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Cytogenetic Analysis of Populations of *Chorthippus albomarginatus* (DE GEER) (Acrididae: Orthoptera)

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Three populations (two from Russia and one from Poland) of the grasshopper *Chorthippus albomarginatus* were analysed by means of C-band and chiasma frequencies. Differences between populations were found and are discussed.

Key-words: *Chorthippus albomarginatus*, polymorphism, C-bands, chiasma frequency.

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Recently, the intraspecific karyological variability of Orthoptera has been intensively studied to explain the character and causes of the microevolutionary processes (CAMACHO *et al.* 1980; FLETCHER & HEWITT 1980; GARSIAL-LAFUENTE *et al.* 1983; LOPEZ-FERNANDEZ *et al.* 1986).

The widely distributed species occurring in different habitats, including populations affected by anthropopressure, are especially interesting. One such species is Palearctic *Chorthippus albomargginatus*, which inhabits various biotopes though its most preferred habitat is the forest-steppe zone.

In the present paper 3 distant populations from a continuous range of *Ch. albomarginatus* were studied and compared by means of C-bands variation and chiasma frequency.

Material and Methods

The material studied comprised: (1) a synantropic population from the city of Novosibirsk (1987), (2) a natural population from the southern part of the High Altai in Kosh-Agach (1989), and (3) a population from a cultivated meadow at Ojców (the National Park near Cracow) (1988).

Adult males and females were analysed cytologically. The individuals were injected with 0.1% colchicine, the female caeca and male testes were fixed in 3:1 ethanol:acetic acid, and squashed. Coverslips were removed by the dry-ice procedure and airdried.

The C-banding examination was carried out according to JONES *et al.* (1975) with a slight modification.

Chiasma frequencies were scored from 25 cells at late diplotene or early diakinesis from each individual (the number of analysed individuals of each population is given in Table 1).

Results

Chorthippus albomarginatus has 17 chromosomes in the male (16+XO) and in the female 18

Table 1

Variation of C-heterochromatin in three populations of *Chorthippus albomarginatus* (N – number of individuals; figures indicate number of chromosome pairs)

Population	N	Variation of extra C-heterochromatin	
		distal	interstitial
Ojców	23	1,2,3,4,5,6,7,8	1,2
Novosibirsk	24	4,5,6,7	3
Kosh-Agach	22	3,4,5,6,7,8	1,2,3,4,7

(16+XX). Three pairs of autosomes (L_1, L_2, and L_3) are long and submetacentric, whereas the remaining five pairs and the X are of medium to small size and acrocentric (Fig. 1).

C-heterochromatin can be classified according to its location within the chromosomes as paracentromeric, distal, and interstitial bands.

All members of the complement showed paracentromeric C-bands. In the population from Novosibirsk and Kosh-Agach the amount of heterochromatin occurring as the paracentromeric C-bands in the submetacentric chromosomes was very small and located exclusively near their centromeres. Acrocentric chromosomes showed somewhat more C-heterochromatin, especially the sixth pair, its amount being classified as small and medium. In both the mentioned populations the paracentromeric C-bands were invariable (Figs. 2 & 3). However, in the Ojców sample paracentromeric C-bands were slightly larger then in the Asiatic populations: three submetacentric pairs showed small-size C-bands while the remaining autosomes and the X had medium and large size ones (Figs. 4 & 5). In the 7th and 8th pairs a variability of size from small to large C-bands was observed (Fig. 6).

In the Asiatic populations (Novosibirsk, Kosh-Agach) the distal C-bands were of small size. The variability of distal C-bands in the Kosh-Agach population occurred in all acrocentric chromosomes (excluding the X) and in one submetacentric chromosome. However, in the Novosibirsk population this polymorphism was visible only in 4 pairs of autosomes (Table 1). In the Ojców population the distal C-band variation was observed in all autosomes. The submetacentric L_2 chromosome showed the greatest variation, this being connected with the different size and combination of C-bands especially in the meiotic chromosomes (Fig. 7).

Interstitial C-bands were scarce. They occurred in submetacentric chromosomes in all populations and in two autosomes of the Kosh-Agach population (Table 1, Figs. 2 & 3).In three submetacentric autosomes of the mentioned population there sometimes occuurred heterochromatic insertions close to the small centromeric blocks; they were usually located near the paracentromeric region. In chromosomes L_1 and L_2 from the Ojców population the interstitial C-band occurred as a separate

Fig. 1. Karyotype of male (similar in 3 populations); bar equals 10 µm.

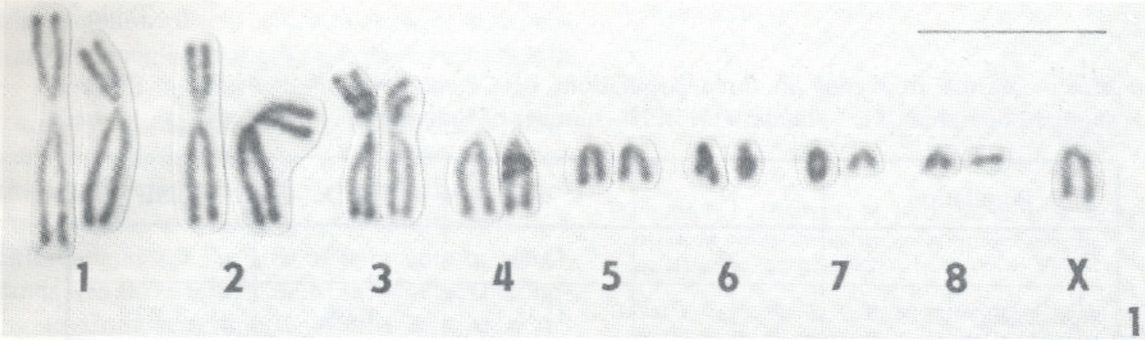
Figs. 2, 3 & 4. Examples of C-heterochromatin distribution in the populations from Novosibirsk, Kosh-Agach and Ojców. Diplotene (2 & 3) and metaphase I (←) indicates polymorphism of interstitial C-bands; (⇐) indicates polymorphism of distal C-bands.

Fig. 5. Mitotic metaphase. Paracentromeric C-bands in the population from Ojców; (●) indicates polymorphism in distal C-bands; (▲) interstitial C-bands.

Fig. 6. Polymorphism of paracentromeric C-bands in bivalents 7 & 8.

Fig. 7. Polymorphism of distal C-band in L_2 (anaphase I).

Figs. 2-7; bar equals 10 µm.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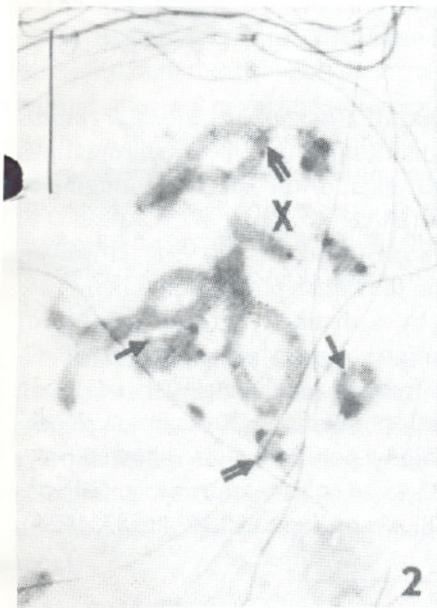
1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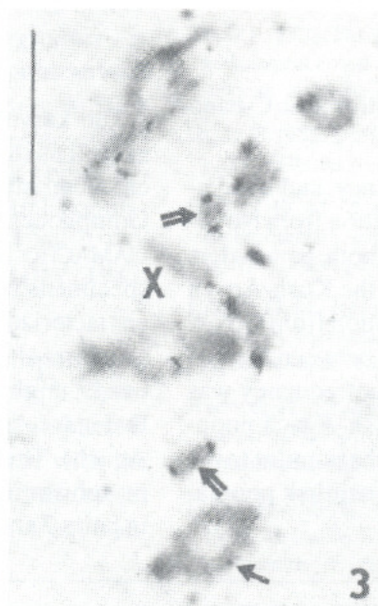
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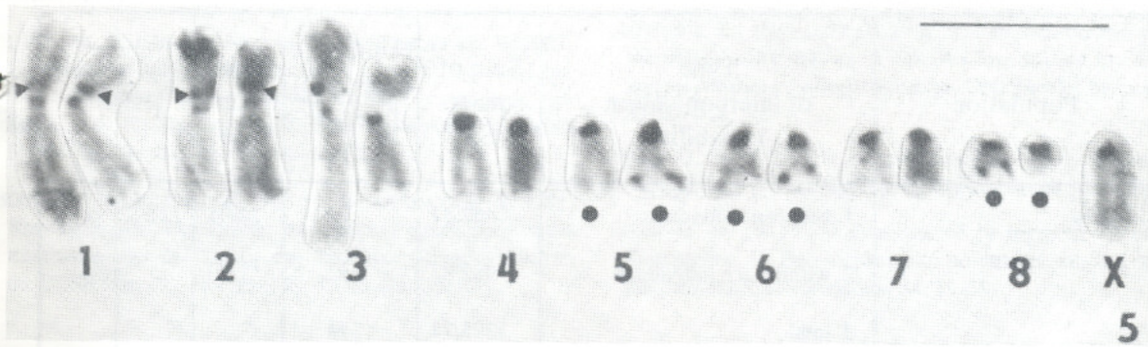
1 2 3 4 5 6 7 8 X
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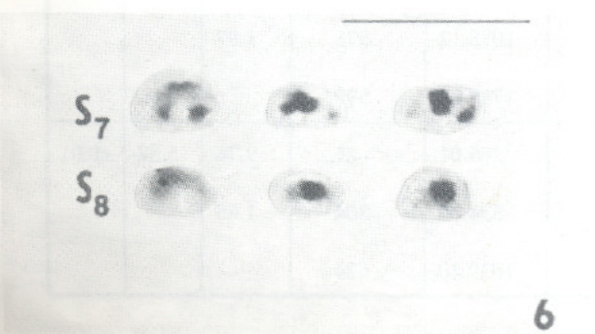
S_7
S_8
6


7

Table 2

Mean chiasma frequency in three populations of *Chorthippus albomarginatus* (SD – standard deviation, SE – standard error, N – number of individuals)

Population	N	$\bar{x}$	±SD	±SE
Ojców	23	14.69	1.559	0.325
Novosibirsk	24	15.18	1.728	0.353
Kosh-Agach	22	14.80	1.408	0.300

block, of a size close to the paracentromeric C-band (Fig. 5).

An analysis of chiasma frequency and its distribution showed that in the population from Novosibirsk the range of variation of both parameters was greater than that obtained for the Kosh-Agach sample (Tables 2 & 3). The population from Ojców occupied an intermediate position between the two Asiatic samples. Its mean chiasma frequency was similar to that observed in the Kosh-Agach population, while the range was somewhat similar to the analysed specimens from the Novosibirsk population (Table 3).

Discussion

The karyotype of *Chorthippus albomarginatus* as well as the distribution of C-heterochromatin is characteristic of most of the species belonging to Gomphocerini (BUGROV *et al.*1987; CABRERO & CAMACHO 1986; BUGROV *et al.*1991). However, specimens from the Polish population (Ojców) are characterized by a distinctly greater amount of C-heterochromatin (large paracentromeric C-bands, higher frequency of distal C-bands) than that in the Asiatic populations (Novosibirsk, Kosh-Agach). The Ojców population also showed polymorphism in the size of paracentromeric C-bands in pairs 7 and 8. According to HEITZ (1933, 1935),

Table 3

Variance analysis of mean chiasma frequency in three populations of *Chorthippus albomarginatus*

Population	Type of interpopulation variability	Sum of squares SS	Number of degrees of freedom dF	Mean square MS	F test	P
Ojców	1. between individuals	462.87	22	21.04	12.38	<0.01
	2. within each individual	982.87	552	1.70		
	3. total	1395.74	574			
Novosibirsk	1. between individuals	714.72	23	31.07	16.61	<0.01
	2. within each individual	1075.12	576	1.87		
	3. total	1789.84	599			
Kosh-Agach	1. between individuals	205.01	21	9.76	5.88	<0.01
	2. within each individual	834.39	504	1.65		
	3. total	1039.40	524			

the equilocal model for the heterochromatin distribution shows that in certain species the heterochromatin of non-homologous chromosomes tends to be located in similar regions in most members of the chromosome set. Exceptionally, in *Ch. albomarginatus* there occurred differentiation of the amount of heterochromatin in particular chromosomes within and between populations. Such a differentiation of the size of paracentromeric C-bands was also noted in three other species belonging to Gomphocerini (CABRERO & CAMACHO 1986).

The localization and amount of C-heterochromatin in populations of *Ch. albomarginatus* are differentiated, this probably being associated with natural selection in various geographic areas. Such variation in C-heterochromatin has been described in grasshoppers by many authors, and it is probably responsible for polymorphism in natural populations of the species (HEWITT & JOHN 1968, 1970; SHAW 1970,1971; SANTOS & GIRALDEZ 1982; SANTOS *et al.*1983).

A comparison of chiasma frequency in particular locations indicates that the population from Novosibirsk shows the highest one. The presumption is that the differences are belier connected with the selection and or adaptation abilities and the effect on the specimens of an anthropogenic environment.

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