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Notes - Research

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\*Genome sizes in some species of Tribolium flour Beetles (Coleoptera, Tenebrionidae).

The DNA content of Feulgen stained spermatids has been measured from wild type laboratory strains of six species of Tribolium McLeay by using T. castaneum as an internal standard. The results are as follows:

Indiv. Spermatids DNA content SD

N (N) mean (pg)

-3

T. audax 10 300 0.164 1.7 x 10

-3

T. brevicornis 9 270 0.384 5.2 x 10

-2

T.castaneum 5 100 0.208 2.0 x 10

-3

T. confusum 10 300 0.248 4.1 x 10

-3

T. freeman 10 300 0.237 1.7 x 10

-3

T. madens 5 150 0.241 4.5 x 10

The range of genome sizes among these congeneric species exceeds a two-fold difference. Pairwise comparisons between the six mean values give statistically significant differences in all but one of them, that between T. freeman and T. madens. T. castaneum ad T. confusum are clearly separated in their nuclear DNA content. These genome data are in support of the karyological differences reported between these species. T. castaneum has 20 chromosomes and a 9 + Xyp male meiotic formula, whereas T. confusum has 18 chromosomes and a 8 + neo XY formula

(Smith, 1952). It agrees with their high genetic distance based upon allozyme electrophoretic studies (Sanchez, 1979; Wool, 1982). Therefore, a substantial increase in the genome size could explain the origin of T. confusum from T. castaneum, plus the presumed Autosome-X chromosome fusion. However, if T. brevicornis were the ancestral species of Tribolium as suggested by Hinton (1948), its highest DNA amount would necessarily imply that the evolution of the remaining species should have mostly taken place by decreases in the genome size.

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(NOTE : This investigation was presented at the International Congres of Coleopterology, Barcelona, September 18-23, 1989, organized by Asociacion Europea de Coleopterologia, Departamento de Biologia Animal, Facultad de Biologia, Universitat de Barcelona and Universita di Torino, Dipartimento di Biologia Animale).

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\*A SET OF METHODS FOR DISTINGUISHING BETWEEN “6- AND 7-INSTAR INDIVIDUALS” IN TRIBOLIUM POPULATIONS.

Introduction

A phenomenon of a particular heterogeneity occurring in insects populations (stored product pests) has been observed for a long time (Howe 1961). There is a fraction of population which shows longer development time and larger weight, and has a one larval instar more in its development than the remaining fraction of individuals. Such heterogeneity in populations of Tribolium castaneum Hbst and T. confusum Duval was described (Prus 1976, Bijok 1984, Prus and Prus 1987) and examined in terms of its influence on autecological features (Prus, Bijok and Prus 1988) and reproductive effort (Prus, Prus and Bijok 1988). Carrying on such studies it is important to have a simple and effective method for distinguishing between these groups of individuals which have been called 6- and 7-instar groups.

Method – 1 : Observation of whole development in synchronized

Individual cultures.

It is the most laborious method, but giving possibility to collect data about duration of all developmental stages and to obtain a growth curve for each individual. This method gives the most reliable answer to the question whether the individual belongs to 6- or 7-instar group. This method has been used by Prus (1976), Bijok (1986), Prus ad Prus (1987).

Newly hatched larvae (not older than 2 hours after hatching) were placed in separate, numerated glass vials each containing 1 g of standard culture medium (95% wheat flour and 5% powdered baker’s yeast, by weight). Cultures were run in a dark incubator at 29 degree C and 70% RH. Every 2 days a content of each vial was sifted through fine mesh (0.5 mm) and the individual was found. The animal was placed on preweighed aluminium foil pan and weighed on electrobalance with an accuracy of 0.01 mg. Besides the exuvium was looked for and its presence (or absence) as well as developmental stage of the individual recorded. Sex of animals was determined during a pupal stage (Sokoloff 1972).

In order to rank precisely each individual to 6- or 7-instar group. It is necessary to plot growth curve for every one individual on a weight v time scale, separately for males and females (Fig. 1). On each curve a moment of pupa appearance and that of eclosion should be marked. If number of examined individuals is large enough two separate bunches of curves can be seen – for 6- and 7-instar individuals. Any curve

(= individual) not grouped in one or another bunch should be rejected as dubious case. In uncertain cases a number of exuiae found, and a time of appearance of developmental stages can e helpful in making the decision.

Using this method to determine duration of subsequent developmental stages and time of whole development one should remember that handling and changes of temperature during sifting, weighing etc. have a significant influence on rate of development. Therefore, the temperature in laboratory during work with animals should be rather close to that used in the incubator.

Method – 2 : Observations of final period of development in synchronized individual cultures.

This method is based on comparison of time of reaching pupal and/or adult stages and weight of newly appeared pupae.

Cultures were started just like in the previous method, but were left in incubator till 15th day of larval development. Then the first observation took place. On that day 4-5 exuviae were found in each vial. The following observations were carried out every day till the time of eclosion. Only newly appeared pupae were weighed and their sex was determined.

In order to distinguish between 6- and 7-instar individuals it is necessary to make two graphs separately for males and females on scale: time of pupae appearance versus weight of pupae. Each individual should be placed as a separate point (Fig. 2). If number of examined individuals is sufficient, two clouds of points should be seen for 6- and 7-instar groups. Any point (=individual) not grouped in clouds should be rejected as dubious case. Number of exuviae found is not a precise criterion and can only have an accessory significance because smallest exuviae could be easily lost.

Method – 3 : Selection in respect of time of pupae appearance in

Synchronized cultures.

This method is not so precise as the previous two, but is less complicated and not so time-consuming. It is used to obtain large quantities of material, consisting of individuals split into 6- and 7-instar groups of males and females. Such material can be used for chemical analysis, for example, lipid content determination, calorific value etc. (Prus & Prus and Bijok 1988).

A group of adult individuals (about 200-3--) was placed in glass jar with about 100-150 g of standard medium for egg lying. After 24 hours animals were separated from medium by sifting through a coarse mesh. Medium with eggs laid was incubated for 20 days at

29 degree C and 70% RH. Then content of jar was sifted in order to check a number of pupae appearing. All pupae were isolated, selected for males and females, counted and placed in vials. This operation should be made every day as long as pupae are appearing. In order to make selection a graph should be made; time versus number of pupae appearing. A curve should show two maxima – corresponding to maxima of appearance 6- and 7-instar pupae. Only individuals forming the very maxima should be taken as 6- or 7-instar groups (Fig. 3).

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\*GROWTH RESPONSE OF TRIBOLIUM LARVAE ON DIFFERENT CULTIVARS OF SORGHUMS

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ABSTRACT

Different cultivars of sorghums differ significantly in their ability to support growth of Tribolium castaneum larvae. The growth response of the larvae could not be predicted on the basis of chemical composition of the cultivars.

INTRODUCTION

Tribolium larvae are a useful model for evaluating the nutritional value of cereals

(Shariff et al., 1983; Rogel et al., 1983), and legumes (Gerpacio et al., 1980; Pao et al., 1987). Ten cultivars of sorghum (Sorghum bicolor (L Moench) wee found to differ significantly in their content of dry matter (DM), crude protein (CP), ether extract (EE), ash, sugar (as glucose), starch, and tannins; and their ability to support growth of

Tribolium castaneum larvae (Banda-Nyirenda et al., 1987). Seventeen more cultivars of sorghum have been compared in the present study for their chemical composition, and their ability to support gowth of Tribolium larvae.

MATERIALS AND METHODS

Seventeen cultivars of sorghum, listed in Table 1, were grown at Davis, CA, during the 1980-81 seasons, The dried grain were ground to pass through a 100 mesh sieve. Two or three replicates of these ground samples were used for chemical analysis. Dry matter (DM), crude protein (% CP = % Kjeldahl N x 6.25), ether extract (EE), and ash were determined according to AOAC 1979). Acid detergent fiber (ADF) and neutral detergent fiber were determined as described by Goering and Van Soest (1970). Available carbohydrates (ACHO) are the sum of starch and glucose, and were determined by the method outlined by Southgate (1969). The procedure of Price et al.(1978) was used for measuring tannins as catechin equivalent.

The procedure for the bioassay of sorghum cultivars to support growth of Tribolium castaneum larvae has been described by Banda-Nyirenda et al., (1987). Each sample was assayed in triplicate. The control diet contained 90% unbleached whole wheat flour and 10% brewer’s yeast. Wheat flour was substituted by the flour of sorghum cultivar under test. The larvae were weighed on 14th day after hatching. The data were subjected to analysis of variance, and the values for least significant difference (LSD) at P = 0.01 were calculated to compare any two means.

RESULTS AND DISCUSSION

A significant difference (P 0.01) was observed in the % DM, % EE, % ADF, % NDF, % sugar, and % tannin contents of different cultivars of sorghums, and their ability to support growth of Tribolium larvae (Table 1). The mean larval weight on control diet was 3.2 + 0.03 mg. Some of the diets containing sorghum cultivars supported as good a growth of larvae as the control diet.

Table 1 : Cultivars of sorghums, their % composition and

Ability to support growth of Tribolium larvae -

ACHO

Sorghum cultivar DM CP EE ADF NDF Ash Sugar Starch Tannin Larval % % % % % % % % % wt./mg

P.A.G.4474 88.7 12.3 2.9 7.0 13.3 2.3 1.1 66.5 0.38 2.8+ 0.4 P.A.G.4433 90.3 12.2 3.7 6.6 10.1 1.8 1.8 66.1 0.25 1.5+ 0.3

P.Valley )

PV5365R ) 89.4 12.1 7.7 3.9 6.9 1.6 1.3 71.5 0.30 2.4 + 0.3

N King X79552 90.3 12.1 3.4 4.3 7.7 1.9 1.2 71.1 0.32 3.0 + 0.2

Poineer X3015 91.2 12.1 3.5 5.7 9.7 2.0 3.4 68.7 0.18 2.1 + 0.4

F.Morse 7601 90.5 12.0 3.9 4.8 9.7 2.1 1.0 69.9 0.19 2.8 + 0.3

Poineer 883 91.9 11.9 3.7 4.0 7.2 1.7 2.6 69.6 0.25 2.7+ 0.2

O’Gold EXP9519 88.3 11.8 2.8 3.5 8.5 1.6 1.7 61.5 0.21 2.2 + 0.2

NC + 161 90.3 11.7 4.2 6.3 11.3 1.9 1.9 66.4 0.31 2.9 + 0.3

F.Morse 7804 89.8 11.7 7.2 7.1 10.2 2.0 1.5 66.5 0.18 2.9 + 0.2

Asgrow H783 88.7 11.6 2.8 5.5 10.9 1.9 2.9 69.2 0.41 3.1 + 0.2

P.Valley 530GR 88.4 11.5 2.8 5.2 10.8 1.9 1.6 66.8 0.21 3.0 + 0.2

F.M.ADV 1922 91.6 11.3 5.6 4.9 11.6 1.9 1.6 68.9 0.23 1.6 + 0.1

Poineer 8855 90.6 11.3 3.4 5.2 8.5 1.9 1.3 66.2 0.11 2.0 + 0.2

P Valley ) 91.0 11.3 5.4 3.2 7.6 1.6 2.2 64.2 0.15 1.5 + 0.3

PV515GR )

Asgrow 7812 92.8 11.1 6.0 5.8 10.1 1.9 0.8 65.9 0.30 2.5 + 0.1

NC 55X 94.2 11.0 5.7 5.2 9.5 1.7 2.8 68.6 0.14 3.0 + 0.1

ANOVA Table

DF Error 34 17 17 34 34 17 17 17 17 34

Mean Sq.Error 0.02 0.08 0.04 0.05 0.16 0.24 0.04 6.4 0.001 0.06

F ratio 23\* 2.82 112\* 87\* 56\* 1.45 26\* 2.0 20\* 15.6\*

Lsd (p 0.01) 0.2 0.13 0.1 0.1 0.1 0.17 0.2

Different cultivars of sorghums differed significantly in supporting the growth of Tribolium larvae. No significant correlation was observed between any of the chemically determined parameters for different cultivars of sorghums. The growth of Tribolium larvae was also not significantly correlated to any of the individually determined parameters. The multiple correlation coefficient (r = 0.41) for Tribolium growth as dependent variable and other parameters as independent variables also suggested a poor prediction of larval growth from the determined parameters.

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\*Karyotypic formulae of Spanish Tenebrionidae from Balearic and Canarian archipelagos.

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Most species of Tenebrionids are apterous or at least flightless beetles, a characteristic which vary probably explain the high rates of speciation found in the insular biotas. The Baleares and Canary Islands are not exceptions to this general rule since most of their darkling beetles are endemics. Therefore, the chromosomal analyses started herein stand for the first contribution on the cytotaxonomy and karyologic evolution of these insular tenebrionids in relationship with the remaining so far known species. Thirty-five species are chromosomally checked, most from Balearic Islands out of nine from Canary Islands and two from Catalonia, nearest to the Baleares. The results obtained are reported below.

Karyotypic

Subfamily and species source formula

ERODIINAE

Erodius emondi laevis Sol. Ibiza 1 + Xyp

TENTYRIINAE

Tentyria grossa Bess. Mallorca, Menorca 9 + Xyp

Tentyria ophiusae Cod. Ibiza 9 + Xyp

Tentyria schaumi Kr. Mallorca 9 + Xyp

Pachychila sublunata Sol. Mallorca

Formentera 9 + Xyp

Hegeter lateralis Brulle Tenerife 9 + Xyp

Hegeter politus Heer Lanzarote 9 + Xyp

Hegeter tenuipunctatus Brulle Tenerife 9 + Xyp

Hegeter transversus Brulle Tenerife 9 + Xyp

Melanochrus lacordairei Woll. Lanzarote 9 + Xyp

STENOSIINAE

Stenosis intricate Reitt. Mallorca 9 + Xyp

ASIDINAE

Asida jurinei Sol. Catalonia 9 + Xyp

Asida planipennis Schauf. Mallorca 9 + Xyp

Alphasida depressa Sol. Mallorca, Menorca 9 + Xyp

Alphasida ibicensis P. Arcas Ibiza 9 + Xyp

AKIDINAE

Akis acuminate F. Mallorca, Menorca 7 + neoXY

Akis bacarozzo Schrank Mallorca, Menorca 7 + neoXY

Akis bremeri Ardoin Formentera 7 + neoXY

SCAURINAE

Scaurus striatus F. Mallorca 11 + neoXY

PIMELIINAE

Pimelia criba Sol. Mallorca, Menorca 9 + Xyp

Pimelia elevate Senac Ibiza 9 + Xyp

Pimelia radula ascendens Woll. Tenerife 8 + Xyp

Pimelia laevigata costipennis Woll. Hierro 8 + Xyp

OPATRINAE

Isocerus balearicus Schauf. Mallorca 9 + Xyp

Phylan abbreviates 01. Catalonia 9 + Xyp

Phylan mediterraneus Pioch. Ibiza, Formentera 9 + Xyp

Micrositus nitidicollis P.Arcas Cabrera 12 + Xyp

Micrositus semicostatus Muls. Mallorca 12 + Xyp

Gonocephalum rusticum Ol. Mallorca, Ibiza 9 + Xyp

Melasmana lineatum Brulle Lanzarote 10 + neoXY

PHALERIINAE

Phaleria acuminate Kust. Mallorca 9 + Xyp

CRYPTICINAE

Crypticus gibbulus Quens. Mallorca 9 + Xyp

Crypticus vavicularis

Latihumeralis Har. Lindb. Tenerife 9 + Xyp

DIAPERINAE

Diaperis boleti bipustulata L. Mallorca 6 + neoXY

HELOPINAE

Nesotes viridicollis Schauf. Mallorca 9 + Xyp

As it can be seen in the above findings the most frequently encountered formula is

9 + Xyp, in agreement with previous results in Tenebrionidae (Yadav et al. 1980). The tenebrionids keep the primitive and most frequent beetle formula despite their great morphological differences, which implies a high degree of canalization of the gross karyological features in correspondence with their larval uniformity. Only some Pimelia, the Akis, Scaurus, Micrositus and Diaperis deviate from the common formula. Both increases and decreases account for these deviations which can involve translocations in the sex-chromosomes too as shown in Akis, Scaurus and Diaperis. From our work we can also conclude that not only Blaptinae and Elenophorinae display centric fissions as reported by Yadav and Pillai (1976) but the Scaurinae and a few Opatrinae can display increases in number too, by centric fissions presumably.

Acknowledgements

We should give our grateful thanks to Dr. P. Oromi, Dep. Of Zoologia, Univ. La Laguna (Tenerife), for his generous efforts in collecting and sending the Canarian tenebrionids of the present report.

Nuclear DNA CONTENT OF Tribolium castaneum and Tenebrio molitor (Coleoptera: Tenebrionidae).

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Undoubtedly Tribolium castaneum is the best surveyed beetle on genetic grounds (Sokoloff, 1966; 1977), and has been reasonably well studied from the cytogenetic viewpoint (Smith, 1952). Nevertheles, its nuclear DNA amount was unknown to date. Since we have recently used T. castaneum as standard for calibration to measure genome sizes in several species of beetles, we report herein the C value of this species and that of another, Tenebrio molitor, also extensively used in many laboratories.

The technique we followed was the conventional Feulgen staining of teased and squashed tests according to the regular procedures, except for the fixation in 10% formaline and a 5N HC1 hydrolysis at room temperature for 45 minutes. The measures of light extinction were performed by a NPV microdensitometer coupled to a Leitz Dialux-20 microscope. Both the intensity of monochromatic light and the size of window were kept invariant in each set of experiments. Moreover, the cell size of every checked spermatid was scored by an ocular micrometer.

Since the DNA content of Dermestes maculates was previously known (Rees et al., 1976), we took its spermatids as standard to estimate the C value of Tribolium castaneum CSIC wild type strain from Barcelona). The DNA amounts of spermatids for the two species are given in Table 1. Also, the range of variation of the total 100 DNA measures is depicted in the histograms of fig. 1.

Table 1. Mean light extinctions (arbitrary units) and standard errors Per individual of Dermestes maculates and Tribolium castaneum.

Dermestes maculates T. castaneum

Indv. No. esperm Mean + S. E. Mean + S. E.

1 20 27.834 + 0.593 4.632 + 0.103

2 20 24.383 + 0.529 4.685 + 0.118

3 20 25.849 + 0.371 4.586 + 0.123

4 20 25.546 + 0.452 5.253 + 0.098

5 20 26.228 + 0.399 4.825 + 0.156

Total 100 25.963 + 0.237 4.789 + 0.058

1C nuclear DNA content of D. maculates 1.129 pg (Rees et al., 1976), id of

T. castaneum 0.208 + 0.002 pg.

After estimating the DNA content of T. castaneum, this species was used as standard to measure the counterpart value of Tenebrio molior spermatids (CSIC WILD TYPE STRAIN FROM Barcelona), by checking again five individuals and twenty spermatids of each individual. This gave a mean 1C value of 0.517 + 0.007 ;g.

Figure 1 - Histograms of the distribution of spermatid extinctions (arbitrary units) for the 100 cells measured of Dermestes maculates (A) and Tribolium castaneum (**B)**

The nuclear DNA contents of Tribolium castaneum and Tenebrio molitor espermatids are among the lowest and the highest values, respectively, so far found in a sample of nearly twenty species of tenebrionids (Juan & Petitpierre, 1988). The genome size of T. castaneum is similar to that of Drosophila melanogaster (0.18 pg), but the haploid value of the latter, n = 4, is lower than that of the former, n = 10 chromosomes. Therefore, the averaged DNA content of T. castaneum chromosomes is clearly smaller than the averagd chromosomes of D. melanogaster.

SUMMARY

The nuclear DNA content of Tribolium castaneum spermatids was measured by Feulgen microdensitometry using those of Dermestes maculates as standard. The mean value of genome size for T. castaneum was 0.208 + 0.002 pg. Furthermore, the analysis of Tenebrio molitor spermatids, using T. castaneum as standard for calibration, gave a higher value 0.517 + 0.007 pg, about 2.5 fold that of the previous species.

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\*Influence of pupal age on the adult recovery and survival of Tribolium anaphe Hinton. To different doses of omma irradiation.

Tribolium anaphe Hint. Is an obnoxious pest of the stord commodities and cosmopolitan in distribution, and is originating in Ethiopia (Hinton, 1948). The adults of this pest are long-lived and laid eggs continuously over long periods belongs to the second type of oviposition in Coleoptera (Dick, 1937). Applied pest control largely depends on limiting the longevity of the beetles which survive to go on reproducing and add to the desolation of good materials.

Inoizing radiation has been used successfully to control several insect species and may prove valuable in controlling stored grain pests (Brown et al., 1972; Dramola, 1980; Huda & Rezaur, 1982; Khattak & Jilani 1984; Arunachalam & Curtis, 1985; Dawes et al., 1987 and Navon et al., 1988). Gamma radiation appears to be a potential alternative to chemical for pest control in stored products (Laudni et al., 1965 and Cornwell, 1966) and have no residual problems like chemical insecticides (Pattrson et al., 1975). Inoizing radiation destroy life by causing physical and chemical changes in the cell that they penetrate, and among different rays, gamma rays have great penetrating effects and hence these rays are most considered for insect control (Bushland, 1958).

Attempts have been made to determine the effect of radiation on the flour beetles by several researcher’s (ork, 1957; Ducoff & Walburg, 1961; Sokoloff, 1961; Tilton et al., 1966; Yano et al., 1970; McKibben & Mills. 1972; Brower & Tilton, 1973; Faustini, 1976; Ramos-Elorduy de Conconi, 1978; Bhatia & Sethi, 1980; Bhat et al., 1981: Bongirwar et al., 1981; Ratti et al. 1982 and Wool, 1982). But information concerning the effect of gamma radiation on T. anaphe is very scanty. So, the following experiments were set up to determine the effect of gamma radiation on the adult recovery and longevity of

T. anaphe when exposed on different ages of pupae.

Insects used for this study were originally obtained from Pest Infestation Control Laboratory, Slough, England and maintained for 3 years in the Dept. of Zoology, Rajshahi University. Eggs were collected by placing a large number of adults of nearly similar age on a thin layer of wholemeal flour in a Petri dish and sieving (60 mesh) the content, on the next day. Then they were incubated at 30 + 0.5 degree C for hatching. Newly hatched T. anaphe larvae were transferred to jars (20 x 9 cm) containing 300 g of standard food medium (Park & Frank, 1948). Ten identical jars were used each having 450 larvae. The larvae were carefully checked from time to time by sieving (18 mesh) for pupation. After pupation they were collected and sexed on the basis of exo-genital

processes (Halstead, 1963). When the pupae reached the desired age, they were irradiated from the Co-60 source (75 krad/hr). The exposed doses were 1, 2, 4 and 6 krad, and the age of the pupae at the time of exposure were 1, 2, 3 and 4 days. A control batch was maintained without any exposure. Then they were kept in

an incubator for adult eclosion. After eclosion, the recovery was recorded. The adults of both sex were placed in separate glass jars (10.5 x 4.5 cm) containing food medium and secured at the top with fine net. The mortality of the beetles were observed for

30 days. In every counting day the medium was replaced to avoid conditioning by the adult (Ooden, 1969). All experiments were conducted in an incubator at 30 + 0.5 degree C. uncontrolled relative humidity and without light.

The applied doses significantly reduced the adult emergence of T. anaphe in all levels of age group (Table 1), and higher doses (6 krad) drastically affected the longevity of both sexes (Table 2). It was also found that younger pupae were more sensitive than the older one, and with the increase in ages the adult mortality decreased. Flint et al., (1966) reported that when pupae of the boll weevil), Anthonomus grandis grandis Boheman, of three different ages were irradiated with 3 krad of X-rays, adult emergence was less reduced in older pupae than the younger. Similar results were obtained by Burgess & Bennett (1972) with the alfalfa weevil when pupae of different ages were exposed to gamma radiation. Chen et al. (1983) also noted that 68.70% adult emerged from 1.1 krad irradiated pupae of 2 days old. Dawes et al., (1987) observed that the 5 krad severely affected the adult production of swet potato weevil, Cylas formicarius elegantulus (Summers) when exposed on 2 day old pupae. In the present investigation, none of the dose could impede the adult emergence but the percentage was very meager at 6 krad and died within 10 days, and both sexes of 1 day adult died within the same day at 2 & 4 krad. It was also observed that with the increase in doses the adult production decreased. These findings are in close conformity with Nair (1962) working on house fly, Davich & Linddouist (1962) on boll weevil. Datta et al, (1980) on uzi fly. Tezcan & Zumreoglu (1981) on fruit fly and Prasad & Sethi (1980) on Dacus dorsalis.

Insect populations in stored products can be controlled by producing immediate mortality (Cornwell & Bull, 1960). Considerable variation in results may occur when factors like radiation dose rate and age of species are not considered (O’Brien & Wolfe, 1964 and Brown & Davich, 1973). From that standpoint, in present investigation,

a wide range of parameters both for age and low doses of gamma radiation have considered so as to determine the minimal effective dose for the specific pupal age.

It is inferred from the over all results that the treated doses are not sufficient to inhibit hundred per cent emergence and their quick mortality. So, it is suggested that the higher doses ( ) 6 krad) may be used for controlling this pest.

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\*Effect of egg cannibalism on larval growth of Tribolium confusum.

Introduction

Tribolium is a major pest of stored products and is cosmopolitan in distribution. In Tribolium the larval growth is affected by environmental factors such as temperature, relative humidity, limitation of food and flour conditioning (HOLDAWAY, 1932; Howe, 1956; Boyer, 1976 and Mondal, 1986). Depending on various conditions the number of larval instars ranges from 5 to 11 or more (Brindley, 1930) and larval period varies from 18 to 100 days (Howe, 1956; Mondal, 1986). At 30 degree C which appears to be optimum, the majority of larvae have six instars and the larval period varies from 22-27 days (Good, 1936).

In the population of the flour beetles Tribolium egg cannibalism by both adults and larvae (Park et al., 1965) is one of the natural forces and regulate population size (Park, 1933).

There is no information concerning the effects of egg cannibalism on the larval growth of Tribolium. This led to the present work.

Materials and Methods

Newly hatched larvae were reared in flour medium mixed with 1-2 day old Tribolium eggs at a density of 20, 50 or 100 g of medium. Groups of control larvae were maintained on food without eggs.

Individual larva was placed in flat bottom glass tubes (50 x 25 mm) containing 0.5 g of either fresh or treated medium and secured at the top with cotton wool. They were kept in an incubator at 30 degree C without light and relative humidity control. Every three days the medium was replaced to avoid conditioning by larvae (Mondal, 1983) and eggs were also replaced to avoid hatching. Larvae were regularly observed for pupation and the larval period was noted.

The weights of the larvae were taken on 3rd, 6th, 9th, 12th and 18th day from hatching which correspond to the second, third, fourth, fifth and sixth instar in control respectively (Mondal, 1984). Although larval instars in the treated medium were not known, their weights were taken on these days to make comparison with those of control. Larvae were collected by sieving the medium through a 250 micrometer sieve and the surface of the larvae was thoroughly cleaned by a fine paint brush to remove the flour, if any. Larvae were individually weighed in an electric balance. Twenty larvae from each age were weighed for different treatments.

Results and Discussion

The results are shown in tables 1 and 2. The effect of different treatments on both larval period and larval weight was determined by analysis of variance.

Eggs treated media reduced the larval period and increased the larval weight in comparison with those of control. The weights of all ages particularly those of sixth instars were found increased significantly (P 0.05) in the eggs treated medium in comparison with those of control. The increased weight of larvae is probably due to the phenomenon of egg cannibalism by larvae (Park et al., 1965; Teleky, 1980). In the present experiments the significantly (P 0.05) increased weight of larger larvae also support the findings of Ho and Dawson (1966) who reported that the younger larvae of Tribolium are not very active in egg eating, but as the larvae age and increase in size they become much more cannibalistic. The probable reason of the larval increased weight is that there is a higher concentration of utilizable nutrients in eggs than in the surrounding medium due to high caloric content (Slobodkin, 1962). However, there was no significant difference (P 0.05) in the larval period between treatments and control.

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Table 1 : Larval period (days) of T. confusum reared on fresh medium

(control) and medium treated with different densities of eggs.

Treatment No. of larvae Mean + S. E. Range

Control 42 21.00 + 0.11 18.00 - 23.00

-1

Eggs (20 g ) 40 20.00 + 0.12 18.00 - 22.00

-1

Eggs (50 g ) 40 20.20 + 0.15 18.00 - 22.00

-1

Eggs (100 g ) 40 18.50 + 0.16 17.00 - 22.00

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\*Effect of synthetic methylquinone on adult mortality in Tribolium confusum Duval.

Introduction

The life span of adult Tribolium ranges from 3 months to 3 years and males live longer than females (Good, 1933, 1936; Pajni and Virk, 1982). It may be reduced due to adverse temperatures, relative humidities (Pajni and Virk, 1982) and conditioning of medium (Park, 1935).

Methylquinone (2-methyl-1, 4-benzoquinone) is one of the quinoid secretions of adult Tribolium (Roth, 1943) and are responsible for conditioning of flour medium (Park and Woolcott, 1937). The synthetic methylquinone is repellent to Tribolium adults (Loconti and Roth, 1953) and larvae (Mondal and Port, 1984). It also reduces both fecundity (Taher and cutcomp, 1983) and fertility (Mondal, 1987) in Tribolium.

There is no information on the effect of synthetic methylquinone on adult mortality in T. confusum. This led to the present work.

Materials and Methods

Ten adults aged between 0–1 day were placed in a petri dish provided with 4 g of either fresh (control) or treated medium and covered with a lid. The medium of eah dish was changed every ten days to avoid conditioning by the beetles (Park 1935). Mortality was assessed after 60 days (Khan, 1981) and the percentage mortality was corrected using Abbott’s formula (Abbott, 1925). The medium was treated with different concentrations of synthetic methylquinone by subliming into fresh medium (Ogden,1969).

Five replicates were used for each treatment and for each sex. Experiments were conducted at 30 degree C without light and relative humidity control. The adults used in the experiments were all survivors (Ashford, 1970).

Results and Discussion

The results of the experiments are shown in table 1. In the treated medium, particularly in higher concentration mortality of both male and female were higher than those in control. In control there was no difference in mortality between male and female adults, but in case of treated medium the females show slightly higher mortality compared with males. In the present experiments the higher mortality in treated medium indicates that the life span of Tribolium adults may be reduced due to methylquinone which agrees with the findings of Park (1935). The higher mortality of female adults recorded in the present experiment also supports the results of Good (1936) who reported that males live longer than females.

There are no published data on the effects of synthetic methylquinone on adult mortality to compare with present results, but the present results confirm the assertion of

Park (1935) that the life span of Tribolium adults may be reduced by conditioning of medium.

Tribolium adult’s life span is very long and they reproduce throughout the year. Thus, the reduced longevity could be important in the control of Tribolium (Mondal, 1986).

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Table 1: The percentage mortality of T. confusum adults reared on fresh

Medium (control) and medium treated with synthetic methylquinone.

Sex Concentration of Total % mortality Corrected

Methylquinone adults mortality

-1 dead ( % )

(g of medium)

Male Control 3 6 --

0.2 mg 5 10 4.25

1.0 mg 10 20 14.89

5.0 mg 15 30 25.33

Female Control 2 4 -

0.2 mg 10 20 16.67

1.0 mg 14 28 25.00

5.0 mg 20 40 37.50

Five replicates per test, each replicate consisting of 10 adults (N = 50).

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\*DEVELOPMENT TIME AND SURVIVAL IN 6- AND 7-INSTAR GROUPS OF

TRIBOLIUM CASTANEUM HBST. AND T. CONFUSUM DUVAL UNDER THE

EFFECT OF TRICALCIUM PHOSPHATE

INTRODUCTION

Inorganic substances in the form of minutely grounded powder are harmful for insects in spite of the fact that they remain inactive chemically. Their impact depends on destruction, either by absorption or by mechanical injuring, of the lipid layer of cuticle which prevents evaporation (Ebeling and Wagner 1959, Hassan 1981). Looking for substances which would be not toxic for man but harmful to insects, 66 mineral salts, mainly containing calcium, were examined, by exposure 5 insect pest species (Boczek, 1984). The strongest inhibitory effect was that of ammonium nitrate and tricalcium phosphate (TCP).

Chemical purity (Rao et al., 1971) and the degree of powdering of TCP (Baker et al., 1976) both exert the strong influence on effectiveness of this salt.

The paper aimed at learning about reaction of 6- and 7-instar groups of T. castaneum cI and T. confusum bIV strains earlier discerned by Prus (1976) and Bijok (1984) to different concentrations of tricalcium phosphate in the food. Both survival and duration of development were examined at three concentrations of TCP.

MATERIAL AND METHODS

Experiments were carried out on two strains of Tribolium cI of T. castaneum and bIV of T. confusum both derived from Professor Thomas Park at his Laboratory of the University of Chicago. In each strain, 6- and 7-instar groups were discerned and cultured at 29 degree C and RH – 75% in dark incubator. The same climatic conditions were maintained at the present experiments. Standard mixture of wheat flour ad baker’s yeast in weight proportion 20:1 was used as culture medium. To this medium tricalcium phosphate was added in adequate proportions to form three concentrations: 0.5, 1.0 and 1.5% (by weight). The substance originated from USDA Laboratory, Savannah, Georgia. Culture medium was used as control.

There were two experiments; the first one depended on placing a hundred newly laid eggs into 50 g of medium. After hatching the egg the number of larvae was recorded every two day. Later on the pupation and eclosion moments were ascertained with simultaneous record of reduction in number of pupae and adults. Sex of individuals was determined in the pupal stage. The second experiment was the exact replica of the first, one with only difference that newly hatched larvae (hundred for each treatment) were used to start the experiment instead of eggs.

The whole set of each experiment involved the following design; two species x two instar groups x four TC concentration x 3 replications, which gives a total of 4 samples.

RESULTS

The effect of tricalcium phosphate on T. castaneum cI and T. confusum bIV strains, separately for 6- and 7-instar groups was presented in the form of survival curves for each concentration of the inhibitory salt. In T. castaneum, 6-instar group shows stronger reaction than 7-instar group (Fig. 1 and 2). The effect of TCP concentration is differentiated resulting in higher mortality with increasing concentration. The strongest effect was observed in 6-instar group, a concentration of 1.5%. where only a few individuals survived to the pupal stage and eclosed later. Considering the developmental time, a strong reduction is observed in the egg stage (25 – 40%) which reflects the combined effect of hatchability and mortality due to TCP.

Further reduction follows in the early larval stages, with the curve reaching a certain plateau in elder larvae. Next rather strong reduction is observed in pupal stage or eclosion time. The total reduction in 6-instar group, related to controls, amounts to 15% in 0.5%, 20% in 1.0% and over 40% in 1.5% concentrations. In 7-instar growth corresponding percentages are as follows; 25%, 40% and 45%.

The development is prolonged at medium with TCP by about days, except for concentration 1.0% in 6-instar group, when compared with the control (Fig. 1 and 2).

In T. confusum, 6-instar group shows also strong reaction to TCP than 7-instar group, though the effect is less differentiated here (Fig. 3 and 4). In 6-instar group attention is drawn to a very low hatchability of eggs (55% controls) as compared with that in 7-instar group (70%). From these stage on, the survival in controls of 6-instar group rather good (only 10% reduction) and mortality due to the same effect is about the same in the two first concentrations, and 25% in 1.5% concentration.

In 7-instar group of T. confusum bIV further reduction larval and pupal stages amounts 15% in control Concentrations; 0.5% and 1.0% bring about less than 1 reduction, and 1.5% - 10% reduction.

The development is prolonged at TCP concentrations in both instar groups by 4-6 days except for concentration 0.5% in which it is the same as in controls (Fig. 3 and 4).

In order to avoid the obscuring effect of differentiated egg hatchability on the results of TCP impact another experiment was performed with newly hatched larvae used at the starting point. In T. castaneum 6-instar group, the the reduction in post-larval stages amounts to about 15% in controls, 35% in concentration, 0.5% and over 90% in 1.0% concentration. A hundred per cent mortality was observed at 1.5% concentration at the beginning of the experiment (Fig. 5). In 7-instar group the survival of individuals was very high and similar as in controls and in 0.5%, whereas it was rather poor at 1.0% and very low at 1.5% concentration. The reduction occurred mostly in early larval stages except for 0.5% concentration in both instar groups, where there was either no reduction ( in 7-instar group) or small one (in 6-instar group).

Concerning the developmental time the similar pattern of delayed effect was observed as in the first experiment. In general, survival of individuals representing both instar groups in T. confusum is better than in T. castaneum, but the course of reduction shows a similar pattern (Fig. 6).

At a very low reduction in controls, the concentration of 1.0% and 1.5% caused reduction by about 50% in 6-instar group (0,5% concentration brings about slightly higher reduction than in control) and in 7-instar group the reduction is from 35% in 0.5% to 60% in 1.5% concentration.

Prolongation of development of individuals representing the two instar groups (Fig. 6) in T. confusum bIV is very clear and it amounts to 6 days to the moment of pupal appearance.

DISCUSSION

According to Hassan (1981), in screening tests the Polish TCP did not affect the development of Trogoderma granarium, while American one showed a strong inhibitory effect. Since the only difference between these two products originating from different sources was the size of particle the latter was considered to be the main reason of such difference. This author suggested that the main effect of TCP was through its action on cuticle and through alimentary tract. Small particles having larger surface injure the epicuticle more intensely than larger ones. Small particles get with food in larger amounts inside the alimentary canal of the insects. The high mortality of of larvae observed in the present experiments (Fig. 5 and 6) is a direct effect of such action.

The strong effect of TCP on larvae of T. castaneum was observed by Majumdar and Bano (1964) in the form of delayed growth and change in body coloration. At 2.0% concentration, TCP exerted strong toxic effect hindering the pupation process and killing adults in the moment of metamorphosis.

Bearing all this in mind the concentrations of TCP below 2% were chosen for the experiments in order to be able to trace any differentiated effect on survival and duration of development in both groups of two species of Tribolium.

The intrapolulation differentiation, originally expressed by different number of exuviae during development at the same climatic and food conditions and by the course of growth curve (Prus 1976, Bijok 1984, Prus and Prus 1987), is also perceivable in the way of response of these groups to different concentrations of TCP.

At much stronger effect of TCP on T. castaneum than on T. confusum, the examined concentrations of the toxine bring about more variable effect in 6-instar group than in

7-instar group. It can be inferred from 100% mortality only in 6-instar group at 1.5% concentration and lack of effect in 0.5% concentration in 7-instar group (Figs. 1, 2 and 5). In T. confusum, on the other hand, 6-instar group seems to be less vulnerable to harmful effect of TCP, especially at the lowest concentration (Figs. 3, 4 and 6).

Similar delay of development as in both species of Tribolium was observed by Kraszpulski (1984) in Khapra beetle Trogoderma granarium treated with 2.5% concentration of TCP. In this species delay of development amounted to 3 days.

Further studies will deal with the effect of TCP on such population features as; fecundity, hatchability of eggs reproductive effort, etc.

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Explanation to Figures

Fig. 1. Survival of T. castaneum cI 6-instar group at various concentrations of

TCP during its development (starting from egg stage).

Fig. 2. Survival of T. castaneum cI 7-instar group of various concentrations of

TCP during its development (starting from egg stage).

Fig. 3. Survival of T. confusum bIV 6-instar group at various concentrations of

TCP during its development (starting from egg stage).

Fig. 4. Survival of T. confusum bIV 7-instar group at various concentrations of

TCP during its development (starting from egg stage).

Fig. 5. Survival of T. castaneum cI 6- and 7-instar groups at various concentrations of TCP during its development. (starting with newly hatched larvae).

Fig. 6. Survival of T. confusum bIV. 6- and 7-instar groups at various concentrations of TCP during its development (starting with newly hatched larvae).

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\*Temperature Shock Induced Growth in Tribolium confusum Duval.(Toleoptera : Tenebrionidae).

The confused flour beetle, Tribolium confusum is a serious pest of stored grains and grain-products throughout the globe. Temperature has a great bearing on the physiology of an insect. The egg is, in some cases, the most vulnerable stage. Unfortunately it is the least studied in terms of its relative susceptibility. Insects, like other animals, require a thermal environment optimum for their survival and temperature is involved directly or indirectly in the natural control of abundance of insect species (Uvarov, 1931; Birch, 1948, 1957; Klomp, 1962; Huffaker and Messenger, 1964).

In recent years there has been a growing concern over the indiscriminate application of chemical insecticides on pests. The rate of infestation of an insect depends on the growth, formation and duration of developmental stages, among others. The present investigation aims at determining effects of temperature shock on the egg stage on the above mentioned parameters of T. confusum.

Adults of T. confusum were collected from a stock culture reared on wholemeal flour and maintained at the Department of Zoology, Rajshahi University. A large number of beetles were put on a thin film of wholemeal flour for egg collection. Eggs were collected by sieving and 24 hour old eggs were exposed to 30 (control), 35, 40 and 45 degree C in an oven for 24 hours. Treated eggs were then incubated in separate Petri dishes approximately at 30 degree C for hatching. Newly hatched larvae, 200 for each temperature, were then transferred to glass jars (25.4 x 11.4 cm), containing 150 gm of wholemeal flour each, with the aid of a camel hair brush. The jars were secured at the top with cloth tied with a rubber band.

Mature T. confusum larvae were weighed individually on an electric balance. The larval length was measured with a scale and their head-capsule width with a micrometer (40X). Mature larvae were put on Petri dishes and were carefully observed for pupation. The larval period was noted. Freshly formed pupae were similarly weighed and measured. They were segregated in Petri dishes and were observed for the emergence of adults. The pupal period was also recorded. Freshly emerged adults were similarly weighed and measured. The percentages of pupae and adults formed were also calculated. All the experiments were conducted in an incubator set approximately at 30 degree C.

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Temperature shock produced deleterious effects on the growth of all the stages of

T. confusum (Table 1). The sequence was : 30 35 40 degree C. Lengthened larval and pupal periods were observed in the treated insects. However, insects exposed to 40 degree C showed a significantly lengthened larval period (P 0.001) (Table 2). The production of adults was in the order : 30 35 40 degree C, but no significantly reduced adult production was observed. It was also observed that eggs exposed to

45 degree C did not hatch.

The rate of infestation largely depends on the vigour of the actively feeding stages. The detrimental effects of temperatures on the growth of T. confusum is very much important from an applied control point of view. The lengthened larval period determines a lower production of progeny over a particular period of time. Lower production of adults, though not statistically significant, observed in the present investigation is also suggestive of a lower rate of infestation.

The electric balance installed at the Department of Biochemistry, Rajshahi University, was used in the present works for which the authors remain thankful.

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\*Homosexual behavior in three melanic mutants of Tribolium castaneum

Observations made in this laboratory over a period of several years were reported in

A note by Rich (1972). These involved two strains of beetles which carried the melanic mutation jet. Both jet males and jet-pearl males then showed similar high frequencies of homosexual mountings. Since that time observations have been continued as laboratory exercises for students. One singular set was done under specially careful supervision and that set provides the basis of this report. A standard observation routine was used: ten test males and ten females of different , recognizable phenotype were placed together in an arena 10 cm in diameter. The background was new white paper and the lighting was as uniform as could be arranged in the laboratory. The bench top was synthetic stone and the temperature at the arena was between 22 and 23.5 degree C. In this series of observations all of the test animals were between one and four weeks post-ecdysis. They had been reared at low density at 28 degree C, sexed as pupae and held in four gram vials of standard laboratory medium (95% whole wheat flour and 5% dry brewers yeast) in single sex groups of ten until used in the experiments. None of the animals were used more than once. Each observation consisted of the count of mountings, heterosexual and homosexual during a ten minute period, with the clock starting with the first mounting. This delay was used because of the very real possibility that the disturbance of handling and introduction would not be uniform from one time to another and the beetles were being given an opportunity to calm down. For a mounting attempt to be counted the mounting animal had to be pointed in the right direction and the aedeagus had to be extended to contact the mounted animal, in every case the mounting beetle was a male, but even in heterosexual mounting attempts intromission was not necessarily accomplished. Duration of the mounting attempt might be as brief as less than 5 seconds or last as long as 90 seconds. In this series the duration was noted.

The melanic strains used in this work were derived from the Sokoloff laboratory and maintained at the University of Miami for several years. These were Tribolium castaneum standard (std), jet (j), dark sooty (ds), and Chicago black (cb). All combinations of standard and melanic males and females were replicated 8 to 10 times.

If mounting attempts by the males were random one would expect about 47% of the mountings to be homosexual and 53% to be heterosexual.

RESULTS

Male Female Tests Homosexual Heterosexual Total Mean#

# % mean # % mean

std j 9 38 38 4.2 63 63 7.0 101 11.2

std ds 10 64 50 6.4 64 50 6.4 128 12.8

std cb 8 69 58 8.6 50 42 6.2 119 14.9

j std 10 172 82 17.2 38 18 3.8 210 21.0

ds std 10 141 70 14.1 59 30 5.9 200 20.0

cb std 10 118 66 11.8 61 34 6.1 179 17.9

It is obvious that the proportion of homosexual mounting attempts is greater in all three of the melanic mutants. But perhaps equally striking is the higher rate of mounting attempts by the melanic males. In the 1972 note the tentative interpretation was put forth that either the jet has a sex behavior manifestation or that there is a closely associated gene responsible for the homosexual behavior. Now we must add the possibility that some factor related to melanism or the biosynthetic pathways involved may be related to this behavioral attribute.

The work of Sinnock (1970) suggested that mating behavior might well have a role in the fitness of a genotype. One might expect that if the homozygous melanic males “waste their time” in homosexual mounting efforts in a situation where sperm precedence affords advantage to the frequent copulating male (Schlager, 1960) then such melanic genes might have quite low fitness values. Here, however, the high frequency of homosexual mountings seems to be in addition to, not instead of, the important business of reproduction.

It may be that the most promising future research route could involve signals that seem to stimulate mounting behavior. Ryan and O’Callachian (1976) reported that male Tribolium respond more strongly to male produced than to female produced pheromones. Keville and Kannowski (1975) had earlier reported that several chemically related pheromones had similar effects on the male stimulating copulatory activity.

It is unlikely that this line of research will be actively pursued in this laboratory and the writer offers to share both data and experience with interested students.

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\*A cytogenetic examination of eight species of Tribolium.

A technique was developed to make permanent preparations of Tribolium chromosomes. After dissection testes are hypotonically treated with Simmons citrate, fixed in 3:1 methanol and glacial acetic acid, and are spread along the surface of

a slide that has been covered with fixative. Utilizing this technique eight species of Tribolium representing three species-groups were chromosomally examined and are consistant with the other tenebrionids that have been previously examined (Smith, 1952b; Moore and Sokoloff, 1982; and Juan and Petitpierre, 1988).

In the castaneum species-group T. castaneum and T. freeman have 2N = 20 chromosomes and a 9 + Xyp meioformula. T. audax and T. madens have

2N = 20 chromosomes and supernumeraries; four are seen in T. audax and ten in

T. madens. The meioformula of T. audax is 9 + Xyp + BII 1 + BI 1, and T. madens is

9 + Xyp + BII 3 + BI 2. In the confusum species-group, T. confusum, T.Destructor, and T. anaphe have 2N = 18 chromosomes. T. confusum has an 8 + neo-XY meioformula while T. destructor and T. anaphe have nine bivalents with no heteromorphic sex chromosomes identified.

T. brevicornis of the brevicornis species-group had 2N = 18 and nine bivalents during metaphase I. No heteromorphic sex bivalent was identified.

The average lengths of chromosomes numbers 1 through 9 is recorded in Table 2. Tukey’s analysis of the chromosome measurements revealed significant differences in their sizes intraspecifically and interspecifically.

Table 1. Chromosomally sampled species of Tribolium, Including chromosome number and meioformula

Cells counted Chromosome Meioformula

Species Mitoses Meioses number

T. castaneum 22 17 20 9 + Xyp

T. freeman 12 18 20 9 + Xyp

T. madens 14 16 30 9 + Xyp +

(BII 3 + BI 2)

T. audax 12 19 24 9 + Xyp +

(BII 1 +BI 1)

T. confusum 2 25 18 8 + neo-XY

T. anaphe 11 16 18 9, with no hetero-

Morphic sex chromo-

some identified.

T. destructor 3 18 18 9, with no heteromor-

phic sex chromosome

identified.

T. brevicornis 2 26 18 9, with no heteromor-

phic sex chromosome

identified.

Table 2. Average length\* of meiotic chromosomes numbers 1 though 9 For the eight species of Tribolium examined in this study.

Chromosome Number

Species 1 2 3 4 5 6 7 8 9

T. castaneum 3.5 3.0 3.0 3.0 3.0 2.5 2.5 2.5 2.0

T. freemani 3.17 3.0 2.33 2.0 1.83 1.83 1.67 1.5 1.67

T.madens 4.0 4.0 3.0 3.0 2.5 2.5 2.0 2.0 1.5

T. audax 4.0 3.5 3.5 3.0 2.5 2.5 2.5 2.0 2.0

T. confusum 4.5 4.0 4.0 3.0 3.0 3.0 2.5 2.5 2.0

T. anaphe 2.75 2.42 2.42 2.3 1.9 1.58 1.5 1.29 1.04

T. destructor 3.50 3.00 2.33 2.0 1.75 1.5 1.0 1.0 1.0

T. brevicornis 3.58 3.42 3.08 3.0 3.0 2,75 2.5 2.42 2.17

\*Measurements in microns

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\*Notes on the behavior of Tribolium freeman.

Tribolium freeman Hinton became available for research after its discovery in imported grain (corn) in Japan, and shortly after 1985 Dr. H. Nakakita, Stored-product Entomology laboratory, National Food Research Institute, Ministry of Agriculture, Forestry and Fisheries, Tsukuba, Ibaraki, Japan, and Dr. D.G.H. Halstead, Pest Infestation Laboratory, Slough, Bucks, England made samples available for research to the writer. With these stocks it has been possible to observe the behavior of T. freeman in respect to some behavioral characteristics.

1. Effect of density on development.

Nakakita (1983) has described some of the demographic characteristics of Tribolium

Freeman. At 30 degree C., under uncrowded conditions (5 larvae or less in 2 g of flour), these beetles can complete their development (egg-adult) on an average of 38.3 days (Nakakita, 1983). However, under crowded conditions (more than 10 larvae in the same amount of medium) pupation is greatly delayed. “A very few larvae had pupated sporadically when densities higher than 20 larvae by the 180th day when the observation was ended. However, all larvae that had failed to pupate by the 30th or 60th day due to the crowding effect shortly pupated when the larvae were isolated to reduce the density to either two larvae on 2 g diet in a vial or one larva in an empty vial.”

We have observed the same phenomenon. If we allow 50-100 pairs of beetles to remain in 100 g of wheat flour (no additives) for a week, larvae become large larvae and will remain in the last larvae instar for a very long time, as if they were afraid to succumb to cannibalism by other larvae. But, if one reduces the density, they pupate in a few days and become adults.

Nakakita states in his informative paper that this phenomenon is unique for Tribolium freeman because “no such distinct crowding effect has been observed in T.castaneum or other insects in the genus Tribolium.” This statement should be modified to read “this phenomenon has also been observed in Tribolium destructor.” The Tribolium Stock Center maintains this species which apparently prefers a temperature of about

24 degree C. At temperatures of 29 degree C or higher stocks of this species do not do well and eventually die out. At room temperature they will do very well, but in crowded cultures the larvae will remain as larvae for an exceedingly long time, and larvae skins accumulate on the surface of the medium.

1. Flying ability.

Imura (1987) reported his observations regarding the degree at which this species will attempt flight under experimental conditions. He concluded that both males and females of this species can fly, but their inclination for flying is not strong, both under conditions of dark and light. (The probability of flight per individual per day was .

0155 + .0167 for females and .0036 + 0.0089 for males.) The writer’s observations have been confined to those instances when the beetles are removed (at normal temperatures) from the flour and the adults transferred from the sieve to a plate. As soon as the beetles are transferred to the porcelain soup dish a few extend their membranous wings and a few have been seen flying the 15-18 centimeters of the plate to land on the other side of the plate. Both Imura’s and these observations should alert investigators utilizing T. freeman in their studies to be extra cautious, least they become serious pests in countries where T. freeman does not exist.

1. Elf-poisoning”

Sokoloff (1977) has summarized observations on the effect of quinines on the various stages of Tribolium. This self-poisoning phenomenon has been reported up to now in T. castaneum, T. destructor and T. confusum. It occurs when the beetles are removed from the flour and placed in any kind of glass container which is not broad and shallow like a ;etri dish, but it has walls about 2-3 cms high or higher. If one of the beetles becomes irritated, it may release quinines, and the other beetles may release quinines from their stink gland reservoirs in self-defence. As a result, the quinines in the container increase and since they are highly volatile, they become gaseous, and since they are heavier than air they displace the air around the beetles. The net result is that some or all of the beetles of all stages in the container will be found dead or dying. My previous observations indicated that T. confusum is more likely to undergo this self-poisoning than T. castaneum. Judging from Palm’s (1946) observations T. destructor is also likely to commit suicide. T. freeman now can be added to this list. Both sexes are likely to release their quinines and poison themselves by poisoning their surrounding atmosphere with quinines. There is a preventive measure, and that is to keep the beetles in their flour medium until they are ready to be examined (since they will apparently not suddenly release quinines when they are hiding in the flour and commit suicide) or by sifting only a few vials at a time.

1. Death feigning.

If beetles are touched they “freeze” or play “possum,” or play death. After a variable interval of time they may move their antennae or twitch their legs and eventually resume walking. Tenebrionid flour beetles are no exception to this adaptive behavior. But of all the species of Tribolium so far observed, T. freeman is more likely to feign death when touched and it will remain in that posture, with antennae close to the head and the legs closely applied to the ventral surface of the thorax or abdomen, for about a minute or longer, a relatively long time. Under the microscope it is, of course, possible to determine which beetles are alive (feigning death) and which are dead. But with the unaided eye it is very difficult to distinguish live from dead beetles. This may be due to the short time T. freemani has been under domestication in the laboratory.

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\*THE ESTIMATIONS FOR GENETIC PARAMETERS OF 30-DAY OLD ADULT WEIGHT IN TRIBOLIUM CASTANEUM

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Tribolium castaneum Herbst is an excellent laboratory organism. It serves as an important interface between the theorists and the animal breeders.

The means of 21 day old pupal weight and 30-day old adult weight in Tribolium castaneum were 2162.4 + 10.75, 1799.3 + 8.21 g and 2369.8 + 10.37,

1956.9 + 8.45 g for males and females respectively. The average body weight of the two traits of females were 207.4 g and 157.6 g heavier than that of males.

The heritabilities of 21-day old pupal weight and 30-day old adult weight were 0.2134 and 0.2874 for males resp. 0,4036 and 0.3858 for females resp. The genetic correlations of the two traits were 0.7322 and 0.8433 for males and females resp. Heritabilities and genetic correlations of the two traits were estimated using variance components. These traits can be used for selection experiments.

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THE EFFECT OF DIFFERENT AIR TEMPERATURES AND HUMIDITIES ON THE DURATION OF THE DEVELOPMENT OF COMMON BEAN WEEVIL ACANTHOSCELIDES OBTECTUS SAY

INTRODUCTION

The common bean weevil Acanthoscelides obtectus, Say (Coleoptera. Bruchidae), originating from hot climatic regions, is widespread all over the world as a dangerous pest of common bean. It has been found in Poland since 1934, initially in Lowere Silesia (Filipek 1962, Niezgodzinski 1963). At present it occurs throughout the whole of Poland and is on the quarantine list. This insect is a dangerous pest in storehouses and in fields.

A obtectus damages bean seeds by contaminating them with excreta, exuviae etc., causing elevation of air temperature and humidity, inducing bacterial infections and lowering the germination power. All this greatly deteriorates the commercial value of bean seeds (Boczek. Stepien 1976).

The aim of the present studies was to determine the effect of certain environmental changes, e.g. different air temperatures, air humidities and population densities, on the duration of the development of common bean weevil.

MATERIAL AND METHODS

The material comprised common bean weevil Acanthoscelides obtectus, Say, wild strain originating from a suburb of Warsaw. White bean (Phaseolum vulgaris L.) in laboratory experiments were used. Starting cultures were kept in 1-L jars covered with a fine plastic gauze. Jars were maintained at ca. 18 degree C and at a mean air humidity of ca. 70%.

Individual experiments were performed in thermostats, using 5 temperature levels and   
4 humidity levels. Individuals of the same age, which have just emerged from bean seeds were used in the experiments. Prior to each experiment, bean seeds were humidified for 1 week in a jar at air humidity of ca. 75%. It was aimed to soft bean, seed epidermis and to facilitate penetration of the hatched larvae into seeds for further development.

In individual experiments, 30 bean seeds (ca. 10 g) were placed into 50-mL culture vessels together with 10 adult weevils (lower population density) or 40 adult weevils (higher population density). These culture vessels were covered with fine plastic gauze and then placed into 1-L jars containing also small salt containers. Salt solutions in the containers were used to maintain constant air humidity (MgCl 3 – 33%, Mg (NO 3) 2 – 55%, NaC1 – 76%, KC1 – 85%. Air humidity, respectively) (Hempel-Zawitkowska, Klekowski 1968).

The jars were tightly closed and placed in culture thermostats at 22, 24, 26, 28 and 30 degree C. respectively. Each experimental variant was performed in 6 replications. After 21 days all adult individuals were discarded. Then culture vessels were inspected daily until the end of the experiment (i.e. until no more adult beetles emerged from bean seeds), for counting and discarding the second – generation adults. Thus the duration of the d3evelopment in each experimental variant was obtained.

RESULTS

Table 1 presents the duration of the development of common bean weevil at 22, 24, 26, 28 and 30 degree C, respectively, at air humidities of 33, 55, 76 and 85% respectively, under conditions of low population density. In the present experiments the duration of the development of A.obtectus was shortest at 28 degree C. In general, the duration of the development is the shorter, the higher the temperature. Air humidity exerted an only very slight effect on the duration of the development.

Table 2 presents the duration of the development of A. obtectus at the same air temperatures and humidities as in Table 1 but under conditions of high population density. Similarly as in Table 1, the duration of the development of A. obtectus was shorter, with the rise of temperature (the shortest duration of the development was shorter at 30 degree C). Also in this case air humidity only very slightly influenced the duration of the development. Under conditions of high population density, as compared with low population density, the duration of the development was prolonged.

DISCUSSION

So far, studies of biology and ecology of common bean weevil have mainly concerned the effect of food and population density of its development. (Sandner 1961, 1962, Sandner, Cichy 1962, Howe, Currie 1964, Umeya, Kato 1970, Sandner, Pankanin, 1973). On account of the large losses of bean seeds in storehouses it is of importance to determine the response of this pest to some environmental conditions.

Various parts of storehouses differ in air temperature ad humidity. In the external layer of bean seeds, as compared with the internal layers, the temperature is much lowere. Newly hatched larvae are very sensitive to low temperatures. Their mortality being 100% at 10 degree C. According to Zachariae (1960), young larvae survive only at temperatures higher than 12 degree C; older larvae and pupae survive even at 19 degree C. Filipek (1962) has studied the development of larvae and pupae of A.obtectus at 15, 18, 22 and 25 degree C, respectively, and at several air humidities Author found that – at all air humidities – the duration of the development was prolonged at lower temperatures, particularly below 20 degree C. Likewise, Romankow (1958) has found a substantial difference between the duration of the development at 17 degree C and at 25 degree C. In general the duration of the development is shortest at 27 – the 31 degree C and at air humidity of 80 – 90% (Zachariae 1960).

The present findings consist with the above literature data. Additionally we found that higher population density prolongs the duration of the development.

CONCLUSIONS

1. The duration of the development of common bean weevil Acanthoscelides obtectus Say is shorter at higher temperatures. The development is optimal at 28 – 30 degree C.
2. Relative air humidity (between 33 -85%\_ exerts an only very slight effect on the duration of the developmet.
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THE EFFECT OF DIFFERENT AIR TEMPERATURES AND HUMIDITIES ON THE  
DURATION OF THE DEVELOPMENT OF COMMON BEAN WEEVIL ACANTHOSCELIDES OBTECTUS SAY

INTRODUCTION

The common bean weevil Acanthoscelides obtectus Say (Coleoptera. Bruchidae). Originating from hot climatic regions, is widespread all over the world as a dangerous pest of common bean. It has been ound in Poland since 1934, initially in Lower Silesia (Filipek 1962, Niezgodzinski 1963). At present it occurs throughout the whole of Poland and is on the quarantine list. This insect is a dangerous pest in storehouses ad in fields.

A obtectus damages bean seeds by contaminating them with excreta, exuviae etc., causing elevation of air temperature and humidity. Inducing bacterial infections and lowering the germination power. All this greatly deteriorates the commercial value of bean seeds (Boczek, Stepien 1976).

The aim of the present studies was to determine the effect of certain environmental changes, e.g. different air temperatures, air humidities ad population densities, on the duration of the development of common bean weevil.

MATERIAL AND METHOD

The material comprised common bean weevil Acanthoscelides obtectus Say, wild strain originating from a suburb of Warsaw. White bean (Phaseolum vulgaris L.) in laboratory experiments were used. Starting cultures were kept in 1-L jars covered with a fine plastic gauze. Jars were maintained at ca. 18 degree C and at a mean air humidity of ca. 70%.

Individual experiments were performed in thermostats, using 5 temperature levels and   
4 humidity levels. Individuals of the same age, which have just emerged from bean seeds were used in the experiments. Prior to each experiment, bean seeds were humidified for 1 week in a jar at air humidity of ca. 75%. It was aimed to soft bean, seed epidermis and to facilitate penetration of the hatched larvae into seeds for further development.

In individual experiments, 30 bean seeds (ca. 10 g) were placed into 50-mL culture vessels together with 10 adult weevils (lower population density) or 40 adult weevils (higher population density). These culture vessels were covered with fine plastic gauze and then placed into 1-L jars containing also small salt containers. Salt solutions in the containers were used to maintain constant air humidity (MgC1 2 – 33%. Mg (NO 3) 2 -55% NaC1 – 76%. KC1 -85%. Air humidity, respectively) (Hempel-Zawitkowska, Klekowski 1968).

Then jars were tightly closed and placed in culture thermostats at 22, 24, 26, 28 and   
30 degree C, respectively. Each experimental variant was performed in 6 replications. After 21 days all adult individuals were discarded. Then culture vessels were inspected daily until the end of the experiment (i.e. until no more adult beetles emerged from bean seeds), for counting and discarding the second – generation adults. Thus the duration of the development in each experimental variant was obtained.

RESULTS

Table 1 presents the duration of the development of common bean weevil at 22, 24, 26, 28 and 30 degree C. respectively, under conditions of low population density. In the present experiments the duration of the development of A. obtectus was shortest at   
28 degree C. In general, the duration of the development is the shorter, the higher the temperature. Air humidity exerted an only very slight effect on the duration of the development.

Table 2 presents the duration of the development of A.obtectus at the same air temperatures and humidities as in Table 1 but under conditions of high population density. Similarly as in Table 1, the duration of the development of A.obtectus was shorter, with the rise of temperature (the shortest duration of the development was shorter at 30 degree C). Also in this case air humidity only very slightly influenced the duration of the development. Under conditions of high population density, as compared with low population density, the duration of the development was prolonged.

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