

Williams, C. B. 1972. A graphical method of demonstrating allometric growth, with special reference to antennae of Thysanoptera. J. Entomol. Ser. B, Taxon. 41:151-152.

TAXONOMIC STUDIES

Abdullaeva, E. A. 1973. On study of fauna of acaroid mites in Azerbaijan. Izv. Akad Nauk Az. SSR, Ser. Biol. Nauk. 3:70-77.

Anonymous, 1973. Pest identification from air, or finding insects from 10,000 feet up. Aerial Appl. 11:4-5.

Ardoin, P. 1973. New species of Tenebrionidae from Laos. 3. Bull. Soc. Entomol. Fr. 78:42-48.

_____ 1973. Two new African species belonging to genus Stronglium Kirdy. Bull. Soc. Entomol. Fr. 78:114-117.

_____ 1973. Two new African species of Coleoptera Tenebrionidae belonging to Royal Museum of Central Africa, Tervuren. Rev. Zool. Bot. Afr. 87:126-130.

Baker, W. V. 1973. Genitalia of three species of Pentalobus. J. Nat. Hist. 7:435-440.

Berry, R. L. 1973. Cerenopini and Eulabini, two tribes previously included in Scaurini. Entomol. Soc. Amer. Ann. 66:70-77.

Blackith, R. E. 1972. Modern trends in taxonomic research. In International Study Conference on the Current and Futu Re Problems of Acridology, London, 1970. Proceedings P. 21-26.

Chujo, M. 1973. Five new species of Tenebrionidae from Japan and her adjacent regions, with a new record of Gonocephalum coenosum Kaszab from Senkaku Islands. Esakia 8:13-23.

_____ 1973. Two new tenebrioid species from Borneo and Thailand. Esakia 8:25-29.

Dajoz, R. 1972. Biology and antomy of Scarabaeus semipunctatus F. Comparison with some other coprophagous Coleoptera. Cah. Natur. 28:61-79.

Galewski, K. 1973. On syntopic species and a pair-species occurrence pattern in larvae of Dytiscidae. Pol. Pismo Entomol. 43:225-231.

Graves, R. C. 1973. Tiger beetles of Arkansas, Louisiana and Mississippi. Amer. Entomol. Soc. Trans. 99:157-203.

Horion, A. 1973. New edition of catalog of Central European Coleoptera. Entomol. Bl. 69:3-4.

Kaszab, Z. 1972. New Tenebrionidae species from Laos. Munich Mus. G. Frey Entomol. Arb. 23:287-297.

_____ 1973. Tenebrionidae from Nepal. Acta. Zool. 19:23-74.

Kaszab, Z. 1973. Tenebrionidae fauna of Afghanistan. Entomol.Scand. 4:35-58.

_____ 1973. New contribution to literature on tenebrionids of Afghanistan. Entomol. Scand. 4:35-58.

Kiriakoff, A. G. 1972. Modern opinions concerning taxonomy of Hexapoda. Biol. Jaarb. 40:240-253.

Medvedev, G. S. 1972. A new darkling beetle species of genus Leptodes Sol. from Aral Coast. Entomol. Rev. 51:77-80.

Nakane, T. 1973. Notes on synoymy and on some types of Japanese Coleoptera in certain European collections. II. Heteromera. 1. Nat. Sci. Mus. 16:1-8.

Parkin, P., Parkin, D. T., Ewing, A. W. and Ford, H. A. 1972. A report on arthropods collected by Edinburgh University Galapagos Islands Expedition, 1968. Pan-pacific Entomol. 48:100-107.

Paulus, H. 1972. State of knowledge concerning family Byrrhidae. Rovartani Kozlemenyek 25:335-348.

Petrovitz, R. 1972. When and how should Coleoptera be affixed? Koleopterol. Rundsch. 50:35-36.

Pierre, F. 1972. Caedius from African continent: Ecology, biogeography and taxonomy. Soc. Entomol. France Ann. 8:951-981.

Reichardt, H. 1972. Monograph of Lebia. Arq. Zool. 23:1-72.

Retan, A. H. and Curtis, J. 1972. Lady beetles. Washington State University Cooperative Extension Service Wash. State Univ. Ext. Em. 3705, 2 P.

Skopin, N. G. 1972. Darkling beetles of genera Diesia Fisch. W, and Platyesia, gen. n. Entomol. Rev. 51:70-76.

_____ 1972. Revision of Tenebrionidae, genus Stalagmoptera Solsky, 1875. Munich Mus. G. Frey Entomol. Arb. 23:298-313.

Spilman, T. J. 1972. An amendment to proposal concerning Uloma. Z.N. 1979. Bull. Zool. Nomencl. 29:194-195.

Tadzhibaev, M. 1972. Tenebrionids of low-mountain area of southern Tadzhikistan. Entomol. Rev. 51:165-169.

Triplehorn, C. A. 1973. A review of Strongylium of America north of Mexico, with descriptions of two new species. Amer. Entomol. Soc. Trans. 99:1-27.

Ueno, S. I. 1973. Two new cavenicolous Kurasawatrechus from northern side of central Honshu, Japan. Annot. Zool. Jap. 46:127-134.

Van Valen, L. 1973. Are categories in different phyla comparable? Taxon 22:333-373.

TECHNIQUE

Anonymous, 1973. Automatic counting and classification of insects. West Cotton Prod. Conf. Sum-proc. P. 23-26.

_____ 1973. Inert atmosphere vs. stored grain pests. Agric. Res. 22:12.

Atmar, J. W. 1973. Construction of a device to identify and count insects automatically. Environ Entomol. 2:713-716.

_____ 1973. An advanced environmental chamber control system. Environ. Entomol. 2:88-94.

Baturin, V. V. 1973. Fluorescent microscopy in hematology of insects. Zool. Zh. 52:203-207.

Bignell, D. E. 1973. A modified technique of tissue incubation for insect fat body. Experientia 29:252-254.

Bourgogne, J. 1973. How to send prepared insects without danger. Alexanor 8:20-22.

Brickey, P. A. 1973. Method for determining direction of insect boring through food packaging materials. Ass Offic. Anal. Chem. J. 56:640-642.

Cherry, E. T. 1973. Use of pheromone traps for survey of overwintering boll weevil populations in West Tennessee. Tenn. Farm. Home Sci. Prog. Rep. 86:20-21.

Craig, D. A. 1973. A simple accessory for examining pinned insect material at low magnifications in a stereoscan, scanning electron microscope. Can. Entomol. 105:995-996.

Douwes, P. and Stenram, H. 1972. Stationary light trap for catching insects. Entomol. Tidskr. 93:70-82.

Drechsel, U. 1972. A method for serial production of insect genital preparation. Deut. Entomol. Z. 19:327-329.

Fye, R. E., Patana, R., Jackson, C. G. and Bryan, D. Eu. S. 1972. An inexpensive mobile rack for rearing insects. Agricultural Research Service. U.S. Agr. Res. Serv. Ars. 33: 138, 3 P.

Girish, G. K., Goyal, R. K., Srivastava, P. K. and Drishnamurthy, K. 1972. An easy method for detection of eggs of Tribolium castaneum and Trogoderma granarium in milled products/debris. Bull. Grain Technol. 10:97-99.

Guimaraes, J. M. 1971. An efficient bleaching method for microscopical mounts of insects. Agron. Lusit. 33:145-149.

Haapala, O. K. 1973. Changes caused by air-drying and alcohol dehydration of spread insect sperm and fungal spore chromosome fibres. Exp. Cell Res. 79:235-239.

Hawkes, R. B. 1972. A fluorescent dye technique for marking insect eggs in predation studies. J. Econ. Entomol. 65:1477-1478.

Houyez, P. 1973. Freezing of unflattened butterflies: Statement. Alexanor 8:19.

Keiser, I., Chambers, D. L. and Schneider, E. L. 1972. Modified commercial containers as laboratory cages, watering devices, and egging receptacles for fruit flies. J. Econ. Entomol. 65:1514-6.

Khlistovskii, E. D. 1973. Large-scale reproduction of plant-eating insects on artificial media. Obz. Inf. Minist. Sel'sk Khoz. SSSR Vses Nauchno-Issled Inst. Inf. Tekh-Ekon Issled Sel'sk Khoz. 645A , 59 P.

Kryzhanovskiy, O. L. 1972. On methods for preparing genitalia of beetles. Entomol. Rev. 51:121-122.

Larochelle, A. 1973. Collecting hibernating ground beetles under snow. Entomol. News 84:82.

Larson, W. L., Gogala, M. and Ali, M. A. 1972. A computer controlled microspectrophotometer for study of visual pigments. Rev. Can. Biol. 31:301-311.

Loschiavo, S. R. 1973. An improved trap to detect beetles in stored grain. Can. Entomol. 105:437-440.

Martinez-Lopez, G. 1973. A simple and accurate method for measurement of growth of cell monolayers. In Vitro 9:1-7.

Marzke, F. O. 1973. Spectral responses of six species of stored-product insects to visible light. Ga. Entomol. Soc. J. 8:195-200.

Middleton, S. G., Giles, F. E., and Grau, J. G. 1973. Preparation of insect specimens for analysis by means of atomic-absorption spectrophotometry. Entomol. Soc. Amer. Ann. 66:226-227.

Moody, R. and Bailey, J. C. 1972. A small cage for insect studies on seeding soybeans. J. Econ. Entomol. 65:1501-1502.

Navarro, S. and Donahaye, E. 1972. An apparatus for studying effects of controlled low pressures and compositions of atmospheric gases on insects. J. Stored Prod. Res. 8:223-226.

Nei, T. 1973. Direct observation of frozen specimens with a scanning electron microscope. J. Electronmicrosc. 22:185-190.

Nigam, B. S., Perti, S. L. and Agarwal, P. N. 1972. Insect-proof packaging of materials. Pesticides 1:Iii-vii.

Peacock, J. W. 1973. Laboratory investigations of frass of Scolytus multistriatus as a source of pheromone. Environ Entomol. 2:355-359.

Pixton, W. W. and Warburton, S. 1973. Determination of moisture content and equilibrium relative humidity of dried fruit-sultanas. J. Stored Prod. Res. 8:263-270.

Polles, S. G. and Payne, J. A. 1972. An improved emergence trap for adult pecan weevils. J. Econ. Entomol. 65:1529.

Proctor, D. L. 1972. A technique for marking stored product insects when studying dispersion. J. Stored Prod. Res. 8:233-234.

Schoot, P. 1973. A battery driven light source. Entomol. Z. 83: 124-127.

Speight, M. C. D. 1973. A greased-belt technique for extraction of arthropods from organic debris. Pedobiologia 13:99-106.

Stahnke, H. L. 1972. UV light, a useful field tool. Bioscience 22: 604-607.

Szentesi, A. 1972. Studies on mass rearing of Acanthoscelides obtectus Say. Acta. Phytopathol. 7:456-465.

Tan, K. H. 1973. Peracetic acid as an oxidizer to replace permanganate in staining of neurosecretory cells. Stain. Techno. 48:140-141.

Touflet, P. 1973. Construction of an oven for drying insects. Alexanor 8:39-46.

Townes, H. 1973. Comments on design of insect nets. Entomol. News 84:1-7.

_____ 1973. A scientifically designed drawer for scientific insect collections. Entomol. News 84:53-61.

Trottier, R. 1973. A controlled temperature and humidity cabinet for recording emergence behaviour of aquatic insects. Can. Entomol. 105:971-974.

Tshernyshev, W. B. 1972. Catches of insects by light trap and solar activity. Zool. Anz. 188:452-459.

Unger, W. 1973. House beetle rearing for testing of wood preservatives. Holzindustrie 26:263-265.

Ungureanu, E. M. 1972. Methods for dissecting dry insects and insects preserved in fixative solutions or by refrigeration. World Health Organ Bull. 47:239-244.

Wightman, J. A. 1973. Rearing Costelytra zealandica. Obtaining eggs from field collected adults. N. Z. J. Sci. 16:21025.

Willemstein, S. C. 1973. A note on how to prepare insect genitalia without loss of stomach contents for pollen analytical research. Entomol. Ber. 33:69.

Yoon, J. S. 1973. A technique for improving salivary chromosome preparations. Experientia 29:639-641.

TERATOLOGY

Anonymous, 1973. Juvenile hormone makes monster insects. Agric. Res. 21:3-.

Ashworth, A. C. 1972. Deformed head of a fossil Plateumaris sericea L. Entomol. Mon. Mag. 108:65.

Hertel, G. D. 1972. Abnormalities of antennae, elytra, and head position in pales weevil, Hylobius pales. Fla. Entomol. 55:283-285.

Luca, Y. de 1972. Heterodynamic splitting of parts of antennae of Bruchidius biguttatus. Soc. Sci. Natur. Ouest. France Bull. 69: 3-4.

Lucinska, A. 1972. Preliminary communication on teratological changes in chewing-lice. Wiad Parazytol. 18:535-536.

Marer, P. J. 1972. An eye deformity in a tarantula spider, Aphonopelma reversum. Panpacific Entomol. 48:221-225.

Meyer, M. 1973. An extraordinary gynander of auroral spot. Entomol. Z. 83:149-152.

York, A. C., Koons, F. A. and Gyrisco, G. G. 1973. Abnormal presence of thoracic legs on larva of alfalfa snout beetle Brachyrhinus ligustici Entomol. Soc. Amer. Ann. 66:474-475.

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