TRIBOLIUM INFORMATION BULLETIN

Number 25

1985

EDITORS

A. Sokoloff, School of Natural Sciences, California State College, San Bernardino, California, and
M. Hani Soliman, Genetics Research Laboratories, University of New England, Armidale, N. S. W. 2351, Australia

TRIBOLIUM INFORMATION BULLETIN

Number 25

July, 1985

Bibliography

NOTE

TIB is not an official publication. Information appearing in the bulletin should not be used for publication without the consent of the author. Unless the note "Reference Authorized" (or an asterisk) accompanies the article, permission to quote from the bulletin must be obtained from the authors, who are solely responsible for the contents of their articles.

FOREWORD

The editors are indebted to Alexandra Sokoloff, Elaine Sokoloff and Michael Sokoloff, for assistance in the publication and distribution of TIB-25.

Stock Lists

Note: The present listing of laboratories is greatly reduced from the previous issue of TIB. M. Hani Soliman contacted the various laboratories previously listed in TIB-24 and those laboratories still carrying research with *Tribolium* remained in this list, while those not responding or those who are no longer active in *Tribolium* research were dropped from the list. If anyone was dropped but continues to be active in *Tribolium* research, please contact one of the editors and provide a current list of stocks for reinstatement.

ANNOUNCEMENT

Dr. A. E. Bell has provided the editors of the Tribolium Information Bulletin with the following letter.

"Dear Dr. Bell,

Perhaps you recall sending to our institute in 1976 subcultures of your base populations (+, b and p). Together with the population 'rust-red flour beetle' (TIB 17:57) these populations havb e been inbred in my lab for 40 generations by full sibbing. Presently we have available++

24 lines from population +
3 lines from a wild type population from England,
6 lines from population 'rust-red flour beetle", and
16 lines from population p.

After completion of some quantitative studies with these inbred stocks, we are no longer able to continue this research because of shortage in our funds. In view of the labor invested to develop the materials, we would like to offer the materials to institutions working with Tribolium.

May I therefore ask you, whether you would be interested in these stocks or whether you know of colleagues that might be interested? Since our technician in charge of this research program has meanwhile overtaken other tasks, I would be interested to hear from you as soon as possible."

Investigators interested in this material should write to

Dr. H.H.Geiger
Professor of Population Genetics
Universitat Hohenheim
Institut fur Pflanzenzuchtung, Saatgutforschung und Populationsgentik
D-7000 Stuttgart 70 (Hohenheim), Germany

STOCK LISTS

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

Tribolium confusum

1. "+" - a wild type strain derived from Genetics Department, University of California, Berkeley.

2. Black - an autosomal semi-dominant body color mutant. From 1.

3. Miniature - an autosomal recessive body size mutant. From 1.

4. Short elytra - an autosomal dominant elytron-size mutant. Low viability in adults, indicating a recessive lethal gene.

5. Blistered elytra - an autosomal recessive mutant. Low viability.

Tribolium brevicornis.

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

(Ed.).

BRIDGEPORT, CONNECTICUT
UNIVERSITY OF BRIDGEPORT
DEPARTMENT OF BIOLOGY

Tribolium confusum

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

(Ed.).

Stock Lists

BURLINGTON, NORTH CAROLINA
CAROLINA BIOLOGICAL SUPPLY COMPANY

Tribolium castaneum

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

Tribolium confusum

1. Wild

(Ed.).

BURLINGTON, VERMONT 05401
UNIVERSITY OF VERMONT
DEPARTMENT OF ZOOLOGY

Tribolium castaneum

Unsaturated fatty acid corn oil sensitive (cos)

Tribolium confusum

Chicago wild
black

Tribolium madens

Tribolium brevicornis

All stocks derived from stocks at University of Rhode Island.

(Ed.).

Stock Lists

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

Tribolium castaneum

I. Wild type strains

1. Purdue + Foundation

II. Mutant strains

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

D.C. Englert

CARLISLE, PENNSYLVANIA
DICKINSON COLLEGE
DEPARTMENT OF BIOLOGY

I. Wild type strains (T. confusum)

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 (T. confusum).

1. Black -Sault Ste Marie (1956)
2. Ebony - Chicago (1957)
3. Eyespot - sex-linked - from a I.1 strain 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- from insects found in NYC, 1955.

Dan McDonald

Stock Lists

CHARLOTTESVILLE, VIRGINIA
UNIVERSITY OF VIRGINIA
DEPARTMENT OF BIOLOGY

Tribolium castaneum

I. Wild type strains

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

II. Mutant strains

1. McGill black — University of Chicago

(Ed.).

CHICAGO, ILLINOIS
UNIVERSITY OF CHICAGO
DEPARTMENT OF BIOLOGY

I. Wild type strains

A. Tribolium castaneum

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

B. Tribolium confusum

1. "Chicago"
2. cI an inbred strain derived from the Chicago strain)
3. cII (same)
4. cIII (same)
5. cIV (same)

C. Tribolium madens

D. Latheticus oryzae

(Ed.).

Stock Lists

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

I. Wild type strains

A. Callosobruchus maculatus

B. Oryzaephilus surinamensis

C. Tribolium castaneum

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

D. Tribolium confusum

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

II. Mutant

A. T. confusum ebony, an autosomal recessive body color mutant.,
B. T. castaneum black

III. Other wild type strains
A. Callosobruchus maculatus
B. Oryzaephilus surinamensis

D. B. Mertz

CORAL GABLES, FLORIDA
UNIVERSITY OF MIAMI
DEPARTMENT OF BIOLOGY

I. wild type strains

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

II. Mutant

T. confusum - ebony — Sokoloff
T. castaneum - jet - from Chicago wild
T. cataneum - Chicago black, via Sokoloff
T. castaneum - sooty
T. castaneum - dark sooty, from sooty
(Ed.)

(Ed.).

Stock Lists

CORVALLIS, OREGON
OREGON STATE UNIVERSITY
DEPARTMENT OF ZOOLOGY

I. Wild type strains

A. Tribolium castaneum
1. Oregon (synthetic)

B. Tribolium confusum
1. Oregon synthetic

II. Mutant strains

A. Tribolium castaneum

1. aa, mc, j
2. ap^D, s
3. apt, b
4. b,mc,p
5. bb
6. Be
7. dve,pd
8. Fta
9. h^c
10. mc^c, s
11. nd, s
12. p, lod
13. Rd, s
14. sa-2, +/s
15. Sa-2, s
16. ser, py, r
17. Spa
18. wd, s

Tribolium confusum

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

Peter S. Dawson

Stock Lists

DAVIS, CALIFORNIA
UNIVERSITY OF CALIFORNIA
DEPT. OF ANIMAL SCIENCE

Research on Tribolium has been discontinued

(Ed.).

DENTON, TEXAS
TEXAS WOMAN'S UNIVERSITY
DEPARTMENT OF BIOLOGY

I. Wild type strains and origin

A. Tribolium castaneum (Brazil cI)
B. Tribolium confusum (Chicago Standard)

(Ed.).

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

Tribolium castaneum wild type, Purdue University

(Ed.).

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

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

(Ed.).

Stock Lists

HUNTSVILLE, TEXAS
SAM HOUSTON STATE UNIVERSITY
BIOLOGY DEPARTMENT

A. Dewees no longer works with *Tribolium*. All *Tribolium* stocks have been discontinued.

(Ed.).

IMMACULATA, PENNSYLVANIA
IMMACULATA COLLEGE, CANCER RESEARCH UNIT

Dr. S. K. Ladisch is no longer associated with the college. All stocks are presumed lost.

(Ed.).

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

Tribolium castaneum

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

Tribolium confusum

Chicago	Park 1955
black	via San Bernardino
pearl	via San Bernardino

Tribolium madens	via San Bernardino
Tribolium brevicornis	via San Bernardino

(Ed.).

Stock Lists

LAFAYETTE, INDIANA 47907
PURDUE UNIVERSITY
ANIMAL SCIENCES DEPARTMENT

Tribolium castaneum

I. Wild type strains

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

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

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

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

A.E. Bell.

LAURINGBURG, NORTH CAROLINA
ST. ANDREWS COLLEGE

Tribolium confusum-- Wild type stock infected with Nosema whitei (Ed.).

LEXINGTON, KENTUCKY
UNIVERSITY OF KENTUCKY
AGRICULTURAL EXPERIMENT STATION

I. Base populations

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

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

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

Stock Lists

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

(Ed.).

MADISON, WISCONSIN
UNIVERSITY OF WISCONSIN

Xyleborus ferrugineus

I. Wild type strain WIS-1 from Costa Rica

II. "germfree" strain WIS-2, derived from WIS-1.

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

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

(Reproduced from an earlier issue of TIB, Ed.).

Stock Lists

MANHATTAN, KANSAS
KANSAS STATE UNIVERSITY
DEPARTMENT OF ENTOMOLOGY

LEPIDOPTERA

Phycitidae: Cadra cautella and Plodia interpunctella

Gelechiidae: wild and red eyed strains.

Pyralidae: Corcyra cephalonica

COLEOPTERA

Anobiidae: Lasioderma serricorne and Stegobium paniceum

Bostrichidae: Rhyzopertha dominica

Bruchidae: Callosobruchus maculatus

Cucujidae; Cryptolestes ferrugineus, C. pusilius,

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

Dermestidae: Trogoderma inclusum, Attagenus megatoma

Ostomatidae: Tenebroides mauritanicus

Ptinidae: Gibbium psylloides

Silvanidae: Ahasverus advena, Oryzaephilus surinamensis, O. mercator

Tenebrionidae:

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

Valerie Wright

Stock Lists

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

Tribolium castaneum

I. Insecticide-resitant strains

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

II. Mutant strains

1. au, lod, p--aureate, light ocular diaphragm, pearl (III,III,II) — from San Bernardino, 1981
2. sa, c--short antenna, chestnut (VII, VII) — "
3. pd, py, pte--paddle, pygmy, platinum eye (I, I, I) — "
4. mc, j--microcephalic, jet (V,V) — "
5. Dch--Dachs (II) — "
6. rb--ruby (V) — "
7. mas--missing abdominal sternites (II) — "
8. s--sooty (IV) — "
9. sq-like (squint-like (VIII?) — "
10. mxp--maxillopedia (II) — "
11. Mo--Microphthalmic (VI) — "
12. fas3a--fused antennal segments (V) — "
13. p-- pearl (II) — "
14. B, ap--black, antennapedia (III, VIII) — "
15. b, apt--black, alate prothorax (III, IX) — "
16. h, s--hazel, sooty (IV, IV) — "
17. b--black (III) — "
18. b^t--tawny (III) — "
19. Chr--Charcoal (III) — "
20. b^d--dusky (III) — new mutant, Manhattan, 1983
21. Rmal--Resistance to malathion (VI) — "

22. Rd-- Reindeer (linkage group not determined)
23. Be, s --Bar eye, sooty (IV, IV)
24. Fta--Fused tarsi and antennae (VII)
25. Sa--Short antennae (VII)
26. Spa, s--Spatulate, sooty (IV,IV)
27. mas, au, s, rb, Rmal+, ap (multimarker strain).

R.W. Beeman

SAN BERNARDINO, CALIFORNIA
CALIFORNIA STATE UNIVERSITY
BIOLOGY DEPARTMENT

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

II. Tribolium audax

III. Tribolium brevicornis

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

IV. Tribolium castaneum

A. Wild type strains

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

B. Mutants

1. Sex-linked

26. dve--divergent elytra	Chazy, 1959
30. pd--paddle	Park, 1955

Stock Lists

34.	pte	Berkeley, 1965
36.	py--pygmy	Chazy, 1959
38.	r--red	Chazy, 1959
39.	r^{D} --red	Berkeley
54.	pd, r--paddle, red	
55.	py, r, M^{r} --pygmy, red, red modifier	
59.	r, sp--red spotted	
61.	pd, pte--paddle, platinum eye	

Autosomal

63.	p--pearl II New York	1976
64.	p^{Pk} --pink II	Chazy, 1959
65.	p pearl II	Park 1955
66.	p^{S} pearl II	
76.	au--aureate III	
78.	b--black III	
81.	b^{S-1} -- black, Brazil	
82.	b--black	Chicago 1955
84.	b--black	McGill 1959
85.	b--black	McGill via New York, 1976
86.	b--black	NASA 1959
88.	b--black synthetic (Chicago/McGill)	
90.	Chr--Charcoal III	
91.	lod p--light ocular diaphragm, pearl III,II	
94.	msg--melanotic stink glands III	
96.	mt--mottled	
98.	b^{t} --tawny III	
105.	fas-2--fused antennal segments-2 IV	
107.	ap, ju--antennapedia, juvenile urogomphi	
113.	s--sooty (Berkeley synthetic background) IV	
114.	s--sooty (New York) IV	
135.	j--jet V	
136.	j^{AS} --jet V	
139.	mc--microcephalic V	Chazy, 1959
140.	mc-1 microcephalic-1 (eyeless) V	Hayward 1967
143.	fas-3a fused antennal segments 3a V	Berkeley, 1963
148.	m--maroon V	Purdue 1970
150.	rb--ruby	Berkeley, 1962
156.	Mo--Microphthalmic VI	Chazy, 1959
162.	sa=ca--short antenna VII	Cold Sprg. Hbr. 1960
165.	c--chetnut	Purdue, 1962
168.	ju-7--juvenile urogomphi	Purdue
170.	ble--blistered elytra	Berkeley 1962
173.	c, Rd	Corvallis 1975
180.	ap^{S} --antennapedia VIII	Berkeley 1962

Stock Lists

D

186. sq ---squint VIII Chazy 1959
189. apt---alate prothorax IX Berkeley 1963
192. ptl---prothoraxless IX Chazy 1959
194. ppas---partially pointed abdominal sternites Berk. 1963
196. mas---missing abdominal sternites II Berkeley 1964
228. Dch---Dachs II San Bernardino 1976
230. fas-1---fused antennal segments-1 Chazy 1959
233. imp---incomplete mesothoracic projections
238. mxp---maxillopedia II berkeley 1965
240. Npp---Non-punctate prothorax, a phenodeviant
245. pec---pectinate
252. sc---scar Purdue
259. w---white Purdue
261. fas-8---fused antennal segments-8
271. Gi---Giant PIL
278. la---long abdomen PIL
290. Veracruz small
298. fas-9 fused antennal segments--9 San Bernardino, 1975
295. pd,p---paddle, pearl I, II
296. pd,p,b---paddle, pearl black I, II, III
297. sp,p---spotted, pearl I, II
299. py,i,p---pygmy, ivory, pearl I, II, II
301. p, au, lod---pearl, aureate, light ocular diaphragm II, III, III.
302. p, au, mc---pearl, aureate, microcephalic II, III, V
303. p,b---pearl, black (II, III)
304. p,au,lod,msg---pearl, aureate, light ocular diaphragm, melanotic stink glands (II, III, III, III)
306. p,b,pe---pearl, black, pointed elytra (II, III,?)
308. p,mc---pearl, microcephalic II, V
310. p,s---pearl, sooty II, IV
312. p,j,Npp---pearl, jet, Non-punctate prothorax II, V
313. p,apt,Mo---pearl, alate prothorax, Microphthalmic II, II, VI.
315. p,mas---pearl, missing abdominal segments II, II
316. p, knp---pearl, knobby prothorax II, II
317. p,aa---pearl, abbreviated appendages II, ?
322. p,Fas-4,b---pearl, Fused antennal segments-4, black II, ?, III
415. mxp,s---maxillopedia, sooty II, IV
416. au, s---aureate, sooty III,IV
417. h, s---hazel, sooty III, IV
428. c, Npp---chestnut, Nonpunctate prothorax VII, ?
430. au,Npp---aureate, Nonpunctate prothorax III, ?
436. au,mc---aureate, microcephalic III, V
442. Df,s,Mo---Deformed, sooty, Microphthalmic ?, IV, VI
444. i,lod,Mo---ivory, light ocular diaphragm, Microphthalmic II, III, VI
445. i,ppas---ivory, partially pointed abdominal sternites II
446. Chr,ap---Charcoal, antennapedia III, VIII
450. au,ble---aureate, blistered elytra III, VII

ELL Pk

454. p /p

462. mas, mc--missing abdominal segments, microcephalic II,V
469. i,lod--ivory, light ocular diaphragm II,III
470. lod,rb--light ocular diaphragm, ruby III, ?
473. fas-6--fused antennal segments-6

V. Tribolium confusum

Wild type strains

1.	Chicago	Park, 1955
2.	Chicago	via Sokal, 1975
3.	McGill	via McDonald
4.	McGill	Stanley, 1958
5.	New York	1961
6.	Sacramento	
7.	San Bernardino	1968
8.	Yugoslavia	1975

Synthetic strains

1. Berkeley

Mutant strains

apt--alate prothorax I
apt,fas-2--alate prothorax, fused antennal segments-2
b-black III
b,cas,p--black, creased abdominal segments, pearl
b,lod,p--black, light ocular diaphragm, pearl
b,p--black, pearl
b,rus--black, ruby spot
b,rus,spl--black, ruby spot, split
b,twa--black, twisted abdomen
b-2--black-2
b-2/b McGill--synthetic black
bZ,rZ--black Zagreb, red Zagreb
(black strains from Carlisle, Pa., Chicago, Donner lab, Georgia, McGill, Sault saint Marie, Winnipeg and Yugoslavia)
b-Chicago/b McGill--synthetic black
b-Mcgill,fas--black, fused antennal segments
b-Mcgill,p--black, pearl
b-SSM,spl--black, split
ble--blistered elytra V
ble,e--blistered elytra, ebony
car,p--carmine, pearl
cas--creased abdominal segments II
cla-claret
cru--crumpled I
dpe--dirty pearl eye II
dj--disjoined VI
dt--dent (see umb--umbilicus)
dt,p--dent, pearl
e--ebony V Chicago, 1955
(other ebony alleles)

Stock Lists

e,fas-3--ebony, fused antennal segments-3
e-2--ebony-2 (not allelic with e) II
e-2,fas-1--ebony, fused antennal segments-1
ele--elongated elytra
ele,fas-2--elongated elytra, fused antennal segments-2
es--eyespot I
es,fas-1--eyespot, fused antennal segments-1
es,fas,msg--eyespot, fused antennal segments melanotic stink glands
es,fas,sti--eyespot, fused antennal segments, sternites incomplete
eu,fas-2--extra urogomphi, fused antennal segments-2
fas-2--fused antennal segments-2 II
fas-2,lod,msg,p--fused antennal segments-2, light ocular diaphragm, melanotic stink glands, pearl
fas-2,lod,p--fused antennal segments-2, light ocular diaphragm pearl
fas-2,msg--fused antennal segments-2, melanotic stink glands
fas-3--fused antennal segments-3
fro--frosted
lod,rus--light ocular diaphragm, ruby spot
msg--melanotic stink glands III
msg,rus--melanotic stink glands, ruby spot
msg,twa--melanotic stink glands, twisted abdomen
ov-like--overshot-like
p-pearl
p-Slough-pearl
p^R--pearl riboflavinless II
r-red I
r,sh--red, short elytra
r^U--red
r^Z--red from Zagreb
rby--ruby
rus--ruby spot III
sh--short elytra (Berkeley)
sh,sp,twa--short elytra, split, twisted abdomen
sp--split III
sp-1--split-1
twa--twisted abdomen
thu--thumbed IV
thu^S--an allele of thu. IV
thu, Xl--thumbed, Extra large
umb--umbilicus

VI. Tribolium destructor

VII. Tribolium freemani

VIII. Tribolium madens

A. Sokoloff.

Stock Lists

South Orange, New Jersey
Seton Hall University
Department of Biology

T. castaneum

Wild Type Strains

Seton Hall-1
McGill, via California State

Synthetic Strains

Pearl Foundation, via Purdue University

Black Foundation, via Purdue University

Mutant Strains

Ho
Red Via California State

White Via California State

Ca Via California State

Paddle Via California State

Short antenna Via Purdue University

Tribolium confusum Via Carolina Biological Supply

Eliot Krause

Stock Lists

SAVANNAH, GEORGIA
STORED-PRODUCT INSECTS RESEARCH AND DEVELOPMENT LABORATORY

I. Wild type strains

A. Lepidoptera

1. Anagasta kuenniella (Zeller)	N.C. State, Raleigh,
2. Cadra cautella (Walker)	Tifton, Ga.
3. Corcyra cephalonica Stainton	
4. Plodia interpunctella (hubner)	Modesto, Ca.
5. Sitotroga cerealella (Olivier)	Manhattan, Ka
6. Tineola bisselliella (Hummel)	Savannah, Ga.; Ottawa, Can., and Durham, N.H.

b. Coleoptera

1. Acanthoscelides obtectus (say)	
2. Anthrenus flavipes LeConte	Savannah, and Durham
3. Attagenus unicolor (Brahm)	
4. Calloscbruchus analis (Say)	
5. Callosobruchus chinensis (Linnaeius)	
6. Callosobruchus maculatus (Fab.)	Fresno, ca.
7. Callosobruchus phaseoli Gyllenhal)	
8. Caryedon serratus (Olivier)	
9. Cathartus quadricollis (Guerin--Meneville)	Unknown
10. Cryptolestes ferrugineus (Stephens)	
11. Cryptolestes pusillus (Schonherr)	Tifton, Ga.
12. Dermestes maculatus De Geer	Madison, Wis.
13. Lasioderma serricorne (Fab.)	Unknown
14. Oryzaephilus mercator (Fauvel)	Unknown
15. Oryzaephilus surinamensis (L.)	Manhattan, Kan.
16. Rhyzopertha dominica Fab.)	Unknown
17. Sitophilus granarius (L.)	Manhattan, Kan.
18. S. oryzae (L.)	Ark., Calif., Kan., La. Minn. and Tex.
19. S. zeamais Motchulsky	Estill, S.C.
20. Stegobium paniceum (L.)	Madison, Wis.
21. Tenebrio molitor (L.)	Manhattan, Ka, Durnam, N.H.
22. Tenebroides mauritanicus (L.)	Savannah, Ga.
23. Tribolium castaneum (Herbst)	Unknown
24. Tribolium confusum duVal	Manhattan, Kan.
25. Tribolium madens Charpentier	Tifton, Ga.
26. Trogoderma glabrum (Herbst)	Madison, Wis.,
27. T. variabile Ballion	Fresno, Riverside, Ca.

II. mutant strains

A. Plodia interpunctella

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

Stock Lists

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 — "
3. Crumpled elytra — "
4. Blade elytra — "
5. Umbilicus — "
6. Red eye pupae

New mutants

1. peg-leg (pl)--autosomal recessive with appendages extremely reduced in length. Savannah

2. separated elytra (sep)--elytra divergent from proximal end. Savannah

3. creased elytra (cr)--elytra creased and distal portion divergent. Savannah.

R. Davis

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

1. Tribolium brevicornis (two vials)

2. Tribolium castaneum

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

3. Tribolium confusum

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

(Ed.).

Stock Lists

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

I. Wild type strains

A. Coleopterastrains

Dermestidae	
Attagenus megatoma (F.)	Madison, Wis., Savannah, Ga.
A. elongatulus (Casey)	Madison, Wis.
Dermestes maculatus DeGeer	Madison, Wis., U. Minn.
Trogoderma variabile Ballion	Minnesota
Cucujidae	
Cathartus quadricollis (Guerin-Meneville	Savannan
Oryzaephilus surinamensis (L)	"
Silvanidae	
Ahasverus advena Waitl.	Minnesota
Tenebrionidae	
Cyaneus angustus (LeConte)	Winnipeg; Minnesota
Tribolium castaneum (Herbst)	Corvallis, Ore
Tribolium confusum duVal	Unknown
Bruchidae	
Acanthoscelides obtectus (Say)	Winnipeg
Anobiidae	
Lasioderma serricorne (Fab.)	Savannah, Ga.
Bostrichidae	
Rhizopertha dominica (F.)	Manhattan, Ka.
Curculionidae	
Sitophilus granarius (L.)	Unknown
S. oryzae (L.)	"
S. zeamais motsch.	Madison, Wis.

B. Lepidoptera

Pyralidae	
Anagasta kuehniella (Zeller)	Savannah, Ga.
Plodia interpunctella (Hubner)	Manhattan, Ka.
Gelechiidae	
Sitotroga cerealella (Oliver)	Savannah, Ga.

II. Mutant strains

Tribolium castaneum, wd (weird egg) Corvallis, ore.

Attagenus elongatulus C (Black) Madison, Wis.

(Ed.).

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

Coleoptera

Anobiidae
Stegobium paniceum (L.)

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

Bostrichidae
Rhyzopertha dominica (F.)

Bruchidae
Acanthoscelides obtectus (Say)

Cleridae
Necrobia rufipes (Deg.)

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

Curculionidae
Sitophilus granarius (L.)
S. zeamais Motschulsky

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

Ostomidae
Gibbium psylloides (Czemp.)

Silvanidae
Ahasverus advena (Waltl.)
Oryzaephilus surinamensis

Tenebrionidae
Alphitobius diaperinus (Panz.)
Gnathocerus maxillosus (F.)

Stock Lists

Palorus ratzeburgi (Wissm.)
Tribolium brevicornis (LeConte)
T. castaneum (Herbst)
T. confusum Duv.
T. destructor Uytt.--weak culture, may be diseased.
T. madens (Charpentier)

M. Nakashima

Stock Lists

AUSTRALIA

Burnley, Victoria
Victoria Plant Research Institute
Department of Agriculture

COLEOPTERA

Tribolium castaneum

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

Tribolium confusum

Wild type strains
Malathion specific strain

Oryzaephilus surinamensis

Wild type strain
Malathion resistant strain

Oryzaephilus mercator

Alphitobius diaperinus

Cryptolestes ferrugineus

Gnathocerus cornutus
Gnathocerus maxillosus

Latheticus oryzae

Rhyzopertha dominica

Sitophilus granarius
Sitophilus oryzae
Sitophilus zeamais

Tenebroides mauritanicus

LEPIDOPTERA

Ephestia cautella
Ephestia figulella
Galleria mellonella
Plodia interpunctella

P. Williams

Stock Lists

BELGIUM

GEMBLOUX
INSTITUT AGRONOMIQUE DE L'ETAT
ZOOLOGIE GENRALE

No updated list has been received (Ed.).

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

No updateo list has been received (Ed.).

BRAZIL

CAMPINAS, SAO PAULO
INSTITUTO AGRONOMICO, SECAO DE ENTOMOLOGIA

No updated list has been received (Ed.).

PIRACICABA, STATE OF SAO PAULO
CENTRO DE ENERGIA NUCLEAR NA AGRICULTURA
DEPARTMENT OF RADICENTOMOLOGY

No updated list has been received (Ed.).

CANADA

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

Tribolium castaneum

Purdue Foundation from Purdue, 1960
pygmy from Tribolium Stock Center, San Bernardino.

For G.W. Friars, Dianne Winkelman

COLOMBIA

BOGOTA, COLOMBIA
UNIVERSIDAD NACIONAL DE COLOMBIA
DEPARTAMENTO DE BIOLOGIA
APDO. AEREO #23227

Tribolium castaneum

Wild type strains

1. Apulo	Cundinamarca, Col.	1982
2. Bogota	Inst. Publ. Health,	1978
3. Bucaramanga	Trichogramma lab.,	1981
4. Cartagena	Cartagena, Col.	1980

Mutant strains discovered in Colombia

antennapedia (1981)
bifurcated antenna (1980)
fused antennal segments (1980)
miniature appendaged (ma) (1981)
Charcoal (1979)
vestigial elytra (1981)
black? 1982
narrow eye (sq?) (1980)
dark grey eye (c?) (1980)
pearl eye (p?) (1982)
platinum eye (pte?) (1981)
rose eye (p^{Pk} ?) (1980)
deformed legs (dfl?) (1980)
twisted legs (1981)

Fernando Nunez del Castillo

(For original Spanish names of these mutants, see TIB 24, Ed.).

Stock Lists

DENMARK

LYNGBY
STATENS SKADEDYRLABORATORIUM
(DANISH PEST INFESTATION LABORATORY)

Acheta domestica
Aedes aegypti
Anthrenus flavipes (vorax)
Anthrenus museorum
Anthrenus verbasci
Attagenus smirnovi
Attagenus unicolor (piceus)
Attagenus woodroffei
Blatta orientalis
Blatella germanica
Chrysomya chloropyga putoria
Cryptolestes ferrugineus
Ctenocephalides felis
Fannia canicularis
Gybbium psylloides
Hylotrupes bajulus
Lasioderma serricorne
Oryzaephilus mercator
O. surinamensis
Periplaneta americana
Ptinus tectus
Rhizopertha dominica
Sitophilus granarius
Sitophilus oryzae
Sitophilus zeamais
Sphaericus gibbioides
Stegobium (Sitodrepa) paniceum
Supella longipalpa
Tenebrio molitor
Tenebroides mauritanicus
Thylodrias contractus
Tineola bisselliella
Tribolium confusum
T. destructor
Trogoderma angustum

(Director)

Stock Lists

FRANCE

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

A. Wild type strains

1. Sitophilus granarius L.

    7 wild strains from France
    one strain selected for short rostrum (RCT)

2. S. oryzae L.

    a. Wild strain from England
    b. Four wild strains from France
    c. Wild strain from China
    d. Two wild strains from Africa (Tunisia and Benin)
    e. One wild stain from Guadeloupe
    d. FB strain (Le Reunion)
    e. SFr strain (lyon) (56,500+3,000 ovarian symbiotes)
    f. W strain (Villeurbane) (22,700+1500 ovarian symbiotes)

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

    One wild strain from England
    Two wild strains from France
    One wild strain from Reunion
    Four wild strains from Africa (Cameroun, Belgian Congo, Algiers and Ivory Coast).

B. Selected lines of Sitophilus oryzae

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

C. Other Coleoptera

    Tenebrio molitor from France
    Metamasius hemipterus from Guadeloupe, West Indies.

P. Nardon

Stock Lists

GERMANY

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

Wild type strains

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

Mutant strains (All from San Bernardino)

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

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

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

K. Sander

Stock Lists

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

COLEOPTERA

Bruchidae---Acanthoscelides obtectus (Say)	
Cucujidae---Cryptolestes turcicus Grouv.	Munich, 1966
Ptinidae	
Gibbium psylloides (Czemp)	Regensburg, 1960
Ptinus tectus (Boi.)	Munich, 1972
Silvanidae	
Oryzaephilus mercator (Fauv.)	Munich, 1966
O. surinamensis (L)	? 1971
Tenebrionidae	
Gnathocerus cornutus (F.)	MUNICH, 1966
Tribolium castaneum	? 1971
T. confusum Duv.	Munich, 1960
T. destructor Uyttenb.	" 1957

LEPIDOPTERA

Phycitidae---Ephestia kuehniella (Zell.)	" 1966

E. Naton.

INSTITUT FUR FLUGMEDIZIN DER DFVLR
GODESBERGER ALLEE 70
5300 BONN 2

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

A. Tribolium castaneum, not inbred.
A-1. T. castaneum inbred more than 50 generations with <2.2% anomalies.

B. T. confusum, not inbred
B-1. T. confusum, inbred more than 48 generations with <1.2% anomalies.
B-2. T. confusum, inbred over 74 generations with passages over several single pair steps, with <o,6% anomalies.

II. C. T. castaneum, a highly inbred strain (C-1) from Prof. Bell, Purdue University, which showed more than 50% different anomalies during first generations in our laboratory. Now, after 47 generations, shows < 0.8% anomalies.
C-1. T. castaneum, wild type strain.
C-2. T. castaneum, mixed mutations strain.

W. Brieglet

Stock Lists

TEL AVIV, ISRAEL
TEL AVIV UNIVERSITY
DEPARTMENT OF ZOOLOGY

A. Tribolium castaneum

1. Wild type strains

Berkeley--via Tribolium Stock Center, San Bernardino
McGill--via Tribolium Stock Center (TSC).
3 strains collected from different stored products, in Israel.
CTC 12 from PICL, Slough, England
Kano C from PICL, Slough, England

2. Mutant strains

Visible mutants

Chicago b via Stony Brook, N.Y.
eu++ (extra urogomphi, normal body color)
eu b (extra urogomphi, black body color)
p--pearl. From TSC
mc--microcephalic. Originated as a single mutant in p.
pd--paddle--From TSC.
pd b--paddle, black
py,r--pygmy, red from TSC.

electrophoretic mutants

bEs (slow esterase, b)--selected from b.
bPs (Acph-1 slow, est-1 null, b) selected from eu b.
PF (fast Acid phosphatase, + body color). Selected from eu ++.

B. Tribolium confusum

Wild type strains
Chicago +--from TSC.
Israel

Mutant strains
McGill b--via Stony Brook
msg melanotic stink glands (prothoracic)--from TSC.
msg (strong)--from TSC
p (pearl) from TSC.
XL (extra large) from TSC

c. T. brevicornis

Riverside + via TSC.

d. T. freemani from Japan

David Wool

JAPAN

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

Psocoptera
    Liposcelis bostrychophilus Badonel   Wild

Coleoptera
    Silvanidae
        Oryzaephilus surinamentsis (L.)   Wild

    Cucujidae
        Cryptolestes sp.   Wild

    Tenebrionidae
        Gnathocerus cornutus (Fabricius)   Wild
        Latheticus oryzae Waterhouse   Wild
        Palorus ratzeburgi (Wissmann)   Wild
        Tribolium castaneum (Herbst)   Wild
        T. confusum Jacquelin du Val   Wild
        T. freemani Hinton   Wild

    Anobiidae
        Lasioderma serricorne (Fabricius)   Wild
        Stegobium paniceum (L.)   Wild

    Bostrichidae
        Rhyzopertha dominica (Fabricius)   Wild

    Curculionidae
        Sitophilus oryzae (L.)   Wild
        S. zeamais Motschulsky   Wild

    Bruchidae

Stock Lists

Callosobruchus chinensis (L.) Wild

Lepidoptera
  Phycitidae
    Ephestia elutella (Hubner) Wild
    E. cautella (Walker) Wild, brown mut. strain
    E. kuhniella (Zeller Wild
      Mutant:
        b black wing mutant
        pl-1 white larval color strain
        pl-2 " " " "
        pl-9 red larval color strain
        pl-10 " " " "
        pl-11 Intermediate larval color strain
        pl-12 " " " "
        pl-13 " " " "
    Plodia interpunctella (Hubner) Wild
  Gelechiidae
    Sitotroga cerealella (Olivier) Wild

O. Imura

Note: Dr. H. Nakakita"s list in TIB 2d also includes the following information on Tribolium stocks:

Wild type strains and geographic origin

Tribolium audax H......derived from Dr. D.G.H. Halstead, Slough
T. castaneum (H.) Japan
T. castaneum (H.)
  TCP.A (PH3-resistant)--derived from Dr. R.G.Winks, Stored Grain Research Lab, Division of Entomology, CSIRO
  CTC4 (PH3-susceptible)--derived from R.G. Winks
T. confusum...........Japan
T. freemani........... captured in Japan (contaminated imported corn from Brazil).

H. Nakakita

OKAYAMA
LABORATORY OF APPLIED ENTOMOLOGY
COLLEGE OF AGRICULTURE
OKAYAMA UNIVERSITY

1. Wild type strains

COLEOPTERA

1. Alphitobius diaperinus	Miyazaki
2. Alphitobius bifasciatus	Okayama
3. Callosobruchus chinensis	Several strains
4. Callosobruchus maculatus	Several strains

5. Gnathocerus cornutus — Miyazaki
6. Lasioderma serricorne — Okayama
7. Latheticus oryzae — Miyazaki
8. Oryzaephilus surinamensis — Oksyamai
9. Rhyzopertha dominica — Okayamai
10. Sitophilus oryzae — Okayama
11. S. zeamais — Okayama
12. Tenebrio molitor — Okayama
13. Tenebroides mauritanicus — Okayama
14. Tribolium castaneum — Okayamai
15. T. confusum — Okayamai
16. T. freemani — Unknown

HYMENOPTERAN PARASITES

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

Toshiharu Yoshida

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

Bruchidae
  Callosobruchus chinensis
    10 wild type strains from different localities in Japan.
    Black colored mutant derived from one of the geographical strains.
  C. maculatus
    10 wild type strains from different localities in the world.
  C. analis
  C. phaseoli
  Zabrotes subfaciatus
  Acanthoscelides obtectus

K. Fujii

Stock Lists

SPAIN

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

Tribolium castaneum

A. Wild type strains

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

B. Mutant type strains

13.	Black Purdue	Purdue, USA,	1964

C. Experimental lines

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

		Selected for	Temperature (oC)
14.	AN-I	high performance at	33
15.	AN-II	" "	33
16.	AF-I	" "	28
17.	AF-II	" "	28
18.	AT-I	" "	38
19.	AT-II	" "	38
20.	BN-I	low performance at	33
21.	BF-I	" "	28
22.	BF-II	" "	28
23.	BT-I	" "	39
24.	BT-II	" "	39
25.	RN-I*	high cross performance at	33
26.	SN-I*	" " " "	33
27.	RN-II	" " " "	33
28.	SN-II	" " " "	33
29.	RF-I	" " " "	28
30.	SF-I	" " " "	28
31.	RF-II	" " " "	28

Stock Lists

32. SF-II " " " " 33
33. RT-I " " " " 38
34. ST-I " " " " 38
35. RT-II high cross performance at 38
36. ST-II " " " "
37. CTD-I high performance at diff. levels of selection
38. CTD-II " " " " " "
39. DTD-I " " " " " " "
40. DTD-II " " " " " " "
41. ETD-I " " " " " " "
42. ETD-II " " " " " " "
43. FTD-I " " " " " " "
44. FTD-II " " " " " " "

D. mutants

45. antennapedia ap, VIII — Purdue, 1964
46 black b III
47. diferencial Df, IV — Purdue, 1964
48. fused antennal segments-2 fas-2 IV — Sokoloff, 1968
49. ivory i ? — Purdue, 1964
50. jet j V
51. paddle, pd i — Purdue, 1964
52. pearl p II — Sokoloff, 1968
53. pegleg pg II — Purdue, 1968
54. pygmy py I — Purdue, 1968
55 red r I
56. rose rs I — Purdue, 1964
57. ruby rb ? — Purdue, 1964
58. short elytra sh VIII
59. squint sq VIII — Purdue, 1964
60. white w ? — Purdue, 1964
62 w
63. wine r I — Purdue, 1968
64. eye mutant ? — Madrid, 1967
65. maroon m V — Purdue, 1977
66. melanotic stink glands--like — Madrid, 1968
67. sooty s Iv — Sokoloff, 1977
68. chestnut c VII — Sokoloff, 1977
69. microcephalic mc V — Sokoloff, 1977
70. Microphthalmic Mo VI — Sokoloff, 1977
Pk
71. pink p II — Sokoloff, 1977
72. Bar eye Be IV — Sokoloff, 1977
73. prothoraxless ptl IX — Sokoloff, 1977
74. light ocular diaphragm lod III — Purdue, 1968
75. black B III — Sokoloff, 1977

Tribolium confusum

A. Wild type strains

76. Coronada — La Coronada, Spain

77. Alcala guadaira

B. Mutants

78. creased abdominal sternites cas II Sokoloff, 1968
79. ebony-2 e-2 II Sokoloff, 1968
80. e2, p, cas

C. Other mutants

eye
ojo Ecija
bm eye
ap eye

Ma. C. Fuentes

UNITED KINGDOM

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

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

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

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

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

TROPICAL DEVELOPMENT AND RESEARCH INSTITUTE (TDRI)

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

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

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

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

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

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

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

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

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

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

I. Wild type strains

A. Coleoptera

Bostrichidae

1. Prostephanus truncatus -- Mexico, Tanzania

Bruchidae

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

Curculionidae

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

B. Lepidoptera

Galleriinae: Corcyra cephalonica -- Malawi

Gellachiidae: Sitotroga cerealella -- Sudan

Phycitinae: Ephestia cautella -- Brazil

CHEMICAL CONTROL SECTION

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

Wild type strains

Coleoptera

Bruchidae
- Acanthoscelides obtectus -- Ethiopia
- Callosobruchus chinensis -- India

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

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

Dr. P. F. Prevett
Deputy Head of Department

Notes-Research

Adu, Olayeye Olaletan
Nigerian Stored Products Research Institute
P.M.B. 5063
Port Harcourt, Nigeria

*Comparative susceptibility of adult and immature stages of Tribolium castaneum (Herbst) to seven fumigants

ABSTRACT:

Life stages of Tribolium castaneum (Herbst) were exposed to seven fumigants. The trend of susceptibility in decreasing order was Egg-Larva-Adult-Pupa at LD95. the relative toxicity of the seven fumiganits to all the life stages at LD95 was Phosphine-Acrylonitrile-Methyl bromide-Ethylene dibromide-Methyl iodide-Methyl formate-Ethyl formate.

INTRODUCTION>

Stored agricultural products are prone to attack by several agents of devastation. Of the real losses during storage, the most direct is the material eaten or destroyed by the pests which include insects. Several workers have highlighted the quantity loss due to insect attack of stored produce; Howe (1965), Campbell and Sinha (1976), Adams (1976). Quality losses arising from insect and mite infestation of grains include: Presence of frass, reduction in thiamine content, increase in fat acidity and non-nitrogenous protein, uric acid and quinone (Pingale et al. 1957; Rajan et al. 1975; and Venkat Rao et al. 1958).

Among stored product insects, Tribolium castaneum (Herbst) seems to be the most favoured by the climatic conditions of the tropics. Howe (1962) has reported that minimum temperature at 22 degrees centigrade and maximum of 32-35 degrees centigrade are favourable to the rapid development of T. castaneum at 70% relative humidity. The life of this beetle is longest at 25 degrees in combination with 70-85% relative humidity (Simwat and Chahal, 1970). The menace and ubiquity of T. castaneum in stored products in Nigeria has been highlighted by the works of Howe (1952) and Cornes (1971). Loconti and Roth (1953) have shown that quinones and hydroquinones are ubiquitous in Tenebrionidae infesting stored food. Ladisch (1953) reported these chemicals as potential carcinogens.

While several methods have been reported for insect control in stored products, Monro (1969) and Hall (1970) opined that fumigants are now gaining wide usage because stored produce could be disinfested without disturbing the bulk. Majumder (1973) and Dhaliwal (1975) extensively reviewed the various properties of fumigants which make them superior to existing methods of insect control. This work reports an attempt to control T. castaneum (Herbst) through the use of fumigants.

MATERIALS AND METHODS.

The following fumigants were used in the trial: Acrylonitrile (AN), Ethylene dibromide (EDB), ethyl formate (EF) methyl bromide (MB), methyl formate (MF), methyl iodide (MI) and phosphine (pH3).

Life-cycle stages of Tribolium castaneum (Herbst) adult 12-15 days old, pupae 2-3 days old, fourth instar larvae, and eggs 1-2 days old reared in a standard diet of Sokoloff et al (1966) at 25-27 degrees centigrade and 70-85% R.H. were used in the experiment. Thirty specimens of each stage were separately confined to a glass tube of 1 cm diameter and 5 cm long. Both sides of the tube were covered with muslin cloth held tightly with a rubber band. Each tube was placed in a side-spouted gas-tight Erlenmeyer flask of 297 capacity. The open end of the side spout was covered with a rubber stopper, through which the fumigant vapour was introduced into the flask. For each life-cycle stage, a minimum of five dosages of five replicates per dosage was maintained for each fumigant and control. For all treatments a constant exposure period of 24 hours was maintained. At the end of the exposure period, the insects were reared in plastic vials 4-5 cm deep and of 3.5 cm diameter for post-fumigation observations and adult emergence. The insects were supplied with diets compounded according to Sokoloff et al (1966) and reared at temperatures of 25-30 degrees centigrade and 70-85% R.H.

Adult mortality counts were taken daily for ten days after incubating while other life-cycle stages were reared until the adults emerged. The emerging adults from control and treated life-cycle stages were counted continuously for ten days after the first emerging adult was observed. Percentage mortality for each treatment was corrected by Abbot's formula. The LD50 and LD95 were determined from probit log concentration curves, while the fiducial limits and regression equations were calculated using the procedure of Busvine (1971)

RESULTS AND DISCUSSION

The LD50, LD95 fiducial limits and CT products of the seven fumigants are presented in Tables 1-7. Table 7 shows a summary of the LD50, LD95 and the comparative toxicity of the fumigants to each life cycle stage of Tribolium castaneum (Herbst)

Tables 1-5 show the eggs and larvae to be most susceptible, and the pupae as the most tolerant to acrylonitrile, ethylene dibromide, methyl bromide, methyl formate and ethyl formate in that order. Table 7 shows that the adult and larvae are most susceptible to phosphine, while the pupae are the most tolerant. Krohne and Lindgren (1958), Bang and Telford (1966), Muthu

(1973), Adu and Muthu (1985) have reported similar trends for various fumigants for several stored product insects.

Brown (1954) also reported that pupae of insects require about twice the adult dose to achieve comparable mortality. The susceptibility of the larvae and adult may be due to their respiratory activities while the eggs owe their susceptibility to the porousity of their shells which enable the fumigants to interfere with the embryonic development. Chapman (1973) reported that the insect pupa has the least respiratory activity. This may account for the low intake of fumigants which result in tolerance.

Table 6 shows that the larva is the most tolerant to methyl iodide while the pupa is the most susceptible. Muthu (1978) also reported this trend. But Kashi et al (1977) and Adu and Muthu (1985) had observed that the pupa of S. oryzae and C. chinensis are the most tolerant, while their larvae and eggs are most susceptible to methyl iodide. The high tolerance of the larvae to methyl iodide reported in this work may be due to the age of the larvae used. Kashi et al (1977) reported that the tolerance of the larvae increases as it goes to higher instar stages.

The variation in susceptibility of insects to different fumigants has also been examined by Lindgren et al (1954), Muthu and Shrinath (1974), Rajendran and Muthu (1976). Pillai (1977) also observed varietal responses of different life cycle stages of T. castaneum to phosphine.

The work of Muthu et al (1970) showed that mites also respond differently to phosphine, methyl bromide and ethylene dibromide at LD95. Various reasons have been advanced for the variance in response of insects and their immature stages to fumigants. Carpenter and Moore (1938) suggested that the amount of fumigant sorbed before an insect dies is mainly responsible for its susceptibility to the fumigant. Lindgren (1935) opined that the initial effect of the fumigant on the respiratory mechanism of the insect is supreme among factors influencing insect susceptibility. The findings of Brown (1951), however, seem to throw a revealing light on the reaction of insects and their developmental stages to a particular fumigant. Both situations, however, are hinged on the tracheal ventilation as affected by whether stupefaction or stimulation of tracheal openings result from initial content of the insect with the fumigant. Therefore, the variations found in response of the four stages to each of the fumigants can be ascribed to the theory of respiratory differences among the stages as related to rate of sorption and detoxification as well as the inherent property of the fumigant to stupefy or stimulate tracheal opening. The results of this work, therefore, show that in practical fumigation for disinfestation purposes, the insect species and life cycle stages and their response to a particular fumigant should be considered when determining concentration and time of exposure required for complete kill.

CONCLUSIONS:

At LD95, Tribolium castaneum papae showed greatest tolerance to Acrylonitrile, Ethylene dibromide, Ethyl formate, Methyl bromide, Methyl formate and Phosphine with CT products of 61.680, 113.520, 1349.520, 93.6, 955.440, 3.888 mg hr/L, while the larval stage was most tolerant to Methyl iodide, with a CT product of 214.320 mg hr/L.

An overall assessment of the fumigants revealed that their LD95 to Tribolium castaneum in the order of effectiveness was Phosphine-Acrylonitrile-Methyl bromide-Ethylene dibromide-Methyl iodide-Methyl formate-Ethyl formate. The relative susceptibility of the life cycle stages of the insect was in the decreasing order of egg-larva-adult-pupa.

ACKNOWLEDGEMENT

I am grateful to Messrs. M. Muthu and S. K. Majumder both of ICT Discipline CFTRI, Mysore, India, for their interest and guidance during the work.

Thanks are due to the United Nations University for granting me a fellowship to carry out the work under the World Hunger Programme Scheme of the University.

References Cited

Adu, O.O., and Muthu, M. 1985. The relative toxicity of seven fumigants to life cycle stages of Callosobruchus chinensis L. Insect Sci. Applic. 6:75-78.

Bang, Y.H. and Telford, H.S. 1966. Effect of sublethal doses of fumigants on stored grain insect. Tech. Bull. Wash. St. Univ. Agric. Expt. Stn. 50:22

Brown, W.B. 1954. Fumigation with methyl bromide under gas proof sheets. Bull. Pest Infest. Res. Bd. 1.

Busvine, J.R. 1971. A critical review of the techniques for testing insecticides. Pub. Com Agric. Bureaux.

Carpenter, E.L. and Moore, W. 1938. Sorption of HCN by five species of insects. J. Econ Ent. 31:270-275. Cited in A.W.A. Brown, 1951, INSECT CONTROL BY CHEMICALS. J. Wiley and Sons, New York.

Cornes, M.A. 1971. A check list of insects associated with stored products in Nigeria. Nig. Stored Prod. Res. Inst. Ann. Rpt. 11:73-98.

Hall, D.W. 1970. Handling and storage of food grains in tropical and sub-tropical areas. FAO home Agric. Dev. Paper 69.

Howe, R.W. 1952. Entomological problems of food storage in Northern Nigeria. Bull. Ent. Res. 43:111-114.

Howe, R.W. 1962. The effects of temperature and humidity on the oviposition rates of Tribolium castaneum (Herbst) Coleoptera, Tenebrionidae. Bull. Ent. Res. 53:301-310.

Howe, R.W. 1965. Losses caused by insects and mites in stored foods and feeding stuffs. Nutrition Abst. and Rev. 35:285-301.

Kashi, K.P., Rajendran, S. and Muthu, M. 1977. Toxicity of methyl iodide to the life stages of Sitophilus oryzae (l.) and Callosobruchus chinensis (L.). Bull Grain Tech 15:34.

Krohne, H.E. and Lindgren, D.L. 1958. Susceptibility of life cycle stages of Sitophilus oryzae to various fumigants. J. Econ. Ent. 51:157-158.

Ladisch, R.K. 1953. Quinones as food contaminants and carcinogens. Rep. Pioneering Lab. U.S. Army Quarter Master Corps Biochem. Serv. 4:6-7.

Lindgren, D.L. 1935. Stage species and susceptibility of insects to fumigants. Min. Agric. Expt. Station Tech. Bull. 109:32-33.

Lindgren, D.L., Vincent, L.E. and Krohne, H. 1954. Relative effectiveness of ten fumigants to adults of eight species of stored product insects. J. Econ. Ent. 47:923-926.

Loconti, J.D. and Roth, L.M. 1953. Composition of the odorous secretion of Tribolium castaneum. Ann. Entomol. Soc. Amer. 46:281-289.

Muthu, M. 1973. Some aspects of phosphine as a fumigant in fumigation and gaseous pasteurization. S.K. Majumder and J. S. Venugo Pal (Eds.). Pub. Acad. Pest Cont. Sci. India.

Muthu, M. 1976. Insecticidal doses of methyl iodide in foods and its residues. J. Fd. Sci. Tech. 13:43-44.

Muthu, M and Srinaih, D. 1974. Toxicity of methyl iodide to the adults of five beetles from stored products. J. stored Prod. Res 10:65-66.

Muthu, M. Pillai, P.R.P. and Hiranniah, S.V. 1970. Relative toxicity of ethylene dibromide, methyl bromide and phosphine to the adult of Caloglyphus krameri and Tyrophagus pultiscentiae. J. stored Prod. Res. 6: 93-96.

Notes-Research

Muthu, M. Rejendran, S. and Kashi, K.P. 1978. toxicity of methyl iodide to some life stages of Ephestia cautella (Wlk.) (Pyralidae), Tribolium castaneum (Herbst), (Tenebrionidae) and Trogoderma granarium (Everts) (Dermestidae). J. Fd. Sci. Tech. 15:155-156.

Oxley, T.A. 1950. grain storage in East and Central Africa. Dept of Sci. and Ind. Res. HMSO (Lond.).

Pingale, S.V., Kadkol, S.S., Narayana Rao, M. and Swaminathan, M. 1957. Effect of insect infestation on stored grain. II. studies on husked hand pounded, milled rice and parboiled milled rice. J. sci. Fd. Agric. 8:512-516.

Pillai, S.P. 1977. Studies on insect and microbial problems of cashew processing industry for development and standard dosation of suitable disinfestation techniques. M. Sc. Thesis, Univ. of Mysore.

Rajan, P., Sanjeevayarappa, K.V., Daniel, V.A., Jayaraji, P.P. and Swaminathan, M. 1975. Effect of insect infestation on the chemical composition and nutritive value of maize and cowpea. Indian J. Nut. Diet. 12:325-332.

Rejendran, S. and Muthu, M. 1976. Toxicity of acrylonitrile to the adults of five species of stored product insects. Bull. Grain Tech. 14:179.

Simwat, G.S. and Chahal B.S. 1970. Effect of temperature and relative humidity on the longevity of Tribolium castaneum (Herbst) (Tenebrionidae: Coleoptera). Bull. Grain Tech. 8:107-111.

Sokoloff, A. Franklin, I.R. and Lakhanpal, R.K. 1966. Comparative studies with Tribolium castaneum (Coleoptera, Tenebrionidae). II. Productivity of T. castaneum (Herbst) and T. confusum (Duv.) on natural, semisynthetic and synthetic diets. J. Stored Prod. Res. 1:219-229.

Soysa, E. and Jajavardena, M.D. 1945. Pulmonary acariasis: a possible cause of asthma. Brit. Med. Journ. 1:1-3

Venkat Rao, S., Nuggehalli, R.N., Swaminathan, M. Pingale, S.V. and Subrahmanyan, V. 1958. Effect pf insect infestation on stored grain. III. Studies on Sorghum vulgare. J. Sci. Fd. Agric. 9:837-839.

TABLE 1

Lethal dose values of Acrylonitrile for life stages of *Tribolium castaneum*

Exposure period: 24hrs.

Life Stages	Regression Equation	LD50 (mg/L)	Fiducial Limits	CxT-Mg hr/L	LD95 (mg/L)	Fiducial Limits	CT Mg hr/L	χ^2	(n-2)
Egg	y-1.905+6.750x	0.107	0.100 0.113	2.568	0.161	0.142 0.184	3.864	2.550	3
Larva	y-2.107+3.386x	0.850	0.774 0.935	20.440	1.490	1.451 1.502	35.760	6.604	3
Pupa	y-2.969+8.862x	1.718	1.570 1.884	41.232	2.570	2.128 3.105	61.680	2.691	3
Adult	y-0.795+4.408x	0.891	0.817 0.973	21.384	1.995	1.750 2.382	47.880	0.063	3

LD50 E > L > A > P

LD95 E > L > A > P

TABLE 2

Lethal dose values of ethylene dibromide for life stages of Tribolium castaneum (Herbst)

Exposure period: 24hrs.

Life Stages	Regression Equation	LD50 (mg/L)	Fiducial Limits	CxT= Mg hr/L	LD95 (mg/L)	Fiducial Limits	CxT= Mg hr/L	X^2	(n-2)
Egg	y=2.231+3.154x	0.885	0.652 0.906	21.240	2.239	1.570 3.192	53.736	3.588	3
Larva	y=3.407+2.439x	0.457	0.3451 0.6053	10.968	1.995	1.148 3.467	47.880	2.718	3
Pupa	y=2.662+5.763x	2.512	2.203 2.864	60.288	4.730	3.750 5.970	113.520	4.990	3
Adult	y=1.577+3.372x	1.072	0.957 1.197	25.728	3.236	2.382 4.395	77.664	1.338	3

LD50 L > E > A > P

LD95 L > E > A > P

TABLE 3

Lethal dose value of ethyl formate for life stages of *Tribolium castaneum* (Herbst)

Exposure period: 24hrs.

Life Stages	Regression Equation	LD50 (mg/L)	Fiducial Limits	CxT= Mg hr/L	LD95 (mg/L)	Fiducial Limits	CxT= Mg hr/L	X^2	(n-2)
Egg	y=0.691+5.232x	10.30	10.96 13.18	295.200	24.83	20.89 29.51	595.920	2.809	3
Larva	y=0.212+4.929x	10.96	10.91 13.24	263.040	20.14	15.14 25.79	483.36	1.418	3
Pupa	y=1.078+7.357x	33.88	31.12 36.90	812.120	56.23	49.55 63.83	1349.520	1.646	3
Adult	y=1.024+8.974x	27.86	26.55	668.640	41.98	38.90	1007.520	0.140	3

LD50 L > E > A > P

LD95 L > E > A > P

TABLE 4

Lethal dose values of methyl bromide for life stages of *Tribolium castaneum* (Herbst)

Exposure period: 24hrs.

Life Stages	Regression Equation	LD50 (mg/L)	Fiducial Limits	CxT= Mg hr/L	LD95 (mg/L)	Fiducial Limits	CxT= Mg hr/L	X^2	(n-2)
Egg	y=1.661+3.115x	1.175	0.982 1.406	28.200	1.389	1.343 1.439	33.336	0.224	3
Larva	y=3.960+4.283x	1.758	1.496	42.192	3.800	3.589 3.936	91.200	0.486	3
Pupa	y=0.308+11.987x	2.754	2.594 2.924	66.096	3.900	3.707 5.023	93.600	4.762	3
Adult	y=3.149+6.612x	1.950	1.770 2.148	46.800	3.133	2.580 3.926	75.192	3.535	

LD50 E > L > A > P

LD95 E > A > L > P

TABLE 5

Lethal dose values of Methyl formate for life stages of *Tribolium castaneum* (Herbst)

Exposure period: 24hrs.

Life Stages	Regression Equation	LD50 (mg/L)	Fiducial Limits	CxT= Mg hr/L	LD95 (mg/L)	Fiducial Limits	CxT= Mg hr/L	X^2	(n-2)
Egg	y=0.326+5.703x	6.761	6.300 7.244	162.264	13.180	11.480 15.140	316.320	1.06	3
Larva	y=3.761+1.958x	4.169	3.451 5.035	100.056	29.51	19.72 44.16	708.240	3	3
Pupa	y=0.674+988	27.54	27.35 27.73	660.960	39.81	38.28 41.40	955.440	0.775	3
Adult	y=4.020+5.146x	15.14	14.29 16.03	363.360	30.62	27.10 34.43	734.880	5.22	3

LD50 L > E > A > P

LD95 E > L > A > P

TABLE 6

Lethal dose values of Methyl iodide for life stages of *Tribolium castaneum* (Herbst)

Exposure period: 24hrs.

Life Stages	Regression Equation	LD50 (mg/L)	Fiducial Limits	CxT= Mg hr/L	LD95 (mg/L)	Fiducial Limits	CxT= Mg hr/L	X^2	(n-2)
Egg	y=3.486+2.260x	0.050	0.039 0.064	1.200	0.209	0.111 0.392	5.016	4.66	3
Larva	y=2.741+4.091x	3.548	3.177 3.963	85.152	8.930	6.516 12.250	214.320	0.318	3
Pupa	y=6.948+12.363x	0.933	0.900 0.968	22.392	1.245	1.062 1.459	29.880	2.67	3
Adult	y=3.729+4.612x	1.905	1.762 2.062	45.720	3.981	3.281 4.837	95.544	5.797	3

LD50 E > P > A > L

LD95 E > P > A > L

TABLE 7

Lethal dose values of Phosphine for life stages of *Tribolium castaneum* (Herbst

Exposure period: 24hrs.

Life Stages	Regression Equation	LD50 (mg/L)	Fiducial Limits	CxT= Mg hr/L	LD95 (Mg/L)	Fiducial Limits	CxT= Mg hr/L	X^2	(n-2)
Egg	y=2.054+2.95x	0.018	0.015 0.022	0.432	0.091	0.603 0.137	0.456	18.25	3
Larva	y=3.501+2.214x	0.005	0.0038 0.0067	0.120	0.025	0.018 0.041	0.600	1.614	3
Pupa	y=2.402+1.904x	0.023	0.0187 0.0281	0.552	0.162	0.098 0.268	3.888	3.606	3
Adult	y=3728+7.615x	0.0146	0.0139 0.0154	0.350	0.02350	0.0214 0.0259	0.566	4.501	3

LD50 L > A > E > P

LD95 A > L > E > P

TABLE 8

DOSAGES OF SEVEN FUMIGANTS FOR 50% AND 95% KILL OF LIFE STAGES OF TRIBOLIUM CASTANEUM (HERBST) AT EXPOSURE PERIOD OF 24 HOURS.

FUMIGANTS	LD50 EGG	LD50 LARVA	LD50 PUPA	LD50 ADULT	LD95 EGG	LD95 LARVA	LD95 PUPA	LD95 ADULT
ACRYLONITRILE	0.107	0.850	1.718	0.891	0.161	1.490	2.570	1.995
ETHYLENE DIBROMIDE	0.885	0.457	2.512	1.072	2.239	1.995	4.750	3.236
ETHYL FORMATE	12.30	10.96	33.88	27.88	24.83	20.14	56.23	41.98
METHYL BROMIDE	1.175	1.758	2.754	1.950	1.389	3.800	3.900	3.133
METHYL FORMATE	6.761	4.169	27.54	15.14	13.180	29.51	39.81	30.62
METHYL IODIDE	0.050	3.548	0.933	1.905	0.209	8.930	1.245	3.981
PHOSPHINE	0.018	0.005	0.023	0.0146	0.091	0.025	0.162	0.0236

LD50:

EGG = pH3 > MI > AN > EDB > MB > MF > EF
LARVA = pH3 > EDB > AN > MB > MI > MF > EF
PUPA = pH3 > MI > AN > EDB > MB > MF > EF
ADULT = pH3 > AN > EDB > MI > MB > MF > EF

pH3 MI > AN > EDB > MB > MF > EF

LD95:

EGG = pH3 > AN > MI > MB > EDB > MF > EF
LARVA = pH3 > AN > EDB > MB > MI > EF > MF
PUPA = pH3 > MI > AN > MB > EDB > MF > EF
ADULT = pH3 > AN > MB > EDB > MI > MF > EF

pH3 > AN > MI > MB > EDB > MF > EF

TABLE 9

Relative Susceptibility of life stages of *Tribolium castaneum* of fumigants.

Fumigant	Order of Susceptibility				Order of Susceptibility			
	1 > 2	> 3	> 4		1 > 2	> 3	> 4	
Acrylonitrile	E	L	A	P	E	L	A	P
Ethylene Dibromide	L	E	A	P	P	E	A	P
Ethyl Formate	L	E	A	P	L	E	A	P
Methyl Bromide	E	L	A	P	E	A	L	P
Methyl Formate	L	E	A	P	E	L	A	P
Methyl Iodide	E	P	A	L	E	P	A	L
Phosphine	L	A	E	P	A	L	E	P

E = Egg, L = Larva, P = Pupa, A = Adult.

Notes-Research

Bell, A. E. and D. A. Miles
Department of Animal Sciences
Purdue University
West Lafayette, IN 47907

Bi-directional selection and symmetry of response for quantitative traits

Quantitative genetic theory predicts symmetrical responses when equal selection intensities are applied. Short-term responses observed in many selection studies have agreed well with the theoretical expectations. However, long-term selection studies, with few exceptions, have reported many discrepancies from genetic theory including asymmetrical responses. *Tribolium castaneum* has been used widely as an experimental model for testing the validity of selection theory (Bell, 1969 and 1982).

Proposed factors contributing to these discrepancies between theory and practice have been genetic asymmetry, unconscious secondary selection, major gene effects, genotype x environment interactions, transient correlations with fitness, high polygenic mutation rates, real changes in genetic parameters, and scaling effects (Bell, 1969).

Long-term selection responses in terms of response plateaus, their duration, and ultimate limits are of special interest today due to their unpredictable nature. As more is learned about the forces contributing to response plateaus it may become possible to anticipate their occurrence and circumvent them.

Since 1954 our laboratory has conducted numerous experiments on the nature of response to bi-direction selection for Tribolium pupal weight and on aids to extending selection limits. A recent review of these studies (Bell, 1981) pointed out that after more than 130 generations of selection, response for large exceeded the unselected base population by some 20 σ_P while the response for small had been only 5 σ_P. In an effort to learn more about the nature of this asymmetry and the observed limits, the Large, Base and Small Populations were crossed in a diallel manner with growth characteristics observed on the resulting offspring including advanced F_2, F_3, F_4 and appropriate back-crosses. This preliminary report will describe the pupal weight results for the parental and F_1 populations.

MATERIAL AND METHODS

The genetic material for this study was represented by three related purebred populations of Tribolium castaneum and all possible crosses among them including reciprocals. The populations were:

Code	Genetic History
Base (F)	Purdue "+" Foundations, a synthetic heterogeneous base population founded in 1954 from 8 laboratory stocks.
Large 2(L)	Originating from Base and selected for large pupal weight for 133 generations.
Small (S)	Originating from Base and selected for small pupal weight for 75 generations.

The Large and Small Populations were mass mated without selection for 2 generations in order to expand these populations. Then virgin males and females were collected as pupae from each of the three populations and crossed as mass matings of 10♂ x 10♀ in a diallel mannner to provide 9 genetic groups (3 parental purebreds and 6 single crosses including the reciprocal). Two consecutive 24-hour egg collections were taken in half-pint bottles with standard medium (whole wheat flour with 5% yeast) and were cultured at 33°C and 70% R.H. Individual pupae were screened from each mating on a daily basis, sexed, and weighed on a Mettler Micro-balance to the nearest 10 micrograms (dμg). An additional replication of these diallel crosses was made in the same manner using a new sample of parents from each population.

The observed pupal weights were analyzed by the following statistical mdoel,

$$Y_{ijklm} = \mu + G_i + R_j + D_k + S_l + GR_{ij} + GD_{ik} + GS_{il} + RD_{jk} + RS_{jl} + DS_{kl} + \text{remainder}$$

where Y_{ijklm} = individual pupal weight and

μ = the overall mean

G_i = the fixed effect of the i^{th} genetic group, i = 1, 2, ...9

R_j = the random effect of the j^{th} replication, j = 1, 2

D_k = the fixed effect of the k^{th} day of collection, k = 1, 2

S_l = the fixed effect of the l^{th} sex, l = 1, 2

GR_{ij}, GD_{ik}, RD_{jk}, RS_{jl} and DS_{kl} are the appropriate two factors interactions; higher order interactions were tested and pooled with the random individual error for the remainder term.

In view of the logarithmic nature of the growth curve and the tendency for the variances to increase with increasing body weight, the individual pupal weights were also transformed to the log scale and analyzed by the above model.

RESULTS

The analyses of variance for individual pupal weights, untransformed and transformed, based on the above statistical model are given in Table 1.

Table 1. Analyses of variance

		Levels of Significance	
Source	df	Pupal Weight	Log Pupal Weight
Groups	8	***	***
Replication	1	***	***
Days of Collection	1	-	-
Sex	1	**	**
Group x Rep	8	***	***
Group x Day	8	**	**
Group x Sex	8	***	***
Rep x Day	1	**	-
Rep x Sex	1	-	-
Day x Sex	1	-	**
Remainder	2576	-	-

***, **, * signify F ratios significant at .01, .05, and .10 probabilities, respectively.

The most striking thing about Table 1 is that most of the main effects and two-factor interactions were highly significant on both arithmetric and logarithmic scales. Obviously, the large observed differences between genotypes did not result from a scaling effect associated with body weight. The highly significant effect due to "Groups" was not surprising in view of the long-term bi-directionally selected lines and the highly significant "Replication" effect could have resulted from some undetected environmental time trend. However, the highly significant interactions involving genetic groups is disturbing and suggests some genotypes by environment interaction independent of scale.

For the purpose of this report we wish to concentrate on the nature of the differences among the 9 genetic groups which are summarized in a diallel manner in Table 2. The reciprocal cross means are above and below the underscored purebred means. The contrasts of interest are illustrated in Figure 1.

Table 2. Pupal weight means for diallel crosses among selcted lines

Sire Line	Dam Line: Large	Dam Line: Base	Dam Line: Small
Large	[a]799.0 ± 2.4	423.6 ± 1.8	251.8 ± 5.6
	[b] 2.90 ± .003	2.62 ± .002	2.40 ± .008
Base	435.8 ± 3.1	257.6 ± 1.8	165.3 ± 2.6
	2.64 ± .004	2.41 ± .002	2.22 ± .003
Small	240.4 ± 2.8	170.8 ± 1.4	82.6 ± 2.6
	2.38 ± .004	2.23 ± .002	1.91 ± .003

[a] pupal weight (dμg) and standard errors

[b] log pupal weight (dμg) and standard errors

On the arithmetic scale one observes a much larger response in the large direction than for small. Both crosses between Large (L) and Base (F) and between Large and Small (S) showed a significant negative heterosis to suggest a directional dominance for "small" genes. On the other hand, the reciprocal crosses between F and S were intermediate to indicate a simple additive gene action. As one might expect, the contrasts on the log scale are quite different. While highly significant differences between genetic groups are still evidenced, the bi-direction responses for large and small on this scale are symmetrical. In addition, all crosses involving the Large Population are intermediate to suggest that "large" genes were acting additively. But both reciprocal crosses between F and S showed significant heterosis on the log scale to suggest some dominance for "large" genes.

SUMMARY

1. A fourfold greater response on the arithmetic scale was observed for large pupal weight selection than for small, and reciprocal crosses with the Base population showed a negative heterosis (directional dominance for small) for the Large Population and no heterosis (additive gene action) for Small.

2. On the log scale, bi-directional responses were symmetrical and the Large crosses were intermediate (no heterosis), but both crosses between Small and Base showed significant positive heterosis to indicate directional dominance for large gene effects.

3. An appropriate scale for the statistical analysis and interpretation of long-term bi-directional selection studies is not available to provide additivity of gene effects, homogeneous variances and normality. Some of these requirements must be compromised in order to analyze large and small selection responses as a single quantitative trait. It might be more informative to consider the two directions as separate traits and conduct an appropriate analysis of covariance.

REFERENCES

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

BELL, A. E. 1981. Direct and correlated responses to long-term selection in *Tribolium*. Proc. 30th National Breeders Roundtable, pp 1-32.

BELL, A. E. 1982. The *Tribolium* Model in animal breeding research. Proc. 2nd World Congress on Genetics Applied to Livestock Production, Vol. 5:26-42.

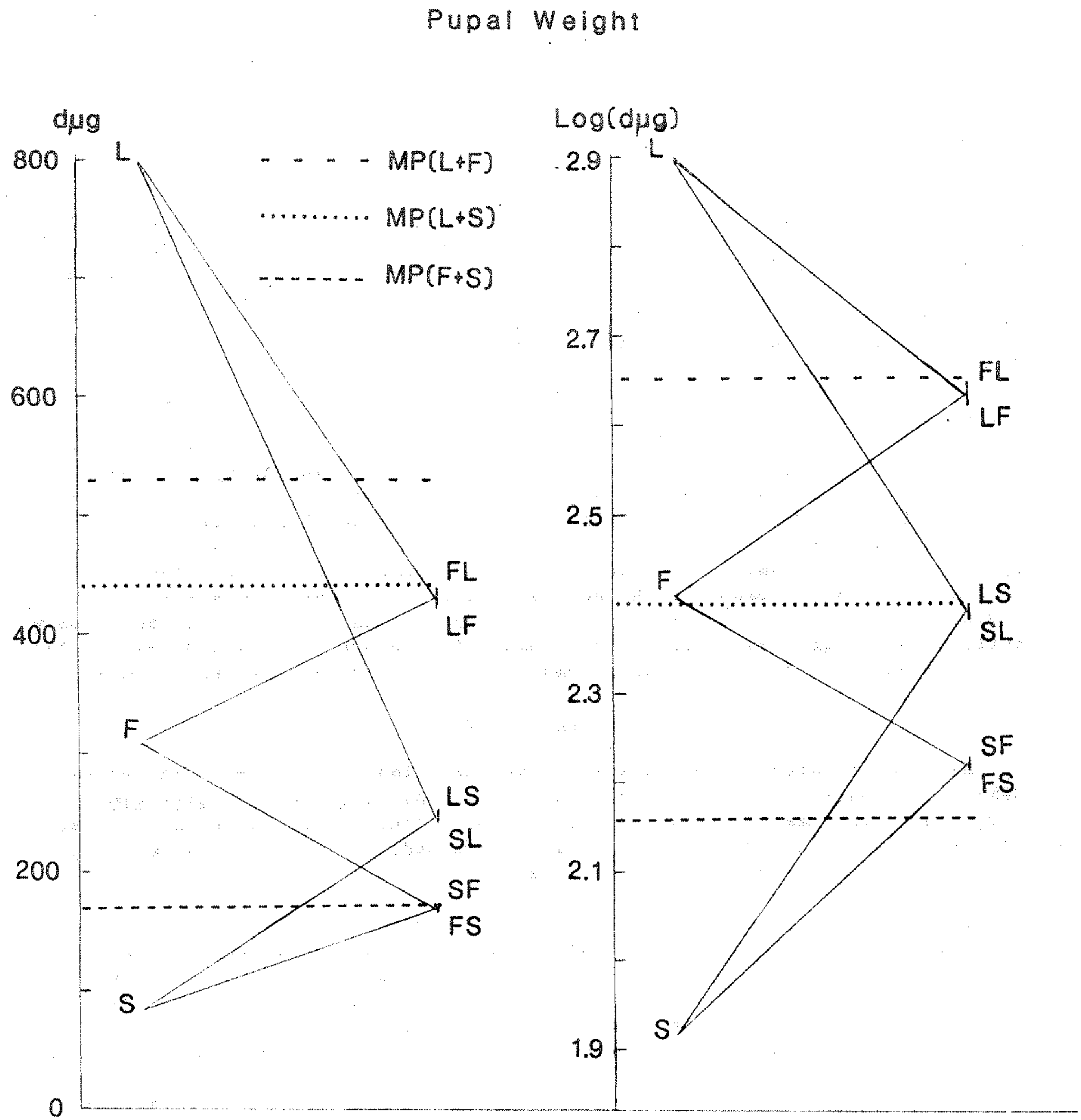


Figure 1. Relationship among purebred and reciprocal F1.

Notes-Research

Bell, A. E., D. A. Miles and M. E. Einstein
Department of Animal Sciences
Purdue University
West Lafayette, IN 47907

Correlated responses to long-term bi-directional selection in *Tribolium*

The growth and developmental patterns of 19 genetically diverse *Tribolium* populations, all originating from the same base population, were described by Englert and Bell (1969). They reported that bi-directional selection for three primary traits (13-day larval weight, pupation time and pupal weight) had produced profound effects upon the total growth and developmental complex. In addition to the three primary traits, three secondary traits (larval molts, adult emergence time and adult weight) had been observed. A consistent asymmetry of direct and correlated responses was described as being determined by the direction of selection.

For studies on the nature of selection limits, our laboratory has continued the large and small pupal weight selection lines described by Englert and Bell (1969). The H_2 (LOS) Line, now called ''Large 2'' after 133 generations of selection, and the S_W and S_D lines, after being combined into a single population called ''Small'' and selected for 75 generations were recently crossed in a diallel manner with the Foundation (F^+) or Base Population with growth traits recorded on the resulting offspring. An analysis for the primary trait, pupal weight, was made in an accompanying report (Bell and Miles, 1985). The correlated responses for other components of growth are presented here.

MATERIALS AND METHODS

The genetic material for this study was detailed earlier (Bell and Miles, 1985). It consisted of three purebred populations of *Tribolium castaneum* (Large, Base and Small) and all possible crosses including reciprocals. Mass matings of 10 males and 10 virgin females were made in two replications of a diallel design to provide 9 genetic groups (3 parental purebreds and 6 single crosses). On two consecutive days, egg collections were taken in half-pint bottles and cultured at 33°C and 70% R.H. Beginning 14 days later, individual pupae were screened from each collection on a daily basis, sexed, weighed to the nearest deca-microgram (dμg), saved in individual vials for subsequent observations on a daily basis as to adult emergence time and adult weight. The results for pupal weight, the primary trait, were reported earlier (Bell and Miles, 1985). Two aspects of developmental rate, days to pupation (''Pupation Time'') and days from pupation to adult emergence (''Adult Time''), and two functions of body size, ''Adult Weight'' and the metamorphic loss in weight from pupa to adult (''Weight Loss'') will be presented. In view of the logarithmic nature of growth and the tendency for the variances to increase with increasing body weight, the weight traits were analyzed on both arithmetic and log scales.

RESULTS

The analyses of variance for the two weight traits, untransformed and transformed, and those for pupation time and adult time are presented in Table 1.

Table 1. Analyses of variance for correlated traits in diallel crosses.

		Significant Levels by Traits					
Source	df	Adult Weight	Log A Wt	Wt Loss P → A	Log Wt L	Pupation Time	Adult Time
Group	8	***	***	***	***	***	-
Replication	1	***	***	***	**	***	***
Day	1	-	-	-	-	-	-
Sex	1	**	*	*	-	-	-
Group x Rep	8	***	***	***	***	***	***
Group x Day	7	***	***	***	***	***	***
Group x Sex	8	***	***	***	*	***	-
Rep x Day	1	***	**	**	**	***	*
Rep x Sex	1	-	-	-	**	-	**
Day x Sex	1	-	-	-	-	-	-
Remainder	2504	-	-	-	-	-	-

***, **, * signify F ratios were significant at .01, .05 and .10 probability levels, respectively.

In view of the long-term bi-directional selection for body size represented in the Large and Small Populations, and the known high genetic correlation between adult and pupal weights (Englert and Bell, 1963), the highly significant ''Group'' mean squares for the four weight traits observed in Table 1 are not surprising. The highly significant effect of ''Replication'' could have resulted from some undetected environmental time trend and is disturbing only because of the significant interactions with both ''Group'' and ''Day of Collection''. Since the transformed traits showed similiar interactions one can rule out scaling effects as the cause. In addition, both ''Pupation Time'' and ''Adult Time'' revealed highly significant interactions involving ''Group'' and ''Replication'' effects. These interactions may have arisen from some undetected changes in the culturing environment or in experimental procedures which were also manifested in the highly significant ''Replication'' effect. Some indication of these interactions can be observed in Table 2 where the trait means are presented by genetic groups or matings and replication.

Table 2. Correlated traits for diallel crosses among pupal weight selection lines.

Mating ♂ x ♀	n	Adult Wt (dμg)	Weight Loss (dμg)	Pupation Time (days)	Adult Time (days)
Large x Large	[a]110	558.1±3.1	202.1±2.0	19.7±.11	5.3±.06
Large x Large	[b]120	627.1±2.9	180.5±1.9	22.1±.11	5.2±.06
Large x Base	171	307.7±2.4	78.5±1.6	18.4±.09	5.2±.05
Large x Base	240	343.9±2.1	108.5±1.4	20.0±.08	5.2±.04
Base x Large	159	364.0±2.6	86.7±1.7	17.6±.10	5.8±.05
Base x Large	42	316.3+5.0	104.8±3.3	18.6±.19	5.3±.10
Base x Base	201	194.5±2.3	50.0±1.5	17.8±.08	5.1±.05
Base x Base	190	210.8±2.3	60.7±1.5	20.3±.09	5.2±.05
Large x Small	15	218.4±8.3	31.4±5.4	16.0±.31	4.8±.17
Large x Small	32	218.5±5.8	35.8±3.8	16.2±.21	4.6±.12
Small x Large	136	193.4±2.7	47.9±1.8	15.8±.10	4.5±.06
Small x Large	59	203.6±4.2	38.0±2.7	15.7±.16	4.8±.08
Base x Small	180	142.4±2.4	22.4±1.6	17.7±.09	5.8±.05
Base x Small	64	130.5±4.0	37.5±2.6	18.6±.15	5.1±.08
Small x Base	329	142.4±1.8	26.0±1.2	17.3±.07	5.8+.04
Small x Base	293	151.3+1.9	23.1±1.2	18.2±.07	5.2±.04
Small x Small	139	63.1±2.7	17.5±1.8	16.8+.10	5.7+.06
Small x Small	62	69.9±4.1	15.7±2.7	18.3±.15	5.2±.08

[a]Replication 1
[b]Replication 2

The magnitude of the genetic differences in adult weight is strikingly revealed in Table 2. The mean adult weight for the Large Population is roughly 10-fold that of Small with the Base Population and various crosses being intermediate. This result is not surprising since others (Englert and Bell, 1963 and 1969; Bell and Burris, 1973) have reported a very high correlation (+ 0.9) between pupal weight and adult weight.

The trait ''Weight Loss'', calculated on an individual basis as the difference between 1st day pupal weight and 1st day adult weight, is an interesting characteristic of growth in that the total metabolic resources required for the complex metamorphosis from mature larva to adult beetle must be encompassed in the pupa. Even though ''Weight Loss'' as reported in Table 2 appears to be proportional to adult weight evidence will be presented later that such was not the complete story.

The rate of development or growth for these genetic groups was reflected in the two traits, ''Pupation Time'' (days from egg to pupa) and ''Adult Time'' (days from pupation to adult emergence). The Large Population takes nearly 2 days longer for pupation than the unselected Base and the shortest pupation time was observed for some of the crosses, rather than for the Small Population, signifying a negative heterosis. Significant genetic differences for ''Adult Time'' are reflected by the ''Group x Replication'' and ''Group x Day'' interactions of Table 1. The mean values for this trait in Table 2 do not appear to be related to adult weight or weight loss during adult metamorphosis, but are positively correlated with pupation time as was observed by Englert and Bell (1969).

The justification or need for transforming the weight traits is shown in Table 3. The square root of the pooled variance within each of the major genetic groups (reciprocal crosses are combined) reflect the positive correlation between means and variances. Except for the Small x Small Mating, the log transformation correctly removes this correlation for ''Adult Weight'' as reflected by the uniform coefficients of variation. While ''Weight Loss'' variances were smaller than comparable ones for adult weight, they were two-fold larger when expressed as coefficients of variation.

Table 3. Phenotypic standard deviations and coefficients of variation for adult weight and weight loss, from pupa to adult, and the proportional weight losses for diallel crosses.

Mating	Adult Weight		Weight Loss		Ratio
	σ	C.V.	σ	C.V.	WL/PW
Large x Large	73.4	0.12	43.0	0.22	0.239
Large x Base	31.8	0.10	23.8	0.25	0.221
Base x Base	24.5	0.12	15.9	0.29	0.214
Large x Small	30.0	0.14	15.0	0.40	0.156
Base x Small	16.6	0.12	12.5	0.46	0.161
Small x Small	12.2	0.18	9.9	0.59	0.200

The last column of Table 3 relates to the metabolic efficiency of the metamorphosis from pupa to adult, and expresses weight loss during this stage as a proportion of pupal weight. In addition to the significant genetic differences observed in Tables 1 and 2 for ''Weight Loss'' on both arithmetic and log scales, we observed genetic differences here in Table 3 when the loss is expressed proportional to initial pupal weight. Such genetic differences in metabolic efficiency in the utilization of the fixed pupal resources were observed and discussed by Bell and Burris (1973) in terms of selection limits for antagonistic changes in growth patterns.

The relationship among purebreds and crossbreds for the various traits are shown graphically in Figure 1. The purebred performance of the Base Population (labeled F) provides a guide as to the symmetry of these correlated responses. In addition, evidence for non-additive gene action is observed in the crosses. The direction of heterosis and relative superiority of reciprocal crossbreds over the two purebred lines are given in Table 4.

Table 4. Heterosis (%) for correlated traits in crosses among selected pupal weight lines.

Trait	% Heterosis by Crosses		
	L X F	L X S	S X F
Adult Weight	-15.6	-38.1	+6.5
Log Adult Wt.	-0.4	+0.9	+4.7
Weight Loss	-23.3	-60.0	-29.3
Log Wt. Loss	-1.8	-7.2	-5.7
Pupation Time	-7.0	-16.7	-1.6
(A-P) Time	+5.2	-15.4	+4.2

The purebred responses for ''Adult Weight'' and ''Weight Loss'' (Figure 1) show the same asymmetry on the arithmetic scale as previously found for pupa weight (Bell, and Miles, 1985), and on the log scale the selection responses were again perfectly symmetrical. Heterosis or non-additive gene action in the crossbreds clouds this issue of scale effects and asymmetry. Crosses involving Large showed a significant negative heterosis for adult weight which became additive on the log scale. Yet the reciprocal crosses between Base and Small showed a slight positive heterosis for adult weight on both scales to indicate some directional dominance for ''large'' genes.

The trait ''Weight Loss'' reflected a different heterotic picture. Here all crosses showed a significant negative heterosis to indicate that the crossbreds were consistently more efficient metabolically in the metamorphosis of pupa to adult.

In regard to developmental or growth rate as depicted for purebreds and crosses in Figure 1, one sees an inconsistent picture. The correlated response for pupation time was positive, i.e. selection for ''large'' resulted in an increased pupation time of about two days and a decrease in pupation time followed the ''small'' selection. This is in agreement with our earlier findings (Englert and Bell, 1963 and 1969). In addition, the observed negative heterosis (Table 4) for pupation time is in agreement with our earlier findings. However, the findings for ''Adult Time'' do not follow those for pupation time. While the differences among the purebreds are small and insignificant, the order is actually reversed with Small taking longer for adult metamorphosis than either Large or Base. In regard to heterosis, it is interesting to note that while the L X F and S X F crosses showed a small positive heterosis (i.e. the crosses spent a longer time as pupa than did the purebreds), the L X S cross showed a 15% negative heterosis. This reduction in ''days as pupae'' by nearly one full day may account for the 60% negative heterosis observed for weight loss for this crossbred.

SUMMARY

1. Long-term bi-directional selection for pupal weight resulted in significant correlated responses in both purebreds and crossbreds for the quantitative traits-pupation time, adult time (days from pupa to adult), adult weight, and weight loss from pupa to adult.

2. The asymmetrical purebred responses on the arithmetic scale for adult weight and weight loss became symmetrical when transformed to logs. The negative heterosis exhibited by the ''Large'' crosses on the arithmetic scale was not observed on the log scale. Yet both reciprocal crosses between Base and Small showed a positive heterosis for adult weight to indicate some dominance for ''large'' genes.

3. Days to pupation was positively correlated with the weight traits and showed negative heterosis for all crosses.

4. Genetic differences in metabolic efficiency to utilize the fixed resources in a pupa were described for the traits (1) proportional weight loss from pupation to adult emergence, and (2) time required for adult metamorphosis.

REFERENCES

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 D. A. Miles, 1985. Bi-directional selection and symmetry of response for quantitative traits. Tribolium Information Bulletin 25 (In Press).

Englert, D. C. and A. E. Bell, 1963. Genetic differences in the growth curve of Tribolium castaneum. Growth 27:87-99.

Englert, D. C. and A. E. Bell, 1969. Components of growth in genetically diverse populations of Tribolium castaneum. Canadian J. Genetics and Cytology 11:896-907

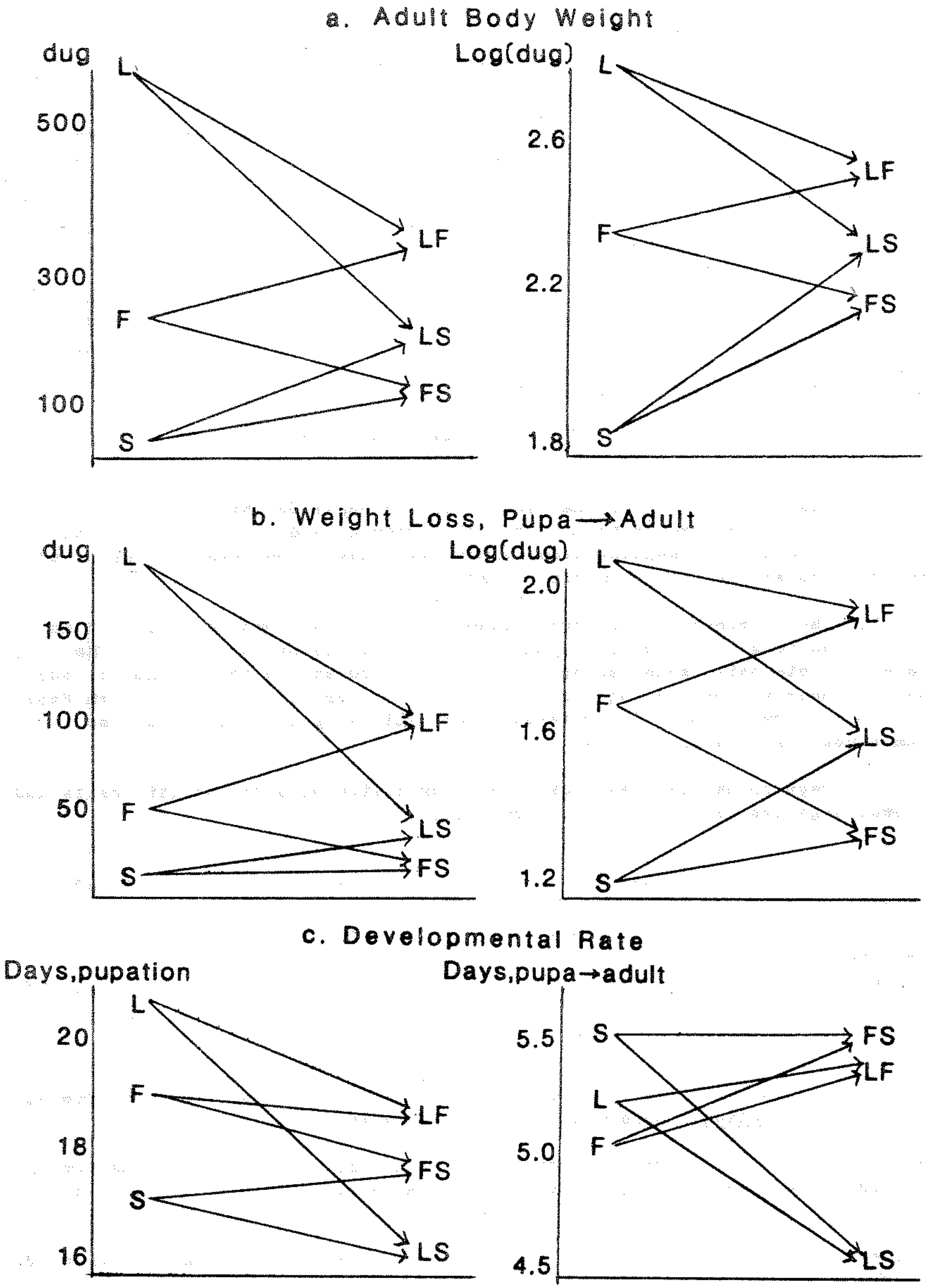


Figure 1. Relationship among purebreds and crossbreds for correlated traits

Binder, Bradley F., and Alexander Sokoloff
California State University, San Bernardino
5500 State University Parkway
San Bernardino, California 92407

CHANGES IN THE GROWTH AND DEVELOPMENT OF THE CABBAGE LOOPER TRICHOPLUSIA NI (Lepidoptera: Noctuidae) AFTER CONSUMPTION OF AN ARTIFICIAL DIET INCORPORATING THE NON-PROTEIN AMINO ACID L-CANAVANINE*.

The toxic non-protein amino acid, L-canavanine, has been used widely to investigate plant-insect interactions (Rosenthal, 1977). However, only one study has been on beetles of the Tribolium genus (Harry et al., 1976). The current study, using the cabbage looper as a model, illustrates the type of study which can be performed easily on Tribolium beetles.

Larvae of the fifth stadium cabbage looper, Trichoplusia ni (Hübner), were fed artificial diets containing 0 , 20 , and 30 mM L-canavanine sulfate. Larval weight and developmental changes were recorded for six days (Figure 1). Significant ($P \leq 0.05$) reductions in larval weight gain in the groups consuming diets incorporating 20 and 30 mM L-canavanine occurred by day 1. Concomitant with lower weight gains were reductions in larval maximal weight and a delay in attaining the maximal weight. However, when larvae reared on diets with 30 mM L-canavanine were returned to control diet after 4 days (Figure 1), growth and weight gain were similar to control larvae. The larvae did not attain the maximal weight acquired by the control larvae and pupated instead.

Larvae feeding on diets containing L-canavanine sulfate also exibited indications of developmental interference. Pupal formation was significantly ($P \leq 0.05$) delayed or prevented as the dietary concentration of L-canavanine was increased (Table 1). There were larvae which matured to pupae regardless of the concentration of L-canavanine; however, nearly all larvae consuming diet with the 30 mM concentration of the amino acid were prevented from pupation and became malformed pupae (melanization prior to actual pupal formation). Adult emergence was almost completely inhibited due to the larval ingestion of L-canavanine. The effect of L-canavanine ingestion could be reversed if the larvae were returned to control diet after 4 days on the diet with 30 mM L-canavanine. In that case, there was 100% pupation with adult emergence comparable to the control.

*Presented as part of a M.S. Thesis.

Figure 1. T.ni weight gain vs. time

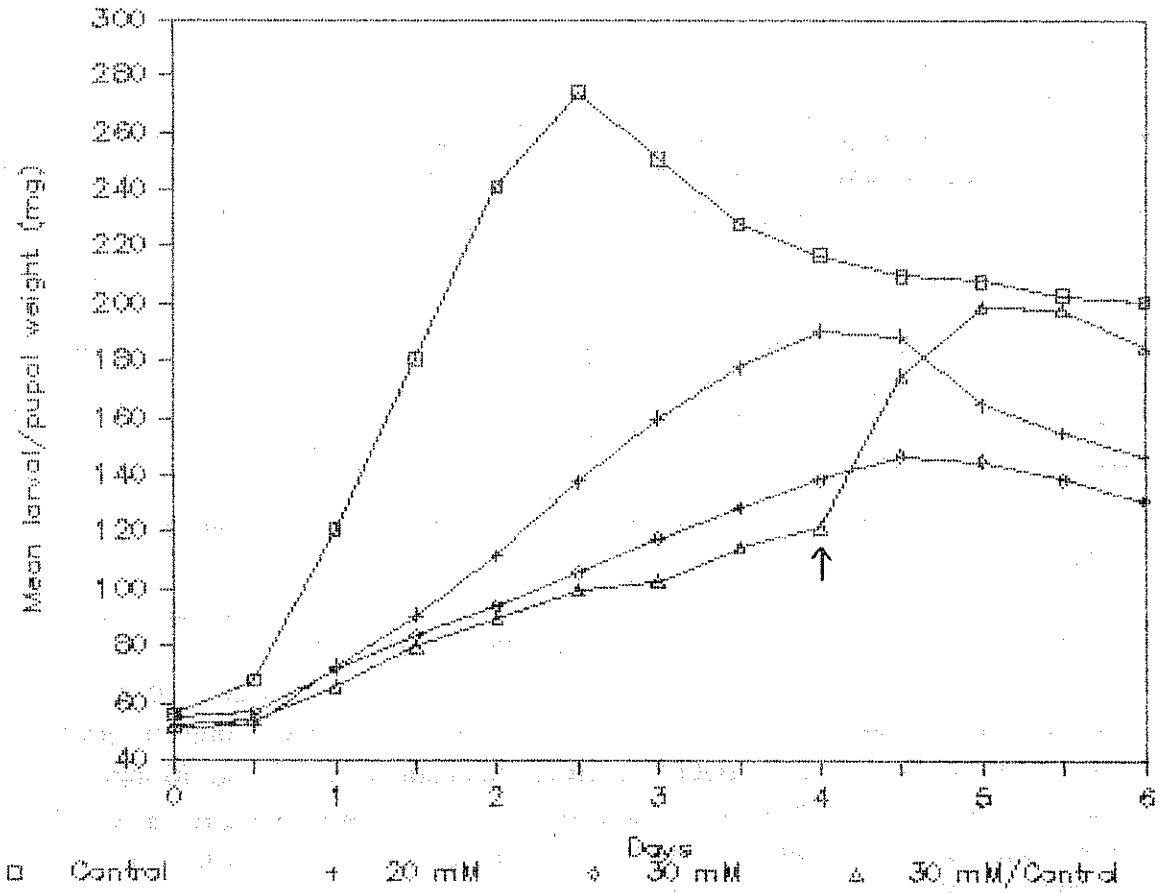


Figure 1. Mean larval/pupal body weights of T. ni reared on diets containing 0 , 20 , 30 mM concentrations of L-canavanine sulfate and then returned to control diet at day 4. Note the much lower maximal weights and delay in maximal weight gain of animals reared on diets containing 20 or 30 mM L-canavanine sulfate and that L-canavanine inhibition of insect growth was reversed when the animals were returned to control diet on day 4. Arrow indicates time when the larvae were returned to control diet. Solid symbols indicate pupae.

Table 1. Delay and reduction in the frequency of pupation of *Trichoplusia ni* when reared on experimental diets containing L-canavanine sulfate and then returned to control diet on day 4.

Time to pupation (Days)	Number of pupae at each dietary L-canavanine sulfate concentration (mM)*			
	0	20	30	30/control¥
4.0	7			
4.5	11			
5.0	1			
5.5				
6.0		3		
6.5		10		6
7.0			1	6
7.5				--
8.0				8
Mean time to pupation (Days)	4.3	6.4	7.0	7.3
Sample size	19	18	19	20
Percent pupation	100	72	5	100
Percent adult emerged	63	6	---	55

* Pupation time for animals at all diet concentrations (0mM, 20 mM, 30 mM, 30 mM/control) were significantly different statistically ($P \ll 0.001$) from each other except the 20 mM and 30 mM groups or the 30 mM and 30 mM/control as determined by the Kruskal-Wallis test (Conover, 1980).

¥ Larvae were reared on 30 mM L-canavanine diet for 4 days then transferred to control diet for the remainder of the experiment.

The amazing recovery of the cabbage looper after ingestion of the toxic non-protein amino acid L-canavanine indicates that the effects of L-canavanine are temporary and can be reversed if the animals are returned to control diet. The physiological mechanisms allowing the cabbage looper to recover from L-canavanine inhibition remain to be elucidated.

REFERENCES

Harry, P., Y. Dror, S. W. Applebaum. 1976. Arginase activity in Tribolium castaneum and the effect of canavanine. Insect Biochem. 6: 273-279.

Rosenthal, G. A. 1977. The biological effects and mode of action of L-canavanine, a structural analog of L-arginine. Quart. Rev. Biol. 52: 155-178.

Muir, William M.
Department of Animal Sciences
Purdue University
West Lafayette, IN 47907

*Use of logistic equation to characterize the efficiency of a population to utilize feed

Ability of Tribolium to efficiently utilize limited feed resources may be an important factor in determining the outcome of competition between populations. An equation which describes a population's resistance to starvation in a competitive situation would be useful.

MATERIAL AND METHODS

Three populations of Tribolium castaneum, derived from the same Purdue Black base population, were utilized. These populations were: b_C an unselected control and two lines (b_S and b_P) selected for survival in a competitive environment using different selection procedures as reported by Muir (1977). A 24 hour egg collection was taken from each population and divided into 40 creamers of 100 eggs each. The creamers contained 1 gram of alphacellulose into which .008 g of standard media was mixed. All eggs were incubated at 33° C and 95% RH. For each population, a one gram supplement of standard media was added to two creamers initially and on each of 19 consecutive days, thereafter. Twenty-one days after adding the supplement, the number of adults emerging in each creamer was counted.

The average percent survival (Y) for each population was fit to the following logistic equation (Finney, 1971),

$$Y = (1 + e^{-B_0})/(1 + e^{-B_0 + B_1X})$$

by equivently transforming the data to logits and finding the parameters by linear regression

$$\log (Y/1-Y) = B_0 + B_1X$$

where B_0 and B_1 are parameters to be estimated, X is the day fed supplemental media. A multiple correlation coefficient (R^2), which is the proportion of the total sums of squares that can be accounted for by the model, was computed for each population to determine how well the model fit the data.

Notes-Research

RESULTS AND DISCUSSION

Figure 1 presents the percent survival of each line. Table 1 gives estimates for the parameters and R^2 values. The model fit the data very well as over 81 percent of the variation could be accounted for. The values of B_0 indicate the extent of the initial lag period or resistance to starvation before the death phase takes over, the larger the value of B_0 , the more resistant the population. Thus, the control is less resistant than either selected population. the value of B_1 indicates the rate of death loss in the death phase. Hence, the control was initially more sensitive to starvation, and the rate of death loss for the control was greater than either selected populations.

LITERATURE CITED

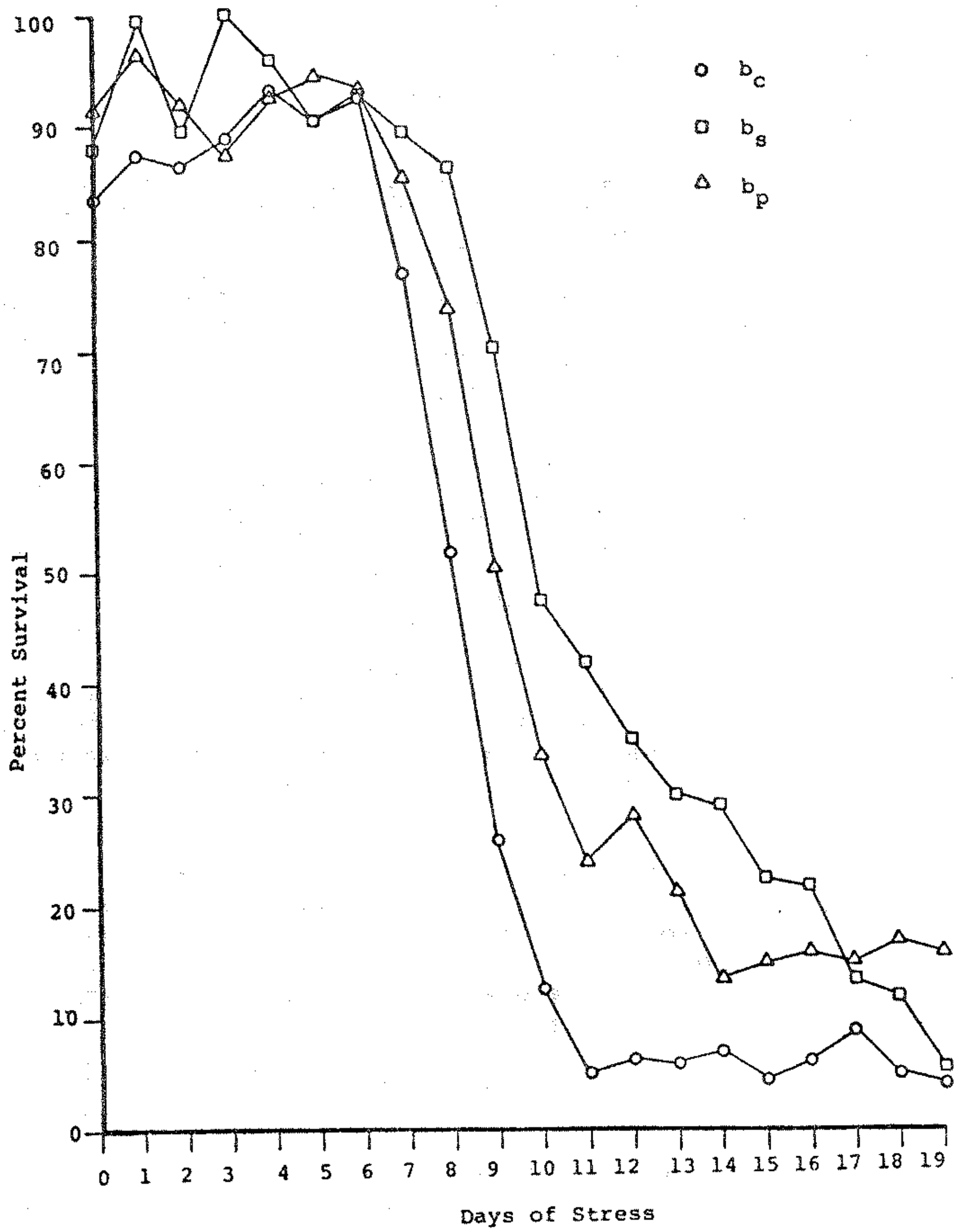
Finney, D. J. 1971. Statistical Methods in Biological Assay. Griffin. London.

Muir, W. M. 1977. Competitive selection between and within populations of Triboium castaneum. Ph.D. Thesis, Purdue.

Table 1. Parameter estimates and multiple correlation coefficient.

Line	Parameter Estimates $\hat{B}_0$	$\hat{B}_1$	R^2
b_c	2.778 $\pm$ .440	.355 $\pm$ .035	.814
b_p	3.887 $\pm$ .362	.340 $\pm$ .031	.870
b_s	3.240 $\pm$ .312	.306 $\pm$ .024	.868

Figure 1. Percent survival of black experimental populations



Notes-Research

Sokoloff, Alexander
Biology Department
California State University
San Bernardino, California 92407

* Occurrence of the blistered gene (ble) in natural populations of Eleodes sp. (Coleoptera:Tenebrionidae) in Southern California.

A vast literature dealing with descriptions of teratologies occurring in all sorts of Arthropods has been reviewed by Balazuc (1948, 1969), and more recently for the Coleoptera by Sokoloff (1972). Teratologies are of interest because they are the result of developmental accidents. They may be due to the action of mutant genes, to the effects of the environment during critical stages of development, or to the interaction between the genetic and environmental factors (Sokoloff, 1972).

Teratologies have their intrinsic value: They provide useful clues regarding the type of abnormality which may be genetically determined in organisms which have not been well investigated from the genetic standpoint, and it turn, once an organism is reasonably well known genetically, the genetic library of organisms occurring in other genera within the same family or species included in different families and even in different orders can be inferred from the discovery of similar teratologies. The best way to recognize mutants which may be homologous in widely separated species is to work out their genetics, but teratologies should not be overlooked since ultimately they may have a genetic basis.

From the information compiled by Balazuc (1948, 1969) Sokoloff (1972) was able to prepare a table (table 8.3 in Sokoloff, 1972) showing the various types of abnormalities affecting the elytra. That table showed that blisters on the elytra have been reported in several species of Carabidae (Carabus cancellatus and Eurytrachelus purpurascens); Cerambycidae (Cerambyx miles); Chrysomelidae (Lena merdigera L. brunnea and Timarcha nicaensis); Coccinellidae (Epilachna sp.); Lucanidae (lucanus cervus); Scarabaeidae (Geotrupes stercorosus and G. vernalis). Although about a dozen species of tenebrionids are listed in this table, the teratologies involving the elytra do not include a blistering effect. However, two tenebrionids, Tribolium castaneum and T. confusum have been studied genetically, and these two species have yielded mutations which produce blisters on the elytra (Sokoloff 1966). The blistered elytra mutants, to be sure, do not appear to be homologous: the ones in the T. castaneum ble stock are variable in expression, ranging from one small blister on one of the elytra to more extensive blistering perhaps extending to about one third of the area of both elytra. The expression in this species is also sex influenced: the blisters in females occur predominantly in the middle portion of the elytra, while those in the male occur distally, on the elytral tips. The ble mutant in T. confusum also produces blisters of variable size. The blisters occur primarily in the middle of the elytra; they often raise the elytra away from the dorsal surface of the abdomen, and the blisters may contain a brownish-red pigment. Whether ble in T. confusum exhibits sexual dimorphism has not been determined, and the linkage studies in T. confusum have not progressed sufficiently to be able to state whether the chromosome which bears the ble gene is homologous to the one in T. castaneum.

In regard to the main purpose of this note, I believe a blistered elytral mutant has been discovered in the stink beetle Eleodes sp. This mutant was found in the fall of 1984 during a collecting trip for insects in the chaparral area of the CSUSB campus. A rough sketch of the elytra of this beetle is shown in Fig. 1. As can be seen in the figure, the specimen bears bears a blister on each elytra. The blisters are prominent, but they are not placed completely symmetrically. They are located on the lateral aspects of the elytra, and they are of about the same size. The specimen apparently had no trouble surviving in the heat of San Bernardino, where summer temperatures during the day are often in excess of 100 degrees Fahrenheit for several days in succession. The voucher specimen is on deposit in the entomological collection at CSUSB.

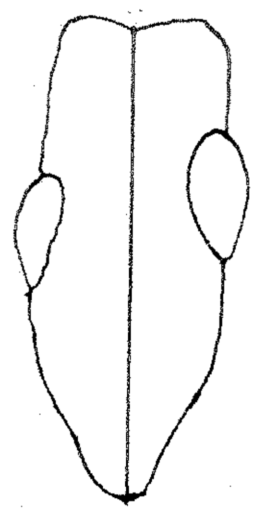
References Cited

Balazuc, J. 1948. La Teratologie des coleopteres et experiences de transplantation sur Tenebrio molitor L. Mem. Museum nat Hist. nat., Paris 25, 1-293.

Balazuc, J. 1969. Supplement a la teratologie des coleopteres. Redia, 51: 39-111.

Sokoloff, A. 1966. The Genetics of Tribolium and Related Species. Academic Press, New York.

Sokoloff, A. 1972. The Biology of Tribolium with Special Emphasis on Genetic Aspects. Volume 1. Clarendon Press, Oxford.



Sokoloff, A. and Brownlee, A.
Biology Department
California State University
San Bernardino, California, 92407

*Linkage identification of Giant.

Giant (Gi) is an autosomal dominant with complete penetrance and variable expression. It was discovered at the Pest Infestation Laboratory and subsequently deposited in the Tribolium Stock Center. Its effect is to increase the body weight of either heterozygous (Gi/+) and homozygous (Gi/Gi) beetles about two-fold over the normal (+/+) counterparts. Thus the effect is opposite to that brought about by the sex-linked semidominant pygmy (py) gene, which reduces the body weight to about one half the normal.

Brownlee (1984) determined the body weights of synthetic wild type and Giant and pygmy in mg. (All strains shared the Berkeley synthetic background). 25 pupae pupae of each sex and strain were individually weighed to obtain the following results.

Strain	Male	Female
Giant	4.3 + .08	4.5 + .08
pygmy	1.3 + .05	1.4 + .05
Berk. synth. +	2.2 + .04	2.3 + .03

We have attempted to establish the linkage relationships of the Gi gene. We took advantage of the availability of semidominants, dominants and dominants with recessive lethal effects. Gi was crossed to these various markers, located on different linkage groups. Once the F1 bearing two of these dominant mutants were available, they were crossed back to wild type which served as the double recessive. Thus, for example, in crosses between Spa and Gi, Spa-Gi double heterozygotes were crossed back to wild type in reciprocal crosses:

Spa +/+ Gi female X ++/++ male and
Spa +/+ Gi male X ++/++ female

The results of these crosses are shown in Table I.

These results show that Spa and Gi are linked, on the fourth linkage group. Furthermore these genes recombine with a frequency of 26.5 + .04 % in the female, and 22.0 + .03% in the male. The map position of the Gi gene in the fourth linkage group is yet to be determined

REFERENCES CITED

Brownlee, Aaron. 1984. Contributions to the genetics of Tribolium (Coleoptera: Tenebrionidae). I. Linkage relationships of aureate in linkage group III of Tribolium confusum. II. transmission of T. castaneum mutants to T.freemani-T.castaneum hybrids. Unpublished MS Thesis, California State University, San Bernardino.

Table I. Phenotype of backcross progeny in Spa +/+ Gi X + +/+ + reciprocal crosses

	Cross	
Phenotype	Spa +/+ Gi o X ++ o	Spa +/+ Gi o X ++ O
+ +	16	36
Spa +	40	80
+ Gi	68	104
Spa Gi	23	16
Total	147	236

Notes-Research

Sokoloff, A. and Faustini D.L.
Biology Department
California State University
San Bernardino, California, 92407
and
Philip Morris Research Institute
Richmond Virginia 23261

*A mutant, in Tribolium castaneum, with analogous morphological effects as those produced by engrailed in Drosophila melanogaster.

The mutant engrailed, en, in Drosophila melanogaster, is characterized by a longitudinal cleft which extends from the rear of the scutellum forward; the cleft may be reduced to a median nick or posterior flattening of the scutellum. The bristles are often javelin- or hooked-like. The wings are larger, broader, and thin textured, with spatulate end. The wing venation is always disturbed (like that of ci), with a gap in L4 and L5 and branching plexus of extra veins. In males, an extra sex comb is often present which is smaller than normal and in mirror image position on the outer side of the tarsus. The action of en is autonomous on the differentiation of secondary sex comb on male foreleg. The male genitalia may be malformed and rotated, resulting in sterility.

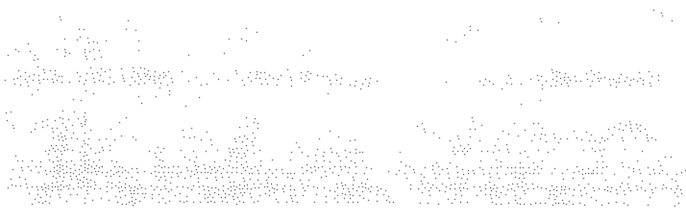
The mutant Dachs, Dch, is an autosomal dominant with complete penetrance but variable expression which modifies the phenotype of the beetle in the following ways:

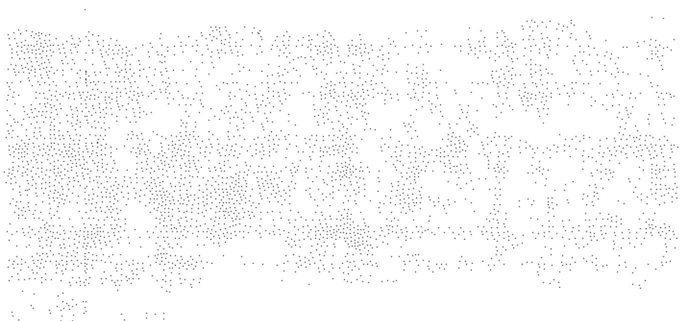
The main effect is a fusion of the club and/or funicular segments. In extreme manifestation of the Dch gene, the antennal club and distal funicular segments are fused into a solid mass. Ofter the time of the antenna is oriented ventrally, forming a structure scoop-like in appearance. In less extreme form, only adjacent segments of the funicle and sometimes of the club are either partly or completely fused. However, the mutant is always recognizable by having fusion of antennameres, resulting in an antenna with fewer than the 11 segments characteristic of normal antennae. The Dch gene does not seem to affect the proximal segments, the pedicel and the scape, of the antenna.

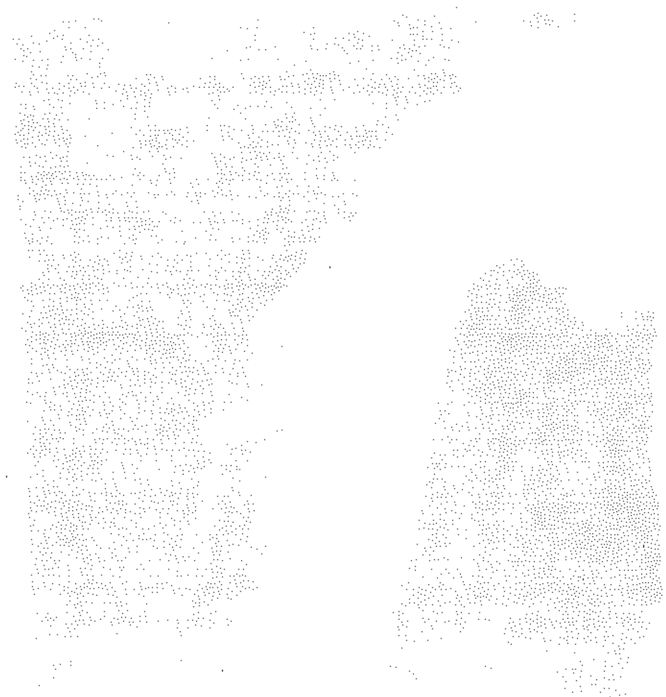
Sometimes Dch also affects the legs: the tibia may be reduced to about half the normal length, and the tarsal segments may fuse into a solid mass. There may be a definite tibio-tarsal joint, or the tibio-tarsal complex may fuse into a solid mass with no recognizable tibio-tarsal joint. Other tarsal joints may be incomplete.

But the most interesting effect is the duplication of the sex-spot which is present in the femur of the male but is absent in the female. This was discovered by one of us (D.L.F.) while studying the possible presence of a pheromone in *T. castaneum*, and studying the possibility that the pheromone is produced by glands in the sex-spot and associated hairs present in the first legs of the male *T. castaneum*. This sex-spot is often covered (or caked) with flour. In some specimens this sex spot appeared to be more extensive than in others, and a bigger encrustation of flour covered it. When the flour from these individuals was removed, there were two sex-spots instead of one, as shown in the accompanying figures.

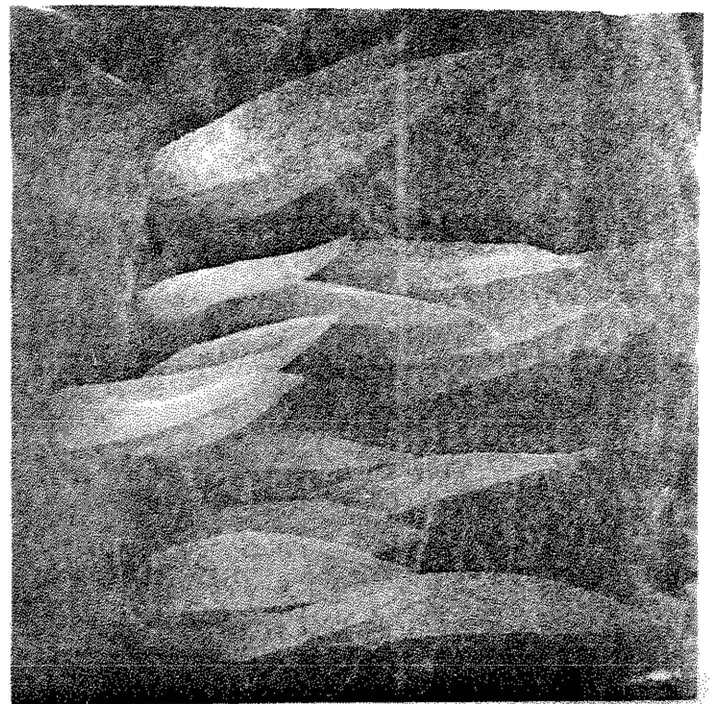
The Dch gene has been identified with linkage group II.

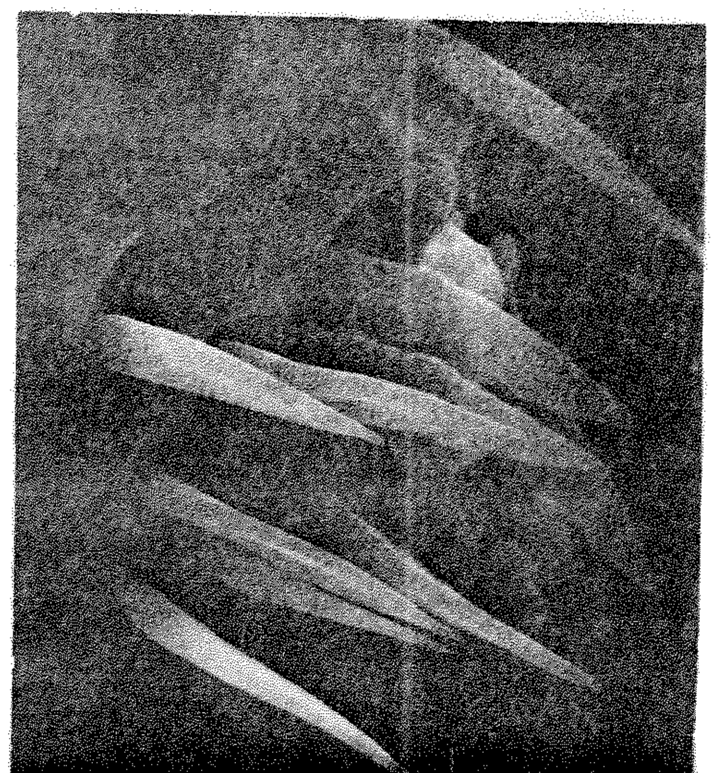


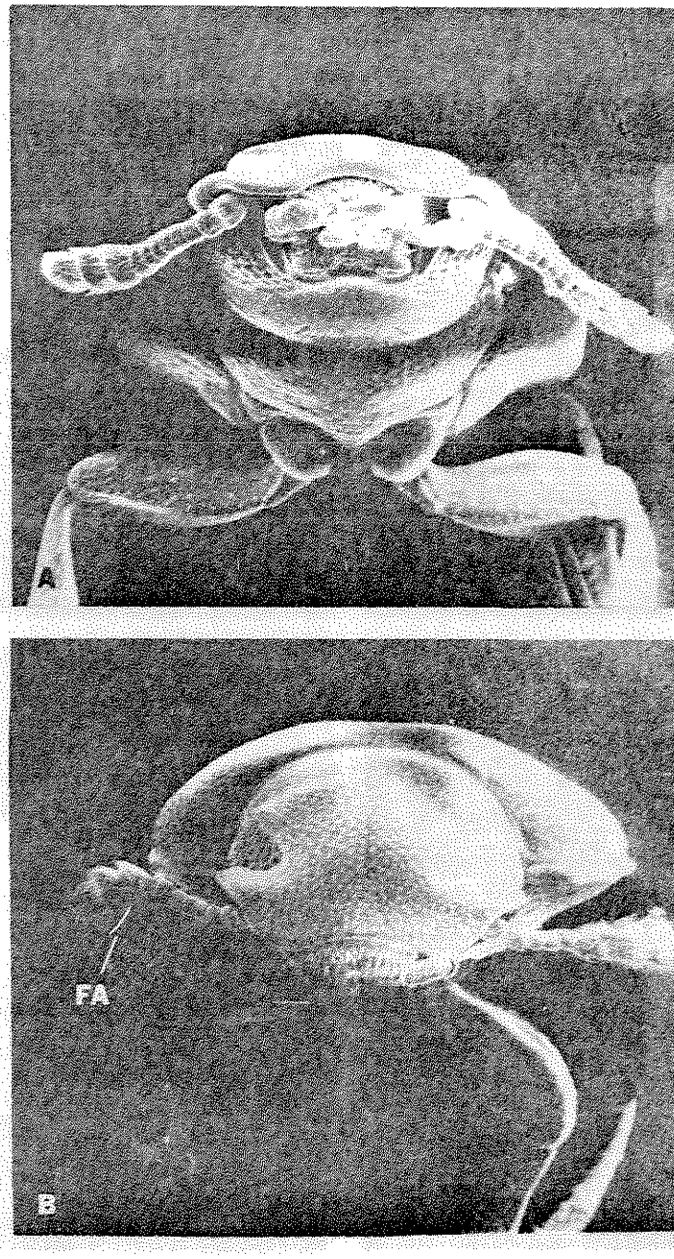


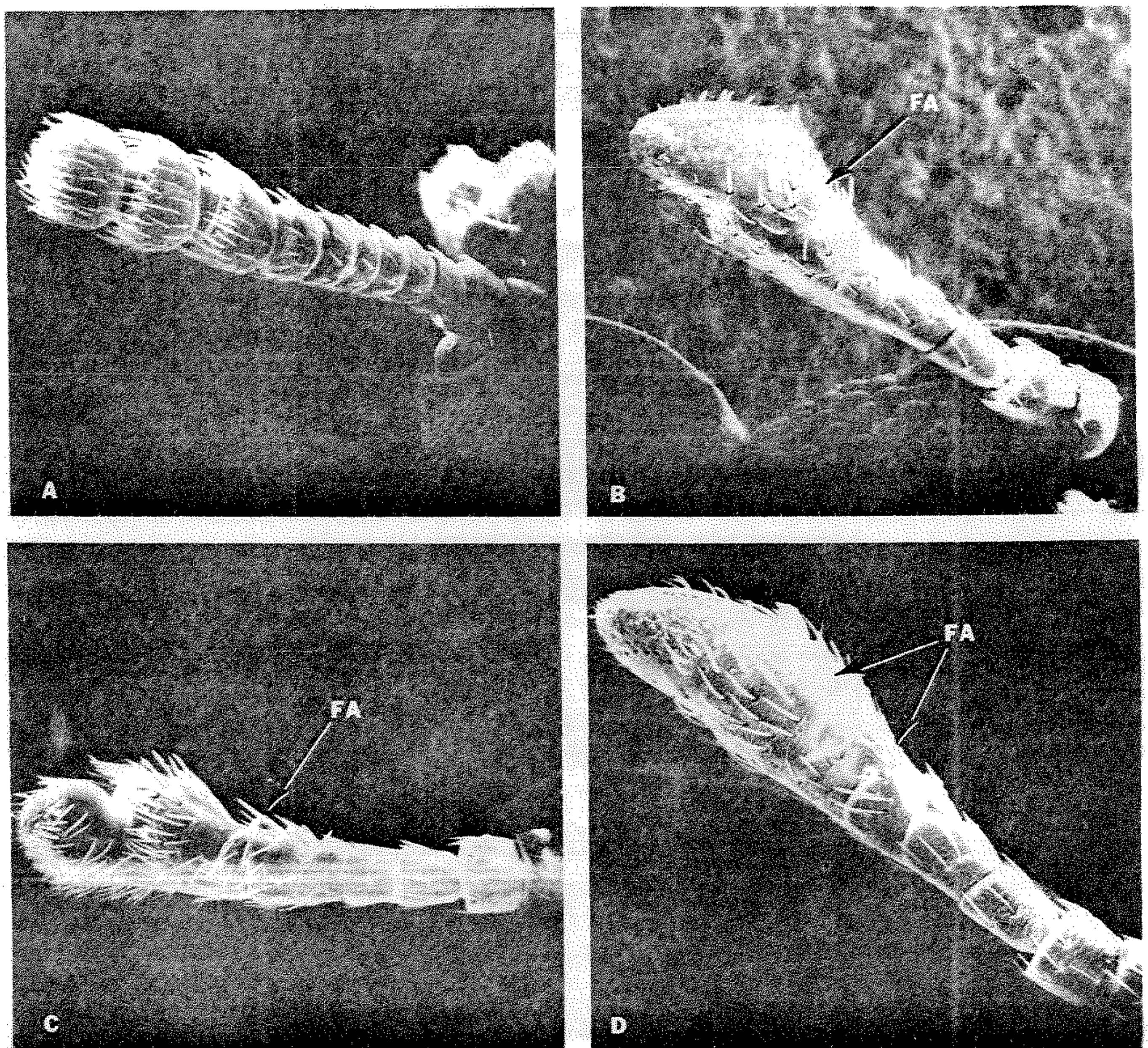


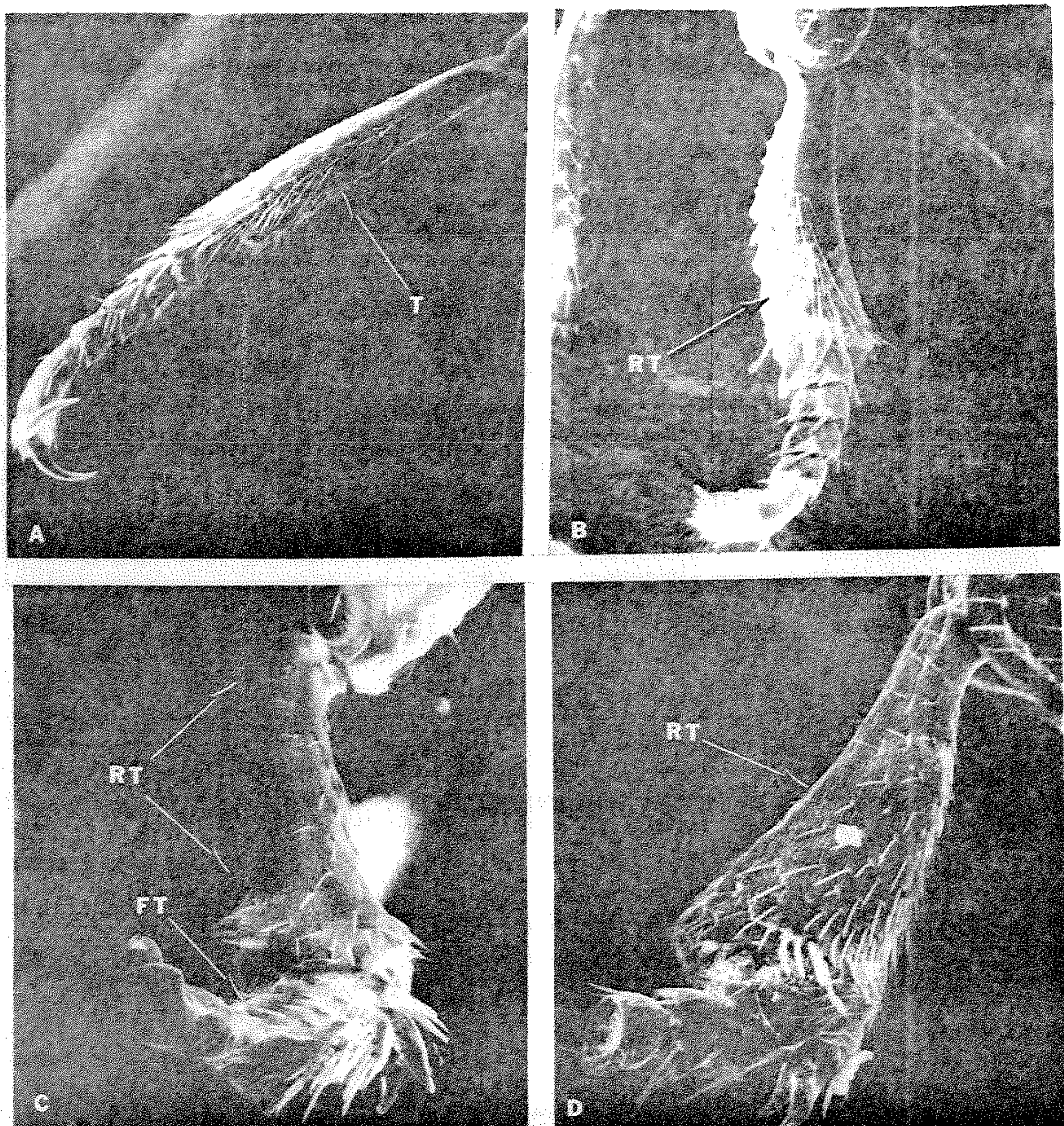
SS






A
B
FA


FA
FA
FA
A
B
C
D


T
RT
RT
FT
RT
A
B
C
D

Notes-Research

Sokoloff, A. and Ferrone, R.
Biology Department
California State University
San Bernardino, California.

*A revision of linkage group II.

In The Biology of Tribolium, Vol. III, Sokoloff showed a map of linkage group II consisting essentially of three points. One point was occupied by p and its pink allele. Near it was ivory (i), which Dewees and Bell (1967) showed to be 0.03 map units away from p. Sokoloff showed pg to be located 30 units away from p. These three genes were determined to be in the order i-p-pg. A fourth mutant, Reduced eye notch (Ren) has been located in this linkage group, near pearl. Schmitz and Englert, in fact, state that there is close linkage between p and Ren, but they do not indicate whether the Ren gene is located to the left or to the right of p.

Recent linkage studies have made it possible to add several genes to the linkage map of chromosome II, identified by the pearl gene. The complete data will be published elsewhere. For the time being it is possible to summarize the following linkage data:

Mutants	Unit distance
Rd-mxp	29.1-39.9
Rd-mas	31.9-36.7
p-i	0.03
Dch-mas	2.3-8.7
Dch-mxp	7.8-5.7
Dch-p	15.4-19.7 or 20.2-24.1 (two separate experiments)
p-mxp	23.4-25.9
p-Ren	close linkage

From these data we have constructed the map of linkage group II shown in Fig. 1.

Dawson (1984) failed to detect any linkage between Rd. and p. This probably means that Rd is located too far from p to detect any crossover products, and thus the position of Rd must be very far (rather than near) p. Dawson and Berends (in press) have reported that Reindeer and alate prothorax are linked and recombine at a frequency of 32.8+1.1% in the male and 28.6+1.1 in the female, and on the basis of previous information have assigned these two genes to linkage group IX. The data reported here suggest that Rd and apt should be reassigned to linkage group II. we are correctly carrying out three point crosses to determine whether this hypothesis is correct.
hypothesis is

References cited

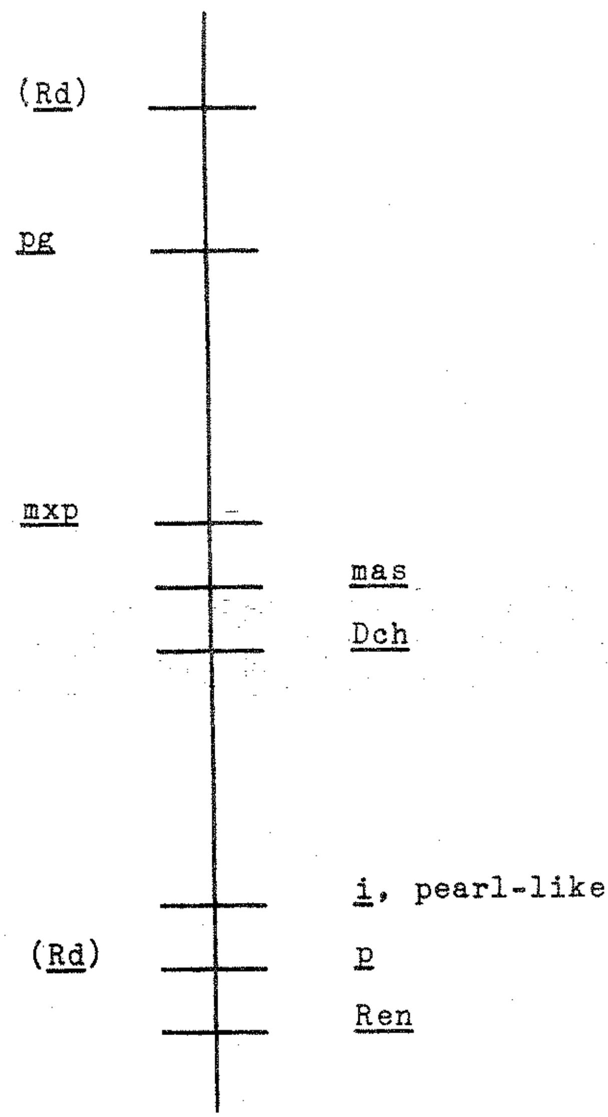
Dawson, P.S. 1984. The "reindeer" mutation and a revision of linkage group V and X in the flour beetle Tribolium castaneum. Can. J. Genet. Cytol. 26:762-764.

Dawson, P.S. and Berends, K. L. (1985). Linkage of the reindeer and alate prothorax loci and sex differences in recombination frequency in linkage group IX OF tribolium castaneum. Can. J. Genet. Cytol. (in press)

Sokoloff, A. 1977. The Biology of Tribolium with Special Emphasis on Genetic Aspects. Clarendon Press, Oxford. Vol. III.

Linkage map of group II in *Tribolium castaneum*.

Linkage Group II



Bibliography

1. ANATOMY, HISTOLOGY AND MORPHOLOGY

Bibliography

2. BEHAVIOR STUDIES

Barrer, P.M. 1983. A field demostration of odour-based, host-food finding behavior in several species of stored grain insects. J. Stored Prod. Res. 19:105-110

Hughes, A.L. 1982. Attraction of adult Tribolium confusum to flour conditioned by conspecifics. Behav. Process. 7:247-253.

Riddle, R.A., and Dawson, P.S. 1983. Genetic control of emigration behavior in Tribolium castaneum and Tribolium confusum. Behav. Genet. 13: 421-434

Bibliography

3. INSECT TISSUE CULTURE AND EMBRYOLOGY

Bibliography

4. CYTOLOGY AND ELECTRON MICROSCOPY

Al-Khalifa, M.S. 1981. An electron microscope and histological study of the egg development in flour beetle, Tribolium castaneum (Herbst). (Tenebrionidae, Coleoptera). J. Coll. Sci. Univ. Riyadh 12: 367-383.

Bibliography

5. ECOLOGY AND POPULATION ECOLOGY

Khan, A.R. and Bhuiyan, A.R. 1983. Effect of foods on the sex ratios of the flour beetle, Tribolium confusum. Entomol. Exp. Appl. 34:123.

Mulder, G. and Sokoloff, A. 1982. Observations on populations of Tribolium brevicornis Le Conte (Coleoptera, Tenebrionidae). III. Preliminary comparisons between feral and domesticated populations. J. Adv. Zool. 3:33-45.

Pajni, H.R. and Virk, N. 1982. Observations on some aspects of the biology of Tribolium castaneum Herbst. (Coleoptera:Tenebrionidae. Res. Bull. Panjab Univ. New Ser. Sci. 33:155-158.

Pajni, H.R. and Virk, N. 1982. A note on the life cycle of Tribolium castaneum Herbst (Coleoptera: Tenebrionidae). Res. Bull. Panjab Univ. New Ser. Sci. 33:159-163.

Sarin, K. and Nehra, P. 1981. Food preference of Tribolium castaneum. Bull Grain Technol. 19:104-106.

Sokoloff, A., Wilson, R., Mulder, G. and Faustini, D. 1982 Observations on populations of Tribolium brevicornis Le Conte (Coleoptera: Tenebrionidae). II. The habitat niche of a local population in southern California. Pan-Pac. Entomol. 58:177-183.

Bibliography

6. GENERAL

Bibliography

7. GENETICS AND PHENOTYPIC VARIATION

Bartlett, A.C. and Randall, W.C. 1983. Allozyme variation among populations of boll weevils in Arizona and Mexico. Southwest. Entomol. 8:118-130.

Beeman, R.W. 1983. Inheritance and linkage of malathion resistance in the red flour beetle. J. Econ. Entomol. 76:737-740.

Bell, A.E. 1982. On the utilization of total genetic variation, an overview. Genetique quantitative et appliquee des populations croisees. Les Colloque de l'INRA 10:20-28

Bell, A.E. 1982. Utilization of non-additive gene effects--Experimental results from laboratory and domestic animals. Genetique Quantitative et appliquees des populations croisees. Les Colloques des l'INRA 10:107-123.

Bell, A.E. 1984. Laboratory animals for animal breeding research--Experimental models versus model experiments. Genetics: New Frontiers, pp159-168. Oxford & IBH publishing Co. New Delhi.

Bohn, G.I., Friars, G.W. and McMillan, I. 1983. The variance of response to selection in Tribolium castaneum. Can. J. Genet. Cytol. 25: 44-46.

Bremner, T.A., Anderson, M.D., Pope, G.J. and Anderson, R.M. 1983. Genetic polymorphism of amylase in three species of Tribolium (Coleoptera, Tenebrionidae). Comp. Biochem. Physiol. B Comp. Biochem. 74:755-758.

Dawson, P.S. 1983. Successful selection for reduced competitive ability in Tribolium. Am. Naturalist 122:292-294.

Dawson, P.S. 1984. The "reindeer" mutation and a revision of linkage groups V and X in the flour beetle, Tribolium castaneum. Can J. Genet. Cytol. 26:762-764.

Dawson, P.S. and J. Jost. 1983. Linkage relationships among the malic enzyme, hexokinase-1, and red loci on the X chromosome of Tribolium confusum. Biochem. Genet. 21: 661-665.

Dawson, P.S. and R.A. Riddle. 1983. Genetic variation, environmental hetergeneity and evolutionary stability. In Population Biology: Retrospect and Prospect. C.E.King and P.S. Dawson (eds), Columbia Univ. Press, New York.

Bibliography

Dawson, P.S. and P.B. Samollow. 1985. Chromosome evolution in Tribolium flour beetles: Evidence of the hexokinase-1 and malic enzyme loci in T. castaneum and T. confusum. Evolution 39:320-323.

Dawson, P.S. and Jost, J. Linkage relationships among the malic enzyme, hexokinase-1 and red loci on the X chromosome of Tribolium confusum. Biochem. Genet. 21: 661-665.

Gupta, A.K., and Taneja, V.K. 1983. Effect of different selection intensities in response to selection for 19-day pupal weight in Tribolium castaneum. Indian J. Anim. Sci 53:405-410.

Langholff, W.K. and A.E. Bell. 1984. Starvation resistance in Tribolium castaneum larvae. Tribolium Inf. Bull. 24:105-108.

Mayes, P.A. and Englert, D.C. 1984. interstrain differences for larval dispersal and egg cannibalism in the flour beetle Tribolium castaneum. Can. J. Genet. Cytol. 26: 420-424.

Miles, D.A. and A.E. Bell. 1984. Genetic drift in large random mating control populations. Tribolium Inf. Bull. 24:114-119.

Neelam, V. and Bhatia, S.K. 1983. a new X-linked body colour mutation in Tribolium confusum. Entomol. Exp. Appl. 34:124-126.

Patterson, D.L., Friars, G.W. and McMillan, I. 1983. Effects of parental age and sampling method on response to index selection in Tribolium castaneum. Can. J. Gent. Cytol. 25:47-52.

Rich, S.S., A.E. Bell, D.A. Miles and S.P. Wilson. 1984. An experimental study of genetic drift for two quantitative traits in Tribolium. J. Heredity 75:191-195.

Riddle, R.A. and P.S. Dawson. 1983. Genetic control of emigration behavior in Tribolium castaneum and T. confusum. Behavioral Genetics 13: 421-434.

Tyagi, A.K. 1981. Effect of solar eclipse on insect species: colour mutation in Tribolium castaneum (Herbst). Bull. Grain Technol. 19:220-222.

Wool, D. 1982. Family selection for DDT resistance in flour beetles (Tribolium: Tenebrionidae) as a model for group selection of fitness traits. Isr. J. Entomol. 16:73-85.

Bibliography

8. INSECTICIDES AND INSECTICIDE RESISTANCE

Anderegg, B.N. and Madisen, L.J. 1983. effect of insecticide distribution and storage time on the degradation of (14C) malathion in stored wheat. J. Econ. Entomol. 76:1009-1013.

Brun, L.O. and Attia, F.I. 1983. resistance to lindane, malathion and fenitrothion in Coleopterous pests of stored products in New Caledonia. Proc. Hawaii Entomol. Soc. 24:211-215.

Calderon, M. and Leesch, J.G. 1983. Effect of reduced pressure and CO2 on the toxicity of methyl bromide to two species of stored-product insects. J. Econ. Entomol. 76:1125-1128.

Cline, L. D., Zettler, J.L., McDonald, L.L. and Highland, H.A. 1984. continuous exposure to sublethal doses of synergized pyrethrings: Effects on resistance and repellency in Tribolium confusum (Coleoptera: Tenebrionidae). J. Econ. Entomol. 77:1189-1193.

Dhingra, S. and Sarup, P. 1981. Effect of some non-toxic chemicals in mixed formulations with different insecticides against the lindane-resistant strain of Tribolium castaneum (Herbst) (Coleoptera, Tenebrionidae). J. Entomol. Res. 5:1-11.

Dhingra, S. and Sarup, P. 1981. Categorization of type of action in mixed formulations comprising some non-toxic chemicals and different insecticies agains the normal strain of Tribolium castaneum (Herbst) Coleoptera: Tenebrionidae). J. Entomol. Res. 5:101-110.

Evans, N.J. 1985. the effectiveness of various insecticides on some resistant insect pests of stored products from Uganda. J. Stored Prod. Res. (in press).

Golob, P. Prostephanus truncatus (Horn), the Larger Grain Borer, in East Africa: the development of a control strategy. Proceedings of the Third International Working Conference on Stored-Product Entomology, Manhattan, Kansas, USA, (23-28 October 1983), 1984:711-721.

Golob, P. Changjarden, P. Ahmed, A. and Cox, J. 1985. Susceptibility of Prostephanus truncatus (Horn) to insecticides. J. STORED prod. Res. (in press)

Halliday, D., Harris, A.H. and Taylor, R.W.D. Recent developments in the use of phosphine as a fumigant for grains and other durable agricultural produce. Chemistry and Industry, 20 June 1983, 468-471.

Halliday, D. Harris, A.H. and Taylor R.W.D. Development of resistance to phosphine by insect pests of stored grains. Proceedings of the International Congress of Plant Protection, Brighton, November 1983, Session 3c-R15, 640.

Ishaaya, I., Elsner, A., Ascher, K.R.S. and Casida, J.E. 1983. synthetic pyrethroids: toxicity and synergism on dietary exposure of Tribolium castaneum (Herbst) larvae Pestic. sci. 14:367-372.

Khan, M.A. 1983. Effectiveness of insecticides and repellents on stored product insect pests. Anz. Schädlingskd. Pflanzenschutz Umweltschutz 56:25-29.

Kirkpatrick, R.L. 1982. Candidate formulations for disinfecting transport vehicles 1981. Insectic. Acaricide Tests 7:231.

Kirkpatrick, R.L. and Fons, J.F. 1982. Candidate pesticides for stored-product insects, 1981. Insectic. Acaricide Tests 7:231-232.

Kumar, J. and Bhatia, S.K. 1983. Evaluation of bioassay techniques for measurement of lindane resistance in Tribolium castaneum (Herbst). Entomon. 8:123-126.

Kumar, J. and Bhatia, S.K. 1983. Comparison of the biology of strains of Tribolium castaneum (Herbst) resistant and susceptible to lindane. Indian J. Agric. Sci 53:578-581.

McGovern, T.p., Zettler, J. L. and McDonald L.L. 1984. Repellents for adult Tribolium confusum: Mandelic acid esters of branched-chain alcohols. J. Georgia Entomol. Soc. 19:356-366.

Mensah, G.W.K. and White, N.D.G. 1984. Laboratory evaluation of malathion-treated sawdust for control of stored-product insects in empty granaries and food warehouses. J. Econ. Entomol. 77:202-206.

Mishra, R.C., and Kumar, J. 1983. Evaluation of Mentha piperita L. oil as a fumigant against red flour beetle, Tribolium castaneum (Herbst). J. Indian Perfum. 27:73-76.

Taber, M. and Dutkomp, L.K. 1983. Effects of sublethal doses of DDT and three other insecticides on Tribolium confusum J. du V. (Coleoptera: Tenebrionidae). J. Stored Prod. Res. 19:43-50.

Vardell, H.H. 1984. potential of seven insecticides for stored-product insect control. J. Georgia Entomol. Soc. 19:138-141.

Bibliography

Valles, X. and Ventura, J. 1982. Repellent properties of four juvenile hormone biomimetics against adults of Tribolium confusum J. du Val (Coleoptera Tenebrionidae). An. Inst. Nac. Invest. Agrar. Ser. Agric. 18:111-115.

Vrba. C.J., Arai, H.P. and Nosal, M. 1983. The effect of silica aerogel on the mortality of Tribolium confusum (Duval) as a function of exposure time and food deprivation. J. Can. Zool. 61:1481-1486.

White, N.D.G., Nowicki, T.W. and Watters, F.L. 1983. Comparison of fenitrothion and malathion for treatment of plywood and galvanized steel surfaces for control of the red flour beetle (Coleoptera: Tenebrionidae) and the rusty grain beetle (Coleoptera: Cucujidae). J. Econ. Entom. 76:856-863.

Winks, R.G. 1982. The toxicity of phosphine to adults of Tribolium castaneum (Herbst):time as a response factor. J. Stored Prod. Res. 18:159-169.

Wood, C.D. and Halliday, D. Fighting infestation. Infofish Marketing Digest. 1983, No. 6183, 24-25.

Bibliography

9. IRRADIATION AND USE OF ISOTOPES

Buscarlet, L.A. 1983. Effects of gamma irradiation on respiration and on food consumption measured through 22Na in Tribolium confusum J. du V. (Coleoptera:Tenebrionidae). J. Stored Prod. Res 19:19-24

Faustini, D.L. and Sokoloff, A. 1982. The effect of gamma irradiation on crossing over of various developmental stages of Tribolium castaneum (Herbst) (Coleoptera:Tenebrionidae). J. Adv. Zool. 3:12-19.

Bibliography

10. NUTRITION

Wyckoff, S., Vohra, P., and Kratzer, F.H. 1983. Improvement of nutritional value of common beans (Phaseolus vulgaris) by autoclaving or extraction. J. Sci. Food Agric. 34:612-618.

Bibliography

11. PARASITES AND SYMBIONTS

Mettrick, D.F. and Rahman, M. S. 1984. Effects of parasite strain and intermediate host species on carbohydrate intermediary metabolism in the rat tapeworm Hymenolepis diminuta. Can. J. Zool. 62:355-361.

Osuna Carrillo, A., Suarez Carrillo, L.E., Guevara Benitez, D.C. and Gamarro Conde, F. 1982. In vitro culture of Hymenolepis nana (Cestoda): influence on its development of the hormonal levels of serum and liver extract used in the culture. Rev. Iber. Parasitol. 42:399-409.

Bibliography

12. PESTS

Dobie, P. 1984. Biological methods for integrated control of insects and mites in tropical stored procucts.-I: The use of resistant varieties. Tropical Stored Prod. Information 48:4-8.

Dobie, P 1984. Biological methods for integrated control of insects and mites in tropical stored products -IV: integrated control: the role of biological methods. Tropical Stored Products Inf. 48:37-45.

Dobie, P., Haines, C.P., Hodges, R.J. and Prevett, P.F. 1984. insects and arachnids of tropical stored products: their biology and identification. (A training manual). TDRI, U.K. VII + 273pp.

Haines, C.P. 1983. Pest management of stored products. (Proceedings of the Symposium on Pest Ecology and Pest Management, 18-20 September 1979, BIOTROP, Bogor, Indonesia.) Biotrop Special Publication No. 18, 199-207.

Haines, C.P. 1983. The implications of some problems in the identification of stored-product arthropods. (Proceeding of the Symposium on Pest Ecology and Pest Management, 18-20 September 1979, BIOTROP, Bogor, Indonesia.) BIOTROP Special Publication 18, 263-267.

Haines, C.P. 1984, Biological methods for integrated control of insects and mites in tropical stored products - III: The use of predators and parasites. Tropical Stored Products Information 48:17-25.

Haines, C.P. and Pranata, R.I. 1983. survey on insects and arachnids associated with stored products in some parts of Java. (Proceedings of the 5th Annual Workshop on Grains Post-Harvest Technology, Chiangmai, Thailand, 19-21 January 1982). Progress in Grain Protection, SEARCA, 17-48.

Hodges, R.J. 1984. Field ecology and monitoring of Prostephanus truncatus (Horn). Proceedings of the GASGA worksnop on the Larger Grain Borer, Prostephanus truncatus (24-25 February 1983, TPI, Slough). Published GTZ, Eschborn, pp 32-48.

Hodges, R.J. 1984. Biological methods for integrated control of insects and mites in tropical stored products-II: Thew use of pheromones. Tropical Stored Products Information, 48:9-15

Hodges, R.J. 1984. Biological methods for integrated control of insects and mites in tropical stored products--IV: The use of sterile insects. Tropical Stored Products Information, 48:27-32

Bibliography

Hodges, R.J. 1984. Biological methods for integrated control of insects and mites in tropical stored products--V: The use of sterile insects. Tropical Stored Products Information 48:33-36.

Hodges, R.J.; Benton, F.P., Hall, D.R. and Serodio, R. 1984. Control of Ephestia cautella (Walker) (Lepidoptera: Phycitidae) by synthetic sex pheromones in the laboratory and store. J. stored Prod. Res. 20:191-197.

Hodges, R.J., Cork, A. and Hall, D.R. 1984. aggregation pheromones for monitoring the greater grain borer Prostephanus truncatus. Proceedings of the British Crop Protection Conference, Brighton, pp255-259.

Hodges, R.J., Hall, D.R., Golob, P. and Meik, J. 1983. Responses of Prostephanus truncatus to components of the aggregation pheromone of Rhyzopertha dominica in the laboratory and field. Entomologia Experimentalis et Applicata 34:266-272.

Hodges. R.J. and Meik, J. 1984. Infestation of maize cobs by Prostephanus truncatus (Horn) (Coleoptera: Bostrichidae)--Aspects of biology and control. J. stored Prod. Res. 20:205-213.

Khan, M.A. 1983. Invasion of egg-larvae of stored product insects through different sizes of pores of the packing material. Anz. Schadlingskd. Pflanzenschutz Umweltschutz 56: 65-67.

Khan, M.A. 1983. Invasion of stored product insects through packages. Anz. Schadlingskd. Pflanzenschutz Umweltschutz 56:91-94.

Khan. M.W.Y., Ahmad, F. and Osman, S.M. 1983. nonedible seed oils as insect repellents. J. Am. Oil Chem. Soc. 60:949-950.

Kim, Y.S., and Ryoo, M.I. 1982. Activities of molds and insects during rice storage. I. Activities of Tribolium castaneum Herbst and Aspergillus species. Han'guk Nonghwa HAkhoe Chi J. Korean Agric. Chem. Soc. 25:252-256.

Pranata, R.I. and Haines, C.P. 1983. research and training on stored products insects at BIOTROP. (proceedings of the 5th Annual Workshop on Grains Post Harvest Technology, Chiangmai, Thailand, 19-21 January 1982). Progress in Grain Protection. SEARCA pp 74-81.

Proctor, D.L. and Rowley, J.Q. 1983. The thousand grain mass (TGM) method-- a basis for better assessment of weight losses in stored grain. Tropical Stored Products Information 45:19-23.

Bibliography

Redden, R.J., Dobie, P. and Gatehouse, A.M.R. 1983. The inheritance of seed resistance to Callosobruchus maculatus F. in cowpea (Vigna unguiculata L. Walp.) I: Analyses of parental, F1, f2, f3 and backcross seed generations. Australian J. Agric Res. 34:681-695.

Rees, D.P. 1985. Life history of Teretriosoma nigrescens Lewis (Coleoptera: Histeridae) and its ability to suppress populations of Prostephanus truncatus (Horn) (Coleoptera: Bostrichidae). J. stored Prod. Res. (in press).

Sarin, K., and Sharma, A. 1981. Effect of some environmental physical abiotic factors on the resistance/susceptibility of wheat varieties to Tribolium castaneum. Bull. Grain Technol. 19:191-193.

Sarin, K., and Sharma, A. 1982. Varietal resistance and susceptibility to Tribolium castaneum (Herbst) in wheat. Indian J. Entomol. 44:197-200.

Simwat, G.S. and Chahal, B.S. 1982. Multiplication of some stored grain insect pests and extent of loss to wheat grains at constant environment. Indian J. Ecol. 9:125-129.

Storey, C.L. Sauer, D.B. and Walker, D. 1983. Insect populations in wheat, corn, and oats stored on the farm. J. Econ. Entomol. 76:1323-1330.

Suzuki, T., Ozaki, J. and Sugawara, R. 1983. Synthesis of optically active aggregation pheromone analogues of the red flour beetle, Tribolium castaneum. Agric. Biol. Chem. 47:869-875.

Thompson, E.G. 1984. The integrated pest management approach to food production. Cereal Foods World 29:149-151.

Bibliography

13. PHYSIOLOGY AND BIOCHEMISTRY

Faustini, D.L., Rowe, J.R. and W.E. Burkholder. 1982. A male-produced aggregation pheromone in Tribolium brevicornis Leconte) (Coleoptera: Tenebrionidae) and interspecific responses of several Tribolium species. J. Stored Prod. Res. 18:153-158.

Singh, R.N. and Krishna, S.S. 1982. Electrophoretic patterns of the water-soluble proteins in diet, fat body ovary and newly laid eggs of the red flour beetle considered in relation to differences in the physiological status of the female during her reproductive life. J. Adv. Zool. 3:129-134.

Srivastava, S.K. and Sharan, R.K. 1981. Histochemical localization of alkaline phosphatase in the alimentary canal of Tribolium castaneum (Herbst). J. Entomol. Res. 5:175-176.

Tunc, I. 1983. Mortality of Tribolium confusum du Val. (Coleoptera: Tenebrionidae) adults in various atmospheric gas compositions. Z. Angew. Entomol. 95:263-267.

Bibliography

14. SPACE AND AERIAL ECOLOGY

Bibliography

18. SPECIATION

Bibliography

1e. STATISTICAL METHODS

Bibliography

17. TAXONOMIC STUDIES

Nakakita, H. 1983. Rediscovery of Tribolium freemani Hinton: a stored product insect unexposed to entomologists for the past 100 years. JARQ Jap. Agric. Res. Q. 16:239-243.

Rowley, J.Q. 1983. A simple method for the separation of Gnatocerus spp. and Tribolium spp. (Coleoptera: Tenebrionidae). J. Stored Prod. Res. 19: 139-140.

Bibliography

16. TECHNIQUE

Banks, H.J. and Annis, P.C. 1981. Treatment of bulk grain in freight containers with CO_2 while in transit as an insect control measure: a commercial trial using bulk malt. CSIRO Div. Entomol. Rep. 13: iii.

White, G.G. 1983. A modified inclined sieve for separation of insects from wheat. J. Stored Prod. Res. 19:89-91.

Bibliography

19. TERATOLOGY

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

ARGENTINA

Buenos Aires, Argentina.
Universidad de Buenos Aires.
Facultad de Ciencias Exactas y Naturales.
Laboratorio de Citogenetica.

VIDAL, Osvaldo R., Ph.D. Scarabs.

AUSTRALIA

Armidale, New South Wales 2351
University of New England
Department of Animal Science

MCRAE, T.A., B.Rur.Sc. (5, 7, 10)
SOLIMAN, M. Hani, Ph.D. (2, 5, 7, 9, 10, 13, 19)
SWEETNAMm, R.B., B.Agr.Sc. (5, 7)

+Brisbane, Queensland
Department of Primary Industries
Entomology Laboratory
Meirs Road, Indooroopilly

*CHAMP, B.R., B.Agr.Sc., Ph.D., D.I.C. Entomologist, storage pests, insecticide resistance. (7, 12)

+Epping, N.S.W.
CSIRO

FRANKLIN, Ian R., Ph.D., Geneticist. (7)
FRANKEL, O.H., Ph.D.

Glen Osmond, South Australia 5064
Waite Agricultural Research Institute
Private Bag No. 1

NIVEN, B.S., Ph.D. (16)

+Sydney
The University

BIRCH, L.C. (5)

Melbourne, Victoria
Plant Research Institute
Department of Agriculture
Burnley, Victoria 3121

AMOS, T.G., B.Sc., Ph.D., M.I. Biol. (2, 5, 12)
CARTER, V., Technician
EVANS, P.W.C., D.D.A. (12)
SEMPLE, R.L., L.D.A. (8)
WILLIAMS, P., B.Sc., A.R.C.S., Ph.D., D.I.C., M.I. Biol. (5, 8, 12, 18)

AUSTRIA

+Vienna I. Kaerntnerring
International Atomic Energy Agency

BINGGELI, M.H., Ph.D.

BANGLADESH

Dacca
Irradiation and Pest Control Research Institute
c/o Atomic Energy Center

MATIN, A.

BELGIUM

Gembloux
Institut Agronomique de l'Etat
Zoologie Generale

LECLERCQ, Jean, Ph.D.

Ghent
Rijks Universiteit
Faculteit de Landbouwwetenschappen

PELERENTS, C. (9)

+Louvain
F.A. Janssens Memorial Laboratory for Genetics
Agricultural Institute of the University
Heverlee, Louvain

HEUTS, M.J., Professor. Genetics; population genetics. (7)
*LINTS, F.A., Ph.D. Premier Assistant U.C.S. Physiological genetics. (7)
WATTIAUX, J.M., Ph.D. Charge de Recherches au F.N.R.S. Age effects. (13)

BRASIL

Piracicaba
Centro de Energia Nuclear No Agricultura
(CENA)

CERVELLINI, A.
*WIENDL, F.M. (12)

+Porto Algre, RGS, Brazil
Departamento de Genetica - ICN
Universidade Federal do Rio Grande do Sul
Cx. Postal. 1953
Laboratories of Animal Genetics:

CORDEIRO, Antonio R., Professor. Cytogenetics. Population Genetics. (7)
MARQUES, Edmundo K. Assistant Professor. Radiation effects on population. (8)
WINGE, Helga. Assistant Professor. Speciation. (15)

+Ribeirao Preto, S.P.
Universidade de Sao Paolo
Faculdade de Medicina de Ribeirao Preto
Departmento de Genetica

KERR, Warwick E. (7)

Rio Claro, S.P.
13500 Rio Claro, S.P., Brasil
UNESP.
Instituto de Biociencias.
Departanento de Biologia.

MESA, A., Ph.D. Myxophaga, Buprestidae.

CANADA

+Edmonton, Alberta
University of Alberta
Deparment of Animal Science
Division of Poultry Science

HARDIN, R.T., Ph.D. Quantitative Genetics. (7)

Edmonton, Alberta
University of Alberta
Department of Genetics

WEIJER, J., D.Sc. Radiation genetics. (7, 9)

Guelph, Ontario
Department of Animal and Poultry Science
Ontario Agriculture College
University of Guelph

FRIARS, G.W., Ph.D. Population genetics. (7)
PATTERSON D.L., graduate student. Population genetics.

+Cooperative Electron Microscopy:

GRINYER, I., Scientist. Department of Avian Pathology and Wildlife Diseases, University of Guelph. (4)

Montreal, P.Q.
McGill University
Biology Department

SITTMANN, K., Ph.D. Population Genetics. (7)

+Ottawa, Ontario
Canada Department of Agriculture
Animal Research Institute, C.E.F.
Animal Genetics Section

*SCHEINBERG, Eliyahu, Ph.D. (7)

+Postal Station P. Thunder Bay, Ontario
Lakehead Universtiy

*GRAHAM, W.M., B.Sc., Ph.D. Behavior and biology of stored products insects. (2, 5, 12)

+Quebec
Universite Laval
Department de Biologie
Faculte des Sciences Pures

BENSKIN, J., Ph.D. Post-doctorat. Endocrinology. (13)
CHAWLA, S.S., Ph.D. Post-doctorat. Physiology. (13)
CORRIVAULT, G.W., D.Sc. Professor. Histology (1)
HUOT, L., D.Sc. Professor. Entomology and Physiology. (10, 13)
PERRON, J.M., D.Sc. Professor. Entomology and physiology. (10, 13)

+Tunney's Pasture, Ottawa, Ontario
Department of National Health and Welfare
Food and Drug Directorate

BRAY, D.F., Head. Biometrics Section. (16)

Saskatoon, Saskatchewan
University Campus
Research Station
Research Branch, Agriculture Canada

DAVIS, G.R.F., Ph.D. Insect nutrition and Biochemistry. (10, 13)

+Victoria, B.C.
Department of Forestry and Rural Development
Forest Research Laboratory

ATKINS, M.D., Ph.D. Experimental Ecology. (5)
CHAPMAN, J.A., Ph.D. Physiology and study of attractants. (Scolytid studies).
EDWARDS, D.K., Ph.D. Dispersal, survival and population dynamics. Periodic phenomena in insects. (5)
MANSINGH, A., Ph.D. Nutritional Physiology. (10, 13)
MCMULLEN, L.H., Ph.D. Douglas-fir beetle biology and control. Balsam Woolly Aphid, biology and life history. (12)
MORRIS, O.N., Ph.D. Insect Pathology. (13)
SAHOTA, T.S., Ph.D. Endocrinology. (13)
WELLINGTON, W.G., Ph.D. Experimental ecology. (5)

Winnipeg, Manitoba R3T 2M9
Agriculture Canada
Research Station
Stored Product Section
195 Dafoe Road

ABRAMSON, D., Ph.D. Mycotoxicology, Analytical Chemistry.
BARKER, P.S., Ph.D. Entomology, Fumigation.
LOSCHIAVO, S.R., Ph.D. Entomology, Ethology, Pheromones.
MILLS, J.T., Ph.D. Mycology, Ecology.
SINHA, R.N., Ph.D. Entomology, Ecology, Acarlology, Biostatistics.
SMITH, L.B., Ph.D. Entomology, Ethology.
WHITE, N.D.G., Ph.D. Entomology, Insecticical Control.

DENMARK

Lyngby
Statens Skadedyrlaboratorium

ANEVAD, K., cand. mag., biological investigations.
BORLUND, H.P., Agronomist (Testing of insecticides).
FUNDER, J.V., Agronomist (Testing of insecticides).
HALLAS, T., cand. mag., research on pests of stored products.
NIELSEN, H., Technical assistant.
PESCHEL, K., Technical assistant
ROSENKILDE, I., Technical assistant.
WICHMAND, H., Director.

EASTERN NIGERIA

+Port Hartcourt
The Nigerian Stored Products Research Institute

ONYEARU, A.K., B.Sc. (London), Ph.D. (St. Andrews). Ecology of infestation behavior and biology applied to control genetics. (5,7,12)

EGYPT

+Giza
Stored Products Insects Research Section
Ministry of Agriculture

KAMEL, A.H., B.Sc.Agr., M. Sc. Ent. Biology and control of stored grain insects.

Alexandria
Alexandria University
Faculty of Agriculture
Plant Protection Department

KHAMIS, Awatef E.

FINLAND

Helsinki, Finland.
P. Rautatiekatu 1300100 Helsinki 10, Finland.
Department of Genetics.

SUOMALAINEN, Esko, Ph.D. Parthenogenesis and Polyploidy.

FRANCE

+Lyon, Rhone
Faculte des Sciences de Lyon
Laboratoire de Zoologie Generale
Section d'Entomonlogie Experimentale et de Genetique

DAVID, J. Professeur. Nutrition and quant. genet. in Drosophila.

+Villeurbanne (Lyon) Rhone
Laboratoire de Biologie
Institut National des Sciences Appliquees

LAVIOLETTE, P. Professeur. Head of the department.
NARDON, P., Assistant. Biology of irradiated insects.

GERMANY

+Bad Godesberg
Deutsche Versuchsanstalt
Fur Luft-Und Raumfahrt E.V.
Institut fur Flugmedizin

BRIEGLER, W., Ph.D. (5, 13)

D 78 Freiburg i. Br.
Biologisches Institut I (Zoologie) der Universitat

KULD, I. Cand. Biol.
LOHS-SCHARDIN, M.
SANDER, Klaus, Dr. rer. nat. Ph.D.
ZISSLER, D. Dr. rer. nat.

Field of interest: 3, 4, 6, 7, 11

+Munich
Bayer. Landesanstalt f. Bodenkultur
und Pflanzenbau, Abt. Pflanzenschutz

NATON, E., Ph.D. Control of pests: pheromone traps in orchards. (5, 12, 13)

D-44 Munster (Westf.)
Bade-Strasse 9.
Zoologisches Institut der Universitat.

WEBER, Fr., Ph.D. Carabidae.

D -7000 Stuttgart 70
Universitat Hohenheim (LH)
Lehrstuhl fur Populationsgenetik
Postfach 106 - Garbenstrasse 30

HARTWIG H. Geiger, Ph.D. (7)

GREAT BRITAIN

Aberdeen, AB8 2TN, Scotland.
University of Aberdeen.
Department of Genetics.

REES, R.W., Ph.D. Dermestidae.

+Dundee, Scotland
University Dundee
Department of Biological Sciences

NOWOSIELSKI-SLEPOWRON B.J.A., Ph.D. Staff member researching in Stored Products Insects. (2, 5)
WATERHOUSE, F.L., Ph.D. Staff member researching in Stored Products Insects. (2, 5)

+Edinburgh, Scotland
Agricultural Scientific Services
Department of Agriculture and Fisheries for Scotland

CUTLER, J.R., B.Sc. Stored Products Entomology. (12)
JEFFREY, I.G., Stored Products Entomology. (12)

+Glasgow, Scotland
Universtiy of Glasgow G12800
Department of Zoology

CROWSON, R.A. (17)
KASAP, H. (16)

+London
Queen Elizabeth College
University of London

HAFEEZ, M.A., Ph.D.

+Newcastle upon Tyne
The University of Newcastle upon Tyne, School of Agriculture

BICHARD, M., Ph.D. Animal Genetics. (7)
HUGHES, M.A., Ph.D. Genetics. (7)
SSELMAN B.J., Ph.D. Taxonomy of Coleoptera. Microbial parasites of Tribolium. (11, 17)

Slough, Berks
Ministry of Agriculture, Fisheries and Food
Pest Infestation Control Laboratory

ADAMS, R.G. M.Sc. Taxonomy and identification. (17)
BELL, C.H., Ph.D. Ecology and fumigation. (5, 8)
BILLINGS, Mrs. C.J. Insect rearing
BLACKMAN, Miss D.G. Insecticide resistance. (8)
COGAN, P.M., M.Sc. Insecticides and resistance
COOMBS, C.W., M.Sc. Ecology and behavior (2, 5)
COX, P.D., Ph.D. Ecology (5)
DYTE, C.E., B.Sc. F.I.Biol. Insecticide resistance and hormones (5, 8, 13)
EDWARDS, J.P., B.Tech. Hormones (8, 13)
HALSTEAD, D.G.H. Ph.D. Taxonomy, ecology, behavior (2, 5, 17)
HOLE, Miss, B.D. Fumigation (8)
HOWE, R.W. D.Sc., F.I.Biol. Ecology (5, 8, 17)
LLOYD, C.J., L.I.Biol. Toxicity of insecticides (8)
MILLS, K.A. Ph.D. Fumigation. (8)
MUGGLETON, J. Ph.D. Insecticide resistance, genetics (2, 5, 7, 8)
PINNIGER, D.B., B.Sc. M.F.Biol. Behavior, insecticides. (2, 5,

8)
PRICKETT, A.J. B.Sc. Insecticides, resistance statistics (5, 7, 8, 16)
SOUTHGATE, B.J. M.I.Biol. Taxonomy. (17)
SPRATT, Miss E.C. B.Sc. Behavior ecology. (5)
STUBBS, Miss M.R. Ph.D. Ecology (5)
THIND, B.B. B.Sc. Ecology, Genetics.

Slough, Berks.
Tropical Products Institute, Storage Department
Overseas Development Administration

BAKER, A.A., B.Sc. Stored products technology. Control of insect pests. (8, 12)
BOXALL, R.A., B.Sc., M.I.Biol. Control of stored products insects with insecticides. Methodology of loss-assessment. (6, 8)
CALVERLEY, D.J.B., B.Sc., M.Sc., M.S., F.I.Agri.E. Head of Centre. Storage engineering. (6)
CONWAY, J.A., M.I.Biol. Stored products technology. Biology and control of insect pests. (12)
DOBIE, P., B.Sc., Ph.D. Stored products entomology, especially hostplant resistance among crop varieties. (12, 18)
EVANS, N.J. (mrs.) Control of stored product pests, especially with insecticides. (8) .
GILES, P.H., B.Sc., D.I.C., Dip.Agric.Sci., M.I.Biol. Stored products technology. Biology and control of insect pests. (12)
GILMAN, G.A., B.Sc., D.T.A. Stored products technology. Storage mycology (6, 12)
GOLOB, P., B.Tech., Ph.D. Control of stored product pests, especially with insecticides. (8, 12, 18)
HAINES, C.P., B.Sc., Ph.D. Stored products entomology and acarology. Control by pheromones and natural predators. (2, 5, 12, 17)
HODGES, R.J., B.Sc., Ph.D. Stored products entomology. Control and inspection procedures using pheromones. (2, 12)
LOCKE. M.T., b.Sc., Ph.D. Stored products entomology. Control and inspections procedures using pheromones (2, 12)
MCFARLANE, J.A., B.Sc., D.I.C., M.I.Biol. Stored products technology. Biology and control of insect pests. (12)
MEIK, J. (Miss), M.I. Biol. Stored products entomology: biology and monitoring of insect pests. (12)
PREVETT, P.F., B.Sc., Ph.D., D.I.C., A.R.C.S., M.I. Biol. Deputy Head of Centre. Biology and control of storage insects. (6, 12, 17)
PROCTOR, D.L., B.Sc. Biology and control of storage insects. Inspection methods for storage management. (6, 12)
REES. D., B.Sc. Stored products entomology: biology and monitoring of insect pests. (12)

TAYLOR, R.W.D., B.Sc. Stored products technology. Control of pests with insecticides and fumigants. (6, 8)
TYLER, P.S., M.I.Biol. Stored products technology. Assessment

of losses, control of pests with insecticides, and insecticide resistance. (6, 8, 12)
WALKER, D.J., B.Sc., D.I.C. Stored products technology. Control of pests with insecticides (8, 12)

GUATEMALA

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

BRENES, Roberto Gomes, Ph.D.
BRESSONI, R.
MEDRANO, J., Ph.D., Biochemical genetics.

INDIA

Coimbatore
Department of Entomology
Agricultural College and Research Institute

BALASUBRAMANIAN M.
SOBRAMANIAN, T.R.

+Delhi
University of Delhi
Department of Zoology

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

+Gorakhpur, U.P.
University of Gorakhpur
Department of Zoology

KRISHNA, S.S., M.Sc., Ph.D. Morphology and Nutritive Physiology of Insects. (2, 13)
INGHh, R. Narayan, Ph.D. (2, 13)

+Hissar, Harayana
Punjab Agricultural University

Department of Genetics

GILL, Kulbir S., Ph.D. Associate Professor.

+Jabalpur, Madhya Pradesh
J.N. Agricultural University
Department of Animal Breeding and Genetics

SHRIVASTAVA, P.N., B.V.Sc. and A.H. Research Assistant.

Jorhat, Asam
Assam Agriculture University
Dept. of Entomology

BENUDHAR BORAH

Karnal, Haryana
National Dairy Researcn Institute
Division of Dairy Cattle Genetics and Breeding.

CHAWLA, D.S., Ph.D. Scientist. (7)
GOPI, K., B.Sc. Research Fellow. (7)
GUPTA, V. K. B. Sc. Research Fellow. (7)
SINGH, R. P. M. Sc. Scientist. (7)
TANEJA, V.K., Ph.D. Research Officer. (7)

Kurukshetra
Kurukshetra University

YADAV, J.S., Ph.D. (All).

Mathurz
Central Institute for Research on Goats.
P.O. Farah - 281122

BHAT, Pushkar, N., Ph.D., Director.
BHAT, Pran P., Assistant Professor.

+Muzaffarpur
University of Bihar
Department of Zoology

*SRIVASTAVA, U.S., Professor and Head of tne Department. (3)

+New Delhi
I.A.R.I., Division of Entomology

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

+New Delhi
Maulana Azad Medical College
Department of Biochemistry

LYALL, Kapoor), R.P.D., Research Scholar.

Punjab, Ludhiana - 141004
Punjab Agricultural University
Department of Entomology

CHAHAL, B.S. (12)
PATNA (14)

Rajenda Agricultural University
Department of Animal Geneticist Breeding
Bihar Veterinary College

MOHAN, Mani

INDONESIA

Denpasar, Bali
Universitas Udayana
Fakultas Kedoteran Hewan and Peternakan

DARMADJA, D. (7)

Bogor, Indonesia
Seameo Regional Center for Tropical Biology

PRANATA, Rafael I., M.A.

IRAN

Rasht, Iran
Gilan University
Department of Biology, Faculty of Science

MARINI, Letizia, Ph.D. (12)

IRELAND

Dunsinea
Dublin County
Agricultural Institute

CUNNINGHAM, E.P.

Dublin
University College
Zoology Department

RYAN, Michael, Ph.D.

ISRAEL

Haifa
Institute of Evolution
University of Haifa

LAVIE, B. Ph.D.

Jerusalem
Vision Research Laboratory
Hadassah University hospital

YINON, U, Ph. D.

The Hebrew University of Jerusalem
Department of Genetics

RITTE, Uzi, Ph. D.

Tel-Aviv
Tel-Aviv University
Department of Zoology

WOOL, David, Ph. D. (5, 7, 8)
BERGERSON, Orna. M.Sc. Graduate Student
ZIVONN, Avi. Graduate Student
MANHEIM, Ora. M.Sc. Technician

ITALY

+Pavia
Universita, Institut Lazzaro Spallanzani
Centro di Genetica

MILANI, R. Professor
*SPRINGHETTI, Antonio, Ph. D. Vitamin Tests (13)

JAPAN

Hiroshima, Higashi-Senda-Machi, Naka-Ku 730
Hiroshima University
Faculty of Integrated Arts and Sciences
Department of Environmental Studies

TAKAHASHI, F., Ph.D.

+Ino, Agawa-gun, Kochi
Pref. Institute of Agricultural and Forest Science
Department of Entomology

KIRITANI, K., D. Agr. Head, Population ecology (5)

Sapporo
Sapporo 064, Japan
Hokkaido University of Education
Sapporo College
Biology Laboratory

TAKENOUCHI, Yasushi, Ph.D. (Parthenogenesis and Polyploidy).

Tsukuba
Sakura-Mura, Ibaraki, 300-31
University of Tsukuba
Institute of Biological Sciences

FUJII, Koichi, Associate Professor, Ph. D. (2,5,6,7,11)
SHIMADA, Masakazu, Graduate student (2,5,11)

Tsukuba
National Food Research Institute
Stored Product Entomology Laboratory

IMURA, O. Ecology and Genetics
MITSUI, E. Ecology
NAKAKITA, H., Ph. D. Physiology and Fumigants

+Misima, Shizuoka-ken
National Institute of Genetics

YAMADA, Yukio, Ph. D. (7)

Okayama
Okayama University
Faculty of Agriculture
Laboratory of Applied Entomology

YOSHIDA, T., Population ecology and biology of stored product insects (2,5,13)

Tokyo
Tokyo University
Laboratory of Animal Breeding

NAITO, M. Ph. D.

Yamaguchi University
Biological Institute

CHIBA, Yoshihiko

MEXICO

Mexico City 20, D. F.
Universidad Nacional Autonoma de Mexico, Instituto de Biologia
Departamento de Zoologia, Laboratorio de Entomologia

RAMOS-ELORDUY DE CONCONI, Julieta, Ph. D. (9)

NETHERLANDS

Amsterdam
Royal Tropical Institute
Department of Agricultural Research
Product Research Division
Entomology Section

SCHULTEN, G.G.M., Ph.D. Entomologist, storage pests (12)
KLASHORST, Van de, G., D.Sc. Assistant Entomologist, storage pests (12).

+Wageningen
Laboratory for Research on Insecticides

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

Wageningen
Department of Genetics

STAM, P. (7,16)

NEW ZEALAND

Auckland, Private Bag
Entomology Division
Department of Scientific and Industrial Research

CLARE, G.K. Rearing.
FREDERICKSEN, S., B.Sc. Rearing.
SSINGH Pritam, Ph.D. Rearing. (10)
SURREY, M.R., B.Sc. Rearing.
WATT, J.C., Ph.D. Systematics. (5, 17)

NEW ZEALAND.

Hamilton, Private Bag,
Ruakura Agricultural Research Centre

BAKER, R.L., M. Agr. Sci., Ph.D. Quantitative genetics and animal breeding. (7)
CARTER, A.H., M.A., Ph.D., Leader of genetics section. (7)
CLARKE, J.N., M. Agr. Sci., Ph.D. Quantitative genetics and animal breeding. (7)
MEYER, H.H., M.S., Ph.D. Quantitative genetics and animal breeding. (7)

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

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

POLAND

Warsaw
Szkola Glowna Gospodarstwa Wiejskiego
Katedra Entomologii Stosowanej

BOCZEK, Jan Professor. (5, 12)

Institute of Ecology
Dziekanow Lesny near Warsaw
05-092 Lomianki

PRUS, Tadeusz. Assistant Professor, Laboratory Head. (E).
BIJOK, Pawel, MSc. Working for doctoral degree.
ZIMAKOWSKA-GNOINSKA, Danuta, Ph.D.

PORTUGAL

+Lisbon
Laboratorio da Defesa Fitossanitaria dos Produtos Armazenados (L.D.F.P.A.)
Ministerio da Economia
Brigada de Estudos da defesa Fitossanitaria dos Produtos ultramarinos (B.E.D.F.P.U.)
Ministerio do Ultramar
Tapada de Ajuda

BAETA NEVES, C.N., Prof. of entomology of the Institute of Agronomy for higher studies. Director of the L.D.F.P.A. head of the B.E.D.F.P.U. (5, 12)

SPAIN

Madrid
Instituto Nacional de Investigaciones Agronomicas
Laboratorio de Genetica de Poblaciones

*BARRERA, Antonio; Prto. Agr. Population Genetics. (7)
CAMPO, Jose Luis; Dr. Ing. Agr. Population Genetics and Poultry Breeding. (7)
CARCELES, Francisco; Prto. Agr. Poultry Breeding. (7)
*DIEZ-BARRA, Rafael; Prto. Agr. Population Genetics. (7)
*FRIAS, angel. Prto. Agr. Population Genetics. (7)
*FUENTES, Ma. Carmen; Dr. Ing. Agr. Population Genetics. (7)
*JODAR, Bartolome; Dr. Ing. Agr. Population Genetics. (7)
*LOPEZ-FANJUL, Carlos; Dr. Ing. Agr. and Ph.D. Popul. Genetics. (7)
*OROZCO, Fernando; Dr. Ing. Agr. and Ph.D. Head of Department Population Genetics and Poultry Breeding. (7)
*RUANO, Ramiro G.; Dr. Veterinario. Population Genetics. (7)
*SILVELA, Luis; Dr. Ing. Agr. and Ph.D. Population Genetics. (7)
*TABARRO, Ma. Pilar; Prto. Agr. Population Genetics. (7)
*Actually working with Tribolium.

+Madrid
Escuela Tecnica Superior de Ingenieros Agronomos
Catedra de Genetica

ESPINOS, A., Prof. Enc. Lab. Genetica General. (7)
NUEZ, F., Prof. Enc. Lab. Mejora Genetica. (7)

Madrid 6.
Castellana 80
Museo Nacional de Ciencias Naturales.

SERRANO, J., Ph.D. Caraboidea.

Palma de Mallorca
University of Palma de Mallorca
Department of Genetics.
Faculty of Sciences.

PETITPIERRE, E., Ph.D. Chrysomelidae

SWEDEN

S-223 62 Lund
Institute of Genetics
Solvegatan 29

NORSEGAARD, Rolf

Uppsala
The Swedish University of Agricultural Sciences
Department of Plant and Forest Protection

PETTERSSON, Jan, Prof. of Agricultural Entomology

TAIWAN, REPUBLIC OF CHINA

Wufeng, Taiwan
Plant Protection Center
Division of Entomology
189 Chung Cheng Road
Taichung Hsien, Taiwan 431

HSIEH, F.K. Ph.D. (12)
HUNG, L.M. (Miss)
KAO, Suey-Sheng, Ph.D. (12)
LIN, T. (12)

THE NETHERLANDS

Ghent
Rijksuniversiteit-Gent
Faculteit van de Landbouwwetenschappen
Laboratorium voor Dierkunde

DEGHEELE, D. Dr. ir

TURKEY

Ankara
Ankara Universitesi Zootekni Enstitusu Ziraat Fakultesi

DUZGUNES, Orphan, Ph. D.

DIRECTORY-GEOGRAPHICAL

UNITED STATES

ARIZONA

Tempe, Arizona
Arizona State University
Department of Zoology

RASMUSSEN, D. I., Ph.D. Associate Professor. Population Genetics (7)

Tucson, Arizona
USDA
Cotton Insect Research Laboratory

BARTLETT, A.C., Ph.D. Insect genetics (7)

CALIFORNIA

+Berkeley, California
University of California
Donner Radiation Laboratory

GRAISE, L.M.S.X.
HAYES, T.L., Ph.D. (4)
YANG, T.C.H., Ph.D., Radiation biophysics (9)

Berkeley, California
University of California
Engineering Department

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

Los Angeles, California 90024
University of California Medical Center
Department of Medical Microbiology

TAYLOR, Charles (7))

+Northridge, California
San Fernando Valley State University
Department of Biology

Moore, Joseph, Ph.D. Associate Professor. (11)

San Bernardino, California 92407
California State University
School of Natural Sciences
Department of Biology

BINDER, Bradley, Graduate Student
BRADEN, Jerry
MANKAU, Sarojam, Ph. D. (11)
SOKOLOFF, Alexander Ph. D. (5,7)
SOKOLOFF, Elaine A.
SOKOLOFF, Michael A.

Santa Barbara, California 93103
Westmount College
995 La Paz Road

PERCIVAL, Frank

CONNECTICUT

+Bridgeport, Connecticut
University of Bridgeport
Department of Biology

RAGHUVIR, N.N., Ph.D. Effects of ultraviolet on T. confusum

Storrs, Connecticut
University of Connecticut
Department of Biology

SILANDER, John A., Ph.D.

FLORIDA

Gainesville, Florida
U.S.D.A.
Biology Research Laboratory

AGEE, H.R., Research Entomologist
ASHLEY, T.T., Asst. Prof., Univ. of Florida
CALKINS, C.O., Research Entomologist
CALLAHAN, P.S., Research Entomologist
CHAMBERS, D.L., Research Entomologist-Laboratory Director
*COFFELT, J.A., Research Entomologist
DOOLITTLE, R.E., Research Chemist

*FERKOVICH, S.M., Research Entomologist
GREANY, Ph.D., Asst. Prof., Univ. of Florida
*HAGSTROM, D.W., Research Entomologist
HAMILTON, E.W., Research Entomologist
HUETTEL, M.D., Asst. Prof., Univ of Florida
LEPPLA, N.C., Research Entomologist
*MARZKE, F.O., Research Entomologist
MAYER, M.S., Research Entomologist
MITCHELL, E.R., Research Entomologist
MCLAUGHLIN, J.R., Asst. Prof., Univ. of Florida
*OBERLANDER, H., Research Physiologist
SHARP, J.L., Asst. Prof., Univ. of Florida
SILHACEK, D., Research Chemist
*SOWER, L., Research Entomologist
SPENCER, N.R., Research Entomologist
STANLEY, J.M., Agricultural Engineer
TINGLE, F.L., Research Entomologist
TUMLINSON, J.H., Research Chemist
TURNER, W.K., Agricultural Engineer
*VICK, K., Research Entomologist
WEBB, J.C., Agricultural Engineer

*Working with stored products insects.

+Athens, Georgia
University of Georgia, United State Department of Agriculture
Agricultural Research Service

TINDELL, L.D., Ph.D., Population genetics.
COOK, Robert E. Ph.D., Coordinator. Poultry Breeding

Decatur, Georgia
Agnes Scott College
Department of Biology

NISTRAND, H. (5,7)

Savannah, Georgia
U.S.D.A.
Stored Product Insects Research and Development Laboratory

ARBOGAST, Richard T., Ph.D. Ecology. (5)
BAKER, J.E., Ph.D. Physiology and nutrition. (10, 13)
BROWER, J.H., Ph.D. Radiation biology and genetics. (7,9)
BRUCE, W.A., Ph.D. Physiology. (13)
BRY, R.E., B.S. Mothproofing. (12)
CLINE, L.D., M.S. Biology. (5)
DAVIS, Robert, Ph.D. Acarology and Ecology. (5)
HALLIDAY, W.R., Ph.D., Protectants and space treatments (8)
HIGHLAND, H.A., Ph.D. Insect-resistant packaging. (8)
JAY, E.G., Ph.D. Controlled atmospheres and temperatures. (15)

KEEVER, D.W., Ph.D., Ecology (2, 5, 11)
KIRKPATRICK, R.L., M.S. Physical energy control. (9)
LEESCH, J.G., Ph.D. Toxicology. (13)
LUM, P.T.M., Ph.D. Biology. (5)
MULLEN, M.A., Ph.D. Physiology and ecology. (5,13)
PRESS, J.W., M.S. Biology. (5)
REDLINGER, L.M., M.S. Biology. (5)
SIMONAITIS, R.A., Ph.D. Insecticide residues.(8)
STREET, M.W. B.A. Light and Sound. (13)
SU, H.C.F., Ph.D. Sex attractants. (13)
TILTON, E.W., M.S. Radiology. (9)
VARDELL, H.H., M.S. Physical control and genetics. (7,9)
ZEHNER, J.M. Ph.D. Insecticide residues. (8)
ZETTLER, J.L., Ph.D. Physiology and toxicology. (13)

Savannah, Georgia
Armstrong State College
Biology Department

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

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

REDLINGER, L.M. Investigations Leader.

IDAHO

+Pocatello, Idaho
Idaho State University
Department of Biology

MINSHALL, G. Wayne (5)

ILLINOIS

Carbondale, Illinois 62901
Southern Illinios University at Carbondale
Department of Zoology. (618) 536-2314.

ENGLERT, DuWayne C., Ph.D., Professor (5,6,7)

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

CRAIG, David M., M.S. Graduate Student. (5,7)
MERTZ, David B., Ph.D. Professor. (5,7)
WU, Ai-Chu Joy, B.S. Graduate Student. (5,7)

+Chicago, Illinois
University of Chicago
Department of Zoology

MCCAULEY, David, Ph.D., Ecology, Population Ecology, Genetics and Phenotypic Variation (5,7)
TELEKY, Steven B., M.A., Population Ecology
WADE, Michael J., Ph.D. Ecology, Population Ecology, Genetics and Phenotypic Variation, Speciation (2, 5, 7)

Urbana, Illinois
University of Illinois
Department of Dairy Science

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

Urbana, Illinois
University of Illinois
Department of Physiology and Biophysics

CHENG, C., M.S.; Radiation Biology (9)
DUCOFF, H.S., Ph.D., Professor, Radiation Biology, Experimental Gerontolgy (9,13)
HEATH, M., Ph.D.; Physiological Ecology, Radiation Biology (5,9,13)
LEE, Y.J., M.S.; Experimental Gerontology; Radiation Biology (9)

INDIANA

West Lafayette, IN 47907
Purdue University
Department of Animal Sciences

BELL, A.E., Ph.D., Population and Quantitative Genetics (7)
DOOLITTLE, D.P., Ph.D. Population and Quantitative Genetics (7)
LANGHOLFF, W.K., B.S., Population and Quantitative Genetics (7)
MILES, D.A., B.S., Population and Quantitative Genetics (7)
MUIR, W.M., Ph.D., Population and Quantitative Genetics (7)

+Muncie, Indiana
Ball State University
Department of Physiology and Health Science

HENZLIK, Raymond E., Ph.D. Radiation effects. (9)

+Notre Dame, Indiana
University of Notre Dame
Department of Biology

ACKERMAN, John. (5)
BENDER, Harvey A., Ph.D. Genetics. (7)
GRIFFING, Thomas C., Ph.D. Ecology. (5)

IOWA

+Ames, Iowa
Iowa State University of Science and Technology
Department of Animal Science

*FREEMAN, A.D., Professor. (7)

KANSAS

Manhattan, Kansas
Kansas State University
Department of Entomology

CHARLTON, Loretta, Laboratory Assistant. (12)
MILLS, Robert B., Ph.D. Associate Professor, Stored-product insects. (12)
PARTIDA, Gregory J. Ph.D. Assistant Professor. (12)
WHITE, Stephen, Undergraduate Hourly Employee. (12)

KENTUCKY

Lexington, Kentucky
University of Kentucky
Department of Animal Science

GOODWILL, Robert E., Ph.D., Population Genetics (7)
GREEN, Cynthia B., B.S., Graduate assistant

Department of Agronomy

FINKNER, V.C.
VIAN, W.E.

MARYLAND

+Beltsville, Maryland
U.S.D.A.-A.R.S.
Animal Husbandry Research Division

KINNEY, T.B., Jr., Ph.D., Population genetics (located at Lafayette, Indiana). (7)
LEPORE, P.D., Ph.D. Biochemical genetics (7, 13)
SARVELLA, P.A., PhD. Cytological genetics (4, 7)
TINDELL, L.D., Ph.D. Population genetics (located at Athens, Ga.). (7)

MASSACHUSETTS

+Natick, Massachusetts
Applied Entomology Group
Pioneering Research Laboratory
U.S. Army Natick Laboratories

FLORENTINE, G.J., Ph.D. Research entomologist. Sensory physiology of insects (13).
GINGRICH, J., 1Lt., Ph.D. Research entomologist. Effect of ultraviolet on cockroaches (13)
PRATT, J.J., Jr., Ph.D. Group Head. Toxicology, insect nutrition, behavior of rodents. (2,10,13) -Retired
SMITH, L.W., Jr., Ph.D. Research entomologist. Insect behavior and ecology (2,5). Director.

Entomology Group

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

Norton, Massachusetts
Wheaton College
Department of Biology

KIRCHER, J.C.
KEIM, Barbara Howell (5)

+South Lancaster, Massachusetts
Atlantic Union College
Department of Biology

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

MICHIGAN

+East Lansing, Michigan
Michigan State University
Biology Research Center

*SCHEIDT, G.C.

+East Lansing, Michigan
Michigan State University
Insecticide Research Institute

BROWN, A.W.A.

+Midland, Michigan
The Dow Chemical Company
Bioproducts Department

WHITNEY, W.K., Ph.D. Insect physiology and toxicology (13)

MINNESOTA

St. Paul, Minnesota
University of Minnesota
Institute of Agriculture
Department of Entomology, Fisheries and Wildlife

BARAK, A.V. Ph.D. Dermestid pheromones (2,5,7,12)
DUNKEL, F.V. Ph.D. Insecticidal mode of action of food additives in stored grain insects and protozoan associates (1,3,4,11,13)
HAREIN, P.K., Ph.D. Stored product insect management; RPAR (5,12,13,18).

St. Paul, Minnesota
University of Minnesota
Department of Genetics and Cell Biology

BRASKERUD, Ove A. B.A. Associate Scientist (7)
COMSTOCK, Ralph E. Ph.D. Professor (7)
ENFIELD, Franklin D. Professor (7)
ERICKSEN, Kim. B.S., Senior Lab Technician (7)
ANKLESARIA, Farhad, B.S., Graduate Student

MISSOURI

Kirksville, Missouri
N.E. Missouri State
Science Division

BELL, Max E., Ph.D. Ecology (5)
DIMIT, James E., M.A. Ecology (5)
HANKS, David L., Ph.D. Microbiology (11)
JAY, Austin E., Ph.D. Physiology (13)
SHADDY, James H., Ph.D. Entomology (12)

MONTANA

Bozeman, Montana 59715
Montana State University
Animal and Range Sciences Department

KRESS, D.D.

NEW JERSEY

Madison, New Jersey
Fairleigh Dickinson University
Department of Biology

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

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

CROSSNER, Ken Ph.D. Ecology (5)
KATZ, Frank F. Ph.D. Parasitology (11)
KRAUSE, Eliot Ph.D. Genetics and Population Genetics (7)
MARSH, Chris B.S. Genetics (7)

NEW YORK

Ithaca, New York
New York State College of Agriculture
Cornell University
Department of Animal Husbandry

HOGUE, D.E., Ph.D. Nutrition (10)
VAN VLECK, L.D.,Ph.D. Animal breeding (7)

+Ithaca, New York
New York State College of Agriculture
Cornell University

KNUTSON, Lloyd V., Ph.D.
KRAMER, John P., Associate Professor. (11)

New York City (Flushing), New York
Queens College of the City University of New York
Department of Biology

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

Schenectady, New York
Union College
Department of Biological Sciences

BOYER, John F., Ph.D.

NORTH CAROLINA

+Raleigh, North Carolina
North Carolina State University
School of Agriculture and Life Sciences
Department of Genetics

GROSCH, Daniel S., Ph.D. Professor of Genetics.

NORTH DAKOTA

+fargo, North dakota
Metabolism and Radiation Research Laboratory

CHANG, T.H. Ph.D. Insect tissue culture (3)
FLINT, H.M. Ph.D. Insect radiation sterilization (9)
KLASSEN, W. Ph.D. Insect genetics (7)
LaCHANCE, L. E. Ph.D. Insect genetics, radiobiology (7,9)
RIEMANN, J.G. Ph. D. Insect cytology (4)
WAGONER, D.E. Ph. D. Insect genetics (7)

Grand Forks
University of North Dakota
Institute for Ecological Studies

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

OHIO

Bowling Green
Bowling Green University
Department of Biology

SCHURR, Karl (9, 12, 13)

+Marietta
Marietta College
Department of Biology

BROWN, Wm. P. Ph.D. Population genetics (7)

OKLAHOMA

Edmond 73134
central State University
Department of Biology

GUTHRIE. Peggy, Ph. D.

Norman
University of Oklahoma
Department of Zoology

SONLEITNER, Frank J. Ph. D. (5)

OREGON

Corvallis
Oregon State University
Department of zoology

BYBEE, L., B.S., Population biology
DAWSON, P.S., Population biology
TRENEMAN, Nancy, B.S., Population biology

PENNSYLVANIA

Carlisle
Dickinson College
Department of Biology

MCDONALD, D. J. Ph. D. Population genetics (7)

Pittsburgh,
Duquesne College
Department of Biological Sciences

SILLMAN, E.I., Ph. D.

PUERTO RICO

Rio Piedras
University of Puerto Rico
Agricultural Experiment Station
Department of Crop Protection

VIRKKI, Niilo, Ph.D. (4)

RHODE ISLAND

Kingston
University of Rhode Island
Department of Zoology

COSTANTINO, R.F. Ph.D. (7)

TEXAS

Denton
Texas Woman's University
Department of Biology

ERDMAN, H. E. Ph.D. (5,7,9)

UTAH

Salt Lake City
University of Utah
Department of Zoology and Entomology

GRUNDMANN, A.W. pn. D. (11)

VERMONT

Burlington
University of Vermont
Department of Zoology

JILLSON, D.A. Ph.D. Population biology (5,7)

VIRGINIA

Charlottesville
University of Virginia
Department of Biology

HOWELL, Barbara l. M.S. graduate student
MURRAY, J.J. Ph. D. Ecological genetics (5,7)

Fairfax
George Mason College
Department of Biology

STANLEY, M.S.M. Ph. D. (3)

WASHINGTON

Pullman
Washington State University
Department of Poultry Sciences

BECKER, W.A.

Seattle
University of Washington
Burke Museum

HATCH, Melville H. (17)

WASHINGTON D.C. 20204

Department of Health, Education and Welfare
food and Drug Administration
Division of Microbiology

BOESE, J.
NAKASHIMA, M.
RUPP, R.

WISCONSIN

Beloit
Beloit College
Department of Biology

RESSEGUIE, Lawrence, J.

Milwaukee
University of Wisconsin
Zoology Department

HSIAO, Ku-Chuan B.s. Teaching Assistant
LANGE, E.L. Ph D. (7)

U.S.S.R.

Moscow
All-Union Grain and Grain Products
Research Institute

CHERKOVSKAYA, A Ya.

DIRECTORY-PERSONAL

ACKERMANN, MARY c/o Dr. John Ackermann, Biology Department, Notre Dame University, South Bend, IN 46615.

ADU, O. O., nigerian Stored prodUcts Research Institute, P.M.B. 5069 Port Harcourt, Nigeria (11)

AKRE, R., Department of Entomology, Washington State University, Pullman, Washington 99163. (2)

AMOS, T.G., Department of Agriculture, Victorian Plant Research Institute, Burnley, Victoria, Australia. (2, 5, 13)

ANDERSEN, F.S., Statens Skaderdyrlaboratorium, Skobrynet, Lyngby, Denmark. (5, 7, 16)

+ARBOGAST, R.T., Stored-Product Insects Research and Development Laboratory, Savannah, Georgia. (5)

+ASHMAN, F., Tropical Stored Products Centre, Slough, Bucks, England. (2,5)

ASO, Y., Department of Entomology, Kansas State University, Manhattan, Kansas.

BAKER, J.E., U.S. Department of Agriculture, Agricultural Research Service, Savannah, Georgia. (10, 13)

BAKER, R.L., Ruakura Agricultural Research Centre, Private Bag, Hamilton, New Zealand.

BALASUBRAMANIAN, M., Tamil Nadu Agricultural University, Department of Agricultural Entomology, Coimbatore-641 003 India.

BARKER, P.S., Canada Dept. of Agriculture, Research Station Winnipeg, Manitoba. (5, 12)

BARRERA, A., Instituto Nacional de Investigaciones Agronomicas, Madrid, Spain. (5, 7)

+BARTLETT, A.D., United States Department of Agriculture, Agricultural Research Station, Cotton Insects Research Branch, Tucson, Arizona. (5, 7)

BAUMGARTNER, J., Institut fur Geflugelforschund, Poultry Research Institute, 900 28 Ivanka pri Dunajl, Czechoslovakia.

*Numbers after directory names indicate research specialties.

BECKER, W.A. Department of Poultry Science, Washington State University, Pullman Washington 99163.

BEEMAN, R.W., Department of Entomology, Kansas State University, and U.S. Grain Marketing Research Laboratory, ARS, USDA

BELL, A.E., Purdue University, Population Genetics Institute, Lafayette, Indiana. (5, 7, 10)

BELL, M.E., Northeast Missouri State College, Kirksville, Missouri 63501. (5)

+BENDER, H.A., University of Notre Dame, Notre Dame, Indiana. (7)

BENSKIN, J., Universite Laval, Quebec, Canada. (13)

BENSON, A.J., Southern Illinois University at Carbondale, Department of Zoology, Carbondale, Illinois. (6, 7)

BERNACKY, B.J., Purdue University, Department of Animal Sciences, West Lafayette, IN. (7)

+BHAT, P.N., J.N. Agricultural University, Department of Animal Breeding and Genetics, Jabalpur, Madhya Pradesh, India. (5, 7)

+BICHARD, M., The University of Newcastle upon Tyne, Newcastle upon Tyne, England. (7)

BIJOK, pawel. Inst. of Ecology, Dziekanow Lesny near Warsaw, 05-092 Lomianki, Poland

BINDRA, O.S., Deaprtment of Entomology, Punjab Agricultural University, Ludhiana, Punjab, india.

+BINGGLI, M.H., International Atomic Energy Agency, Vienna I, Kaerntnerring, Austria. (9)

BLAKE, G.M., Pest Infestation Laboratory, Slough, Bucks, England. (13)

BLAKELY, W., Radiation biology; aging (9), University of Illinois at Urbana-Champaign. (9)

BOCZEK, J., Szkola Glowna Gospodarstwa Wiejskiego, Katedra Entomologii Stosowang, Warsaw, Poland.

BORGES, S., Colegio Original Aguadil, Department of Natural Sciences, Raney, Puerto Rico 00604.

BORLUNG, H.P., Statens Skadedyrlaboratorium Skovbrynet, Lyngby, Denmark. (8, 12)

+BOYER, JOHN F., Department of Biological Sciences, Union

College, Schenectady, New York 12308

+BOYER, LESLIE S., Biological Sciences Department, California Polytechnic State, San Luis Obispo, California 93407.

BRENES, ROBERTO GOMEZ. Instituto de Nutricion de Centro America y Panama, Carretera Roosevelt, Zona 11, Guatemala City, Guatemala.

+BRIEGLEB, W., Deutsche Versuchsanstalt, Fur Luft-Und Raumfahrt E. V., Institut fur Flugmedizin, Bad Godesberg, Germany. (13)

BRINCKMAN, D., National Pest Control Association, 8150 Leesburg Pike, Suite 1100, Vienna VA 22180.

+BROWER, J.H., Stored-Product Insects Research and Development Laboratory, Savannah, Georgia. (1, 9, 12)

BROWN, A.W.A. Insecticide Research Institute, Michigan State University, E. Lansing, MI 48823.

BROWN, E., 44301 Ardale, Lancaster, California 93584.

BROWN, E.H., University of Illinois, Department of Genetics and Development, 515 Morrill Hall, Urbana, Illinois 61801.

BROWN, W.P., Marietta College, Marietta, Ohio 45750.

BRUCE, W.A., U.S. Department of Agricultural Research Service, Savannah, Georgia. (13)

BRY, R.E., U.S.D.A., A.R.S., Savannah, Georgia. (12)

BYRNE, B.J., Wells College, Building and Grounds Department, Aurora, N.Y. 13026.

BYWATERS, J.H., 400 Larick Drive, Marion, Iowa 52302. (7)

CALHOUN, R.E., Department of Biology, Queens College of the City University of New York, New York (Flushing) N.Y., 11367. (7, 15, 16)

CAMADRO, E.L., University Nacional de Mar Del Plata, Balcarce, Buenos Aires, Argentina. (7)

CAMPBELL, L.J., Oregon State University, Department of Zoology, Corvallis, Oregon.

CAMPO, J.J., Instituto Nacional de Investigaciones Agronomicas, Madrid, Spain. (7)

CARBONELL, E., Instituto Nacional de Investigaciones

Agronomicas, Madrid, Spain. (7)

CARCELES, F., Instituto Nacional de Investigaciones Agronomicas, Madrid, Spain. (7)

+CARTER, A.H., Ruakura Agricultural Research Centre, Private Bag, Hamilton, New Zealand. (7)

CERVELLINI, A. Centro de Energia Nuclear na Agricultura. USP-CNEN Caixa Postal 96, Piracicaba, Estado de Sao Paulo, Brazil.

CHAHAL, B.S. Department of Entomolgy, Punjab Agricultural University, Fujab, Ldhiana -141004, India. (12)

+CHAMP, B.R., Department of Primary Industries, Entomology Laboratory, Meins Road, Indooroopilly, Brisbane, Queensland, Australia. (7, 11)

CHANG, T.H., Metabolism and Radiation Research Laboratory, Fargo, North Dakota. (3)

CHAPMAN, A.B., Department of Genetics, University of Wisconsin, Madison, Wisconsin.

CHAUDHARY, K.D., Universite Laval, Quebec, Canada. (10)

+CHAUDHRY, H.S., University of Gorakhpur, Gorakhpur, U.P., India. (3, 4, 13)

CHAWLA, S.S., Universite Laval, Quebec, Canada

CHERKOVSKAYA, A., Ya. All-Union Grain and Grain Products Research Institute, Moscow, USSR.

CHIBA, Y. Biological Institute, Yamaguchi University, Yamaguchi, Japan.

CHITTY, J., Oregon State University, Dpartment of Zoology, Corvallis, Oregon. (2, 5, 7)

CHIU, M., Radiation biology (9) University of Illinois at Urbana-Champaign. (4)

CLARKE, J.N., Ruakura Agricultural Research Centre, Private Bag, Hamilton, New Zealand. (7)

CLOVER, R., Cal State Long Beach, Biology Department, Long Beach, California 90804.

COHEN, E., Department of Zoology, Tel Aviv University, Israel. (12, 13)

COOK, R.E., Coordinator Southern Regional Poultry Breeding Project ARS-AHRD Livestock-Poultry Bldg., University of Georgia, Athens, Georgia.

CORRIVAULT, G.W., Department of Biology, Universite Laval, Quebec, Canada. (10)

COSTANTINO, R.F., Department of Zoology, University of Rhode Island, Kingston, R.I., 02881. (7, 10). (Visiting Purdue University.)

CRAISE, L.M., University of California, Lawrence Radiation Laboratory, Berkeley, California. (9)

+CRENSHAW, J.W., School of Biology, Georgia Institute of Technology, Atlanta, Georgia. (7, 9)

+CRENSHAW, R.A., Zoology Department, University of Glasgow W2, U.K.

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

CROWSON, R.A., University of Glasgow, Department of Zoology, Glasgow G128QQ, U.K..

CUTKOMP, L.R., Department of Entomology, University of Minnesota, St. Paul, Minnesota 55101. (7)

+CUTLER, J.R., Agricultural Scientific Services, Department of Agriculture and Fisheries for Scotland Edinburgh, Scotland, Great Britain. (12)

DARMADJA, D., Fakultas, Kedoteran Hewan and Peternakan, Universitas Udayana, Denpasar, Bali, Indonesia. (7)

+DAS, A.B., University of Gorakhpur, Gorakhpur, U.P., India. (17)

+DASGUPTA, J., Department of Biology, Jawaharlal Institute of Post-graduate Medical Education and Research, Pondicherry 605006, Indiana.

+DAVENPORT, L.B., Armstrong State College, Savannah, Georgia.

+DAVID, J., Faculte des Sciences de Lyon, Lyon, Rhone, France. (7, 10)

DAVD, M.H., Kansas State University, Manhattan, Kansas. (12)

DAVIS, G.R.F., Ph.D., Insect nutrition and biochemistry, Research Station, Research Branch, Agriculture Canada, University Campus Saskatoon, Saskatchewan. (3, 10)

DAWSON, P.S., Department of Zoology, Oregon State University, Corvallis, Oregon. (2, 5, 7)

DE LAS CASAs, E., University of Minnesota, Department of Entomology, Fisheries and Wildlife, St. Paul, Minnesota. (5, 13)

DELE, A.H. Centre de Recherches de Bordeaux, Bordeaux, France.

DELGADO, M.A., Southern Illinois University at Carbondale, Department of Zoology, Carbondale, Illinois 62901. (5)

DEL SOLAR, E., Instituto de Ecologia, Universidad Austral de Chile, Casilla 57-D, Valdivia, Chile.

DETURCK, J.E., Cabrini College, King of Prussia Road, Radnor, PA 19087.

DEWEES, A.A., Sam Houston State University, Department of Biology, Huntsville, Texas, 77340 (5,7).

DEXTER, J., St. Anselm College, Department of Biology, St. Anselm Drive, Manchester, N.H. 03102.

DIEZ-BARRA, R., Instituto Nacional de Investigaciones Agronomicas, Madrid Spain (7).

DING, G. M.S. Radiation Biology. University of Illinois, Urbana-Champaign, Illinois (9).

DOOLITTLE, D.P., Ph.D., Department of Animal Sciences, Purdue University, West Lafayette, IN 47907

DOBAO, M.T., Instituto Nacional de Investigaciones Agronomicas, Madrid, Spain. (7, 13).

DRICKAMER, L.C., Williams College, Thompson Biology Lab, Williamstown, MA. 01267.

DUCOFF, H.S., Ph.D., Department of Physiology and Biophysics and Bioengineering, University of Illinois, Urbana-Champaign, Illinois. (9, 13)

DUFFY, J.P., St. John's University, Jamaica, New York. (13)

DUGGLEBY, W.F., State University of New York, Department of Biological Science, Buffalo, N.Y. 14214.

DUGUESCLIN, F.B., Victorian Plant Research Institute, Department of Agriculture, Burnley, Victoria, Australia. (6)

DUNKEL, F.V., University of Minnesota, Department of Entomology, Fisheries and Wildlife, St. Paul, Minnesota.

DUZGUNEZ, O., Ankara Universitesi Ziraat Fakultesi Zootekni Enstitusu, Ankara, Turkey.

DYTE, C.E., Pest Infestation Control Laboratory, Slough, Bucks, England. (5, 7, 8)

EDONGALI, H., Al Fateh University, P.O. Box 13274, Tripoli, Libya.

EISNER, T., Cornell University, Department of Neurobiology and Behavior, Ithaca, N.Y. 14853.

ELORDUY DE CONCONI, J.R., Instituto de Biologia UNAM, Laboratorio de Biologia UNAM, apdo. Postal 70-153, Mexico 20, D.F.

EL-SABAE, A.H., Plant Protection Department, Faculty of Agriculture, Alexandria University, Alexandria, Egypt.

+ENFIELD, F.D., Department of Animal Husbandry, University of St. Paul, Minnesota. (7)

ENGLERT, D.C., Department of Zoology, Southern Illinois University, Carbondale, Illinois. (5, 6, 7)

+ERDMAN, H.E., Texas Woman's University, Denton, Texas. (5, 7, 9).

+ESPINOS, A., Escuela Tecnica Superior de Ingenieros Agronomos, Valencia, Spain. (7)

+FABER, W., Bundesanstalt fur PflanzenscHutz, Trunner Str. 5, Vienna, Austria.

FAIRFULL, R.W., Department of Animal Science, University of Guelph, Gueldph, Ontario, Canada. (7)

FAUSTINI, D.L. Ph.D. Philip Morris Research Center, P.O. Box 26583, Richmond VA, 23261.

FERNS, P.N., Department of Zoology, University College, Cardiff, Wales, U.K.

FINKNER, V.C., Department of Animal Sciences, University of Kentucky, Lexington, Kentucky.

+FLINT, H.M., Metabolism and Radiation Research Laboratory, Fargo, North Dakota. (9)

+FLORENTINE, G.J., U.S. Army Natick Laboratories, Natick, Massachusetts. (10)

FRANKEL, O.H., CSIRO, P.O. Box 109, Canberra, A.C.T., Australia.

+FRANKLIN, I.R., CSIRO, Epping. N.S.W., Australia. (7)

+FREEMAN, J.E., Iowa State University of Science and Technology, Ames, Iowa. (7)

FREEMAN, J.A., Pest Infestation Laboratory, Slough, Bucks, England. (12)

FRIARS, G.W., Ontario Agricultural College, Department of Poultry Science, Guelph, Ontario, Canada. (7)

FRIAS, A., Instituto Nacional de Investigaciones Agronomicas, Madrid, Spain.

FUENTES, C., Instituto Nacional de Investigaciones Agronomicas, Madrid, Spain. (7)

FUJII, K., University of Tsukuba, Institute of Biological Science, Sakura-Mura, Ibaraki, 300-31, Japan.

FUNDER, J.V., Statesn Skadedy-laboratorium, Skovbrynet, Lyngby, Denmark. (8)

GALL, B.A.E., University of California, Davis, California. (7, 13)

GALLEGO, A., Instituto Nacional de Investigaciones Agrarias, Dept. de Genetica, Avda. Puerta de Hierro, S/N, Madrid, Spain.

GALLEGO-DIAZ, J., Instituto Nacional de Investigaciones Agronomicas, Madrid, Spain. (7)

GEIGER, H.H., Ph.D., Lehrstuhl fur Populationsgenetik, Universitat Hohenheim (LH), Postfach 106, Garbanstrasse 30, Germany. (7)

GERBER, G.H., Canada Department of Agriculture, Research Station, Winnipeg, Manitoba.

GERDY, J., Department of Biology, Benison University, Granville, Ohio 43023.

+GEISERT, P., Oak Park River Forest High School, Oak Park, Illinois. (10)

+GILBERT, E., Department of Biology, West Georgia College, Carrollton, Georgia 30117.

+GILES, P.H., Tropical Stored Products Centre, Slough, Bucks, England. (5, 12)

DIRECTORY-PERSONAL

+GILL, K.S., Punjab Agricultural University, Department of Genetics, Hissar, Harayana, India. (7)

GINGRICH, J., U.S. Army Natick Laboratories, Natick, Massachusetts.

GOLD, P., Health Sciences; State University of New York, Buffalo, N.Y. 14214.

GOLEBIOWSKA, ZOFIA, Plant Protection Institute, Poznan, Poland.

GOLOB, P., Ministry of Overseas Development., Tropical Stored Products Centre (TPI) Slough, Berks., England. (8, 12, 18)

GOMEZ B.R., Instituto de Nutricion de Centro America y Panama. Guatemala, Guatemala, C.A.

+GONZALES R.P., University of Puerto Rico, Humacao, Puerto Rico. (3, 9)

GOODMAN, C., Department of Biology, State University of New York, Buffalo, N.Y.

GOODWILL, ROBERT, University of Kentucky, Lexington, Kentucky 40506. (7)

GOUGH, M.C., Ministry of Overseas Development, Troical Stored Products Centre (TPI) Slough, Berks., England. (6, 18)

GRAF, Ulrike, Dept. of Zoology, University of Vienna, Vienna A-1090, Austria

+GRAHAM, W.M., Lakehead University, Postal St. P., Thunder Bay, Ontario, Canada. (7)

GREEN, C.B., University of Kentucky, College of Agriculture, Department of Animal Sciences, Lexington, Kentucky.

GRIFFING, T.C., University of Notre Dame, Notre Dame, Indiana. (5)

GRINYER, I., University of Guelph, Guelph, Ontario, Canada. (4)

+GROSCH, D.S., North Carolina State University, Raleigh, North Carolina. (4,7,8)

GROSSMAN, M., Ph.D., Department of Dairy Science, University of Illinois, Urbana, Illinois. (7, 16)

+GRUNDMANN, A.W., University of Utah, Salt Lake City, Utah. (3)

GUTHRIE, P., Dept. of Biology Central State University, Edmond, Oklahoma 73034.

HAFEEZ, M.A., Queen Elizabeth College, University of London, London, England. (5)

HAGSTRUM, D.W., Insect Attractants, Behavior and Basic Biology Research Laboratory, ARS, USDA, Gainesville, Florida. (5)

HAINES, C.P., Ministry of Overseas Development, Tropical Stored Products Centre (TPI) Slough, Berks., England. (2, 6, 12 17)

+HALL, D.W., Tropical Stored Products Centre, Slough, Bucks, England. (5, 12)

HALLAS, T., Statens Skadedyrlaboratorium, Lyngby, Denmark. (5, 12)

HALLIBURTON, R., University of California, Department of Animal Science, Davis, California 95616.

HALLIHAN, M., University of Chicago, Department of Biology, Chicago, Illinois 60637.

HALSTEAD, D.G., Pest Infestation Laboratory, Slough, Bucks., England. (5,12,17).

HAMALAINEN, M.K., Institute of Pest Investigation, Agricultural Research, Box 18, SF-01301 Vantaa 30, Finland

HANES, D., Facultad de Veterinaria, Catedra de Genetica, Cordoba, Spain.

HANKS, D.L., N.E. Missouri State College, Kirksville, Missouri, 63501. (11)

HARDIN, R.T., University of Alberta, dept. of Animal Science, Div. of Poultry Science, Edmonton, Alberta, Canada (7).

DIRECTORY-PERSONAL

HAREIN, P.K., University of Minnesota, Department of Entomology, Fisheries, and Wildlife, St. Paul, Minnesota. (5, 12, 13)

HARRIS, D.L. Department of Animal Sciences, Purdue University, Lafayette, Indiana 4797. (7)

HASHIGUCHI, G., Lakehead University, Thunder Bay, Ontario, Canada P7B 5E1.

+HATCH, M.H., University of Washington, Seattle, Washington. (17)

+HAYES, T.L., University of California, Donner Radiation Laboratory, Berkeley, California. (4)

HEATH, M., Ph.D., University of Illinois, Department of Physiology and Biophysics, Urbana, Illinois. (5, 13, 17)

+HENZLIK, R.E., Ball State University, Muncie, Indiana. (9)

+HEUTS, M.J., F.A. Janssens Memorial Laboratory for Genetics, Agricultural Institute of the University, Heverlee, Louvain, Belgium. (9)

+HIGHLAND, H.A., Stored-Product Insects Research and Development Laboratory, Savannah, Georgia. (2)

HOENIGSBERG, H.F., Universidad de los Andes, Department of Genetics, Bogota, D.E., Columbia, South America.

HOFFMAN, GEORGE, Department of Biology, University of Southern California, Los Angeles, California 90007.

+HOGUE, D.E., Cornell University, Ithaca, New York. (10)

HOLLINGSWORTH, N.M., Oregon State University, Department of Zoology, Corvallis, Oregon.

HOLM, E., University of Pretoria, Department of Entomology, Pretoria 0002, South Africa.

HOLSAPPLE, J.G., Applied Entomology Group, Pioneering Research Laboratory, U.S. Army Natick Laboratories, Natick, Massachusetts, 01760. (2)

HOPKINS, T.L., Kansas State University, Department of Entomology, Manhattan, Kansas.

HOWE, R.W., Pest Infestation Laboratory, Slough, Bucks, England. (5, 12)

HSIEH, F.K., Division of Entomology, Plant Protection Center, Taiwan.

HSU, K., 1149 Jane Avenue, Naperville, Illinois 60540.

HUBER, I., Ph.D., Department of Biology, Fairleigh Dickinson University, Madison, New Jersey. (1, 4, 7, 17 -- all of these with special reference to cockroaches.)

HUETS, M.J., F.A. Henssens Memorial Lab, Agriculture Institute of the University, Heverlee, Louvain, Belgium.

HUGHES, A.M., Pest Infestation Laboratory, Slough, Bucks, England.

+HUGHES, M.A., The University of Newcastle upon Tyne, Newcastle upon Tyne, England. (7)

HUOT, L., Universite Laval, Quebec, Canada. (10)

IMURA, O., National Food Research Institute, Stored Product Entomology Laboratory.

+JAMESON, G.W., Department of Agriculture, Victorian Plant Research Institute, Burnley, Victora, Australia.

JAY, A.E., N.E. Missouri State College, Kirksville, Missouri 63501. (13)

JAY, E.G., U.S.D.A., A.R.S., Savannah, Georgia 31401.

JAYARAMAN, S., Ph.D., Visiting Assistant Professor, Radiation biophysics. University of Illinois at Urbana-Champaign. (9)

JAYASINGH, D.B., Ministry of Industry and Communication, Storage and Infestation Division, 20 Hope Road, Kingston 10, Jamaica, W.I..

+JEFFREY, I.G., Agriculture Scientific Services, Department of Agriculture and Fisheries for Scotland. (12)

JILLSON, D.A., Ph.D., Visiting Assistant Professor, Population Biology Department of Zoology, University of Vermont, Burlington Vermont.

JOHANNSEN, I., Royal Agricultural College, Uppsala 7, Sweden.

JOHNSON, G., Department of Biology Sciences California State University, Hayward, California.

JOST, J., Oregon State University, Department of Zoology and Genetics Program, Corvallis, Oregon.

JUI, P.Y., University of Guelph, Guelph, Ontario, Canada. (7)

DIRECTORY-PERSONAL

+KAMEL, A., Stored Products Insects Research Section, Ministry of Agriculture, Giza, Egypt. (13)

KAMIS, A.E., Plant Protection Dept., Alexandria University, Alexandria, Egypt.

KALTHOFF, K., Ph.D., University of Texas, Department of Zoology, Austin, Texas 78712.

KANDASAMY, S., Tamil Nadu Agri. Univ., Dept. of Entomology, Madurai-625104 India.

KANGAS, D.E., N.E. Missouri State College, Kirksville, Missouri. (5)

KANNOWSKI, P.B., Ph.D., Pheromones and behavior, Institute for Ecological Studies, University of North Dakota, Grand Forks, North Dakota 58202. (2, 5, 13)

KAO, SUEY SHENG., Division of Entomology, Plant Protection Center, Taiwan.

KAPOOR, (LYALL), R.P.D., c/o Rev. S.P.Lyall, St. Marin's Church, Assuran, Gorakhpur, U.P., India (5)

KARPUS, James Y., Food and Drug Administration, Room 1222 Post Office Building, Chicago, Ill.

KATZ, F.F., Seton Hall University, South Orange, New Jersey. (11).

KEIM, BARBARA H., Department of Biology, Wheaton College, Norton, Massachusetts 02766. (5)

KELLY, R.P., St. Peter's College, Department of Biology, Kennedy Blvd., Jersey City, N.J. 7300.

KENCE, W.E., Department of Ecology and Evolution, State University of New York, Stony brook, New York 11791 (5,7).

KHAMIS, AWATEF E., Plant Protection Department, Faculty of Agriculture, Alexandria University, Alexandria, Egypt.

KHARE, M.K., University of Gorakhpur, Gorakhpur, U.P., India (1, 3).

KINKADE, M.L., N.E. Louisiana Univ., Dept. of Biology, Monroe, Louisiana 71209.

KINNEY, T.B., U.S.D.A., A.R.S., Beltsville, Maryland (7)

KIRITANI, K., Prefectural Institute of Agricultural and Forest Science, Oosone, Nangoku, Kochi, Japan (5, 12)

KISSINGER, D.G., Atlantic Union College, South Lancaster, Massachusetts. (3, 7, 17)

+KLASSEN, W., Metabolism and Radiation Research Laboratory, Fargo, North Dakota. (9)

+KNUTSON, L.V., Cornell University, Ithaca, New York.

KORUNIC, Z., Plant Protection Institute, Zagreb, Yugoslavia.

+KRAMER, J.P., Cornell University, Ithaca, New York. (11)

KRAMER, K.J., Department of Entomology, Kansas State University, Manhattan, Kansas.

KRAUSE, E., Seton Hall University, South Orange, New Jersey. (7)

KRESS, D.D, Animal and Range Sciences Department Montana State University, Bozeman, MT 59715.

KRICHER, V.C., Wheaton College, Norton, Massachusetts 02766.

+KRISHNA, S.S., University of Gorakhpur, Gorakhpur, U.P., India. (1, 10, 13)

KUMAR, S.A., University of Gorakhpur, Gorakhpur, India.

+LACHANCE, L.E., Metabolism and Radiation Research Laboratory, Fargo, North Dakota. (7, 9)

+LADISCH, R.M., Immaculata College, Immaculata, Pennsylvania. (13)

+LADISCH, S.M., Immaculata College, Immaculata, Pennsylvania. (13)

LAI, P., M.S. Radiation biophysics. University of Illinois at Urbana-Champaign. (9)

LANG, D., University of Illinois at Chicago Circle, Department of Biological Sciences, Chicago, Illinois.

LANGHOLFF, W.K., Purdue University, Department of Animal Sciences, West Lafayette, IN 47907. (7)

LAVIE, B., University of Haifa, Institute of Evolution; Haifa, Israel.

+LAVIOLETTE, P., Institut National des Sciences, Appliquees, Villeurbanne (Lyon) Rhone, France. (12)

LAWRENCE, W.S., Box 5385, Brown University, Providence, Rhode Island 02912.

LECLERCQ, J., Zoologie Generale, Institut Agronomique de l'Etat, Gembloux, Belgium.

LEACH, C.E., Insect Attractants, Behavior and Basic Biology Research Laboratory, A.R.S., U.S.D.A., Gainesville, Florida 32601.

LECATO, G.L., U.S. Department of Agriculture. Agricultural Research Service, Savannah, Georgia. (5)

LEE, Y.J., University of Illinois, Department of Physiology and Biophysics, Urbana, Illinois. (9)

LEESCH, J.G., U.S. Department of Agriculture, Agricultural Research Service. Savannah, Georgia. (8, 13)

LEMONDE, A., Universite Laval, Quebec, Canada. (10, 13)

+LEPORE, P.D., United States Department of Agriculture, Agricultural Research Service. Beltsville, Maryland. (7, 13)

LEROI, B.R., Universite F. Rabelais, Avenue Monge, Parc Grandmont, 37200 Tours (France).

LEVAN, A., Institute of Genetics, Solvegatou 29, S-223 62 Lund, Sweden.

LEVY, O., Department of Zoology, Tel Aviv University, Israel. (7).

LINTS, F.A., Janssens Memorial Laboratory for Genetics. Heverlee, Louvain, Belgium.

LIPA, J.J., Institut Ochrony Roslin, Miezurina 20, Poznan, Poland 60-318.

LISTOV, M.V., S.M. Kirov Military Medical Academy, Leningrad, U.S.S.R.

LLOYD, M., University of Chicago, Chicago, Illinois. (5)

LOHS-SCHARDIN, M. Biologisches Institut I (Zoologie) der Universitat Freiburg i. Br. D 78 Germany.

LOMNICKI, A., Jagiellonian University, Krakow, Poland.

LOOKJART, G.L., Kansas State University, Department of Entomology, Manhattan, Kansas.

+LOSCHIAVO, S.R., Canada Department of Agriculture, Research Station, Winnipeg, Manitoba, Canada. (5, 10, 12)

+LUM, P.T.M., Stored-Product Insects Research and Development Laboratory, Savannah, Georgia. (5)

MANKAU, S.K., California State College at San Bernardino, San Bernardino, California 92407. (11)

MARGHAM, J.P., Liverpool Polytechnic, Department of Biology, Liverpool L33AF, England.

MARINI, L., Department of Biology, Faculty of Science, Gilan University, Rasht, Iran.

+MARQUES, E.K., Departamento de Genetica - ICN, Universidade Federal do Rio Grande do Sul, Cx. Postal, 1953, Porto Alegre, RGS, Brazil. (7)

MATIN, A., Irradiation and Pest Control Research Institute, c/o Atomic Energy Center, Dacca, Bangladesh.

MAYES, P.A., Muscatine Community College, 152 Colorado Street, Muscatine, Iowa 52761.

MACCAULEY, D., Department of Zoology, University of Chicago, Chicago, Illinois 60037.

+MCDONALD, D.J., Dickinson College, Carlisle, Pennsylvania. (5, 7)

+MCFARLANE, J.A., Tropical Stored Products Centre, Slough, Bucks, England. (5, 12)

+MCGINNIS, A.J., Canada Department of Agriculture, Research Station, Winnipeg, Manitoba, Canada.

MCLEOD, R.L., Oregon State University, Department of Zoology, Corvallis, Oregon.

+MCMULLEN, L.H., Department of Forestry and Rural Development, Forest Research Laboratory, Victoria, B.C., Canada. (5, 12)

MCRAE, T.A., University of New England, Department of Animal Science, Armidale, New South Wales 2351. (5, 7, 10)

MEDLINGER, S., Tel-Aviv University, Department of Zoology, Tel Aviv, Israel.

MEDRANO, J.F., Div. de Ciecias Agricolas Alimentos-INCAP, Apt. No. 11-88, Guatemala, Guatemala.

MERTZ, D.B., University of Illinois, Chicago, Illinois 60680. (5)

MEYER, H.H., Ruakura Agricultural Research Centre, Private Bag, Hamilton, New Zealand.

MIDDLE, R.A., Oregon State University, Dept. of Zoology, Corvallis, Oregon 97331.

+MILANI, R., Universita, Instituto Lazzaro Spallanzani, Pavia, Italy. (7)

MILES, D.A., Purdue University, Department of Animal Sciences, West Lafayette, IN 47907. (7)

MILLER, S.A., The School of the Ozarks, Biology Department, Point Lookout, Missouri 65726.

MILLER, S.G., State University of New York at Albany, Albany, New York.

+MILLS, R.B., Kansas State University, Manhattan Kansas. (5, 12)

+MINSHALL, G.W., Idaho State University, Pocatello, Idaho.

MINSINGH, A., University of West Indies, Department of Zoology, Mona, Kingston 7, Jamaica.

MINVIELLE, F., Universite Laval, Zootechnie, Quebec, Canada.

MITSUI, E., National Food Research Institute, Stored Product Entomology Laboratory, Tsukuba, Japan.

MOCK, O.B., N.E., Missouri State College, Kirksville, Missouri 63501. (13)

MONDAL, K.A.M.S.H. Department of Zoology, University of Rajshahi, Rajshahi, Bangladesh.

MOORE, J., San Fernando Valley State College, Northridge, California. (11)

MORGAN, M., St. Catherine of Siena Church, 4200 Federal Blvd. Denver, Colorado (2,).

MORGAN, T.D., Kansas State University, Department of Entomology, Manhattan, Kansas.

MORRISON, M., University of Georgia, Department of Genetics, Athens, Georgia.

MOTARA, M.A., Univ. of Notre Dame, Coll. of Sci., Dept. of Biology, Notre Dame, Indiana 46556.

MUIR, W.M., Department of Dairy Science, University of Illinois, Urbana, Illinois, 61801.

MULLEN, M.A., U.S. Department of Agriculture, Agricultural Research Service, Savannah, Georgia. (5, 12)

MURRAY, J.J., University of Virginia, Charlottesville, VA. (5, 7)

MURRAY, K., Oregon State University, Department of Zoology, Corvallis, Oregon 97331.

MUSGRAVE, A.J., Ontario Agricultural College, Department of Entomology and Zoology, Guelph, Canada.

NAITO, M., Laboratory of Animal Breeding, Tokyo University, Tokyo, Japan.

NAKAKITA, H., National Food Research Institute, Stored Product Entomology Laboratory, Tsukuba, Japan.

NAKANE, T., The National Science Museum, Veno Park, Tokyo, Japan.

NARDON, P., Institut National des Sciences Appliquees, Villeurbanne (Rhone), France.

+NASH, D.J., Colorado State University, Fort Collins, Colorado. (2)

+NATON, E., Bayer, Landesanstalt f. Bodenkultur, Pflanzenbau u. Pflanzenschutz, Pflanzenschutz, 8 Munich 38 Postfach, Germany. (5, 10, 12)

NEW, J.H., Minister of Overseas Development, Tropical Stored Products Centre (TPI) Slough Berks., England. (6, 12)

NIVEN, B.S., Waite Agric. Res. Int., Glen Osmond, S. Australia 5064.

NORRIS, D.M., Department of Entomology, University of Wisconsin, Madison, Wisconsin 53706.

NORSEGAARD, R., Institute of Genetics, Solvegatan 29, S-223 62 Lund, Sweden.

+NOWOWSIELSKI-SLEPOWRON, B.J.A., University of St. Andrews, Queen's College, Dundee, Scotland, Great Britain. (2, 5)

+NUEZ, F., Escuela Tecnica Superior de Ingenieros Agronomos, Valencia, Spain. (7)

NUNEZ, F., Dept. de Biologia, U.N., Apdo Aereo 23227, Bogota, D.E., Colombia, S.A..

O'BRIAN, D.M., Seton Hall University, South Orange, New Jersey

07079.

OGDEN, J.C, W. Indies Laboratory, St. Croix, Virgin Islands 00820.

OKA, H., National Institute of Genetics, Misima City 411, Japan.

OKURA, E., Okayama University, Laboratory of Genetics, Okayama, Japan.

OLKOWSKI, W., John Muir Institute, 1307 Acton Street, Berkeley, California 94706.

OROZCO, F., Inst. Nacional de Investigaciones, Departamento de Genetica, Avda. Puerta de Hierro, Madrid-3, Spain.

ORR, E.C., Oregon State University, Department of Zoology, Corvallis, Oregon.

+PANT, N.C., I.A.R.I., Division of Entomology, New Delhi, India. (5, 10)

PEREIRA, C., Purdue University, Dept. of Entomology, West Lafayette, Indiana 47907.

+PARK, T., University of Chicago, Chicago, Illinois. (5, 13)

PARTIDA, G.J., Kansas State University, Manhattan, Kansas. (12)

PAYNE, J.A., Stored Products Insects Laboratory, ARS, U.S.D.A., Tifton, Georgia 31794.

+PEASE, R.F.W., University of California, Engineering Department, Berkeley, California. (4)

PEDERSON, L., Rio Hondo College, Biology Department, 3600 Workman Mill Road, Whittier, California 90608.

PELERENTS, C., Faculteit De Landbouwwetenschappe, Rijks Universiteit, Ghent, Belgium.

PERCIVAL, F., Westmount College, 995 La Paz Road, Santa Barbara, California 93103.

PERRON, J.M., Universite Laval, Quebec, Canada. (12, 13)

PIERANTONI, ROGERO, Director, Laboratory of Biophysics and Cybernetics, National Research Center, Camugli, Italy.

POLESKI, D., St. Anselms College, Biology Department, St. Anselms Drive, Manchester, N.H. 03102.

POPOV, V.V., Institute of Applied Molecular Biology and Genetics, 23 Vuchetich St., Moscow, 125206, U.S.S.R..

POST, D., University of Wisconsin, Biology Department, Stevenspoint, Wisconsin 54481.

PRANATA, R.I., Seameo Regional Center for Tropical Biology, Bogor, Indonesia.

PREVETT, P.F., Tropical Stored Products Centre, Slough, Bucks, England. (5, 12)

PRUS, T., Institute of Ecology, Dziekanow Lesny, 05-150 Lomianki, Poland.

PUGH, J.B., Southern Illinois University at Carbondale, Carbondale, Illinois.

QUINTANILHA, A., Laboratorio de Biologia, Universidade de Maputo, Maputo, Mozambique.

RABINDRA, R.J., Agricultural College and Research Institute, Coimbatore, India 641003.

+RAGHUVIR, N.N., University of Bridgeport, Bridgeport, Connecticut. (9)

RAHOO, G.M., Sind Agricultural College, Tandojam, Pakistan.

RAISBECK, B., U.S. Army Natick Laboratories, Natick, Mass.

RAMIREZ, M., Instituto de Biologia, UNAM, departamento de Zoologia, Apdo Postal 70-153, Mexico 20, D.F.

RAMOS-ELORDUY DE CONCONI, J., Laboratorio de Entomologia, Departamento de Zoologia, Instituto de Biologia, Universidad Nacional de Mexico, Mexico 20, D.F., Mexico. (9,10)

RASMUSSEN, D.I., Department of Zoology, Arizona State University, Tempe, Arizona. (5)

+REDLINGER, L.M., Coastal Plain Experiment Station, Peanut and Southern Corn Insects Investigations, Tifton, Georgia

RESSEGUIE, L.M., Department of Biology, Beloit College, Beloit, Wisconsin 53511.

+RICH, E.R., University of Miami, Coral Gables, Florida 33124

RICH, S.S., Purdue University, W. Lafayette, Indiana

+RIEMANN, J.G., Metabolism and Radiation Research Laboratory, Fargo, North Dakota. (4,9)

RITTE, U., Department of Genetics, The Hebrew University of Jerusalem, Israel

+ROBINSON, R., Bibliography Center, Ealing, London, England.

ROBOTTI, C.A., Universita di Torino, Via Academia Albertina Turin 10123, Italy.

RODRIGUEZ, P., University of Texas, San Antonio, Texas 78285.

ROLLING, W.C., University of Caifornia, College of Agriculture, Department of Animal Husbandry, Davis, California 95616.

+ROPPEL, R.M., Stored-Product Insects Research and Development Laboratory, Savannah, Georgia.

ROSE, S., University of New England, Department of Microbiology and Genetics, Armidale, N.S.W., 2351 Australia.

ROSEBERRY, D.A., N.E. Missouri, Kirksville, Missouri 63501. (5)

ROSELAND, C.R., Kansas State University, Department of Entomology, Manhattan, Kansas.

ROSS, M.H., Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061.

+ROTH, L.M., U.S. Army Natick Laboratories, Natick, Massachusetts. (5, 10, 12, 13)

ROY, D., University of Kalnany, Distr of Nadga, W. Bengal, India 741235.

ROY, P., Bidhan Chandra Krishi Viswa Vidyals, Department of

Agricultural Entomology, Kalyani 741235 (West Bengal), India.

ROZOK, M., Polish Acad. Science, Krakow, 26.IX.87, Poland.

RUANO, R.G., Instituto Nacional de Investigaciones Agronomicas, Madrid, Spain. (5, 7)

+RUMBALL, W., Department of Scientific and Industrial Research, Palmerston North, New Zealand. (5, 7)

RUSSEL, G.E., U.S. Food and Drug Administration, Detroit District, 1560 East Jefferson Avenue, Detroit, MI 48207.

RYAN, M., Zoology Department, University College, Dublin, Ireland.

SAMOLLOW, P.B., Oregon State University, Department of Zoology, Corvallis, Oregon.

SANCHEZ-MONGE, E., Escuela Tecnica Superior de Ingenieros Agronomos, Madrid, Spain. (7)

SANDER, K., Biologisches Institut I (Zoologie) des Universitat. Freiburg, Germany. (3, 4, 6, 7, 11)

+SARVELLA, P.A., United States Department of Agriculture, Agricultural Research Service, Beltsville, Maryland. (4, 7)

SAUER, D.B., Plant Pathology, U.S., Grain Marketing Research Laboratory, A.R.S., U.S.D.A., Manhattan, Kansas 66502.

+SAXENA, K.N., University of Delhi, Delhi, India. (10)

+SCHEINBERG, E., Animal Research Institute, C.E.G., Canada Department of Agriculture, Ottawa, Ontario, Canada. (7, 16)

SCHURR, K., Bowling Green State University, Department of Biology, Bowling Green, Ohio. 43403 (2, 9).

SELLIN, L., Seton Hall University, South Orange, New Jersey 07079.

SELLS, G.D., N.E. Missouri State College, Kirksville, Missouri 63501. (13)

+SELMAN, B.J., The University of Newcastle upon Tyne, Newcastle upon Tyne, England.

SHADDY, J.H., Northeastern Missouri State College, Kinsville, Missouri. (12)

SHELBY, C.E., Stored Products Research and Development

Laboratory, Savannah, GA 31403.

SHRIVASTAVA, P.N., Agricultural University, Jabalpur, Madhya Pradesh, India. (7)

+SHUKLA, G.S., University of Gorakhpur, Gorakhpur, U.P., India. (1, 13)

SILANDER, J., The University of Connecticut, Biological Sciences, Box U42, Storrs, Connecticut 06268.

+SILHACEK, D.L., Stored-Product Insects Research and Development Laboratory, Savannah, Georgia.

+SILLMAN, E.E., Duquesne University, Department of Biological Sciences, Pittsburgh, Pennsylvania 15219.

SILVELA, L., Instituto Nacional de Invetigaciones Agronomicas, Madrid, Spain. (7)

SIMONAITIS, R.A., U.S. Department of Agriculture, Agricultural Research Service, Savannah, Georgia. (8, 13)

SINGH, N.B., Canada Deparment of Agriculture, Research Station, Winnipeg, Manitoba, Canada. (5, 12, 13)

SINGH, P., Department of Scientific and Industrial Research Entomology Division, Auckland, New Zealand. (5, 12)

SINGH, R.N., University of Gorakhpur, Department of Zoology, Gorakhpur, U.P., India. (2, 13)

SINHA, R.N., Canada Department of Agriculture, Research Station, Winnipeg, Manitoba, Canada. (5, 10, 11, 12, 13)

+SINHA, T.B., University of Gorakhpur, Gorkhpur, U.P., India. (17)

+SITTMAN, K., McGill University, Department of Genetics, Montreal, P.Q., Canada. (7)

+SLADEN, B., The John Hopkins University, Baltimore, Maryland. (5)

SLATER, J.V., S.U.N.Y., Department of Biology, New Paltz, NY 12561.

+SMITH, L.B., Canada Department of Agriculture, Research Station, Winnipeg, Manitboa, Canada. (2, 5)

+SMITH, L.W., U.S. Army Natick Laboratory, Natick, Massachusetts.

SMITH, P.D., University of Georgia, Athens, Georgia 30602.

SOBRAMANIAN, T.R., Department of Entomology, Agricultural College and Research Institute, Coimbatore, India 641003.

SOKOLOFF, A., California State College, San Bernardino, California. (2, 5, 7, 10, 11, 13, 19)

SOKOLOFF, E., California State College, San Bernardino, California.

SOKOLOFF, M., California State College, San Bernardino, Department of Biology, San Bernardino, California.

SOLIMAN, M.H., Department of Microbiology and Genetics, University of New England, Armidale, N.S.W., Australia.

+SONLEITNER, F.J., University of Oklahoma, Department of Zoology, Norman, Oklahoma. (5, 16)

SOOMRO, B.A., Sind Agricultural College, Tandojam, Pakistan.

SPRATT, E.C., Pest Infestation Control Laboratory, Slough, Berks, England.

+SPRINGHETTI, A., Universita, Instituto Lazzaro Spallanzani, Pavia, Italy.

+SRIVASTAVA, U.S., University of Bihar, Muzaffarpur, India.

STAM, P., Department of Genetics. Wageningen (The Netherlands). (7, 16)

+STANLEY, M.S.M., George Mason College, Fairfax, Virginia. (3)

+STROSS, R.G., University of Rhode Island, Department of Zoology, Kingston, Rhode Island. (7)

SU, H.C.F., U.S. Department of Agriculture, Agricultural Research Service, Savannah, Georgia. (13)

SVERDLOV, E., Tel Aviv University, Tel Aviv, Israel. (7)

SWEETNAM, R.B., University of New England, Department of Animal Science, Armidale, New South Wales 2351. (5, 7)

TAGARRO, M.P., Instituto Nacional de Investigaciones Agronomicas, Madrid, Spain. (7)

TAKAHASHI, F., Hiroshima University, Faculty of Integrated Arts and Sciences, Higashi-Senda-Machi, Naka-Ku, Hiroshima 730, Japan.

+TAYLOR, C., University of California, Riverside, California.

(2, 5, 7)

TELEKY, S., University of Chicago, Biology Department, Chicago, Illinois 60637.

THOMAS, I., Pest Infestation Laboratory, Slough, Bucks, England.

TORO, M.A., Instituto Nacional de Investigaciones Agrarias, Departamento do Genetica, Carretera de la Coruna KM. 7, Madrid-35, Spain.

+TSCHINKEL, W., Cornell University, Ithaca, New York. (2, 5, 13)

+VAN VLECK, L.D., Cornell University, Ithaca, New York. (13)

VATT, K.V., Leningrad State University, Department of Genetics, Leningrad 199164, U.S.S.R..

VATTI, K.V., Leningrad State University, Department of Genetics, Leningrad 199164, U.S.S.R..

VAZQUEZ, A.W., Division of Microbiology, H.E.W., P.H.S., Food and Drug Administration, Washington, D.C. 20204.

VEA, E.V., Deparment of Entomolgy, Fisheries and Wildlife, University of Minnesota, St. Paul, Minnesota 55101. (7)

VIAN, W.E., University of Kentucky, College of Agriculture, Department of Animal Sciences, Lexington, Kentucky.

VICK, K.W., Insect Attractants, Behavior and Basic Biology Research Laboratory, A.R.S, U.S.D.A., Gainesville, Florida 32601.

VILLENEUVE, J.L., Universite Laval, Quebec, Canada. (10)

VIRKKI, N., Agricultural Experiment Station, Department of Crop Protection, Rio Piedras, Puerto Rico 00928.

VOGE, M., Department of Medical Microbiology, University of California Medical Center, Los Angeles, California 90024.

VON DE KLASHORT, G., Koninklijk Instituut Voor De Trupen, Amsterdam-Oost, The Netherlands.

WADE, M., Department of Zoology, University of Chicago, Chicago, Illinois 60637.

+WAGONER, D.H., Metabolism and Radiation Research Laboratory, Fargo, North Dakota. (7, 9)

WANNA, S., M.S., Radiation biology; mathematical biology.

University of Illinois at Urbana-Champaign. (9, 16)

WARTOMO, H., Fakultas Peternakan, Universitas Hadja Mada, Yogyakarata, Indonesia.

WASSERMAN, S.S., University of Virginia, Biology Department, Charlottesville, VA. 22901.

+WATERHOUSE, F.L., University of St. Andrews, Queen's College, Dundee, Scotland, Great Britain. (2, 5)

WATTERS, F.L., Canada Department of Agriculture, Winnipeg, Manitoba. (7, 12)

WATT, J.C., Entomology Division (17). D.S.I.R. Auckland, New Zealand. (17)

+WATTIAUX, J.M., Janssens Memorial Laboratory for Genetics, Heverlee, Louvain, Belgium. (13)

WEBLEY, D.J., Ministry of Overseas Development, Tropical Stored Products Centre (TPI) Slough, Berks., England. (8, 12)

WEIDNER, H., Zoologisches Institut und Zoologisches Museum der Universitat, Hamburg, Germany.

WEIJER, J., University of Alberta, Edmonton, Alberta, Canada. (9)

WELDMAN, H., Zoologisches Institute, Zoologisches Museum der Universitat, Hamburg, Germany.

WELSH, G., Donner Laboratory and Lawrence Radiation Laboratory, University of California, Berkeley, California. (9)

WELSH, J.F., Humboldt State University, Arcata, California 95521.

WHITE, A.M., University of Florida, Department of Pediatrics, Box J-296, JHMHC, Gainesville, FL 32610.

+WHITNEY, W.K., The Dow Chemical Company, Bioproducts Department, Midland Michigan. (12, 13)

WIENDL, F.M., Centro de Energia Nuclear na Agricultura (CENA) Piracicaba, Brazil. (9, 12)

WILLIAMS, P., Department of Agriculture, Victorian Plant Research Institute, Burnley, Victoria, Australia. (8, 12, 18)

+WILSON, S.P., Purdue University, Population Genetics Institute, Lafayette, Indiana. (7)

WIRTZ, R.A., Letterman Army Institute of Res., Department of Tropical Medicine, Presidio of San Francisco, CA 94129.

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

WOOL, D., Tel-Aviv University, Department of Zoology, Tel-Aviv, Israel. (5, 7)

WRIGHT, V.F., Department of Entomology, Kansas State University, Manhattan, Ks.

+YAMADA, Y., National Institute of Genetics, Misma, Sizuokaken, Japan. (7)

YAMAMOTO, M., Iwakuni Br. Kobe Plant Protect, Iwakuni Kowan Godo Chosha, 3-9-57, Shinko-Cgo, Iwakuni-Shi, Yamaguchi-Ken 740, Japan.

YANG, T.C, University of California, Donner Radiation Laboratory, Berkeley, California. (9)

YAO, K., Central China College of Agriculture, Plant Protection Department, Wuhang, Hupei, China.

YEE, Y.J., University of Illinois, Department of Physiology and Biophysics, Urbana, Illinois.

YEH, F.C., University of Calgary, Calgary, Alberta, Canada.

YINON, U., Vision Research Laboratory, Hadassah University Hospital, Israel, Jerusalem.

YOSHIDA, T., Okayama University, Okayama, Japan. (5, 12)

YOUNG, A.M., Milwaukee Public Museum, 300 West Wells Street, Milwaukee, WI 53233.

ZEHNER, J.M., U.S. Department of Agriculture, Agricultural Research Service, Savannah, Georgia. (8, 13)

ZETTLER, J.L., U.S. Department of Agriculture, Agricultural Research Service, Savannah, Georgia. (8, 13)

ZIEGLER, J.R., Box 1045, Lafayette, CA 94549.

ZISSLER, D., Biologisches Institut I (Zoologie) der Universitat D 78 Freiburg i. Br. Germany. (3, 4, 6, 7, 11)