

EKOLOGIA POLSKA (Ekol. pol.)	34	1	87-93	1986
---	-----------	----------	--------------	-------------

Paweł BIJOK

Department of Ecological Bioenergetics, Institute of Ecology, Polish Academy of Sciences,
Dziekanów Leśny (near Warsaw), 05-092 Łomianki, Poland

ON HETEROGENEITY IN bIV STRAIN OF *TRIBOLIUM CONFUSUM* DUVAL.*

ABSTRACT: A heterogeneous character of bIV strain of *Tribolium confusum* was found by determining changes in body weight and duration of developmental stages in individual cultures. The population consisted of 6-larval instar and 7-larval instar groups. The 6-instar group had shorter development and reached lower maximum weight than the 7-instar group. Six-instar females developed faster than 6-instar males.

KEY WORDS: *Tribolium confusum*, dynamics of growth, time of development, interpopulation heterogeneity, life strategies.

1. INTRODUCTION

Heterogeneity in respect to weight of individuals and rate of development was observed in insects — store product pests. H o w e (1961) has pointed out that usually certain, not large fraction of population developed more slowly than the rest, and reached maturity later but attained larger weight. This phenomenon can be observed at the moment of appearance and weight of pupae in synchronized cultures. Similar phenomenon was reported by P r u s (1976) in research on cI strain of *Tribolium castaneum* Hbst. (selected with some other genetic strains and tested in respect of primary characteristics in University of Chicago — P a r k et al. 1961). He noticed that there was a fraction of population with faster growth and which has one larval instar less than the rest of individuals. It could be found by observing appearance of exuviae in individual cultures. Analogous phenomenon was observed in bIV strain of *T. confusum* coming from the same group of strains from University of Chicago. Strain bIV was the least productive of the genetic strains of *T. confusum* and the strain cI of *T.*

* This study was financially supported under project MR II/15.

castaneum investigated by Prus (1976) has the highest productivity of strains of *T. castaneum* (productivity was defined by authors as ability of population to build up and sustain a given level of abundance).

The aim of this paper is to describe the heterogeneity in bIV strain of *T. confusum*.

2. MATERIAL AND METHODS

The object of investigation was bIV strain of *Tribolium confusum* brought from University of Chicago in 1963 and cultured under laboratory conditions. The studies were carried out in 1983.

Separate cultures of 50 individuals were run starting from newly hatched larvae (0 – 2 hours after hatching) till maturity. Each larva was placed into a separate vial with 1 g of culture medium (95% wheat flour, 5% powdered baker yeast by weight). These synchronized cultures were run in dark incubator at +29°C and 70% relative humidity. Every 2 days each vial content was sifted through fine mesh, developing larvae being separated, weighed with Cahn electrobalance model G and replaced into fresh medium. Besides the exuviae were looked for and their presence (or absence) recorded.

After emerging of pupae their sex was determined, and later on, emerging adults were mated in separate pairs, placed into 8 g of standard medium and their weight was measured in three-day intervals until 100th day of life.

3. RESULTS

The group of 48 surviving individuals consisted of 7 males and 14 females having 6 larval instars in their development and 17 males and 10 females having 7 larval instars (Table 1).

Table 1. Proportions between the 6- and 7-instar groups and sexes in population of bIV strain of *T. confusum*

Sex	6-instar	7-instar	Sum
Males	7 (29.2%)	17 (70.8%)	24 (100%)
Females	14 (58.3%)	10 (41.7%)	24 (100%)
Sum	21 (43.8%)	27 (56.2%)	48 (100%)

For comparison of groups the following criteria were used: maximum body weight, time of reaching maximum weight, body weight on 73rd day of postembryonal life, time of development. Statistical comparisons were made using Student *t*-test.

Maximum body weight of 7-instar individuals was higher than that of 6-instar individuals within both sexes (Table 2). Maximum body weight of males was lower than that of females (within both instar groups).

Table 2. Comparison of maximum weight (μg) within sexes and the instar groups in bIV strain of *T. confusum* (mean values \pm standard deviations)

Sex	6-instar	t-test	7-instar
Males	2667.3 \pm 167.1 n = 7	t = 6.29 p < 0.001	3259.8 \pm 288.5 n = 17
t-test	t = 5.67 p < 0.001		t = 2.34 p < 0.05
Females	3099.2 \pm 159.0 n = 14	t = 6.47 p < 0.001	3438.8 \pm 97.5 n = 10

Six-instar individuals reached maximum weight sooner than 7-instar individuals (Table 3). There were no significant differences in time of reaching maximum weight between males and females within instar groups.

Table 3. Comparison of time of reaching maximum weight (days) within sexes and the instar groups in bIV strain of *T. confusum* (mean values \pm standard deviations)

Sex	6-instar	t-test	7-instar
Males	16.28 \pm 0.76 n = 7	t = 12.95 p < 0.001	20.00 \pm 0.00 n = 17
t-test	t = 0.97 no differ.		t = 1.50 no differ.
Females	16.00 \pm 0.00 n = 14	t = 13.55 p < 0.001	19.60 \pm 0.00 n = 10

Body weight of 7-instar individuals on 73rd day of life was higher than that of 6-instar individuals (within both sexes). Body weight of females was higher than that of males within both instar groups (Table 4).

Table 4. Comparison of weight on 73rd day of life (μg) within sexes and the instar groups in bIV strain of *T. confusum* (mean values \pm standard deviations)

Sex	6-instar	t-test	7-instar
Males	2005.71 \pm 111.48 n = 7	t = 7.71 p < 0.001	2418.00 \pm 127.57 n = 17
t-test	t = 11.25 p < 0.001		t = 7.85 p < 0.001
Females	2582.50 \pm 101.28 n = 14	t = 4.96 p < 0.001	2835.00 \pm 131.76 n = 10

There are no significant differences in body weight of newly hatched larvae between the instar groups and sexes.

Summing up, growth curves for males and females of both the instar groups showed clear differences (Fig. 1). The 6-instar group individuals grew faster and during first 16 days their weight was higher than that of the 7-instar group. The weight increment was, however, stopped about 4 days earlier and the achieved maximum weights were lower than in the 7-instar group. This difference was maintained for the remaining life span of insects. In two instar groups the body weight of females was higher than that of males.

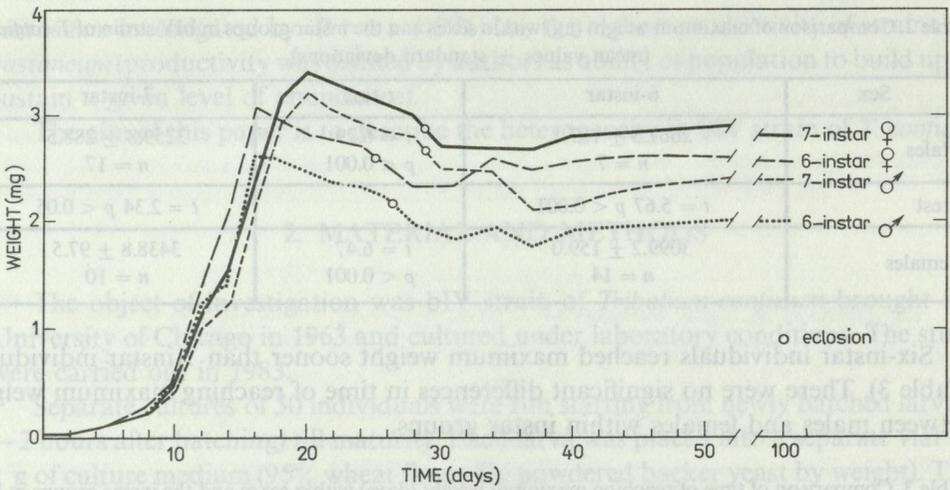


Fig. 1. The growth curves of the 6- and 7-larval instar groups of bIV strain of *T. confusum*

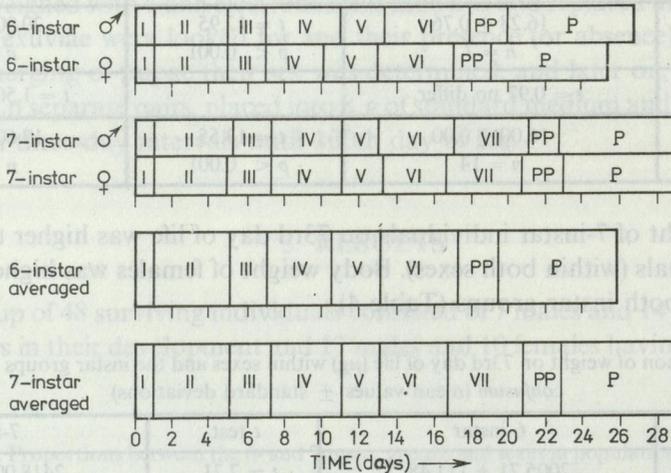


Fig. 2. Duration of successive developmental stages in the 6- and 7-larval instar groups of bIV strain of *T. confusum*
pp - prepupae, P - pupae

Six-instar females, about 6 days after eclosion, showed a short period of growth after which their body weight became closer to that of 7-instar females.

Clear differences in duration of subsequent developmental stages (Fig. 2) as well as of the whole development since hatching until eclosion (Table 5) were observed. Six-instar individuals had their development shorter than 7-instar individuals, the 6-instar group showed higher differences between sexes in duration of the subsequent developmental stages than the 7-instar group (Fig. 2). Development of females in this group was more than one day shorter than that of males. Such differences within the 7-instar group were not observed.

Table 5. Comparison of time of development (days) within sexes and the instar groups in bIV strain of *T. confusum* (mean values \pm standard deviations)

Sex	6-instar	t-test	7-instar
Males	26.71 \pm 0.76 n = 7	t = 7.97 p < 0.001	29.00 \pm 0.00 n = 17
t-test	t = 4.00 p < 0.001		t = 0.00 no differ.
Females	25.31 \pm 6.75 n = 14	t = 18.40 p < 0.001	29.00 \pm 0.00 n = 10
Averaged	25.80 \pm 1.00 n = 21	t = 14.66 p < 0.001	29.00 \pm 0.00 n = 27

4. DISCUSSION

Average time of development of bIV strain of *T. confusum* — with time of embryonal development (5.60 days) added — equals 33.21 days. It is only about one day different from that reported by Park et al. (1961): 32.24 days. The natural variability accounts for this. It suggests that during handling the cultures environmental conditions as temperature, humidity, etc., were close enough to those designed for the experiment not to change significantly time of development.

Park et al. (1961) investigating time of development of eight strains of *Tribolium* ascertained that there is not any satisfactory evidence to suggest that sex is significantly related to duration of the postembryonal period. Time of development of males was significantly ($p < 0.05$) shorter than that of females only in two strains, but the authors considered it as curiosities. Results of the present work suggest that such relation occurs but only within the 6-instar group: time of development of females was shorter than that of males. This difference is clear and significant ($p < 0.001$). From results of the paper by Rus (1976) it appears that in cI *T. castaneum* the 7-instar group has time of development related with sex, but on the contrary to bIV *T. confusum*, the females develop longer than males ($p < 0.05$). There is also a difference (although not tested statistically) in proportion of 6- and 7-instar individuals within females: in *T. castaneum* there were more 6-instar females.

These observations allow to suppose that basis of this heterogeneity is reproductive strategies different in these two species (strains). It may be thought that a specific strategy for bIV strain of *T. confusum* is to shorten the period of reaching maturity. This strain during its evolution produced a group of individuals with larval development by one instar shorter (6 instars) than others. This shortening is at the expense of the body weight (which may have repercussion on fecundity). It hastens, however, the process of coming new individuals to reproductive activity. The fact that females dominated in the 6-instar group, and within this group females had shorter development time than males, exerts also an influence on acceleration of reproduction in population (as females have greater influence on dynamics of reproduction than males).

It is interesting to note that 6-instar females after eclosion have a short period of gaining weight — as if a period of additional growth — so they partly made up their deficiency of biomass (Fig. 1).

In cI strain of *T. castaneum* (P r u s 1976) the 7-instar group is more numerous than the 6-instar group and shows differences in time of development between males and females: females developed more slowly, and reached higher weights than males. It permits to suggest that in cI *T. castaneum* a specific strategy is to reach high body weight even at the expense of time of development.

We might venture an opinion that, for some reason, in bIV strain of *T. confusum* a shortening period of reaching maturity is preferred what leads to formation of a group of individuals with fastened development.

5. SUMMARY

In bIV strain of *Tribolium confusum*, similarly as it was observed in several populations of insects — store product pests, a heterogeneity was observed. It is manifested by existence of two groups — differing in respect of time of development, number of larval stages, and maximum body weight. Analogous phenomenon was observed in cI strain of *T. castaneum* by P r u s (1976).

Heterogeneity was investigated in separate cultures of 50 individuals. It was ascertained that the population consisted of two groups: 6- and 7-instar group (having 6 and 7 larval stages, respectively). The 6-instar group individuals grew faster, but their growth was earlier terminated, maximum body weight was lower than that of 7-instar group (Fig. 1). Time of development of 6-instar individuals was shorter than that of 7-instar individuals (Table 5). The 6-instar group showed, however, greater differences between sexes in duration of subsequent developmental stages and in time of all development (Fig. 2). The development of females, within this group, was more than one day shorter than that of males (Table 5).

The supposed cause of this heterogeneity can be specific life strategy. Generation of the group with shortened developmental cycle (the 6-instar group) allows the young individuals to enter earlier the reproductive phase.

6. POLISH SUMMARY

W obrębie szczepu bIV *Tribolium confusum*, jak to obserwowano w niektórych populacjach owadów — szkodników magazynowych — występuje niejednorodność wyrażająca się istnieniem 2 grup różniących się czasem rozwoju, liczbą stadiów larwalnych i maksymalnym ciężarem ciała. Analogiczne zjawisko zaobserwował P r u s (1976) w szczepie cI *T. castaneum*.

Niejednorodność badano prowadząc indywidualne hodowle 50 osobników. Stwierdzono, że populacja składa się z 2 grup: 6- i 7-stadialnej (6 i 7 stadiów larwalnych). Osobniki z grupy 6-stadialnej charakteryzowały się szybszym wzrostem, lecz wzrost ten był zakończony wcześniej, a maksymalny ciężar ciała był niższy niż w przypadku grupy 7-stadialnej (rys. 1). Czas rozwoju osobników z grupy 6-stadialnej był krótszy niż z grupy 7-stadialnej (tab. 5). Grupa 6-stadialna wykazywała większe zróżnicowanie pomiędzy płciami w czasie trwania poszczególnych stadiów rozwojowych i całego rozwoju (rys. 2). Rozwój samic w tej grupie był ponad jeden dzień krótszy niż samców (tab. 5).

Przypuszczalnie powodem niejednorodności może być specyficzna strategia życiowa. Wytworzenie grupy o skróconym cyklu rozwojowym pozwala na wcześniejsze przystąpienie młodych osobników do rozrodu.

1. Howe R.W. 1961 – Developmental time and weight in *Tribolium castaneum* – *Tribolium Infor. Bull.* 4: 21–22.
2. Park T., Mertz D.B., Petrusiewicz K. 1961 – Genetic strains of *Tribolium*: Their primary characteristics – *Physiol. Zool.* 34: 62–80.
3. Prus T. 1976 – On heterogeneity in cI strain of *Tribolium castaneum* Hbst. – *Tribolium Infor. Bull.* 19: 97–104.

Carlos GRANADO-LORENCIO, Francisco GARCÍA-NOYO

Department of Ecology, Faculty of Biology, University of Sevilla,
Apdo. 1095, 41080 Sevilla, Spain

FEEDING HABITS OF THE FISH COMMUNITY IN A EUTROPHIC RESERVOIR IN SPAIN

ABSTRACT: The feeding habits of the fish community were studied in Arrocampo reservoir (Jaén 1976). Using food samples of 363 individuals of eight species were used and the food mass was estimated by a new food index. Food habits of fish species show the expected combination of benthic and planktonic resources to cyprinid diet and the distinct quantitative habits of herbivore *R.* and largemouth bass. The trophic segregation between cyprinid and *R.* was observed.

KEY WORDS: Fish community, feeding strategies, diet overlap, eutrophic reservoir, Spain.

1. INTRODUCTION

The feeding habits of fish species are related to their digestive tract and pharyngeal teeth (Weatherley 1972, Loren 1980), life history (Lagler et al. 1977), availability of food resources (Neveau 1979, Bartell 1982) and competition (Werner and Hall 1977, Pasach and White 1981). These factors distinguish feeding between juveniles and adults (Hamilton and Powles 1979) causing spatial segregation (McCandless 1975) and diet seasonal fluctuations (Neveau 1981, Colton and Alevison 1983).

In the literature of feeding habits of freshwater fish (Mann 1973, Marais 1980, Wallace and Ramsey 1983) there is a scarcity of data on species from the Iberian Peninsula, apart from Margalef (1948), and more recently Hernando and Pareja (1974), Hernando (1978) and Granado-Lorencio and Garcia-Novo (1981). This paper presents the analysis of feeding habits of eight fish species with a wide distribution over the Iberian Peninsula. The study was carried out during two years in a eutrophic reservoir with a fish community that was representative of a large section of Spanish freshwaters.