POPULATION VARIABILITY OF SOME QUANTITATIVE CHARACTERS IN ARGAS POLONICUS LARVAE (ACARINA: ARGASIDAE)

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Abstract. The nature of variability of quantitative morphometrical characters was studied in larvae of two local populations of Argas (Argas) polonicus Siúda, Hoogstraal, Clifford et Wassef, 1979 collected in Czechoslovakia and Poland. Statistically significant differences in five quantitative characters studied, in which the larvae of both wild populations differed from one another, disappeared during three generations of laboratory rearing. The variability of these characters was lower in laboratory populations than in field collected ticks. The results of hybridization experiments and analysis of variability of larvae of individual populations and parental pairs suggest that rather adaptive than genetic variation is involved. The genetic component of the variation is inferior and is expressed probably by dominant relations between alleles of the same locus, or by different types of non-allelic interactions.

The phenotypic variation of continuous and discontinuous characters comprises genetic and nongenetic or environmental components of variation.

According to the predictions of Price (1977), the parasites will exhibit low level of genetic variation within populations and high level of variation between populations. In the case of ticks this prediction has been supported by the studies of Wals in and Miller (1983) and Bull et al. (1984), who analysed electrophoretically enzymes of different populations of several Ornithodoros, Argovoma and Amblyomma species and reported a relatively low average heterozygosity per individual. However, they found a very low genetic distance (Nei 1972) between conspecific populations.

Hilburn and Sattler (1986a) on the basis of enzymatical studies carried out by Healy (1979a, b) on Ixodes ricinus (L., 1758) and their own studies of the tick species of the genera Amblyomma and Boophilus (Sattler et al. 1986a, b; Hilburn and Sattler 1986a, b) expressed their doubts about the general validity of this theory in large tick populations and suggested that population-size, host specificity and mobility are more important factors in determining genetic heterozygosity in ticks.

The influence of nongenetic or environmental components of variation on the phenotypic variation of ticks has been recorded in many cases. Hunt and Drummond (1985), Davey et al. (1984) and Dusbahek (1986) observed phenotypic differences between laboratory-reared and field-collected tick population samples. Oliver and Herrin (1976) demonstrated that laboratory-reared populations of Haemaphysalis longicornis Neumann, 1901 are less variable than field-collected ticks. In our previous papers (Dusbahek 1984, 1985b) we pointed out that the phenotypic differences between local populations of Argas (Persicargas) persicus (Oken, 1818) have often a clinal character and change in dependence on the climatic gradient of the environment. Balashov (1972), on the other hand, did not find any dependence of the phenotypic variation of Ornithodoros (Pavlovskyla) tartakowskyi Olenev, 1931 local populations on the situation of the population in the distribution area of a species, physical conditions of the environment, or the main host species.

An analysis of individual variations in larvae of Argas (Argas) polonicus Siúda, Hoogstraal, Clifford et Wassef, 1979 was made by Siúda (1979). In our comparative
studies of the morphology and measurements of two local populations of the same species originating from Czechoslovakia and Poland, statistically significant differences were recorded in five of the 23 quantitative characters studied in larvae (length of hypostome, length of the second palpal segment, width of the dorsal plate, and length of the anterodorsal setae — Duskašek 1985a). Since these character values of a great taxonomical value, we attempted to evaluate their stability under constant conditions of laboratory rearing and to determine the portion of the genetic and nongenetic component of variation in their final phenotypic manifestation.

MATERIALS AND METHODS

The tick larvae of the Polish population originated from a type locality of the species at Kraków. The larvae of the Czechoslovak population were collected in pigeon nest site in St. Michael Chapel at Košice. In the laboratory, the ticks of both populations were kept at the constant temperature of 27 ± 1 °C and 75 ± 5% r.h. in dark and fed on pigeons. Unfed larvae used for the measuring were prepared in Swain's medium. Each group consisted of 80 larvae originating from 5 different parental pairs. The first filial generation (F₁) comprised hybrid specimens of second laboratory generation, whereas F₂, B₁ and B₂ were specimens of the third laboratory generation. Larvae of the third laboratory generation were also designated as laboratory parental line. The variability of the characters studied in the progeny of different parental pairs within a population was evaluated by one-way analysis of variance after previous verification of variance homogeneity by Bartlett's test. Student's t-test was used for the comparison of mean values of individual characters of population samples and differences in variance values of these characters were compared by Fišer's F-test.

Individual populations and hybrid generations were designated as follows:

\[ \begin{align*}
Pp & = \text{homogenous Polish population (P₁)} \\
Cp & = \text{homogenous Czechoslovak population (P₂)} \\
Cp \times Pp & = \text{hybrid progeny } C_{2} \times P_{2} \sigma \quad (F_{2} \times P_{1} = F_{1}) \\
Pp \times Pp & = \text{progeny of brother-sister cross } (F_{1} \times F_{1} = F_{1}) \\
Pp \times Cp & = \text{progeny of back-crosses } (F_{1} \times F_{1} \sigma = B_{1}, F_{1} \sigma \times F_{1} = B_{2})
\end{align*} \]

RESULTS

The third laboratory generation of Pp and Cp populations kept under identical constant conditions did not exhibit the same differences in which the two wild populations originally differed from one another (Table 1). Of the five characters studied, the laboratory populations differed from one another only in the length of postero-dorsal setae (P < 0.05), whereas other differences were statistically insignificant. Significant differences were found in two characters (length of IIInd palpal segment and length of postero-dorsal setae) in which the two laboratory populations differed from both parental field-collected population samples (P < 0.05—0.01), and in three characters (hypostome length, dorsal plate width and length of anterodorsal setae) they differed only from one of them. Compared to the field-collected larva of Pp population, the variation of three characters (hypostome length, IIInd palpal segment length and dorsal plate width) in both laboratory populations was significantly lower (P < 0.01), as it was demonstrated by F-test.

A similar situation was in F₁ and F₂ hybrid generations and in their back-crosses with B₁ and B₂ (Table 2). No differences were observed in the width of dorsal plate (P > 0.05), the length of hypostome was different only in F₁ generation and length of postero-dorsal setae only in F₂ generation. The F₁ generation differed from F₂ in the length of IIInd palpal segment and anterodorsal setae, but was always identical with one of the combinations of B₁ or B₂ back-crosses in these characters.

Table 1: Mean values of five main characters in field populations and laboratory colonies of Argas (D.) persicus larva from Poland and Czechoslovakia (in μm ± SD). Means followed by the same letter are not significantly different at the 5% level of confidence, by Student's t-test.

<table>
<thead>
<tr>
<th>Character</th>
<th>Pp (μm) ± SD</th>
<th>Cp (μm) ± SD</th>
<th>Pp vs. Cp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypostome length</td>
<td>16.2 ± 7.7μm</td>
<td>18.2 ± 8.2μm</td>
<td>p &gt; 0.05</td>
</tr>
<tr>
<td>Dorsal plate width</td>
<td>206.4 ± 19.0μm</td>
<td>205.6 ± 18.8μm</td>
<td>p &gt; 0.05</td>
</tr>
<tr>
<td>Postero-dorsal setae length</td>
<td>15.4 ± 1.6μm</td>
<td>15.4 ± 1.6μm</td>
<td>p &gt; 0.05</td>
</tr>
</tbody>
</table>

Table 2: Mean values of five main characters in hybrid first and second filial generations and back-crosses of Czechoslovak and Polish populations of Argas (D.) persicus larva (in μm ± SD). Means followed by the same letter are not significantly different at the 5% level of confidence, by Student's t-test.

<table>
<thead>
<tr>
<th>Character</th>
<th>F₁ (μm) ± SD</th>
<th>F₂ (μm) ± SD</th>
<th>B₁ (μm) ± SD</th>
<th>B₂ (μm) ± SD</th>
<th>F₁ vs. F₂</th>
<th>F₁ vs. B₁</th>
<th>F₁ vs. B₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypostome length</td>
<td>16.2 ± 7.7μm</td>
<td>16.2 ± 7.7μm</td>
<td>p &gt; 0.05</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dorsal plate width</td>
<td>206.4 ± 19.0μm</td>
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<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
Table 3. Calculated values of F-distribution (F) and level of confidence (P) in comparison of values of characteristica studied among progenies of five parental pairs of the field populations and laboratory colonies of Czechoslovak and Polish Arugas (A.) polonicus

<table>
<thead>
<tr>
<th></th>
<th>Pp field population</th>
<th>Pp laboratory colony</th>
<th>Ce laboratory colony</th>
<th>Ce field population</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F</td>
<td>P</td>
<td>F</td>
<td>P</td>
</tr>
<tr>
<td>Hypostome length</td>
<td>1.02</td>
<td>n.s.</td>
<td>2.21</td>
<td>n.s.</td>
</tr>
<tr>
<td>Palpal segment II length</td>
<td>4.56</td>
<td>0.05</td>
<td>6.54</td>
<td>0.01</td>
</tr>
<tr>
<td>Dorsal plate width</td>
<td>8.23</td>
<td>0.01</td>
<td>14.60</td>
<td>0.001</td>
</tr>
<tr>
<td>Posteroventral setae length</td>
<td>2.07</td>
<td>n.s.</td>
<td>4.71</td>
<td>0.01</td>
</tr>
</tbody>
</table>

An analysis of individual variations in larvae of both parental Pp and Ce populations, both wild and laboratory ones, made by means of one-way variance analysis demonstrated that the values of the characters studied significantly differ (P < 0.05 — 0.01) in most of the progeny of different parental pairs of the same population (Table 3). The least variable from this point of view was the length of hypostome, while the most variable was the width of the dorsal plate. The length of anterodorsal setae could not be evaluated by one-way ANOVA due to the heterogeneity of variances demonstrated by the Bartlett's test.

**DISCUSSION**

The disappearance of statistically significant differences in four of the five characters under study in Arugas (A.) polonicus larvae of Ce and Pp laboratory populations kept under identical conditions indicates that the outer environment significantly affects their values and that the nongenetic or environmental components of their variation prevailed.

Mean values of the characters studied in hybrid laboratory-reared generations were in most cases similar to those of parental laboratory generations which also shows the prevailing effect of constant conditions of the environment over the genetic factor in the phenotypic expression of those characters. The larvae of F1 hybrid generation, which are the progeny of the first laboratory generation, significantly differ from other hybrid combinations (progeny of second laboratory generation) in two characters (length of hypostome and length of second palpal segment). Rather than the effect of the genetic component of variation, it can be supposed that an insufficiently long effect of constant conditions of the living environment was involved.

The fact that the mean values of the characters studied in laboratory and hybrid generations in most cases are close to those of single wild parental population suggests a certain dominance of the respective parental population in the canalization of phenotypic expression of the character under study and, consequently, a certain involvement of the genetic component of its variation. The preservation of individual variations in larvae of different parental pairs of laboratory populations can be regarded as a consequence of genetic homeostasis. It seems that under constant laboratory conditions, the effect of the genetic component of variation can also assert itself probably by means of the dominant relations between the alleles of the same locus. In case of the hypostome length this is indicated by the relatively high stability of this character in the progeny of different parental pairs of the same population (Table 3).

Since the variance values of F1 generation do not exceed significantly the variance values of F2 generation (P < 0.05) and the variation curve of distribution of metrical values in the size groups is more sheer in F2 generation (Fig. 1), the proportion of an additive component of genetic variation in the variability of characters studied, can be considered negligible.

The phenotypic and genetic changes as consequences of insect's colonization were reported in the surveys by Mc Donald (1976) and Mason et al. (1987). They documented numerous cases of phenotypic changes in laboratory-reared insects such as changes in host-plant acceptability, pheromonal responses, visual sensitivity, flight capacity, reproductive behaviour and other reproductive parameters. The behavioral differences in pheromone response between laboratory-reared and field-collected Arugas (Perennarion) peregrinus were recorded by Dushkova (1971) and Drummond and Drummond (1983) also reported on the effect of laboratory rearing on the reproductive biology of lone star tick, Amblyomma americanum. Engorged colony females weighed less, look longer to engorge, had longer preoviposition and oviposition periods, laid fewer eggs per female, converted less of the engorged weight to eggs, and had significantly lower egg hatch than wild females. Davey et al. (1984) found the female weight, egg mass weight, and preoviposition period in laboratory-adapted Boophilus microplus to be significantly greater than in the representatives of five other wild populations. They found some phenotypic differences in quantitative morphological features, too. The laboratory-adapted males were significantly larger in whole-body surface and surface area of the caudal process than males of all wild populations compared. All these differences are considered to be the consequence of a limited gene flow due to the isolation of the laboratory tick colony. Similarly Mason et al. (1987) conclude that the causes of genetic changes in laboratory-adapted insect colonies include founder effect resulting in random genetic drift, nonrandom mating and selection.

It can therefore be summarized that the phenotypic expression of five quantitative characters studied by us in Arugas (A.) polonicus larvae is influenced rather by nongenetic or environmental components of variation. The genetic component of variation is involved to a lower degree, most probably by means of dominant relations between the alleles of the same locus and by means of different types of non-allelic interactions.
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ПОПУЛЯЦИОННАЯ ИЗМЕНЧИВОСТЬ НЕКОТОРЫХ КОЛИЧЕСТВЕННЫХ ПРИЗНАКОВ ЛИЧНИКОВ ARGAS POLONICUS (ACARINA: ARGASIDAE)

Ф. Дусабен

Резюме. Изучали характер изменчивость количественных морфометрических признаков личинок двух локальных популяций Argas (Argas) polonica, происходящих из Чехословакии и Польши. Статистически достоверные разницы в изучаемых количественных признаках, в которых личинки обеих популяций отличались друг от друга, исключали в течение трех генераций, разведены в лаборатории. Имеющие эти признаки у лабораторных популяций была ниже, чем у личинок, собранных в природе. Результаты опытов по гибридизации и анализ изменчивости личинок из отдельных популяций и родительских пар показывают, что изменчивость этих признаков имеет большую часть адаптивной, т. е. негативной функции. Генетический комплекс изменчивости существует только в небольшой мере, вероятно через доминантные отношения между аллелями того же локуса и, вероятно, также через разные типы независимых взаимодействий.

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