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A Contribution to our Knowledge of the Taxonomy and Distribution of Lithobius austriacus Verhoeff, 1937 (Chilopoda, Lithobiidae) in Germany [1]

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With 11 Figures and 6 Tables

Zusammenfassung

Zur Kenntnis von Taxonomie und Verbreitung von *Lithobius austriacus* Verhoeff, 1937 (Chilopoda, Lithobiidae) in Deutschland.

Lithobius (*Monotarsobius*) *austriacus* Verhoeff, 1937 ist eine bisher selten nachgewiesene Art. Die Abgrenzung zu *Lithobius aeruginosus* L. Koch, 1862 ist außerordentlich kompliziert, so daß oft Zweifel am realen Artstatus von *L. austriacus* bestehen. Außerdem existieren nur drei recht unvollständige Beschreibungen taxonomischer Merkmale.

Aus diesem Grunde wurde die Variabilität einer Vielzahl von Merkmalen späterer Postlarvalstadien von *L. austriacus* aus Deutschland im Detail geprüft.

Einige Bemerkungen zu Verbreitung und Habitatwahl ergänzen das Bild.

Summary

Lithobius (*Monotarsobius*) *austriacus* Verhoeff, 1937 is a rarely recorded species and is very similiar to *L. aeruginosus* L. Koch, 1862. The real status of the species remains doubtful. Only three incomplete descriptions of taxonomic characters exist.

The variability of a number of characters of a large series of later post-larval stages of *L. austriacus* from Germany is here described in detail.

Some remarks on the distribution and habitat selection of the species are given.

[1] Dedicated to my venerated mentor, Prof. Dr. habil. Wolfram Dunger, on the occasion of his 65th birthday.

1. Introduction

Within the subgenus *Monotarsobius* Verhoeff, 1905 it is difficult to distinguish between *Lithobius austriacus* Verhoeff, 1937 and *Lithobius aeruginosus* L. Koch, 1862. Some of Verhoeff's original descriptions, being based upon only a single male of *L. austriacus*, are rather misleading when they are applied to the species as a whole. Some of his characteristics described are of doubtful value in distinguishing between the two species. These characteristics therefore need to be checked. Records of *L. austriacus* are rare. Only in a few cases taxonomic descriptions of specimens were given (FOLKMANOVÁ 1945, LOKSA 1947, BOREK 1969). Some of these investigations and the occurrence of atypical specimens of *L. aeruginosus* (LATZEL 1880, ATTEMS 1895, KOREN 1992) give rise to the supposition that the species is a variety or a sexual dimorph of *L. aeruginosus*. To confirm or disapprove this assumption was it necessary to study a large series of specimens of both species and to rear them in culture. This paper gives a detailed description of *L. austriacus* as a first step.

2. Material and localities

The individuals examined come from several parts of Eastern and Southern Germany. The largest series studied were from 3 localities: Oberlausitz/Deutsch Paulsdorf (40 individuals), Osterzgebirge/Rabenauer Grund (18 ind.), Sachsen-Anhalt/Dübener Heide (37 ind.). Additionally some individuals have been sampled from other sites in these areas and from other parts of Germany: Oberlausitz: »Olba« minesites, Neißetal; Osterzgebirge: Luchberg, Ziegenbusch, Plauenscher Grund; Thüringen: Leutratal, Schwarza, Poxdorf; Bayern: Abbachhof, Höglwald.

Description of the localities of the series examined:

Sachsen, Oberlausitz (near Görlitz): Deutsch Paulsdorf (Fig. 1, A)
The material was found in a small forest on weathered rocky soil on Biotite-Granodiorite. *Corylus avellana* is predominant and a herb layer with mainly *Senecio fuchsii* is well developed. At the southern edge of the forest *Quercus robur* and some *Picea abies* occur in addition. This part is dryer, with a dense grass cover and strongly degraded. Two little streams form the eastern and western boundary of the wood. At the eastern stream area there is a remain of an Alnetum.

Sachsen-Anhalt (near Bitterfeld): Dübener Heide (Fig. 1, B)
The Dübener Heide lays within the area »Hercynisches Trockengebiet« with a relatively continental climate. The predominant soil type is a brown podsol. A large part is very dry and poor pine forests (*Pinus sylvestris*) are characteristic.
A precise description of the vegetation, local climate etc of the sample sites is given in STEINMETZGER (1979) and VOIGTLÄNDER (in print).

Sachsen, Osterzgebirge (near Dresden): Rabenauer Grund (Fig. 1, C)
The deeply cut lower reaches of the river »Rote Weißeritz« form the Rabenauer Grund near Dresden. In spite of the relative aridness of the valley there exist areas in the slopes investigated where the ground is permanently cool and moist. At these places the chilopods were mostly found. The forest association is a ravine woodland with a predominance *of Ulmus glabra, Acer platanoides* and *A. pseudo-platanus. Tilia platyphyllos, Fraxinus excelsior* and *Carpinus betulus* are also represented. The herb layer consists of *Urtica, Impatiens* and *Mercurialis*. A description of this and of the other places in the Osterzgebirge where *L. austriacus* was found is given in RICHTER (1967).

The material is deposited in the collection of the Naturkundemuseum Görlitz (SMNG).

3. Distribution and habitats

L. austriacus is known from Austria, Germany, Czech Republic, Hungary, Slovenia, Poland and from the former USSR (Transcarpathia). The hitherto known distribution in Germany is shown in Fig. 1.

Fig. 1 The hitherto known distribution of *L. austriacus* in Germany. A - Deutsch Paulsdorf, B - Dübener Heide, C - Rabenauer Grund respectively further localities of Osterzgebirge, D - Neißetal , E - »Olba«, F - Leutratal, Schwarza, Poxdorf, G - Abbachhof, H - Höglwald

The relatively small number of records complicates the assessment of the ecology. According to these records *L. austriacus* occurs in very different habitats. The optimal life conditions are unknown, as are the factors which mainly influence habitat selection. At the present time the species seems to be quite euryoecious without special requirements.

On the one hand it is found in deciduous and mixed forests, often in river valleys (for example FOLKMANOVÁ 1945, 1947; VOIGTLÄNDER & DUNGER 1992, Bobr valley in Poland and valleys in the Osterzgebirge - material in the collection of the SMNG) or in an alder fenwood (ZULKA, by letter), suggesting to a certain preference for moister habitats. In Hungary *L. austriacus* prefers closed forest communities to mediterranean-type shrublands (LOKSA 1966). On the other hand the species occurs in relatively dry habitats, for example in Bohemian spruce forests (LELLÁKOVÁ-DUŠKOVÁ 1959), in Austria in a spruce forest (VOIGTLÄNDER et al., in print) in East Germany in pine forests (VOIGTLÄNDER, in print), at minesites deriving from brown coal open mining (DUNGER 1966) and in an Epipactis-Seslerietum and Teucrio-Seslerietum in Thuringia as well as in West Germany in a poplar afforestation (material in SMNG). In Deutsch Paulsdorf *L. austriacus* occurs most densely in the middle and the dry edge of the wood whereas the moister areas near the streams are avoided (VOIGTLÄNDER 1988). According to investigations in the Dübener Heide the pH-value seems to be of greater importance in habitat selection than moisture (VOIGTLÄNDER, in print). There the optimum lies between pH 4 and 5. In contrast the species have been found also on calcareous soil (FOLKMANOVÁ & LANG 1955, LOKSA 1966, VOIGTLÄNDER 1988, material from Thuringia in SMNG).

4. Taxonomic characters

The taxonomic characters usually used to separate Lithobiid species are the following: projections on tergites 9, 11 and 13, teeth on the forcipular coxosternite, number of antennal articles, ocelli, coxal pores, spinulation, accessory apical claws on the 15th pair of legs, body length, head-length, ratios head-length/body-length and head-length/head-width, genitalia, male secondary sex-characters and pattern on the cephalic shield. The taxonomic value of these is very different (see ANDERSSON 1981 a). Most of these characteristics depend more or less on the age of specimens, not only in the younger post-embryonic but also in later adult stages. For many Lithobiid species the stadia were described by ANDERSSON, published in Ent. scand. (such as 1976, 1978, 1981 b, 1984), but *L. austriacus* has not been investigated thus far. I am currently planning such investigations. An undoubted fact is that in adults characteristics (number of antennal articles, coxal pores, body length and so on) keep within certain limits and so make a specification of the range of variation possible.

4.1. Body length

The body length of preserved individuals is difficult to measure, because the specimens contract, often bend and become rigid in ethanol. Furthermore it depends on the age of specimens. Therefore this feature is not of high taxonomic value.

In my investigations body length of *L. austriacus* varies from 6 to 9,5 mm.

4.2. Head and antennae

Measurements of the head are better because this sclerotized part of the body does not deform in ethanol. The measured lengths are indicated in Fig. 3. The results are shown in Table 1. The absolute values of head length and width increase more or less with each moult. Therefore it is better to estimate the ratio between the two features. It can be then a useful taxonomic character.

Table 1 Head length and width of *L. austriacus*

n	ø head length in mm	SD	ø head width in mm	SD	proportion length to width	SD
51	0,77	0,08	0,76	0,09	1,02	0,08

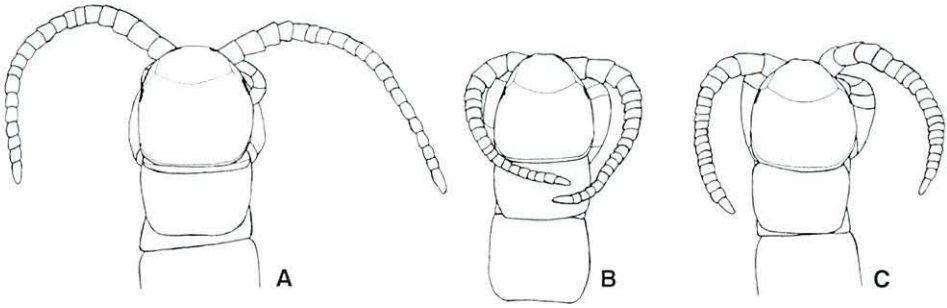

Fig. 2 Variability of antennal size (see text for explanation)

The shape of the head and of the antennae varies very widely. The specimens from Deutsch Paulsdorf are distinguished by a longish head shape generally, often linked with long antennae (Fig. 2 A). In contrast the heads of individuals from Osterzgebirge are mostly as broad as long or broader (Fig. 3 A, B), often with very compact antennae (Fig. 2 C). The series from Dübener Heide has an intermediate position: mostly the specimens are similar to these of Deutsch Paulsdorf, seldom resembling individuals from Osterzgebirge. In most cases the head is as long as broad and roundish (Fig. 3 B) with rather compact antennae (Fig. 2 B).

The established differences are only general tendencies and not statistically significant.

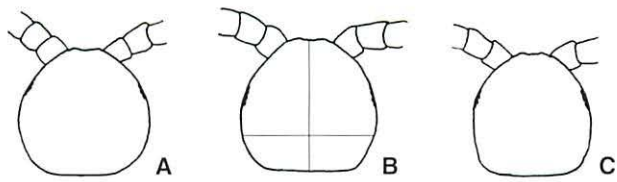

Fig. 3 Variability of head size

The number of antennal articles varies between 17 and 23:

17:	1 ind.	20:	78 ind.	21:	5 ind.
18:	1 ind.			22:	-
19:	9 ind.			23:	1 ind.

The lower numbers are always in conjunction with very sturdy antennae.
In some cases the right site differs from the left. This seems to be a result of injury.

4.3. Number of ocelli

In adults the number of ocelli varies between 3 (only 1 male from Rabenauer Grund), 4, 5 and 6 (only 1 female from Deutsch Paulsdorf), but very seldom differs between the left and right side. FOLKMANOVA (1945) also described specimens with 4 and 5 ocelli. The typical arrangements in adults are shown in Fig. 4 Characteristic of *L. austriacus* is the larger ocellus adjacent to the posterior one.

Fig. 4 Ocelli

4.4. Forcipular coxosternite

Within of the range (Fig. 5) the mostly commonly represented shapes are illustrated in Fig. 5 A-C). There exists no link between coxosternum shape and any one of the populations studied.

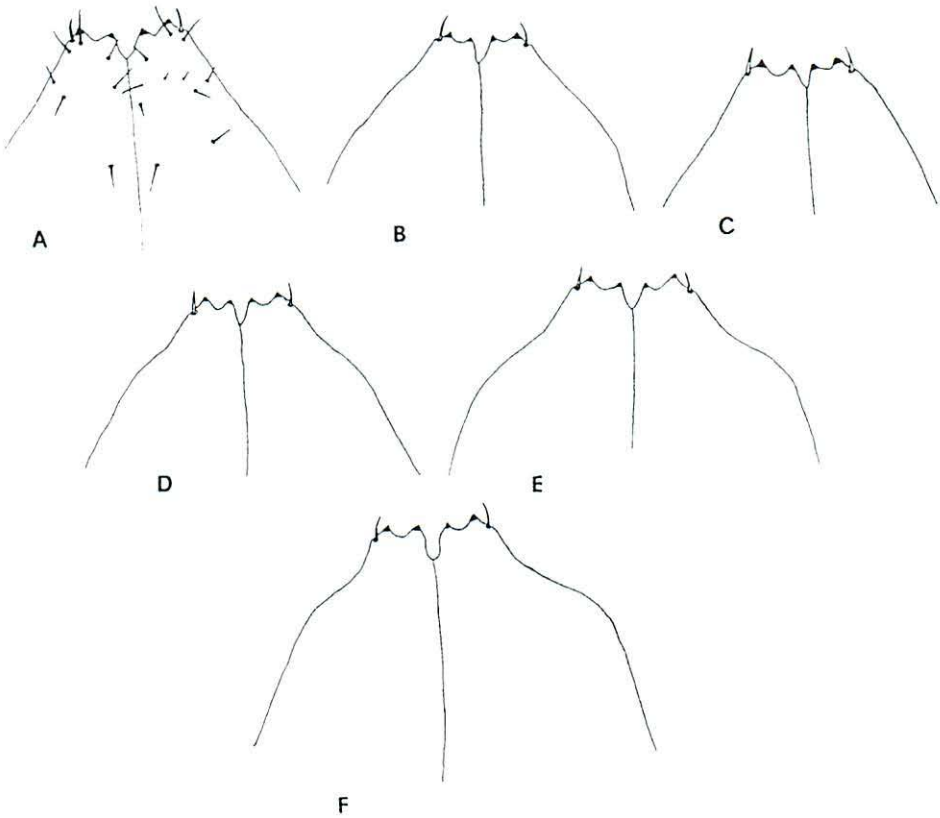

Fig. 5 Variability of forcipular coxosternite

The anterior border of the coxosternum has 2+2 small, recurved and relatively narrow teeth. The lateral pairs project clearly further forwards. The median sinus is V-shaped. Lateral to the parodontal spines the anterior border slopes irregularly backwards (slanting or a little concave) with the formation of very feeble shoulders. In rare cases the shoulders can be absent or rounded. The setae are relatively sparse and the arrangement seems to by very variable. Fig. 4 A shows two possible forms of the right and left half respectively.
The shape pictured in Fig. 4 F, differs most markedly from the typical form. This coxosternum with its very pointed anterior border and the deep and drop-shaped median sinus strongly reminds one of *L. aeruginosus* (see KOREN 1992, Fig. 36 g).

4.5. Female genitalia

For the study of the gonopods 73 females were available. They were prepared (lateral, inside) and examined with a magnification of 160 times.

1st article of gonopods. All specimens examined have 2+2 spurs on the basal articles of the gonopods. More than 50 % show an arrangement of setae as in Fig. 6. In the rest of the females the number of setae varies between 4 and 12, most commonly 8 or 9.

2^{nd} article of gonopods. In Fig. 6 the most commonly found setal arrangements are shown. 52 of the studied females (71,2 %) had 3 strongly developed dorsolateral setae on the base of the 2^{nd} article (Fig. 6 A), 17 with 2 only (Fig. 6 B). In 4 females their occurs an additional 4^{th} seta, which stands lateral and staggered near d_3. On the proximal end a d_4 seta exists in all females, as well as the long seta near it. The number of setae on the inner lateral side mostly varies from 6 to 8, rarely more or fewer (4-10) are found.

It is not clear whether the arrangement, the absence or presence of some setae, could be a good distinguishing feature between *L. austriacus* and *L. aeruginosus*. LOKSA (1947) mentioned a distal dorsolateral seta on the second article of the gonopod (one of the long dorsolateral setae ??).

Claw of gonopods. The claw of all female gonopods is tridentate and pointed. The chaetotaxy is shown in Fig. 6. In 2 females the middle seta is absent and 3 other individuals have 2 setae next to one another. The gonopod bears a small peg-like lateral denticle at the base of the claw (Fig. 6 C). This peg sits on a little hump, which varies clearly in growth and shape.

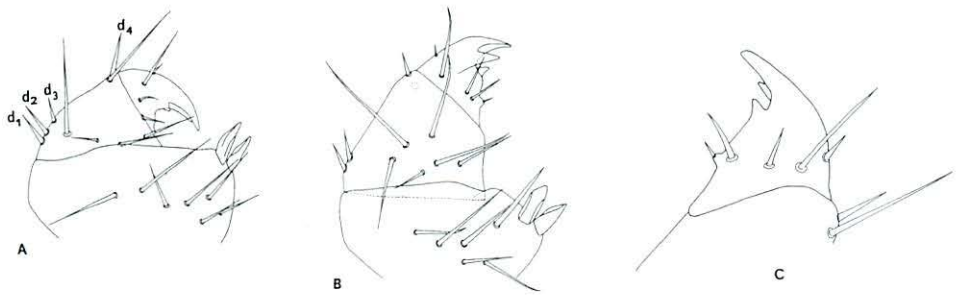

Fig. 6 A, B - female gonopod (inner lateral side), C - claw of the gonopod

4.6. Male genitalia

The male genitalia is shown in Fig. 7. The gonopod consists of a single article. The second genital sternite has one pair of setae. The short setae of the first genital sternite are more or less numerous.

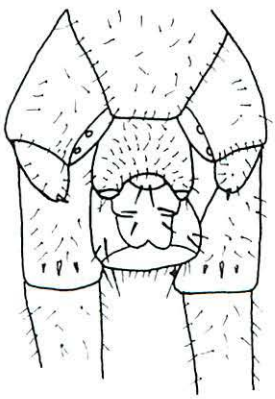

Fig. 7 Posterior end, ♂ (ventral)

4.7. Legs

4.7.1. Brief description

The 14th and 15th legs are markedly swollen in both sexes, particularly the 14th; both are without accessory apical claws (Fig. 8 A, B and 9).
In males the 15th prefemur is strongly thickened (Fig. 9 A) on average 1,4x as long as broad, in females twice as long as broad (Table 4, length a). Characteristic of males is a stout DpP with three teeth (Fig. 9 B). The 15th femur is barely twice as long as broad. Coxal pores are round and arranged in a single row - in females mostly 3332, in males 2332.

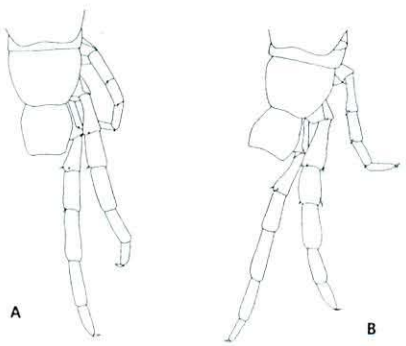

Fig. 8 Posterior end and last legs of two ♀♀

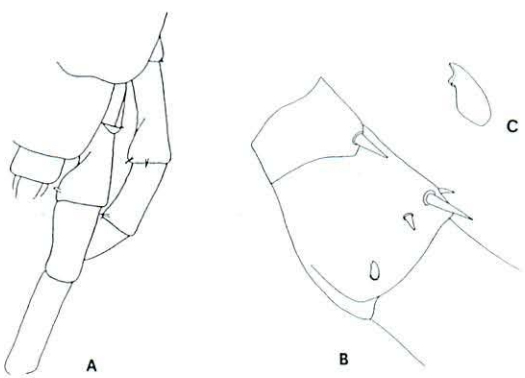

Fig. 9 A - Posterior end, ♂ (dorsal), B -thickened 15th prefemur, ♂ (dorsoventral), C - spine with 3 teeth (DpP) of the 15th prefemur

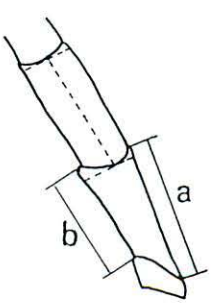

Fig. 10 Mesurement lines on prefemur and femur of 15th leg

Spinulation

	ventral					dorsal				
	C	t	P	F	T	C	t	P	F	T
1			p	am	am			p	a p	a
2				am	am			p	a p	a p
3				am	am				a p	a p
4				am	am				a p	a p
5				am	am				a p	a p
6				am	am				a p	a p
7				am	am				a p	a p
8				am	am				a p	a p
9				am	am				a p	a p
10				am	am				p	a p
11				am	am				p	a p
12			mp	amp	am				p	p
13			mp	amp	am			p	p	p
14		m	amp	am		a		mp	p	
15		m	amp	m		a		mp		

4.7.2. Length and width of prefemur and femur of the 15th legs

The length and width of prefemur and femur of the 15th leg were measured under the stereo-microscope at a magnification 12,5 x 2,5. The lines of measurement are marked in Fig. 10. I have first measured the length of prefemur to the top of trochanter (Fig. 10, b) ventrally in order to have a fixed point. This measurement is used for comparisation with results of later investigations on *L. aeruginosus*. A second measurement line is lateral to the coxa. I think, this could be the same as that made by VERHOEFF (1937). He says »seitlich«. Therefore it can be compared directly with Verhoeff's measurements. The results can be seen in the tables 2-5.

Table 2 Mean length and width of 15th prefemur
a - mean length laterally including trochanter, b - mean length ventrally excluding trochanter

	n	mean length a in mm	SD	mean length b in mm	SD	mean width in mm	SD
♂♂	24	0,376	0,064	0,257	0,038	0,268	0,045
♀♀	55	0,438	0,062	0,307	0,044	0,218	0,034

Table 3 Mean length and width of 15th femur and their relation

	n	mean length in mm	SD	mean width in mm	SD	length/width
♂♂	24	0,383	0,048	0,221	0,028	1,74
♀♀	55	0,412	0,052	0,222	0,041	1,85

Table 4 Relation length/width of 15th prefemur
a - mean length laterally including trochanter, b - mean length ventrally excluding trochanter

	length a/width	length b/width
♂♂	1,40	0,96
♀♀	2,00	1,40

Table 5 Relation between mean length of prefemur (P) to femur (F) of the 15th leg
a - mean length laterally including trochanter, b - mean length ventrally without trochanter

n	relation mean length a P/F	relation mean length b P/F
♂♂	0,98	0,67
♀♀	1,06	0,74

According to the description given by VERHOEFF (1937) prefemur and femur in males should be of the same length approximatly. The femur should be nearly twice as long as broad. This is the same as in my investigation.
It would be very interesting to know which proportions occur in the 15th legs of *L. aeruginosus*. The comparisation can then give information about the real value of this characteristic in distinguishing the two species.

4.7.3. Variation in spinulation of legs

The spinulation Table 6 were made up on the basis of 120 individuals. For this, for one side of the body, a preparation of each leg was made and observed at a magnification of 160 times. In few cases (see the differences between the numbers) some legs were absent. The following variations were observed:

Table 6 Variations in legs (reg-regenerated)

	ventral						dorsal					
	C	t	P	F	T	n	C	t	P	F	T	n
1st legs												
			p	am	am	56			p	a p	a	55
				am	am	25			p	a	a	25
			p	am	m	17			p	a p	a p	8
				am	m	12				a p	a	7
				m	m	6				a p	a p	5
				a	am	1				a	a	4
									p	a p	p	2
									p	a p		2
										p	a p	2
										p	p	1
										a	a p	1
												1
									p	p	a	1
									p	p		1
									p		a	1
									p	a	a p	1
						117						117
	C	t	P	F	T	n	C	t	P	F	T	n
2nd leg												
				am	am	60			p	a p	a p	85
			p	am	am	51				a p	a p	21
				am	m	2			p	a p	a	2
				m	m	2					a p	2
				m	am	1				a p	a	1
					am	1				a	a p	1
									p	a p	p	1
									p	p	a p	1
									p	a	a p	1
											a	1
										a p	p	1
						117						117

C	t	P	F	T	n	C	t	P	F	T	n
3rd leg											
			am	am	103				a p	a p	112
		p	am	am	12			p	a p	a p	3
			am	m	2				p	a p	2
			m	am	1					a p	2
			m	m	1						
					119						119
C	t	P	F	T	n	C	t	P	F	T	n
4th leg											
			am	am	116				a p	a p	114
		p	am	am	1				p	a p	2
			am	m	1			p	a p	a p	1
			m	m	1					a p	1
									a p	a	1
					119						119
C	t	P	F	T	n	C	t	P	F	T	n
5th leg											
			am	am	116				a p	a p	114
			am	m	2					a p	2
			m	am	1			p	a p	a p	1
									p	a p	1
								p	a p		1
					119						119
C	t	P	F	T	n	C	t	P	F	T	n
6th leg											
			am	am	115				a p	a p	115
		p	am	am	1				p	a p	1
			am	m	1					a p	1
					117						117
C	t	P	F	T	n	C	t	P	F	T	n
7th leg											
			am	am	116				a p	a p	113
			am	m	2				p	a p	2
										a p	1
									a	a p	1
											1
					118						118
C	t	P	F	T	n	C	t	P	F	T	n
8th leg											
			am	am	116				a p	a p	108
			am	m	2				p	a p	7
			m	m	1				p	p	2
									a p	a	1
										a p	1
					119						119
C	t	P	F	T	n	C	t	P	F	T	n
9th leg											
			am	am	113				a p	a p	98
			m	m	3				p	a p	16
			m	am	1						2
				am	1					a p	2
					118						118

	C	t	P	F	T	n	C	t	P	F	T	n
10th leg				am	am	105				p	a p	96
				m	am	5				a p	a p	13
				am	m	2				p	p	3
					am	1					p	2
				amp	am	1					a p	1
			m	am	am	1				a	a p	1
				m	m	1,1reg						1reg
						117						117
	C	t	P	F	T	n	C	t	P	F	T	n
11th leg				am	am	71				p	a p	100
				amp	am	18				p	p	10
				m	am	9					p	2
			m	amp	am	4				a p	a p	2
			m	am	am	3						1
				am	m	2			m	p	a p	1
			p	amp	am	2				p	a	1
				m	m	2						
			mp	am	am	2						
			mp	am		1						
			mp	amp	am	1						
			m	am	am	1						
			m	m	am	1						
						117						117
	C	t	P	F	T	n	C	t	P	F	T	n
12th leg			mp	amp	am	63				p	p	90
			mp	am	am	13				p	a p	12
			mp	mp	am	5			p	p	p	8
			mp	m	am	5					p	2
				amp	am	5			m	p	p	1
			p	amp	am	5				p	a	1
				am	am	3				p		1
			m	amp	am	3			p	p		1
			m	am	am	3				a p	a p	1
				m	am	2			mp	p	p	1
			m	m	am	2						
			mp	amp	m	2						
			mp	mp	m	1						
			p	mp	am	1						
				am	a	1						
				m	m	1						
			a	am	am	1						
				mp	am	1						
			amp	am	am	1						
						118						118
	C	t	P	F	T	n	C	t	P	F	T	n
13th leg			mp	amp	am	57			p	p	p	48
			mp	amp	m	21	a		p	p	p	18
			mp	am	am	9			mp	p	p	17
			mp	mp	m	8	a		mp	p	p	12
			mp	mp	am	6			p	p		5
			mp	m	m	2			m	p	p	4
			mp	am	m	2	a		mp	p		4
			mp	m	am	2	a			p	p	2
			amp	am		2					p	1
			amp	am		1				p		1
			mp	m		1	a		m	p	p	1
			m	m	m	1			mp	p		1
				amp	am	1				p	p	1
			p	amp	m	1				p	a p	1
			p	amp	am	1	a		p	p	a	1
			amp	mp	am	1						
				amp		1						
						117						117

C	t	P	F	T	n	C	t	P	F	T	n
14th leg											
	m	amp	am		61	a		mp	p		101
	m	amp	m		18			mp	p		5
	m	mp	m		9			p			3
	m	mp	am		8			mp			2
	m	mp	mp		6			p	p		1
	m	amp	amp		4						1
	m	m	m		3				p		1
	m	amp	am	m	2			m			1
	m	m			1						
	m	mp	mp	am	1						
		amp	m		1						
	m	amp	mp		1						
	m	m			1						
	m	mp			1						
					115						115

C	t	P	F	T	n	C	t	P	F	T	n
15th leg											
	m	amp	m		91	a		mp			72
	m	mp	m		9	a		p			26
	m	mp			3	a		m			6
	m	amp			3	a		mp	p		6
	m	amp	mp		2	a		p	p		1
	m	m	m		1	a		mp	mp		1
	m	m			1	a					
	m	p	m		1						
	m	p	p		1						
					112						112

4.7.4 Variation in coxal pores

Coxal pores are round and arranged in a single row. Females have the following series:

2332	11	females	3332	27	females	4433	2	females
2322	4	females	3432	12	females			
2321	2	females	3322	6	females			
			3433	1	female			
			3422	1	female			
			3443	1	female			

The number of pores in males is less than in females as also the number of possible arrangements:

2332	18	males	3433	2	males
2322	8	males			

Differences between the left and right coxae were very seldom seen.

The number of pores increases with each moult. Females have higher numbers. It can be assumed that they reach later stadia and become obviously older than males. This is one of the things which can be checked in laboratory rearing of *L. austriacus*.

4.8. Tergites

Tergites of anterior half of body are shown in Fig. 2. Posterior angles of T.9, 11 and 13 are rounded with no trace of projections. The posterior border of the intermediate tergite has a feeble indentation (Fig. 11).

Fig. 11 Tergites of posterior half of body (dorsal)

4.9. Integument

In most cases the body of *L. austriacus* is coloured reddish to brownish. Only in a few instances the individuals are more yellowish to orange with a darker head and often a darker end to the bodies. According to FOLKMANOVÁ (1945) *L. austriacus* is darker than *L. aeruginosus*. The integument is very smooth and shiny and, with exception of the posterior edge of tergites, not punctate (Fig. 11).

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