Segmental and other malformations in *Neobisium simoni* (L. Koch) and *N. bernardi* Vachon (Neobisiidae, Pseudoscorpiones) from France

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Abstract

A study has been made of the phenomenon of traumatic (teratological and accidental) variation in the segmentation of the abdomen and pedipalpal anomalies in two neobisiid species: **Neobisium simoni** (L.Koch 1843) and **N. bernardi** Vachon, 1937, from France. In the former species, sclerite aberrations were noted in the adult (both sexes) and as well as in all subadult stages (proto-, deuto- and tritonymphs). In the latter species, abnormal specimens were found in the adult (males and females) and in the tritonymph stage. The following types of sclerite anomalies were noted: atrophy (single and multiple), symphysomery, helicomery and various combinations of these aberrations. In **N. simoni** partial atrophy and symphysomery showed the highest frequency of the total number of anomalies recorded. In **N. bernardi** partial atrophy and a combination of atrophy and symphysomery were most frequent. All other anomalies were less abundant. In the proto- and deutonymphs of **N. bernardi** sclerite aberrations were not noted, while such anomalies were in evidence only in **N. simoni**. Although a number of factors may generate abdominal anomalies in pseudoscorpions, it seems likely that one of the main causes that provokes such malformations is of a genetic nature. Pedipalpal anomalies were observed in one **N. simoni** female and one **N. bernardi** tritonymph. In both instances, the trichobothriotaxy and number of teeth of the aberrant pedipalpal chelae are altered.

Résumé

Le phénomène de variation traumatique (tératologique et accidentale) dans la segmentation de l'abdomen et les anomalies des pédipalpes ont été étudié sur deux espèces de neobisiides en France **Neobisium simoni** (L.Koch 1843) et **N. bernardi** Vachon, 1937. Sur la première, des aberrations des sclérites ont été notées chez l'adult (des deux sexes) et aux stades subadultes (proto-, deuto- et tritonymphal). Sur la second, des specimens anormaux ont été trouvée parmi les adultes (males et femelles) et au stade tritonymphal. Les types suivants d'anomalies des sclérites ont été enregistrées: atrophie (simple et multiple), symphysomérie, helicomérie et diverses combinations de ces abérrations. Chez **N. simoni**, l'atrophie partielle et la symphysomérie l'emportent par leur fréquence par rapport au nombre total d'anomalies enregistrées. Chez **N. bernardi** ce sont l'atrophie partielle et la combinationd atrophie et de symphysomérie, qui apparaissent le plus fréquemment, les autres anomalies étant nettement moins représentées. Chez proto- et deutonymphes de **N. bernardi** aucune aberration des sclérites n'a été noté, tandis que telles anomalies sont apparues a ces deux stades chez **N. simoni**. Bien que de nombreux facteurs puissent entraîner des anomalies abdominales chez les pseudoscorpions, il semble qu'une des principales causes à l'origine de ces malformations soit de nature genetique. Des anomalies des pédipalpes ont été observées chez une femelle de **N. simoni** et chez une tritonymphe de **N. bernardi**. Dans les deux cas

Within the family Neobisiidae, teratology of the abdominal sclerites and other body parts has been recorded in 18 epigean and cavernicolous species belonging to the genera **Neobisium** Chamberlin and **Roncus** (L.Koch)(Pedder 1965; Ćurčić 1980,1988; Ćurčić and Dimitrijević 1984,1985; Drogla 1988). In this study we analysed the quantitative and qualitative traits of teratological variability in the structure of the abdominal segmentation in two sympatric neobisiid species, **Neobisium simoni** (L.Koch) and **N. bernardi** Vachon.

The analysed pseudoscorpions were collected at two sites: Moulis and Passarole, Ariege, France, by sifting leaf litter and humus in a mixed oak forest during a period from May to September 1987. (Table 1). The terminology for different abdominal anomalies established by Balazuc (1948) was used in this study.

In both species from the two collecting sites we gathered all postembryonic instars, tritonymphs being most numerous. In **N. simoni** aberrant specimens of both sexes and all subadult stages were noted only at Passarole. At Moulis, both anomalous males and one tritonymph and protonymph were found (Table 1). In **N. bernardi** at both localities we registered abnormal males and tritonymphs while aberrant females were found only at Passarole (Table 2). The total number of anomalous specimens of both species has similar values, in **N. simoni** - 37 and in **N. bernardi** 38. The percentage of specimens with abnormal sclerites varied from 1.76-2.45% depending on the growth stage, sex, species and locality (Tables 1 and 2). Males of **N. simoni** are characterised by the highest percentage of abnormal specimens at both localities (6.25-6.36%). In other species, **N. bernardi**, the highest percentage of abnormal specimens proved to be females. In this species, the percentages of aberrant males and tritonymphs are similar (Table 2).

The following types of anomalies were registered in both species: partial atrophy (single and multiple), symphysomery and helicomery as well as various combinations of the above-mentioned types of anomalies (Table 3). In both species, atrophy and symphysomery together represent more than 70% of the total number of anomalies observed in those two species.

The analysis of all subadult stages and specimens of both sexes revealed that the percentage of the aberrant abdominal sclerites was mostly represented in adults: males of **N. simoni** (77.78%) and females of **N. bernardi** (85.71%). Abnormal **N. bernardi** tritonymphs are characterised also by a high percentage (64.52%)(Table 4). In the latter species, no sclerite deficiencies have been observed in proto- and deutonymphs.

The analysis of the frequency of tergal and sternal aberrations in different sexes and subadult stages of the two species (Tables 5 and 6) has shown that in **N. simoni** males the most frequent tergal anomaly was atrophy, while symphysomery and sclerite enlargement were less abundant. In females, symphysomery, atrophy and tergite enlargement were noted only at Passarole, symphysomery being the most frequent. Tritonymphs of this species had the highest percentage of symphysomery at both localities. Deutonymphs with tergal

Table 1. Number and percentage of normal and aberrant specimens of **N. simoni** from Moulis and Passarole

	NORMAL SPECIMENS		ABERRANT SPECIMENS		% ABERRANT SPECIMENS	
	M	P	M	P	M	P
TOTAL NUMBER	510	1589	9	28	1.76	1.76
MALES	110	160	7	10	6.36	6.25
FEMALES	23	189	0	9	0.00	4.76
TRITONYMPHS	281	679	1	4	0.35	0.59
DEUTONYMPHS	68	378	0	3	0.00	0.79
PROTONYMPHS	28	183	1	2	3.57	1.09

Abbreviations: M= Moulis, P= Passarole

Table 2. Number and percentage of normal and aberrant specimens of **N. bernardi** from Moulis and Passarole

	NORMAL SPECIMENS		ABERRANT SPECIMENS		% ABERRANT SPECIMENS	
	M	P	M	P	M	P
TOTAL NUMBER	291	1263	7	31	2.40	2.45
MALES	36	156	1	5	2.77	3.20
FEMALES	10	138	0	6	0.00	4.34
TRITONYMPHS	200	648	6	20	3.00	3.09
DEUTONYMPHS	31	172	0	0	0.00	0.00
PROTONYMPHS	14	149	0	0	0.00	0.00

Abbreviations: M= Moulis, P= Passarole

Table 3. Types of segmental anomalies in **N. simoni** and **N. bernardi** as a percentage of the total number of anomalies registered.

SEGMENTAL ANOMALY	**N. simoni**		**N. bernardi**	
	M	P	M	P
Partial atrophy				
single	33.33	3.57	42.85	29.03
multiple	-	32.14	14.29	9.68
Symphysomery				
single	33.33	25.00	-	25.81
Helicomery	-	3.57	-	-
Combination of hemimery (atrophy) and sclerite enlargement	11.11	7.15	14.29	19.35
Combination of atrophy and symphysomery	22.23	3.57	28.57	6.45
Combination of atrophy, sclerite enlargement and symphysomery	-	-	17.86	6.45
Combination of atrophy, hemimery, symphysomery and helicomery	-	3.57	-	-
Combination of helicomery and symphysomery	-	3.57	-	3.23
	100.00	100.00	100.00	100.00

Abbreviations: M= Moulis, P= Passarole

Table 4. Percentage of abdominal abnormalities in different sexes and growth stages of two pseudoscorpion species studied.

SPECIES	SITE	I N S T A R				
		M	F	T	D	P
Neobisium simoni	Moulis	77.78	11.11	11.11	0	0
Neobisium simoni	Passarole	35.71	32.14	14.29	10.72	7.14
Neobisium bernardi	Moulis	14.29	85.71	0.00	0.00	0.00
Neobisium bernardi	Passarole	16.13	19.35	64.52	0.00	0.00

Abbreviations: M= Males, F= Females, T= Tritonymphs, D= Deutonymphs, P= Protonymphs

Table 5. Types of tergal aberrations as a percentage of the total number of tergite anomalies in **N. simoni** and **N. bernardi**

SPECIES	SEX/ INSTAR	TERGITES (M)				TERGITES (P)			
		atr	sym	sen	hel	atr	sym	sen	hel
N. simoni	M	60.00	20.00	20.00	-	-	-	-	-
	F	-	-	-	-	37.50	43.75	18.75	-
	T	50.00	50.00	-	-	25.00	50.00	25.00	-
	D	-	-	-	-	50.00	50.00	-	-
	P	-	100.00	-	-	25.00	50.00	-	25.00
N. bernardi	M	100.00	-	-	-	60.00	40.00	-	-
	F	-	-	-	-	60.00	-	40.00	-
	T	55.56	33.33	11.11	-	44.00	28.00	24.00	4.00

Abbreviations: M= Moulis, P= Passarole, atr= atrophy, sym= symphysomery, sen= sclerite enlargement, hel= helicomery

Table 6. Types of sternal aberrations as a percentage of the total number of sternite anomalies in **N. simoni** and **N. bernardi**

SPECIES	SEX/ INSTAR	STERNITES (M)				STERNITES (P)			
		atr	sym	sen	hel	atr	sym	sen	hel
N. simoni	M	75.00	25.00	-	-	81.82	9.09	-	9.09
	F	-	-	-	-	-	-	-	-
	T	-	-	-	-	-	-	-	-
	D	-	-	-	-	-	-	-	-
N. bernardi	M	-	-	-	-	100.00	-	-	-
	F	-	-	-	-	60.00	20.00	20.00	-
	T	-	-	-	-	40.00	40.00	20.00	-

Abbreviations: M= Moulis, P= Passarole, M= Males, F=Females, T= Tritonymphs, D= Deutonymphs, atr= atrophy, sym= symphysomery, sen= sclerite enlargement, hel= helicomery

anomalies were found only at Passarole, with equal values for atrophy and symphysomery (50%). In protonymphs, symphysomery was most frequent at both localities.

In all aberrant specimens of **N. bernardi** (males, females and tritonymphs) tergal atrophy was most frequent. Helicomery is represented by the smallest percentage in tritonymphs from Passarole (Table 5).

Sternal anomalies are less frequent than tergal aberrations. In **N. simoni** such abnormalities were recorded only in males from both sites, atrophy being the most frequent anomaly (Table 6). In **N. bernardi** sternal anomalies were noted only in the specimens from Passarole (atrophy in both sexes and in tritonymphs was the most frequent type of anomaly).

In this study special attention was also paid to the analysis of the relative distribution of the abdominal anomalies in all aberrant specimens. The results obtained have shown that this distribution of anomalies is specific for each of the observed aberration types. Namely, in both species atrophy develops on anterior or posterior abdominal tergites or on the central and posterior sternites. Sclerite enlargement is directly correlated (spatially and temporally) to the occurrence of atrophy. Symphysomery occurs on all abdominal sclerites, being most frequent in the central part of the abdomen. Rare cases of helicomery are present on central and posterior abdominal sclerites. These findings are in concordance with the data obtained from other analysed neobisiid species (Ćurčić and Dimitrijević 1988).

The majority of abdominal anomalies probably develop during the process of metamorphosis. Some external factors also may influence the origin of some abdominal abnormalities. There are several facts that indicate that some genetic factors may cause such deficiencies: the constancy of teratological variability, the similar incidence of the percentage of abnormal specimens in samples of wild populations of pseudoscorpions, a noted degree of qualitative diversity and the specific features of the distribution of different aberrations at various growth stages and in both sexes of each studied species.

In view of the fact that the highest percentages of abdominal aberrations are found in males (Ćurčić et al. 1981,1983) a hypothesis has been put forward that such cases could involve heredity associated with (male) sex. The data obtained from **N. simoni** and **N. bernardi** substantiate the above-mentioned hypothesis. In the case of **N. bernardi** there are indications that in this species heredity associated with the female sex could be involved too. The lerge number of abnormal tritonymphs in this species indicates that the factors which generate different abdominal anomalies at various growth stages and in taxa of pseudoscorpions are exceptionally complex.

There is little data concerning pedipalpal anomalies in pseudoscorpions(Chamberlin 1949; Ćurčić 1980,1983; Drogla 1988). Up to now only a few adult specimens have been observed with anomalies affecting the chelal fingers. In the analysed pseudoscorpions we registered two specimens with pedipalpal anomalies. In one **N. simoni** the aberrant was the fixed finger of the right chela, being greatly reduced in length. As a consequence of this anomaly, the trichobothriotaxy was altered and the number of teeth was less than its normal complement for females of this species. The movable chelal finger was normal. Furthermore, one **N. bernardi** tritonymph had an anomalous movable finger of the right chela. Its length was also reduced. The trichobothrium t was missing and the movable chelal finger

carried a smaller number of teeth than in normal specimens of this growth stage. The fixed chelal finger was normal. The above-mentioned anomalies in these two neobisiid species were recorded for the first time (Ćurčić and Dimitrijević 1989).

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