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# SEGMENTAL DEFICIENCIES IN SOME NEOBISIIDAE (PSEUDOSCORPIONES, ARACHNIDA).

Arachnids have been observed with different anomalies ranging from various disturbances in the body plan to some minor deficiencies. Such abnormalities have been reported for pseudoscorpions as well (Vachon 1947, Chamberlin 1949, Pedder 1965, Ćurčić 1980, Ćurčić & Dimitrijević 1984, 1986).

The aims of this study were to make: (a) an analysis of the variation of segmental anomalies in four European pseudoscorpion species of Neobisium Chamberlin and in one species of Roncus L. Koch from different sites, (b) an analysis of the frequency of different tergal and sternal anomalies in the postembryonic stages of each pseudoscorpion species, and (c) an analysis of the possible factors that affect the origin and development of such anomalies in the pseudoscorpions studied.

We have analysed the accidental and teratological variation of abdominal deficiencies in the population samples of Neobisium carpaticum Beier from five sites: Košutnjak Park, Topčider Park, Mt. Avala and Sremčica, all near Belgrade, Yugoslavia, and from Deliblatska Peščara, near Pančevo, Yugoslavia; of N. sylvaticum (C.L. Koch) from Topčider Park and Mt. Avala, and of N. fuscimanum (C.L. Koch), N. cephalonicum (Daday) and Roncus lubricus L. Koch from Mt. Avala only. The numbers of specimens collected in these localities are presented in Tables 1 and 2.

Samples of all the pseudoscorpion species under study were obtained by sifting leaf-litter and humus over a period running from October 1984 to November 1986.

The majority of all postembryonic stages of each species were collected in each of the localities, with the exception of trito-, deuto-, and protonymphs of N. carpaticum

from Košutnjak Park, and deuto- and protonymphs of the same species from Mt. Avala (Table 1). In addition, protonymphs of N. sylvaticum were not found either in Topčider Park or on Mt. Avala. In the latter locality, no deutonymphs of this species were collected either. Furthermore, protonymphs of N. fuscimanum and of N. cephalonicum were not collected from Mt. Avala (Table 2).

In the most frequently occurring species, N. carpaticum, 61 abnormal specimens were noted (Table 3), whilst in other species the numbers of aberrant examples ranged from two to six (Table 4). All abnormal specimens studied were adults, with the exception of a single tritonymph of N. carpaticum (Tables 3 and 4).

In N. carpaticum from different sites we found that the anomalies of the abdominal sclerites vary from 0.68 % to 1.26 % (Table 3), depending on the locality. The highest percentage of these anomalies has been noted in the population sample from Košutnjak Park, and the lowest in the sample of N. carpaticum from Topčider Park. It is pertinent to note that the percentage of segmental anomalies in N. carpaticum is essentially similar in different population samples.

In the samples of N. sylvaticum we noted the lower percentage of aberrant cases in the population from Topčider Park, and the higher in that from Mt. Avala (Table 4). Both N. fuscimanum and N. cephalonicum exhibit a similar frequency of abnormal specimens from Mt. Avala (Table 4). In addition, the sample of R. lubricus from the same site shows the least percentage of abdominal anomalies if compared to all other pseudoscorpion samples (Tables 3 and 4). On the other hand, the lowest percentage of different aberrations was observed in N. sylvaticum from Topčider Park (Tables 3 and 4).

Ćurčić & Dimitrijević (1986) have recently found a high frequency of abnormal specimens on Mt. Avala where the soil and humus are subject to negative anthropogenic influence, unlike Topčider Park. However, in the present study we have observed that the greatest percentage of abnormal specimens of N. carpaticum was collected in Košutnjak Park, at a different time and on a site other than that where earlier collections

were made. Therefore, it is probable that the frequency of segmental anomalies in the pseudoscorpion species under study might be affected either by the successive changes in the intensity of influence of different teratogenic agents in particular sites, or by the individual tolerance of each particular pseudoscorpion species (during its life cycle) to the factors that spark the origin and development of different anomalies, or, even by the combined action of different agents (physical, chemical, hereditary, developmental and others).

Deficiencies in abdominal sclerites of the species studied were variable. Thus, in N. carpaticum, the following anomalies were noted: partial atrophy (single and multiple), hemimery, symphysomery (single and multiple), occurrence of a supernumerary sclerite (?), and different combinations of these anomalies: combined multiple hemimery and tergite enlargement, partial atrophy and symphysomery, and partial atrophy and tergite enlargement. In N. sylvaticum, partial atrophy (single and multiple), symphysomery and combined partial atrophy and multiple symphysomery were noted. On the other hand, only symphysomery was observed in N. fuscimanum, and in N. cephalonicum we found combined hemimery and tergite enlargement, as well as combined partial atrophy and enlargement of a sclerite. In addition, abnormal specimens of R. lubricus are characterized by the presence of partial atrophy, symphysomery, and combined hemimery and tergite enlargement.

In N. carpaticum (Table 5), partial atrophy and symphysomery together represent more than 70 % of the total number of anomalies observed in this species. In N. sylvaticum, the frequency of the anomalies mentioned is similar to that in N. carpaticum. In broad lines, the same is true even for N. fuscimanum and R. lubricus, although the additional material is needed to verify this assumption (Table 5). In addition, N. cephalonicum shows a specific pattern of frequency of different anomalies which is probably due to the insufficient number of specimens in the sample studied.

Combinations of two segmental anomalies are far less frequent than single aberrations.

The analysis of the Neobisium and Roncus species has

shown that teratological variation of the abdominal sclerites was confined mostly to adults (98.72 %), with the exception of a single tritonymph of N. carpaticum (1.28 %)(Table 3). No deficiencies have been observed in the earlier instars (Table 3). It is also evident that tergal anomalies (noted altogether in 75 specimens or 96.15 %) are much more frequent than those affecting the sternites (three specimens or 3.85 %).

The study of the relative distribution of segmental anomalies in the adult stage (and in a single tritonymph of N. carpaticum) has enabled us to make some generalizations, as follows:

- Hemimery is probably restricted to the anterior part of the abdomen.

- Partial atrophy (both single and multiple) is found mostly in the anterior abdominal region, although it may occur occasionally in the posterior region.

- Symphysomery develops most often in the central region of the abdomen. In a few cases it affects the posterior abdominal segments.

- Sclerite enlargement is often correlated to the presence and relative position of partial atrophy of a sclerite. Hence this anomaly is present mostly in the anterior abdominal region, although it may occur occasionally in the central or posterior parts of the abdomen.

- Rare examples of combined deficiencies are found in the posterior and central abdominal parts (atrophy or hemimery and tergite enlargement), or in the anterior region (symphysomery and partial atrophy).

- A single case of a supernumerary sclerite (?) was noted in the anterior abdominal part.

- As a consequence of different deficiencies, the sclerite setation is altered, as compared to the values quoted elsewhere for the species studied (Ćurčić 1982).

- There is no evidence on the relative position of helicomery, since this phenomenon (otherwise rare in pseudoscorpions studied) has not been found during this study. This also refers to the reduction in number of a sclerite. It is pertinent to note that Ćurčić & Dimitrijević (1986) have found elsewhere

that (a single case of) helicomery in N. carpaticum was restricted to the posterior abdominal region.

In each analyzed species, segmental deficiencies are unequally distributed among representatives of different sexes (Table 6). It is relevant to note that in N. carpaticum, 56-75 % of anomalous pseudoscorpions from different sites were males (with an average of 65.50 %), and only 0-44 % females (with an average of 27.83 %)(see Table 6). Similar results were obtained for N. fuscimanum and Roncus lubricus. On the other hand, in N. sylvaticum, the majority of segmental anomalies were confined to females, while in N. cephalonicum the number of aberrant males equalled that of abnormal females (Table 6). However, it is probable that the population samples in the two latter instances were insufficient, hence the "unusual" values of the male/female ratio concerning the presence of different anomalies.

The results achieved in this study point to the possible (male) sex-linked nature of the origin of some segmental anomalies, as was already emphasized by Ćurčić et al. (1983), and by Ćurčić & Dimitrijević (1986). Further studies are necessary to verify the assumption whether the origin of segmental anomalies in other Neobisiid species is associated with the sex-linked inheritance. If such opinion proved true, this would pose an interesting genetical problem, especially as regards the issue proposed by Mayr (1969) that teratological phenomena belong in non-genetic variation.

Some segmental deficiencies are probably the result of a mechanical injury, either at the adult stage or in some preceding instars. The most frequent consequence of such injuries is the occurrence of partial atrophy, manifested by the loss of pigmentation in the damaged area. In such malformations, the setation of the affected sclerites is usually not altered.

Since the majority of the abdominal anomalies occur during the transformation of the tritonymph into adults, it appears likely that the main cause of the origin of such aberrations may be induced by some irregularity in the process of metamorphosis, or moulting. Considerably smaller number of specimens become anomalous when transforming from the deutonymph

into tritonymphs (Ćurčić et al., 1983), or even from the protonymph into deutonymph stage, as was shown by Pedder (1965) for some species of the British Neobisiidae. However, the possible causes of the lower frequency of aberrations in earlier instars still remain obscure.

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## TABLES 1-6

**Table 1** - Number of specimens of N. carpaticum (including different sexes and growth stages), collected from various sites.

| SPECIES | SITE | MALE | FEMALE | INSTAR TRITO | INSTAR DEUTO | INSTAR PROTO | TOTAL |
|---|---|---|---|---|---|---|---|
| N. carpaticum | KP | 996 | 748 | - | - | - | 1,744 |
| " | TP | 1,098 | 2,138 | 401 | 27 | 19 | 3,682 |
| " | MA | 430 | 408 | 32 | - | - | 870 |
| " | SR | 150 | 61 | 103 | 60 | 3 | 377 |
| " | DP | 298 | 199 | 72 | 9 | 1 | 579 |
| | Totals | 2,972 | 3,553 | 608 | 96 | 23 | 7,252 |

Abbreviations: KP = Košutnjak Park, TP = Topčider Park, MA = Mt. Avala, SR = Sremčica, DP = Deliblatska Peščara

**Table 2** - Number of specimens of Roncus lubricus, Neobisium sylvaticum, N. fuscimanum and N. cephalonicum (including different sexes and growth stages), collected from various sites.

| SPECIES | SITE | MALE | FEMALE | INSTAR TRITO | INSTAR DEUTO | INSTAR PROTO | TOTAL |
|---|---|---|---|---|---|---|---|
| R. lubricus | MA | 164 | 181 | 199 | 120 | 76 | 740 |
| N. sylvaticum | TP | 170 | 82 | 88 | 60 | - | 400 |
| " | MA | 97 | 109 | 32 | - | - | 238 |
| N. fuscimanum | MA | 110 | 92 | 41 | 3 | - | 246 |
| N. cephalonicum | MA | 61 | 76 | 24 | 18 | - | 179 |
| | Totals | 602 | 540 | 384 | 201 | 76 | 1,803 |

Abbreviations: MA = Mt. Avala, TP = Topčider Park

**Table 3** - Abdominal abnormalities in different sexes and growth stages of Neobisium carpaticum from various sites.

| SITE | INSTAR | | | | | | % | % |
|---|---|---|---|---|---|---|---|---|
| | MALE | FEMALE | TRITO | DEUTO | PROTO | TOTAL | MALES | ABNORM. |
| KP | 16 | 6 | - | - | - | 22 | 72.73 | 1.26 |
| TP | 14 | 11 | - | - | - | 25 | 56.00 | 0.68 |
| MA | 4 | 3 | - | - | - | 7 | 57.14 | 0.80 |
| SR | 2 | - | 1 | - | - | 3 | 66.67 | 0.79 |
| DP | 3 | 1 | - | - | - | 4 | 75.00 | 0.69 |
| Totals | 39 | 21 | 1 | - | - | 61 | | |
| Mean | | | | | | | 65.51 | 0.84 |

Abbreviations: as in Table 1.

**Table 4** - Abdominal abnormalities in different sexes and growth stages of Roncus lubricus, Neobisium sylvaticum, N. fuscimanum and N. cephalonicum from various sites.

| SPECIES | SITE | INSTAR | | | | | | % | % |
|---|---|---|---|---|---|---|---|---|---|
| | | MALE | FEMALE | TRITO | DEUTO | PROTO | TOTAL | MALES | ABNORM. |
| sylv | TP | 1 | 5 | - | - | - | 6 | 16.67 | 0.67 |
| " | MA | 1 | 1 | - | - | - | 2 | 50.00 | 0.84 |
| fusci | MA | 2 | - | - | - | - | 2 | 100.00 | 0.81 |
| ceph | MA | 1 | 1 | - | - | - | 2 | 50.00 | 1.12 |
| lubr | MA | 4 | 1 | - | - | - | 5 | 80.00 | 0.67 |
| Total | | 9 | 8 | - | - | - | 17 | | |
| Mean | | | | | | | | 59.33 | 0.94 |

Abbreviations: sylv = N. sylvaticum, fusci = N. fuscimanum, ceph = N. cephalonicum, lubr = R. lubricus. Other abbreviations as in Table 1.

**Table 5** - Frequency of different segmental anomalies in the species of Neobisium Chamberlin and Roncus L. Koch (expressed as a percentage of the total number of anomalies noted in each particular species).

| SEGMENTAL ANOMALY | GENUS AND SPECIES | | | | |
|---|---|---|---|---|---|
| | N.carp. | N.sylv. | N.fusc. | N.ceph. | R.lubr. |
| Hemimery | 5.17 | - | - | - | - |
| Partial atrophy | | | | | |
| - single | 27.59 | 37.50 | - | - | 20.00 |
| - multiple | 6.90 | 12.50 | - | - | - |
| Symphysomery | | | | | |
| - single | 34.48 | 25.00 | 100.00 | - | 40.00 |
| - multiple | 3.45 | - | - | - | - |
| Combined partial atrophy (or hemimery) and tergite enlargement | 17.24 | 12.50 | - | 100.00 | 40.00 |
| Combined partial atrophy and (multiple) symphysomery | 3.45 | 12.50 | - | - | - |
| Combined symphysomery and sclerite enlargement | 1.72 | - | - | - | - |
| Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

**Table 6** - Sex ratio in the samples of anomalous pseudoscorpions pertaining to the genera Neobisium Chamberlin and Roncus L.Koch, collected from various sites.

| SPECIES | LOCALITY | % MALES | % FEMALES | % TRITO |
|---|---|---|---|---|
| N. carpaticum | Košutnjak Park | 72.73 | 27.27 | 0 |
| " | Topčider Park | 56.00 | 44.00 | 0 |
| " | Mt. Avala | 57.14 | 42.86 | 0 |
| " | Sremčica | 66.67 | 0 | 33.33 |
| " | Delibl.Peščara | 75.00 | 25.00 | 0 |
| | **Mean** | **65.50** | **27.83** | **6.67** |
| N. sylvaticum | Topčider Park | 16.67 | 83.33 | 0 |
| | Mt. Avala | 50.00 | 50.00 | 0 |
| | **Mean** | **33.33** | **66.67** | **0** |
| N. fuscimanum | Mt. Avala | 100.00 | 0 | 0 |
| N. cephalonicum | Mt. Avala | 50.00 | 50.00 | 0 |
| R. lubricus | Mt. Avala | 80.00 | 20.00 | 0 |