TRIBOLIUM INFORMATION BULLETIN

VOLUME 27

1987

EDITORS

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

M. Hani Soliman, Genetics Research Laboratories, University of New England, Armidale, N.S.W. 2351, Australia

TRIBOLIUM INFORMATION BULLETIN

Number 27

July, 1987

Note.. ii

Acknowledgements.. iii

Announcement.. iv

Stock Lists... 1-49

Notes-Research.. 51-99

The linkage relationship and relative position of diminished eye in *Tribolium confusum* Duval. Aaron Brownlee and Alexander Sokoloff............. 51

Biomass selection at different stages of *Tribolium castaneum* life. M. C. Fuentes and M. P. Tagarro.. 53

Effect of maize flour on the sex-ratio, formation and duration of various stages of the red flour beetle, *Tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae). Mahbub Hasan and M. Khalequzzaman. 58

Growth of *Tribolium anaphe* (Coleoptera: Tenebrionidae) on *Lathyrus sativus* flour. Mahbub Hasan and Ataur Rahman Khan...................... 63

Flight ability of *Tribolium freemani* Hinton. O. Imura.. 68

Sexual maturation of *Tribolium freemani* Hinton. O. Imura.. 70

Effectiveness of silica aerogel against the merchant grain beetle, *Oryzaephilus mercator* Fauvel. S. R. Loschiavo................................ 73

Evaporation of a carbon tetrachloride-carbon bisulfide grain fumigant through paper and plastic films. S. R. Loschiavo and N. D. G. White......... 74

Population biology of *Tribolium freemani* Hinton (Coleoptera: Tenebrionidae). M. Matsumura and T. Yoshida..................................... 75

Growth of *Tribolium confusum* Duval larvae (Coleoptera: Tenebrionidae) on barley and rice flours. Abdul Mazid and Ataur Rahman Khan......... 78

Linkage group assignment of "antena bifurcada" (ab). Fernando Núñez and Indiana Bustos.......... 81

"Ojo blanco" (obl), a new marker gene for linkage group IV in *Tribolium castaneum*. Fernando Núñez.. 82

Autoclaving of beans (*Phaseolus vulgaris*) to improve their nutritive value for *Tribolium* larvae. Wen Flora Pao, Pran Vohra and F. H. Kratzer........... 83

Phenotypic differentioation of *Tribolium castaneum* Hbst. cI strain. Tadensa Prus and Miroslawa Prus. 89

A search for incompatibitily strains in *T. castaneum*. A. Sokoloff, L. Shimeld and P. O'Neal. 96

Notes-Technical.................................. 101-103

Fabrication of a sieve frame for collecting *Tribolium*. Peter Backer, Joe Borelli and Pran Vohra... 101

A simple, economical, and escape-proof plastic device to detect insects in stored grain. Dr. F. Madrid and S. R. Loschiavo................. 103

Bibliography 105-139

1. Anatomy and Histology 106

2. Behavior 107

3. Cytology and Electron Microscopy 108-109

4. Insect Tissue Culture and Embryology 110

5. Ecology and Population 111-113

6. General 114

7. Genetics and Phenotypic Variation 115-116

8. Insecticides and Insecticide Resistance . 117-119

9. Irradiation and Use of Isotopes 120-121

10. Nutrition 122

11. Parasites and Symbionts of Coleoptera 123

12. Pests 124-131

13. Physiology and Biochemistry 132-133

14. Space and Aerial Ecology 134

15. Speciation 135

16. Statistical Methods and Mathematical Models . 136

17. Taxonomic Studies 137

18. Technique 138

19. Teratology 139

Directory-Geographical 141-170

Directory-Personal 171-190

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 an asterisk or the note "Reference Authorized" 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.

ACKNOWLEDGMENTS

The editors are indebted to ALEXANDRA SOKOLOFF and ELAINE SOKOLOFF for assistance in the preparation and distribution of TIB 27

ANNOUNCEMENT: RE: INTERNATIONAL CONGRESS OF ENTOMOLOGY 1988

The XVIII International Congress of Entomology is to be held at the University of British Columbia, Vancouver, Canada July 3-9, 1988. The first announcement was sent in January 1987. The section on stored product entomology will include the following topics:

1. Pheromones and Attractants
2. Acarology (including household mites of medical significance)
3. Ecology (including biology, population dynamics simulation modelling, detection and sampling, acclimation, nutritional ecology, genetics, predator-parasite-pest relationships, mycology and mycotoxins)
4. Chemical, Physical and Biological Control (including insecticides, insect growth regulators temperature, aeration, radiation of all types, inert dusts, controlled atmospheres, resistance, parasites, predators and other microbial agents, integrated pest management).
5. Practical aspects (including storage engineering, regulatory entomology, economics, structural pests, urban pest control).

Poster submissions reporting high quality original research are encouraged. Workshops on the above or other topics, and/or informal meeting of stored product entomologists may be arranged depending on response and availability of space. If you wish to participate in an evening informal meeting please inform Dr. Loschiavo as soon as possible.

Please prepare papers of 20-minute duration, including discussion. If time permits, we shall have a general discussion at the end of each session.

The above outline is tentative and may be subject to change before the final program is distributed.

You are encouraged to attend and to participate by contributing papers reporting original work of high standard. For further information and guidance see the announcements, or contact the Secretary General or member of the Organizing Committee listed below:

Dr. C.G. E. Scudder
Secretary General
XVIII Enternational Congress of Entomology
Department of Zoology
The University of British Columbia
Vancouver, B.C. Canada
V6T 2A9
Ph 604 228-3168

Dr. S.R. Loschiavo
Convenor, Section on Stored Product Entomology
XVIII International Congress of Entomology
Research Station, Agriculture Canada
195 Dafoe Road
Winnipeg, Manitoba, Canada
R3T 2M9
Ph 204 269-2100

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

B. Tribolium confusum

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

C. Tribolium madens

D. Latheticus oryzae

(Ed.)

Steck Lists

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

I. Wild type strains

A. Oryzaephilus surinamensis

B. Tribolium castaneum

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

C. Tribolium confusum

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

D. B. Mertz

CORAL GABLES, FLORIDA
UNIVERSITY OF MIAMI
DEPARTMENT OF BIOLOGY

I. wild type strains

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

II. Mutant

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

Earl R. Rich

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

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

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

Tribolium castaneum

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

Tribolium confusum

Chicago	Park 1955
black	via San Bernardino
pearl	via San Bernardino

Tribolium madens	via San Bernardino
Tribolium brevicornis	via San Bernardino

(Ed.).

LAFAYETTE, INDIANA 47907
PURDUE UNIVERSITY
ANIMAL SCIENCES DEPARTMENT

Tribolium castaneum

I. Wild type strains

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

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

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

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

A.E. Bell.

Stock Lists

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

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 arrhenotokous parthenogenesis with unfertilized (haploid n=7) eggs yielding male progeny, and fertilized (diploid, n=14) eggs yielding female progeny. Females can be kept alive for 9-12 months and will retain fertility over most of their life. Thus many experiments 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 whe will tend until they are adults, then will mate with a son, and then will produce mostly diploid female progeny which can be used to continue the created line.

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

MANHATTAN, KANSAS
KANSAS STATE UNIVERSITY
DEPARTMENT OF ENTOMOLOGY

LEPIDOPTERA

Phycitidae: Cadra cautella and Plodia interpunctella

Gelechiidae: wild and red eyed strains.

Pyralidae: Corcyra cephalonica

COLEOPTERA

Anobiidae: Lasioderma serricorne and Stegobium paniceum

Bostrichidae: Rhyzopertha dominica

Bruchidae: Callosobruchus maculatus

Cucujidae; Cryptolestes ferrugineus, C. pusillus,

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

Dermestidae: Trogoderma inclusum, Attagenus megatoma

Ostomatidae: Tenebroides mauritanicus

Ptinidae: Gibbium psylloides

Stock Lists

Silvanidae: Ahasverus advena, Oryzaephilus surinamensis, O. mercator

Tenebrionidae:

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

Valerie Wright

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

Tribolium castaneum

I. Insecticide-resitant strains

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

II. Mutant strains

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, II) "
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 (II)
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 UFF 1976
24. San Bernardino 1976
25. CS-4 (from New York) 1976

B. Mutants

1. Sex-linked

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

Autosomal

63. p--pearl II New York 1976
64. p^{Pk}--pink II Chazy, 1959
65. p pearl II Park 1955
66. p^S pearl II
76. au--aureate III
78. b--black III
81. b^{S-1} -- black, Brazil
82. b--black Chicago 1955
84. b--black McGill 1959
85. b--black McGill via New York, 1976
86. b--black NASA 1959
88. b--black synthetic (Chicago/McGill)
90. Chr--Charcoal III
91. lod p--light ocular diaphragm, pearl III,II
94. msg--melanotic stink glands III
96. mt--mottled III
98. b^t--tawny III
105. fas-2--fused antennal segments-2 IV
107. ap, ju--antennapedia, juvenile urogomphi
113. s--sooty (Berkeley synthetic background) IV
114. s--sooty (New York) IV
135. j--jet V
136. j^{AS}--jet V

Stock Lists

139. mc--microcephalic V Chazy, 1959
140. mc-1 microcephalic-1 (eyeless) V Hayward 1967
143. fas-3a fused antennal segments 3a V Berkeley, 1963
148. m--maroon V Purdue 1970
150. rb--ruby V Berkeley, 1962
156. Mo--Microphthalmic VI Chazy, 1959
162. sa=ca--short antenna VII Cold Sprg. Hbr. 1960
165. c--chetnut VII Purdue, 1962
168. ju-7--juvenile urogomphi VII-IV Purdue
170. ble--blistered elytra VII Berkeley 1962
173. c, Rd_S VII,II Corvallis 1975
180. ap_D --antennapedia VIII Berkeley 1962
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
280. Veracruz small
288. fas-9 fused antennal segments-9 San Bernardino, 1975
295. pd,p--paddle, pearl I, II
296. pd,p,b--paddle, pearl black I, II, III
297. sp,p--spotted, pearl I, II
299. py,i,p--pygmy, ivory, pearl I, II, II
301. p, au, lod--pearl, aureate, light ocular diaphragm II, III, III.
302. p, au, mc--pearl, aureate, microcephalic II, III, V
303. p,b--pearl, black (II, III)
304. p,au,lod,msg--pearl, aureate, light ocular diaphragm, melanotic stink glands (II, III, III, III)
306. p,b,pe--pearl, black, pointed elytra (II, III,?)
308. p,mc--pearl, microcephalic II, V
310. p,s--pearl, sooty II, IV
312. p,j,Npp--pearl, jet, Non-punctate prothorax II, V
313. p,apt,Mo--pearl, alate prothorax, Microphthalmic II, II, VI.
315. p,mas--pearl, missing abdominal segments II, II
316. p, knp--pearl, knobby prothorax II, II
317. p,aa--pearl, abbreviated appendages II, V
322. p,Fas-4,b--pearl, Fused antennal segments-4, black II, ?, III
415. mxp,s--maxillopedia, sooty II, IV

Stock Lists

416. au, s--aureate, sooty III,IV
417. h, s--hazel, sooty III, IV
428. c, Npp--chestnut, Nonpunctate prothorax VII, ?
430. au,Npp--aureate, Nonpunctate prothorax III, ?
436, au,mc--aureate, microcephalic III, V
442. Df,s,Mo--Deformed, sooty, Microphthalmic ?, IV, VI
444. i,lod,Mo--ivory, light ocular diaphragm, Microphthalmic II, III, VI
445. i,ppas-ivory, partially pointed abdom. sternites II, ?
448. Chr,ap--Charcoal, antennapedia III, VIII
450. au,ble--aureate, blistered elytra III, VII
454. ELL Pk
p /p II
462. mas, mc--missing abdominal segments, microcephalic II,V
469. i,lod--ivory, light ocular diaphragm II,III
470. lod,rb--light ocular diaphragm, ruby III, ?
473. fas-6--fused antennal segments-6

V. Tribolium confusum

Wild type strains

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

Synthetic strains

1. Berkeley

Mutant strains

apt--alate prothorax I
apt,fas-2--alate prothorax, fused antennal segments-2
b-black III
b,cas,p--black, creased abdominal segments, pearl
b,lod,p--black, light ocular diaphragm, pearl
b,p--black, pearl
b,rus--black, ruby spot
b,rus,spl--black, ruby spot, split
b,twa--black, twisted abdomen
b-2--black-2
b-2/b McGill--synthetic black
bZ,rZ--black Zagreb, red Zagreb
(black strains from Carlisle, Pa., Chicago, Donner lab, Georgia, McGill, Sault Ste. Marie, Winnipeg and Yugoslavia)
b-Chicago/b McGill--synthetic black
b-Mcgill,fas--black, fused antennal segments
b-Mcgill,p--black, pearl

Stock Lists

b-SSM,spl--black, split
ble--blistered elytra V
ble,e--blistered elytra, ebony V,V
car,p--carmine, pearl
cas--creased abdominal segments II
cla-claret
cru--crumpled I
dpe--dirty pearl eye II
dj--disjoined VI
dt--dent (see umb--umbilicus)
dt,p--dent, pearl
e--ebony V

Chicago, 1955

(other ebony alleles)
e,fas-3--ebony, fused antennal segments-3 V, ?
e-2--ebony-2 (not allelic with e) II
e-2,fas-1--ebony, fused antennal segments-1
ele--elongated elytra
ele,fas-2--elongated elytra, fused antennal segments-2
es--eyespot I
es,fas-1--eyespot, fused antennal segments-1
es,fas,msg--eyespot, fused antennal segments melanotic stink glands I, ?, III
es,fas,sti--eyespot, fused antennal segments, sternites incomplete
eu,fas-2--extra urogomphi, fused antennal segments-2
fas-2--fused antennal segments-2 II
fas-2,lod,msg,p--fused antennal segments-2, light ocular diaphragm, melanotic stink glands, pearl II,III,III,II
fas-2,lod,p--fused antennal segments-2, light ocular diaphragm pearl II,III,II
fas-2,msg--fused antennal segments-2, melanotic stink glands II,III
fas-3--fused antennal segments-3
fro--frosted
lod,rus--light ocular diaphragm, ruby spot
msg--melanotic stink glands III
msg,rus--melanotic stink glands, ruby spot III,III
msg,twa--melanotic stink glands, twisted abdomen III,?
ov-like--overshot-like
p-pearl II
p-Slough-pearl
p^R--pearl riboflavinless II
r-red I
r,sh--red, short elytra
r^U--red
r^Z--red from Zagreb
rby--ruby
rus--ruby spot III
sh--short elytra (Berkeley)
sh,sp,twa--short elytra, split, twisted abdomen
sp--split III

sp-1--split-1
twa--twisted abdomen
thu--thumbed IV
thu^{S} --an allele of thu. IV
thu, Xl--thumbed, Extra large
umb--umbilicus

VI. Tribolium destructor

VII. Tribolium freemani

VIII. Tribolium madens

A. Sokoloff

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

Red^{Ho} 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 kuehniella (Zeller)	N.C. State, Raleigh, N.C.
2. Cadra cautella (Walker)	Tifton, Ga.
3. C. figulilella (Gregson)	Unknown
4. Ephestia elutella (Hubner)	Richmond, Va.
5. Plodia interpunctella (hubner)	Modesto, Ca.
6. Sitotroga cerealella (Olivier)	Manhattan, Ka
7. Tineola bisselliella (Hummel)	Savannah, Ga.; Ottawa, Can., and Durham, N.H.

b. Coleoptera

1. Anthrenus flavipes LeConte	Savannah, and Durham
2. Attagenus megatoma (Fab.)	CSMA strains
3. Callosobruchus maculatus (Fab.)	Fresno, ca.
4. Cathartus quadricollis (Guerin-Meneville)	Unknown
5. Cryptolestes pusillus (Schonherr)	Tifton, Ga.
6. Dermestes maculatus De Geer	Madison, Wis.
7. Gibbium psylloides (Czenpinski)	Unknown
8. Lasioderma serricorne (Fab.)	Unknown
9. Oryzaephilus mercator (Fauvel)	Unknown
10. Oryzaephilus surinamensis (L.)	Manhattan, Kan.
11. Rhyzopertha dominica Fab.)	Unknown
12. Sitophilus granarius (L.)	Manhattan, Kan.
13. S. oryzae (L.)	Ark., Calif., Kan., La. Minn. and Tex.
14. S. zeamais Motchulsky	Estill, S.C.

15. Stegobium paniceum (L.) — Madison, Wis.

16. Tenebrio molitor (L.) — Manhattan, Ka, Durham, N.H.

17. Tenebroides mauritanicus (L.) — Savannah, Ga.

18. Tribolium castaneum (Herbst) — Unknown

19. Tribolium confusum duVal — Manhattan, Kan.

20. Tribolium madens Charpentier — Tifton, Ga.

21. Trogoderma glabrum (Herbst) — Madison, wis., Riverside, Ca.

22. T. inclusum LeConte — Madison; Riverside

23. T. variabile Ballion — Fresno, Riverside, Ca.

II. mutant strains

A. Plodia interpunctella

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

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-B, culture 8d; Generation 123)
   d. b,p (black, pearl
   e. dj, e (disjoined, ebony)
   f. sh (short elytra

(Ed.).

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

I. Wild type strains

A. Coleoptera strains

Dermestidae

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

Cucujidae

Oryzaephilus surinamensis (L)	Savannah, Georgia, 1975.
Oryzaephilus mercator (Fauvel)	Savannah, Georgia, 1984.
Cryptolestes pusillus (Schoenherr)	Manhattan Ka. 1967.
Cryptolestes ferrugineus (Stephens)	Unknown

Stock Lists

Silvanidae

Ahasverus advena Waltl.	Field collected, Mn., 1984

Tenebrionidae

Cyaneus angustus (LeConte)	Winnipeg; 1974. Field collected, Mn., 1977
Tribolium castaneum (Herbst)	Corvallis, Ore. 1976.
Tribolium confusum duVal	Unknown *
Tenebrio molitor	Carolina Biological, 1984

Anobiidae

Lasioderma serricorne (Fab.)	Savannah, ga., 1975
Stegobium paniceum	Unknown *

Bostrichidae

Rhizopertha dominica (F.)	Manhattan, Ka.
Prostephanus truncatus (Horn)	Unknown *

Curculionidae

Sitophilus granarius (L.)	Unknown *
S. oryzae (L.)	Inknown *

B. Lepidoptera

Pyralidae

Plodia interpunctella (Hubner)	Manhattan, Ka., 1972

Gelechiidae

Sitotroga cerealella (Oliver)	Savannah, Ga., 1975

KRISTEN BERG

Stock Lists

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

Coleoptera

Anobiidae

Stegobiium paniceum (L.)

Anthribidae

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

Bostrichidae

Rhyzopertha dominica (F.)

Bruchidae

Acanthoscelides obtectus (Say)

Cleridae

Necrobia rufipes (Deg.)

Cucujidae

Ahasverus advena (Waltl)

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

Curculionidae

Sitophilus granarius (L.)
S. zeamais Motschulsky

Dermestidae

Anthrenus flavipes LeC. Weak culture
Anthrenus verbasci (Linnaeus)

Dermestes maculatus De Geer

Trogoderma variabile Ballion

Ostomidae

Gibbium psylloides (Czemp.)

Stock Lists

Silvanidae

Ahasverus advena (Waltl.)

Oryzaephilus surinamensis

Tenebrionidae

Alphitobius diaperinus (Panz.)

Gnathocerus maxillosus (F.)

Palorus ratzeburgi (Wissm.)

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

M. Nakashima

AUSTRALIA

Burnley, Victoria
Plant Research Institute
Department of Agriculture and Rural Affairs

COLEOPTERA

Tribolium castaneum

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

Tribolium confusum

Wild type strains
Malathion specific strain

Oryzaephilus surinamensis

Wild type strain
Malathion resistant strain
Fenitrothion 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
(No change--Ed).

Queensland Department of Primary Industries, Entomology Branch,
Indooroopilly, Queensland,
Australia

Coleoptera

	TYPE	ORIGIN
Carpophilus dimidiatus	Wild	Queensland
Dermestes maculatus	Wild	Queensland
Lasioderma serricorne	Wild	Queensland
Necrobia rufipes	Wild	Queensland
Oryzaephilus surinamensis		
VOS 48	insecticide susceptible	Victoria
QOS 42	fenitrothion resistant	Queensland
ZOS 73	fenitrothion resistant	Queensland

Stock Lists

	Type	Origin
Rhyzopertha dominica		
QRD 14	Insecticide susceptible	Queensland
QRD 2	multi-resistant	Queensland
QRD 63	multi-resistant	Queensland
Sitophilus oryzae		
LS 2	insecticide susceptible	Queensland
QSO 56	multi-resistant	Queensland
CSO 231	multi-resistant	W. Australia
Tribolium castaneum		
Wild type strains		
QTC 4	insecticide susceptible	Queensland
QTC 279	pyrethroid insecticide resistant	Queensland
QTC 285	multi-resistant, composite strain	Queensland
CTC 12	non-specific malathion resistant	Queensland
QTC 34	malathion soecific-resistant	Queensland
Mutant strains		
TC 65	pearl p	
TC 86	black b	
TC 179	antennapedia ap	
TC 113	sooty s	
TC 136	jet j	
TC 156	microphthalmic Mo	
TC 165	chestnut c	
LEPIDOPTERA		
Ephestia cautella	Wild	Queensland
Plodia interpunctella	Wild	New South Wales

Graham White, Senior Entomologist.

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 updated 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 RADIOENTOMOLOGY

No updated list has been received (Ed.).

CANADA

GUelph, Ontario.
University of Guelph
Dept. of Animal and Poultry Science

1. Wild type strains

   Tribolium castaneum — Purdue, 1960
   Base population for quantitative genetics

2. Mutant strains

   pygmy py — Purdue, 1960
   Base populations maintained with no artificial selection and minimum of inbreeding.

Zhang Lao

Winnipeg, Manitoba R3T 2M9
Research Station, CDA
195 Dafoe Rd.

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

Species	Origin
Cryptolestes ferrugineus	
C. turcicus	
Oryzaephilus mercator	
O. surinamensis	
Prostephanus truncatus	Mexico City, Mexico 1977
Rhyzopertha dominica	
Sitophilus granarius	
S. oryzae	
S. oryzae	Minnesota, USA 1982
Stegobium paniceum	
Tribolium audax	
T. castaneum	
T. confusum	

R.N. Sinha

CHINA

Beijing, People's Republic of China
Beijing Agricultural University
Department of Animal Science

1. Wild Type Strains

   Tribolium castaneum — Guelph, 1987
   Base populations for
   Quantitative genetics.

2. Mutant strains

   pygmy py
   Base populations maintained with no artificial selection and minimum of inbreeding.

Zhang Lao

Stock Lists

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

I. 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
5. Abbc	Synthetic, 1982
6. bbc	Synthetic, 1982

Mutant strains (originals)

7. antennapedia, (ap^N -VIII (1981)	Bogota, 1981
8. bifurcated antenna, ab-II (1979)	Bogota, 1979
9. black, b-III	Bogota, 1983
10. charcoal, chr-III	Bogota, 1981
11. chestnut eyes, oc- ?-	Bogota, 1984
12. disjuncted elytra, es- ?	Bogota. 1982
13. fused antennameres, af- ?	Bogota, 1980
14. glass legs, pv-?-	Bogota, 1980
15. ivory eyes, omf-I	Bogota, 1981
16. light eyes, op -?-	Bogota, 1985
17. miniature appendaged ma-I-	Bogota, 1981
18. narrow eye (oje) -?-	Bogota, 1980
19. red eyes or- ?-	Bogota, 1980
20. scars, ca -sc?-	Bogota, 1984
21. white eye, obl -IV-	Bogota, 1982

II. gnathocerus cornutus

1.Wild strain.	Apulo, (Cund.) Colombia

III. Oryzaephilus surinamensis

1. Wild strain	Chocolate from U.S.A.

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)

Alphitobius diaperinus
Anobius punctatus
Anthrenus museorum
A. vorax
Attagenus alfieri
A. piceus
Dermestes frischi
Hylotrupes bajulus
Lasioderma serricorne
Oryzaephilus mercator
O. surinamensis
Rhizopertha dominica
Sitophilus granarius
S. oryzae
Stegobium (Sitodrepa) paniceum
Tenebrio molitor
Tenebroides mauritanicus
Thylodrias contractus
Tribolium confusum
T. destructor
Trogoderma granarium

(Ed.).

FRANCE

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

A. Wild type strains

1. Sitophilus granarius L.

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

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

B. Selected lines of Sitophilus oryzae

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

Stock Lists

3. RR strain (fast development) 88,000+5000 ovarian symbiotes)

P. Nardon

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

Munich (cont'd)

Tenebrionidae

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

Lepidoptera

Phycitidae--Ephestia kuehniella (Zell.) " 1966

E. Naton.

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.
B-1. T. confusum, not inbred
B-2. T. confusum, inbred by 12 single-pair passages

II. C. T. castaneum, a highly inbred strain (C-1) from Prof. Bell, Purdue University, which showed more than 505 different anomalies during first generations in our laboratory.
C-1. T. castaneum, wild type strain.
C-2. T. castaneum, mixed mutations strain.

W. Briegleb

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.

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.

David Wool

Stock Lists

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
  - 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 " " " "

p1-13 " " " "
Plodia interpunctella (Hubner) Wild

Gelechiidae
Sitotroga cerealella (Olivier) Wild

O. Imura

Note: Dr. H. Nakakita"s list in TIB 24 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

Stock Lists

OKAYAMA
LABORATORY OF APPLIED ENTOMOLOGY
COLLEGE OF AGRICULTURE
OKAYAMA UNIVERSITY

1. Wild type strains

COLEOPTERA

1.	Alphitobius diaperinus	Miyazaki
2.	Callosobruchus chinensis	okayama
3.	Callosobruchus maculatus	
4.	Cryptolestes pusillus	Okayama
5.	Gnathocerus cornutus	Miyazaki
6.	Latheticus oryzae	Miyazaki
7.	Oryzaephilus surinamensis	Okayama
8.	Palorus ratzeburgii	Miyazaki
9.	Palorus subdepressus	Miyazaki
10.	Rhyzopertha dominica	Okayamai
11.	Sitophilus oryzae	Okayama
12.	Sitophilus zeamais	Okayama
13.	Tenebrio molitor	Okayama
14.	Tenebroides mauritanicus	Okayama
15.	Tribolium castaneum	Okayamai
16.	T. confusum	Okayamai
17.	T. freemani	Unknown

LEPIDOPTERA

1.	plodia interpunctella	Okayama

HYMENOPTERAN PARASITES

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

Toshiharu Yoshida

Stock Lists

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

POLAND

POLISH ACADEMY OF SCIENCES, INSTITUTE OF ECOLOGY
DZIEKANOW LESNY, 05-092 LOMIANKI, POLAND

1. Acanthoscelides obtectus - wild type from Poland
2. Tribolium castaneum cI --Genetic strain from Chicago
3. Tribolium castaneum cII --Genetic strain from Chicago
4. Tribolium confusum bIV --Genetic strain from Chicago

T. Prus

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. Andujar	Andujar, Spain	1975
6. Jerez	Jerez, Spain	1975
7. Osuna	Osuna, Spain	1975
8. Carpio	Carpio, Spain	1975

Stock Lists

9. Jafo Jafo, Israel 1975

B. Mutant type strains

10. Black Purdue Purdue, USA, 1964

C. Experimental lines

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

11. A high performance
12. B low performance
13. DTD high performance

Inbreeding lines

Originated from mating full sibs through 40 generations and relaxed

14. LC
15. C-5
16. 45
17. 68
18. 73
19. 97

D. mutants

20. antennapedia ap, VIII Purdue, 1964
21. antennapedia, black, ap b, VIII, III
22. antennapedia, black, pearl, ap,b,p, VIII,III,II
23. antennapedia, eye ap, eye VIII,?
24. antennapedia, black, eye, ap,b,eye VIII,III,?
25 black b III Sokoloff, 1977
26. chestnut, c VII Purdue, 1977
27. Diferencial, Df, IV Purdue, 1968
28. eye, ? Madrid, 1967
29. ivory i_e ? Purdue, 1968
30. jet Purdue, 1977
31. light ocular diaphragm, ruby lod, rb III, ? Purdue, 1968
32. melanotic stink glands-like ? Madrid, 1968
33. maroon, m, V Sokoloff, 1977
34. microcephalic, mc, V Purdue, 1968
35. Microphthalmic Mo, VI Sokoloff, 1968
36. pearl p II Sokoloff, 1968
37. prothoraxless, ptl IX Sokoloff, 1977
38. pygmy, paddle py, pd I,I Purdue, 1964
39 red r I Purdue, 1979
40. rose rs I Purdue, 1968
41. sooty, s IV Sokoloff, 1977
42. sooty, fused antennal segments s, fas2 IV, Purdue 1968

43. squint sq VIII Purdue, 1964
44. white w^w ? Purdue, 1964
45. wine r I Purdue, 1968

Tribolium confusum

A. Wild type strains

46. Boreal La Coronada, Spain

B. Mutants

47. ebony, pearl, creased abdominal sternites, e,p,cas II Purdue, 1968

F. Tagarro

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.).

Stock Lists

Anthribidae				
Araecerus fasciculatus (Deg.)	Coffee bean weevil (Cacao weevil)		25	25
Bostrichidae				
Prostephanus truncatus (Horn)	Larger grain borer		25	25
Rhyzopertha dominica (F.)	Lesser grain borer		1	30
Bruchidae				
Acanthoscelides obtectus (Say)	Dried bean beetle (American seed beetle)	W.Africa	27	30
Acanthoscelides obtectus (Say)	" " "	Portugal	27	30
Acanthoscelides obtectus (Say)	" " "	N.Germany	27	25
Callosobruchus analis (F.)	Chinese beetle		29	25
Callosobruchus chinensis (L.)	Cowpea weevil		30	25
Callosobruchus maculatus (F.)	Southern cowpea weevil	Sierra Leone	29	30
Callosobruchus maculatus (F.)		Burma	29	30
Callosobruchus phaseoli (Gyll.)		Malaya	26	25
Callosobruchus rhodesianus (Pic)		Swaziland	26	25
Caryedon serratus (Oliv.)	Groundnut seed beetle (Groundnut bruchid) (Groundnut borer)		19	30
Zabrotes subfasciatus (Boh.)	Mexican bean beetle		15	25
Cerylonidae				
Murmidius ovalis (Beck)		Ceylon	76	25
Cleridae				
Necrobia rufipes (Deg.)	Copra beetle (Red-legged ham beetle)		24	30
Necrobia ruficollis (F.)		Bangladesh	24	30
Cucujidae				
Cryptolestes capensis (Walt1)			6	25
Cryptolestes ferrugineus (Steph.)	Rust red grain beetle		6	25/30
Cryptolestes pusilloides (Steel & Howe)		(Canada)	6	20
Cryptolestes pusillus (Schön.)	Flat grain beetle		6	25
Cryptolestes turcicus (Grouv.)			8	20
Cryptolestes ugandae Steel & Howe		(East Africa)	6	20
Curculionidae				
Sitophilus granarius (L.)	Grain weevil	(Russia)	1	25
Sitophilus oryzae (L.)	Rice weevil	Britain	1	25
Sitophilus zeamais Motsch.	Maize weevil		1	25
Dermestidae				
Anthrenocerus australis (Hope)	Australian carpet beetle	(Britain)	22	25/20
Anthrenus flavipes LeC.	Furniture carpet beetle		22	30
Anthrenus olgae Kalik		Poland	22	20
Anthrenus sarnicus Mroczkowski			21	20
Anthrenus verbasci (L.)	Varied carpet beetle	Britain	21	20
Attagenus brunneus Faldermann		(Spain)	21	30
Attagenus nr. *fasciatus* (Thunberg)		Botswana	12	25
Attagenus unicolor (Brahm) (=*megatoma* (F.))	Black carpet beetle		22	30
Attagenus pellio (L.)	Fur beetle	Britain	21	20
Attagenus rufiventris Pic		Botswana	11	25
Attagenus smirnovi Zhantiev		Kenya	11	20

Stock Lists

Dermestes ater Deg.	Black larder beetle	Britain	25b	25
Dermestes frischii Kug.	Hide beetle	(Nigeria)	25b	25
Dermestes haemorrhoidalis Küster		Britain	25b	25
Dermestes lardarius L.	Bacon beetle	Britain	25a	25
Dermestes maculatus Deg.	Leather beetle		25b	25
Dermestes peruvianus Castelnau		Britain	25a	25
Trogoderma angustum (Solier)		(Germany)	2	25
Trogoderma anthrenoides (Sharp)		U.S.A.	2	25/30
Trogoderma glabrum (Herbst)		U.S.A.	2	25
Trogoderma granarium Everts	Khapra beetle	(Britain)	2	30
Trogoderma grassmanii Beal		U.S.A.	11	25
Trogoderma inclusum LeC.	Larger cabinet beetle		6	25
Trogoderma irroratum Reitt.		Egypt	2	30
Trogoderma ornatum (Say)		U.S.A.	11	25
Trogoderma simplex Jayne		U.S.A.	2	25
Trogoderma sternale plagifer Casey		New Mexico	20	25
Trogoderma variable Ballion		U.S.A.	2	30
Languriidae				
Pharaxonotha kirschi (Reitt)	Mexican grain beetle	Portugal	11a	20
Mycetophagidae				
Typhaea stercorea (L.)	Hairy fungus beetle	Nigeria	5b	25
Nitidulidae				
Carpophilus dimidiatus (F.)	Corn-sap beetle	(Amer.)	17	25
Carpophilus hemipterus (L.)	Dried fruit beetle		16	25
Trogositidae				
Lophocateres pusillus (Klug)	Siamese grain beetle		6	30
Tenebroides mauritanicus (L.)	The Cadelle	Pakistan	9	30
Tenebroides mauritanicus (L.)	"	Britain	9	30
Ptinidae				
Gibbium psylloides (Czenp)	Hump beetle	Britain	11a	20
Mezium affine Boield.		Britain	11a	20
Mezium americanum (Lap.)	American spider beetle		11a	20
Niptus hololeucus (Fald.)	Golden spider beetle	Britain	11a	20
Pseudeurostus hilleri (Reitt.)		Britain	11a	20
Ptinus clavipes Pans.	Brown spider beetle	Britain	11a	20
Ptinus exulans Er.		Britain	11a	20
Ptinus pusillus Sturm			11a	20
Ptinus sexpunctatus Pans.			11a	20
Ptinus tectus Boield.	Australian spider beetle		20a	25
Stethomezium squamosum Hint.	African spider beetle	Britain	11a	20
Tipnus unicolor (P. & M.)		Kenya	11a	20
Trigonogenius globulus Sol.	Globular spider beetle	Ireland	11a	20
Trigonogenius particularis Pic		Kenya	13a	20
Silvanidae				
Ahasverus advena (Waltl)	Foreign grain beetle	(W.Africa)	8	25
Cathartus quadricollis (Guer.)	Square necked grain beetle	W. Africa	8	25
Oryzaephilus mercator (Fauv.)	Merchant grain beetle		8	25
Oryzaephilus surinamensis (L.)	Saw-toothed grain beetle		8	25

Stock Lists

ORDER	COMMON NAME	COUNTRY OF ORIGIN	CULTURE MEDIUM	REARING TEMPERATURE °C
COLEOPTERA contd.				
Tenebrionidae				
Alphitobius diaperinus (Panz.)	Lesser mealworm		11	25
Alphitobius laevigatus (F.)	Black fungus beetle		5	25
Alphitophagus bifasciatus (Say)	Two banded fungus beetle	Britain	2b	25
Gnatocerus cornutus (F.)	Broad horned flour beetle		11	25
Gnatocerus maxillosus (F.)	Slender horned flour beetle		5	25
Latheticus oryzae Waterh.	Long headed flour beetle		5	30
*Palembus dermestoides (Fairm.)		Malaya	12	25
Palembus ocularis Casey		Jamaica	14	25
Coelopalorus foveicollis (Blair)		Trinidad	13	25
Palorus laesicollis (Fairm.)		Kenya	13	25
Palorus ratzeburgii (Wissm.)	Small eyed flour beetle		5	25
Palorus subdepressus (Woll.)	Depressed flour beetle	Turkey	5b	25
Sitophagus hololeptoides (Cast.)		Trinidad	12	25
Tenebrio molitor L.	Yellow mealworm		8a	25
Tenebrio obscurus F.	Dark mealworm		8a	25
Tribolium anaphe Hint.		Nigeria	11	25
Tribolium audax Halstead	American black flour beetle	Canada	11	25
Tribolium brevicornis LeC.		USA	26	25
Tribolium castaneum (Herbst)	Rust red flour beetle	Britain	26	25
Tribolium confusum J.du V.	Confused flour beetle		26	25
Tribolium destructor Uytt.	Dark flour beetle	(Holland)	11	25
Tribolium madens (Charp.)	Black flour beetle	(Yugoslavia)	11	25
LEPIDOPTERA				
Pyralidae - Phycitinae				
Ephestia (Cadra) cautella (Walk.)	Tropical warehouse moth (Almond moth, dried currant moth)	(S. Africa)	6a	25
Ephestia (Cadra) cautella (Walk.)	" " " "	Cyprus	15	25
Ephestia (Ephestia) elutella (Hübn.)	Warehouse moth (Tobacco moth, Cacao moth)	Britain	6a	25
Ephestia (Cadra) figulilella Gregs.	Raisin moth	Cyprus	6a	25
Ephestia (Anagasta) kuehniella Zell.	Mediterranean flour moth (Mill moth)	Britain	6a	25
Plodia interpunctella (Hübn.)	Indian meal moth	Britain	6a	25
Pyralidae - Galleriinae				
Achroia grisella (F.)	Lesser wax moth		10	25
Corcyra cephalonica (Stainton)	Rice moth	(Burma)	6a	25
Galleria mellonella (L.)	Honeycomb moth		10	25
Galleria mellonella (L.)	" "	U.S.A.	4	25
Gelechiidae				
Sitotroga cerealella (Oliv.)	Angoumois grain moth		1	25
Tineidae				
Tinea columbariella Wocke			22	2[illegible]
Tineola bisselliella (Humm.)	Common clothes moth		22	20
Tinea flavescentella Haw.		(Scotland)	22	20
Tinea metonella Pierce & Metcalfe		(East Africa)	22	20

*(= Martianus dermestoides Fairm.)

Stock Lists

MUTANT STOCKS

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

Silvanidae (mutants)

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

Tenebrionidae (mutants)

Tribolium castaneum

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

Tribolium confusum

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

Also available occasionally:-

Amphibolus venator Klug

Chaetospila elegans (Westw.)

Dinarmus basilis Rondani (= laticeps (Ashmead))

Thylodrias contractus Mots.

Some strains which are periodically renewed from the field

Species and date of last addition:-

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

CULTURE MEDIA

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

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

(Ed.)

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

TROPICAL DEVELOPMENT AND RESEARCH INSTITUTE (TDRI)

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

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

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

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

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

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

Stock Lists

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)

PEST BIOLOGY and INSPECTION SECTION

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

Anobiidae
1. Lasioderma serricorne--unknown

Bostrichidae
1. Dinoderus distinctus--Tanzania
2. Dinoderus minutus--Indonesia
3. Dinoderus porcellus--Togo
4. Prostephanus truncatus -- Mexico, Tanzania, Togo
5. Rhyzopertha dominica--ex MAFF Lab., Slough; Mali

Bruchidae
1. Acanthoscelides obtectus --Colombia; Swaziland; Turkey
2. Callosobruchus analis -- MAFF Lab., Slough;
3. Callosobruchus chinensis -- Nepal; Kenya, Indonesia
4. Callosobruchus maculatus -- Yemen A.R.; Nigeria; Brazil; Uganda
5. Callosobruchus rhodesianus--Zimbabwe
5. Caryedon serratus -- Unknown; India
6. Zabrotes subfasciatus -- Uganda; Colombia

Cucujidae
1. Cryptolestes ferrugineus--Unknown

Curculionidae
1. Sitophilus oryzae --
   normal strain--Indonesia
   Pulse feeding strains--Burma; Peru; Trinidad
2. S. zeamais -- Tanzania; Indonesia; Mexico; ex MAFF Lab., Slough

Dermestidae
1. Trogoderma granarium--unknown

Histeridae
1. Teretriosoma nigrescens--Mexico

Lophocateridae
1. Lophocateres pusillus--Philippines

Tenebrionidae
1. Gnathocerus maxillosus--Tanzania
2. Latheticus oryzae--unknown
3. Palembus ocularis--Jamaica?
4. Tribolium castaneum--Tanzania; unknown

B. Lepidoptera

Galleriinae: Corcyra cephalonica -- Malawi
Phycitinae: Ephestia cautella -- Brazil
Plodia interpunctella--unknown
Gelechiidae: Sitotroga cerealella--Sudan

CHEMICAL CONTROL SECTION

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

Wild type strains

Coleoptera

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

Bruchidae
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.
S. oryzae--strains tested for phosphine resistance (Bhutan; Brazil (4 strains); Nepal; Pakistan; Tunisia).
s. zeamais--strains tested for phosphine resistance (Burma; Ghana; Thailand; Zimbabwe

Stock Lists

Dermestidae

Dermestes ater--ex MAFF Lab., Slough
Dermestes frischii--ex MAFF Lab., Slough
Dermestes maculatus--Malawi
Dermestes carnivorus--Indonesia

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
T. castaneum-- strains tested for phosphine resistance (Bhutan; Brazil (2 strains); Burma; Ethiopia; Indonesia; (7 strains); Liberia; Mali; Nepal; Pakistan (7 strains); Sri Lanka; Zimbabwe).

Dr. Chris P. Haines

Brownlee, Aaron and Alexander Sokoloff
Biology Department
California State University
San Bernardino, California 92407

THE LINKAGE RELATIONSHIP AND RELATIVE POSITION OF DIMINISHED EYE IN *Tribolium confusum* DUVAL

Recently, five mutant markers (pearl (*p*), black (*b*), thumbed (*thu*), ebony (*e*) and disjoined (*dj*) were used to determine the linkage relationship of diminished eye (*de*) in *T. confusum*. Diminished eye was discovered in 1972 and reported by Blackman in TIB #22 (p. 80, 1982). The *de* mutant resembles the Bar eye (*Be*) mutant in *T. castaneum* (Herbst), in that the facet area of the eye is smooth and slit-like. The *de* trait also appears as a normal eye reduced in size. A description of *p, b, thu, e, dj* and *Be* can be found in Sokoloff, 1977.

Dimished eye is linked with pearl on chromosome #2. Diminished eye and pearl are approximately 31.23 ± 1.5 units apart in heterozygous ♂♂ and 38.48 ± 3.3 units) apart in heterozygous ♀♀. Testcross results can be seen in Table 1. The calculated Chi Square values are X_L = 127.26 for the heterozygous ♂ and X_L = 11.77 for the heterozygous ♀.

Three point crosses involving *de* are being carried out and will be reported at a later date.

REFERENCES

1. Blackman, D. G. 1982. Section on New Mutants. Tribolium Information Bulletin 22:80.

2. Sokoloff, A. 1977. The Genetics of *Tribolium* and Related Species. Advances in Genetics, Academic Press, New York.

TABLE 1.

Backcross progeny from *T. confusum* (A) *de* +/+ *p* ♀ × *de p*/*de p* ♂ and (B) the reciprocal cross from 15 successful matings (numbers in parenthesis are decimal fractions of the total).

Phenotype	Cross A	Cross B
+ +	26 (.264)	158 (.175)
+ *p*	155 (.470)	388 (.430)
de +	49 (.148)	233 (.258)
de p	39 (.118)	124 (.137)
Total	330	903

Biomass Selection at Different Stages of Tribolium castaneum Life.

M.C. Fuentes and M.P. Tagarro
Departamento de Genetica. INIA. Madrid.

For the question of biomass selection, a character associated to a series of fitness characters, such as fecundity, fertility, precocity, etc, several studies have been undertaken focused on comparing different selection methods wich maximized the response to selection. Thus FAIRFULL et. al.(1977) compares quadratic indices, linear indices, direct biomass selection, offspring number selection and body weight selection meassured at pupal stage. DOOLITLE et. al. (1972) studies the matter with mice; offspring number, new-born weight,etc, comparing also different selection methods.

The purpose of the present investigation is to see in which moment of the life of an organism a greater response is obtained when selecting for biomass; whether it's at an early, medium or advanced stage. Therefore two experiments were carried out. In the first one Tribolium Castaneum at larva state, line (L) , was selected for biomass; seeing the obtained results another experiment was programed for wich 3 lines were made. For line (SL) biomass was selected at a larva stage after applying an stabilizing selection regarding body weight, taking 50-60% of the population around the average; line (P) was selected for biomass at pupal stage and line (A) selected for biomass at adult stage.

The reason of creating line (SL) is because of the relative small response to selection obtained in line (L) wich seemed to be produced by selecting indistinctly very heavy larvas from small offspring number families and lighter larvas from greater offspring number families and therefore body size could drive the total biomass to oscilations if both extremes were mated; that's why we tried to remove extremes weights in order to get a greater answer.

Experiment (1) was carried out with line "consejo" wich has been "in parmixia" for 25 years in our laboratory and experiment (2) with "Jerez" line wich has been "in parmixia" for 5 years in our lab too.

In both experiments 24 hrs. offspring was collected, biomass weight of larvas was measured 15 days after coupling, lines (L) and (SL); at pupal stage we measured biomass weight 21 days after coupling, line (P) and at adult stage we did it 32 days after. In all of lines, the offspring number was controlled too.

Population size was of 132 couples for experiment (1) and of 100 for experiment (2). Selection Pressure was 25%. Enviroment conditions were: 33 ± 0.5°C and 70 ± 2% Hr. For both experiments 7 generations for selection and two identical repetitions time-spaced were done.

Figure (1) gives you obtained responses for wich generations averages of each line have been shown, average is been calculated for both repetitions too.

In main terms we can say that "jerez" population has more weight than "consejo" one and the line wich seems to have greater response is line (P). To study the average response per generation regression line for responses wihtin generations was calculated, the values obtained are shown in Table 1

TABLE 1: Intercept and regresion coeficients with its standard deviation and the weight gained with regards to initial weight percentage.

POPULATION	INTERCEPT	REGRESSION C.	ST.DEVIATION	% GAIN/GENERATION
Consejo(L)	33.03	0.98 †	0.51	3%
Jerez (SL)	29.18	0.33	0.55	1%
Jerez (P)	29.14	2.18 **	0.57	7%
Jerez (A)	23.24	1.21 *	0.44	5%

† Significant at 10% level
* Significant at 5% "
** Significant at 1% "

The results show that the line wich proportionally gains more weight due to selection is line (P). On the other hand line (SL) selected to increase larva weight after carrying out an stabilizing selection for body weight has shown a much worse response than line (L) for wich selection was not carried out.

In Table 2 we show heritabilities obtained by regression to the parents mean and carried out heritabilities, taken as regression the response in the accumulated differential of selection.

Table 2: Heritability estimates obtained by offspring/parents regression and the realized one.

POPULATION	h^2 REGRESSION	h^2 REALIZED
Consejo (L)	0.22 ± 0.09	0.10 ± 0.05 †
Jerez (SL)	0.18 ± 0.08	0.05 ± 0.08
Jerez (P)	0.29 ± 0.08 *	0.18 ± 0.05 *
Jerez (A)	0.13 ± 0.09	0.11 ± 0.04 *

† Significant at 10% level
* Significant at 5% "

At the same time correlated response for the character offspring number was studied, results are shown on Figure 2

Average increaase for offspring/family character was calculated by generations means regression, wich are shown on Table 3.

Table 3: Intercepts, regrssion coefficients and standard errors for offspring number per family character.
Correlated Response

POPULATION	INTERCEPT	REGR. COEFFICIENT	STAND. ERROR	GAIN %
Consejo (L)	13.48	0.42	0.23	3%
Jerez (SL)	14.09	0.20	0.19	1%
Jerez (P)	13.95	0.65 *	0.25	5%
Jerz (A)	12.63	0.38	0.22	3%

* Significant at 5% level

These values indicate that there has been some response correlated to offspring number and the line with the greater response is pupal biomass selected line.

These results demonstrate that a better response to selection is obtained when it is applied at pupal stage, followed by selection applied at adult stage and the least response comes from selection applied at larva stage. If we think about the bigger influence of enviroment and maternal factors, wich decrease heritability, we come to the conclusion that our results are reasonable. On the other hand the previous stabilizing selection didn't help to improve response to selection at larva stage, probably due to the decrease in genetic and phenotypic variance that the stabilizing selection produces as Robertson (1956), Tantawy and Tayel (1970), Bulmer (1976), Soliman (1982), etc. have reported.

Correlated response to offspring number is also bigger when biomass is selected at pupal stage than at the rest of stages. In this case is also self-defeating the stabilizing selection.

All of these leads us to believe that in spite of the difficulty that selection for such a complex trait as biomass raise, a 7% gain per generation over initial weight can be obtained making the selection at pupal stage, wich is a very acceptable response and wich supports Fairfull et al.(1977) results who found that direct selection of pupal biomass had as good an answer as that of a quadratic index that included offspring number and pupal body weight, therefore we deduce that for the calculus complexity it takes is not worth it to apply an index for such selection.

Figure 1: Biomass means in each generation for lines L, SL, P and A. Also both replications mean.

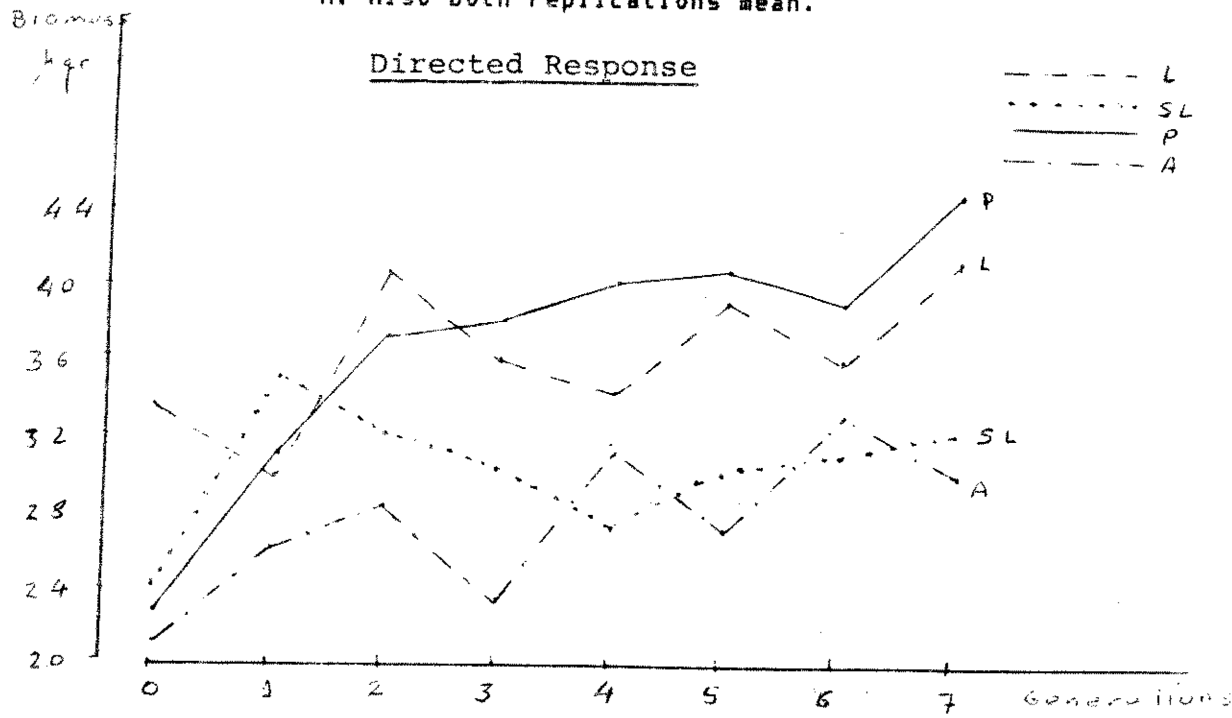
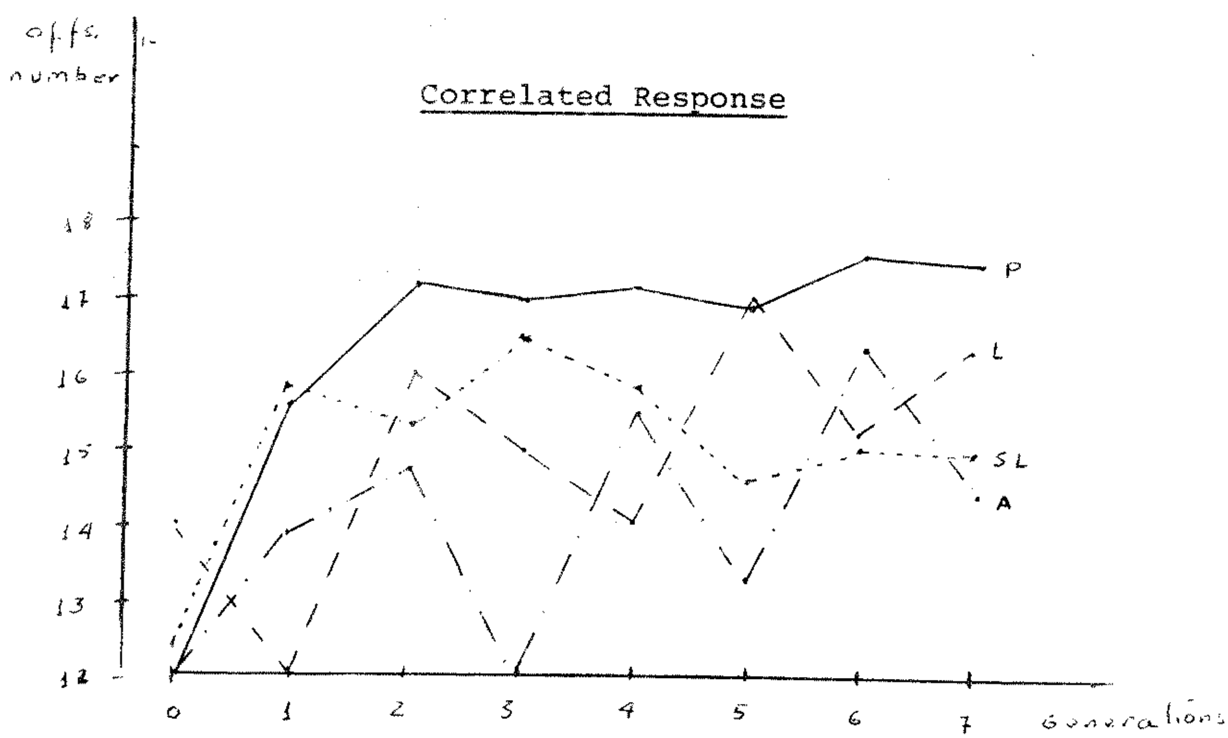


Figure 2: Offspring number means in each generation for lines L, SL, P and A. Also both replications mean.



BIBLIOGRAPHY

BULMER,M.G.,1976.- The effect of selection on genetic variability: a simulation study. Genetic. Res. Camb:101-117.

DOOLITLE,D.P.,WILSON,S.P. and L.L.HUBERT, 1972.- A comparison of multiple trait selection, methods in the mouse. Jour. Hered. 63: 366-372.

FAIRFULL, R.W., FRIARS,G.W. and J.W. WILTON, 1977.- An empirical comparison of selection methods for the improvement of biomass. Theor. Appl. Genet. 50: 193-198.

ROBERTSON,A., 1956.- The effect of selection against extreme deviants based on deviation or on homozygosis. J.Genet. 54: 236-248.

SOLIMAN, M.H., 1982.- Directional and stabilizing selection for developmental time and correlated response in reproductive fitness in *Tribolium castaneum*. Theor.Appl. Genet. 63: 111-116.

TANTAWY,A.O. and A.A. TAYEL,1970.- Studies on natural populations of *Drosophila*.X. Effects of disruptive and stabilizing selection on wing length and the correlated response in *D. melanogaster*. Genetics 65: 121-132

Mahbub Hasan and M. Khalequzzaman[1]
Department of Zoology
Rajshahi University
Rajshahi, Bangladesh.

*Effect of Maize flour on the sex-ratio, formation and duration of various stages of the red flour beetle, Tribolium castaneum (Herbst) (Coleoptera:Tenebrionidae).

The red flour beetle, Tribolium castaneum is widely distributed all over the globe and is found on almost every kind of stored products, especially cereals and their products. Maize has good status among the cereal crops. It ranks after wheat and rice as the third most important food in the world. It is used directly as food for human consumption and as a feed grain for animals. Maize contains 77% starch; 2% sugar; 9% protein; 5% fat; 5% pentosan and 2% ash (Purseglove, 1972).

In nature most animals give birth to equal numbers of males and females following the typical Mendelian sex-ratio of 1:1. Sex-ratios influence the number of offspring of animals and play an important role in the maintenance of species. However, some organisms show considerable distortion of the typical sex-ratio. The environment has been found to control sex-ratios in a number of invertebrates (Banta & Brown, 1929 a,b; Chistie, 1929; Clausen, 1939; Flanders, 1939; Ellenby, 1954; Mackauer, 1976 and Khan & Bhuiyan, 1983). It is well known that survival rates and developmental periods affect the intrinsic rate of increase of pests. The rate of infestation due to a pest is directly linked with its sex-ratio and offspring production. As a stored product maize flour is attacked with a number of insect pests. The present work aims at finding out the effect of maize flour on the production of sex as well as its bearing on the formation and durations of various stages of T. castaneum.

The insects were originally received from the Pest Infestation Control Laboratory, Slough, England. The beetles have been cultured for about one year in the Dept. of Zoology, Rajshahi University. About 800 beetles were collected from the culture and placed on a thin layer of wholemeal flour previously passed through a 60-mesh sieve in a deep Petri dish (9.5 cm diameter). On the next day the contents were passed through a 18-mesh sieve to separate the adults and then through a 60-mesh sieve to collect the eggs. The eggs were placed in a Petri dish (9 cm diameter) and incubated at 30°C. Neonate larvae, 200 for each food, were transferred to glass jars (25.40 X 11.43 cms) containing 200 g of wholemeal flour (control); maize flour and a mixture of both in equal proportions with the aid of a sable hair brush. The jars were secured with fine cloth. Larvae were checked at intervals for pupation. Pupae were sexed by microscopic examination for the exogenital processess of the female pupae (Halstead, 1963). The larval period was recorded, sexed pupae were put on separate Petri dishes for adult emergence. The pupal period was then recorded. All the experiments were conducted at 30°C.

1 Address for correspondence

Maize flour produced no significant effect on the sex-ratios of T.castaneum. This flour significantly reduced the production of adults ($P<0.001$) (Table-1). The same results were obtained by Khan & Bhuiyan (1983) working on the effect of gram, pea and red lentil flours on T.confusum. Moreover, maize flour lengthened both larval and pupal periods of the beetle significantly ($P<0.001$)(Table-2). A lengthened larval period was also noted by Khan & Bhuiyan (1983). Sokoloff et al. (1966) tested flours of maize (C), rice (R), soybean(S), whole wheat (W), a mixture of maize, rice soy bean and whole wheat (M), white wheat (WW) and brown rice (BR) with and without a supplement of brewer's yeast and observed that with T. castaneum and T. confusum, the ranking of productivity in decreasing order was M, W, C, BR, R, WW and S. But the performance on all media was somewhat increased by the addition of yeast.

Geier (1966) states that one way to control insect pests is to modify intrinsically favourable habitats in such a way that they no longer provide adequate environments for the population of the pest involved, e.g. by providing unsuitable sources of food. The significantly lowered production of T. castaneum adults on the maize flour will eventually reduce the rate of infestation due to curtailed feeding and reproduction. In addition, higher larval and pupal periods of the insect on maize flour will evidently lower the number of generations per year and this will consequently reduce the rate of infestation. These results seem very much promising in days when there is a growing concern over the control of insects nutritionally.

The authors express sincere thanks to the Chairman, Department of Zoology, Rajshahi University, for providing necessary laboratory facilities.

: Literature Cited :

Banta, A.M. and Brown, L.A. 1929a. Control of sex in Cladocera. I. Crowding the mothers as a means of controlling male production. Physicl. Zool. 2 : 80-92

Banta, A.M and Brown, L.A. 1929b. Control of sex in Cladocera. III. Localization of the critical period for control of sex. Proc.natn. Acad.Sci. U.S.A. 15 : 71-81

Chistie, J.R. 1929. Some observations on sex in the Mermithidae, J.exp. Zool. 53 : 59-76.

Clausen, C.P. 1939. The effect of host size upon the sex-ratio of hymenopterous parasites and its relation to methods of rearing and colonization. J.N.Y.Ent. Soc. 47 : 1 - 9.

Ellenby, C. 1954. Environmental determination of sex-ratio of plant parasite nematode, Nature. London. 174: 1016-1017

Flanders, S.E. 1939. Environmental control of sex in hymenopterous insects Ann. ent.Soc.AM. 32 : 11-26

Geier,P.W. 1966. Management of insect pests. Ann.Rev.Ent. 11 : 471-490.

Halstead,D.G.H. 1963. External sex differences in stored-products Coleoptera. Bull. Ent. Res. 54 : 119-134.

Khan,A.R. and Bhuiyan,A.R. 1983. Effect of foods on sex-ratios of the flour beetle, Tribolium confusum. Entomologia exp. appl. 34(1) : 126.

Mackauer,M. 1976. An upper boundry for the sex-ratio in a haplodiploid insect. Can.Ent. 1399-1402.

Purseglove,J.W. 1972. Tropical Crops Monocotyledons. Longman Gr. Ltd. London. pp. 316.

Sokoloff,A.; Franklin,I.R.; Overton,L.F. and HO,F.K. 1966. Comparative studies with Tribolium (Coleoptera : Tenebrionidae)- I : Productivity of T.castanium (Herbst) and T.confusum Duv. on several commercially- available diets. J. Stored Prod. Res. 1 : 295-311.

Table - 1

Effect of maize flour on the sex-ratio and formation of various stages of *T. castaneum*.

Foods	No.of larvae	No.of male pupae obtd. (percentage)	No.of female pupae obtd. (percentage)	Total pupae obtd. (percentage)	t-val.	Total adults obtd. (percentage)	d-val.
a. Wholemeal flour(control)	200	103 (57.22)	77 (42.78)	180 (90.00)	1.96	175 (87.50)	-
b. Maize flour	200	76 (51.01)	73 (48.99)	149 (74.50)	0.25	143 (71.50)	4.00
c. Mixture of wholemeal maize flours	200	85 (53.46)	74 (46.54)	159 (79.50)	0.87	155 (77.50)	2.50

Table - 2

Effect of maize flour on the larval and pupal periods of *T. castaneum*.

Foods	Larval period (day)					Pupal period (day)				
	No. of obs.	Mean ± SD	95% conf. limits Lower	Upper	CV%*	No. of obs.	Mean ± SD	95% conf. limits Lower	Upper	CV%*
Wholemeal flour (control)	180	17.69±1.42	17.48	17.90	8.03	175	5.19±0.37	5.13	5.25	7.13
Maize flour	149	19.82±1.90	19.51	20.13	9.59	143	6.28±0.61	6.18	6.38	9.71
Mixture of wholemeal+ maize flour	159	18.00±2.07	17.69	18.31	11.50	155	5.45±0.49	5.37	5.53	8.99

*CV - Coefficient of variance.

Mahbub Hasan* and Ataur Rahman Khan
Department of Zoology
Rajshahi University
Rajshahi, Bangladesh

**Growth of *Tribolium anaphe* (Coleoptera : Tenebrionidae) on *Lathyrus sativus* flour.

Tribolium anaphe is an Ethiopean beetle originally found in Africa infesting groundnuts and Hinton (1948) considered it to be a potential pest of stored commodities in the tropics.

In many parts of the world the flour of the pulse ; *Lathyrus sativus* is taken as an important ingredient of diet and is liable to the attack of insects. This pulse contains a neuro-toxin, β - N - oxalyl - amino - l - alanine, which is responsible for a serious disease of the spinal cord called lathyrism in man and livestock when more than 50% the diet contains this pulse. One way to control insect pests is to modify intrinsically favourable habitats in such a way that they no longer provide adequate environments for the pest population involved, e.g. by providing unsuitable sources of food (Geier,1966). The present investigation is am attempt to determine the effect of *L. sativus* flour on *T. anaphe*.

A large number of beetles (*T. anaphe*) were collected from a culture maintained at the Department of Zoology, Rajshahi University, Bangladesh and were put on a thin layer of wholemeal flour previously passed through a fine sieve. Eggs,collected on the following day, were incubated 30°C for hatching. Neonate larvae (150 for each food medium) were transferred to jars (25.4 X 11.4 cms) containing 100 g of wholemeal (control) and *L. sativus* flours each with the aid of a sable hair brush. The mouths of the jars were secured with a fine, netted cloth tied with a rubber band. The growth of *T. anaphe* larvae was determined at two stages : after 10-day and after attaining maturity. The weight of various stages was taken on an electric balance, the length with the aid of a scale and the headcapsule width using a micrometer (40X). Insects were carefully checked for pupation. Freshly formed pupae were cleaned and were sexed (Halstead,1963). The larval period was noted and the percentage of pupation recorded. They were now transferred to separate Petri dishes for adult emergence. The percentage of adult recovery was noted and the pupal period determined. All the experiments were conducted at 30°C.

L. sativus significantly reduced mature larval, pupal and adult weight, headcapsule width and body length ($P < 0.05$) (Table-1). This pulse flour significantly increased the larval and pupal

* address for correspondence

periods of the beetle ($P < 0.001$) (Table-2). L. sativus flour produced no significant distortion of the typical Mendelian sex-ratio of 1 : 1 in T. anaphe. However, this flour significantly reduced adult recovery ($d=4.13$, $P < 0.001$) (Table-3).

Recently there is a growing concern over pest control through nutritional regulations. Pratt et.al. (1972) gave a comprehensive review and a prospectus of pest control programmes based on nutritional principles. The significantly reduced recovery of T. anaphe adults on L. sativus flour will eventually reduce the rate of infestation due to curtailed feeding and reproduction. Besides increased larval and pupal periods of this beetle will lower the number of generations per year which will consequently reduce the rate of infestation. All these seem very much promising from the point of nutritional regulation of the pest.

Thanks are due to the Pest Infestation Control Laboratory, Slough, England, for supplying the beetle used in this investigation. The authors remain grateful to Dr. M. Sayedur Rahman, Chairman, Department of Zoology, Rajshahi University, Bangladesh, for providing necessary laboratory facilities.

Literature Cited

Geier, P.W. 1966. Management of insect pests. Ann. Rev. Ent. 11 : 471-490.

Halstead, D.G.H. 1963. External sex differences in stored-products Coleoptera. Bull. ent. Res. 54 : 119-134.

Hinton, H.E. 1948. Bull. ent. Res. 39 : 13-55.

Pratt, J.J. Jr.; House, H.L. and Mansingh, A. 1972. Insect control strategies based on nutritional principles : a prospectus. In : "Insect and mite nutrition", pp. 651-668. North - Holland, Amsterdam.

Table-1

Effect of *L.sativus* flour on the growth of *T. anaphe*.

	Foods	No. of obs.	Mean weight ± SD(mg)	Mean headcapsule width ± SD(mm)	Mean length ± SD(mm)
A.	Wholemeal flour	30	0.39 ± 0.09	0.27 ± 0.04	2.68 ± 0.46
	L. sativus flour	30	0.23 ± 0.05	0.19 ± 0.09	2.09 ± 0.32
B.	Wholemeal flour	30	5.16 ± 0.47	0.77 ± 0.05	6.50 ± 0.22
	L.sativus flour	30	2.93 ± 0.34	0.63 ± 0.06	5.47 ± 0.26
C.	Wholemeal flour ♂	30	4.76 ± 0.51	0.83 ± 0.07	5.35 ± 0.25
	♀		5.04 ± 0.47	0.86 ± 0.04	5.61 ± 0.32
	L.sativus flour ♂	30	1.98 ± 0.26	0.71 ± 0.05	4.85 ± 0.34
	♀		2.16 ± 0.29	0.72 ± 0.04	4.92 ± 0.22
D.	Wholemeal flour ♂	30	3.39 ± 0.38	0.86 ± 0.07	5.17 ± 0.26
	♀		3.64 ± 0.31	0.89 ± 0.06	5.47 ± 0.89
	L.sativus flour ♂	30	1.76 ± 0.42	0.75 ± 0.05	4.32 ± 0.38
	♀		1.99 ± 0.39	0.79 ± 0.04	4.61 ± 0.39

A - 10 day larvae ; B - Mature larvae ; C - Pupae and D- Adult.

Table-2

Effect of L. *sativus* flour on the larval and pupal periods (days) of *Tribolium anaphe*.

Foods	Larval period					Pupal period				
	No. of obs.	Mean ± SD	95% Conf.limits lower	upper	C.V*%	No. of obs.	Mean ± SD	95% conf.limits lower	upper	C.V.%
Wholemeal flour	131	20.17 ±1.20	19.97	20.37	5.95	120	6.07 ±0.57	5.97	6.17	9.39
L. sativus flour	99	38.15 ±3.69	37.42	38.88	9.67	86	7.21 ±0.69	7.07	7.35	9.57

C.V*. - Coefficient of variance

Table-3

Effect of *L. sativus* flour on the sex ratio and formation of various stages of *T. anaphe*.

Foods	No. of larvae	% male	% female	X^2-values	%pupae	% adults	d-value
Wholemeal flour	150	45.80	54.20	0.70	87.33	80.00	4.13
L. sativus flour	150	56.57	43.43	1.73	66.00	57.33	

IMURA, O.
STORED-PRODUCT ENTOMOLOGY LABORATORY
NATIONAL FOOD RESEARCH INSTITUTE
YATABE, TSUKUBA
305 JAPAN

*Flight ability of Tribolium freemani Hinton.

Flight ability is an important trait of insect species, especially in relation to their dispersion. Among Tribolium species, T. castaneum flies (Good, 1936) and T. confusum (Good, 1936) and T. brevicornis (Mulder & Sokoloff, 1982) do not. The present study aims at determining the flight ability of T. freemani at an experimental condition.

Clear plastic boxes (30cm x 30cm x 30cm) which had a shelf of stainless steel wire lattice held 15cm above the bottom of the box were used as a flying chamber. Ten glass petri dishes (5.5cm diam. by 2cm deep) were placed on the shelf of each box. In each petri dish, a filter paper (5.5cm diam.) was placed and a 50-100 days old virgin female or male was placed on it. Ten gram wheat feed in a glass dish (12cm diam. by 2.5cm deep) was placed on the bottom of the box as an attractant. The boxes were examined daily and the number of adults on the bottom of the box and the wheat feed dish was recorded. When the petri dish became empty owing to the adult flight, a substitutional individual was placed in it. Since the adults can not crawl up on the glass wall, any adult found on the bottom and the wheat feed dish was considered to have flown. The experiments ware carried out for 7 days in a dark or a lightened room at 30 ± 0.5°C and 70 ± 10% r.h. There were 6 replications for each sex and light condition and nonparametric Mann-Whitney's U-test was employed on the results (Sokal & Rohlf, 1963).

Table 1. Incidence of flying in dark and lightened conditions in Tribolium freemani

Light condition	Adult sex	No. of adults scored*	Probability of flight / day / individual	
			x ±	s.d.
Dark	Female	4	0.0143	0.0128
	Male	1	0.0024	0.0058
Lightened	Female	7	0.0167	0.0021
	Male	2	0.0048	0.0117
Pooled	Female	11	0.0155	0.0167
	Male	3	0.0036	0.0089

* Total number of adults which made a flight in 6 replications.

The results indicate that both female and male can fly but their inclination for flying is not strong (Table 1). Although mean probabilities of flight / day / individual for females and those of the lightened condition were larger than those for males and those of the dark condition, respectively, the differences in observations between the groups were not significant ($P > 0.05$). However, when data of both dark and lightened conditions were pooled, the probability of flight for females was significantly larger than that for males ($P < 0.05$), indicating that females were more inclinable to flying than males.

Although there is no observation for flight ability of T. castaneum which is directly comparable with that of T. freemani, the propensity for flight of the latter seems lower than that of laboratory strains of the former. Dawson (1977) stated that "natural" populations of T. castaneum seldom fly. If so then the low propensity for flight in T. freemani might be partly due to the fact that this species is a less domesticated one. However, I actually observed that once adults of T. freemani flew off they could fly well. Ziegler (1978) inferred that T. castaneum, which can fly well, is better suited to locate and exploit widely dispersed temporal habitats than T. confusum, which lacks flight ability. Since the growth and reproduction rates of T. freemani are much reduced under crowded conditions (Nakakita, 1982; Imura, unpublished), the flight ability for dispersion may have a significant role in the life of T. freemani to avoid sib competition.

References

Dawson, P. S. 1977. Life history strategy and evolutionary history of Tribolium flour beetles. Evolution 31: 226-228.

Good, N. E. 1936. The flour beetles of the genus Tribolium. U.S.D.A. Tech. Bull. 498: 1-57.

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

Nakakita, H. 1982. Effect of larval density on pupation of Tribolium freemani Hinton (Coleoptera: Tenebrionidae). Appl. Ent. Zool. 17: 269-276.

Sokal, R. R. and Rohlf, F. J. 1969. Introduction to biostatistics. Freeman and company, San Francisco.

Ziegler, J. R. 1978. Dispersal and reproduction in Tribolium: the influence of initial density. Environ. Entomol. 7: 149-156.

IMURA, O.
STORED-PRODUCT ENTOMOLOGY LABORATORY
NATIONAL FOOD RESEARCH INSTITUTE
YATABE, TSUKUBA
305 JAPAN

*Sexual maturation of Tribolium freemani Hinton.

Insects require a period for sexual maturation after adult eclosion, which differs depending on the species and environmental conditions. The time of onset of sexual maturity may also reflect the life history of the insect species. Dick (1937) reported that oviposition commenced about 8 days after adult eclosion in Tribolium confusum. Erdman (1962, 1964) found that males of T. confusum and Tribolium castaneum were fertile within 24 and 48 hours, respectively, whereas females of T. confusum and T. castaneum were not fertile before the day 6 and 4, respectively. Dawson (1964) carried out more precise experiments and confirmed that T. confusum female could be fertilized in 17-20 hours and lay viable eggs 114-126 hours after adult eclosion, whereas T. castaneum females could be fertilized in 0-3 hours and lay fertile eggs 96-108 hours after adult eclosion. The average pre-oviposition period in Tribolium destructor was 16 days (Reynolds, 1944). This preliminary study was undertaken to elucidate the sexual maturation of T. freemani adults.

T. freemani pupae were sexed and maintained separately to obtain virgin adults. Twenty five virgin female and male adults eclosed within 24 hours were mated individually to 40-60 days old virgin adults of opposite sex. Eggs laid by each pair were collected daily and viability of the eggs was examined on a double-sided sticky tape (Imura & Nakakita, 1984). Oviposition and viability of eggs for another group of 25 virgin adult females of 40-60 days old which were not allowed to mate were examined daily for 5 days. All examinations were carried out using glass vials (2cm diam. by 7.5cm deep), each containing 500mg of a medium (a mixture of wheat flour and brewer's yeast in a ratio of 19:1 parts by weight) in a dark room at 30 ± 0.5°C and 70 ± 10% r.h.

The virgin adult females of 40-60 days old laid eggs without insemination (average daily egg production per female was 1.8 ± 1.9(s.d.)), but none of 222 eggs laid did not hatch. In the newly eclosed female adults mated to the aged-males, the first female laid a viable egg on day 8 and 92% of females initiated laying viable eggs by the day 19, however two females were never fertilized during the whole experimental period of 31 days (Fig. 1). The mean age of initiation of viable egg laying in the newly eclosed females was 12.5 ± 2.2 days, excluding the two unfertilized females. On the other hand, the first aged-female mated to the newly eclosed male was fertilized on the second day and by day 14, 100% of the females was fertilized by the new males (Fig. 1). The mean age of fertilization by the newly eclosed males was 6.7 ± 2.4 days.

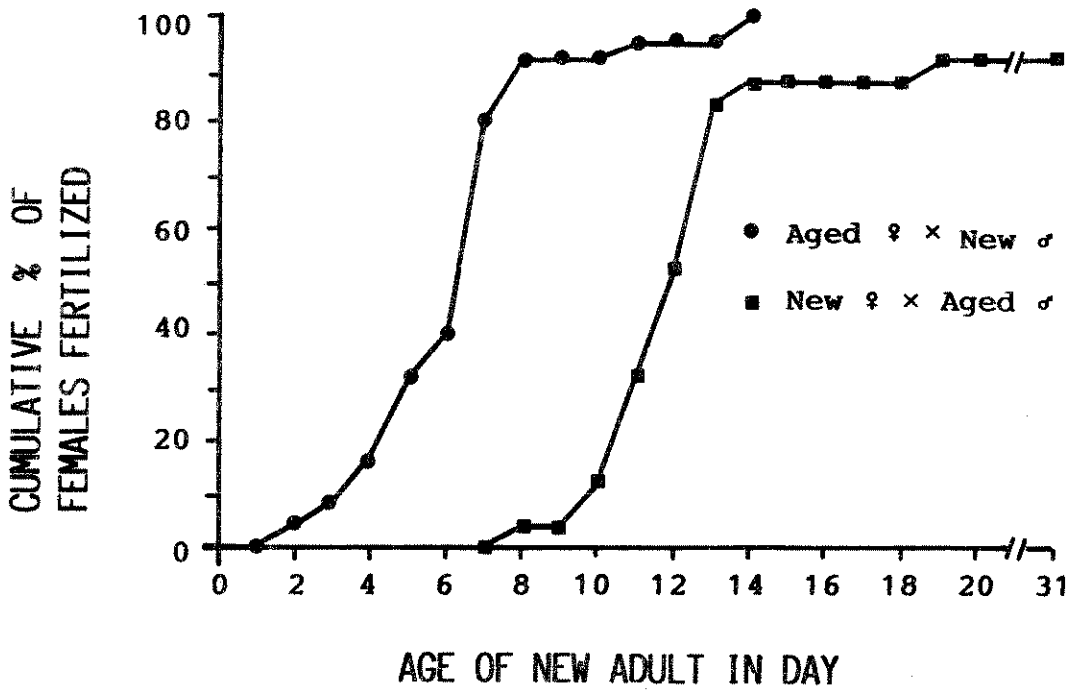


Fig. 1. Cumulative percentage of females which laid viable eggs in pairs of different female x male age combinations of Tribolium freemani.

The results indicate that T. freemani females take longer time for sexual maturation than T. castaneum and T. confusum (Dawson, 1964) and probably mature sexually earlier than T. destructor (Reynolds, 1944). The onset of sexual maturity of T. freemani males was similar to that of T. castaneum (Erdman, 1964). Such precedence of sexual maturity in males is commonly observed in many insect species (Ross, 1965). The sperm transferred in later copulations predominated in the fertilization of eggs over sperm already in the spermatheca in T. castaneum (Schlager, 1960). If this phenomenon is common in Tribolium species, then the early sexual maturity and repeated matings in males would be advantageous for their reproductive success. On the other hand, the high cost of producing female gametes may retard the sexual maturation of the females, and females may also compromise the sexual maturity with migration (Dingle, 1972). Environmental conditions such as temperature (Erdman, 1964) and food quality (Reynolds, 1944) affect the sexual maturation of Tribolium species.

References

Dawson, P. S. 1964. Age at sexual maturity on female flour beetles, Tribolium castaneum and T. confusum. Ann. Entomol. Soc. Amer. 57: 1-3.

Dick, J. 1937. Oviposition in certain coleoptera. Ann. Appl. Biol. 24: 762-796.

Dingle, H. 1972. Migration strategies of insects. Science 175: 1327-1335.

Erdman, H. E. 1962. Beginning of reproduction determined by age of the female flour beetle, Tribolium confusum (Coleoptera: Tenebrionidae). Naturwissenschaften 49: 428.

Erdman, H. E. 1964. Sexual precocity of the male flour beetle, Tribolium castaneum Herbst, and the influence of temperatures on reproduction during early adult life. Can. Ent. 96: 656-659.

Imura, O. and Nakakita, H. 1984. The effect of temperature and relative humidity on the development of Tribolium freemani Hinton (Coleoptera: Tenebrionidae). J. stored Prod. Res. 20: 87-95.

Reynolds, J. M. 1944. The biology of Tribolium destructor Uytt. I. Some effects of fertilization and food factors on fecundity and fertility. Ann. Appl. Biol. 31: 132-142.

Ross, H. H. 1965. A textbook of entomology. John Wiley and Sons, Inc., New York.

Schlager, G. 1960. Sperm precedence in the fertilization of eggs in Tribolium castaneum. Ann. Entomol. Soc. Amer. 53: 557-560.

Note - Research

Effectiveness of silica aerogel against the merchant grain beetle, *Oryzaephilus mercator* Fauvel.

S.R. Loschiavo
Agriculture Research Station
195 Dafoe Road
Winnipeg, Manitoba, Canada
R3T 2M9

1. Silica aerogel was highly effective against adults of the merchant grain beetle, *Oryzaephilus mercator* Fauvel exposed for as short a time as 5 sec, even when passed through an air stream after exposure. Those rinsed in water or provided with food after exposure had a high rate of survival.

   This material, applied by an environmentally safe method, was found effective against this species even on deposits up to 42 days old. It was effective also against adults of the confused flour beetle for at least 35 days but only after a 24-hr exposure to the heavier of two concentrations used.

Note - Research

Evaporation of a carbon tetrachloride-carbon bisulfide grain fumigant through paper and plastic films

S.R. Loschiavo and N.D.G. White
Agriculture Research Station
195 Dafoe Road
Winnipeg, Manitoba, Canada
R3T 2M9

2. Several materials used to hold gas inside bagged commodities or to seal cracks in windows and doors of buildings during fumigation were tested to determine their retention of an 80:20 carbon tetrachloride : carbon bisulfide mixture. The loss through kraft paper up to 5 plies in thickness ranged from 78 to 95% in 3 days. The loss through 1, 2 and 5 plies of kraft paper gum-tape was about 40, 21, and 11%, respectively, during the same period. The 3-day loss through 2, 4, and 6 mil plastic was 15, 11, and 9%, respectively, and through Saran wrap (Dow Chemical, Toronto, Ontario), 3%. Saran wrap was the thinnest, (30 microns) and the most effective material. Commercial pest control operators would probably obtain better results if they used plastic materials instead of gummed kraft paper for sealing cracks and holes prior to fumigating large installations.

Notes-Research

Matsumura, M. and Yoshida, T.
Laboratory of Applied Entomology
College of Agriculture
Okayama University
Okayama 700
Japan

*Population biology of Tribolium freemani Hinton (Coleoptera: Tenebrionidae)

The Kashmir flour beetle, Tribolium freemani Hinton was described by Hinton (1948) from a single adult female specimen which was captured in 1890's at Hispar in Kashmir, India. After an absence of about nine decades, the species was rediscovered in 1978 in Japan (Nakakita et al, 1981), and some biological characteristics have been studied by the several authors (Nakakita et al, 1981; Nakakita, 1982; Imura et al, 1982; Imura and Nakakita, 1984).

In the present note the population biology, adult survivorship (l_x curve) and age specific fecundity (m_x curve), was determined for Tribolium freemani.

The experiments were carried out in a darkened incubator maintained at 30 °C and 70-80 % R.H. using the vials, 5-0 mm hight and 25 mm in diameter. Each pair of the beetle was placed in the vial with 5 g of whole wheat flour supplemented with 5 % dried yeast. The food was renewed every day. The survivorship of adult was observed and the number of eggs deposited was counted every day.

Fig. 1 shows the survivorship curve and the age-specific fecundity. Table 1 shows the population parameters of the beetle. Mean adult longevity of the beetle was extremely long: over 500 days. Males lived longer than females. The pre-oviposition period was relatively long and the average number of eggs deposited per female per day was relatively small. The reproductive ability was relatively low: the value of the intrinsic rate of natural increase (r_m) was 0.048 per day.

Table 1. Population parameters of the Kashmir flour beetle, Tribolium freemani

Pre-oviposition period (Mean ± S.E. in days)	16.2 ± 1.6
Total number of eggs per female (Mean ± S.E.)	1332.8 ± 124.1
Female adult longevity (Mean ± S.E. in days)	538.8 ± 38.1
Net reproductive rate, R_o	575.0
Intrinsic rate of natural increase, r_m	0.048
Mean generation time in days, T	132.1

Hinton H. E. (1948) A synopsis of the genus Tribolium Macleay, with some remarks on the evolution of its species-groups (Coleoptera: Tenebrionidae). Bull. ent. Res. 39:13-55.

1

Imura O., Basuki and H. Nakakita(1982) Changes in size and weight during development of *Tribolium freemani* Hinton (Coleoptera: Tenebrionidae). Appl. Ent. Zool. 17(2):281-283.
Imura O. and H. Nakakita(1984) The effect of temperature and relative humidity on the development of *Tribolium freemani* Hinton (Coleoptera: Tenebrionidae). J. stored Prod. Res. 20(2):87-95.
Nakakita H. Imura O. and R. G. Winks (1981) Hybridization between *Tribolium freemani* Hinton and *Tribolium castaneum* (Herbst), and some preliminary studies on the biology of *Tribolium freemani* (Coleoptera, Tenebrionidae). Appl. Ent. Zool. 16(3):209-215.
Nakakita H. (1982) Effect of larval density on pupation of *Tribolium freemani* Hinton (Coleoptera: Tenebrionidae). Appl. Ent. Zool. 17(2):269-276.

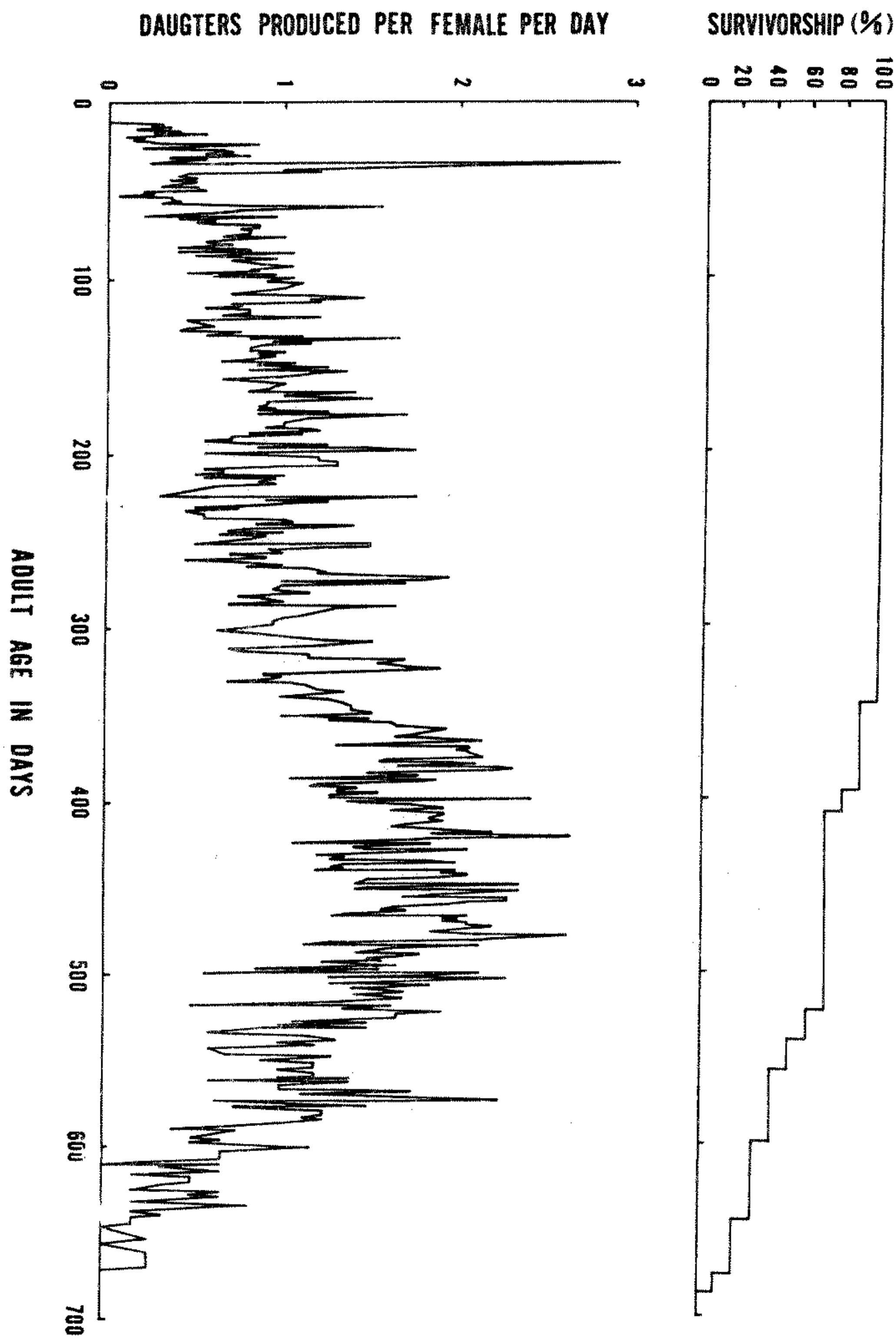


Fig. 1. Survivorship curve and age-specific fecundity curve for *Tribolium freemani*.

Abdul Mazid and Ataur Rahman Khan[1]
Department of Zoology
Rajshahi University
Rajshahi
BANGLADESH

*Growth of Tribolium confusum Duval. larvae (Coleoptera: Tenebrionidae) on barley and rice flours

The confused flour beetle, Tribolium confusum Duval. is a serious pest of cereals and cereal products and is cosmopolitan in distribution. Wheat (Triticum aestivum), barley (Hordeum vulgare) and rice (Oryza sativa) are major cereals of the world and constitute the chief sources of carbohydrates. The larvae of T. confusum are the most destructive stage of the life-cycle. The present work deals with the effect of barley and rice flours on this pest.

Adult T. confusum were originally collected from a flour mill of a local market and were cultured on wholemeal flour in the Department of Zoology, Rajshahi University, Bangladesh. Beetles from the culture were put on a thin layer of wholemeal flour in a Petri dish for oviposition. Eggs were collected on the following day and were incubated. Newly hatched larvae, 200 for each food, were transferred to glass jars (15.4 x 8.4 cms) containing wholemeal, barley and rice flours with the aid of a sable hair brush. The jars were secured at the top with a fine-netted cloth tied with a rubber band. The growth of T. confusum larvae was assessed at two stages: after 10 days and after attaining maturity. Larvae were sieved out from the food media and the adhered flour particles were cleaned with a brush. They were individually weighed on an electric balance. The larval length was determined with a scale and the head-capsule width using an eye-piece micrometer (40 X). Mature larvae from various flours were separately kept in Petri dishes and were carefully observed for their pupation. After pupation the larval period of the insect on each food was carefully noted. All the experiments were carried out at $27 \pm 1^{\circ}$ C.

The effect of barley and rice flours on different aspects of growth of T. confusum larvae is shown in Table 1. Barley and rice flours incurred a deleterious effect on the insect by decreasing the 10-day larval length ($P < 0.01$) and the mature larval weight, length and headcapsule width ($P < 0.01$). Haque (1983) also observed lower larval weight, length and headcapsule width of T. confusum grown on rice flour. Barley flour significantly lowered and rice flour significantly lengthened the larval periods of the beetle ($P < 0.001$). Haque (1983) also noted increased larval periods of T. confusum grown on rice flour.

In recent years there is a growing tendency over the control of insect pests through nutritional regulations owing to a number of serious drawbacks produced by chemical insecticides. One way to control insect pests is to modify intrinsically favourable habitats in such a way that they no longer furnish adequate envi-

[1]Address for correspondence

ronments for the populations of the pest concerned, e.g. by providing unsuitable sources of food (Geier, 1966). Pratt et al. (1972) gave a comprehensive review and prospectus of insect pest control strategies based on nutritional principles. More nutritious foods give a better growth of pests, which in its turn, will produce a greater rate of infestation on foods. The significantly lower growth of T. confusum on barley and rice flours is promising in this connection. In addition, the higher larval period of the insect on rice flour will reduce the number of generations of T. confusum per year and this will consequently reduce rate of infestation.

Similar results were obtained by Sokoloff et al. (1966) in their comparative studies of productivity of T. castaneum and T. confusum on several commercially-available diets including rice and brown rice.

The authors wish to thank Professor M. Altaf Hossain (II) and Dr. M. Sayedur Rahman, Department of Zoology, Rajshahi University, for providing necessary laboratory facilities. It is a pleasant duty to extend sincere thanks to Professor M. Quaisuddin, Department of Biochemistry, Rajshahi University, for permitting to use the balance installed there.

References

GEIER, P. W. (1966). Management of insect pests. Ann. Rev. Ent. 11: 471-490.

HAQUE, A.A.T.M. (1983). A survey of stored products beetles of Rajshahi District and effect of different varieties of rice on the confused flour beetle, Tribolium confusum Duval. (Coleoptera: Tenebrionidae). M. Sc. thesis, Rajshahi University. 60 pp.

PRATT, J. J., Jr., HOUSE, H. L. and MANSINGH, A. (1972). Insect control strategies based on nutritional principles: a prospectus. In "Insect and mite nutrition", pp. 651-668. North-Holland, Amsterdam.

SOKOLOFF, A., FRANKLIN, I. R., OVERTON, L. F. and HO, F. K. (1966). Comparative studies with Tribolium (Coleoptera: Tenebrionidae). I. Productivity of T. castaneum (Herbst) and T. confusum Duv. on several commercially-available diets. J. stored Prod. Res. 1: 295-311.

Table 1 Growth of *Tribolium confusum* on barley and rice flours

Characters	Foods Wholemeal flour Mean±SD (No.)	 Barley flour Mean±SD (No.)	 Rice flour Mean±SD (No.)
A. Larval weight (mg)			
a. 10-day old larvae	0.49±0.16 (35)	0.53±0.12 (35)	0.47±0.11 (35)
b. Mature larvae	2.80±0.23 (35)	2.32±0.29 (35)	2.30±0.25 (35)
B. Larval length (mm)			
a. 10-day old larvae	3.62±0.43 (35)	3.21±0.27 (35)	3.21±0.44 (35)
b. Mature larvae	4.83±0.25 (35)	4.62±0.29 (35)	4.46±0.32 (35)
C. Larval headcapsule width (mm)			
a. 10-day old larvae	0.94±0.10 (35)	0.91±0.11 (35)	0.94±0.07 (35)
b. Mature larvae	1.45±0.11 (35)	1.37±0.09 (35)	1.38±0.08 (35)
D. Larval period (days)	22.30±1.97 (164)	20.23±2.71 (154)	24.05±7.05 (186)

LINKAGE GROUP ASSIGNMENT OF "ANTENA BIFURCADA" (ab)

Fernando Núñez and Indiana Bustos
Departamento de Biología
Universidad Nacional de Colombia
Bogotá, De.E.
Apartado aereo 23227

A mutant in T. castaneum with coincident phenotypic manifestations as those of "branched" (Dawson, 1962) and "spikes on trochanters and antennae" (Sokoloff, 1966), was discovered in the Tribolium lab., Department of Biology, National University of Colombia (Bogotá). The mutant strain was selected along a work of five years. A noticeable characteristic of the gene is that it produces whole sterility in homozygote males (Vásquez & Núñez, 1985), being semi-lethal in both sexes.

Linkage test-crosses indicate that the gene is located in the second linkage group. "Bifurcated antenna" recombines with "pearl" with a frecuency of 29 $\pm$ 0.7 %. These results were obtained from coupling backcrosses and F_2 coupling and repulsion over a total of 8776 descendants. The map possition of the ab locus in the second linkage group has not been determined as yet.

BIBLIOGRAPHY CITED

DAWSON, P. 1962: Preliminary report on a possible phenodeviant in T. castaneum. TIB 5 (section on new mutants).

VASQUEZ, W. y F. NUÑEZ 1985: Estudios genéticos en Tribolium castaneum II. Mutante "antena bifurcada". BOL. DPTO. BIOL., U.N. 2 (6): 9-22

SOKOLOFF, A. 1966: The genetics of Tribolium and related species. ADV. GENET., supl. 1

"OJO BLANCO" (obl), A NEW MARKER GENE FOR LINKAGE GROUP IV IN Tribolium castaneum

Fernando Núñez
Departamento de Biología
Universidad Nacional de Colombia
Bogotá, D. E.,A. A. # 23227

During 1982, in a culture bottle of a synthetic wild strain, several light-eyed adult mutants were discovered. The colour of the eyes varies from a pearl-like tone to a brownish one (2.5 YR 5/8 according to the Munsell table). The mutant has been succesfully reared along five years in our laboratory. It is a recessive autosomic spontaneous mutation with excellent viability and complete penetrance (Arrieta, L. 1986). The Linkage test-crosses were positive with "sooty". The calculated distance was 15.64 ± 0.92 cM. This distance was worked out from backcrosses in repulsion and coupling phases. Of wich,1630 descendants from the coupling and 2843 from the repulsion phase were obtained. Neither discrepance of recombination between the two sexes, nor between the two phases were found.

It is probable that the mutant would be a re-ocurrence of the white mutant of Eddlemam & Bell (1963). These observations will be published elsewhere.

Bibliography cited.

Arrieta, L. 1986: Relaciones de ligamiento em Tribolium castaneum (Herbst.) Tesis de pre-grado. Dpto. Biología, Universidad Nacional de Colombia. Bogotá.

Eddlemam, H. and A. Bell 1963: Four New eye color mutants in Tribolium castaneum. Genetics 48: 888 (Abstr.).

Notes-Research

*AUTOCLAVING OF BEANS (PHASEOLUS VULGARIS) TO IMPROVE THEIR NUTRITIVE VALUE FOR TRIBOLIUM LARVAE

Wen Flora Pao, Pran Vohra and F.H. Kratzer
Department of Avian Sciences, University of California,
Davis, CA 95616

ABSTRACT

Beans (*Phaseolus vulgaris*) need to be autoclaved for 2 hours to overcome their antinutrient properties for tribolium larvae. Varietal differences exist in the nutritional values of beans to support the optimal growth of Tribolium larvae.

INTRODUCTION

Beans (*Phaseolus vulgaris*), an important source of dietary protein for animals and humans, also contain antinutritional proteinous substances such as antienzymes (1) and lectins (2) which can be inactivated by autoclaving (3). Raw beans significantly reduced the growth of larvae of *Tribolium castaneum* and increased their mortality. If the beans were autoclaved for 30 minutes at 127°C (21 p.s.i), the growth rate of larvae was improved and mortality was reduced (4, 5). The present study was undertaken to determine the time needed for autoclaving to obtain the optimum growth of the Tribolium larvae.

MATERIALS AND METHODS

A sample of red kidney beans was purchased from a local market and has been designated as the commercial sample. This variety was used to test the optimal time needed for heating to improve its nutritive value. The beans (*Phaseolus vulgaris*) were ground in a Moulines Regal coffee mill to pass through a 100 mesh screen. Aliquots of the finely ground samples of beans were autoclaved in 1 cm layers in dishes at 124°C (pressure of 18 p.s.i.) for 8, 15, or 30 minutes, 1, 1.5 or 2 hours and then mixed in the diets for bioassay with Tribolium larvae. *Tribolium castaneum* were maintained on a stock diet of 90% unbleached white flour and 10% brewer's yeast in an incubator at 33 ± 1°C and 70 ± 5% relative humidity. The protein content of the test and the control diets was 12.5%. The larvae were hatched from a 24-hour egg collection. At 6 days of age, about 40 larvae per diet were transferred onto test diets. The test diet in the studies on optimum time for autoclaving contained 10% brewer's yeast, 35% commercial bean powder and 55% corn starch. At 10 days of age, 10 larvae of about same weight per replicate were transferred onto their respective diets. Each diet was tested in triplicate. The final larval weights were determined on the 14th day after egg collection. The growth of larvae on the stock diet was used as control in each assay. An optimum time of 2 hours was needed for autoclaving in these studies (Experiment 1).

The effect of supplementation of diets containing this commercial bean with methionine, lysine and tryptophan on the growth of Tribolium was also tested (Experiment 2).

Two red kidney bean varieties (Nos. 2602 and DRK), and 4 of white varieties (7813, 79125, 79129 and 79131) were obtained from the Department of Agronomy, University of California at Davis. The crude protein content of the samples was determined by multiplying the Kjeldahl nitrogen by 6.25. The protein content of the commercial variety was 23%, and of varieties 2602 and DRK was 17.1%. The 4 white varieties had 14.9% crude protein.

One of the red bean variety from Davis (2602) was incorporated after autoclaving for 2 hours at levels of 35%, 47.6% and 55.8% to provide 10.45%, 12.5% and 14.5% protein in the test diets which were bioassayed with and without amino acid supplementation (Experiment 3).

The protein content of test diets in the experiment comparing the 6 varieties was adjusted to 14%. These diets were also tested with and without amino acid supplementation (Experiment 4).

The data on average larval weight on the different test diets were subjected to analysis of variance for any significant differences (6). The significant data were compared by least significant difference (LSD).

RESULTS AND DISCUSSION

Table 1. The effect of duration of autoclaving of a commercial red kidney bean on the growth of Tribolium larvae (Experiment 1)

Dietary treatment	Ave. Larval weight, mg
Series 1	
Control (wheat flour, 90% + 10% yeast)	1.91
Kidney beans, raw	0.78
Kidney beans, autoclaved 8 min	0.93
Kidney beans, autoclaved 15 min	0.87
Kidney beans, autoclaved 30 min	1.08
Series 2	
Control	2.21
Kidney beans, raw	0.77
Kidney beans, autoclaved for 1 hour	1.24
Kidney beans, autoclaved for 1.5 hours	2.19
Kidney beans, autoclaved for 2 hours	2.35

Statistical analysis

	Series 1	Series 2
Mean square	0.626	1.489
Mean square error	0.024	0.038
LSD (P<0.05)	0.14	0.27

Our unpublished studies indicated that the growth of Tribolium larvae fed ground beans heated in a hot air oven at 100° for 24 hours was better than on raw bean diet, but still inferior to the growth of those fed the control diet. In the present studies with moist heat, the larval weight increased significantly and reached that of the control diet as the time of autoclaving of kidney beans was increased from 8 minutes to 1.5 hours. No further significant (P<0.05) improvement occurred by increasing the autoclaving time to 2 hours.

The commercial bean diets may have a deficiency of methionine (7). Also, overheating may reduce the availability of lysine (8). These possibilites were tested and the data are presented in Table 2.

Table 2. The effect of supplementation of commercial red kidney bean diets with methionine and lysine on the growth of tribolium larvae (Experiment 2)

Dietary treatment	Ave. larval weight, mg
Series 1	
Control (Wheat flour + yeast)	1.95
Kidney beans, autoclaved 2 hr	2.25
Kidney beans, autoclaved 2 hr + 0.05% met	2.24
Kidney beans, autoclaved 2 hr + 0.05% lys	2.52
Kidney beans, autoclaved 2 hr + 0.1% lys	2.50
Kidney beans, autoclaved 2 hr + 0.05% met + 0.1% lys	2.22
Kidney beans. autoclaved 2 hr + 0.05% met + 0.2% lys	2.27
Kidney beans, autoclaved 2 hr + 0.1% met	1.94
Kidney beans, autoclaved 2 hr + 0.1% met + 0.1% lys	2.26
Kidney beans, autoclaved 2 hr + 0.1% met + 0.2% lys	2.34
Series 2	
Control (Wheat flour + yeast)	2.20
Kidney beans, raw	0.90
Kidney beans, raw, + 0.1% met + 0.2% lys	0.93
Kidney beans, raw, + 0.2% met + 0.4% lys	0.95
Kidney beans, autoclaved 1 hr + 0.2% met + 0.4% lys	1.50
Kidney beans, autoclaved 2 hours	2.27
Kidney beans, autoclaved 2 hr + 0.2% met	2.15
Kidney beans, autoclaved 2 hr + 0.4% lys	2.40
Kidney beans, autoclaved 2 hr + 0.1% met + 0.2% lys	2.37
Kidney beans, autoclaved 2 hr + 0.2% met + 0.4% lys	2.29

Statistical analysis

	Series 1	Series 2
Mean square	0.111	1.274
Mean square error	0.073	0.022
LSD (P<0.05)	N.S	0.14

No significant difference was observed in any of the diets by analysis of variance in Series 1 to support the growth of larvae in Experiment 2. No significant differences were found in the average body weights of larvae on any of the treatments except autoclaving in the 2nd series of this experiment.

Raw beans were not improved by a supplementation of amino acids for the growth of Tribolium larvae when the diet contained about 12.5% crude protein. A significant improvement in the larval growth to reach the same level as on the control diet was observed if the beans were autoclaved for 2 hours. No further significant (P<0.05) improvement in larval growth was observed by supplementing the beans autoclaved for 2 hours with methionine and lysine, individually or together. When supplemented with lysine and methionine, beans autoclaved for 1 hour supported larval growth intermediate between no treatment and 2 hour autoclaving. It appears that these amino acids were not deficient in autoclaved beans for meeting the needs of the Tribolium larvae. However, these data may not be projected to other animal species.

An improvement in growth of chicks has been observed if diets containing 35% of the Chief variety of beans were supplemented with 0.04% tryptophan (9). The data on the effect of supplementation of tryptophan on the larval growth using the bean variety 2602 are given in Table 3.

Table 3. Effect of lysine, methionine and tryptophan supplementation of red kidney bean variety 2602 autoclaved for 2 hours on the growth of Tribolium larvae (Experiment 3)

Dietary treatment	Ave. larval weight, mg
Control	2.36
Red kidney beans, 35%	1.97
Red kidney beans, 35% + 0.1% met + 0.2% lys	2.38
Red kidney beans, 35% + 0.1% met + 0.2% lys + 0.1% try	2.61
Red kidney beans, 47.6%	2.19
Red kidney beans, 47.6% + 0.1% met + 0.2% lys	2.38
Red kidney beans, 47.6% + 0.1% met + 0.2% lys + 0.1% try	2.35
Red kidney beans, 55.88%	2.12

Statistical analysis

Mean square	0.115
Mean square error	0.035
LSD ($P<0.05$)	0.20

Growth of Tribolium larvae was significantly improved by the addition of methionine and lysine and further improved by the addition of tryptophan when beans were used at a level of 35% of the diet to provide about 10.5% crude protein. However, if the level of the beans was increased to 47.5% to provide about 12.5% protein with or without supplementation with methionine and lysine, no further improvement in larval growth was observed by addition of tryptophan. An increase of bean level to 55% was of no advantage for larval growth. The results with a dietary level of 12.5% protein in Tables 2 and 3 with two different bean samples are in agreememnt. The addition of 0.1% methionine and 0.1% lysine to the diet containing 12.5% protein did not improve the larval growth. The improvement was noticed with a level of 10.5% protein in Experiment 3.

The growth rate of larvae was different for different varieties of beans and for heat treatment. When the beans were fed raw, poor growth was observed with all varieties and mortality was observed with varieties 7813, 79125 and 79129 of small white beans. The nutritional value of 6 varieties of beans was improved by autoclaving (Table 4), but none of these, except DRK, supported as good growth of larvae as the control diet. The color of the beans or their protein content was not the determinant of their nutritional value. A white variety (79125) was significantly inferior to the other white or colored varieties after autoclaving.

Table 4. The growth of tribolium larvae fed diets containing 6 varieties of beans raw, and autoclaved for 2 hours and supplemented with amino acids (Experiment 4)

Bean variety	% in Diet	Raw	Bean treatment and supplement — Autoclaved	+0.2% lys +0.1% met	+0.2% lys	+0.4% lys	Mean without raw
			Ave. larval weight, mg				
2602	55.1	0.20	1.47	1.62	1.57	1.19	1.46 b
DRK	55.1	0.25	1.89	1.40	1.54	1.22	1.39 b
7813	63.3	0.18 (2)	1.31	1.37	1.65	1.29	1.41 b
79125	63.3	0.15 (6)	1.10	1.21	1.41	1.02	1.19 a
79129	63.3	0.16 (11)	1.44	1.33	1.45	1.14	1.34 ab
79131	63.3	0.16	1.42	1.34	1.79	1.24	1.45 b
Control		1.91	2.0	2.01	2.11	1.77	1.97 c
		0.43	1.45b	1.47b	1.65c	1.27a	

Statistical analysis (2 way) omitting raw beans

	DF	Mean squares	
Treatments	3	0.510	
Varieties	6	0.723	
Treatments x varieties	18	0.021	
Error	56	0.027	
LSD ($P<0.05$) treatments			0.14
LSD ($P<0.05$) varieties			0.18

Varieties: 2602, red kidney bean; DRK, dark red kidney bean; 7813, 79125, 79129 and 79131, small white beans.

Number of larvae dead out of a total of 30 in 3 replicates are in paranthesis.

When autoclaved beans were supplemented with methionine and lysine (Table 4), variety 2602 gave significantly better larval growth than any of the others. With the addition of 0.2% lysine alone, variety 79131 resulted in significantly better growth of larvae than any of the other varieties. The variety 79125, on the other hand, proved significantly inferior to the varieties 7813 and or the unsupplemented 79125. When lysine was increased to 0.4%, variety 79125 proved inferior to 3 of the other 5 varieties.

A significant improvement in the growth of larvae is confirmed when beans were autoclaved, according to the 2-way analysis of variance. An addition of 0.2% lysine to the autoclaved beans caused a significant improvement in larval growth which was lost by addition of 0.1% methionine.

An addition of 0.4% lysine to autoclaved beans caused a significant depression in larval growth when compared to autoclaved beans alone. Variety 79125 was inferior to all varieties except 79129. In none of these tests was the growth of the larvae fed different varieties of beans as good as on the control diet.

It may be concluded that autoclaving for about 2 hours may be needed to overcome the antinutrients in beans to support the optimal growth of Tribolium larvae. Varietal differences exist in the nutritional quality of beans. Methionine and lysine supplementation of raw beans was ineffective, indicating that poor amino acid availability is not the cause of poor growth of tribolium with raw beans. Some of the experimental varieties had more growth depressing properties than the variety available in the supermarkets. The autoclaved experimental varieties were improved by supplementation with lysine alone. The variety 2602 was improved by supplementation with lysine, methionine and tryptophan if incorporated at a 35% level when tested in a diet containing 10.5% CP. These amino acids were not needed when the dietary protein level was 12.5% and the level of this variety was 47%.

REFERENCES

1. Liener, I. E. and Kakade, M.L. Protease inhibitors. In Toxic Constituents of Plant Foodstuffs (I.E. Liener, editor), Academic Press, New York, 1980, p.7.

2. Jaffe, W.G. Hemagglutinins (Lectins). In Toxic Constituents of Plant Foodstuffs (Liener, I.E., editor), Academic Press, New York, 1980, p. 73.

3. Antunes, P.L. and Sgarbieri, V.C. Effect of heat treatment on the toxicity and nutritive value of dry bean (*Phaseolus vulgaris* var. *Roshina G2*) proteins. J. Agric Food Chem. 28, 935 (1980).

4. Shariff, G., Penz, Jr., A.M. and Vohra, P. Nutritional improvement of beans (*Phaseolus vulgaris*) by autoclaving or water extraction for *Tribolium castaneum* larvae. Nutr. Reports Int. 24, 1087 (1981).

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

6. Steele, R. G. D. and Torrie, J.H. Principles and Procedures of Statistics with Special Reference to the Biological Sciences. McGraw-Hill, New York, 1960.

7 Almas, K., and Bender, A.E. Effect of heat treatment of legumes on available lysine. J. Sci. Good Agric. 31, 448 (1980).

8. Tobin, G., and Carpenter, K.J. The nutritional value of the dry bean (*Phaseolus vulgaris*): A literature review. Nutr. Abst. and Reviews, Ser. A. 48, 919 (1978).

9. Penz, Jr., A.M., Earl, L., Kratzer, F.H. and Tucker, C. Availability for chicks of tryptophan from autoclaved beans. Nutr. Int. Reports, 27, 161 (1983).

Prus, Tadeusz and Miroslawa Prus

Department of Ecological Bioenergetics, Institute of Ecology, Polish Academy of Sciences, Dziekanow Lesny, 05-092 Lomianki, Poland

*Phenotypic differentiation of Tribolium castaneum Hbst cI strain

Introduction

Recently, our laboratory is dealing with the problem of performance of life history strategy by two species of Tribolium: T. castaneum and T. confusum. The long-term goal of this research is evaluation of position of these two species on r---K continuum (Stearns, 1980). To avoid the excess of variation in populational features, two strains representing each species were chosen: cI strain of T. castaneum and bIV strain of T. confusum (Park et al. 1961). From cI strain two substrains were separated in our laboratory (Prus 1976), which are being used as an experimental tool to attack the main problem. They can be distinguished by number of larval instars: 6- instar and 7-instar group. The similar differentiation was observed in T. confusum bIV strain (Bijok, 1984). For life history studies the substrains are tested in respect of such features as time of development, maximum weight in larval stage, fecundity, egg hatchability (fertility), and mean individual egg weight. After some laboratory experience the material for experiments is derived from these two substrains by the method of time shifting in the appearance of pupae. In order to look for differences, a short time experiment was performed, aimed at description of the above listed features in T. castaneum cI substrains.

Material and methods

All experiments were carried out in standard conditions: 29 C, 75% relative humidity, medium: 95% of wheat flour and 5% of brewer's yeast. On the basis of differences of time development in two substrains 6- and 7-instar individuals were separated from substrains as pupae appearing on 19-20th day of larval development (6-instar) and 24th day (7-instar). Two days after eclosion the experiment on fecundity and egg hatchability was started in four series. Individuals were mated according to the following scheme: (1) 6-instar female x 6-instar male, (2) 6-instar female x 7-instar male, (3) 7-instar female x 7-instar male, (4) 7-instar female x 6-instar male. These pairs were placed each into 8g of medium for 30 days. At each census eggs were separated, counted, weighed as total and left over in Petri dishes to hatch. Number of hatched larvae was determined under biocular microscope. First stage of experiment had five replications in each series and consisted of 160 samples (4 series x 4 replicates x 10 time moments). The second experiment with 10 replications in each series consisted of 400 samples (4 series x 10 replicates x 10 time moments). When elaborating results, the significance of effects was tested with analysis of variance.

Results and discussion

Comparison between substrains within each sex of cI strain showed that both males and females of 6-instar group develop faster than those of 7-instar group (23.8 vs 26.3 days). The difference is statistically significant (Table I). This is in accordance with earlier results (Prus, 1976), although absolute figures are somewhat different. The present values are a little lower, but in general they follow the earlier observed pattern.

Subsequent stages of larval development appear more or less uniformly in both substrains up to VI instar. There is additional VII instar in the second group which lasts about two days in males and three and a half days in females. This is the stage which prolongs the whole develpoment in this substrain (Table II).

From the individual cultures of both substrains growth curves were drawn (Fig. 1 and 2). For purpose of convenience the values were arranged in two ways. The first way involved ignorance of stages and only age (in days) was plotted on abscissa. However such approach causes additing of weights of different stages which is an error especially when examining the energetic requirements of species tested (Fig. 1). To avoid such error, technical operation was made consisting of calculation of weight of real stages in the middle of their duration and plotting these values on the graph basing on duration of subsequent stages (Fig. 2). Thus time was ignored and this graph was based primarily on stages.

From Figures 1 and 2, one can see that, depending on what approach is used, the energetic parameters such as production, consumption, and respiration will differ. In our bioenergetic studies we choose the second way of calculation (Bijok, 1986).

Similarly the two substrains differ in maximum individual weight achieved by larvae. Both males and females of 7-instar group are heavier than those of 6-instar group with significant difference (Table III).

Analyzing fecundity of these substrains, it was observed that series (3) has highest fecundity and series (4) - the lowest one. Such pattern was observed in the two experiments (Table IV).

Hatchability was generally higher in the second experiment, however it did not reflect the pattern observed in the first experiment. The highest values of hatchability were observed in series (1) and (4). The earlier postulated hypothesis that 6-instar form has been maintened for a rather long time in the population was due to the fact that higher fecundity of 7-instar individuals was counterbalanced by higher hatchability of progeny resulting from matings between substrains. The results of second experiment corroborated partly this hypothesis i.e. that 7-instar group showed the highest fecundity (Table IV).

The significance of effects of time, series, and interaction between them on fecundity and hatchability is presented in Table V. Both time and series showed significant effect on fecundity and hatchability, except for the series effect on the latter. This holds for both experiments.

Mean weight of eggs laid by pairs in four series of the first experiment are given in Table VI. They oscillate around overall mean of 48.76 ug wet weight. Since the analysis of variance of the material supplied in the first experiment showed no significant effect of series i.e. substrains and their combinations , this characteristic was not examined further.

It would be interesting to examine other populational features of these substrains such as longevity and mortality which may be responsible, together with the examined features, for the constant maintenance of two pools of phenotypes in the population of T. castaneum and T. confusum strains. Their existence seems to be responsible for shifting the species along r---K continuum, with property of being 6-instar representative pushing the life strategy towards "r" and that of being 7-instar representative - towards "K" type.

Summary

Phenotypic differentiation of such features as duration of development, maximum larval weight, fecundity, and hatchability in two substrains , were investigated. Statistical tests showed significant differences in all these features between substrains. The existence of substrains within Tribolium strains will be used for interpretation of life strategy performance by Tribolium populations.

References

Bijok, P. 1984. On heterogeneity in bIV strain of Tribolium confusum Duval. Tribolium Information Bulletin, 24, 89-96.

Bijok, P. 1986. Energetic budget of Tribolium cunfusum Duval bIV strain in its developmental cycle. Ph. D. Thesis, Institute of Ecology, PAS, pp. 88.

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

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

Stearns, S. C. 1980. A new view of life-history evolution. Oikos, 35,266-288.

Table I. Comparison of developmental time between sexes and substrains (days).

	6-instar	t-test	7-instar
males	24.00+1.34 n = 22	t=3.69 $p<0.001$	25.62+0.96 n = 13
t-test	t=0.96 $p>0.05$		t=2.84 $p>0.001$
females	23.55+0.93 n = 11	t=7.33 $p<0.001$	26.84+1.26 n = 21
average	23.85+1.22 n = 33	t=8.15 $p<0.001$	26.35+1.25 n = 34

means and standard deviation; n - replicates; p - probability

Table II. Mean time of appearance of subsequent developmental stages from the moment of hatching of larva (days)

Stage	6-instar substrain		7-instar substrain	
	males	females	males	females
Larva II	1.0	1.2	1.2	1.4
III	4.5	4.3	4.7	4.2
IV	6.7	7.2	7.0	7.0
V	9.3	9.2	9.6	9.4
VI	13.7	12.8	12.5	12.4
VII	-	-	15.9	15.3
Prepupa	16.2	15.9	17.8	18.8
Pupa	18.2	17.9	19.8	20.8
Adult	24.0	23.6	25.6	26.8

* Values are weighed means of appearance of a given stage in a series of individual cultures

Table III. Comparison of maximum body weight (micrograms) between sexes and substrains.

	6-instar	t-test	7-instar
males	2282+206 n = 22	t = 8.42 p<0.001	2893+193 n = 13
t-test	t = 1.73 p>0.05		t = 2.56 p>0.001
females	2248+211 n = 11	t = 6.78 p<0.001	2871+252 n = 21
average	2271+205 n = 33	t = 11.25 p<0.001	2879+229 n = 34

means and standard deviation; n - replicates;
p - probability

Table IV. Fecundity and egg hatchability in four series of experiments.

Series	Combination females x males	Fecundity eggs/female.72h I	II	Hatchability per cent I	II
(1)	6/6	50.8	55.9	53.9	67.6
(2)	6/7	50.7	55.1	59.5	65.0
(3)	7/7	57.5	57.9	57.5	65.2
(4)	7/6	53.6	53.6	61.2	68.9

I,II - subsequent experiments

Table V. Significance of time, substrain, and interaction effects on fecundity and hatchability (analysis of variance)

Experiment	I			II		
Replications	160			400		
Source of variation	time	series	inter-action	time	series	inter-action
	Fecundity					
Significance	s	s	s	s	s	ns
F	11.38	7.48	15.72	6.80	6.85	1.86
P = 0.005	2.62	4.28	2.62	2.62	4.28	2.62
	Hatchability					
Significance	s	ns	s	s	ns	s
F	3.81	1.29	3.44	6.92	0.35	4.54
P = 0.005	2.74	4.28	2.74	2.62	4.28	2.62

Table VI. Average individual weight (micrograms wet weight)* of eggs in four series.

Series	(1)	(2)	(3)	(4)
Mean+SD	49.79+2.08	48.33+1.41	47.67+1.12	49.25+1.10
CV %	26.49	18.42	14.92	14.17

* Weights uncorrected for flour coating.

Fig. 1. Changes in individual body weight in subsequent days (stage ignored)

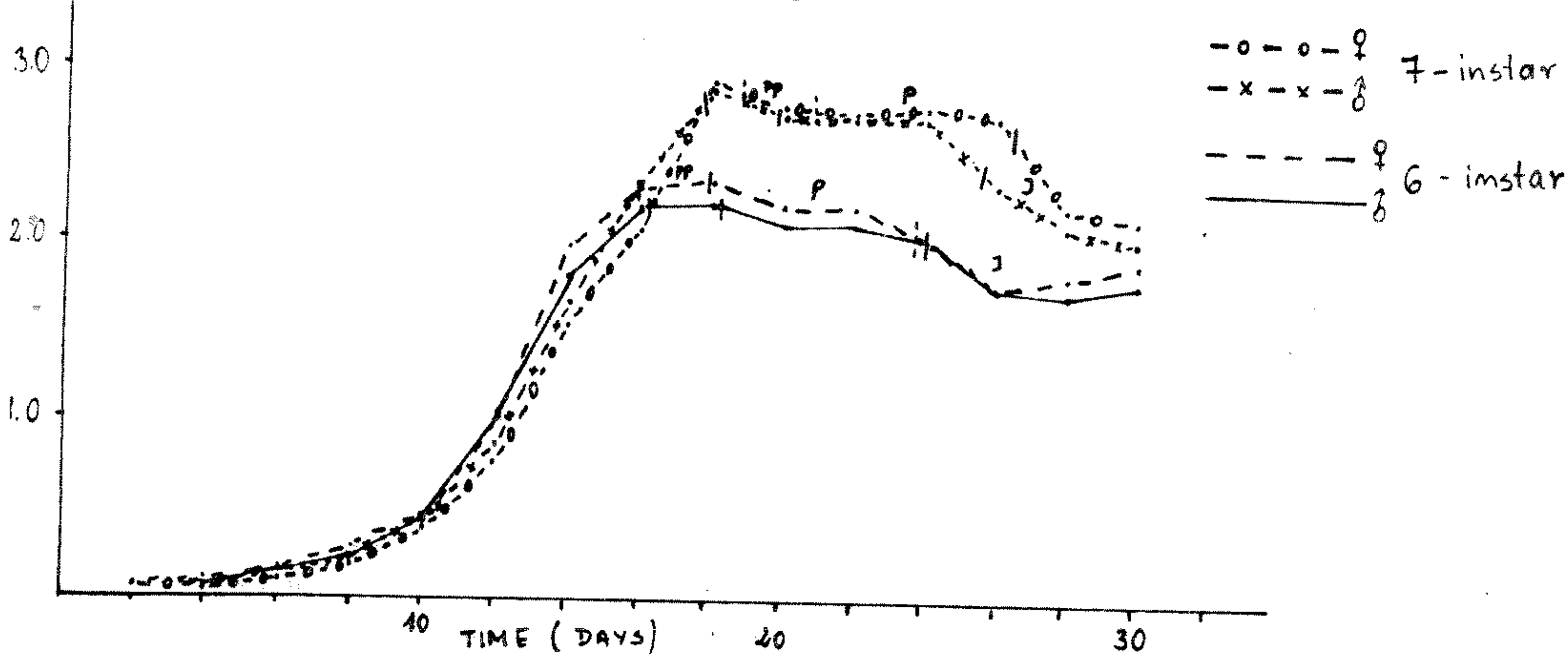
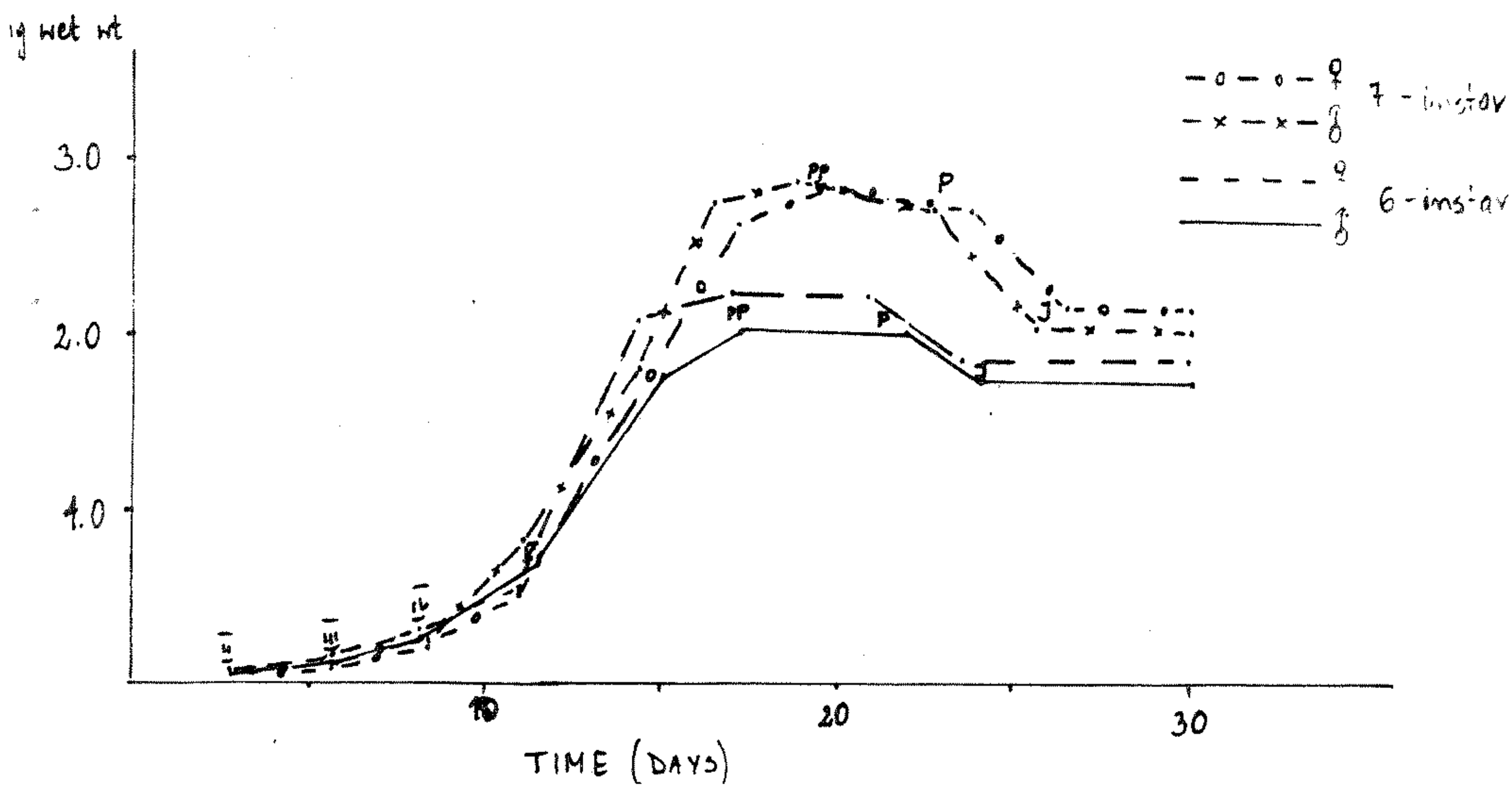


Fig. 2. Changes in individual body weight of subsequent stages (time ignored)

Mean weight of egivent stage in marked in the middle of the stage duration



Sokoloff, A., Shimeld, L. and O'Neal, P.
Biology Department
California State University
San Bernardino, CA 92407

*A search for incompatibility strains in T. castaneum.

Stanley (1961) reported that females of the McGill black T. confusum strain were reproductively incompatible with two other strains: b females, when crossed with b males from the same strain, produce abundant progeny. The same females, mated to unrelated non-b males produced many eggs, but they proved to be sterile. b males successfully fertilize females from any source, producing abundant offspring. b females crossed with hybrid males (obtained by crossing black males with females of other strains are also reproductively incompatible. Sokoloff (1966) was able to corroborate these observations in early crosses after obtaining Stanley's strain, but later crosses did not show the reproductive incompatibility. Subsequently Stanley's strain was lost. Cawthon and Mertz (1975) discovered a similar phenomenon in an inbred genetic strain of T. confusum referred to as bI. The trait exhibited a cytoplasmic pattern of inheritance: bI females laid sterile eggs when mated with F_1, F_2 and F_3 backcross hybrid males obtained by crossing bI males with Chicago strain females.

Wade and Stevens (1985) in 1979 tested the mating compatibilities of 12 strains of T. confusum. One strain, b-Circle A, also referred to as the Illinois strain, while interfertile with the bI strain, produced no progeny when b-Circle A females were crossed to males from any other source.

A few years later Wade and Stevens found that females were interfertile with males of other strains; but b-Circle a males were no longer compatible with bI females. Females from the b-Circle strain are completely infertile with males from all other tested strains except bI.

Wade and Stevens summarize these observations as follows:

1. bI females are incompatible with males of wild populations from geographically dispersed portions of the species distribution.

2. b-circle shows mating incompatibility similar to that previously reported for the lab bI and McGill black strains.

3. Strains that show incompatibility with other strains are completely infertile; and

4. Reproductive compatibility can be naturally acquired (B-Circle A), but when this occurs the strain is no longer interfertile with other incompatible strains.

This reproductive incompatibility can be cured by raising the beetles in tetracycline and other antibiotics, so Wade and Stevens conclude that

(1) most strains of T. confusum harbor a microorganism whose loss can induce a non-genetic partial reproductive isolation from other infected strains.

(2) infected males are not reproductively compatible with cured females, but infected females can successfully reproduce with either cured or infected males.

(3) Furthermore, the numbers of offspring produced by cured and uncured pairs are not significantly different.

In a survey of five laboratory and nine recently collected strains of Tribolium castaneum Wade and Stevens failed to find any reproductive incompatibility, and they failed to induce it by rearing adults in 0.1% tetracycline for 20 days.

The purpose of this investigation was to determine whether any of the wild type strains maintained at the Tribolium Stock Center exhibit this kind of reproductive incompatibility.

Materials and Methods

The following wild type strains were used:

A = Chicago
B = Davis
C = Florida
D = McGill
E = Pest Infestation Lab
F = Calif. State College, San Bernardino*
G = Sacramento
H = Texas
I = Yucaipa, CA
J = Veracruz
K = Berkeley synthetic, marked with s
L = Berkeley synthetic, no body color markers
M = Origin unknown
N = UPF (Purdue Foundation via New York)
O = San Bernardino, CA
P = CS-4 an inbred strain from from T. Park's research
Q = Veracruz small
R = Veracruz reared in association with b-circle T.cf. for 3 generations

*a strain found in the biology stockroom, in a brewer's yeast container.

Male and female pupae from each stock were separated as to sex until use.

Intra-strain crosses are represented by AA,BB,CC ... RR.

Interstrain crosses were carried in reciprocal fashion, and the code gives females first. Thus, AB is A female X B male, while BA is B female X A male.

Wherever possible 10 replicates were crossed. Each pair of beetles was introduced into a one-gram vial about 2/3 filled with unbleached flour.

Results

Table 1 shows the fraction of successful matings. (The numerator shows the number of vials in which progeny were found and the denominator, the number of vials for that mating set up.)

Although the table shows that some combinations of crosses were not carried out because of the lack of sexed beetles when the experiment was set up (strain L = the Berkeley synthetic strain not marked with body color genes; R-is one of the Veracruz strains) generally there were other strains from the same source to fill the gap, so all of the partial matings with those strains could have been omitted altogether.

Conclusion

This study with at least 15 different strains of *T. castaneum* from different sources, plus the nine strains of *T. castaneum* investigated by Wade and Stevens seems to indicate that the reproductive incompatibility observed in *T. confusum* is not a general phenomenon in *Tribolium*. However, future investigations in flour beetles should keep this phenomenon in mind.

Fraction of successful intra- and interstrain matings. (Most of the crosses had 10 replicates. A few had either 3 or 5 replicates. A dash (-) indicates those crosses were not done.)

AA 9/10	AB 9/10	AC 9/10	AD 10/10	AE 8/10	AF 7/10	AG 7/10	AH 6/10	AI 5/10	AJ 6/10	AK 6/10	AL 6/10	AM 8/10	AN 8/10	AO 10/10	AP 6/10	AQ --	AR --
BA --	BB --	BC 9/10	BD 8/10	BE 1/10	BF 9/10	BG 9/10	BH 8/10	BI 9/10	BJ 6/10	BK --	BL 5/10	BM 9/10	BN --	BO --	BP --	BQ --	BR --
CA 7/10	CB --	CC 10/10	CD 9/10	CE 8/10	CF 9/10	CG 10/10	CH 10/10	CI 9/10	CJ 10/10	CK 2/5	CL 10/10	CM 10/10	CN 10/10	CO 10/10	CP 10/10	CQ 10/10	CR 9/10
DA 8/10	DB 10/10	DC 8/10	DD 10/10	DE 8/10	DF 10/10	DG 8/10	DH 9/10	DI 10/10	DJ 10/10	DK --	DL 9/10	DM 9/10	DN 10/10	DO 8/10	DP 10/10	DQ 9/10	QR 10/10
EA 7/10	EB 8/10	EC 7/10	ED --	EE 9/10	EF --	EG 8/10	EH 8/10	EI --	EJ 5/10	EK --	EL --	EM 9/10	EN 6/10	EO --	EP --	EQ 5/10	ER 8/10
FA 10/10	FB 9/10	FC 10/10	FD 9/10	FE 7/10	FF 5/10	FG 10/10	FH 10/10	FI 8/10	FJ 10/10	FK --	FL 8/10	FM 10/10	FN 10/10	FO 10/10	FP 10/10	FQ 10/10	FR 6/10
GA 10/10	GB 10/10	GC 9/10	GD 9/10	GE 10/10	GF 8/10	GG 9/10	GH 7/10	GI 9/10	GJ 8/10	GK --	GL 8/10	GM 10/10	GN 9/10	GO 9/10	GP 10/10	GQ 9/10	GR 10/10
HA 6/10	HB 9/10	HC 9/10	HD 10/10	HE 9/10	HF 10/10	HG 10/10	HH 7/10	H 8/10	HJ 10/10	HK 5/10	HL 5/10	HM 7/10	HN 4/10	HO 7/10	HP 5/10	HQ 5/10	HR --
IA 9/10	IB 9/10	IC 10/10	ID 10/10	IE 3/5	IF 9/10	IG 9/10	IH 7/10	II 10/10	IJ 10/10	IK 7/10	IL 8/10	IM 9/10	IN 10/10	IO 10/10	IP 8/10	IQ 9/10	IR 10/10
JA 9/10	JB 10/10	JC 9/10	JD 9/10	JE --	JF 10/10	JG 7/10	JH 10/10	JI 9/10	JJ 10/10	JK 7/10	JL 10/10	JM 9/10	JN 9/10	JO 10/10	JP 7/10	JQ 8/10	JR 10/10
KA 6/10	KB 7/10	KC 10/10	KD 9/10	KE 7/10	KF 7/10	KG 7/10	KH 8/10	KI 8/10	KJ 7/10	KK 9/10	KL 9/10	KM 9/10	KN 10/10	KO 10/10	KP 10/10	KQ 10/10	KR 9/10
LA 10/10	LB 7/10	LC 10/10	LD 7/10	LE --	LF 5/5	LG --	LH --	LI --	LJ --	LK --	LL --	LM --	LN --	LO --	LP --	LQ --	LR --
MA 9/10	MB 8/10	MC 10/10	MD 9/10	ME 3	MF 10/10	MG 9/10	MH 4/5	MI 9/10	MJ 7/10	MK 6/10	ML 10/10	MM 9/10	MN 8/10	MO 10/10	MP 10/10	MQ 10/10	MR 8/10
NA 10/10	NB 10/10	NC 10/10	ND 10/10	NE --	NF 10/10	NG 8/10	NH 9/10	NI 9/10	NJ 10/10	NK --	NL 10/10	NM 8/10	NN 7/10	NO 6/10	NP 4/10	NQ 8/10	NR 6/10
OA 10/10	OB 9/10	OC 9/10	OD 10/10	OE --	OF 9/10	OG 9/10	OH 8/10	OI 10/10	OJ 9/10	OK 9/10	OL --	OM 10/10	ON 10/10	OO 10/10	OP 9/10	OQ 9/10	OR 5/5
PA 9/10	PB 10/10	PC 9/10	PD 9/10	PE --	PF 10/10	PG 10/10	PH 9/10	PI 10/10	PJ 10/10	PK 10/10	PL --	PM 10/10	PN 10/10	PO 9/10	PP 9/10	PQ 10/10	PR 9/10
QA 10/10	QB 10/10	QC 10/10	QD 10/10	QE 2/3	QF 9/10	QG 8/10	QH 9/10	QI 10/10	QJ 10/10	QK 10/10	QL --	QM 10/10	QN 7/10	QO 10/10	QP 9/10	QQ 10/10	QR 10/10
RA 3/5	RB 4/5	RC 3/5	RD 4/5	RE --	RF 3/5	RG 4/5	RH 3/5	RI --	RJ 3/5	RK --	RL --	RM --	RN 3/5	RO --	RP 3/5	RQ --	RR --

FABRICATION OF A SIEVE FRAME FOR COLLECTING TRIBOLIUM

Peter Backer, Joe Borelli and Pran Vohra

Department of Avian Sciences, University of California

Davis, CA 95616

We have been unable to buy brass ring frames to assemble the sieves needed for sifting Tribolium beetles, larvae or eggs from the stock diet. We decided to fabricate the ring frames from white polyvinyl plastic pipes readily available in any hardware store. Two pieces of pipe were needed. For the inner ring, a 4.0 cm long section was cut from a pipe with a 11.4 cm external diameter and 10.4 cm internal diameter. A 2 cm long piece of a pipe with an internal diameter of 11.4 cm and external diameter of 12.0 cm served as the outer ring. The thickness of the a length (2.5 cm) of the inner ring was reduced by 0.01 cm by uniform milling of the outer surface so that when the silk bolting was in place, the outer ring would slide easily but tightly over the end. The overall dimensions are given in the sketch. The fabrication of this ring frame is inexpensive and relatively easy. As the internal surface of polyvinyl plastic rings is more rough than of brass rings, the beetles may climb the sides. It may be possible to overcome this drawback by polishing the internal surface to a more smooth finish.

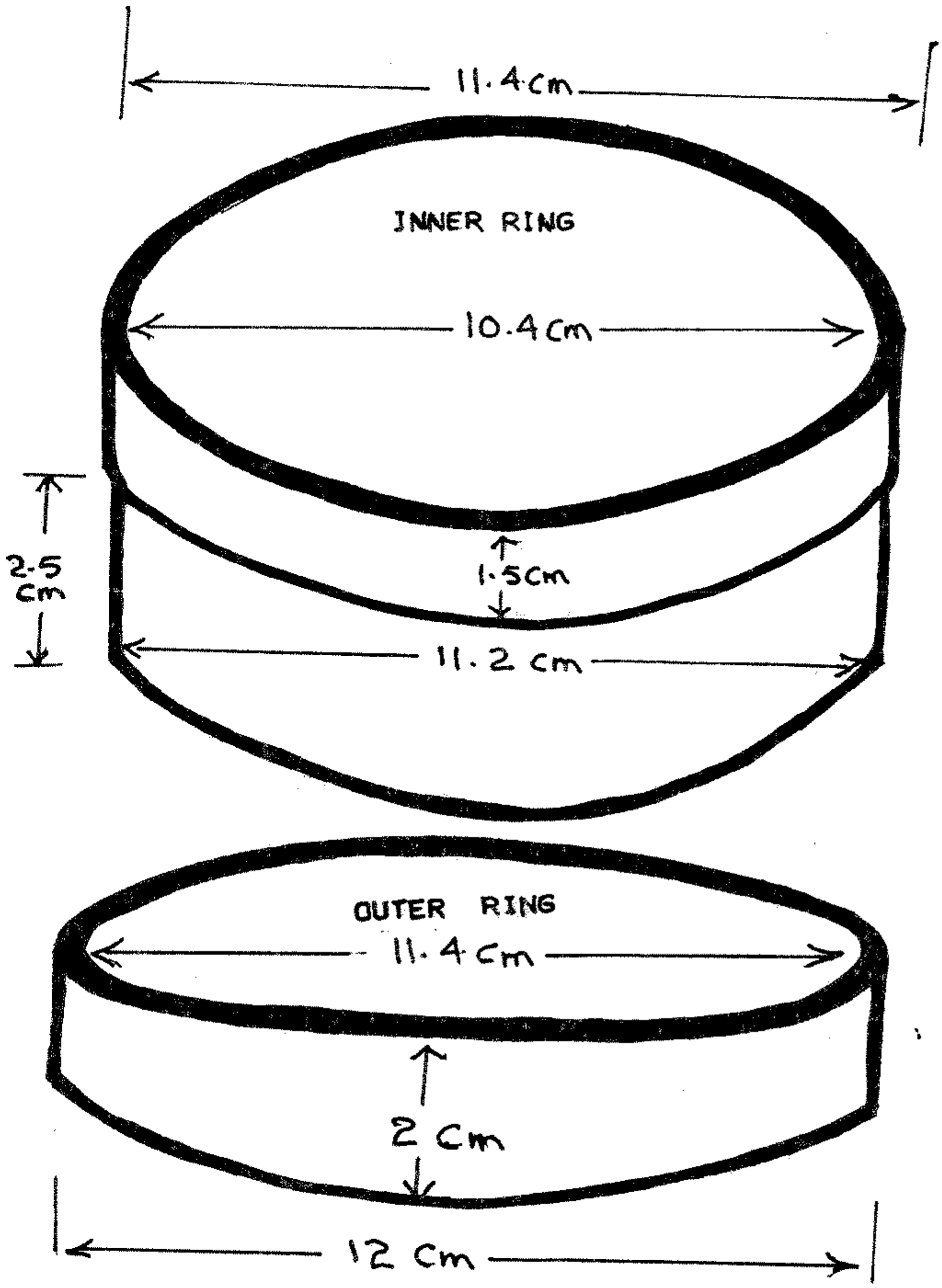


DIAGRAM FOR FABRICATION OF A SIEVE FRAME

Note - Technical

A simple, economical, and escape-proof plastic device to detect insects in stored grain

A new plastic trap to detect insects in stored grain has been developed by Canadian entomologists. It is a new version of a metal one originally designed in 1967 at the Agriculture Canada Research Station Winnipeg and improved in 1973. These were described in the Canadian Entomologist 99:1160-1163, 1967, and 105:437-440, 1973. The unique escape-proof feature of these traps allows the user to leave them inserted in grain for any desired period. Thus, the longer it is left in the stored commodity, the greater is the probability of insect detection.

The new plastic version is simpler in design and more economical to produce than the original trap. Producers and grain handlers could use them in quantity to monitor their stores.

The presence of primary grain feeding beetles in the traps indicates the need for fumigation. The presence of fungus beetles indicate that the grain may be going out of condition and that immediate remedial action is necessary. In this situation, fumigation is not sufficient because, although it will kill the beetles, it will not stop the deterioration process caused by storage microflora. The recommended procedure is to physically move the grain to dissipate heat, break up lumps, and if necessary, dry the grain. This is a monumental task for producers or handlers with large volume storages but is a preferable alternative to facing a total loss. The use of the traps as early detection devices would help to minimize or prevent losses.

A licence to produce and sell the plastic traps has been granted by Canadian Patents and Development Ltd. to:

Dr. F. Madrid, President
Agribiotech International Inc.
35 Mount Allison Bay
Winnipeg, Manitoba, Canada
R3T 3L4

For further information, contact Dr. Madrid or the undersigned.

S.R. Loschiavo
Research Station, Agriculture Canada
Winnipeg, Manitoba, Canada

BIBLIOGRAPHY OF TRIBOLIUM AND OTHER COLEOPTERA

Compiled

by

A.SOKOLOFF

BIBLIOGRAPHY

1. ANATOMY AND HISTOLOGY

2. BEHAVIOR

ALI, A. and KHAN, A.R. 1985. Effect of Lathyrus sativus flour on food preference of Tribolium confusum larvae (Colептera: Tenebrionidae). Univ. J. Zool. Rajshahi Univ. 4:83-84.

NAWROT, J., BLOSZYK, E., HARMATHA, J. and NOVOTNY, L.Z. 1984. The effect of bisaboloangelone, helenalin and bakkennolide A on development ande behavior of some stored product beetles. Z. Angew. Entomol. 98:394-398.

MILLAR, J.G., PIERCE, H.D., Jr., PIERCE, A.M., OEHLSCHLAGER, A. and BORDEN, J.H. 1985. Aggregation pheromones of the grain beetle, Cryptolestes turcicus (Coleptera: Cucujidae). J. Chem. Ecol. 11:1071-1081.

MILLAR, J.G., PIERCE, H.D., Jr., PIERCE, A.M., OEHLSCHLAGER, A. C., BORDEN, J.H. and BARAK, A.V. 1985. Aggregation pheromones of the flat grain beetle, Cryptolestes pusillus (Coleoptera: Cucujidae). J. Chem. Ecol. 11:1053-1070.

PIERCE, A.M., PIERCE, H.D., Jr., OEHLSCHLAGER, A.C. and Borden, J.H. 1985. Macrolide aggregation pheromones in Oryzaephilus surinamensis and Oryzaephilus mercator (Coleoptera: Cucujidae). J. Agric. & Food Chem. 33:848-852.

PIERCE, A.M., PIERCE, H.D., JR., BORDEN, J.H. and OEHLSCHLAGER, A.C. 1986. Enhanced production of aggregation pheromones in four stored-product coleopterans feeding on methoprene treated oats. Experientia 42:164-165.

SHINODA, K. and YOSHIDA, T. 1984. Relationship between adult feeding and emigration from beans of azuki bean weevil, Callosobruchus chinensis Linne (Coleoptera: Bruchidae). Appl. Ent. Zool. 19:202-211.

TANAKA, Y., HONDA, H., OHSAWA, K. and YAMAMOTO, I. 1986. A SEX attractant of the yellow mealworm, Tenebrio molitor L., and its role in the mating behavior. Nippon Noyaky Gakkaishi 11:49-55.

BIBLIOGRAPHY

3. CYTOLOGY AND ELECTRON MICROSCOPY

BERDAN, R.C., LEES-MILLER, J.P. and CAVENEY, S. 1985. Lack of cell communication in an epithelium: ultrastructure and electro-physiology of the midgut epithelium of the larval mealworm, Tenebrio molitor. J. Ultrastruct. Res. 90:55-70.

FERREIRA, A., CELLA, D.M., MESA, A. and VIRKKI, N. 1984. Cytology and systematical position of Stylopsids (=Strepsiptera). Hereditas 100:51-52.

FLORES, M., DENTON, A. and VIRKKI, N. 1984. Chromosomes of Sphictyrtus Whitei (Guerin. Meneville) (Hemiptera: Coreidae). Chromos. Int. Service 37: 15-17.

MAZZELLA, C., VIRKKI, N. and DENTON, A. 1985. Citoquímica de la asociación Xyp en Coleoptera. Abstracts, VII Congr. Latinoam. Genét. Bogotá, 1985.

SPEIRS, R.D., WHITE, G.D. and WILSON, J.L. 1986. SEM observations of rice weevil larvae, Sitophilus oryzae (L.) (Coleoptera: Curculionidae). J. Kans. Entomol. Soc. 59:390-394.

UBELAKER, J.E., RITZ, D.E., KNIGHT, J., and ALLISON, V.F. 1986. Electron microscopy of midguts from adult and larval Tenebrio molitor (Coleoptera) as barriers to oncospheres of Hymenolepis diminuta (Cestoda). Trans. Am. Microsc. Soc. 105:282-289.

VIRKKI, N. 1983. Further Chrysomelids with an X + Y sex chromosome system: Megalopodinae. Hereditas 98: 200-213.

VIRKKI, N. 1983. Colores cromatidales proximales vs distales en Coleóptera. Resúmenes VI Congr. Latinoam. Genét. (Maracaibo) p. 10.

VIRKKI, N. 1983. Banding of Oedionychina (Coleoptera:Alticinae) chromosomes: c- and Ag-bands. J. Agric. Univ. P.R. 67:221-255.

Virkki, N. 1984. Colores cromatidales proximales vs distales en Coleóptera. Genética. Mem. VI Congr. Latinoam. de Genet.p.241.

VIRKKI, N. 1984. Additional observations on the life history of the Oedionychina. J. Agric. Univ. P.R. 68:107-109.+

VIRKKI, N. 1984. Chromosomes in evolution of Coleoptera. In: A.K. Sharma and . Sharma (Eds). Chromosomes in evolution of Eukaryotic groups. CRC Press, Florida. II:41-76.

VIRKKI, N. (In press). Cytotaxonomy of Alticinae. In : Jolivet, P., Petitpierre, E. and Hsiao, H. (Eds.). Biology of Chrysomelidae. Dr. W. Junk, Publishers, The Netherlands.

BIBLIOGRAPHY

VIRKKI, N., CELLA, D.M., RAMOS TARDIVO, J. and VIRKKI, N. 1984. Two pairs of chromosomes: A new low record for Coleoptera. Rev. Brazil Genet. 7:231-240.

VIRKKI, N., FLORES, M. and ESCUDERO, J. 1984. Structure, orientation, and segregation of the sex trivalent in _Pyrophorus luminosus_ Ill. (Coleoptera:Elateridae). Can. J. gen. Cyt. 26:326-330.

VIRKKI, N. and MAZZELLA, M.C. 1984. Silver staining of the sex parachute (Xy , X neoXneoY) of some polyphagan beetles. XVII Internat. Congr. Entom. Hamburg. Abs. Vol.:391

VIRKKI, N. 1985. The cytogenetic system of Oedionychina (Alticinae). Entomography 3:480-497.

VIRKKI, N., BRUCK, T. and DENTON, A. (in press). Brief notes on the cytology of Neotropical Coleoptera. 5. Storage and activation of the large sperm cells in Alticinae. J. Agric. Univ. P.R.

VIRKKI, N. and DENTON, A. (In press). Brief notes on the cytology of Neotropical Coleoptera. 4. _Chalcolepidius silbermanni_ Chevrolat (Lateridae: Pyrophorini). J. Agric. Univ. P.R.

WEITH, A. 1985. The fine structure of euchromatin and centromeric heterochromatic in _Tenebrio molitor_ chromosomes. Chromosoma 91:287-296.

WHITE, P.R. and LUKE, B.M. 1986. Fine structure, function and distribution of antennal sensilla in the saw-toothed grain beetle, _Oryzaephilus surinamensis._ Physiol. Entomol. 11:227-238.

BIBLIOGRAPHY

4. INSECT TISSUE CULTURE AND EMBRYOLOGY

BIBLIOGRAPHY

5. ECOLOGY AND POPULATION ECOLOGY

AWADALLAH, K.T., TAWFI, M.F.S., EL-HUSSEINI, M.M., and IBRAHIM, A.M.A. 1986. Effect of larval preys on the biocycle of Xylocoris sordidus (Reuter) (Anthocoridae, Hemiptera). Arch. Phytopathol. Pflanzenschutz. 22:237-242.

BAIRD, C.R., BISHOP, G.W. and BARUNI, M.A.M. 1985. Life history and distribution of Pseudobaris nigrina (Say) in Idaho (Coleoptera: Curculionidae). Colept. Bull. 39: 221-225.

BHATIA, P. 1963. Studies on the interspecific competition between Tribolium castaneum (Herst) (Coleoptera: Tenebrionidae) and Corcyra cephalonica Staint (Lepidoptera: Pyralidae). M.Sc. Thesis submitted to the P.G. School, IARI, New Delhi.

BIJOK, p. 1986. Energetic budget of Tribolium confusum Duval bIV strain in its developmental cycle. Ph.D. thesis, Institute of Ecology, PAS Library, 88pp.

DASS, R., NAVARAJAN PAUL, A.V. and AGARWAL, R.A. 1984. feeding potential and biology of lesses mealworm Alphitobius diaperinus (Panz.) (Col., Tenebrionidae), preying on Corcyra cephalonica St. (Lep. Pyralidae). Z. Angew. Entomol. 98:444-447.

DOWDY, A.K., BERBERET, R.C. and CADDEL, J.L. 1986. Population densities of alfalfa weevil, Hypera postica (Colepteral: Curculionidae), with varied fall planting dates for alfalfa. J. Econ. Entomol. 79:790-796.

FISCHER, r. 1984. Sclerophaedon orbicularis (Suffr.) and its development stages (Coleoptera, Chrysomelidae). Deut. Entomol Z. Neue Folge 31:291-298.

GOLEBIOWSKA, ZOFIA. 1967? Migration of several species of beetles in piles of stored wheat. 15. Institute for Protection of Plants, Posnan, Poland.

HAGRAS, A.E. 1986. Some ecological factors affecting population growth of the rust-red flour beetle Tribolium castaneum Herbst (Coleoptera: Tenebrionidae). I. Space and temperature. Arab Gulf J. Sci. Res. 4:303-312.

HAREIN, P.K. 1986. Tribolium confusum DuVal responses to certain molds and mycotoxins. In: S. Barry and D.R. Houghton (Eds.). Biodeterioration 6: 664-666. The Cambrian News Ltd., Aberystwyth.

LOSCHIAVO, S.R. 1983. distribution of the rusty grain beetle (Coleoptera: Cucujidae) in columns of wheat stored or with localized high moisture content. J. Econ. Entomol. 76:881-884.

BIBLIOGRAPHY

LOSCHIAVO, S.R. 1985. Post-harvest grain temperature, moisture and insect infestation in steel granaries in Manitoba. Can. Ent. 117:7-14.

LOSCHIAVO, S.R. and LAMB, R.J. 1985. Food preference, survival, and development of four stored-product pests (Coleoptera) on rapeseed and canola (Brassica spp.). Can. Ent. 117:575-580.

LOSCHIAVO, S.R. and WHITE, N.D.G. 1986. Effects of diet and population density on larval development and pupal weight of Tribolium confusum. Can. Ent. 118:733-734.

MOOKHERJEE, P.B., BHATIA, P. and VERMA, S. 1976. Interspecific competition between Tribolium castaneum and Corcyra cephalonica (Staint). Indian J. Ent. 38:201.

MULLER, J.K. 1986. Adaptations for reducing intraspecific competition in Carabid beetles (Coleoptera). Zool Jahrb. Abt. Syst. Okol. Geogr. Tiere 113:343-352.

PIERCE, A.M., BORDEN, J.H. and OEHLSCHLAGER, A.C. 1983. Effects of age and population density on response to the beetle and food volatiles by Oryzaephilus surinamensis and O. mercator (Coleoptera: Cucujidae). Environmental Ent. 12:1367-1374.

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. 21:115-118.

RYOO, M. II, and CHO, K.J. 1986. Life history and intrinsic rate of natural increase of the rice weevil, Sitophilus oryzae (l.) (Coleoptera: Curculionidae) in rice. Korean J. Entomol. 16:1-5.

SHAZALI, M.E.H. 1985. Intraspecific competition and progeny production in Sitophilus oryzae (L.) (Coleopt.) and Sitotroga cerealella (Oliv.) (Lepid.) in Sorghum grain. Anz. Schadlingskd. Pflanzenschutz Umweltschutz. 58:121-123.

SHINODA, K. and YOSHIDA, T. 1985. Field biology of the azuki bean weevil, Callosobruchus chinensis (L.) (Coleoptera: Bruchidae). I. Seasonal prevalence and assessment of field infestation of aki-azuki, autumn variety of Phaseolus angularis W. Jpn. J. Appl. Ent. Zool. 29:14-20

SINCLAIR, E.R. and HADDRELL, R.L. 1085. Flight of stored products beetles over a grain farming area in Southern Queensland. J. Aust. ent. Soc. 24:9-15.

TILTON, E.W. and BROWER, J.H. 1973. Utilization of irradiated sperm from successive matings by the female cowpea weevil. J. Econ. Entomol. 66:545-546.

BIBLIOGRAPHY

TOGASHI, K. 1986. Effects of the initial density and natural enemies on the survival rate of the Japanese pine sawyer, *Monochamus alternatus* Hope (Coleoptera: Cerambycidae) in pine logs. Appl. Entomol. Zool. 21:244-251.

TSUDA, Y. and YOSHIDA, T. 1985. Population biology of the broadhorned flour beetle, *Gnathocerus cornutus* (F.) II. Crowding effects of larvae on their survival and development. Res. Popul. Ecol. 27:77-85.

WHITE, G.G. 1984. Variation between field and laboratory populations of *Tribolium castaneum* (Herbst) (Coleoptera:Tenebrionidae). Aust. J. Ecol. 9:153-155.

WHITE, N.D.G. and LOSCHIAVO, S.R. 1986. Effects of insect density, trap depth, and attractants on the capture of *Tribolium castaneum* (Coleoptera: Tenebrionidae) and *Cryptolestes ferrugineus* (Coleoptera: Cucujidae) in stored wheat. J. Econ Entomol. 79:1111-1117.

BIBLIOGRAPHY

6. GENERAL

VIRKKI, N. And ZAMBRANA, I. 1983. Life history of Alagoasa bicolor (L.) (Coleoptera) in indoor rearing conditions. Entom. Arb. Mus. Frey 31/32:131-155.

YOSHIDA, T. 1983. Damage and losses in stored products by insect pests in tropical countries. Proc. 3rd NFRI-UNU Work.:9-19.

YOSHIDA, T. 1983. Bio-loss of grains by stored-product insects in tropical countries. -Loss Assessment- Food Industry 26:23-28.

YOSHIDA, T. 1985. Integrated stored-product pest management. House & Household Insect Pests Nos. 25,26:86-93.

BIBLIOGRAPHY

7. GENETICS AND PHENOTYPIC VARIATION

CAMPO, J.L., and RAYA, L.G.1986. Realized genetic parameters from an antagonistic selection index in Tribolium castaneum. Can. J. Genet. Cytol 28:358-364.

CAMPO, J.L. and RODRIGUEZ, M.C. 1985. Experimental comparison of methods for simultaneous selection of two correlated traits in Tribolium. I. Empirical and theoretical selection indexes. Theor. Appl. Genet. 71:93-100.

COHEN, E. 1986. Glutathione-S-transferase activity and its induction in several strains of Tribolium castaneum. Entomol. Exp. Appl. 41:39-44.

DAWSON, P.S. 1984. The "reindeer" mutation and a revision of linkage groups V and X in 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. 27:276-278.

DESHARNAIS, R.A. and Costantino, R.F. 1985. Genetic analysis of a population of Tribolium. VIII. The stationary stochastic dynamics of adult numbers. Can J. Genet. Cytol. 27:341-350.

DION, N. and MINVIELLE, F. 1985. The effects of alternated vcycles of full-sib and random mating on selection for pupa weight in Tribolium castaneum. Can. J. Genet. Cytol. 27:251-254.

FASULATI, S.R. 1985 (1986). Polymorphism and population structure of the Colorado beetle Leptinotarsa decemlineata Say in European part of the USSR. sov. J. Ecol. 16:355-360.

FERNANDO, R.L. and GIANOLA, D. 1986. Effect of assortative mating on genetic change due to selection. Theor. Appl. Genet. 72:395-404.

MWENYA, W.N.M., GIANOLA, D. and GROSSMAN, M. 1986. Effects of assortative mating for pupa weight on genetic parameters of unselected Tribolium castaneum. Theor. Appl. Genet. 72:388-394.

GRAUP, D. and WOOL, D. 1985. Unidirectional interspecific mating in Tribolium castaneum and Tribolium confusum: evolutionary and ecological implications. Entomol. Exp. Appl. 38:261-265.

RAHALKAR, G.W., TAMHANKAR, A.J. and GOTHI, K.K. 1985. Selective breeding for reduced male response to female sex pheromone in Trogoderma granarium Everts (Coleoptera: Dermestidae). J. Stored Prod. Res. 21:121-126.

BIBLIOGRAPHY

RIDDLE, R.A., DAWSON, P.S. and ZIRKLE, D.F. 1986. An experimental test of the relationship between genetic variation and environmental variation in *Tribolium* flour beetles. Genetics 113:391-404.

RIDDLE, R.A., SYKES, R. LEFFEL, L.J. and DAWSON, P.S. 1985. Genetic basis of extremely slow development in population of *Tribolium confusum*. Can. J. Genet. Cytol. 27:650-654.

SOKOLOFF, A. and FAUSTINI, D. 1987. Dachs, a mutant in *Tribolium* with effects analogous to engrailed in Drosophila. J. Hered. 78:2-7.

SOKOLOFF, A., FERRONE, R.R., CHANEY, J.D., BRADEN, J. and MUNOZ, R.R. 1987. Linkage studies in Tribolium castaneum (Herbst). XII. A revision of linkage group II. Gnome 29:26-33.

BIBLIOGRAPHY

8. INSECTICIDES AND INSECTICIDE RESISTANCE

AMIN, M.E., KAMEL, A.H., ISMAIL, I.I. and EL-NAHAL, A.K.M. 1983. Effect of rearing Tribolium castaneum (Hbst.) on rice germ and rice bran on the susceptibility of its developmental stages to methyl bromide fumigation. Bell. Entomol. Soc. Egypt Econ Ser. 11:57-63.

BANKS, H.J., and CAVANAUGH, J.A. 1985. Toxicity of phosphine to Trogoderma variabile Ballion (Coleoptera: Dermestidae) Aust. Entomol. Soc. 24:179-186.

BEEMAN, R.W. and NANIS, S.M. 1986. Malathion resistance alleles and their fitness in the red flour beetle (Coleoptera:Tenebrionidae). J. Econ. Entomol. 79:580-587.

BOWRY, S.K., PANDEY, N.D. and TRIPATHI, R.A. 1984. Evaluation of certain oilseed cake powders as grain protectant against Sitophilus oryzae Linnae us. Indian J. Entomol. 46:196-200.

CHANDER, H., and AHMED, S.M. 1985. Efficacy of natural embelin against the red flour beetle, Tribolium castaneum (Herbst). Insect Sci. Appl. 6:217-220.

COLLINS, P.J. 1985. Resistance to grain protectants in field populations of the sawtoothed grain beetle in southern Queensland. Aust. J. Exp. Agric. 25:683-686.

COLLINS, P.J. 1986. Genetic analysis of fenitrothion resistance in the sawtoothed grain beetle, Oryzaephilus surinamensis (Coleoptera: Cucujidae). J. Econ. Entomol. 79:1196-1199.

COLLINS, P.J. and WILSON, D. 1986. Insecticide resistance in the major coleopterous pests of stored grain in southern Queensland. Qd. J. Agric. Anim. Sci. 43:107-114.

DIKSHIT, A.K. 1985. Evaluation of fenitrothion as a wheat protectant. Pestology 9:34-37.

FARAGALLA, A.A., IBRAHIM, M.A. and MOSTAFA, S.A.S. 1985. Reproductive inhibition of F1 progeny of some stored grain pests (Tenebrionidae, Bostrichidae) fed on grains treated with the antimoulting inhibitor Dimilin. Z. Angew. Entomol. 100:57-62.

GOLOB, P., CHANGIAROEN, P., AHMED, A and COX, J. 1985. Susceptibility of Prostephanus truncatus (Horn) (Coleoptera: Bostrichidae) to insecticides. J. Stored Prod. Res. 21:141-150.

HEATHER, N.W. 1986. Sex-linked resistance to pyrethroids in Sitophilus oryzae (L.) (Coleoptera:Curculionidae). J. Stored Prod. Res. 22:15-20.

BIBLIOGRAPHY

HIGHLAND, H.A., CLINE, L.D. and SIMONAITIS, R.A. 1986. Insect resistance of chlorpyrifos-methyl and permethrin-treated film overwraps on cases of packaged food. J. Econ. Entomol. 79:775-778.

HODGES, R.J. and MEIK, J. 1986. Lethal and sublethal effects of permethrin on Tanzanian strains of Tribolium castaneum (Herbst), Gnatocerus maxillosus (F.), Sitophilus oryzae (l.) and Sitophilus zeamais Motschulsky. Insect Science and its Application 7:533-537.

JOIA, B.S., LOSCHIAVO, S.R. and WEBSTER, G.R.B. 1985. Cypermethrin and fenvalerate as grain protectants against Tribolium castaneum (Coleoptera: Tenebrionidae) and Cryptolestees ferrugineus (Coleoptera: Cucujidae) at different moisture levels and temperatures. J. Econ. Entomol.78:637-641.

JOIA, B.S., WEBSTER, G.R.B. and LOSCHIAVO, S.R. 1985. Cypermethrin and fenvalerate residues in stored wheat and milled fractions. J. Agric Food Chem. 33:618-622.

LEVCHENKO, E.A. 1986. Laboratory evaluation of the toxicity of a number of insecticides for Sitophilus granarius and Tribolium castaneum. Agrokhimiia 4:90-95.

MURUVANDA, D.A., BEARDSLEY, J.W. and MITCHELL, W.C. 1986. Insectidal control of sweet potato weevils (Coleoptera: Curculionidae) in Hawaii. Trop. Agric. 63:155-157, 164.

NAKAKITA, H., and KURODA, J. 1986. Differences in phosphine uptake between susceptible and resistant strains of insects. Nippon, Nayaky Gakkaishi 11:21-26.

ROSE, H.A., and WALLBANK, B.E. 1986. Mixed-function oxidase and glutathione S-transferase activity in a susceptible and a fenitrothion-resistant strain of Oryzaephilus surinamensis (Coleoptera: Cucujidae). J. Econ Entomol. 79:896-899.

SALEEM, M.A. and SHAKOORI, A.R. 1986. Biochemical effects of sublethal doses of cypermethrin on the sixth-instar larvae of Tribolium castaneum (Herbst). Arch Insect Biochem. Physiol. 3:447-455.

SANTOS, S.C., and LIM-SYLIANCO, C.Y. 1985. DDT resistance in three local populations of rice weevils. Philip. J. Sci. 114:151-157.

SAXENA. S.C. and KUMAR, V. 1984. Suppression in reproducibility of Trogoderma granarium (Everts) on treating different larval instars with penfluron. Indian J. Entomol. 46:162-168.

BIBLIOGRAPHY

SAXENA, S.C. and YADAV, R.S. 1986. A preliminary laboratory evaluation of an extract of leaves of Delonix regia Raf. as a disruptor of insect growth and development. Trop. Pest Manage 32:58-59.

SETHE, G.R., GAY, A.K., BHATIA, P., BIGBY, W.S. and MEHROTRA, K.N. 1985. Kinetics of penetration of met methyl parathion in desert locust Schistocerca gregaria (Forshal). J. Nuclear Agric. Biol 14:41-42.

SU, H.C.F. 1985. Laboratory evaluation of biological activity of Cinnamomum cassia to four species of stored-product insects. J. Entomol. Sci. 20:247-253.

SU, H.C.F. 1986. Laboratory evaluation of the toxicity and repellency of coriander seed to four species of stored-product insects. J. Ga. Entomol. Sci. 21:169-174.

THAUNG, M. and COLLINS, P.J. 1986. Joint effects of temperature and insecticides on mortality and fecundity of Sitophilus oryzae (Coleoptera: Curculionidae) in wheat and maize. J. Econ. Entomol. 79:909-914.

TOMAR, S.S. and SAXENA, V.S. 1986. Synergistic effect of alpha-hexachlorocyclohexane with pyrethrins. Agric. Biol. Chem.50:2115-2116.

VEVERKA, K. and OLIBERIUS, J. 1985. Synergistic insecticidal activity of urea and ammonium nitrate. A. pflanzenkr. Pflanzenschutz. 92:258-262.

WHITE, N.D.G. 1985. Uptake of malathion and pirimiphos-methyl by rye, wheat or triticale stored on treated surfaces. J. Econ Entomol. 78:1315-1319.

WHITE, N.D.G. and LOSCHIAVO, S.R. 1985. Testing for malathion resistance in field-collected populations of Cryptolestes ferrugineus (Stephens) and factors affecting releability of the tests. J. Econ. Entomol. 78:511-515.

WHITE, N.D.G. and NOWICKI, T.W. 1985. Effects of temperature and duration of storage on the degradation of malathion residues in dry sapeseed. J. Stored Prod. Res. 21:111-114.

WILLIAMS, P. 1985. Toxicity of methyl bromide in carbon dioxide-enriched atmospheres to beetles attacking stored grain. Gen. app. Ent. 17:17-24.

BIBLIOGRAPHY

9. IRRADIATION AND USE OF ISOTOPES

ASHRAF, M. and BROWER, J.H. 1974. Histological studies of irradiation effects on the gonads of Tenebrio molitor (Coleoptera: Tenebrionidae). J. Ga. Entomol. Sci. 9:228-235.

BHATIA, P. 1978. Studies on the effect of gamma radiation on the insecticide resistant strains of Tribolium castaneum (Herbst). Ph.D. thesis submitted to the P.G. School, IARI, New Delhi.

BHATIA, P. and SETHI, G.R. 1973. effect of food medium on the susceptibility of Tribolium castaneum to gamma radiation. ISNA Newsletter 2:30-32.

BHATIA, P. And SETHI, G.R. 1976. Effect of rearing media on the susceptibility of Triboliu m castaneum (Herbst) to gamma radiation studies on the insects reared on the same media for ten generations. J. Nuclear Agric. Biol. 5:7-8.

BHATIA, P. and SETHI, G.R. 1978. Effect of gamma radiation on the adults and larvae of susceptible and insecticide resistant strains of Tribolium castaneum (Herbst). J. Nuclear Biol. 7:75-77.

BHATIA, P. and SETHI, G.R. 1979. Effect of gamma radiation and insecticidal treatment (films) on the adults of insecticide resistant strains of Tribolium castaneum (Herbst). J. Nuclear Agric. Biol. 8:28-29.

BHATIA, P. and SETHI, G.R. 1980. Combined effects of gamma radiations and insecticidal treatment (Direct Spray) on the adults of susceptible strains of Tribolium castaneum (Herbst). Indian J. Ent. 42:82-89.

BROWER, J.H. 1973. Sensitivity of Tenebrio molitor and T. obscurus to gamma irradiation. J. Econ. Entomol. 66:1175-1179.

BROWER, J.H. 1974. Radioresistance of the red flour beetle, Tribolium castaneum (Coleoptera: Tenebrionidae), exposed to sublethal doses of gamma irradiation for 25 generations. 106:241-246.

BROWER, J.H. 1973. Low-dosage gamma radiation effects on the reproductive capacity of Callosobruchus maculatus. Ann. Entomol. Soc. Am. 66:617-619.

BROWER, J.H. 1973. Depressed flour beetle: sensitivity to gamma irradiation. J. Econ. Entomol. 66:1318-1320.

BROWER, J.H. 1974. Inability of populations of Callosobruchus maculatus to develop tolerance to exposures of acute gamma irradiation. Ann. Entomol. Soc. Am. 67:287-291.

BIBLIOGRAPHY

BROWER, J.H. and MAHANY, P.G. 1973. Gamma radiation sensitivity of the cadelle, Tenebroides mauritanicus (Coleoptera: Ostomidae) and the flat grain beetle, Cryptolestes pusillus (Coleoptera: Cucujidae). J. Ga. Entomol. Sci. 8:174-184.

DELBECQUE, J.P. MEISTER, M.F. and QUENNEDEY, A. 1986. Conversion of radiolabelled 2,22,25-tri-deoxyecdysone in Tenebrio pupae. Insect Biochem. 16:57-63.

HU, T., TSAI, L.T. and fu, y.k. 1985. Gamma irradiation control Tribolium castaneum Herbst in wheat flour. Chung Hua Chih Wu Pao Hu Hsueh Hui 27:371-378.

NAKAKITA, H., HAYASHI, T., AOKI. S. and KAWASHIMA, K. 1985. Radiosensitivity of phosphine-resistant and -susceptible strains of the red flour beetle Tribolium castaneum (Herbst) (Coleoptera: Tenebrionidae). Nihon Oyo Dobutsu Konchu Gakkai Shi 29:242-246.

RABINDRA, R.J., BALASUBRAMANIA, M. and JAYARAJ, S.J. 1985. Effect of heat and gamma irradiation on the infectivity of Farinocystis tribolii to Tribolium castaneum. J. Invert. Pathol. 45:365-366.

SETHI, G.R. and BHATIA, P. 1975. Radiation methods in Entomology. Paper presented at Seminar on Radiation Analysis in Agriculture, Biology and Animal Science. Patel Chest Institute, Delhi University.

SETHI, G.R. AND BHATIA, P. 1979. Nuclear methods in entomological investigations. J. Nuclear Agric. Biol. 8:117-120.

SETHI, G.R., BHATIA, P. and PRASAD, H.H. 1974. Losses caused by sterile adults of stored grain pests in wheat. Proc. B.A.R.C. Symposium on Use of Radiation and Radioisotopes in studies of Plant Productivity. Pantnagar.

SETHI, G.R., PRASAD, H.H. and BHATIA, P. 1975. evaluation of losses caused by Trogoderma granarium (Everts) in wheat. Paper presented at seminar on Radiation Analysis in Agriculture, Biology and Animal Science. Patel Chest Institute, Delhi University.

SETHI, G.R., PRASAD, H. and BHATIA, P. 1979. Studies on the control of stored grain pest by gamma radiation under different storage conditions. J. Nuclear Agric. Biol. 8:123-125.

TILTON, E.W., BURKHOLDER, W.E. and COGBURN, R.R. 1966. Effect of gamma radiation on Trogoderma glabrum and Attagenus piceus. J. Econ. Entomol. 59:944-948.

TILTON, E.W., BURKHOLDER, W.E. and COGBURN, R.R. 1966. Effects of gamma radiation on Rhyzopertha dominica, Sitophilus oryzae, Tribolium confusum, and Lasioderma serricorne. J. Econ Entomol. 59:1363-1368.

BIBLIOGRAPHY

10. NUTRITION

ISLAM, Z. and KHAN, A.R. 1983. Effect of different millets on the formation and duration of various stages of the confused flour beetle, Tribolium confusum Duval (Coleoptera: Tenebrionidae). Univ. J. Zool. Rajshahi Univ. 2:73-74.

KABISSA, J. and FRONK, W.D. 1986. Bean foliage consumption by Mexican bean beetle (Coleoptera: Coccinellidae) and its effect on yield. J. Kans. Entomol. Soc. 59:275-279.

KHAN, A.R. and BHUIYAN, A.R. 1983. Effect of foods on the sex ratios of the flour beetle, Tribolium confusum. Ent. exp. & Appl. 34:123.

KHAN, A.R. and MAJID, A. 1985. The oviposition and fertility of the confused flour beetle, Tribolium confusum Duval (Coleoptera: Tenebrionidae) on barley and rice flours. Univ. j. Zool. Rajshahi Univ. 4:8-10.

SUJATHA, A, and PUNNAIAH, K.C. 1984. Effect of different vegetable oils on the development of Callosobruchus chinensis (1.) in black gram. Andhra Agric. J. 31:325-327.

TIPPING, P.W., MIKOLAJCZAK, K.L., RODRIGUEZ, J.G., ZILKOWSKI, B.W. and LEGG, D.E. 1986. Attraction of Sitophilus oryzae (L.) and S. zeamais Motsch. (Coleoptera: Curculionidae) to extracts from two corn genotypes. J. Kans. Entomol. Soc.59:190-194.

BIBLIOGRAPHY

11. PARASITES AND SYMBIONTS OF COLEOPTERA

ANAND, M. and PANT, N.C. 1983. Studies on symbiotes of Rhizopertha dominica (Fabricius)--isolation, cultivation and identification. Indian J. Entomol. 45:470-474.

ARMSTRONG, E. and BASS, L.K. 1986. Effects of infection by Nosema whitei on the mating frequency and fecundity of Tribolium castaneum. J. Invert. Pathol. 47:310-316.

GEDEN, C.J., AXTELL, R.C. and BROOKS, W.M. 1985. Susceptibility of the lesser mealworm, Alphitobius diaperinus (Coleoptera: Tenebrionidae) to the entomogenous nematodes Steinernema feltiae, S. Glaseri (Steinermatidae) and Heterorhabditis heliothidis (Heterorhabditidae). J. Entomol. Sci. 20:331-339.

HASAN, R. and KHAN, A.M. 1985. In vivo effect of different sulpha drugs on the mycetomal symbionts of Sitophilus granarius L. Proc. Indian Natl. Sci. Acad. Part B, Biol. Sci 51:248-253.

HURD, H. and ARME, C. 1986. Hymenolepis diminuta: effect of metacestodes on production and viability of eggs in the intermediate host, Tenebrio molitor. J. Invertebr. Pathol. 47:225-230.

HURD, H. and ARME, C. 1986. Hymenolepis diminuta: influence of metacestodes on synthesis and secretion of fat body protein and its ovarian sequestration in the intermediate host, Tenebrio molitor. Parasitology 93: 111-120.

KHAN, A.R. and SELMAN, B.J. 1984. Effect of insecticide, microsporidian, and insecticide-microsporidian doses on the growth of Tribolium castaneum larvae. J. Invertebr. Pathol. 44:230-232.

PEREZ, G. 1985. Hymenoptera parasitizing Apion spp. (Coleoptera, Curculionidae, Apionidae) in Tepoztlan, Morelos State, Mexico. Folia Entomol. Mex. 63:39-46.

PEREZ, G. and BONET, A. 1984. Some biological characteristics of Stenocorse bruchivora (Crawford) (Hymenoptera, Braconidae), an ectoparasite of Acanthoscelides obtectus (Say) (Coleoptera, Bruchidae). Folia Entomol. Mex. 62: 59-74.

BIBLIOGRAPHY

12. PESTS

ABDEL-RAHMAN, H.A., SHAUMRAR, N.F., SOLIMAN, Z.A., and EL-AGOZE, M.M. 1983. Efficiency of the anthocorid predator Xylocoris flavipes (Reut.) in biological control of stored grain insects. Bull. Entomol. Soc. Egypt Econ. Ser. 11:27-34.

ANDREWS, K.L., RUEDA, A., GANDINI, G., EVANS, S, ARANGO, A., and AVEDILLO, M. 1986. A supervised control programme for the pepper weevil, Anthonomus eugenii Cano in Honduras, Central America. Trop. Pest Manage 32:1-4.

Anonymous. 1986. Stored grain insects. U.S. agricultural Research Service. Washington D.c. The Service. 57pp.

Anonymous. 1971. Stored tobacco insects: biology and control. Washington, D.C.: The Service. 43pp.

Anonymous. 1971. Controlling insect pests of stored rice. Agric. Research Service, U.S. Dept. of Agric., Washington D.C.

ARLEU, R.J., NETO, S.S., GOMEZ, J.A., NOBREGA, A.C., and SCARDINI, D.M. 1984. Population dynamics of Cosmopolites sordidus (Germ. 1824) (Coleoptera: Curculionidae) in a banana plantation of the cv. Prata (Group aab) at Alfredo Chaves, Espiritu Santo. Turrialba 34:473-480.

BLOOME, P.D. and CUPERUS, G.W. 1984. Aeration for management of stored grain insects in wheat. Pap. Am. Soc. Agric. Eng. Microfiche Collect. 12pp. (84-3517)

CAMPION, D.G., HALL, D.R. and PREVETT, P.F. 1986. Use of pheromones in crop and stored products pest management: control and monitoring. Proc. 1st Int. Conf. on Tropical Entomol. ICIPE, Nairobi. (In Press).

CHEANEY, R.L. and TASCON, J.E. 1985. Insects attacking stored grains and their control. Arroz: investigacion y produccion; referencia de los cursos de Capacitacion sobre Arroz dictados por el Centro Internacional de Agricultura Tropical. Compilado y editado pr: Eugenio Tascon, j. y Elias Garcia D. PNUD, CIAT pp539-554.

CONWAY, J.A. 1986. insects and other arthropods recorded on stored food commodities in Nepal and Bhutan. Tropical Science 26:145-162.

CONWAY, J.A. 1986. A global view of arthropod pest status in relation to changing storage and marketing practice. Proc. 4th Int. Working Conf. Stored Prod. Prot., Tel Aviv, Israel, 1986 (in press)

BIBLIOGRAPHY

COTTON, R.T. 1958. Insect control in flour mills. Washington, D.C. : U.S. dept. of Agriculture, Agricultural Marketing Service. Marketing Research Division.

DOBIE, P. 1986. Potential use of host plant resistance. Proc. 4th Int. Working Conf. Stored Prod. Prot., Tel Aviv, Israel, 1986. (in press).

FARAGE, F.A. and ISMAIL, A.Y. 1986. Effect of stored tobacco variety on certain biological aspects of the cigarette beetle Lasioderma serricorne Fab. Iraqi J. Agric. sci. Zanco 4:91-95.

GATEHOUSE, A.M.R., FENTON, K.A. JEPSON, I. and PAVEY, D.J. 1986. The effects of alpha-amylase inhibitors on insect storage pests: inhibition of alpha-amylase in vitro and effects on development in vivo. J. Sci. Food Agric. 37:727-734.

HAINES, C.P. and LYNCH, S.M.T. 1987. A new species of Madaglyphus Fain (Acarina: Araridae) from a rice mill in Java, Indonesia. Acarologia 1987 (in press).

HIGHLAND, H.A. and LINE, L.D. 1986. Resistance to insect penetration of food pouches made of untreated polyester or premethrin-treated polypropylene film. J. Econ. Entomol. 79:527-529.

HOLSTEN, E.H. 1982. Carpenter ants: insect pests of wood products. Publ. Univ. Alaska. Coop. Ext. Serv. Div. Statewide Serv. 8pp.

INGEMANSEN, J.A. REEVES, D.L. and WALSTROM, R.J. 1986. Factors influencing stored-oat insect populations in South Dakota. J. Econ. Entomol. 79:518-522.

IVBIJARO, M.F., LIGAN, C. and YOUDEOWEI, A. 1985. Control of rice weevils, Sitophilus oryzae (L.) in stored maize with vegetable oils. Agric. Ecosys. Environ. 14:237-242.

JOHNSON, C. 1986. Weevil war faces a new battle. Farm J. 110:18-20.

LIEBHERR, J. 1986. kitchen pests: beetles, mites, moths, cockroaches, silverfish, book lice, ants. Ext. Bull E. Coop. Ext. Serv. Mich. State Univ. 8pp.

LOSCHIAVO, S.R., and LAMB, R.J. 1985. Food preferences, survival, and development of four stored-product pests (Coleoptera) on rape seed and canola (Brassica spp.). Can. Entomol. 117:575-580.

MANDAL, S.C. and GHOSH, S.N. 1984. Control of stored grain pests with particular reference to Sitophilus oryzae L. on wheat. Indian J. Entomol. 46:245-247.

BIBLIOGRAPHY

SHEHATA, A.M.E.T., MESDSALLAM, A.S., EL-BANNA, A.A., YOUSSEF, M.M. and EL-ROUBY, M.M. 1984. the effects of storage under different conditions on cooking quality, viability and bruchid infestation of faba beans (Vicia faba L.). Trop. Stored Prod. 49:9-18.

SIMONTON, W. and STONE, M. 1985. A counterflow particle-to-particle heat exchanger for thermal disinfestation. Pap. Am. Soc. Agric. Eng. Microfiche Collect. 17pp. (fiche no 85-3009).

SINCLAIR, R.E. and ALDER, J. 1985. Development of a computer simulation model of stored product insect populations on grain farms. Agricultural Systems 18:95-113.

SOKOLOV, E.A. 1985. Control of pests in grain stores. Zashch. Rast. 10:25-26.

WARNER, R.D. and GORDON, J.C. 1986. Integrated pest management of insects in food products. Dairy Food Sanit. 6:4-9.

WEIDNER, H.Z. 1985. New literature on biology and ecology of stored-products mites and insects as a basis for sound storage. Z. Pflanzenkr. Pflanzenschutz 92:535-555.

WHITE, N.D.G. and LOSCHIAVO, S.R. 1986. Effects of insect density, trap depth, and attractants on the capture of Tribolium castaneum (Coleoptera: Tenebrionidae) and Cryptolestes ferrugineus (Coleoptera: Cucujidae) in stored wheat. J. Econ. Entomol. 79:1111-1117.

ZAKLADNOI, G.A. 1984. Save grain from insect storage pests. Zashch. Rast. 7:40-41.

*****

ARTICLES FROM FRED. J. BAUR (ED.) 1984. INSECT MANAGEMENT FOR FOOD STORAGE AND PROCESSING. AMERICAN ASSOCIATION OF CEREAL CHEMISTS, St. PAUL, MINN. XIV + 384pp.

ARBOGAST, R.T. Biological control of stored-product insects: status and prospects p226-238.

BAUR, F.J. Introductory background information.

BAUR, F.J. Important behavioral characteristics of selected insects. (A table).

BURKHOLDER, W.E. The use of pheromones and food attractants for monitoring and trapping stored-product insects.

BIBLIOGRAPHY

BAUR, F.J., BURKHOLDER, W.E., CROSBY, E.R., EVERS, T.E., GENTRY, J.W., GILBERT, D., HANSON, D.S., HARTMAND. J.W., LEYSE, H. and LISCOMBE, E.A.R. Illustrations of insect problems and solutions (case histories).

BOND, E.J. Fumigation of raw and processed commodities.

DAVIS, R. and HAREIN, P.K. Fumigation of structures.

DAWSON, J.C. Spot fumigation.

GENTRY, J.W. Inspection techniques.

GILBERT, D. Insect electrocutor light traps.

HIGHLAND, H.A. Insect infestation of packages.

JAY, E. Recent advances in the use of modified atmospheres for the control of stored-product insects.

LISCOMBE, E.A.R. Fumigation of food shipments in-transit.

MULLEN, M.A. and ARBOGAST, R.T. Low temperatures in control of stored-product insects.

OKUMURA, G.T. Insect pest identification.

OLMSTEAD, G.W. Insecticides and occupational health in the food industry.

OSMUN, J.V. Insect pest management and control.

OUYE, M.T. An overview of post harvest insect research performed by USDA, ARS laboratories.

PHILLIPS, J.K. and BURKHOLDER, W.E. Health hazards of insects and mites in food.

RUTLEDGE, J.H. Space treatments in food plants.

SHEPPARD, K.O. Heat sterilization (superheating) as a control for stored-grain pests in a food plant.

WATTERS, F.L. Potential of ionizing radiation for insect control in the cereal food industry.

YEAGER, R.C. The role of the pest control operator (PCO).

ZETTLER, J.L. and REDLINGER, L.M. Arthropod pest management with residual insecticides.

BIBLIOGRAPHY

ARTICLES FROM 1984 PROCEEDINGS OF THE FOURTH AUSTRALIAN APPLIED ENTOMOLOGICAL RESEARCH CONFERENCE: ADELAIDE, SEPTEMBER 24-28, 1984; PEST CONTROL: RECENT ADVANCES AND FUTURE PROSPECTS. PETER BAILEY AND DON SWINCER, EDS. ADELAIDE, SOUTH AUSTRALIA.

EVANS, D.E. Moving towards insecticide-free storage of grain in Australia.

JEFFERIES, M.G. The identification of pests--implications for export.

LONGSTAFF, B.C. An analysis of the demographic consequences of temperature manipulation upon the efficacy of certain perticides used in the control of stored product pests.

SINCLAIR, E.R. Views on studies of long distance dispersal of stored grain insects.

WALLBANK, B.E. Fenitrothion resistance in Oryzaephilus surinamensis (L.), saw toothed grain beetle in New South Wales.

WEGECSANY, M. and ROSENBAUM, H. Vapour toxicity of methacrifos to stored grain insects.

WILLIAMS, P., MINETT, W., BUCHANAN, S.A., WILSON, A.D., SAVAGE, P., ROSENBAUM, H. and GUIFFRE, V. Developments in the use of methyl bromide and carbon dioxide mixtures for the control of grain insects.

*****

ARTICLES FROM PROCEEDINGS OF THE THIRD INTERNATIONAL WORKING CONFERENCE ON STORED-PRODUCT ENTOMOLOGY OCTOBER 23-28, 1983. KANSAS STATE UNIVERSITY, MANHATTAN, KANSAS.

ADKISSON, P.L. A perspective on pest management.

ANDREGG, B.N. Studies on the distribution and movement of 14C-malathion in stored wheat.

ARBOGAST, R.T. Natural enemies as control agents for stored-product insects.

AYERTEY, J.N. Prospects for the use of permethrin dust in the control of pests of stored grains in northern Nigeria.

BANKS, H.J. and RIPP, B.E. Sealing of grain storages for use with fumigants and controlled atmospheres.

BEEMAN, R.W. and SPEIRS, W.E. Toxicity, persistence and antagonism of avermectin B1 against stored-product insects.

BIBLIOGRAPHY

BENEZET, H.J. Survival of consecutive generations of cigarette beetles reared on media containing less than 1 ppm methoprene.

BOND, E.J. Resistance of stored product insects to fumigants.

BROWER, J.H. Tricogramma: potential new biological control method for stored-product Lepidoptera.

BURKHOLDER, W.E. Stored-product insect behavior and pheromone studies: keys to successful monitoring and trapping.

CASAS, E. de las. FAO'S programme on prevention of food losses.

CHAMP, B.R. and MCCABE, J.B. Storage of grain in earth-covered bunkers.

CHEN, Q. A survey on the distribution of stored grain insects in the People's Republic of China.

CHILDS, D.P. and BEARD, J.T. Cooling tobacco storages during the winter season for control of the cigarette beetle.

CLAFLIN, J.K., EVANS, D.E., FANE, A.G. and HILL, R.J. Thermal disinfestation of wheat in a spouted bed.

COGBURN, R.R., BURKHOLDER, W.E. and WILLIAMS, H.J. Efficacy and characteristics of dominicalure in field trapping lesser grain borers, Rhysopertha dominica.

CONCONI, J.R.E. de, CALCANEO GARCES, M., CUEVA BARAJAS, L. de la, RAMIREZ MARTINEZ, M., and SIQUEIROS BELTRONES, J. Comparative effect on life cycle and reproductive degree of Oryzaephilus surinamensis L. and Prostephanus truncatus (Horn) provoked by the action of a laser light.

DAVIS, R. A review of in-transit shipboard fumigation of grain--methodology, efficacy and safety.

DESMARCHELIER, J.M. Maximizing benefit:risk ratios from insecticide.

DUNKEL, F.V., LIANG, C. and HUANG, F.Y. Insect and fungal response to sorbic acid treated stored commodities.

FAUSTINI, D.L. Magnesium phosphide as a fumigant for control of the cigarette beetle, Lasioderma serricorne (F.) at low temperature.

FRIEDLANDER, A. Biochemical reflections on a non-chemical control method. The effect of controlled atmosphere on the biochemical processes in stored products insects.

GOLOB, P. Prostephanus truncatus (Horn), the larger grain borer, in East Africa: the development of a control strategy.

BIBLIOGRAPHY

HAGSTRUM, D.W. The population dynamics of stored-products insect pests.

HASSAN, M.R. and STEPIEN, Z. Effect of different mineral salts in food on the respiratory metabolism of _Oryzaephilus surinamensis_ (L.) (Coleoptera: Cucujidae).

JACOBSON, M. Control of stored-product insects with phytochemicals.

KRAMER, K.J., MORGAN, T.D., ROSELAND, C.R., HOPKINS, T.L. and BEEMAN, R.W. Regulation of cuticle pigmentation and sclerotization in red and black strains of the red flour beetle, _Tribolium castaneum_.

LESSARD, F.F. Feasibility and results of population dynamics studies on stored grain insects in small scale bins with simulated climatic conditions.

LESSARD, F.F. and FUZEAU, B. Disinfestation of wheat in an harbour silo bin with an exothermic inert gas generator.

NAVARRO, S., DONAHAYE, E., CALDERON M., and BULBUL, O. A system for monitoring and maintaining quality of grain in storage.

PIERCE, H.D. JR., PIERCE, A.M., MILLAR, J.G., WONG, J.W., VERIGIN, V.G., OEHLSCHLAGER, A.C. and BORDEN, J.H. Methodology for isolation and analysis of aggregation pheromones in the genera _Cryptolestes_ and _Oryzaephilus_ (Coleoptera: Cucujidae).

PINNIGER, D.B., STUBBS, M.R. and CHAMBERS, J. The evaluation of some food attractants for the detection of _Oryzaephilus surinamensis_ (L.) and other storage pests.

RODRIGUEZ, J.G., POTTS, M.F. and PATTERSON, C.G. Sorptive coatings as protectants against stored-product pests.

SANDVOL, L., HALDERSON, J., FINNEGAN, B., WILSON, J., WHITMORE, J., SHARP, W. and BECHINSKI, E. Demonstration of electronic monitoring and management of stored grain.

SAXENA, S.C., RAI, A.K., SAXENA, P.N. and SAXENA, S. Toxicity of a newly synthesized derivative of titanocene dichloride to stored product and household pests.

SAXENA, S.C. and YADAV, R.S. A new plant extract to suppress the population build up of _Tribolium castaneum_ (Herbst).

SINCLAIR, E.R. and HOWITT, C. Tests of pheromones for monitoring infestations of stored products insects.

SMILEY, R.L. The ordinal and subordinal names of mites with a list of the mite pests of stored products.

BIBLIOGRAPHY

SMITH, L.B. Insect infestation in western Canadian grain loaded in railway cars at primary elevators.

SMITH, R.H. and HOWARD, D.C. Design and analysis of competition experiments in stored-product entomology.

SODERSTROM, E.L., and BRANDL, D.G. Modified atmospheres for postharvest insect control in tree nuts and dried fruits.

SPILMAN, T.J. Identification of larvae and pupae of the larger grain borer Prostephanus truncatus (Coleoptera: Bostrichidae), and the larger black flour beetle, Cynaeus angustus (Coleoptera, Tenebrionidae).

TILTON, E.W. and VARDELL, H.H. Combinations of partial vacuum with microwave or infrared heating of grain for insect control.

WEBLEY, D.J. and MINETT, W. Developments in the use of phosphine in the Australian wheat industry.

WHITE, N.D.G., and WATTERS, F.L. Incidence of malathion resistance in Tribolium castaneum and Cryptolestes ferrugineus populations collected in Canada.

WOHLGEMUTH, R. Comparative laboratory trial with insecticides under tropical conditions.

WRIGHT, V.F. and MILLS, R.B. Estimation of stored-product insect populations in small bins using two sampling techniques.

WOJCIAK, J.H., BRIDGES, J.T. and BAGLEY, R.W. Stored product insect control with Ro 13-5223.

YOSHIDA, T. Historical change in the status of stored product insect pests especially in Japan.

BIBLIOGRAPHY

13. PHYSIOLOGY AND BIOCHEMISTRY

ADO, N. YU., PETROV, N.B. and FILIPPOVICH, YU. B. 1985. Repeated and unique sequences of some Coleoptera species. J. Evol. Biochem. Physiol 21:65-70.

BAKER, J.E., and WOO, S.M. 1985. Purification, partial characterization, and postembrionic levels of amylases from Sitophilus oryzae and Sitophilus granarius. Arch. Insect Biochem. Physiol. 2:415-428.

BESSON, M.T., DELBECQUE, J.P., MATHELIN, J., BOISSON, A.M. and DELACHAMBRE, J. 1986. Epidermal polyamine levels related to cell cycle events during the metamorphosis of Tenebrio molitor L. (Insecta, Coleoptera): effect of juvenoid application. J. Comp. Biochem. Physiol. B, Comp. Biochem 83:589-593.

DOWNER, R. G.H. and LAUFER, HANS. 1983. Endocrinology of insects. A.R. Liss, New York XVI, 707PP.

GATEHOUSE, A.M.R., BUTLER, K.J. FENTON, K.A. and GATEHOUSE, J.A. 1985. Presence and partial characterization of a major proteolytic enzyme in the larval gut of Callosobruchus maculatus. Entomol. Exp. Appl 39: 279-286.

GRIMNES, K.A. and HAPP, G.M. 1986. A monoclonal antibody against a structural protein in the spermatophore of Tenebrio molitor (Coleoptera). Insect Biochem. 16:635-643.

HOWARD, R.W., JURCHKA, A.A. and BLOMQUIST, G.J. 1986. Prostaglandin synthetase inhibitors in the defensive secretion of the red flour beetle Tribolium castaneum (Herbst) (Coleoptera: Tenebrionidae). J. Insect Biochem. 16:757-760.

ISMAILOV, A.D, SAKHAROV, G.N., DANILOV, V.S., KOVALEV, B.G. STREL'SKII, V.V. and EGOROV, N.S. 1985. Bioluminescent analysis of aldehyde-type insect pheromones. Dokl. Biochem. Akad. Nauk SSSR 281:103-106.

KAUR, S.P., SIDHU, D.S., DHILLON, S.S. and kumar, n. 1985. tRansaminases during development and aging of the bruchid, Zabrotes subfasciatus (Boh.) (Coleoptera: Bruchidae). Insect Sci. Appl. 6:585-590.

KUWAHARA, Y., YONEKAWA, Y., KAMIKIHARA, T. and SUZUKI, T. 1986. Identification of the double bond position in insect sex pheromones by mass spectrometry; trial comparison of methyl undecenoates with the natural pheromone of the varied carpet beetle. Agric. Biol. Chem. 50:2017-2024.

LEMOINE, A., and DELACHAMBRE, J. 1986. A water-soluble protein specific to the adult cuticle in Tenebrio. Its use as a marker of a new programme expressed by epidermal cells. J. Insect Biochem. 16:483-489.

BIBLIOGRAPHY

LOSCHIAVO, S.R., WONG, J., WHITE, N.D.G., PIERCE, Jr.., H.D., BORDEN, J.H. and oehlschlager, A.C. 1986. Field evaluation of a pheromone to detect adult rusty grain beetles, Cryptolestes ferrugineus (Colepteras: Cucujidae), in stored grain. Can. Ent. 118:1-8

PEFEROEN, M. and DE LOOF, A. 1986. Synthesis of vitellogenic and non-vetellogenic yold proteins by the fat body and the ovary of Leptinotarsa decemlineata. Comp. Biochem. Physiol. B, Comp. Biochem. 83:251-254.

PROVANSAL-BAUDEZ, A. and SLAMA, K. 1985. Effect of perisympathetic organs on extracardiac pulsation in Tenebrio molitor (Coleoptera). Acta Entomol. Bohemoslov. 8a2:161-169.

REDDY, G. and KUMARAN, K. 1985. The effect of juvenile hormone and its antagonists on JH esterase activity in Tenebrio molitor. Entomol. Exp. Appl. 37:213-218.

RIDDLE, W.A. 1986. Hemolymph osmoregulation in three species of beetles. Comp. Biochem. Physiol. A, Comp. Physiol. 83:619-626.

WONG, J.W. 1982?. Identification and syntheses of macrolide pheromones from Cryptolestes ferrugineus. Ph.D. Thesis, Simon Fraser University, Burnaby, B.C., 114pp.

WONG, J.W., VERIGIN, V., OEHLSCHLAGER, A.C., BORDEN, J.H., PIERCE, H.D., PIERCE, A.M. and CHONG, L. 1983. Isolation and identification of two macrolide pheromones from the frass of Cryptolestes ferrugineus (Coleoptera: Cucujidae). J. Chem. Ecol. 9:451-474.

BIBLIOGRAPHY

14. SPACE AND AERIAL ECOLOGY

BIBLIOGRAPHY

15. SPECIATION

Wootton r.j. And BETTS, C.R. 1986. Homology and function in the wings of Heteroptera. SYst. Entomol. 11:389-400.

BIBLIOGRAPHY

16. STATISTICAL METHODS AND MATHEMATICAL MODELS

FREIER, B., WARNSTORFF, K., DORFEL, H., and WETZEL, T. 1986. Mathematical-statistical examination of the horizontal dispersion dynamics of insect pests in winter wheat. Arch. Phytopathol. Pflanzenschutz 22:243-255.

KURTH, H. and ROSSBERG, D. 1986. Colorado potato beetle forecast by means of simulation model. Arch Phytopathol. Pflanzenschutz. 22:65-77.

BIBLIOGRAPHY

17. TAXONOMIC STUDIES

BELLES, X., and HALSTEAD, D.G.H.1985. Identification and geographic distribution of Gibbium aequinoctiale Boieldieu and Gibbium psylloides (Czenpinski) (Coleoptera: Ptinidae). J. Stored Prod. Res. 21:151-155.

LEVINSON, H.Z. and LEVINSON, A.R. 1985. Storage and insect species of stored grain and tombs in ancient Egypt. Z. Angew. Entomol. 100:321-339.

BIBLIOGRAPHY

18. TECHNIQUE

DENT, R.G. and BRICKEY, P.M. 1984. Physical and chemical methods for detecting insect filth in foods. In.: Fred J. Baur, Insect Management for Food Storage and Processing. American Association of Cereal Chemists. St. Paul Minn. pp. 323-328.

MCINNIS, D.O. and CUNNINGHAM, R.T. 1986. Minimum sampling of trap catches in sterile insect release programs. J. Econ. Entomol. 79:879-881.

VIRKKI, N. and DENTON, A. (In Press). Silver staining of elements in spermatogenesis of Oedionychina (Chrysomelidae, Alticinae). Hereditas (In Press).

WILLIAMS, P. 1985. Post-harvest technology in the ASEAN region. Study Tour Report 114, Agdex 110/60.

WILLIAMS, P., MINETT, W., BUCHANAN, S.A. SAVAGE, P., ROSENBAUM, H. and GUIFFRE, V. (1985). Assessment of the commercial application of a methyl bromide and carbon dioxide mixture for the control of grain insects. Plant Protection Quarterly 1:51-56.

BIBLIOGRAPHY

19. TERATOLOGY

WALTON, B.T., EDWARDS, J.S., O'NEILL, E.G. and CHEN, S.W. 1986. Postembryonic development of teratogen-induced supernumerary eyes in Acheta domestica (L.) (Orthoptera: Gryllidae). Int. J. Insect Morphol. Embryol. 15:65-72.

GEOGRAPHICAL DIRECTORY

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
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

Soliman, M. Hani, Ph.D. (2, 5, 7, 9, 10, 13, 19)

+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)

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

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

Indooroopilly, Queensland, Australia
Queensland Department of Primary Industries
Entomology Branch

Bengston, M., M. Sc. Ph.d. Grain protectant insecticides
Collins, p.j. B.Sc., Ph.d. Insecticide resistance genetics, biochemistry, fitness, insecticide assay, resistance management, resistance monitoring, ecology.

White, G.g. B. Agr. Sc., Ph.D. Ecology, pest management

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

Braby, m.f. (8, 12, 18)
Skyllas, C., Technician
Williams, P., B.Sc., A.R.C.S., Ph.D., D.I.C., M.I. Biol.
(8, 12, 18)

BANGLADESH

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

Matin, A.

Rajshahi
University of Rajshahi, Department of Zoology

Mahbub Hasan, M.D., Research Fellow
Mondal, K.A.M. Shahadat Hossain

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

*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)

BRAZIL

Piracicaba
Centro de Energia Nuclear Na Agricultura
(CENA)

Cervellini, A.
*Wiendl, F.M. (12)
Guelph, Ontario
Department of Animal and Poultry Science
Ontario Agriculture College

CANADA

University of Guelph

Friars, G.W., Ph.D. Population genetics. (7)
McMillan, I., B.Sc., m.sc., Ph.d. (7)
Patterson D.L., graduate student. Population genetics.
Zhang, L. m.Sc., graduate student, Quantitative genetics.

+Cooperative Electron Microscopy:

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

+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)
Romanow, W., M.Sc. Insect surveys. (12)
Sahota, T.S., Ph.D. Endocrinology. (13)
Sinha, R.N., Ph.D. Ecology. (5)
Smith, L.B., Ph.D. Ecology and Population dynamics. (5)
Watters, F.L., Ph.D. Insect control. (12)
Wellington, W.G., Ph.D. Experimental ecology. (5)

Winnipeg, Manitoba R3T 2M9
Agriculture Canada
Research Station
25 Dafoe Road

Loschiavo, S.R., Ph.D. Stored grain insect biology. Insect ethology and biology. (2, 5, 10, 12)
*Sholber, P., M.Sc., Microbiology of storage.
**Singh, N.B., Ph.D. Bioenergetics of storage insects, insect physiology. (12, 13)
Sinha, R.N., Ph.D. Ecology of granary insects, mites and fungi. (5, 10, 12)
Smith, L.B., Ph.D. Stored product insect ecology, low

temperature effects. (5, 7, 10, 12)
Watters, F.L., Ph.D. Storage pest control, behavior and control of stored product insects. (2, 8, 9, 12)

* Research Associate
** Post-doctoral Fellow

CHINA, PEOPLE'S REPUBLIC OF

Beijing
Beijing Agricultural University

Zhang, L. M.Sc. (7)

COLOMBIA

Bogota, D.E., Colombia, S.A.
Universidad Nacional
Depto. de Biologia
Apdo Aereo 23227

Nunez, F.

DENMARK

Lyngby
Statens Skadedyrlaboratorium

Anevad, K., cand. mag., biological investigations.
Borlund, H.F., 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

Alexandria
Alexandria University
Faculty of Agriculture
Plant Protection Department

Khamis, Awatef E.

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

Briegleb, 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)

GREAT BRITAIN

+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)

+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)
Selman, 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)
Dobie, P., B.Sc., Ph.D. Stored products entomology, especially hostplant resistance among crop varieties. (12, 18)
Giles, P.H., B.Sc., D.I.C., Dip.Agric.Sci., M.I.Biol. Stored products technology. Biology and control of insect pests. (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, 6, 12, 17)
Hodges, R.J., B.Sc., Ph.D. Stored products entomology. Control and inspection procedures using pheromones. (12)
McFarlane, J.A., B.Sc., D.I.C., M.I.Biol. Stored products technology. Biology and control 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)
Taylor, R.W.D., B.Sc. Stored products technology. Control of pests with insecticides and fumigants. (6, 8)

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)
Singh, R. Narayan, Ph.D. (2, 13)

+Hissar, Harayana
Punjab Agricultural University
partment 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 Research 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)

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

Bhat, Pushkar, N., Ph.D., Director.
Bhat, Prin P., Assistant Professor.

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

*Pant, N.C., Ph.D. (10)
Bhatia, S.K., Head, Department of Entomology, Indian Agricultural Research Institute, New Delhi, 110012, India

Punjab, Ludhiana - 141004
Punjab Agricultural University
Department of Entomology

Chahal, B.S. (12)
Patna (14)

INDONESIA

Denpasar, Bali
Universitas Udayana
Fakultas Kedoteran Hewan and Peternakan

Darmadja, D. (7)

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
Zivon, Avi. Graduate Student
Manheim, Ora. M.Sc. Technician

ITALY

Turin 10123
Universita di Torino
Via Academia Albertina

Robotti, C.A.

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)

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
Singh, Pritam, Ph. D. Rearing
Surrey, M.R., B. Sc. Rearing
Watt, J.C., Ph. D., Systematics (5, 17)

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 Ph.D. (5,7,13)

Institute of Ecology
Dziekanow Lesny near Warsaw
05-150 Lomianki

Bijok, Pawel
Prus, Miroslawa, Ph.D. (5,7,13)
Prus, Tadeusz,Assistant Professor, Laboratory head (5,7,13)
Zimakowska,-Gnoinska, Danuta, Ph.D. (5,13)

SPAIN

Madrid
Instituto Nacional de Investigationes 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)
*Tagarro, 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)

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)

TURKEY

Ankara
Ankara Universitesi Zootekni Enstitusu Ziraat Fakultesi

Duzgunes,Orphan, Ph. D.

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.B.X.
Hayes, T.L., Ph.D. (4)
Yang, T.C.H., Ph.D., Radiation biophysics (9)

Berkeley, California
University of California
Engineering Department

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

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

Voge, Marietta (11)

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)
Imel, J.D., B.S., 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)
wright, Valerie, Ph. D.

Manhattan, Kansas 66502
U.S. grain Marketing Research Lab., ARS, USDA

Beeman, R. W., ph. D.

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

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.

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)

DIRECTORY-GEOGRAPHICAL

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)

WISCONSIN

Beloit, Wisconsin,53511
Beloit College
Deparment of Biology

Resseguie, Lawrence J.

Milwaukee
University of Wisconsin
Zoology Department

Hsiao, Ku-Chuan, B.S., Teaching Assistant
Lange, E.L. Ph.D. Assistant Professor

U. S. S. R.

Moscow
All-Union Grain and Grain Products Research Institute

Cherkovskaya, A. Ya.

WEST INDIES

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

Jayasingh, D.B., B. Ed., Ph.D. (2,5,8,12).
Walker, K.R.

PERSONAL DIRECTORY*

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)

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)

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)

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

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

*numbers after directory names indicate research specialties.

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

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

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

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

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.

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

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)

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

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

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

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

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

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)

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

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

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

+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)

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.

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

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

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, P.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.

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

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

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.

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

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.

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

GERBER, G.H., Canada Department of Agriculture, Research Station, Winnipeg, Manitoba.

GERDY, J., Department of Biology, Benison University, Granville, Ohio 43023.

+GILBERT, E., Department of Biology, West Georgia College, Carrollton, Georgia 30117.

+GILES, P.H., Tropical Stored Products Centre, Slough, Bucks, England. (5, 12)

+GILL, K.S., Punjab Agricultural University, Department of Genetics, Hissar, Harayana, India. (7)

GOLD, P., Health Sciences; State University of New York, Buffalo, N.Y. 14214.

GOLEBIOWSKA, ZOFIA, Plant Protection Institute, Poznan, Poland.

+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)

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.

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. ( )

GUTHRIE, P., Dept. of Biology Central State University, Edmond, Oklahoma 73034.

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)

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., Instirute 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, mSissouri, 63501. (11)

HARDIN, R.T., University of Alberta, Dept. of Animal Science, Div. of Poultry Science, Edmonton, Alberta, Canada (7)

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)

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)

HOLM, E., University of Pretoria, Department of Entomology, Pretoria 0002, South Africa.

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.)

+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.

JAY, E.G., U.S.D.A., A.R.S., Savannah, Georgia 31401.

JAYASINGH, D.B., Ministry of Industry and Communication, Storage and Infestation Division, 20 Hope Road, Kingston 10, Jamaica, W.I..

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.

KAMIS, A.E., Plant Protection Dept., Alexandria University, Alexandria, Egypt.

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.

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.

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)

+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.

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)

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.

LEMONDE, A., Universite Laval, Quebec, Canada. (10, 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)

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)

MCRAE, T.A., University of New England, Department of Animal Science, Armidale, New South Wales 2351. (5, 7, 10)

MERTZ, D.B., University of Illinois, Chicago, Illinois 60680. (5)

MEYER, H.H., Ruakura Agricultural Research Centre, Private Bag, Hamilton, New Zealand.

+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.

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., Father, St. Catherine of Siena Church, 4200 Federal Blvd. Denver, Colorado (2,).

MUIR, W.M., Department of Dairy Science, University of Illinois, Urbana, Illinois, 61801.

MURRAY, J.J., University of Virginia, Charlottesville, VA. (5, 7)

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.

+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.

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.

+PANT, N.C., I.A.R.I., Division of Entomology, New Delhi, India. (5, 10)

+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.

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.

PETITPIERRE, E. Department of Genetics, The University, Mallorca, 07071, Spain

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.

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.

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, 26.1X.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.

VOHRA, P., College of Agriculture and Environmental Sciences, Agricultural Experiment Station, Department of Avian Sciences, University of California, Davis, California 95616

VON DE KLASHORT, G., Koninklijk Institut 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.

WHITE, G.G., Queensland Department of Primary Industries, Entomology Branch, Indooroopilly, Queensland, Australia

+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 and Rural Affairs, Plant Research Institute, Burnley, Victoria, 3121, 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., Laboratory of Applied Entomology, Faculty of Agriculture, 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)

ZHANG, LAO, Department of Animal Sciences, Beijing Agricultural University, Beijing, China (5,12)

ZIEGLER, J.R., Box 1045, Lafayette, CA 94549.

ZISSLER, D., Biologisches Institut I (Zoologie) der Universitat
Freiburg i. Br. Germany. (3, 4, 6, 7, 11)