TRIBOLIUM INFORMATION BULLETIN

Number 6

(Issued in 300 copies)

Editor: A. Sokoloff, Department of Genetics,
University of California, Berkeley, California

1963

NOTE

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TRIBOLIUM INFORMATION BULLETIN

Number 6

March 1963

Notes - Research

Notes - Research--Continued

Notes - Research--Continued

Notes - Teaching

Notes - Technical

FOREWORD

The present issue of TIB, thanks to the cooperation of the contributors, has been very easy to complete. The work has been considerably facilitated by the fact that most contributors have checked the format used in previous issues of the bulletin before preparing their notes, etc., and by the fact that bibliographical references have been grouped according to categories. Thus, the entry in a given category has been decided by the author(s) and not by the Editor.

Some contributors needlessly hesitated in submitting notes on research in other Coleoptera to a bulletin which is primarily devoted to Tribolium. While this is their prerogative, it should be stressed again that, at the present time at least, the bulletin is not restricted to flour beetles. It is hoped that in the future investigators using other organisms in this order would not be reluctant in contributing.

This issue, similar to the past ones, is heavily weighted by contributions from the Berkeley group. I believe that no apologies are necessary and none are intended: the number of contributions from a given laboratory may either reflect the level of activity of a group of investigators or the interest in communicating one's findings through this medium. However, since TIB is open to all investigators and there is no limit to the number of notes that an individual may contribute, lack of, or limited, contributions from other laboratories active in Tribolium research may mean that the investigator was heavily burdened with teaching, research, or administrative duties, and not necessarily that he was not interested in contributing.

It is encouraging to the Editor that so many investigators have expressed the opinion that such exchanges of information are worthwhile. While more information would have been desirable on current research and stocks from certain key laboratories, it is evident from the size of the present issue that interest in the bulletin has not decreased.

Grateful appreciation is expressed to Misses Arleen S. Adachi and Yuriye Uyeno for help in compiling the bibliography, and to Miss LaVerne A. Marts for the competent transcription of this (and the preceding) issue of the Bulletin. Publication of this issue of TIB was made possible by USPHS Research Grant RG8942.

A. SOKOLOFF

Berkeley, California
March, 1963

EDITOR'S RANDOM NOTES

Attention of Tribolium investigators (particularly those who may not have access to large libraries) is drawn to a new publication. "Wheat Abstracts" is published by the Wheat Abstracts Service, Nebraska College of Agriculture Library, 307 Agriculture Hall, Lincoln 3, Nebraska. The price for 12 monthly issues is $10.

The publication includes abstracts, conclusions, summaries or parts of discussions. Apparently it covers the literature from 1960 on.

Of particular interest to Tribolium investigators is the section on Storage Insects. From the sample copy examined, this section includes abstracts from original work on this organism covering all phases of investigation from reports of these organisms as pests to biochemical studies.

* * * * * *

Having gone through the process of bringing the stock lists from our department up to date for the current issue of TIB, I have come to appreciate the advantages of numbering the wild type and mutant stocks. Hence, as will be seen in the stock list section, the wild type strains of each species in this laboratory have been entered separately, since they are least likely to change from year to year, and the mutants (singly or in combination) have been given different numbers. In this manner, future issues of TIB will have a shorter stock list from this department, and additions or deletions to these lists will be made in reference to the present issue of the bulletin.

* * * * * *

Correspondence with officials at the Plant Quarantine Division, USDA, Agricultural Research Service, Washington 25, D.C. has revealed that certain states within the U.S. have regulations governing the movement of plant pests into and within their boundaries. For that reason, before specimens of these insects are shipped into any of these states, the recipient of the proposed shipment should obtain approval for their entry from the plant quaratine official of the state concerned. (For the convenience of those who may be contemplating asking for stocks from other laboratories a list of these officials and their addresses is appended below.) Once authorization for such shipment is granted (usually in the form of a PQ Form 21B label supplied by the USDA Plant Division, Washington 25, D. C.), the label should be attached securely to the outside of each package shipped, and the specimens packed in sturdy containers to prevent escape in transit.

Dr. R. W. Howe, Pest Infestation Laboratory, Slough, Bucks, Great Britain, has informed the writer that they have had one or two requests for material, and that the required import permit from the USDA Plant Quaratine Division, Washington 25, D. C. has not been supplied. Where the request has been for something ordinary, the shipment has been made trusting to luck, but one such shipment was destroyed by the Quarantine Division upon entry into the U.S.

Quoting further from Dr. Howe's letter: "The USDA can quite easily refuse to allow the import of any live material even if the species is common in the U.S.A. They are more likely to exclude those species not known in the U.S.A., even though this may be because the species is not sufficiently successful to multiply when gaining access on imported goods. I understand that they may object to Tribolium anaphe although it seems unlikely to be a potential pest. Still, better safe than sorry--after all Khapra was a nasty shock even if a predictable one. We have no quaratine against storage insects possibly because we import so many in trade. I would say that all our important established pest populations in warehouses, etc., were originally imported. Incidentally, when I was in California, I was refused permission to export some of the native Trogoderma spp. In general, I imagine that nearly every request for an import permit is automatically granted, and it seems a pity to run into difficulties through not applying."

* * * * * *

At the last meeting between Tribolium biologists held in conjunction with the AIBS, Corvallis, Oregon, it was decided that, since some will be away attending the International Genetics Congress in Holland, and others will be attending the International Congress of Zoology in Washington, D.C., no formal meeting will be scheduled at the next AIBS meetings.

* * * * * *

Professor Jean LeClercq writes (July 1962) that he has taken charge of a chair of Zoology at the Institut Agronomique, Gembloux, Belgium. He states that he has maintained two strains of Tenebrio moletor (F = small, G = big) in isolation since 1946. Samples are available to anyone requiring them.

* * * * * *

The illustrations on the cover, prepared by Mr. Roger S. St. Hilaire, show two homeotic mutants found in Tribolium. The one on the left is an example of the antennapedia mutation in Tribolium castaneum, a mutant found independently at the Population Genetics Institute, Purdue University, Lafayette, Indiana, and at the Department of Genetics, University of California, Berkeley, California. The example given is from the latter stock.

It is supposed that the broad large masses in the middle of the antenna represent the femur and the tibia (the spurs of the latter being evident). The one on the right shows the labiopedia mutation in Tribolium confusum discovered at Berkeley. (Antennapedia behaves as an autosomal recessive; labiopedia as a sex linked recessive.) Both of these mutants are identifiable as soon as the larva emerges from the egg.

LIST OF OFFICIALS OF STATES HAVING AGRICULTURAL PEST LAWS

Mr. B. P. Livingston
Chief, Division of Plant Industry
State Department of Agriculture and Industries
P. O. Box 220
Montgomery 1, Alabama

Hon. James W. Wilson
Commissioner of Agriculture
P. O. Box 1828
Palmer, Alaska

Mr. A. P. Messenger, Chief
Bureau of Plant Quarantine
State Department of Agriculture
1220 N Street
Sacramento 14, California

Mr. F. Herbert Gates
Chief of Plant Industry
State Department of Agriculture
3130 Zuni Street
Denver 11, Colorado

Dr. Wm. G. Cowperthwaite
Plant Commissioner
State Plant Board
Gainesville, Florida

Mr. W. E. Blasingame
Director, Department of Entomology
304 Agriculture Building
19 Hunter Street
Atlanta 3, Georgia

Mr. Wm. C. Look
Plant Quarantine Insp. in Charge
Board of Commissioners of Agriculture and Forestry
P. O. Box 2520
Honolulu 4, Hawaii

Mr. C. A. Boyer
Chief, Plant Industry Divisions
State Department of Agriculture
Lansing 13, Michigan

Mr. Henry L. Page, Director
Bureau of Plant Industry
State Department of Agriculture and Markets
Albany 1, New York

Mr. L. H. Senn
Assistant Entomologist
State Crop Pest Commission
Clemson, South Carolina

Mr. Howard L. Bruer
State Entomologist and Plant Pathologist
Insect and Plant Disease Control
Department of Agriculture
410 State Office Building
Nashville, Tennessee

Mr. E. L. Chambers
State Entomologist
Division of Plant Industry
State Department of Agriculture
448 W. Washington Avenue
Madison 3, Wisconsin

ANNOUNCEMENTS

Centennial of Entomology in Canada

A meeting "Centennial of Entomology in Canada" will be held at Carleton University, Ottawa, Canada, September 3-6, 1963. Information available from:

Dr. D. F. Hardwick,
K. W. Neatby Building,
Carling Avenue,
Canada Department of Agriculture,
Ottawa, Canada

Re-Issue of TIB-2 and 3.

For those who have expressed desire in obtaining these issues of the bulletin, apologies are offered. These issues have not yet been mimeographed, but they will be in the near future. Colleagues who requested either one of these issues will be provided with a copy. Patience!

BERKELEY, CALIFORNIA
UNIVERSITY OF CALIFORNIA, DEPARTMENT OF GENETICS

I. Wild type strains

A. Tribolium castaneum

		Source and/or date
1.	Chicago	Park, 1955
2.	McGill	Stanley, 1958
3.	Texas	1958
4.	Virginia	1958
5.	CS-1	Purdue University
6.	CS-2	Univ. of Calif.
7.	CS-3	USDA Lab., Kansas
8.	CS-4	USDA Lab., Georgia
9.	CS-5	Berkeley, Calif.
10.	CS-6	Univ. of Ill.
11.	CS-7	Washington State College
12.	CS-8	Univ. of Minnesota
13.	CS-9	Oakland, Calif.
14.	CS-13	Davis, Calif.
15.	CS-14	Oakland, Calif.
16.	Synthetic strain from CS-1 to CS-6, marked with sooty	
	Inbred lines (started October 8, 1958)	
17.	CSI-2	
18.	CSI-3	
19.	CSI-5	
20.	CSI-7	
21.	CSI-9	
22.	CSI-10	
23.	CSI-11	
24.	CSI-12	

B. Tribolium confusum

1.	Chicago	Park, 1955
2.	McGill	Stanley, 1958
3.	New York	1961
4.	Sacramento	1961
5.	CF-1	Purdue University
6.	CF-2	Univ. of Calif., Berkeley
7.	CF-3	Univ. of Calif., Davis
8.	CF-5	USDA Lab., Kansas
9.	CF-6	Univ. of Ill.
10.	CF-7	Washington State College
11.	CF-8	Univ. of Minn.
12.	CF-9	Oakland, Calif.
13.	CF-13	Oakland, Calif. 1961
14.	CF-14	Oakland, Calif. 1961
15.	Synthetic strain from CF-1, 2, 5, 6, 7 and 8	
	Inbred lines (started October 8, 1958)	

Tribolium confusum (cont.)

16. CFI-1
17. CFI-2
18. CFI-3
19. CFI-5
20. CFI-6
21. CFI-7
22. CFI-8
23. CFI-9
24. CFI-10
25. CFI-11
26. CFI-12

C. *Tribolium destructor*

1. Chicago	Park, 1958

D. *Latheticus oryzae*

1. Chicago	Park, 1955
2. Slough	PIL, 1963

E. *Tenebrio molitor*

1. New York	Pet Shop, 1961

F. *Gnathocerus cornutus*

1. Berkeley (1)	Oakland, Calif. 1959
2. Berkeley (2)	Oakland, Calif. 1961
3. Slough	PIL, 1963

G. *Stegobium paniceum*

1. Chicago	1956
2. Oakland	1961

H. *Oryzaephilus surinamensis*

1. Synthetic, combining two populations: one from Cold Spring Harbor, N. Y., the other from Oakland, Calif. 1961.

I. *Ahasverus advena*

1. Slough	PIL, 1963

J. *Carpophilus dimidiatus*

1. Gambia	PIL, 1963

K. *Cryptolestes pusillus*

1. Slough	PIL, 1963

L. *Cryptolestes turcicus*

1. Slough	PIL, 1963

M. *Dermestes maculatus*

1. Slough	PIL, 1963

II. *Mutants*

A. *Tribolium castaneum*

Chromosome I

25. paddle (*pd*)	Park, 1955
26. red (*r*)	Chazy, New York, 1959
27. red (*r*)	Berkeley, Calif., 1962
28. pygmy (*py*)	Chazy, New York, 1959
29. spotted (*sp*)	Chazy, New York, 1959
30. divergent elytra (*dve*)	Chazy, New York, 1960
31. truncated elytra (*te*)	Chazy, New York, 1959
32. lethal-3 (as heterozygotes)	
33. lethal-4 (as heterozygotes)	Berkeley, 1961
34. red modifier (M^r)	Berkeley, 1961
35. *py pd*	
36. *sp pd*	
37. *dve pd*	
38. *py r pd*	
39. *sp py pd*	
40. *ma r*	
41. *py r*	
42. *r te*	
43. *sp r*	
44. *r pd*	
45. *r* M^r	
46. *py r* M^r	
47. *sp dve py pd*	

Chromosome II

48. pearl (*p*)	Park, 1955
49. pink (p^{Pk})	Chazy, New York, 1959
50. pegleg (*pg*)	Chazy, New York, 1959
51. *p*; *pg*	

Chromosome III

53. McGill black (*McGb*)	Stanley, 1958
54. Chicago black (*Cb*)	Park, 1955
55. Synthetic *McGb*/*Cb*	Chazy, New York, 1958

Chromosome IV

56.	Bar eye (Be)	Chazy, New York, 1959
57.	sooty (s)	Bell, 1959
58.	Be/+ s/s	1961

Chromosome V

59.	jet (j)	Park, 1955
60.	jet (j^E)	Eddleman, 1961
61.	split (spl)	Chazy, New York, 1959
62.	microcephalic (mc)	Chazy, New York, 1959

Chromosome VI

63.	Microphthalmic (Mo)	Chazy, New York, 1959
64.	Microphthalmic (Mo^M)	Chicago, 1962

Chromosome VII

65.	Short antenna (Sa)	Bell, 1962
66.	Short antenna (Sa-1) (= Gn)	Englert, 1961
67.	Short antenna (Sa-2) (= Ds)	Berkeley, Calif., 1959
68.	blistered elytra (ble)	Chazy, New York, 1959
69.	chestnut (c)	Eddleman, 1961
70.	chestnut (c^S)	Chazy, New York, 1959
71.	curved appendages (ca)	Chazy, New York, 1959
72.	fused tarsi and antennae (Fta)	Berkeley, 1962
73.	Sa ble	
74.	ca c	
75.	Fta ble	
76.	Fta c	
77.	Sa c;	

Chromosome VIII

78.	antennapedia (ap)	Englert, 1963
79.	antennapedia (ap^D)	Berkeley, 1962

Multichromosomal

80. ma pd; p
81. py pd; p
82. sp pd; p
83. sp; p
84. py; b
85. ma r; b
86. py r; lod
87. sp; j
88. pd; Mo
89. sp; p; b
90. sp; p; j
97. p; b; Mo
98. p; b; Be; mc
99. p; b; mc
100. p; mc
101. b; Be dfl
102. b; Mo
103. b; Mo; Sa
104. j; Mo
105. Be s/+s; Sa/+
106. Be Fta
107. Be; Sa

Multichromosomal (cont.)

91. dve; b; mc
92. p; lod
93. p; b
94. p; b lod
95. p; j
96. p; Mo
108. Be; ca
109. Be/+; Sa c/+c
110. c; ju ctp
111. Mo; Sa
112. Mo ca
113. Mo; c; ju ctp

Unassigned

114.	abbreviated appendages (aa)	Cold Spring Harbor, New York, 1961
115.	cut prothorax (cpt)	Berkeley, 1962
116.	Deformed (df)	Eddleman, 1961
117.	droopy elytra (dre)	Chazy, New York, 1960
118.	engraved metasternum (ems)	Berkeley, 1962
119.	extra urogomphi (eu)	Chazy, New York, 1960
120.	fused antennal segments-1 (fas-1)	Chazy, New York, 1959
121.	fused antennal segments-2 (fas-2)	Berkeley, 1961
122.	fused antennal segments-3 (fas-3)	Berkeley, 1962
123.	incomplete metasternum (ims)	Berkeley, 1962
124.	juvenile urogomphi (ju)	Berkeley, 1962
125.	pointed elytra (pe)	Berkeley, 1961
126.	prothoraxless (ptl)	Chazy, New York, 1959
127.	short elytra ($sh^{H\&D}$)	Berkeley, 1959
128.	short elytra (sh^{S})	Chazy, New York, 1959
129.	synthetic short elytra ($sh^{H\&D}/sh^{S}$)	Berkeley, 1961
130.	squint (sq)	Chazy, New York, 1959
131.	warped elytra (we)	Chazy, New York, 1959

B. Tribolium confusum

Chromosome I

27.	Striped (St)	McDonald, 1961
28.	eyespot (es)	McDonald, 1961
29.	red (r)	Berkeley, 1962
30.	reduced antennae and elytra (rae)	Berkeley, 1962
31.	labiopedia (lp)	Berkeley, 1962
32.	lethal-1 (l_1) (in heterozygotes)	Berkeley, 1962
33.	St es	

Chromosome II

34.	pearl (p)	PIL via Stanley, 1960
35.	pearl (p)	Berkeley, 1962
36.	ebony-2 (e_2)	PIL via Stanley, 1960
37.	e_2 p/e_2 p	PIL via Stanley, 1963

Chromosome III

38.	McGill black (McGb)	Stanley, 1960

Chromosome V

39.	ebony (*e*)	Park, via Stanley, 1960
40.	ebony ($e^{L\&H}$)	Berkeley, 1959
41.	synthetic ebony (*e*/$e^{L\&H}$)	Berkeley, 1961

Unassigned

42.	blistered elytra (*ble*)	1960
43.	deformed legs (*dl*)	1961
44.	dent (*dt*)	1962
45.	engraved metasternum (*ems*)	1962
46.	fused antennal segments (*fas*)	1962
47.	light ocular diaphragm (*lod*) (with pearl)	1961
48.	melanotic stink glands (*msg*)	1962
49.	ruby spot (*rus*)	1960
50.	short elytra (*sh*)	1961
51.	split (*sp*)	McDonald, 1961
52.	stilted legs (*stl*)	1962
53.	warped elytra (*we*)	1962

lost:
Ruby (*Ru*)

Stocks combining several mutants.

54. *p*; *lod*
55. *p*; *rus*
56. *b*; *sp*
57. *rus*; *sp*
58. *rus*; *ble*
59. *b*; *sp*; *rus*

C. None

D. *Latheticus oryzae*

Chromosome I

3.	red (*r*)	Chazy, New York, 1959
4.	truncated elytra (*te*)	Chazy, New York, 1959
5.	*r te*	

Chromosome II

6.	pearl (*P*)	Park, 1955

Unassigned

7.	dark form	Dyte, 1963

E. None

F. *Gnathocerus cornutus*

Chromosome II

4. pearl-1 (*p*-1)	PIL, 1963
5. pearl-2 (*p*-2)	Berkeley, 1962

Unassigned

6. light ocular diaphragm (*lod*)	Berkeley, 1962
I-2. *Ahasverus advena*--dark form	PIL, 1963
J-2. *Carpophilus dimidiatus*--pearl	PIL, 1963
K-2. *Cryptolestes pusillus*--dark form	PIL, 1963
L-2. *Cryptolestes turcicus*--pearl	PIL, 1963
M-2. *Dermestes maculatus*--pearl	PIL, 1963

A. Sokoloff

BERKELEY, CALIFORNIA:
UNIVERSITY OF CALIFORNIA, DONNER RADIATION LABORATORY

No stock list submitted. See TIB-5, p. 4. (Ed.)

CARLISLE, PENNSYLVANIA:
DICKINSON COLLEGE

See TIB-5, p. 5 for complete list of stocks.

D. J. McDonald

CHICAGO, ILLINOIS:
UNIVERSITY OF CHICAGO, DEPARTMENT OF ZOOLOGY.

No change in stocks. See TIB-5, p. 6. (Ed.)

COLLEGE PARK, MARYLAND:
UNIVERSITY OF MARYLAND, DEPARTMENT OF ZOOLOGY

T. confusum

A. Wild type strains

1. So. Illinois University-1. Carbondale, Ill.
2. Univ. of Maryland-1. Baltimore City, Public Health Department culture, Baltimore, Maryland.

A. Wild type strains (cont.)

3. Univ. of Maryland-2. Feed storage cans, Microbiology Department, University of Maryland, College Park, Md.

Inbred strains

4. CFI-1	Berkeley, Calif. 1959
5. CFI-11	Berkeley, Calif. 1959

B. Mutant strains

6. ebony ($e^{L\&H}$)	Berkeley, 1959
7. melanotic stink glands (msg)	Berkeley
8. melanotic stink glands (msg) from So. Illinois University-1	

J. Crenshaw

CORAL GABLES, FLORIDA:
UNIVERSITY OF MIAMI, DEPARTMENT OF ZOOLOGY

No stock list submitted. See TIB-4, p. 4. (Ed.)

LAFAYETTE, INDIANA:
PURDUE UNIVERSITY, POPULATION GENETICS INSTITUTE

No new stock list submitted (see TIB-5 p. 6-7).

Should have listed the following additions:

p; pg, Be s, mc, spl, j, Mo. (Obtained from Berkeley.) It is probable that by now these mutants can also be obtained in combination with ivory and antennapedia (see section on New Mutants TIB-5 and this issue. Ed.)

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

No stock lost submitted. See TIB-5 p. 7 (ed.)

LAWRENCE, KANSAS
UNIVERSITY OF KANSAS, DEPARTMENT OF ENTOMOLOGY

A. T. castaneum

Wild type strains

1. UPF foundation	Purdue Univ.
2. CS-4	Purdue Univ.

Wild type strains (cont.)

3. Chicago	Univ. of Calif.
4. Chicago (Sonleitner)	Univ. of Chicago
5. Sacramento	Univ. of Calif.

Mutants

6. paddle (*pd*)	Univ. of Chicago
7. pearl (*p*)	Univ. of Chicago
8. McGill black (*McGb*)	via Univ. of California
9. sooty (*s*)	Purdue Univ.

B. *T. confusum*

Wild type strains

1. Chicago (Sonleitner)	Univ. of Chicago
2. Chicago	Univ. of Calif.
3. New York	Univ. of Calif.

Mutant

4. McGill black (*McGb*)	Univ. of Calif.
5. ebony	Univ. of Chicago

R. R. Sokal

LIVERMORE, CALIFORNIA:
BIOLOGICAL FRONTIERS INSTITUTE

No new stock list submitted. See TIB-4, p. 4.

LOS ANGELES, CALIFORNIA:
UNIVERSITY OF CALIFORNIA, DEPARTMENT OF ZOOLOGY

No new stock list submitted. See TIB-4, p. 5.

MANHATTAN, KANSAS:
KANSAS STATE UNIVERSITY, DEPARTMENT OF ENTOMOLOGY

Wild type strains

Cryptolestes pusillus
Oryzaephilus surinamensis
Rhizopertha dominica
Sitophilus granarius
Sitophilus oryzae
Sitophilus zea mais
Sitophilus cerealella

Mutants

"pink eyes" has just been noted in our wild stock of *S. cerealella*. Stock cultures are being observed more closely to determine the extent of this phenomenon.

D. A. Wilbur

MAYAGNEZ, PUERTO RICO
UNIVERSITY OF PUERTO RICO, BIOLOGY DEPARTMENT

No stock list submitted (but known to have the following stocks obtained from Berkeley. Ed.)

T. castaneum

Chicago wild type
paddle
pearl
microcephalic (contains pearl also)
Bar eye, sooty
Short antenna (Sa-2)

RICHLAND, WASHINGTON
GENERAL ELECTRIC COMPANY, BIOLOGY LABORATORY

No change in stock list, see TIB-5, p. 8.

STATE COLLEGE, MISSISSIPPI:
USDA, BOLL WEEVIL RESEARCH LABORATORY

Tribolium castaneum

Wild type

1. Purdue foundation	Purdue University

Mutant

McGill black (McGb)	Purdue University
sooty (s)	Purdue University
ivory (i)	Purdue University

Anthonomus grandis (Curculionidal)

Wild type

1. A & M	A laboratory stock maintained at College Station, Texas, originally started with wild Mexican weevils.
2. milky	A spontaneous mutation occurring in the A & M stock.

A. C. Bartlett

SYCAMORE, ILLINOIS
DeKALB AGRICULTURAL ASSOCIATION, INC.

No stock list submitted. See TIB-5, p. 6.

WASHINGTON, D. C.
THE CATHOLIC UNIVERSITY OF AMERICA, DEPARTMENT OF BIOLOGY

Tribolium castaneum

Wild type:	Chicago	via Berkeley, Calif.
Mutant:	McGill black (McGb)	via Berkeley, Calif.

R. H. Arnett

BRAZIL

CAMPINAS, SAO PAULO
INSTITUTO AGRONOMICO, SECAO DE ENTOMOLOGIA

No stock list submitted see TIB-5, p. 8.

CANADA

GUELPH, ONTARIO:
ONTARIO AGRICULTURAL COLLEGE, DEPARTMENT OF POULTRY SCIENCE

No stock list submitted see TIB-5, p. 9.

GUELPH, ONTARIO:
ONTARIO AGRICULTURAL COLLEGE, DEPARTMENT OF ENTOMOLOGY AND ZOOLOGY

Sitophilus granarius (L.) GG strain (Canada)
Sitophilus granarius (L.) MW strain (Montreal)
Sitophilus sasakii (Tak.) SG strain (Canada)
Sitophilus sasakii (Tak.) SW strain (Canada)
Sitophilus sasakii (Tak.) SL strain (Louisiana, U.S.A.)
Sitophilus oryza (L.) (Louisiana, U.S.A.)
Tribolium sp. cultures derived from a casual laboratory infestation.

A. J. Musgrave

MONTREAL, P. Q.:
McGILL UNIVERSITY, DEPARTMENT OF GENETICS

T. confusum, subcultured 1961 from A. Lemonde strain, maintained and originally found at Larval University, Quebec, P.Q. Canada.

A. F. Naylor

MONTREAL, P.Q.:
McGILL UNIVERSITY, DEPARTMENT OF ZOOLOGY

No new stock list submitted see TIB-4, p. 6.

OTTAWA, ONTARIO:
CANADA DEPARTMENT OF AGRICULTURE, ANIMAL RESEARCH INSTITUTE

No change from list published in TIB-5, p. 9.

D. F. Bray

QUEBEC, P.Q.:
UNIVERSITE LAVAL, FACULTE DE MEDICINE

Tribolium confusum Duval-- Laval strain found in Quebec City.

A. Lemonde

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

T. confusum--Laval strain Quebec.

L. Huot

QUEBEC, P.Q.:
UNIVERSITE LAVAL, PURE SCIENCES BUILDING

T. castaneum

Chicago wild type

jet, pearl, spotted (*j*; *p*; *sp*)
spotted (*sp*)
red pygmy (*r py*)

(Used by J. O. Vandal for teaching purposes. Ed.)

VICTORIA, B.C.:
FOREST ENTOMOLOGY AND PATHOLOGY LABORATORY

No new stock list submitted see TIB-5, p. 9.

WINNIPEG, MANITOBA:
CANADA DEPARTMENT OF AGRICULTURE, RESEARCH STATION

No new stock list submitted. See TIB-5, p. 9.

WINNIPEG, MANITOBA:
THE UNIVERSITY OF MANITOBA, DIVISION OF ANIMAL SCIENCE

T. castaneum

Wild type

Purdue Foundations +, p and b	Purdue Univ.
Inbred lines 5, 10, 11	Univ. of Calif.

W. J. Boylan

DENMARK

SPRINGFORBI:
STATENS SKADEDYRLABORATORIUM
(PEST INFESTATION LABORATORY)

In addition to

Tribolium confusum
Tribolium destructor

Add

Tenebrio molitor. A strain selected for dark larvae.

F. S. Andersen

FRANCE

LYON, RHONE
LABORATORIE DE ZOOLOGIE EXPERIMENTALE, FACULTE DES SCIENCES

No stock list submitted. See TIB-5, p. 10.

VILLEURBANNE (LYON) RHONE:
INSTITUT NATIONAL DES SCIENCES APPLIQUEES, LABORATORIE DE BIOLOGIE ANIMALE

Acanthoscelides obsoletus

Wild type - France

Sitophilus granarius

Wild type from Lyon

Sitophilus oryzae (= zea mais)

Wild type from London (Pest Infestation Laboratory)

Sitophilus Sasakii

Wild type

Tribolium castaneum

Wild type from Ales

P. Nardon

GREAT BRITAIN

DUNDEE, ANGUS:
UNIVERSITY OF ST. ANDREWS, QUEEN'S COLLEGE, NATURAL HISTORY DEPARTMENT

A. Tribolium castaneum

(1) T. castaneum (Slough). Culture obtained from Pest Infestation Laboratory (P.I.L.), Slough, in 1962.

(2) T. castaneum (Dundee). Same as (1), but was obtained in 1958 and has since been cultured at Dundee.

(3) T. castaneum (Kenya). A wild stock collected in Kenya Highlands in 1962.

B. Tribolium confusum

(4) T. confusum (Slough). Obtained from P.I. L. in 1962.

(5) T. confusum (Dundee). Same as (4), but has been at Dundee since 1958.

C. Tribolium castaneum mutants

(6) T. castaneum (Slough, pearl-eye). Isolated from culture (1), in Dundee, in 1962.

(7) T. castaneum (Dundee, pearl-eye). Isolated from culture (2), in Dundee, in 1962.

(8) T. castaneum (Dundee, dark). Isolated from culture (2), in Dundee, in 1962.

All cultures maintained at Queen's College, Dundee, are kept at 25°C., but the relative humidity is uncontrolled.

Pearl-eye from cultures (6) and (7) have been crossed, and have produced pearl-eye progeny. These, I believe, are the first reported pearl-eye T. castaneum in United Kingdom cultures and have not been compared with Park's original pearl-eye nor with any other eye mutants. This eye mutant has not been noticed at Slough in the P.I.L. culture of T. castaneum, yet unless the mutation has occurred twice in Dundee it should be found in the parent cultures at Slough.

The dark body colour mutants of culture (8) have not been compared to the known dark mutants such as black, jet, or sooty.

A dozen cultures of other stored products pests are kept at Queen's College, Dundee, but these have been started with P.I.L. stocks, and therefore a list will not contribute to the lists in T.I.B. no. 4. (pp. 7-12).

Unique cultures include:

A. *Cathartus quadricollis* (Nigeria). A wild stock established in 1961. Also maintained - *C. quadricollis* (ex Slough).

B. Numerous wild stocks of *Carpophilus* spp. are being cultured during the 1963-64 period, in addition to *C. dimidiatus* (Slough) and *C. hemipterus* (Slough).

W. M. Graham

EDINBURGH:
INSTITUTE OF ANIMAL GENETICS

I. Wild type strains

1. *Tribolium castaneum* - Chicago wild type.

II. Mutant strains of *T. castaneum*

1. Micropthalmic (*Mo*)
2. Microcephalic, pearl (*mc*, *p*)
3. Bar eye, sooty (*Be s*/+*s*)
4. Squint (*sq*)

Stocks obtained from Berkeley, California.

(See also report by E. B. Basden for other stocks including inbred strains TIB-5, p. 10.)

C. H. Waddington

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

No stock list submitted. See TIB-5, p. 10.

LONDON: QUEEN ELIZABETH COLLEGE
DEPARTMENT OF BIOLOGY

Alphitobius bifasciatus (Say)
1. A. diaperinus (Panz)
2. A. laevigatus (F.)
3. Alphitobius sp.
4. Gnathocerus cornutus (F.)
5. G. maxillosus (F.)
6. Latheticus oryzae (Waterh.)
7. Palorus ratzeburgi (Wissm)
8. P. subdepressus (Woll.)
9. Tenebrio molitor (L.)
10. T. obscurus (F.)
11. T. castaneum (Hbst)
12. T. confusum (Duv)
13. T. destructor (Uytt)
14. T. anaphe (Hint)

All species derived from Pest Infestation Laboratory, Slough, England.

M. Hafeez

SLOUGH, BUCKS
PEST INFESTATION LABORATORY

Tribolium anaphe

Wild type strain

11	Nigeria	1958

Tribolium castaneum

Wild type strains

4	Kenya	1959
11	Trinidad	1959
14	United Kingdom	1930 with additions to 1942
37	Malta	1959
38	Australia I	1961
39	Australia II	1961

Mutants

(a) Chromosome I
52 pygmy, paddle, spotted (pd py sp) Sokoloff 1962

(b) Chromosome II
53 pearl (p) Sokoloff 1962

Mutants (cont.)

(c) Chromosome III
54 black (b) Sokoloff 1962

(d) Chromosome IV
55 Bar eye, sooty (Be s/+s) Sokoloff 1962

(e) Chromosome V
56 microcephalic (mc) Sokoloff 1962

(f) Chromosome VI
57 Micropthalmic (Mo/+) Sokoloff 1962

(g) Chromosome VII
58 Short antenna-1 (Sa-1) Purdue via Sokoloff 1962

(h) Unassigned to any chromosome
59 chestnut (c) Sokoloff 1962
40 pearl (ex No. 37, Malta) 1959
not yet crossed with Chicago pearl
60 bronze coloured form (ex 38 Australia I) 1961
(see new mutants section)

Tribolium confusum

Wild type strains

17 U.K. (started from 2 pairs, now contains about 20% pearl homozygotes) 1945
18 U.K. from 17 1959

Mutants
(a) Chromosome II
22 ebony-2 (e_2) (ex 17) 1952
23 pearl (p) Wantage U.K. 1959
24 pearl (p) (ex 17) 1958
41 pearl (p) Malta 1959
25 e_2P/e_2P (ex 22 & 24) 1958

Tribolium destructor

Wild type strain

19 started from 5 adults Holland 1939

Tribolium madens

Wild type strain

20 Yugoslavia 1959

Ahasverus advena (Silvanidae)

Wild type strain

43 Soulbury U.K.	1959

Mutant

26 black form	1960

Carpophilus dimidiatus (Nitidulidae)

Wild type strains

33 Gambia	1959
44 origin unrecorded	before 1947

Mutant

27 pearl (ex 44)	1960

Cryptolestes pusillus (Cucujidae)

Wild type strain

45 origin unrecorded	before 1947

Mutant

28 black form (see Research Note)	Trinidad 1960

Cryptolestes turcicus (Cucujidae)

Wild type strains

34 Hull U.K.	1955
46 origin unrecorded	pre 1947

Mutant

29 pearl (ex 46)	1960

Dermestes maculatus (Dermestidae)

Wild type strain

47 origin unrecorded	pre 1947

Mutant

30 white eye (*w*) (ex 47)	1960

Gnathocerus cornutus (Tenebrionidae)

Wild type strains

36 Belfast, N. Ireland	1959
48 origin unrecorded	pre 1947

Mutant

31 pearl (p) (ex 48)	1958

Latheticus oryzae (Tenebrionidae)

Wild type strain

49 origin unrecorded	pre 1947

Mutant

42 Dark form (ex 49)	1962

Oryzaephilus surinamensia (Silvanidae)

Wild type strain

50 Basingstoke, U.K.	1962

Mutant

51 pearl (see New Mutants section)	Australia 1961

Trogoderma granarium (Dermestidae)
(This species may not be imported into the U.S.A.)

Wild type strain

61 U. K.	1958

Mutant

32 pearl (p)	1958

Other species

In addition to the above, wild type cultures of 61 other species of Coleoptera representing 33 genera in 13 families are mentioned. A list of these is available on application, it was reproduced in TIB-4, p. 10-11 with amendments in TIB-5, p. 11. Further amendments are as follows:

delete	Alphitophagus bifasciatus	(Tenebrionidae)
add	Dermestes peruvianus	(Dermestidae)
	Trigonogenius particularis	(Ptinidae)

Other species (cont.)

delete 4 spp of Calandra and replace with
Sitophilus oryzae (L.)
Sitophilus granarius (L.)
Sitophilus zeamais (Motsch)

C. E. Dyte

JAPAN

KYOTO:
KYOTO UNIVERSITY, DEPARTMENT OF AGRICULTURE, ENTOMOLOGICAL INSTITUTE

Same as listed in TIB-5, p. 12 excepting

Rhizopertha dominica, originated from Kyoto
Sitophilus granarius,
Sitophilus oryzae, originated from Kyoto
Sitophilus oryzae, very large strain originated from Kagosima, southwestern part of Japan
Sitophilus sasakii, originated from Kyoto

S. Utida

MIYAZAKI:
MIYAZAKI UNIVERSITY, DEPARTMENT OF BIOLOGY

Callosobruchus chinensis
Wild type strain obtained from Utida's Kyoto stock in 1958.

Callosobruchus maculatus
Wild type strain obtained from California, U.S.A. in 1959

Tribolium castaneum
Wild type strain from Miyazaki.

Tribolium confusum
Wild type strain from Miyazaki.

T. Yoshida

MEXICO

CHAPINGO
CAMPO EXPERIMENTAL "EL HORNO"

No stock list submitted. See TIB-5, p. 12.

POLAND

WARSAW:
ZAKLAD EKOLOGII, POLSKA AKADEMIA NAUK

No new stock list submitted. See TIB-4, p. 13.

PORTUGAL

LISBON:
LABORATORIO DA DEFESA FITOSSANITARIA DOS PRODUTOS ARMAZENADOS MINISTERIO DA ECONOMIA BRIGADA DE ESTUDOS DA DEFESA FITOSSANITARIA DOS PRODUTOS ULTRAMARINOS MINISTERIO DO ULTRAMAR

The laboratory maintains the following cultures in the breeding room at 27° - 29° C and 55 - 70% R.H. The origin of the culture, the year of commencement and the culture media are given for each insect species.

Acanthoscelides obtectus
Angola, 1957 - beans (yellow var.)

Callosobruchus gonagra
Port. Guinea, 1953 - whole groundnut

Callosobruchus maculatus
Angola, 1957 - cowpeas

Cryptolestes sp.
Portugal, 1961 - rolled oats, wheatfeed and yeast powder (5:5:1)

Dermestes frischii
Lisbon, 1960 - fishmeal, wheatfeed, yeast powder and glycerine (9:9:1:1)

Ephestia calidella
Portugal, 1955 - wheatfeed and glycerine (140:28)

Ephestia cautella
Lisbon, 1955 - wheatfeed and glycerine (140:28)

Ephestia kuhniella
Portugal, 1955 - wheatfeed and glycerine (140:28)

Oryzaephilus mercator
Goa, 1959 - broken groundnut

Oryzaephilus surinamensis
Portugal, 1960 - broken wheat

Plodia interpunctella
Portugal, 1955 - wheatfeed and glycerine (140:28)

Rhizopertha dominica
Lisbon, 1956 - wheat

Sitophilus granarius
Portugal, 1957 - wheat

Sitophilus oryza
Lisbon, 1953 - wheat

Sitophilus sasakii
Lisbon, 1956 - wheat

Tenebrio molitor
Portugal, 1957 - wheatfeed, yeast powder and oats (9:1:9)

Tribolium castaneum
Port. Guinea, 1957 - wheat flour

Zabrotes subfasciatus
Cabo Verde, 1956 - beans (red var.)

Stegobium paniceum, Lasioderma serricorne, Tineola bisselliella, Necrobia rufipes and Trogoderma granarium have also occasionally been in culture.

(Information obtained from ITIS. Ed.)

NEW MUTANTS, TESTS OF ALLELISM, AND LINKAGE DATA

A. New Mutants

1. Report of A. E. Bell

Tribolium castaneum

Antennapedia (ap). Englert, 1962. Autosomal recessive, spontaneous in Sa stock. Complete penetrance with variable expressivity. Phenotypic expression varies from partial fusion of 9th and 10th distal segments, with tarsal claws arising from 11th segment, to the replacement of the medial and club segments by a complete tarsus. Is easily identified in larval and pupal stages as well. Good viability and fertility. Linkage tests have been completed to all known linkage groups and to ivory (see TIB 5). Results of the tests revealed no apparent linkage to any of the linkage groups. "Antennapedia" is therefore being tentatively assigned to Linkage Group VIII.

2. Report of C. E. Dyte and Miss D. G. Blackman

Tribolium castaneum

bronze. Body colour darker than normal but not black. Probably autosomal recessive as mating with normal strain yielded a normal F_1 and an F_2 of 405 normal and 136 bronze. Viability and penetrance apparently good. From a stock originating in Australia. May be a re-occurrence of sooty or cordovan so no symbol proposed at present.

Oryzaephilus surinamensis (Silvanidae)

pearl. Phenotype similar to pearl in other species. Genetics not yet studied. From a culture originating in Australia.

3. Report of A. Sokoloff

Tribolium castaneum

1. Antennapedia (ap^D). Dawson, 1962. See note by Dawson in Research Note section, and the front cover of this issue of TIB.

2. Cut prothorax (cpt). Sokoloff, 1962. Spontaneous in a chestnut stock, removed several generations from an irradiated population. Autosomal recessive of good penetrance and viability but variable expressivity, cpt is characterized by a small, unsclerotized area in the dorsal midline of the prothorax. Sometimes there may be two widely separate areas along the midline which fail to sclerotize. In some cases this area

sclerotizes into a small smooth area devoid of the pits which are characteristic of the prothorax. Linked to juvenile urogomphi (q.v. elsewhere in this section) about 4 units apart, but linkage to other autosomal genes has not been established. This character is detectable in the larva, but only with difficulty in some pupae.

3. engraved metasternum (ems). Sokoloff, 1962. Found among the F_3 progeny of an irradiated female. Autosomal recessive of good viability, incomplete penetrance and variable expressivity. Characterized by an irregularly semi-triangular shallow depression midway between the medial metasternal suture and the pleural sclerites and anterior to the (normal) transverse depression on the posterior edge of the metasternum. Often only one side is affected. Hard to detect in the larva, and impossible to detect in the pupa since this area is hidden by the elytra and membranous wings. May be a recurrence of an unnamed mutant reported without any details of its inheritance by Eddleman (TIB-4, p. 14). A sample of this mutant was sent to Eddleman over two months ago for tests of allelism, but to date no information has been received.

4. fused antennal segments-3 (fas-3). Sokoloff and Ho, 1961. Presumably spontaneous. Found in a sample collected in a feed bin at the Zoology Department, University of California, Davis, California. Autosomal recessive of good penetrance but variable expressivity. One of the two original (non-virgin) females having this gene had barely discernible divisions of the club segments, plus fusions of the funnicle. The F_1 of this isolated female were normal. The F_2 distributed themselves into the following phenotypes:

Antenna		Number	
Right	Left	Males	Females
4-5	0	5	5
4-5	4-5	2	4
0	4-5	9	6
6-7	0	2	6
6-7	6-7	5	4
0	6-7	7	4
4-5	6-7	5	0
6-7	4-5	1	1
0	4-5, 6-7	1	0
4-5, 6-7	0	1	1
3-4	0	0	1
4-5, 9-10	0	0	1
4-5, 6-7	4-5, 6-7	3	4
4-5, 6-7	4-5	3	0
6-7	4-5, 6-7	1	0
4-5, 6-7	6-7	1	0
4-5	4-5, 6-7	1	1
		47	38

The modal number is different from that reported for *fas-1* and *fas-2*. While tests of allelism have not been performed, in view of the fact that *fas-1* and *fas-2* though similar are not allelic, it is probable that *fas-3* will prove to be non-allelic to *fas-1* or *fas-2*, particularly since in addition to a different distribution of the fused segments, the indistinct segmentation of the club has persisted for several generations.

5. *incomplete metasternum* (*ims*). Sokoloff, 1962. Found in a sooty stock derived from irradiation of *Be s*/++, several generations after X-ray treatment. The anterior medial projection of the metasternum fails to meet the posterior medial projection of the mesosternum between the coxal of the second pair of legs, resulting in a freer movement of these legs. Autosomal recessive of good viability, and expressivity. No linkage data available.

6. *juvenile urogomphi* (*ju*). Sokoloff, 1962. Spontaneous in a chestnut stock, several generations removed from an irradiated population. Autosomal recessive of good penetrance and viability but variable expressivity. For lack of a better term, this name has been given to a mutant possessing a pair of appendages, located (one on each side) laterally to the anal opening. The appendages appear like the anal cerci in cockroaches, but there is no distinct segmentation. The tips of the appendages appear sclerotized, possessing a brownish pigment. The size of these appendages appears larger in females than in males. There is no evidence that these appendages are secretory, but it has been observed that often, particularly in females, these structures are trapped by caked flour. Whether this is the result of fecal matter becoming stuck to these appendages and progressively covered with flour is open to speculation.

This structure, so far as this writer is aware, has never been observed in the Coleoptera. Whether they are indeed urogomphi-like structures will be determined by combining *eu* (extra urogomphi) with *ju*. *ju* is linked with *cpt* (see description above), about 4 units away, but linkage with other autosomal genes has not been determined.

7. *Fused tarsi and antennae* (*Fta*). Sokoloff and St. Hilaire, 1962. Induced by X-rays at the beginning of the reproductive period of irradiated *Be s*/++ females. Autosomal dominant with recessive lethal effects. Pleiotropic, affecting the antennae and the tarsi of all legs. The antenna is reduced to a total of 2-7 recognizable segments. The only segment not involved in fusions is the scape (first segment), and sometimes the pedicel is likewise not fused. Fusions of the funicle and the club segments are of variable expression but so marked that it is impossible to recognize which originated from the club,

which from the funnicle and which from both sources. The modifications of the tarsi are more constantly expressed, with a complete elimination of the proximal four segments of the tarsus of all legs. However, sometimes the distal segment (which always has claws) may be fused to the tibia. In these cases the tibia loses its angular appearance, the distal portion becoming sub-ovoid in shape. The tibial spurs of all legs may be wanting, vestigial or deformed. It was thought at first that pleiotropy extended to the elytra which in many cases appear split. However, recently individuals exhibiting this abnormality but free from antennal and leg deformities have been found, suggesting that another (dominant) gene may be present. *Fta* is linked with *Sa*. Interaction of the two dominants in F_1 of *Fta/+* X *Sa/+* crosses results in mortality of the *Fta +/+ Sa* class, but other crosses indicate that *Fta* is at a different locus from *Sa*. Viability of *Fta* fair.

8. *lethal-3* (l_3) Sokoloff, 1961. Sex-linked recessive. Found in the *r py* stock. Located about five units to the left of *py*, between *dve* and *py* (Sokoloff and Dawson, in press).

9. *lethal-4* (l_4) Sokoloff, 1961. In F_1 of imagoes emerging from eggs (Chicago wild type) carried 55 miles into space by means of a rocket fired off Wallops Island, Virginia, Dec. 4, 1959. Located about 33 units to the left of pd, between *dve* and *sp*. Apparently allelic with l_2-Dawson, 1962. (Sokoloff and Dawson, in press).

10. *Microphthalmic-1* (*Mo-1*) Sokoloff, 1962. Discovered by David Mertz (1962) in the Chicago stocks. Allelic with *Mo*.

11. *pointed elytra* (*pe*). Sokoloff, 1961. Spontaneous in *Mo b p* stock. Autosomal recessive of complete penetrance but variable expressivity. Elytra typically divergent (often starting at the scutellum) and narrower than normal (and split). In a fairly large proportion of *pe* the membranous wings appear affected (probably by a blister) and the elytra (one or both) may be lifted away from the abdomen. Resembles the phenotype of the sex-linked *dve*. Not enough information to give estimates of viability. Linkage tests are on the way.

12. *red modifier* (M^r). Sokoloff, 1961. Spontaneous in dve x *py r/py r* F_1 crosses, but origin uncertain. Sex linked recessive. Effect visible only when r is present. Hemizygous rM^r and homozygous rM^r/rM^r beetles have dark red eyes, ranging from a phenotype similar to eyespot (*es*) in *T. confusum*, with only a small area of the eye dark red to a phenotype of the whole area within the ocular diaphragm dark red. In addition, some individuals may have

a mosaic eye, with black spots scattered in the red background. The following crosses may illustrate its action (see also teaching note):

	black eye		light red		dark red	
	M	F	M	F	M	F
r/r x *r*			+	+		
r/r x *r*M^r		+	+			
rM^r/*r*M^r x *r*		+			+	
r +/*r*M^r x *r*		+	+	+	+	
r +/*r*M^r x *r*M^r		+	+		+	+
rM^r/*r*M^r x *r*M^r					+	+

The distance between *r* and M^r is about 16 units. With *py* to the left of *r*, this places it in the vicinity of *te*. *te* has been determined at 12-24 units to the right of *pd*. If Sokoloff's 1962 values in "Linkage studies IV" for *te* are correct, the M^r would be to between *te* and *pd*. However, Dawson (see note in this issue of TIB), introducing *te* in a different background gets a value of at most 14 units for the distance between *r* and *te*. Clearly, further crosses are necessary to establish the exact order.

Tribolium confusum

1. *dent (dt)*. Sokoloff, 1962. Spontaneous in a wild population being tested in connection with genetic load experiments. The single non-virgin female isolated had a deformed prothorax resembling prothoraxless (*ptl*) in *T. castaneum*. This condition proved to be non-heritable but her offspring were: 25 normal males and females and 4 males and 5 females *dt*, hence dent behaves as an autosomal recessive. Mutant characterized by a hemispherical to oval depression one third of the way from the hind to the middle legs on the medial metasternal suture. May be variable in size and irregular in form. No linkage data available. (Some of the individuals carrying dent also carried the gene engraved metasternum--see elsewhere in this section).

2. *engraved metasternum (ems)*. Sokoloff, 1962. Spontaneous from a wild population being tested in connection with genetic load experiments. Appeared in some individuals also exhibiting dent (*dt*)--see elsewhere in this section. As in

T. castaneum, this condition results from a gene with good viability, incomplete penetrance and variable expressivity. Characterized by an irregular roughly semi-triangular depression midway between the medial metasternal suture and the pleural sclerites, and anterior to the (normal) transverse depression on the posterior edge of the metasternum. No linkage data available.

3. *labiopedia (lp)*. Sokoloff and St. Hilaire, 1962. Spontaneous. Detected as a single male pupa in a warped elytra stock (q.v.). The pupa seemed to have an extra pair of legs hidden under the head. From it, on September 24, emerged an imago showing that the extra legs originated from the labium. The male died by the time the F_1 emerged. Sex-linked recessive, semi-lethal to lethal in various matings. Complete penetrance but variable expressivity. Labium greatly enlarged; legs somewhat smaller than the first pair with femur, tibia, and tarsus consisting of 5 segments, the distal one bearing claws. Detectible as soon as the larva emerges from the egg, and identifiable in the pupa. The labial legs are not movable except that the beetle can change their position with the first pair of legs. Whether the sex-spot is present in these legs is yet to be determined. An illustration of a typical mutant is shown on the front cover of this issue of TIB. On the basis of 51 male progeny of *St es* +/++ *lp* x ++ *lp*/ the order of these genes appears to be *St-es-lp*.

4. *melanotic stink glands (msg)*. Ho and Sokoloff 1958, 1963. Spontaneous. Discovered (by Ho) in strains CF2, CF3, CF6 and CF9 and subsequently (by Sokoloff) in the Berkeley synthetic strain (see stock list) in some crosses in connection with genetic load experiments currently being investigated. Autosomal recessive of good penetrance and viability but variable expressivity. Typically, the prothoracic stink glands (PSG) are more frequently affected than the abdominal stink glands (ASG). The PSG appear, at both anterior angles of the prothorax, as dark spots (easier to detect from the ventral than from the dorsal side). The shape of the main spots are rounded, elliptic or triangular, appearing pinkish or dark brown in young imagoes but turning black in two or three weeks. In most adults the black PSG appear symmetrical, but in some individuals they may be extremely asymmetrical, and several spots of different sizes may be seen on one or both sides. The ASG are less reliable for classification of the mutant, since neither, only one or both may be pigmented, and usually they acquire pigmentation later than the PSG. Squeezing of the abdomen may empty the contents of the PSG and then they cannot be seen. The fluid so squeezed out appears to have dark particles and feels "crystalline" when touched with forceps. Dissection of the PSG shows that the dark spots on the

prothorax also result from the precipitation of the fluid in the glands. John Crenshaw (personal communication) states that *msg* beetles are classifiable even when the body color is black. No linkage data available. (N.B. A similar condition can often be observed in very old *T. castaneum*, *T. confusum* and *L. oryzae*. This condition, however, is the result of aging and is not heritable insofar as is known.)

5. *pearl* (p^s). Sokoloff, 1963. Spontaneous in the Berkeley synthetic strain (for details see stock list). Allelic to the pearl mutation described by Graham (1957).

6. *warped elytra* (*we*). Sokoloff, 1962. Spontaneous in *fas es* x N.Y +/+ crosses. As in *T. castaneum* one elytron or both may be displaced either to the right or left of the midline, and lifted away from the abdomen. This condition, in both species, apparently results from the formation of a blister on the membranous wings. If the blister is large and if the fluid is not reabsorbed into the body cavity, the elytra sclerotize in an abnormal manner. It is probable that this is the reason that *we* in *T. castaneum* was reported as being of poor penetrance. In both species the gene acts as an autosomal recessive. Linkage studies in the two species have not been attempted so far, since it will be necessary to get the beetles as they hatch to determine (by dissection of the elytra) whether the membranous wings are blistered.

Gnathocerus cornutus

1. *light ocular diaphragm* (*lod*). Sokoloff and Ho, 1962. Spontaneous in pearl (Berkeley stock). As in *T. castaneum* and in *T. confusum* the ocular diaphragm loses its black pigmentation becoming colorless to reddish yellow when observed through the ommatidia. Autosomal recessive of good penetrance. Viability information on this mutant not available because even the wild type strains suffer considerable larval mortality under our conditions.

B. Tests of allelism

1. *T. castaneum*

"Short antenna" (*Sa*); "Gnarled" (*Gn*) and "Distorted" (*Ds*) proved to be allelic. The names of the last two mutants have been changed to Short antenna and given the symbols *Sa-1* and *Sa-2*, respectively.

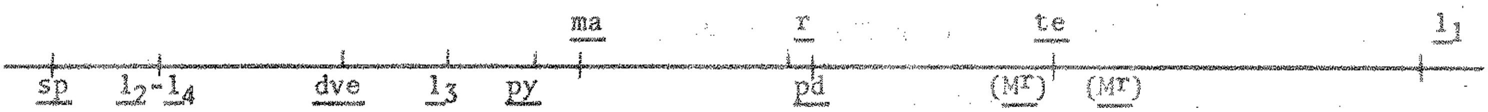
Microphthalmic-Mertz, is allelic with Microphthalmic (*Mo*) Sokoloff.Mertz' mutant is being given the symbol *Mo-1*.

C. Linkage Data

Tribolium castaneum

Chromosome I. (X).

The order of the genes in this chromosome is:



with the following distances (in crossover units)

pd - *te* = 24

pd - l_1 = 61

r - *pd* = 1

ma - *pd* = 13

py - *ma* = 2

l_3 - *py* = 5

dve - *py* = 11

l_2 - *py* = 23

l_4 - *py* = 25

sp - *pd* = 46

Analysis of linkage data shows no significant difference in the position of l_2 and l_4 in respect to *py*. Therefore they have been placed at the same locus. (See Sokoloff & Dawson, Canadian J. Genet. Cytol., In Press).

M^r has been located 16 units to the right of *r* (with some distortion expected since *py* was involved). Crosses have been made to establish whether M^r is to the left or to the right of *te* in view of the fact that *te* may be located 12-24 units to the right of *r* (see note by Dawson, Research Notes Section).

Chromosome II.

No change (see TIB 5, p. 44a.) except to make a correction: since Lasley's pink (p^{Pk}) is allelic to pearl, the symbol p^{Pk} should be added next to *p*.

Chromosome III.

light ocular diaphragm (*lod*) is linked with black. The distance between *b* and *lod* is 24 units.

Chromosome IV.

deformed legs (*dfl*) is linked with bar eye (*Be*). The best estimate available so far is about 21 units from *Be*, but dfl has incomplete penetrance. The order of Be, s, and dfl has not been established.

Chromosome V.

No change from TIB 5, p. 44a.

Chromosome VI.

No change from TIB 5, p. 44a.

Chromosome VII.

Sa - ble = 22 units
Fta - ble = 16 units (estimated, since ble has incomplete penetrance).
Fta - ca = 2 units
ca - c = about 40 units

Sa appears to be near ca.

This chromosome has presented some difficulties in mapping the various genes because of the interaction between Fta and Sa (see teaching note), and the appearance of an autosomal recessive lethal in the ca c stock. One additional peculiarity can be illustrated by the following results:

A. Backcrosses of Sa ble/+ + male to + ble/+ ble gave:

Sa	ble	54
+	+	96
Sa	+	97
+	ble	69
		316

B. Backcrosses of Sa +/+ ble female to + ble/+ ble gave:

Sa	+	526
+	ble	223
+	+	130
Sa	ble	97
		976

The first backcross would lead to the conclusion (using only the non-*ble* classes since *ble* is not fully penetrant) that there is *no* linkage; the second that *Sa* and *ble* are about 20 units apart.

The situation is not unique for the above genes as shown by the following crosses:

Fta *c*/+ + male x + *c*/+ *c* female gave

+ +	186
Fta *c*	151
Fta +	163
+ *c*	172
	672

Fta +/+ *c* female x + *c*/+ *c* male gave

Fta +	226
+ *c*	207
+ +	158
Fta *c*	138
	729

In the latter cross crossover values of about 40 per cent are obtained. In the previous cross there appears to be random segregation of the two genes.

While the reciprocal crosses of the above have only recently been set up, the data presented above seem to indicate the necessity for carrying out reciprocal crosses in coupling and repulsion, and that it is preferable to select females heterozygous for two genes than males if backcrosses are restricted to one sex.

If this phenomenon is a real one, then,at the very least, chromosome VII represents an exception to the findings of Lasley (TIB 3, p. 15) and Sokoloff (1962, and the present issue of TIB) that crossing over is equal in the two sexes of *Tribolium castaneum*.

NOTES - RESEARCH

Bartlett, Alan C. Mortality after irradiation of *Tribolium castaneum*. Three doses of X-ray radiation were given to groups of beetles containing 50 male and 50 female adults. Counts of the number of deaths in the three groups were taken at four days after treatment, as well as at periods of one, two, three, and four months after treatment. The adults were stored at 65°F after the first observation. In the following results the percentages are presented in the order of 4 days, 1 month, 2 months, 3 months and 4 months for each dose:

No irradiation	1%	3%	4%	5%	6%
100 r	3%	7%	13%	15%	24%
1000 r	4%	7%	17%	18%	26%

Per cent mortality increased with dose and with increase in age. At the end of four months, however, there were still sufficient adults present to reproduce an F_1 population. At the end of four months only a few very small larvae were present in the storage jars. Upon warming all populations were able to reproduce at an adequate level. The reproductive potentials of the different treatment groups are significantly different and these parameters did not change with age, under the conditions of this experiment.

Boll Weevil Research
Laboratory
State College, Mississippi

Bates Lake, Charlotta. Sexual Maturation in *Tribolium confusum*. Preliminary studies indicated that females were capable of being fertilized by mature males at the age of 24 hours while young males were not capable of fertilizing mature females until about 72 hours from eclosion. Larger scale studies involving 57 young females and 71 young males were then conducted in an effort to pin down the time of sexual maturation more accurately. Young beetles, within 5 minutes from eclosion, were mated to beetles sufficiently old to be sexually mature. The duration of exposure was a controlled variable. The female in each test case then was maintained in a small vial and kept for several weeks under observation for larval production. All experiments were run at 29°C and about 70% relative humidity. Young females which were isolated as early as 19 hours after eclosion did produce larvae. Young males successfully fertilized their mature mates with reasonable frequency at 90 hours of age. This experiment actually demonstrated the ages at which successfully young males *cannot* mate as evidenced by the limited number of trials made. One aberrant result, a 16 hours old male which apparently had fertilized its mature mate, indicates that there may be considerable variability between individuals. However, experimental error in the form of a non-virgin test female may be involved here. A small experiment involving 6 young males starved for 93 hours and then mated for 24 hours resulted in no offspring. This indicates that nutrition may play a role in sexual maturation. One problem in this work is that there is appreciable cannibalism of the teneral individual by its mature mate; young females seem to suffer the highest fatalities.

This work is being continued with detailed study of the morphology and histology of the male and female reproductive systems of teneral adults of various ages.

Department of Zoology,
University of Miami,
Coral Gables, Florida

Bender, H. A., and J. P. Doll. Bacteriologically sterile Tribolium. A bacteriologically sterile line (germfree) of Tribolium castaneum was obtained through chemical sterilization of the eggs utilizing peracetic acid ($HC_2H_3O_3$). Freshly laid eggs were collected and placed in a 2% solution of peracetic acid (obtained from the Becco Chemical Division, FMC Corp., Tonawanda, N.Y.) for two minutes and washed in distilled water. The treated eggs were then placed in vials containing flour which had been sterilized in a steam autoclave for 20 minutes (121°C.). "Caking" of the flour was avoided by placing the autoclave under vacuum for 20 minutes immediately subsequent to sterilization.

Bacteriological sterility was ascertained on all fractions of the culture vials (waste products, medium, and ground-up beetles). Tests were run for aerobic and anaerobic forms. Sampling was done in triplicate and separate incubations were run at room temperatures, 37°C., and 55°C. Bray dishes with nutrient agar containing 5% horse blood were utilized for anaerobic assays. Aerobic growth was checked utilizing samples grown in nutrient and thioglycollate broth and similarly incubated. (A complete description of such tests is reported by Doll et al., 1963, Amer. Midl. Nat. 69:231-240.)

Sterile cultures were maintained through three generations.

Department of Biology
University of Notre Dame
Notre Dame, Indiana

Dawson, Peter S. The Time of Action of Lethality Associated with the Truncated Elytra (te) gene in T. castaneum. Truncated elytra (te), a sex-linked recessive mutant in T. castaneum, acts as a semi-lethal, causing the death of from one-third to two-thirds of hemizygous males in the juvenile stages (Sokoloff, 1960, 1962). In addition to this pre-imaginal mortality, there is a high mortality among adults, with few males surviving to reproduce. During the course of some experiments designed to determine the position of a sex-linked lethal (l_2), a spontaneous mutation allelic to te was discovered.

The new mutant is phenotypically similar to te, and a test of allelism confirmed the fact that the two genes were at the same locus. Several ++/rte females were pair-mated to wild-type males in shell vials containing about 8 grams of yeast-enriched flour. The cultures were kept at 29°C and 70 per cent relative humidity. Progeny were collected as pupae every 6 days, sexed, and maintained in separate vials by sex for classification at the next collection period. In this way loss due to pupal mortality could be circumvented since pupae which had not eclosed could be classified for both r and te. The results of 8 successful matings are summarized below.

Males					Females
+	r	te	rte	Total	+
554	91	47	542	1234	1279

From these data, it is seen that the expected 1:1 sex ratio was observed ($X^2 = 0.81, .50 < P < .25$). A chi-square test on the expected 1:1 segregation for + and te was not significant ($X^2 = 2.54, .25 < P < .10$). Thus the pre-imaginal mortality associated with te occurs, at least in males of this te allele,predominantly in the pupal stage. A large proportion of this mortality in pupae is due to the inability of the pupa to free itself from the pupal skin.

The location of the te gene on the X chromosome has recently been the subject of two papers. (Sokoloff, 1960, 1962.) The latter paper estimates the distance from pd to te as 24 units, whereas the earlier estimate was 12 units. Since there was no deficiency of te males in the present study, all of the data may be used for computing distances rather than "corrected" figures. The distance between r and te on this basis is 11.2 units, a value close to that obtained by Sokoloff in his first report on te (r is about 1 unit on the other side of pd from te). The "corrected" estimate from the present data is 14.1 units.

The reported incomplete recessivity of te was not observed in these experiments: none of the females were phenotypically te. This probably reflects differences in the genetic background in the stocks used for Sokoloff's and my studies.

The technique of collecting progeny in the pupal stage may thus be used to advantage in matings involving mutants which reduce pupal viability. In addition, this method insures that all progeny collected from a mating will be those of the original parents rather than second-generation individuals from the early-eclosing adults. This may be particularly important when using mutants which increase developmental time.

(The technical assistance of Mrs. Louise Bielfelt is gratefully acknowledged.)

Department of Genetics
University of California
Berkeley, California

Dawson, Peter S.* Homeotic mutants in *Tribolium castaneum*. Homeotic mutants, those which transform one type of organ into another, are well known in several species of *Drosophila*, but until recently had not been reported in *Tribolium*. Two similar mutants of this type, one discovered in this laboratory in July, 1962 and one reported by Englert and Bell (1963), are now known in *T. castaneum*.

Antennapedia (*ap*), an autosomal recessive gene, was described by Englert and Bell as exhibiting ". . . in addition to the reduction and fusion of antennal segments, the presence of tarsal segments and the two tarsal claws on the antenna to give a 'leglike'appearance." In its extreme expression, *ap* conditions "the replacement of all but the basal segments by a complete tarsus" (Englert, personal communication).

A similar mutation was found in this laboratory in the *Sa-2* (formerly Distorted, *Ds*, see section on New Mutants) stock. Because of its basic similarity to *ap*, it is tentatively being given the same name with the symbol *ap*^{D}. A test of allelism is currently in progress utilizing *ap* beetles kindly supplied by Mr. DuWayne C. Englert.

The antennae of *T. castaneum* are typically composed of 11 segments: two proximal basal segments, six funicle segments and three distal club segments. The first and second legs consist of 9 segments: coxa, trochanter, femur, tibia, and five tarsal segments. The third pair of legs has only 8 segments, lacking one tarsal segment. In the typical *ap*^{D} mutant (see front cover), the two basal antennal segments are always present. The remaining 9 segments are usually replaced by what appears to be a large irregular block of sclerotized material and a usually distinct tarsus. The large block of material presumably represents the first four leg segments. The "antennal tarsus," when well expressed consists of five segments plus the typical tarsal claws at the end; thus it is similar to the tarsus of the first two pairs of legs. In addition, the spurs normally found at the end of the tibia are usually present on the mutant antenna.

Thus when *ap*^{D} is strongly expressed, it differs considerably from *ap*, in which evidence for the presence of the leg segments other than the tarsus has not been obtained. Visual examination of a small number of *ap* adults supplied by Mr. Englert has confirmed this difference. In less extreme cases, the two mutants appear much more similar.

Preliminary linkage studies have shown that *ap*^{D} is not linked to pearl, sooty or chestnut (linkage groups II, IV and VII respectively). Similar studies with *ap* failed to place this gene on any of the seven previously marked chromosomes (Englert, personal communication)*

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* (See also section on New Mutants. Ed.)

The viability of individuals homozygous for $\underline{ap}^D$ is reduced below that of wild-type siblings. Pooled data from all completed studies where the expected ratio of normal to mutant progeny was 3:1 gives a total of 1502 normal: 379 mutant. The difference from the expected ratio is highly significant ($\chi^2 = 23.6$, d.f. = 1, $p < .001$). It should be emphasized that these totals include a number of different genetic backgrounds and thus probably are a good reflection of the effect of the $\underline{ap}^D$ gene on the viability of mutant individuals.

Selection for extreme expression of $\underline{ap}^D$ is currently being carried out in an attempt to demonstrate the presence of the remaining leg segments.

Department of Genetics
University of California
Berkeley, California

Dawson, Peter S. The Selection of Virgin Females For Use in Genetic Studies

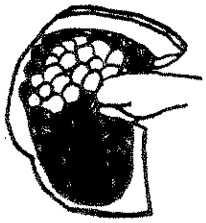
Recent studies (submitted for publication in the Annals of the Entomological Society of America) on the age at which females of T. castaneum and T. confusum may be fertilized have shown that successful copulation may occur in T. castaneum before female imagoes are 3 hours old. The corresponding age for T. confusum is 17-20 hours. Thus the practice of regarding newly eclosed females as virgins for use in linkage (and other) studies should be restricted, in T. castaneum at least, to those females to which the exuvium is still attached.

Department of Genetics
University of California
Berkeley, California

Dawson, Peter S. *Somatic mutation in T. castaneum involving red.

Somatic mutation has been extensively studied in Drosophila and other organisms and has also been reported for the autosomal gene pearl in T. castaneum (Sokoloff, 1959, and TIB-3: 30-33). In the course of some linkage studies involving, among other things, the sex-linked red (r) eye mutation, one aberrant beetle was observed.

The parents of the individual concerned were +/r female and r/- male. One male offspring from this mating had one red eye and one eye which was part red and part black. The line of demarcation between the two colors was very distinct, with the point at which the gena meets the eye dividing it into two colored areas: black ventrally and red dorsally (see accompanying figure). The outer edge of the red area was



black because of the pigmented ocular diaphragm which is not affected by the r gene. Unfortunately this male also carried a sex-linked semi-lethal gene and died before breeding tests could be made.

Since the constitution of this male at the time of fertilization was obviously r/-, it is proposed that the observed phenotype resulted from a somatic mutation from r to +. So far as the author is aware, this is the first case of a back-mutation to wild type observed in somatic tissues of Tribolium. Sokoloff's somatic mutations involving pearl appear to have occurred in beetles heterozygous for pearl and thus were mutations from + to p.

(Note: The figure was redrawn from the (much better) original drawing prepared by Mr. Roger S. St. Hilaire; magnification 80X).

Department of Genetics
University of California
Berkeley, California

Erdman, H. E. Life Cycle Radiation Tolerance of Two Tribolium Species.

X-ray doses required to induce sterility and lethality at eight different stages throughout the life cycle were greater for Tribolium castaneum than for Tribolium confusum. These doses increased with increasing development and differentiation. The egg at 1 to 3 hours after oviposition was the most radiosensitive stage; 1 to 2 kr was lethal and lower exposures failed to induce sterility in adults x-rayed as eggs. At later developmental stages, lethal doses were higher than sterilizing doses and the two markedly diverged after the larval stage. Experimental conditions were 30° C and 70 per cent relative humidity.

Hanford Laboratories
Biology Laboratory
Richland, Washington

Erdman, H. E. X-ray Effects on Single- and Mixed-Species Populations of Two Tribolium Species.

In a series of experiments, single- and mixed-species populations of day-old flour beetles were given 0, 2, 4, and 6 kr of x-rays. Effects on reproductive abilities, induced dominant lethals, and life spans were determined. As the x-ray dose was increased, the reproductive abilities were progressively lowered; however, with time, there was a partial recovery of reproduction as illustrated by a decrease in the frequency of induced dominant lethals. Tribolium confusum had approximately twice the mean number of dominant lethals induced by 2 kr as Tribolium castaneum for the ten-week observation period. Complete sterility in both species and shortened life span in Tribolium confusum occurred at 6 kr.

In non-irradiated single-species populations, both species had comparable reproductive abilities; however, in the x-rayed groups, Tribolium castaneum was more productive. In the mixed-species, Tribolium confusum reproduction was strikingly reduced. Coexistence and 2 kr x-radiation appeared additive in their reduction of Tribolium confusum progeny. This effect was not observed at 4 kr, perhaps due to severe and irreparable damage to the recovery system(s).

Hanford Laboratories
Biology Laboratory
Richland, Washington

Erdman, H. E. Irradiation Effects on Single- and Mixed-Species Populations of Tribolium confusum and T. castaneum in Various Environments.

The radiation responses of young adult flour beetle populations cultured as single- and mixed-species populations are being studied in three regimes of environments; namely 25° C, 30° C and 33° C at 70 per cent relative humidity. The effects due to the environmental stresses, temperature and x-radiation will be evaluated singly and in combination.*

Hanford Laboratories
Biology Laboratory
Richland, Washington

Ho, Frank. Preliminary Studies of Cannibalism in Tribolium.

Although many studies on cannibalism in flour beetles have been carried out, so far as the author is aware there has been no investigation to test the voracity of these beetles when eggs of two species are available. In this study 50 males of castaneum (CS) and confusum (CF) were offered 100 eggs (at most one day old) mixed thoroughly in two or four grams of standard medium as indicated in Tables I and II. The physical conditions were 29°C and 60 per cent relative humidity. The results seem to indicate that neither species of male is particular about the types of egg it eats. A series of studies is under way to determine whether any differences in voracity can be detected on the part of female adults or juvenile CS of CF on the egg and the pupa, the two vulnerable stages in Tribolium, and between larvae of different stages of development.

Department of Genetics
University of California
Berkeley, California

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* Work performed under Contract No. AT(45-1)-1350 between the Atomic Energy Commission and the General Electric Company.

Table I

Cannibalism of male *Tribolium* in 4 grams of whole wheat flour

No. of culture	Adult (♂) no.	Egg no.	Total poss. cann. in 40 days
1	50 CS	100 CS	78 CS
2	50 CS	100 CF	77 CF
3	50 CF	100 CF	74 CF
4	50 CF	100 CS	59 CS
5	50 CS	50 CF 50 CS	48 CF 42 CS
6	50 CF	50 CF 50 CS	33 CF 35 CS

Table II

Cannibalism of male *Tribolium* in 2 grams of whole wheat flour

No. of culture	Adult (♂) no.	Egg no.	Total poss. cann. in 40 days
1	50 CS	100 CS	79 CS
2	50 CS	100 CF	87 CF
3	50 CF	100 CF	87 CF
4	50 CF	100 CS	87 CS
5	50 CS	50 CF 50 CS	49 CF 44 CS
6	50 CF	50 CF 50 CS	38 CF 42 CS

Inouye, N. *Metric characters in Tribolium. Various characters have been investigated to determine which allow the investigator the greatest latitude in scheduling his work.

A. Pupal Weight.

1. Weight of about 50 pupae was determined as soon as they formed from larvae kept at 29° C and 70 per cent relative humidity. The pupae were placed in individual vials containing standard medium, returned to the incubator and weighed again 5 days later.

This method is unsatisfactory because:

1. Pupae, on aging, lose weight by as much as 9-15 per cent,
2. The short pupal period demands a fairly rigid schedule, and restricts the number of pupae which can be handled within a working period.
3. Sifting the pupae from the flour is laborious.

2. Weight of pupae kept in cold storage.

Pupae were placed in plugged individual vials (without flour) in a cold room maintained at 5.6°C (relative humidity was not recorded). Weights were re-determined when the pupae were one, seven and 20 days old. The results, given as per cent gain or loss over the preceding weight were as follows:

	Days in cold storage		
	1	7	20
♀♀	-0.58	-1.39	+0.11
♂♂	-1.89	-5.68	-7.25

It is evident that 1) both sexes still lose weight and 2) the two sexes behave differently under these conditions.

3. Weight of pupae kept in the freezer.

After the first weighing the pupae were placed in a vial, the vial plugged with cotton and set on dry ice. After all the pupae were weighed they were transferred to a freezer. During re-weighing the vials were kept on dry ice. Per cent gain or loss from the preceding period was as follows:

	Days in freezer		
	1	6	22
♀♀	+3.83	+1.38	+1.08
♂♂	+5.88	+1.15	-0.814

Data from the first day are somewhat unreliable since the pupae picked up some moisture from the side of the vials when they were rolled out. When techniques to remedy this were improved, the weights we were fairly constant. However, the method is costly since dry ice must be used, and time-consuming since each vial must be wiped dry before the pupae are rolled out.

B. Tibia length.

Owing to the fact that fully sclerotized imagoes can be stored indefinitely in alcohol without change in shape, a survey of various morphological characters has been carried out. Preliminary measurements (by A. Sokoloff) suggested that the tibia of all three pairs of legs can be used, preferably the hind tibia, since it is the longest. The third left leg is removed from beetles preserved in alcohol (or from lightly etherized beetles if they are to be bred) by breaking the leg at the femur with jeweler's forceps. The legs are mounted on a slide with the minimum of paraffin oil, five to a group, 10 to a line, with males at the top and females at the bottom of the slide, or males to the left and females to the right if, say, 50 males and females are to be mounted on a single slide.

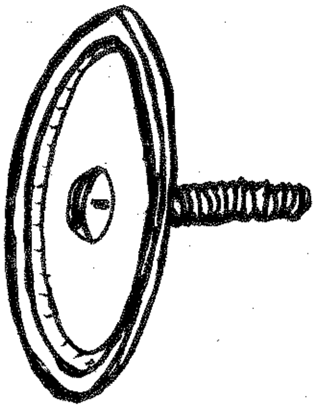
The tibia, once mounted, can easily be measured with an ocular micrometer (a magnification of at least 40X is required). The medial portion of the tibia (which is straight) is set under the micrometer. Since the proximal end of the tibia curves, measurements are made with the zero point on the posterior, distal, end of the tibia. The other point is across the curved proximal anterior end of the tibia, just at the joint with the femur.

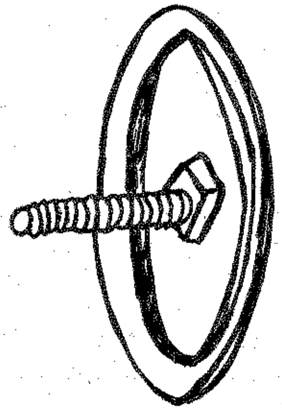
Department of Genetics
University of California
Berkeley, California

Karten, Irving and Maxine L. Howe. *A mixer for small quantities of flour.

A method for preparing homogeneous mixtures of small quantities of flour has been devised which can be useful for work involving the use of conditioned flour. A hole is drilled into the top of a Mason jar lid and fitted with a bolt approximately one inch in length, which is tightened securely in place. The top is then fastened to the jar with the flour to be mixed and the bolt is secured in the chuck of a motor driven flour sifter (Schlager, G. 1960. TIB, 3:20). Approximately 15 to 30 minutes of revolving is sufficient to ensure a thorough mixing of the contents of the jar. The size of the Mason jar to be used and the speed at which the jar is revolved naturally depends upon the quantity of flour to be mixed. With this device it has been possible to obtain homogeneous mixtures of various concentrations of conditioned flour mixed with whole wheat flour to which yeast had been added.

Department of Entomology
The University of Kansas
Lawrence, Kansas





Krause, Eliot. Effect of temperature on Penetrance of the ti mutant. The tarsal irregular (ti) mutation, as reported in TIB #5, is a sex-linked recessive factor which generally causes fusion of the second and third tarsi of the mesothoracic pair of legs. Matings of ti x ti resulted in ti progeny, but some phenotypic wild types (both males and females) were observed. These wild type progeny when testmated to unrelated wild type and ti stocks were found to be genotypically ti.

Table 1. The phenotypic expression of the ti gene observed in progeny from ti x ti matings cultured under different environmental conditions of temperature and humidity.

Environmental conditions			Phenotypes of the progeny		
Temperature	Humidity	No. of matings	ti	+	per cent penetrance
32.8°C	70% R.H.	9	435	15	96.6%
32.8°C	40% R.H.	10	323	10	96.9%
24.4°C	40% R.H.	8	127	36	71.1%
37.8°C	70% R.H.	9	203	0	100.0%

Since the penetrance of ti was suspected of being incomplete, ti individuals were cultured under the four environmental conditions described in Table 1. At 24.4°C, room temperature, only 71% penetrance was observed. At 32.8°C, penetrance was enhanced to 97% while complete penetrance was observed at 37.8°C. No significant differences were found when comparing the per cents of penetrance of the two humidities, 70% versus 40% R.H., under the 32.8°C temperature condition. Therefore, it can be inferred from this data that the penetrance of ti is temperature dependent and that the threshold temperature for full manifestation of ti is at some temperature between 32.8°C to 37.8°C.

Population Genetics Institute
Purdue University
Lafayette, Indiana

Krause, Eliot. Rate of development of the Sa mutant. When investigating the viability of the short antenna (Sa) mutant (see TIB #5 for description of this mutant), differences of developmental time were observed for the mutant class in comparison to that of the wild type class. Means and standard errors of the developmental times for each stage of development are presented in Table 1. As can be seen from this Table, the wild types took slightly longer to develop from egg to larva than did the mutants, but this difference was not statistically significant. On the other hand, the mutant class, Sa, took nearly two days longer to pupate than did the wild type. This difference was found to be statistically significant. The small difference observed for the pupal developmental time of the mutant compared to that of the wild type was non-significant.

Table 1. Means and standard errors of developmental time (in days) of different stages of development.

	Phenotype			
	Sa		Wild type	
Stage of development	Mean (days)	Standard error	Mean (days)	Standard error
Egg to larva	3.98	.060	4.17	.109
Larva to pupa	16.39	.152	14.69*	.190
Pupa to adult	4.55	.050	4.67	.031
Egg to adult	24.90	.147	23.53*	.167

* Significant ($t_{.05}$ test) differences between phenotypes.

When the entire developmental from egg to adult was compared, the mutant took significantly longer to develop than did the wild type. However, this difference appeared to exist due to the difference first observed during the larval stage of development.

Population Genetics
Institute
Purdue University
Lafayette, Indiana

Lefkovitch, L. P. *Differing status of colour forms in Cryptolestes Gangl. (Cucujidae)*

Miss E. Reynolds, of this Laboratory, noticed some dark individuals otherwise morphologically identical with Cryptolestespusillus (Schönherr) amongst living material obtained from Trinidad. In these individuals, the antennae, head, prothorax, ventral side of the body and edges of the elytra were almost black but with a reddish tinge, the central region of each elytron being less intensely black. Even the immature adult of this form, whilst still in its cocoon, is considerably darker than the "ferruginous" of the mature normal form.

Since the same kind of colour difference between two other Cryptolestes was found to be indicative of specific isolation (Lefkovitch, 1959, Proc.R.ent.Soc.Lond.(A) 34: 44 - 48), it was of some interest to discover the relationship between these two colour forms. Crossing experiments, still in progress, have shown that there is no isolation between them and that there is no evidence of any of the usual hybridisation effects associated with differences at the species level. The F_1 generation were all the "normal" brown colour and the F_2 so far comprises 133 brown and 55 black individuals; back-crosses are now being studied. The evidence so far obtained does not disagree with the hypothesis that this dark form is controlled by a single, fully penetrant, autosomal factor which is recessive to the normal brown coloration.

The problems of a taxonomist in this group are thus multiplied. In one case, black and brown forms of otherwise morphologically identical animals indicated differences at the species level (admittedly supported by habitat differences) but in another, the difference appears to indicate no more than a single Mendelian factor.

Pest Infestation Laboratory
Slough, Bucks, England

Lerner, I. Michael and Frank K. Ho. *More on the Montgomery effect in competition experiments.*

We have previously reported (1961, Am. Nat. 95:329-342) that in a series of competition experiemnts between strains of T. confusum and T. castaneum, under the particular conditions of the tests, there was a positive correlation between competitive ability and productivity in unmixed cultures. At the same time it was noted that, so far as the behavior of the species (rather than strains within the species) success in competition was inversely correlated with productivity without competition, a phenomenon designated by Gustafsson (1951, Evolution 5:181-184) as the Montgomery effect.

The present note serves to confirm our previous findings on the basis of a further experiment conducted in the identical manner with the earlier one, but involving some different strains of the two species. The results for both experiments are summarized in the following table.

The technique followed in these experiments has been fully described in our earlier publication. The form of summary used here, however, is different. In each experiment two inbred strains and a cross between them were placed in competition individually against two inbred strains and their cross of the other species. Each competitive situation was replicated 10 times. Thus each experiment contained 90 cultures. In addition adults in 10 unmixed cultures of each line used (60 cultures in each experiment) were censused monthly to provide an estimate of productivity in unmixed cultures.

The table is based on the results of five transfers only. Had later and fuller information been used for the table discrimination between competitive abilities of the different strains would have been impossible, since as shown by Lerner and Dempster (1962, PNAS 48: 821-826) the figures in the cells of the table would have been either 100 or 0.

The table is self-explanatory and with the minor exceptions marked by asterisks indicates a general agreement between the two experiments. It may be noted that the "% cultures leading" discriminates between the competitive abilities of _T. castaneum_ beetles better than "% cultures extant", while the reverse is true of _T. confusum_.

Department of Genetics
University of California
Berkeley, California

Productivity and Competitive Ability of *T. castaneum* (CS)
and *T. confusum* (CF) strains (based on five transfers)

Experiment	Strain	Generations of sib-mating at start	% cultures leading in competition with			% cultures extant in competition with			Competitive rank	Productivity in unmixed cultures
A			CS 2	CS 12	CS X	CS 2	CS 12	CS X		
	CF 9	13	0	0	0	0	10	0	3	444
	CF 11	13	0	0	0	10	90	10	2	950
	CF X	--	10	90	0	90	100	40	1	1101
	C		CF 9	CF 11	CF X	CF 9	CF 11	CF X		
	CS 2	13	100	100	90	100	100	100	2	266
	CS 12	13	100	100	10	100	100	100	3	244
	CS X	--	100	100	100	100	100	100	1	405
B			CS 3	CS 5	CS X_1	CS 3	CS 5	CS X_1		
	CF 1	18	100	0	0	100	40	0	3	397
	CF 11	17	100	0	0	100	80	0	2	626
	CF X	--	100	100	0	100	100	40	1	845
			CF 1	CF 11	CF X	CF 1	CF 11	CF X		
	CS 3	16	0	0	0	60*	90*	20	3	88
	CS 5	18	100	100	0	100	100	100	2	638*
	CS X_1	--	100	100	100	100	100	100	1	529*

*Exceptions from general order

Lerner, I. M., A. Sokoloff and F. K. Ho. *Food Preferences in Tribolium.

An elaborate population cage, referred to as the "combination set" has been used to test variability of T. castaneum and T. confusum when the populations of a given species encounter a variety of ecological niches. The cage (constructed by Mr. N. Inouye) consists of a central chamber to which eight side chambers are attached. In the particular experiment under way, the central chamber is filled about half full with a mixture of corn flour, rice flour, soy bean flour and whole wheat flour to which five per cent brewer's yeast is added. Each of the side chambers contains only one of the four types of flour (replicated) but no yeast. Two hundred pairs of beetles were introduced in the central chamber and the medium renewed once a month, at which time the populations in all the chambers are censused and the adults discarded. At the present time, two combination sets are in operation. One set holds a population of T. confusum and the other T. castaneum. The former has been placed in an incubator set at 29° C, 60 per cent relative humidity, the latter in an incubator set at 20° C, 40 per cent relative humidity. The censuses obtained so far indicate the following distribution of adults of T. castaneum and T. confusum in the various media:

	T. castaneum		T. confusum	
	N	%	N	%
corn flour	619	9.00	867	13.72
rice flour	1061	15.44	1544	24.43
soy bean flour	326	4.75	261	4.13
whole wheat flour	973	14.16	1363	21.57
mixture	3892	56.00	2284	36.15
Total	6871	100.00	6319	100.00

The data are self explanatory. Two observations may be added here: 1) T. confusum appears more likely to migrate to the side chambers than T. castaneum, 2) Larger numbers of T. confusum are found in rice flour, which appears to have more uniform and smoother particles than the other media, and is less likely to contain flour "dust." It is not known whether T. confusum migrates to rice flour because it provides a more suitable nutrient medium or because of the physical characteristics of the flour particles.

Department of Genetics
University of California
Berkeley, California

Loschiavo, S. R. A sporozoan parasite of Trogoderma parabile,

Occasionally our laboratory cultures of T. parabile become decimated by a coccidian parasite belonging to the genus Adelina. Its presence may be suspected by such outward signs as an unusually large number of dead adults, larvae and pupae, the low incidence of live ones, and their peculiar appearance and sluggish movement. Its presence is easily confirmed by microscopic observation under phase contrast, of smears from the whole insect, digestive tract, or fat body. The most frequently observed stage of the parasite is the infective oocyst in various stages of development.

The life cycle of this parasite follow the general account given by Yarwood (Parasitology 29(3):370-390, 1937) for the genus Adelina. It is believed that infection spreads as follows: the uninfected insect feeds on the carcass of an infected one thereby ingesting oocysts. The wall of the oocyst breaks down in the gut and sporocysts are released. Up to 16 sporocysts have been counted in one oocyst. The sporocysts give rise to sporozoites which are released into the gut, probably penetrate the gut wall and infect various tissues including fat body. The sporozoites now develop into schizonts. Each schizont gives rise to bundles of merozoites packed together like staves on a barrel. The merozoite is a long spindle-shaped, transparent, motile organism, One end is stationary and the other end whips about in a spiral-like motion usually in an anti-clockwise direction. Some of these become second generation schizonts; others become gametoblasts to start the sporogony cycle. The male and female gametoblasts become attached to each other and when mature are surrounded by a gametocyst wall. The male microgametoblast divides twice to produce four microgametes of which one fuses with the nucleus of the female macrogamete to form a thick-walled zygote or oocyst. The zygote nucleus divides many times to form a multinucleate sporont which in turn breaks up into uninucleate sporoblasts. Each sporoblast gives rise to a sporocyst containing two sporozoites. It is evident that the parasite can multiply and spread very rapidly. Most of the stages in the life cycle of this coccidian have been photographed through the phase contrast microscope at this station.

We have been unable to transfer the infection to two other species of dermestids or to T. confusum. Therefore it appears the parasite is host-specific and likely a new species. To my knowledge no details of its life history and morphology have been published.

None of the stages of this parasite has been found in the eggs of T. parabile. This is an advantage when one is trying to eliminate the infection. All infected cultures must be subjected to high temperatures before being discarded and all tools, equipment, table tops etc., which were in contact with the infected material must be sterilized. New cultures should be started with eggs making sure that fecal material from the parents is not transferred with the eggs to the new medium. The fresh medium must be heated to 60° C. for at least 4 hours before use. As an extra precaution eggs may be surface sterilized according to Park's method (Ecological Monographs 18:265-308, 1948). If these procedures are followed, tedious as they are, the infection may be kept at a relatively safe level for long periods of time.

Canada Agriculture,
Research Station
Box 6200, Winnipeg,
Manitoba, Canada

McDonald, D. J. and C. L. Spencer. *Mating activity in T. confusum.

Mating activity has been examined by introducing pairs of the adults into a dish and determining how rapidly mating takes place. Pronounced differences in mating activity have been found between mutant strains. In some cases the morphological changes accompanying the mutation may account for the depression of mating activity, and frequently, this depression is greater in the females than in the males. Differences can also be found between strains which do not exhibit obvious morphological abnormalities. The data also indicate the presence of an "excited period" when the male and female are first put together.

Department of Biology
Dickinson College
Carlisle, Pennsylvania

Musgrave, A. J. Mycetomal micro-organisms in weevils.

Further evidence that mycetomal micro-organisms are indeed micro-organisms and not organelles etc., has been obtained in electron micrograph studies (see publications).

It has also been suggested that these mycetomal micro-organisms (which are cytoplasmically inherited through the female weevil) may be of value in helping to identify species and strains of weevils (see publications).

Department of Zoology
Ontario Agricultural College
Guelph, Ontario, Canada

Sinha, R. N. Feeding and Survival of Tribolium confusum on seed borne micro-organisms.

Tribolium confusum Duv. feeds and completes its life cycle at 25 ± 1°C. when freshly laid eggs are placed on pure cultures of the following seed borne micro-organisms grown on potato sugar agar: Absidia orchidis (Vuill) Hagem, Mucor sylvaticus Hagem, M. sphaerosporus Hagem, Nigrospora sphaerica (Sacc.) Mason, Scopulariopsis brevicaulis (Sacc.) Bainier; Curvalaria tretramera (McKinney) Boedijn, and Chaetomium spp. Adults of T. confusum die within a few days when reared on Aspergillus ochracous Wilhelm, A. niger Van Tiegh, A. fumigatus Fres., A. versicolor (Vuill) Penicillium terrestre Jensen, Streptomyces spp.

Experiments of this type are also being carried out for all major species of beetles and mites infesting stored grain.

Stored Products Insects
Laboratory,
Canada Department of
Agriculture Research Station
Winnipeg, Manitoba

Sinha, R. N. and W. L. Gordon. Feeding Specificity of Tribolium confusum on World species of Fusarium. Over 110 species, varieties, and forms of Fusarium collected from all over the World were tested for their suitability as food of adult Tribolium confusum. Mycelial types were in general favored by T. confusum over conidial types. A sample of the results obtained is given below:

A. No Feeding -- Fusarium merismoides Cda.

B. Slight Feeding -- Fusarium poae (Pk.) Wr.

C. Moderate Feeding -- Fusarium graminearum Schwabe

D. Maximum Feeding -- Fusarium avenaceum (Fr.) Sacc.

Entomology and Plant Pathology
Laboratories,
Canada Department of Agriculture
Research Station,
Winnipeg, Manitoba

Sokal, Robert R. A chamber for rearing Tribolium. The editor of TIB has asked me to report on our experiences with a new Tribolium rearing chamber which has been in operation at the University of Kansas for one year. The chamber is a model 1281H Hotpack controlled environmental room of the "walk-in" type. This room has external dimensions of 55" W, 57" D, and 91" H and internal dimensions of 47" W, 49" D and 79" H. The chamber has ample shelf space. We have 12 shelves of 46 1/2" L and 10 1/2" D and could attach more shelves if we wanted to. It has control for both temperature and humidity over the ranges of 13°C - 35°C and 40% - 95% R.H., respectively. The unit is supplied with a humidifier and a refrigeration unit which we have found necessary (in spite of an air conditioned building) in order to maintain our preferred conditions of 85° F and 69% R.H., during the summer months in Kansas. Temperature and humidity control has been quite excellent. We had previously tried to maintain similar conditions in a home-built temperature room. Actual obtained conditions (means of high-low points and their standard errors) in that room over a year of operations were 84.9 ± 0.21°F. and 65.4 ± 0.22% R.H. Absolute limits of conditions would have been meaningless because occasional malfunctioning of the system would cause temperature or humidity to be lowered greatly although for only brief intervals.

Under the conditions employed by us for rearing Tribolium the chamber has been extremely reliable. Whether it would perform equally well under conditions more disparate from the ambient we cannot say. Our main difficulties have been with the humidifier nozzle, which will clog up because of the hardness of the local water. We have had to run the water line to the humidifier through a de-ionizer.

After moving our Tribolium cultures to the new chamber we noted a marked acceleration of the developmental rate in our strains. Since the temperature is not very different we attribute this to the constancy of the environment, especially of the relative humidity. Mean development periods for the UPF strain in the old chamber (data by G. Schlager) were as follows: 31.0 ± 0.31 days for individuals in single culture, 35.0 ± 0.24 days at density of 20/g and 34.1 ± 0.23 days for individuals at 50/g. Comparable values for these same beetles under the new conditions are (data by I. Karten): 26.4 days at density 20/g and 25.44 days at density 50/g. Means as low as 23 days were obtained in some cultures.

Department of Entomology
The University of Kansas
Lawrence, Kansas

<u>Sokal, Robert R.</u> and <u>N. N. Heryford.</u> <u>Data processing in a *Tribolium* selection experiment.</u>

In recent years computers have become increasingly available and growing numbers of biologists are using them in the computation of their research results. Most computer systems permit programs to be written in a compiler language such as FORTRAN, which is easily learned and permits the scientist to write his own programs involving special computations of his own design. In recent months the modified FORTRAN II has come into general use even in medium sized computer installations, such as the IBM 1620 at the University of Kansas. One of the major improvements in FORTRAN II is the great versatility of input and output formats which are permitted, including alphabetical information. This enables the scientist to arrange the output of his computations in any sequence and format which he may desire and to furnish written headings including descriptions for his results.

We have prepared a program for such data processing in a selection experiment currently under way in our laboratory. For each replicate in each generation 28 original measurements are recorded by the technician working with the culture. These are readings such as the total number of eggs laid by the beetles in a 3-day period, the number of adults of the three competing genotypes emerging from the culture, the dry weights of the adults of any one genotype and similar information. The program produces a total of 56 lines of information including the original data and some that is obtained from the previous generation. It carries out such computations as survivorships, adaptive values, Hardy-Weinberg zygotic frequencies, changes in gene frequencies (Δq's), mean weights, etc. Twelve times for each generation observed frequencies are tested against a certain hypothesis by the chi-square method and the deviations as well as the chi-square computed from them are shown.

This method has just been instituted after data for 5 generations each of 21 replicates had been collected. The 105 sets of data took approximately 1 hour machine running time or less than 60 cents per set for processing. An example of a typical output is shown below.

```
3103  001   RAPID SELECTION EXPERIMENT DATA ANALYSIS
3103  002                                                    JAR NO.3-1- 3
3103  003                                 CULTURE JAR  JOINT   CENSUS JAR
3103  01  INPUT GENE F                                  .703
3103  02  OUTPUT GENE F                       .705                .705
3103  03  OUTPUT DELTA Q                      .001                .001
3103  04  NO. ADULTS INPUT                              1704
3103  05  TOTAL FECUNDITY                     3325                3399
3103  06  FECUNDITY PER ADULT                 1.95                1.99
3103  07  INPUT DENS EGGS PER G                 83                  85
3103  08  NO. ADULT OUTPUT                    1804                1523
3103  09  PROP ADULT SURVSHIP                 .542  APPARENT      .448
3103  10  EST TRUE INPUT                                        2827.4
3103  11  EST PROP AD SURVSHIP                                    .538
3103  12  HW PROP INPUT           ++      .087    +B      .416    BB      .495
3103  121                           ++    +B    BB                ++    +B    BB
3103  13  NO. ADULT OUTPUT         170   721   913               149   599   775
3103  14  AD OUTPUT ZYG F         .094  .399  .506              .097  .393  .508
3103  15  HW PROP AD OUTPUT       .086  .415  .498              .086  .415  .497
3103  16  DEV AD FROM HW          .007 -.015  .007              .011 -.022  .011
3103  17  CHI 2 DEV AD FROM HW               2.519              4.356
3103  18  DEV AD FROM INPUT HW    .006 -.017  .010              .010 -.023  .013
3103  19  CHI 2 DEV AD-INPT HW               2.571              4.368
3103  191 DEV AD ZYG F-PR GEN     .003 -.011  .007              .007 -.018  .010
3103  192 CHI2 D AD-PR GEN Z F               1.123              2.492
3103  20  AD SURV AS PROP INPT    .583  .520  .554              .601  .508  .553
3103  21  NO. EGG OUTPUT            TOTAL      171                22    69    80
3103  22  PROP EGG OUTPUT        SURVSHIP     .855              .128  .403  .467
3103  23  EGG OUTPUT Q AND LIM    QB      .669    LO      .572    UP      .717
3103  24  HW PROP OUTPUT                                        .109  .442  .448
3103  25  DEV EGG FROM HW                                       .019 -.038  .019
3103  26  CHI 2 DEV EGG FR HW                                   1.326
3103  27  DEV EGG FR INPUT HW     DELTA Q    -.034              .040 -.013 -.027
3103  28  CHI 2 DEV EG-INPT HW                                  3.616
3103  29  NO. SM LARV OUTPUT        TOTAL       85                 8    37    40
3103  30  PROP SM LARV OUTPUT    SURVSHIP     .850              .094  .435  .470
3103  31  SM LARV Q AND LIM       QB      .688    LO      .585    UP      .735
3103  32  HW PROP SM LARVAE                                     .097  .429  .473
3103  33  DEV SM LARV FROM HW                                  -.003  .006 -.003
```

```
3103  34  CHI 2 DEV SM L FR HW                                  .017
3103  35  DEV SM L FR EGG PROP  DELTA Q      .018            -.034  .031  .002
3103  36  CHI 2 DEV SM L-EGG                                   1.002
3103  37  NO. BG LARV OUTPUT      TOTAL        97               21    39    37
3103  38  PROP BG LARV OUTPUT  SURVSHIP      .970             .216  .402  .381
3103  39  BG LARV Q AND LIM     QB      .582    LO     .565   UP       .595
3103  40  HW PROP BG LARVAE                                   .174  .486  .339
3103  41  DEV BG LARV FROM HW                                 .042 -.084  .042
3103  42  CHI 2 DEV BG L FR HW                                 2.916
3103  43  DEV BG FR SM LV PROP  DELTA Q     -.105             .122 -.033 -.089
3103  44  CHI 2 DEV BG-SM LARV                                17.318
3103  45  NO. PUPAE IN OUTPUT     TOTAL        94               14    46    34
3103  46  PROP PUPAE IN OUTPUT SURVSHIP      .940             .148  .489  .361
3103  47  PUPAE Q AND LIMITS    QB      .606    LO     .570   UP       .630
3103  48  HW PROPORTIONS PUPAE                                .154  .477  .367
3103  49  DEV PUPAE FROM HW                                  -.005  .011 -.005
3103  50  CHI 2 DEV PUPA FR HW                                  .059
3103  51  DEV PUP FR BG L PROP  DELTA Q      .023            -.067  .087 -.019
3103  52  CHI2 DEV PUP-BG L PR                                 3.859
3103  53  DEV AD FR PUP PROP    DELTA Q      .099            -.051 -.096  .147
3103  54  CHI 2 DEV AD-PUP PR                                146.610
3103  55  LOWCASE L APL CUBRT          1.005           .539            .814
3103  56  MEAN WT PER AD IN MG    .904  .902 .856             .820  .826  .754
3103  561
3103  562
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The advantages of this method are several. (1) A routine error free method of computation has now been developed which can be continued until the end of the experiment. From now on we expect to process new data in the experiment after all the records on one generation have been completed. (2) By having written legends for each value the readability of the report is immeasurably improved over earlier computer produced reports which only list numbers. Abbreviations were necessary in the present report because we deliberately limited ourselves to 20 spaces for the description of each line. If we had not minded a lengthier format requiring more lines, we could have written out legends in full. (3) Before the program was written considerable thought went into the various possible types of computations which we might wish to carry out with the data. All of these were included in the program. Although it may well turn out that some of these are of no interest for the interpretation of the phenomena, it is better to have them done and available (at minimal expense) than to have missed them in case they were meaningful. (4) Undoubtedly more computations will have to be carried out. Some of them will probably most conveniently be done on a desk calculator from these data sheets, which can be reproduced in as many sets as one would wish merely be re-running the cards through a tabulator. Every investigator, who has had need to duplicate a set of figures on hand-written data sheets will immediately appreciate the advantage of this. If, unexpectedly, it should develop that an extensive series of computations is needed using either the original data or the results obtained by the program, a new program can easily be written using some of the output cards of the present program as input and forming whatever computations are necessary. (5) The most important advantage lies in our ability to rearrange the output in many different ways merely by re-sorting the output cards. Almost invariably when an investigator wishes to interpret results of an experiment he needs to re-copy his data several times in different arrangements in order to compare different factors or trends. It will be noted that in order to provide easy re-sorting each card (represented by a line in the printed output) has been provided with two code numbers, one representing jar number and the other line number. The jar number in the present example is 3103 standing for the third gene frequency ($q_b = 0.75$), replicate 1, generation 3. These data have already been re-sorted to show trends from generation to generation and to examine differences among replicates treated alike. While the present program is unlikely to be of use to anyone except the authors, we feel that the general approach may be of value to other readers of TIB.

Department of Entomology
The University of Kansas
Lawrence, Kansas

Sokoloff, A. *A somatic mutation involving squint (sq).

In a cross of +/sq ♀ x sq/sq ♂, an aberrant beetle showing one eye normal and the other squint was found. Tested against squint it proved to be genetically +/sq.

Somatic mutations involving the eye apparently occur rather frequently in tenebrionids. They have been reported for the genes flesh colored (g) in *Tenebrio molitor*, pearl in *Tribolium castaneum* and pearl in *Latheticus oryzae* (Schuurman, 1937, Sokoloff, 1959, 1960, and Sokoloff and Shrode, 1960, respectively). For *T. castaneum* I estimated the occurrence of such an event involving the pearl gene as 1: 10,000; for *Latheticus oryzae* as 1: 12,500 from a much smaller sample.

The experiment involving squint did not permit estimation of the frequency at which the wild allelomorph mutates to sq. However, it appears that both p and sq* are fairly unstable at least in somatic tissues of *T. castaneum*. Thus, an experiment in genetics courses could easily be designed to obtain more information.

Department of Genetics
University of California
Berkeley, California

Sokoloff, A. [*]Studies on factors affecting crossing over in *Tribolium castaneum*.

Lasley (TIB-3, 1960) has shown that crossing over between genes located in what is now known as linkage group V is approximately equal in the two sexes. With the discovery that bar eye (Be) and sooty (s), (two easily recognizable characters) are linked in the IV chromosome, the frequency of recombination under different conditions has been investigated for these two genes.

A previous study (Sokoloff, 1962. Can. J. Genet. Cytol. 5) showed that when the beetles are reared at 32° C and 70 per cent and no attempts are made to separate early from late progeny (say, one to four weeks apart) the Be and s genes recombine at a frequency of 25 per cent whether in coupling or repulsion.

In the present experiment the controls (series I) have been kept under the same physical conditions in two separate mass matings: one of the creamers contained five +s/+s males and eight Be s/++ females; the other 14 Be s/++ males and 20 +s/+s females. Series II, a replica of the controls, was kept in a 25° C constant temperature room with no control over relative humidity. A month later the beetles in series II were subdivided into two lots: one half of the beetles were retained in the same conditions; the other (series III) was "cold shocked" by placing the creamers in a 4.5° C cold room for 40 hours and returned after this period to the 25° C room. Series IV consisted of 14 males and 8 females (genetically Be s/++) exposed to 3210 r units of X-rays delivered by a Philips X-ray machine administering 1070 r/minute through

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[*] See also a note by Dawson on a somatic mutation involving red elsewhere in this Bulletin. Ed.

a 1 mm aluminum filter as determined by a Victoreen ionization chamber. The irradiated beetles were mated to a number of s/s beetles of the opposite sex corresponding to the number in the controls and their progeny reared in the same incubator as the controls.

Beetles in all series were transferred to new creamers containing fresh medium twice a week for a period of four months for the most part. The progeny in the creamers kept at 32° were scored as adults 40-45 days after removal of the parents; those reared at 24° C about 75 days after removal of their parents. The results grouped in four-week periods are summarized in Table I. Chi square tests for homogeneity indicate:

1. No significant differences in the two types of controls when the totals are compared, but Chi square values at the .01 level of significance in both types of crosses are suggestive of a high degree of heterogeneity when the data between the various periods and matings are considered. In both A and B there is a gradual increase in crossing over for the first two periods. In A (reflecting the situation in spermiogenesis) the frequency of crossing over is markedly increased only in the last period, whereas in B (revealing the situation in oogenesis) there is a reduction in crossing over towards the end of the egg-laying span in the female. However, the number of progeny obtained in the last productive four-week periods is small for both types of matings, primarily as a result of aging of the females.

2. For males reared at 24° C (Series II, column A) the frequency of crossing over in the totals (in the various periods of four weeks) is not different from that observed in the controls. For females, however, cold temperature appears to produce an over-all reduction in the frequency of crossing over (the difference being highly significant). While the effect appears to be quite consistent, when the Chi square test for homogeneity is applied to the B data in series I and II for any given period, the test fails to show any evidence of heterogeneity, probably because the numbers involved (particularly in the cold series) are small.

3. The frequency of crossing over in the cold-shocked females is not different from that obtained for females maintained at 24° C throughout. The data for the three periods given in Series III B are fairly homogeneous. The reason for beetles in III A not surviving the cold treatment is not clear. It is known, however, that exposure of beetles to cold may cause them to release quinones and a high concentration of these gases may result in their death if the beetles are confined in closed quarters.

4. Irradiation results in a marked drop in productivity, especially in females. The frequency of crossing over for irradiated females is comparable to that obtained for the controls. On the other hand, Chi square tests for homogeneity between the data in series IV A with data of corresponding periods in the control series (to rule out aging effects) suggest that the increase in crossing over in the male as a result of irradiation is real: the Chi square values obtained for periods 1-3 are 4.20, 4.24 and 5.51, respectively.

5. Aging appears to have no effect on the frequency of crossing over in the females. In the controls, the Chi square tests for homogeneity using

the extreme values (periods 1 and 3) gives $X^2 = 1.73$--not significant--but the numbers in period 3 are small compared to those in period 1. The male data suggest a possible aging effect: when period 1 is compared with periods 2, 4 and 5 Chi square values of 5.99, 4.63 and 6.32 are obtained. More data are needed to establish whether the secondary peak of crossing over in period 3 is real.

These preliminary tests* suggest that crossing over is 1. Influenced by sex, the different sexes being affected differently by the prevalent environmental conditions: in the female crossing over is reduced in frequency with a drop in temperature, but the male is not affected. With irradiation, crossing over is increased in frequency in the male but not affected in the female. 2. Modified by age of the beetle, but probably only in the male.

Department of Genetics
University of California
Berkeley, California

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*See also section on linkage results involving the VII chromosome for another factor modifying crossing over. Ed.

Table I

Cross overs and totals observed at four-weekly periods under various experimental conditions in

T. castaneum

Four week period	I		II		III		IV	
	A	B	A	B	A*	B	A	B
1	397/1744 (22.76)	392/1612 (24.32)	263/1006 (26.14)	245/1066 (22.98)	-	-	166/616 (26.95)	43/185 (23.24)
2	450/1711 (26.30)	162/634 (25.55)	130/515 (25.24)	190/829 (22.92)	-	143/705 (20.28)	251/834 (30.10)	44/171 (25.73)
3	375/1511 (24.82)	72/256 (28.12)	157/656 (23.96)	33/148 (22.30)	-	172/750 (22.93)	167/668 (25.00)	12/47 (25.53)
4	238/897 (26.53	7/37 (16.22)	138/542 (25.46)	18/114 (15.79)	-	75/301 (24.92)	8/23 (34.79)	-
5	32/94 (34.04)	-	-	-	-	-	-	-
Total	1492/5957 (25.05)	633/2539 (24.93)	688/2715 (25.34)	486/2157 (22.53)		390/1756 (22.51)	592/2141 (27.65)	99/403 (24.57

I = controls reared at 32° C, 70 per cent relative humidity.
II = reared at 24° C.
III = P_1 cold shocked for 40 hours, F_1 reared at 24° C.
IV = exposed to 3210 r X-rays.
A = Be s/++ ♂ x +s/+s ♀; B = Be s/++ ♀ x +s/+s ♂.
* = none of the beetles survived the exposure to cold.
(Numbers in parenthesis are per cent cross overs.)

Sokoloff, A. and Inouye, N. *Productivity of *Tribolium castaneum* and *Tribolium confusum* in homo- and heterospecific matings.

In TIB-5 Sokoloff and Ho reported a comparison of productivity of *T. castaneum* and *T. confusum* in 1. whole wheat flour plus yeast, 2. corn flour plus yeast and 3. corn alone. It was shown that productivity of *T. castaneum* was greatest in 1, intermediate in 2, and least in 3, whereas for *T. confusum* productivity in these media was 2 > 3 > 1. Following this finding, a series of competition vials was set up in corn plus yeast and corn alone, to determine whether *T. confusum* (CF), when given the advantage of a more suitable medium, could eliminate *T. castaneum* (CS). The results indicated that in both media CS still eliminated CF, although in corn CF survived somewhat longer. It was also noted that once CF is eliminated CS begins to decline in numbers.

The disappearance of CF, despite its greater productivity and longevity in single species vials, is so dramatic in competition vials, that we decided to explore the possibility of the existence of an insemination reaction similar to that observed by Patterson (1946, 1947) and Wheeler (1947) in *Drosophila*. We reasoned that, if introduction of CS sperm into CF females resulted in greater swelling of their vagina than the introduction of CF sperm into CS females, then CF would be placed at a serious disadvantage in competition vials.

In the present experiment (carried out at 29° C and 70 per cent relative humidity) 4 pairs of CS beetles 10 days old were introduced into each of 10 creamers. These will be referred to as "CS-pure." The same was done with CF and they will be referred to as "CF-pure." The adults were transferred to new creamers twice a week (the flour with eggs being returned to their original creamers), to obtain data on productivity from homospecific matings. After three weeks, the males from CF and CS creamers 6-10 were taken out and replaced with males of the other species.

Creamers containing CS females and CF males will be referred to as "CS-mixed"; those containing CF females and CS males as "CF-mixed." Transfer of the 10 pure (5 CS and 5 CF) and the 10 mixed (5 CS and 5 CF) adult combinations was continued twice a week for another three weeks. From the beginning of the experiment any dead beetles were sexed and recorded. At the end of the six weeks the parents in all creamers were discarded. The progeny were recorded as adults, pupae and larvae, six weeks after removal of the parents. The few pupae and larvae observed at this time have been assumed to have completed metamorphosis, and their number added to the adult data.

The data are summarized in Tables I and II. Table I shows that CS was only slightly more productive than CF in the first three-week period (see upper block and totals for periods a-f) in pure species matings.

When CS males were replaced by CF males the totals indicate a marked drop in productivity in the CS-mixed series: these creamers produced only one-fifth as many progeny as the CS-pures. Not evident from these summary data is the fact that one and a half to two weeks later the females in four of the creamers exhibited complete sterility. (In these creamers there was a total of 11 surviving females.) In the remaining creamer (containing 4 females) the number of progeny was beginning to drop when the experiment was discontinued.

In contrast to the results given above, the CF-mixed creamers were all productive, and all the females survived to the end of the experiment. These CF females produced only three quarters as many offspring as the controls. Whether this drop is the result of removal of the CF males or a true effect resulting from introduction of CS sperm into the females is not known. It should be pointed out that while interspecies copulations have been observed by Park, fertilization of eggs, if it occurs at all, results in sterile eggs. Thus, whatever offspring are produced by CS and CF after introduction of the foreing males, result from homospecific fertilizations by sperm stored in the females.

This experiment did not take into account the fact that females of Tribolium have been noted to decrease in productivity once males of their own species are removed. Therefore, another experiment is now in progress in which the males in the "pure" cultures will be removed when males in the "mixed" creamers are replaced by the other species. In this way it will be possible to assess whether the differential drop in productivity of CS and CF females in mixed cultures is indeed caused by the introduction of foreign sperm, or merely by the fact that in CS females the supply of sperm becomes exhausted at a faster rate.

Department of Genetics
University of California
Berkeley, California

Table I

Productivity of CS and CF in pure and mixed matings

Period	CS-pure	CS-mixed	CF-pure	CF-mixed
a	784	-	437	-
b	1417	-	1482	-
c	1206	-	1056	-
d	1591	-	1494	-
e	1582	-	1382	-
f	969	-	1198	-
g	442	249	610	430
h	560	130	783	564
i	458	75	576	464
j	533	71	695	568
k	425	34	602	380
l	516	39	772	520
Total a-f	7549	-	7049	-
g-l	2934	598	4038	2926

Table II

Mortality of P_1

a-f	2♂ : 5♀	-	1♂ : 0♀	-
g-l	0♂ : 3♀	-	0♂ 0♀	-

Note: Number of replicates for periods a-f was 10 for CS-pure and 10 for CF-pure; for periods g-l it was 5 for each of the pure- and mixed-series.

Sokoloff, A., I. Michael Lerner and F. K. Ho. *Egg cannibalism of Tribolium in corn flour. As indicated in the introduction of the preceding article, T. castaneum (CS) eliminates T. confusum (CF), in corn flour almost as rapidly as in standard medium (whole wheat flour plus brewer's yeast). Once CF is eliminated, the CS population also drops. A tentative explanation for this phenomenon is that CF can apparently synthesize its minimum requirements from the corn medium. On the other hand, it seems that CS cannot, but probably can make up for this deficiency by cannibalizing T. confusum eggs, larvae or pupae, or even by eating dead CF adults. Once CF is eliminated, the machinery for conversion of the raw materials available into those utilizable by CS is also gone, and the pupulation of CS cannot maintain itself at a high level.

A preliminary experiment to determine whether the hypothetical essential nutrient is present in CF eggs is in progress. In it 10 pairs of CS and 10 pairs of CF were introduced into separate vials containing eight grams of corn flour (no yeast). Each week the CF vial was supplied with 500 CS eggs, and the CS vial was supplied with 500 CF eggs. (The eggs were thoroughly mixed in the medium.) Each month the adults were counted and discarded and the medium renewed.

The results are shown in Table I.

It is clear that CF does not destroy CS eggs completely, and by so doing CS eventually displaces CF completely (see culture 2 in the Table). On the other hand CS is more thorough in eliminating CF eggs. Despite weekly introductions of 500 CF eggs, only 1 CF adult had been scored by the 3rd and only 12 CF adults by the 4th transfer.

It may be pointed out that the tremendous variation in adult numbers observed at successive transfers is typical when the adults are discarded at each census (see Lerner and Ho, American Naturalist, 1962).

The experiment is being continued, and in other experiments we plan to introduce larvae of different sizes and early pupae of one species into vials containing adults (or larvae) of the other species.

Department of Genetics
University of California
Berkeley, California

Table I

Cannibalism of *Tribolium* in 8 grams of corn flour

(500 eggs of the other species were added weekly)

Culture no.	No. of pairs in Original population	Adults observed at census 1	2	3	4
1	10 CS	20 CS	105 CS	1 CF	12 CF
				14 CS	45 CS
2	10 CF	20 CF	95 CF	0 CF	1 CF
			98 CS	21 CS	58 CS

CS = synthetic strain of *castaneum*

CF = synthetic strain of *confusum*

Sonleitner, Frank J.
*Fecundity and egg cannibalism of *T. confusum* in conditioned medium.

On the basis of evidence presented by Ghent (1960, Doctoral Dissertation, Univ. of Chicago) and Naylor (1959, Ecology 40: 453-65), it seems that *T. confusum* definitely avoids fresh medium (whole wheat flour) in preference to conditioned medium. This is a behavior response to the medium itself in the absence of other beetles and is distinct from their avoidance of high population densities of adults. On the other hand, Park (1935, Physiol. Zool., 8: 91-115) and Park and Woolcott (Physiol. Zool. 10: 197-211) found that egg cannibalism by males was less and fecundity of single pairs was higher in fresh medium. It seemed strange that *confusum* should avoid what apparently was a better habitat for oviposition and choose a poorer one. Some data of Polnik (personal communication) suggested that the aforementioned results concerning egg cannibalism of males and fecundity of pairs did not apply to denser adult populations.

Some preliminary experiments were carried out to compare egg cannibalism and oviposition rate (= Real Fecundity) in these two media at the higher adult density of 64 pairs/8 grams. One of these is reported here. The beetles used were Chicago wild type adults 61-70 days since emergence. The environmental conditions were 29° C and 70% relative humidity. The experiment included ten replicates for each of the two types of medium. Each replicate consisted of a shell vial with 8 grams of medium - stone ground whole wheat flour plus 5% brewers' yeast - fine sifted through 5xx bolting cloth. The conditioned medium was moderately confusum-conditioned and had been resifted through 2xx mesh to remove eggs, frass and other large particles. Egg cannibalism rate and oviposition rate over a 24 hour period were measured using the red egg technique of Rich (1956, Ecology 37: 109-20). The replicated populations were acclimatized in their respective media for three days before the measurements were made. The results are given below:

	fresh medium		conditioned medium	
	Mean	S.E.	Mean	S.E.
Real Fecundity (eggs/female/day)	7.33	0.26	6.13	0.32
Egg cannibalism rate (proportion eaten per adult/day)	0.00767	0.00094	0.01861	0.00107

Egg cannibalism rate in conditioned medium was almost double that in fresh medium. This is quite similar to the response of <u>T. castaneum</u> (Sonleitner, 1961. Physiol. Zool., 34: 233-255). On the other hand, fecundity was only slightly (but significantly) depressed in conditioned medium compared to fresh medium. This is in marked contrast to <u>T. castaneum</u> where fecundity in conditioned medium is reduced to about one-half to one-third its value in fresh medium. The oviposition rate figures for the two species are compared below:

Species:	T. confusum	T. castaneum	
Time since emergence:	(60-70 days)	(54-62 days)*	(96 days)**
fresh medium	7.73	12.11	9.12
conditioned medium	6.33	4.70	4.75

*Sonleitner, unpublished data; **Sonleitner (1961). All data refers to a density of 64 pairs/8 grams.

In making the between columns comparisons, it must be remembered that, although the experimental conditions were the same, the various experiments were done at different times over a period of years and at different laboratories. The degree of conditioning of the experimental medium is especially difficult to reproduce quantitatively. Thus, these figures are not strictly comparable. The table, however, indicates that, at a moderate adult density, confusum may have a higher oviposition rate in conditioned flour than does castaneum. This and the fact that castaneum prefers fresh to conditioned medium (the reverse of confusum - see Ghent, 1960) suggests the following speculations. The difference in medium preference between the two species might have evolved as a mechanism for avoiding interspecies competition. If we assume that oviposition rate is proportional to competitive success (the cannibalism rates being similar in both species) it would be an adaptive advantage for confusum, when in competition with castaneum, to oviposit in conditioned medium.

The experiment reported above was carried out while the author was a Lecturer in the Department of Zoology, the University of California at Berkeley. I am indebted to Prof. I. M. Lerner and Dr. A. Sokoloff for the use of the facilities at the Tribolium laboratory in the Department of Genetics.

Department of Entomology
The University of Kansas
Lawrence, Kansas

Stanley, John and Saraswati Sivaram. Instar determination in Tribolium.

Any study of the life history of an insect demands that one be able to distinguish the larval instars. Stanley (1955) described a method for distinguishing the instars of Tribolium sp., based on Dyar's Rule (Dyar, 1890), but this method is most time consuming. The authors hoped that something better might be found in the way of a morphological criterion.

A most careful study has been made of the larval instars of Tribolium confusum. Setal maps have been made for the head and dorsal surface of all body segments of all instars. Similar maps have been made of the dorsal and anterior surfaces of the labrum, and of all the appendages. In spite of meticulous intercomparisons, seta by seta, no constant difference can be found between the instars. Occasionally a seta will be missing in some specimen, but this absence is not universal for that instar.

It is not usual to report negative results, but this short note may save waste of time by others.

Department of Zoology
McGill University
Montreal, Quebec, Canada

Waddington, C. H., and M. M. Perry An electron microscope analysis of eye development in Tribolium castaneum.

Preliminary observations show that the ultrastructure of the various cell types is essentially similar to that of the Dipteran eye. The rhabdom, composed of a tightly packed array of hexagonal tubules, is cup-shaped and is situated in the distal region only of the retinula cell group. The rhabdomeres of six retinula cells are fused at the lateral edges of adjacent cells, the seventh and eighth cells lie at the base of the cup, and the eighth cell has no rhabdomere. Onset of rhabdom formation occurs during the third day of pupation, when the membranes of the retinulae at the centre of the ommatidia are thrown into shallow folds. These later deepen to form the tubules of the adult rhabdom. In contrast to the situation in the Drosophila eye, in which there is simultaneous folding of the membrane over the surface of the retinulae, where the rhabdom will eventually be formed, there seems to be a progressive change in the Tribolium eye, with the area of membrane folding gradually extending outwards from a central point, during mid-pupal life.

A cursory examination of the mutant Bar eye showed that, in the few existing ommatidial groups, there is some disorganisation of the rhabdom tubules.

Institute of Animal Genetics
Edinburgh, Great Britain.

Bartlett, Alan C. *Baby-food bottles as containers for Tribolium.

In searching for a satisfactory container for Tribolium, I discovered that the tops of Heinz baby-food bottles are constructed like a mason jar lid. The middle section can be removed and fine wire screen placed inside the ring. Number 50 (U.S. Standard Sieve Series) screen is very good for the jar tops since it allows adequate ventilation in the jars and yet prevents even the very small larvae from escaping. Circular pieces of cardboard could also be used. The screen can be soldered either to the outside or the inside of the ring or left free for easy cleaning or replacement. The jars come in two sizes and make ideal containers for small populations. Student groups or laboratories with a small budget should be able to obtain such jars readily. We may even explore the possibility that contribution of baby food bottles is a deductible expense.

Boll Weevil Research
Laboratory
State College, Mississippi

Sokoloff, A. *Two exercises demonstrating factor interaction in Tribolium castaneum Herbst.

Among the mutants currently under investigation at this laboratory, four appear useful in demonstrating factor interaction in Genetics courses. Two, namely red (r) and a red modifier (M^r), are sex-linked; the other two, called short antenna (Sa) and fused tarsi and antennal (Fta) are autosomal dominant having recessive lethal effects located on linkage group VII (see New Mutant section for details).

Consider the following array of crosses involving the sex-linked genes and the progeny resulting from them:

Cross	black eyed		light red-eyed		dark red-eyed	
	M	F	M	F	M	F
a. r/r x r/			+	+		
b. +/+ x r/	+	+				
c. r/r x +		+	+			
d. +/r x +	+	+	+			
e. +/r x r	+	+	+	+		
f. rM^r/rM^r x $rM^r/$					+	+
g. ++/++ x $rM^r/$	+	+				
h. rM^r/rM^r x ++/		+			+	
i. $++/rM^r$ x ++/	+	+			+	
j. $++/rM^r$ x $rM^r/$	+	+	+		+	+
k. rM^r/rM^r x r+/		+			+	
l. r+/r+ x $rM^r/$	+	+				
m. $rM^r/r+$ x r+/	+	+	+		+	
n. $rM^r/r+$ x $rM^r/$	+	+			+	+

The upper block involves only the red (r) gene. Cross a shows that the gene breeds true, producing light red eyed progeny like the P_1. b. that the gene is a recessive; c that it is a sex-linked recessive; d & e that heterozygous females produce red and normal males in equal frequencies, but the type of female progeny produced depends on the type of male to which the mother is mated: if mated to + only black eyed females are obtained, if to r, black eyed and red females are obtained in equal numbers.

The middle block shows the phenotype of the rM^r homo- and hemizygotes in f is dark red, like the parents; in g only wild type progeny are obtained as if only a single recessive gene were involved paralleling the results in b; in h, the reciprocal cross, only wild type females are obtained, but all the males are dark red paralleling the results in c; i parallels the results in d, except the males are dark red; j is a critical cross: if the eyes are not examined carefully, the results of e and j would be identical. If the student is alert, he may notice an excess of wild type females over the dark red-eyed females, and he may be able to compute the distance of r from M^r by considering that the light red eyed males represent only half of the possible crossovers; also, he may conclude that the effect of M^r can be observed only in the presence of r. M^r alone, would have the same phenotype as +.

The demonstration of the modifier without complications resulting from crossing over can be done by crossing the dark reds (rM^r) with the light reds (+ r) both ways and warning the students to compare closely the phenotype of the stocks provided. It is evident that crosses of the dark red females X light red males (cross K) results in dark red males and black eyed females, whereas the reciprocal (cross L) yields the same type of females but light red males. The student may, at this point, wonder what happened to the red gene in the females, when both parents appeared to have it. The answer becomes obvious by suggesting that the student carry two more crosses and warning him (or her) to look closely at the color of the eyes in both sexes. rM^r/r + siblings are mated with light red (cross m) and dark red (cross n). In m half of the female progeny will show light red eyes and the males should be light red and dark red. In n on the other hand, half of the female progeny will be dark red-eyed, but the males will be classificable in two classes like in the n cross. The fact that in both of these crosses all of the males are red should at least prove to the student that the black eyed females were indeed homozygous for red and not heterozygotes.

The second exercise is somewhat easier since a possible explanation for the results can be supplied after one generation of breeding. Four stocks are needed:

wild type
bar eye (Be)
short antenna (Sa)
fused tarsi and antennal (Fta)

Males and female virgins should have been isolated beforehand. Mate:

A. Be/+ x +/+; Sa/+ x +/+; Fta/+ x +/+
B. Be/+ x Be/+; Sa/+ x Sa/+; Fta/+ x Fta/+
C. Be/+ x Sa/+; Be/+ x Fta/+; Sa/+ x Fta/+

In A all matings should give wild type and mutant progeny in equal numbers. In B a ratio of 1 wild type: 2 mutant should be obtained, since the dominant homozygotes die in ovo. In C both types of matings involving Be will produce progeny classifiable into the following phenotypes: 1/4 normal: 1/4 with one dominant gene: 1/4 with the other; 1/4 with both dominant genes: The last mating in C, on the other hand, will give 1/3 +, 1/3 Sa, 1/3 Fta. This result is different from the results obtained in the B matings since Fta and Sa are classifiable. Since Fta and Sa are known to be on different loci, the conclusion is made that the interaction of Fta with Sa results in death of the beetles carrying the two genes.

Department of Genetics
University of California
Berkeley, California

Bosma, Gayle C. and H. S. Ducoff. Plastic Vials for Long-Term Cultures. For maintenance of small Tribolium cultures in long-term life-span expectancy studies, plastic vials offer several advantages. In particular, clear plastic vials with snap-on caps (Armstrong handi-pack) are light weight, do not break easily, can be machine-washed, and are sufficiently squat to stand without tipping. The 5 dram size is especially convenient for 5 to 20 beetles in 5 grams of medium. The vials are sold to pharmacies for dispensing pills and other medications, and are supposedly clean and ready for immediate use. However, it was observed that in about 20% of unwashed plastic vials with plastic snap-on caps all 6 of the adult beetles died within a 12 day period. No deaths occurred in the other 80% of the vials. This was true whether flour-yeast or complete or deficient defined media were employed, and occurred about equally in males and females. However, if the vials were washed before experimental use no such lethal phenomen was observed. Furthermore, if the dead beetles were removed and fresh adults placed in the same vial and medium, no deaths occurred. Thus, it appears there is an initial effect from the unwashed vials which is toxic to the beetles.

When washed before use, the Armstrong clear handi-pack plastic vial with the snap-on cap is excellent for small cultures of Tribolium confusum.

Department of Physiology
and Biophysics
University of Illinois
Urbana, Illinois

Loschiavo, S. R. A useful technique to facilitate recovery of eggs laid by Trogoderma parabile, Beal. T. parabile lays its eggs at random over the surface of the rearing container or through the food medium. When deposited the eggs are extremely fragile and impossible to handle. Investigations demanding accurate periodic assessments of eggs require a suitable technique to facilitate egg recovery without damage. The first technique employed in our laboratory involved the use of a modified version of an oviposition block described by Bond and Monro (Can. Ent. 86:402-408, 1954). A crevice of about 0.27 mm. wide formed by two squares of acrylic plastic 4 mm. thick held apart by a smaller square of Bristol board provided an excellent oviposition site. Eggs could be accurately counted but could not be removed without rish of damage.

A more satisfactory technique had to be developed in which eggs could be easily recovered with a minimum amount of damage. Although normally T. parabile lays eggs at random it was noted that if the beetles are given a choice of scored or unscored blotting paper they lay over 90 per cent of their eggs among the loosened fibers of the scored surface. Here again it was practically impossible to recover them without considerable damage. Noting that beetles laid eggs readily in loose fibers we rolled sterile cotton, dyed black, into small tight balls and tested them as oviposition sites. Beetles deposited large numbers of eggs in these wads. The eggs could be removed quickly without loss or damage by carefully spreading the cotton fibers with needles or fine forceps.

Despite the fact that T. parabile lays eggs readily in crevices or fibers as discussed above it does not oviposit preferentially on similar sites on wheat kernels, for example, creases, brushes, lesions and slit pericarps. It lays eggs at random over the surface of the wheat kernel irrespective of moisture content. Apparently the crevices in oviposition blocks and the fibers of blotting paper or cotton provide suitable thigmotactic stimuli to induce oviposition.

Canada Agriculture Research
Station, Box 6200,
Winnipeg, Manitoba, Canada

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GEOGRAPHICAL

(An asterisk before the name indicates the investigator--so far as is known--has worked or is working on Tribolium or work on Tribolium or related forms is being contemplated.)

AUSTRALIA

Armidale, N.S.W.
University of New England, Department of Zoology.

*Brereton, J. Le Gay, Ph.D.
Taylor, Wesley, Ph.D.

Sydney, N. S. W.
University of Sydney, Department of Zoology.

*Birch, L. C., Ph.D.

BRAZIL

Campinas, SP
Secao de Entomologia, Instituto Agronomico

*Mendes, Luiz, O. T. - Chief
Rossetto, Carlos Jorge - Assistant

Rio Claro
Faculdade de Filosofia Ciencias e Letras de Rio Claro, Departmento Biologia Geral

Kerr, Warwick, E.

Rio de Janeiro
Instituto Oswaldo Cruz and Museu Nacional.

Araujo, R. L.

CANADA

Guelph, Ontario
Ontario Agricultural College, Department of Poultry Science.

Friars, G. W., Ph.D.
Jerome, F. N., Ph.D.

Guelph, Ontario
Ontario Agricultural College, Department of Zoology (Insect Toxicology and Pathology Unit).

*Musgrave, A. J., M.Sc., Ph.D., D.I.C. Interests:

i) Mycetomal micro-organisms in insects, especially *Sitophilus*
ii) Chemico-microbiological aspects of insect pathology.

Montreal, P. Q.
McGill University, Department of Genetics.

*Naylor, Alfred F., Ph.D. Tribolium nutrition, dispersal; Biometry, Population Genetics.

Montreal, P. Q.
McGill University, Department of Zoology.

*Stanley, J., Ph.D., In charge.
Israel, Allan, Assistant.

Ottawa, Ontario
Animal Research Institute, Canada Department of Agriculture, Central Experimental Farm

*Bray, David F., Ph.D., Research Officer.

Quebec
Université Laval, Faculté des Sciences, Department de Biologie

*Corrivault, G. Wilfrid
* Huot, Lucien, Ph.D.

Quebec, P. Q.
Université Laval, Faculté de Médecine.

*Charbonneau, Rene, (D.Sc) Assistant Professor. Nutrition and Biochemistry.
*Chaudhary, Kapil D., (D.Sc.) Post doctorate studies. Nutrition and Biochemistry.
*Lemonde, Andre (D.Sc.) Associate Professor. Nutrition and Biochemistry.
Villeneuve, Jean-Louis (D.Sc.) Post doctorate studies. Nutrition and Biochemistry (Lipids).

Victoria, B. C.
Canada Department of Forestry, Forest Entomology and Pathology Laboratory.

*Edwards, D. K., Ph.D. Bioclimatology of forest insects.

Winnipeg, Manitoba
Canada Department of Agriculture, Research Station

*Liscombe, E.A.R. (M.Sc.) Effect of fumigants on *Tribolium species* at low temps.
Loschiavo, S. R. (M.Sc.) Life history of *Trogoderma parabile*.

Winnipeg, Manitoba (Cont.)
Canada Department of Agriculture, Research Station

*Sinha, R. N. (Ph.D.)	Mites in stored grain.
Smith, L. B. (Ph.D.)	Rate of increase of Cryptolestes ferrugineus
*Watters, F. L. (M.Sc.)	Effect of insecticidal dusts on Tribolium confusum.

Winnipeg, Manitoba
University of Manitoba, Department of Animal Science

*Boylan, W. J. Ph.D., Quantitative genetics

DENMARK

Springforbi
Statens Skadedyrlaboratorium (Government Pest Infestation Laboratory)

Andersen, F. S., M.Sc., Ph.D. Population problems, particularly density-dependent phenomena and spacial distribution.

Arevad, K., M.Sc., Ecology and behaviour, particularly in flies and mosquitoes.

Bang, P., M.Sc., Rodent populations, particularly density oscillations in the field.

Borlund, H.P., Graduate in Agriculture, control of house flies; testing of insecticides and repellents.

Funder, J. V., Graduate in Agriculture. Control of house flies; testing of insecticides.

Keiding, J., M.Sc., Biology of house flies in relation to control; resistance against insecticides, development and reversal of resistance in the field and in the laboratory.

Lund, M., M.Sc., Rodent populations, particularly experimental studies of territorial and aggressive behaviour.

Mourier, H., M.Sc., Ecology and behaviour, particularly in flies.

Rasmussen, S., M.Sc., Ecology of Hylotrupes (Col. Ceramb.), particularly nutrition, growth, and diapause.

Wichmand, H. Director.

FRANCE

Lyon
Faculté des Sciences de Lyon, Laboratoire de Zoologie Experimentale

Ceccatty, (M.de)	Professor
David, J.	Maître Assistant
Fiasson, S. (Mrs.)	Chef de Travaux
Ginet, R.	Maître de Conférence
Juget	Maître Assistant
Pattee, E.	Chef de Travaux
Roux, A.	Maître Assistant
Wautier, J.	Professor, Head of the Department.

Villeurbanne (Lyon) Rhone
Laboratoire de Biologie Animale, Institut National des Sciences Appliquees.

Bonnot G. - Biochemistry of insect hemolymph
Kolenkine, X. (Miss) - Chef de Travaux - Cytology and genetics of fresh water hydra.
Laviolette, P. - Professeur - Head of the department Cell differenciation.
Margotton, N. (Miss) - Assistante - Cartilage specificity
Nardon, P. - Assistant - Biology of irradiated Sitophilus.
Novel, M. (Mrs.) - Attachee de Recherches - Cartilage autoradiography.
Plantevin, G. - Assistant - Insect tissue culture.

GREAT BRITAIN

Bristol
University of Bristol, Department of Zoology

*Hinton, H. E.

Dundee, Angus
University of St. Andrews, Queen's College, Natural History Department.

*Amos, T. G. Graduate student
*Graham, W. M., Graduate student**
Nowosielski-Slepowron, B.J.A., Ph.D.
Sanderson, Ann R., Ph.D., Cytologist
Waterhouse, F. L., Ph.D., Department head.

**Interested in the behaviour, and secondly the biology of stored products insects.

Edinburgh, Scotland
Institute of Animal Genetics

Auerbach, C. A., D.Sc., F.R.S., Reader, Chemical and induced mutagenesis.
Allan, J., Graduate student. Selection.
Basden, E. B., Research assistant. Wild species.
Clayton, G., Lecturer. Selection.
Kelsall, P. J. Graduate Student. Spontaneous and induced non-disjunction.
Khishin, A. Guest investigator. Formaldehyde and radiation induced mutagenesis.
Knight, G. R. Research assistant. Subobscura salivaries.
Leigh, B. Graduate student. Chemical and induced mutagenesis. On leave with Professor Sobels.
Mostafa, A. Graduate student. Selection.
Nafei, H. Graduate student. Formaldehyde induced mutagenesis.
Osman, H. Graduate student. Selection.
Perry, M. Research assistant. Autoradiography.
Reeve, E.C.R. D. Phil. Quantitative inheritance.
Robertson, A. D.Sc. Quantitative genetics.
Robertson, F. W. D.Sc. Population and physiological genetics.

Royes, V., Graduate student. Drosophila mutation.
Scharloo, W. Ph.D. Guest investigator. Quantitative inheritance.
Sen, B. K. Quantitative genetics.
Slizynska, H. (Mrs.) Ph.D. Cytological analysis.
Slizynski, B. M. Ph.D. Salivaries.
Snyder, L. A. Ph.D. Guest investigator. Chemical and induced mutagenesis.
Strachan, K. (Miss). Stock-keeper.
*Waddington, C. H. Sc.D., F.R.S. Professor. General genetics.

Edinburgh, East Craigs
Department of Agriculture and Fisheries for Scotland, Agricultural Scientific Services.

Cutler, J. R. B.Sc., Stored products entomology.
*Morgan, N. C. B.Sc., Stored products entomology.
Sparrow, L.A.D. (Miss) B.Sc., Stored products entomology.
*Williams, D. W. B.Sc., M.Sc., Ph.D., Stored products entomology.

London
Queen Elizabeth College, Department of Biology, Research Division.

Baker, J. (Miss) B.Sc. (Zoo., Helminthology). (British)
Burton, Mr. B.Sc. (Agr. Ent. Stored Product insects)
*Hafeez, M. A., B.Sc. (Agr.). (Ent. Stored Product insects)
Freeman, M. B.Sc. Marine vertebrates
Erman, Fariha (Miss) B.Sc., M.Sc. (Marine vertebrates). (Turkish).
Palmer, (Miss) (B.Sc.) (Tubifex) (British)

Slough, Bucks
Pest Infestation Laboratory

*Blackman, D. G. (Miss) Genetics, insecticides.
Blake, G. M. (Mrs.) Ph.D., B.Sc., diapause, biology of carpet beetles.
Burges, H.D., Ph.D., B. Sc. diapause, biology of Trogoderma spp.
Coombs, C. W., M.Sc., ecology, succession, respiration.
Cunnington, A.M., biology of mites.
*Dyte, C. E., B. Sc., M.I. Biol. genetics, insecticides.
Halstead, D.G.H. B.Sc., biology and taxonomy of Histeridae and Tenebrionidae.
Haskins, K.P.F. maintenance of insect stocks.
Hereford, G.V.B., C.B.E. M.Sc., Director
*Howe, R. W., D.Sc., B.Sc., A.R.C.S., M.I. Biol. ecology, low populations.
Lefkovitch, L.P., B.Sc., ecology, age structure of populations, biology of Cryptolestes spp.
*Reynolds, E. M. (Miss) genetics fumigation.
Solomon, M. E., M.Sc., M.I. Biol. ecology, population dynamics, mites.
Southgate, B. J. biology of Bruchids.
Surtees, G., M.Sc., M.I. Biol. ecology, low populations.
Woodroffe, G. E. ecology, succession, diapause.

Tolworth, Surbiton, Surrey
Ministry of Agriculture, Fisheries and Food, Infestation Control Laboratory, Entomological Department.

Aitken, A. A. (Mrs.) B.Sc. Systematics: genetics, especially of *Oryzaephilus surinamensis*.
Armstrong, M. T. (Mrs.) B.Sc. Ecology of *O. surinamensis*.
Brett, G. A. B.Sc. General entomology.
Freeman, J. A., O.B.E., Ph.D. B.Sc. Chief Entomologist.
Histed, A. G. Maintenance of insect stocks.
Hodgson, J. N. Biology of *Alphitobius diaperinus*.
Hurlock, E. T., B.Sc. Geographical distribution of stored products insects.
Smith, K. G., B. Sc. Biology of *Aphomia gularis*.
Williams, G. C. (Miss). B.Sc. Biology of *Plodia interpunctella*.

The Laboratory, which has also Departments of Chemistry, Rodent Control Research and Mammals and Birds Research, acts as the technical headquarters of the Regional Pests Service, which is responsible for advice and regulatory work in regard to stored products insects and mites, rats and mice and mammals and birds injurious to Agriculture in England and Wales.

The insect inspectors examine most cargoes of dry food entering the country and it may be of interest to note that ever since this work started, in 1941, *Tribolium castaneum* has been by far the most common (and often the most numerous) insect recorded on such cargoes.

JAPAN

Chiba-shi
National Institute of Radiological Sciences.

*Nakao, Yoshio

Kyoto
Kyoto University, Entomological Laboratory.

*Utida, Syunro, Ph.D.

Miyazaki
Miyazaki University, Department of Biology

Yoshida, Toshiharu (Interspecific competition; distribution; evolution)

MEXICO

Chapingo
Campo Experimental "El Horno"

*Ing, de las Casas, Ernesto, M. A. (At present working on his Ph.D. at the University of Minnesota. Ed.)

PORTUGAL

Lisbon
Laboratorio da Defesa Fitossanitaria dos Productos Armazenados and Brigada de Estudos da Defesa Fitossanitaria dos Productos Ultramarinos.

Baeta Neves, C. M. Prof. of Entomology at the Institute Superior de Agronomia; Director of the L.D.F.P.A. and Head of the B.E.D.F.P.U.
Barbosa, A. (Miss) Agric. Engineer. Mycological Studies on Stored Products.
Entrudo, M. M. Agric. Engineer. Storage.
Ferreira, A.M. Agric. Engineer. Chemical Control Methods.
Gouveia, A. S. Forest Engineer. (Investigador da J.I.U.) Chemical Control Methods.
Gouveia, M.E.S. (Miss) Chem. Engineer. Residue Control Methods.
Guimaraes, J. M. Agric. Engineer. Systematic and Insect and Mite Biology.
Matos, A.H.P. Agric. Engineer. Chemical Control Methods.
Moreira, M.I.S. (Mrs.) Agric. Engineer. Analysis of Stored Products; X-Ray Method.
Pinheiro, M. F. V. (Mrs.) Agric. Engineer. Systematic and Insect Morphology.
Serodio, R. S. Agric. Engineer. Physical Studies related with insects.
Sousa, M. S. Agric. Engineer. Chemical Control Methods.

UNITED STATES

Berkeley, California
University of California, Department of Genetics.

Bielfelt, Louise (Mrs.) Assistant
*Dawson, Peter S. Graduate Student
*Ho, F. K. Technician
Inouye, Nobuo, General Coordinator of Laboratory Projects
*Lerner, I. Michael, Ph.D. Professor and Department Chairman.
Michener, Elizabeth (Miss). Assistant
Paige, Richard. Assistant
Rodriguez, Peter. Assistant.
*Sokoloff, Alexander, Ph.D. Associate Research Geneticist
St. Hilaire, Roger S. Assistant

Berkeley, California
University of California, Donner Radiation Laboratory.

*Hayes, Thomas L. Ph.D.
*Slater, John V. Ph.D.

Berkeley, California
University of California, Statistical Laboratory.

*Scott, E. L.

Los Angeles, California
University of California, Department of Zoology.

*Ball, Gordon, H. Ph.D. Parasitology
*Chao, Jowett, Ph.D. Entomology and Parasitology
*Lloyd, Monte, Ph.D. Ecology
*Wistreich, George, M.A. Bacteriology

Los Angeles, California
University of California, Department of Infectious Diseases, School of Medicine.

*Voge, Marietta

Livermore, California
Biological Frontiers Institute.

Shultz, Fred T.

Northridge, California
San Fernando Valley State College, Biology Department.

*Moore, Joseph, Ph.D. Parasitology.

Coral Gables, Florida
University of Miami, Department of Zoology.

*Rich, Earl R., Ph.D.
*Bates Lake, Charlotta (Mrs.?)

Savannah, Georgia
United States Department of Agriculture, Agricultural Marketing Service, Stored Product Insects Branch.

Boles, Hobart Paul. M.S. Insecticide evaluation.
Bry, Roy E. B.S. Mothproofing.
Connolly, William F. B.S. Insect-resistant packaging.
Dennis, Norman M. M.S. Physical energy for controlling insects.
Gillenwater, Hagan B. B.A. Insecticide formulation.
Harein, Phillip K. Ph.D. Insecticide formulation.
Highland, Henry A. Ph.D. Insect-resistant packaging.
Jay, Edward G., Jr. M.S.A. Insect-resistant packaging.
Kirkpatrick, Robert L. M.S. Fumigation.
Loy, E. William. B.S. Chemistry.
Marzke, Frederick O. Ph.D. Station Leader.
Phillips, Margaret F. B.S. Chemistry.
Soderstrom, Edwin L. Ph.D. Physical energy for controlling insects.
Speirs, Roy D. M.S. Insecticide evaluation.
Thompson, John F. B.S. Chemistry.
Williams, Hosea L. B. A. Chemistry.

Argonne, Illinois
Argonne National Laboratory.

*Slatis, Herman M.

Chicago, Illinois
University of Chicago, Department of Zoology.

*Mertz, David. Graduate Student.
*Park, Thomas, Ph.D. Professor.
*Polnik, Amelia, Ph.D. Population Ecology.

Sycamore, Illinois
DeKalb Agricultural Association, Inc.

Alms, Audrey (Mrs.) Regular Tribolium laboratory work and computing
*Shrode, Robert R., Ph.D. Population genetics.

Urbana, Illinois
University of Illinois, Department of Physiology and Biophysics.

Bosma, Gayle Cooper, M. S. Radiation biology.
*Ducoff, Howard S., Ph.D. Radiation biology; cell biology, senescence
Hogan, G. R., M. S. Cell physiology.

Lafayette, Indiana
Purdue University, Population Genetics Institute.

*Bell, A. Earl, Ph.D., Professor. Selection & GxE interactions.
Bhat, P. N., M.S., Graduate Assistant, Irradiation genetics.
*Englert, D. C., M.S. PRF Fellow, Genetics of growth.
*Krause, Eliot, M. S. Graduate assistant. Selection Methods.
Kyle, W. H., Ph.D. USDA Pioneering Research. Mating systems and selection.
Shideler, Doris M. Chief Research Technician.
Wilson, S. P., Ph.D. USDA Post-doctoral Fellow, Mating systems and selection.
*Yamada, Yukio, Ph.D. Research Associate Selection & GxE interaction.

Keota, Iowa
P.O. Box 15

*Bywaters, James H., Ph.D.

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

*Bender, Harvey A. Ph.D. Developmental Genetics. (Drosophila)
Craig, George B., Jr., Ph.D. Population Genetics. (Mosquito)
Gordon, Robert Ph.D. Population Ecology.

Ames, Iowa
Iowa State University of Science and Technology, Department of Genetics.

Gowen, John W.

Lawrence, Kansas
University of Kansas, Department of Entomology.

*Howe, Maxine L. (Mrs.) Research Assistant
*Karten, Irving, B. S. Research Assistant
*Sokal, Robert R., Ph.D. Professor
*Sonleitner, F. J., Ph.D. Assistant Professor
Vandermeer, Dolores (Mrs.) Laboratory Assistant
*Yang, You-Yen, B. S. Research Assistant

Manhattan, Kansas
Kansas State University, Department of Entomology.

Mills, Robert, M.Sc. Biology & Environment of Stored grain insects.
Rettenmeyer, Carl Ph.D. Insect Behavior
Wilbur, Donald A. M.A. Biology & Environment of Stored grain insects.

Beltsville, Maryland
United States Department of Agriculture, Agricultural Research Service, Animal Husbandry Research Division

Cook, R. E. Ph.D. Physiological Genetics (Located at Athens, Georgia).
Hess, C. W. Ph.D. Poultry Genetics
King, S. C. Ph.D. Population Genetics
Marks, H. L. M. S. Poultry Genetics

South Lancaster, Massachusetts
Atlantic Union College

Kissinger, D. G., Ph.D. genetics and development

College Park, Maryland
University of Maryland, Department of Zoology.

*Crenshaw, John W., Jr., Ph.D. Population Genetics
Stross, Raymond G. Ph.D. Population Ecology
*Yuhas, John M. A.B. Genetics

Midland, Michigan
The Dow Chemical Company.

Whitney, W. Keith

St. Paul Minnesota
University of Minnesota, Institute of Agriculture, Department of Entomology and Economic Zoology.

Chiang, H. C. Ph.D. Population Ecology, physical ecology.
Cutkomp, L. K. Ph.D. Toxicology.
De las Casas, A., Ernesto.
Hodson, A. C. Ph.D. Insect-mold relationships.

St. Paul, Minnesota
University of Minnesota, Institute of Agriculture, Department of Animal Husbandry.

Comstock, R. E. Ph.D.
*Enfield, F. D., Ph.D.

State College, Mississippi
United States Department of Agriculture, ARS, Entomology Research Division Boll Weevil Research Laboratory

*Bartlett, A. C. Ph.D.

Flushing, New York
Queens College, Department of Biology

*Johansson, M. P., M.S.; Population physiology
*Johansson, T. S. K., Ph.D. Population physiology

New York, N. Y.
Fordham University, Biology Department

*Wolsky, Alexander.

Rochester, New York
University of Rochester, Department of Zoology.

Krivshenko, J.

Upton, Long Island, New York
Brookhaven National Laboratories.

Demerec, M.

Raleigh, North Carolina
North Carolina State College, Department of Genetics.

Grosch, D. S.

Marietta, Ohio
Marietta College, Department of Biology

Brown, William P., Ph.D., Population Genetics

Eugene, Oregon
University of Oregon, Department of Biology.

*Frank, Peter, Ph.D. Population Ecology

Carlisle, Pennsylvania
Dickinson College.

*McDonald, Daniel J., Professor
Spencer, Charlotte, Research Assistant
Wagner, Mary, Technician

Philadelphia, Pennsylvania
Philadelphia General Hospital, Division of Microbiology

Schatz, Albert, Ph.D., Chief

Mayaguez, Puerto Rico
University of Puerto Rico, College of Agriculture and Mechanic Arts, Biology Department.

*Gonzalez Ramos, P. Ph.D.

Austin, Texas
University of Texas, Department of Zoology.

Oliver, Clarence P.

Mission, Texas
USDA, ARS, Entomology Research Division, P.O. Box 986.

LaChance, Leo E.

Richland Washington
General Electric Company, Biology Laboratory, Hanford Laboratories.

*Erdman, H. E.

Seattle 5, Washington
University of Washington, Laboratory of Radiation Biology, Fisheries Center.

Held, E. E.

Washington, D. C.
Catholic University of America, Biology Department.

*Arnett, Ross H., Jr., Ph.D. Population studies
Macnamara, John P., B.S. NSF Fellow Population studies

Madison, Wisconsin
University of Wisconsin, Department of Genetics.

Crow, James F.

Laramie, Wyoming
University of Wyoming, Department of Zoology and Physiology.

*Kennington, Garth S., Ph.D.