TRIBOLIUM INFORMATION BULLETIN

Volume 40

JULY 2000

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 Interactions in Tribolium : competition or predator-prey?

 (To start the ball rolling Sokoloff write this short paper in

 TIB 36. Since the Forum will be open for a few years, it

 Is re-printed here together with Dr. Charles C.Goodnight’s

 views. Other opinions will be printed as received).

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 Notes - Research

Comment of Mr. Abels letter by A. Sokoloff.

It is unfortunate that Mr. Labels was not aware that Tribolium castaneum and T.confusum differ in numerous characters which can be used to classify unknown beetles to the right species. Although late, he learned that the species differ in the overall shape of the antenna: T. castaneum has a three-segmented club, the segments of which are about the same size and much wider than the funicular segments. Confusum antennae have the distal segments of each antenna gradually enlarging from the middle to the tip of the antenna.

The gena may be used as a trait to distinguish the beetles to species, but as Hinton, 1948 pointed out, the easiest trait to identify the beetles to the correct species is the ventral lobe of the compound eyes.

The following paragraph is quoted from page 72 of my book, The Biology of Tribolium

(c) Compound eyes

 The compound eye consists of a continuous aggregation of about six dozen Ommatidia (more or less depending on the species) arranged in diagonal rows. The eye is arbitrarily divided into three portions, such as the dorsal, lateral and Ventral ‘lobes’. In some species (T. brevicornis), the eye is divided into two Separate lobes separated by the gena (ig. 3.6). The space between the ventral Lobes, the pregula, is equivalent in size to that of the ventral lobe of one of the Compound eyes in T. castaneum, while in T. confusum this distance is almost Twice the length of the ventral lobe. It is thus possible to classify the beetles of These two species by the distance between the ventral lobes of the compound Eye (Hinton 1948).

I include in the next page a cover illustration for the Tribolium Information Bulletin, Volume 6, March 1963. It shows two mutants. The one on the left is a homeotic mutation called antennapedia in T. castaneum. The right is a homeotic mutation in T.confusum called labiopedia. (in antennapedia the antennae are modified to form legs, in labiopedia the labial palps are modified into legs). Neither of these mutations affects other parts of the head or the eyes and they appear quite normal.

Examining the ventral part of the head we see that in T. castaneum (left drawing) the space between the ventral lobes, called the pregula, is equivalent in size to the ventral lobe of one of the compound eyes, while in T. confusum this distance between the eye lobes is twice or more the length of the ventral lobe.

If the student uses this trait for determining the species of beetles, he can’t go wrong.

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Hinton, H.E. A synopsis of the genus Tribolium Macleay with some remarks on the evolution of its species groups. Bull. Entomol. Res. 39 : 13-55.

Sokoloff, A. (Ed), 1963, Tribolium Inf. Bull 6 : Illustration in front of Bulletin.

Sokoloff, A., 1972. Morphology of compound eyes. In ‘The Biology of Tribolium with Special Emphasis on Genetic Aspects, Vol. I, p.72. Oxford University Press.

New Mutants (Tribolium castaneum) : Richard W. Beeman and M. Susan Hass.

Bronze (bz). Spontaneous recessive found in the wild-type HO-TCJ stock from Singapore. This mutation is characterized by red eye color in the pupa and young adult. As the adult matures, the eye color deepens to a very dark red-brown color which is easy to confuse with wild-type eye color. These characteristics are similar to the previously described eye color mutation, maroon (m) (Eddleman, TIB 5), which is closely linked to ruby (rb). Bz has complete penetrance and good viability as A homozygous stock. It has been found to complement the eye color mutants hazel (h), chestnut ©, white (w), pearl (p), ruby, platinum (pte) and ivory (i), and is not X-linked. Linkage testing is currently underway to see if it maps to a locus near rb.

Bronze-2 (bz2). Spontaneous recessive found in the wild-type Nig-1 stock from Nigeria. This mutation is characterized by red eye color in the pupa and young adult. Similar to bz, a the adult matures, the eye color deepens to a very dark red-brown color which is easily confused with wild-type eye color. This mutant fails to complement bz, and thus appears to be an allele of bz.

Brown eye (brn). Spontaneous recessive found in the Reindeer (Crossover Suppressor) /Pinched sternellum (Rd [CS]/Ps) stock. Eyes of mature adults are deep brown and difficult to distinguish from wild-type on casual inspection. This eye color gene complements chestnut ©, bronze (bz) and red (r). It has been shown to be X-linked and may be an allele of Modifier of red (rM). Complementation testing is underway to further characterize this gene.

Sokoloff, A.,

Biology Department,California State University,San Bernardino,California

\*Regeneration in walking sticks.

My colleague, Dr. Britt Leatham from the Geology Departent, received a gift of about 15 immature walking sticks. The donor was vague about the origin, but it is likely she purchased an imported gravid female in a pet shop. Upon my request, Britt gave me two specimens. They turned out to be males. I put them in a rearing chamber, fed them rose leaves, and supplied them with water.

The rearing chamber consisted of a finger bowl, to which a glass tube similar to those used in kerosene lamps was attached. One end of the tube was somewhat wider than the other and could be attached by means of a broad rubber band to the finger bowl. The opposite end was closed by means of a piece of No.00 (29 meshes/inch) silk bolting cloth about 9 cm in diameter sealed to the glass tube and serving for ventilation. This proved to be the favorite perch for one of the walking sticks).

The walking sticks adapted readily to their new quarters. They fed on the rose leaves as food. They began to chew on the edge of the leaf, either the base or the tip of the leaf, leaving a characteristic spindle-shaped space and gradually worked their way to the middle vein of the leaf.

I obtained the walking sticks in early August, 2000. I kept them on the kitchen counter. Both of the walking sticks were green when I obtained them. One of them usually rested on the silk bolting cloth seal, clinging with its claws of the middle and hind legs. The first pair of legs extended in parallel fashion – one on each side of the head, apparently to protect its eyes, antennae and head. As it grew (I did not see any signs of exuvia) the body became too long to fit in the space provided by the silk bolting cloth, but this problem was solved by the insect by attaching itself with the aid of the claws on the third pair of legs. The middle pair of legs was extended and hung on each side of the body. The first pair would hang protectively on both sides of its head and beyond (See Figs. 1 and 2A). The femur of the first legs had a row of numerous spines on its medial surface.

Although the walking sticks are immature, they probably belong to the Phasmatidae. (They have no wings, so they may be immature, but they possess two stout spines on the vertex of the head).

A tragedy occurred at the end of 10 days. I slipped, and trying to recover my balance. I reached out and knocked off the top part of the rearing chamber from the finger bowl. After I grabbed for the top of the kitchen counter to recover my balance, I looked at the walking sticks. The one clinging from the silk bolting cloth was still hanging from the same place, but the other was badly injured; the first pair of legs as well as the right middle and hind legs were sheared off, close to the trochanter (Fig. 2b). The rest of the body did not seem to be injured. Examination of the injured specimen showed that it could not walk, but it could move the remaining legs and push itself along the bottom of the finger bowl. The lateral ommatidia of its left compound eye had been sunk toward the middle of the head.

When I offered the insect some water in a napkin, I saw it drinking. I decided to continue feeding it and see what could happen. A week later, the walking stick had molted. The missing middle and hind legs on the right side had been replaced. The length of the uninjured left middle leg was 3 cm and of the hind leg 4 cm. The length of the replaced right middle leg was 3 cm and of the replaced hind leg 3 cm. The forelegs of both sides had started to form (Fig. 3C) but they failed to expand, forming a coiled leg on each side behind the head (Fig. 2D). The sunken ommatidia of both eyes had returned to their normal position.

A month later another molt occurred. The forelegs had formed, but the walking stick was having difficulty in shedding its exuvium from the left foreleg and the insect had broken off its leg while attempting to remove the old exoskeleton. I tried to help the insect to remove the old exoskeleton from the right leg, but I was unsuccessful, and the freshly formed leg still soft came off with the old exoskeleton.

The newly eclosed insect, now that the new exoskeleton has hardened, can walk uncertainly, albeit in all fours. I am hoping that it will be able to shed its exoskeleton once more, and that it will have normal-sized functional legs. However, in this walking stick the abdomen exhibits two more defects; the abdomen tends to curve to the right for some reason (Fig. E) and its pigmentation is green in the anterior half of the body, and brownish on the posterior part of the body.

Four weeks later

I noticed that the two legs on the right side were turning black and the tips of the legs tended to stick to the leaves. The result was that in trying to free the walking stick, portions of the necrotic legs would remain with the rose leaf. Eventually the regenerated legs were completely lost beyond the trochanter. The walking stick could move itself from place to place by using the two remaining legs, but as time went on, the walking stick remained in the same spot from one day to the next. It would still feed on the rose leaves if I put it close to the edge of the leaf and take drinks if the leaf was wet. I was hoping that it would molt once more before it died, but eventually it died without molting. I removed it from the rearing chamber and pinned it.

The other walking stick has survived from August, 2000 to the end of March 2001. It suffered an accident about a month ago, with the result that the right middle leg broke off beyond the femur. It is about 7.5 cm long with a uniform tan color. When I take it out of its rearing chamber it moves a little, but it does not try to escape. It will be interesting to see it after it molts. Stay tuned.

Legends

Fig. 1 – Rearing chamber and one of the walking sticks hanging from the silk bolting

 cloth with its hind legs.

Fig. 2 - A) Normal walking stick

 B) Injured walking stick with four of its six legs missing.

 C) Appearance of same walking stick after first molt. Note that the forelegs are

 coiled.

 D) A view of the coiled legs magnified.

 E) Appearance of the same walking stick after the second molt. The first pair of legs is missing (see text).

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 Insects. 6th Edition.

Saunders Publishing and Harcourt Brace College Publishers, New York.

  

Grain Marketing and Production Research Center

Biological Research Unit, 1515 College Avenue

Manhattan, KS 66502

Telephone : 785-776-2704/FAX 785-537-5584

James E. Throne, Research Leader

RESEARCH HIGHLIGHTS AND TECHNOLOGY TRANSFER FOR 1999-2000

Product Development:

We began development of a prototype of an NIR-based, automated, single-kernel, seed sorter/insect detection unit. Perten Instruments, USA, is interested in partnering with Control Development (manufacturer of the NIR sensor) to manufacture the complete sorting system. Several large grain processing companies have expressed a strong interest in purchasing such a system. This insect detection unit will allow the rapid, automated analysis and sorting of individual grain kernels for the presence of hidden, internal insects, and the technology will be applicable for sorting based on other quality traits. (Dowell, Baker, Throne).

We are conducting an Area-Wide IPM Project for Stored Wheat to improve pest management practices throughout the hard red winter wheat growing region. The project is a collaboration of ARS with Kansas State University, Oklahoma State University, and 28 grain elevators in Kansas and Oklahoma. These elevators store 31 million bushels of wheat or roughly 1.2% of the national production. We have distributed a quarterly newsletter to collaborators describing the results of the project. We recently met with 5 people from the elevators to discuss the results of the project and the type of information they would like an expert system for stored grain management to provide. This expert system is being developed as part of area-wide project. It will help collaborating elevators manage insect pests after the project ends, and make the results of the project available to other elevators. (Hagstrum, Flinn, Arthur, Dowdy, Mullen, Throne).

INTE. CONF. ON ANIM. SCI & VET. MED. TOWARDS THE 21st CENTURY:

APPLYING TRIBOLIUM CASTANEUM STUDIES CROSS – HERITABILITY:

 Zhang Jun Zhang Lao

China Agricultural University Animal Science & Technology College, Beijing 100094.

Three inbreeding lines of Tribolium castaneum (C, Py and Z), which are crossed in

a complete diallel cross. The data of 21-day pupa weight and pupa length were analyzed using cross-heritability.

The results of Tribolium castaneum for experiment showed that the complete diallel cross in three inbreeding lines (efficient is 0.7851) showed different heterosis, and the heterotic difference of the pupa weight of cross C x Z, Z x C and Z x Py was high significant or significant. The heterotic difference of the pupa length of cross Z x C and Z x Py was significant.

As for pupa weight, the results that were drawn by analyzing the test data were that the cross C x Py and Py x Z has larger epistasis variance than others, that the cross C x Z and Py x Z has larger dominance variance than others, and that the Z x C and Z x Py showed over-dominance.

As for pupa length, the results were that the cross C x Py and Py x Z has larger epistasis variance than others, the cross C x Z and Z x Py showed over-dominance.

In two traits, some cross has minor epistasis variance, which reflect that epitasis effect was restrained to bring about heterosis in the cross.

The results showed by applying cross=heritability method that the cross-heritabilities of the 21-day pupa weight were 0.04 – 0.48, and the 21-day pupa length was 0.17 – 0.70.

Keywords: cross-heritability, heterosis, Tribolium castaneum.

Technical Note

Technical Note submitted for publication in TIB 40

Ramiro Gomez Ruano

I.N.I.A. Dpto.de mejora Animal.

Ctra.La Corufia Km. 7. Apdo. 8111 (28040 MADRID) SPAIN.

HOW TO IMMOBILIZE ADULT TRIBOLIUMS

The following material is needed for this technique: water, small receptacle, small brush and a binocular microscope.

The small receptacle should prevent the insect from escaping. A siracusa glass could be used, but we recommend a glass of smaller diameter, that could be entirely focused with a binocular microscope with a magnifying power of 16. Blister packs, commonly used for pills, capsules or watch batteries, could be used as a receptacle, easiest to handle in strips of two or three.

Use a small brush to put a drop of water, as tiny as the insect, in the receptacle. Then capture the insect, which must be in a clean condition, with the same wet brush. Never try to capture the insect by touching its ventral part, because it would try to climb up the brush, making immobilization extremely difficult. The proper way is to touch the dorsal part, easily adhering the insect to the brush, and transferring it to the drop of water in the receptacle, to finally rotate the insect upside down.

Before replacing the insect to the nutritious medium, it should always be left to dry for some time on paper.

In order to avoid suffocation, the water drop should never cover the whole insect, specially the ventral part of it. Water excess should be removed with the brush, spreading it on the bottom of the receptacle. Even if it should be absolutely avoided, suffocation would not be of a mortal nature in this case, and recovery would present itself, as soon as the insect has dried off.

See: Ruano, R.G. (1977) “A simple technique to immobilize Tribolium adults”.

TIB 20 : 151-152.

