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TRICHOBOTHRIAL PATTERNS DURING POSTEMBRYONIC DEVELOPMENT OF *CYCLOSA CONICA* (PALLAS, 1772) (ARANEAE, ARANEIDAE)

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Abstract –The trichobothrial pattern was studied during the postembryonic development of *Cyclosa conica*. Juvenile and adult specimens have the same trichobothrial pattern but a different number of setae. The considerable difference in the number of trichobothria on the tibias of immature specimens allowed separation into four groups. The distinction in trichobothrial number and pattern between pedipalps of adult male and female spiders is also noted. Mature and immature specimens have the same number of trichobothria on metatarsi I and II.

Key words: Trichobothriotaxy, postembryonic development, *Cyclosa conica*, juveniles, Araneidae

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INTRODUCTION

Trichobothriotaxy, the presence and arrangement of trichobothria on the integument of arthropods, has been widely used in phylogenetic and taxonomic studies of arthropods with gradual larval development (Nayrolles and Betsch 1993, Pomorski 1996, Vachon 1972, 1974). There is a considerable difference between the trichobothrial patterns of immature and adult arthropods and trichobothriotaxy has been argued to represent a good character set for postembryonic and taxonomic studies (Bonaric, Emerit and Calderon 1986, Pomorski, 1996)

Investigations of the trichobothriotaxy of spiders have focused mainly on trichobothrial patterns which serve as an important tool in identification at the species level and are a suitable feature in higher level systematics (Lehtinen 1980, Scioscia 1992). Studies of the correlation between trichobothrial patterns and suitable postembryonic stages in the development of spiders are rare. Trichobothrial patterns have been studied throughout the postembryonic development of *Tryssothele pissii* and *Filistata insidiatrix* (Bonaric, Emerit and Calderon 1986, Emerit and Bonaric 1988). Kaston (1948) stated that the presence, arrangement and location of the trichobothria on the different leg segments were fairly constant for various higher taxa. Emerit (1964) reported that the trichobothria of *Gasteracantha versicolor* followed a progressive developmental pattern and it was possible to identify the different instars of this species using the trichobothrial pattern. In 2006 Tomić studied the trichobothriotaxy of *Araneus diadematus* and found the existence of regularity in the arrangements of trichobothria and the numbers of these setae also.

The objective of this study was to provide the first description of trichobothrial pattern observed during the postembryonic development of *Cyclosa conica*, to propose a nomenclature of particular trichobothria and to create a description model of the immature stages based on the average number of trichobothria for future studies.

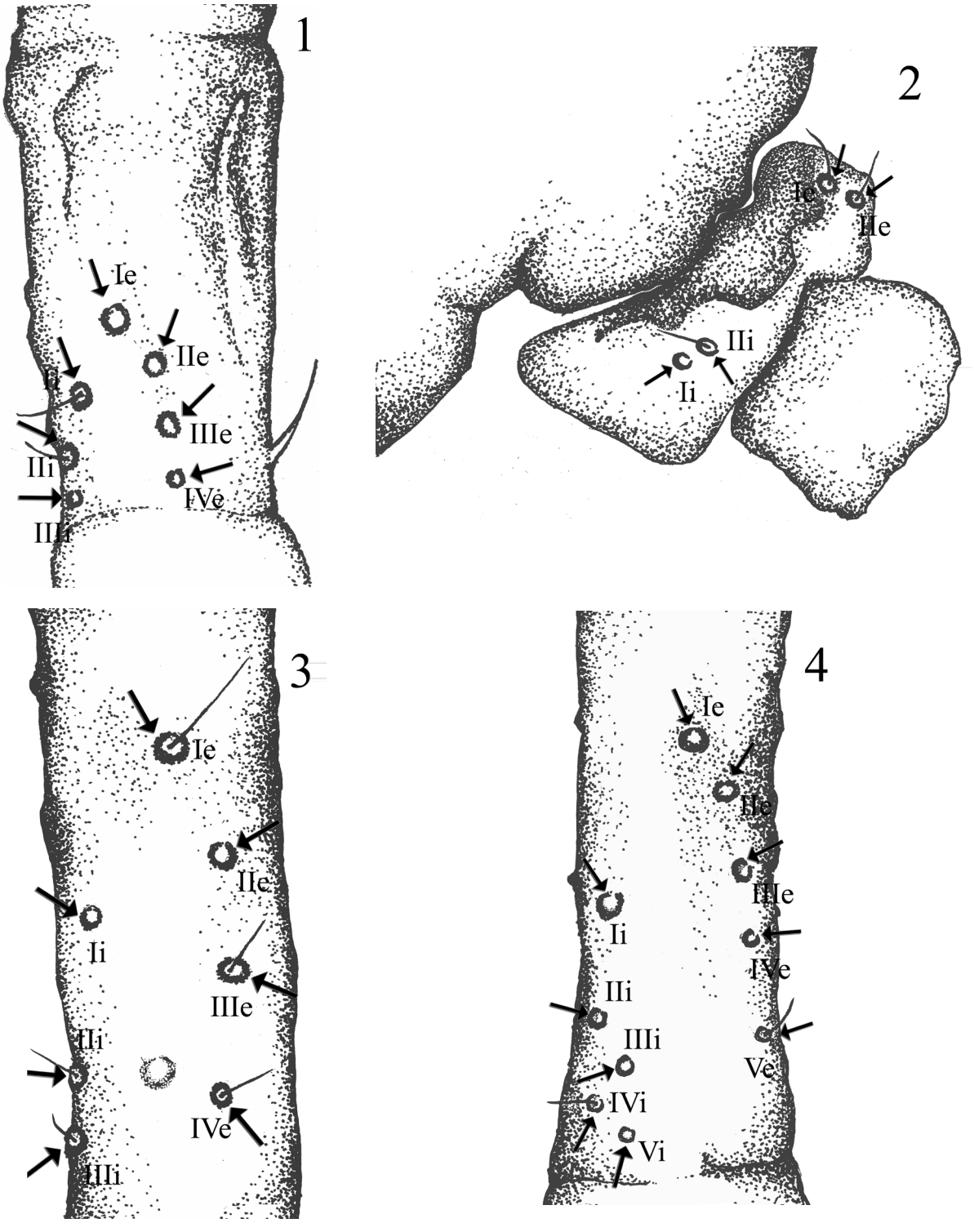
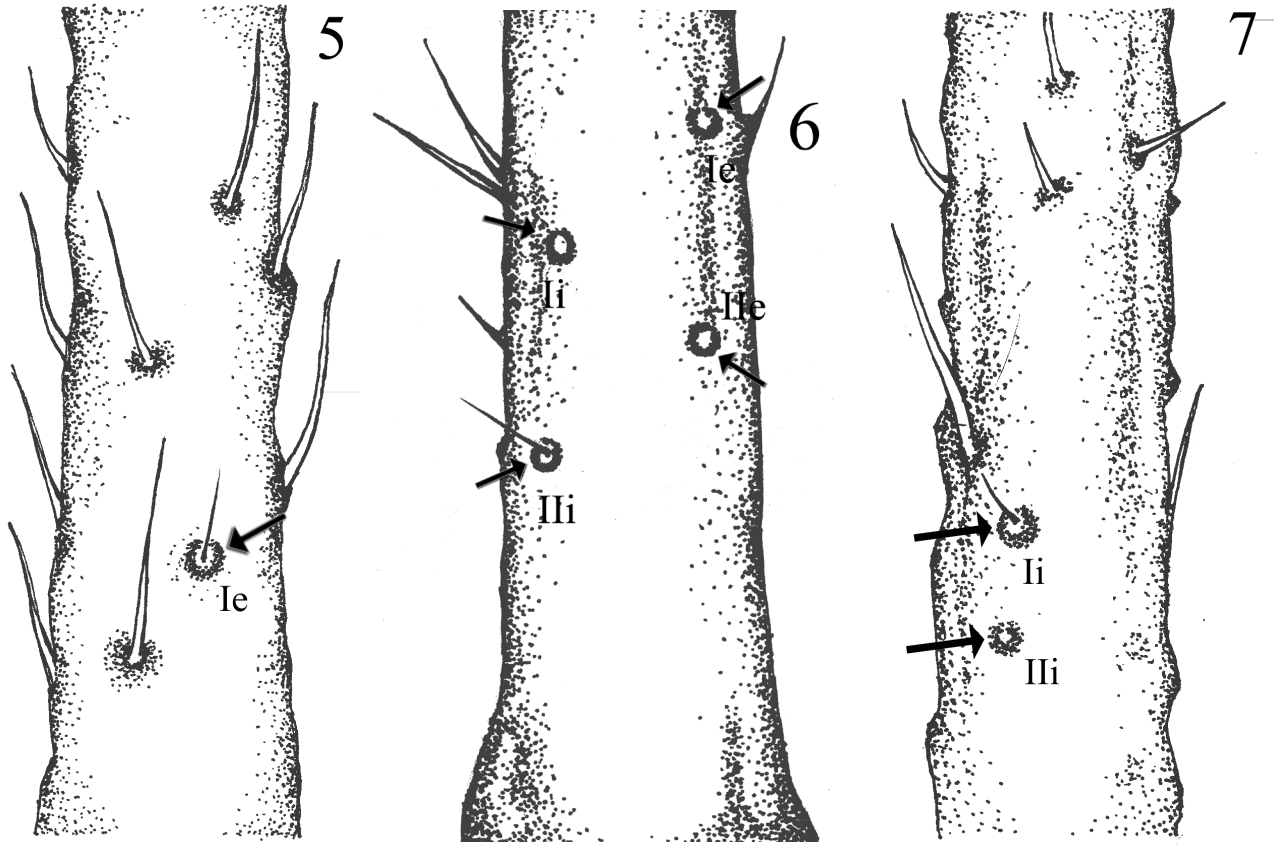


Fig. 1-4. Trichobothrial patterns on the tibia of legs and pedipalps from the right side of *Cyclosa conica* (Pallas 1772) from Košutnjak, Belgrade. 1 – tibia of female pedipalp, 2 – tibia of male pedipalp, 3 – trichobothrial pattern on tibia I, 4 – trichobothrial pattern on tibia IV



Figs 5-7. Trichobothrial patterns on the metatarsi of the legs from the right side of *Cyclosa conica* (Pallas 1772) from Košutnjak, Belgrade. 5 – trichobothrial pattern on metatarsus II, 6 – trichobothrial pattern on metatarsus III, 7 – trichobothrial pattern on metatarsus IV

MATERIALS AND METHODS

Samples of *Cyclosa conica* were obtained from webs in trees from Košutnjak, near Belgrade, over the period March-October 2007. Samples were taken every week and preserved in 70 % ethanol.

Juvenile and adult spiders were identified using a "Stemi 2000 Carl Zeiss" Stereo microscope. The specimens were dissected and mounted on microscope slides. All the specimens were also examined under an "Axioscop Carl Zeiss" microscope and photographed with an "Axiocam" digital camera. In this study, 100 juvenile, 50 adult male and 50 adult female specimens were analyzed.

RESULTS AND DISCUSSION

Analysis of the trichobothrial pattern in *Cyclosa conica* showed that juvenile and adult specimens have the same trichobothrial pattern but different numbers of setae. The number of trichobothria on the dorsal side of the tibia of the pedipalps and legs I-IV of juvenile and adult specimens is shown in Table 1.

Trichobothria appear only on the dorsal side of tibia and metatarsal segments, presumably because they are most exposed to air movements (Barth 2002). For descriptive purposes, we divided the trichobothria on the tibia of legs and pedipalps into external and internal rows (Figs. 1-4). The study showed the dif-

Table 1. Average numbers of trichobothria on the extremities of juvenile specimens and adult males and females of *Cyclosa conica*. PPR –right pedipalp, PPL – left pedipalp, I-IVR – legs on the right side, I-IVL – legs on the left side, $\bar{x}$ j – mean for juvenile specimens, $\bar{x}$ m – mean for adult males, $\bar{x}$ f – mean for adult females, n – total number of analyzed specimens, in - internal side of segment, ext – external side of segment

		$\bar{x}$ j	n	$\bar{x}$ f	n	$\bar{x}$ m	n
PPR	ext	3	100	6	50	2	50
	in	2	100	3	50	2	50
PPL	ext	3	100	6	50	2	50
	in	2	100	4	50	2	50
IR	ext	4	100	6	50	6	50
	in	2	100	3	50	3	50
IL	ext	4	100	6	50	6	50
	in	2	100	4	50	3	50
IIR	ext	4	100	6	50	6	50
	in	2	100	4	50	4	50
IIL	ext	4	100	6	50	6	50
	in	2	100	3	50	3	50
IIIR	ext	2	100	3	50	4	50
	in	4	100	6	50	6	50
IIIL	ext	2	100	3	50	4	50
	in	4	100	6	50	5	50
IVR	ext	2	100	3	50	3	50
	in	4	100	6	50	6	50
IVL	ext	2	100	3	50	3	50
	in	4	100	7	50	6	50

ferences in the trichobothrial pattern on the the tibia of the hind legs which often have an equal or greater number of setae in the internal row (Fig. 4 and Table 1). This particular arrangement of trichobothria on the pedipalps and legs, which is classified as plesiomorphic (Lehtinen 1980), is probably related to the orb-weaving lifestyle of *Cyclosa conica* and the detection of web vibration (Barth 2002).

The classification of trichobothria proposed here is presented in Figs. 1-4 and 5-7. The first trichobothria in the external row is long and arises from a prominent cuticle socket, while the setae near the base of the segment are the smallest ones that emerge from less developed sockets. Fig. 3 shows the morphological differences between the first external and trichobothria which are close to the base of tibia I.

Metatarsus I has only one trichobothria located on the external side (Fig. 5). The trichobothrial arrangement on metatarsus III is similar to that on the tibia (Fig. 6). On metatarsus IV, trichobothria appear on the inner side of the segment, as is shown on Fig.

Table 2. Average number of trichobothria on metatarsi of legs I-IV of *Cyclosa conica*. I-IVR – legs on the right side, I-IVL – legs on the left side, $\bar{x}$ j – mean for juvenile specimens , $\bar{x}$ a – mean for adult specimens, n – total number of analyzed specimens, in – internal side of segment, ext – external side of segment

		$\bar{x}$ j	n	$\bar{x}$ a	n
IR	ext	1	100	1	100
	in	0	100	0	100
IL	ext	1	100	1	100
	in	0	100	0	100
IIR	ext	1	100	1	100
	in	0	100	0	100
IIL	ext	1	100	1	100
	in	0	100	0	100
IIIR	ext	2	100	2	100
	in	2	100	3	100
IIIL	ext	2	100	2	100
	in	2	100	3	100
IVR	ext	0	100	0	100
	in	1	100	2	100
IVL	ext	0	100	0	100
	in	1	100	2	100

Table 3. Trichobothrial numbers on tibiae and metatarsi of juvenile and adult specimens, pp-pedipalps; I-IV – locomotor legs

		tibiae				metatarsi	
juveniles	pp	0-1	2-4	5-7	8-9	-	-
	I	3-6	4-7	5-7	6-9	1	1
	II	3-6	4-7	5-7	6-9	1	1
	III	3-6	4-8	5-8	7-9	2	3-5
	IV	3-6	4-8	5-8	7-9	2	2
adult males	pp	2-3	4-5			-	-
	I	8-10	8-11			1-2	-
	II	8-10	8-11			1-2	-
	III	8-10	8-11			4-6	-
	IV	8-10	8-11			2-4	-
adult females	pp	7-9	10-11			-	-
	I	7-9	10-11			1-2	-
	II	7-9	10-11			1-2	-
	III	8-11	10-11			4-6	-
	IV	8-11	10-11			2-4	-

7. The distribution of trichobothria on the dorsal side of the metatarsi of legs I-IV of juvenile and adult specimens is shown in Table 2.

The difference in trichobothrial number and pattern between the pedipalps of adult male and female spiders is also noted. While male pedipalps have a smaller number of setae and irregular distribution of trichobothria in both rows (Fig. 2), female pedipalps exhibit trichobothriotaxy similar to those on legs I and II (Fig. 1). This difference is caused by developmental changes in the male pedipalp prior to the final molting (Bartos, 1997).

The difference in trichobothrial number between juveniles and juvenile and adult specimens for tibia and metatarsal segments are shown in Table 3. The considerable differences which exist in the number of trichobothria on the tibias of immature specimens allow them to be separated into four main groups. The tibia trichobothria of *Cyclosa conica* follow a progressive developmental pattern and they may be characteristic for certain postembryonic stages.

The first group represents juvenile specimens with none or just 1 trichobothrium on the pedipalps and 3 to 6 trichobothria on the tibiae of the legs. These spiders are small, with yellowish prosoma; undeveloped sexual organs and a less differentiated conical protuberance on the posterior end of the opisthosoma. It could be assumed that spiders with a very low number of tibial trichobothria represent the earliest postembryonic stages.

In the second group are spiders with 2 to 4 trichobothria on the pedipalps and 4 to 7 on the forelegs or 4 to 8 tibial trichobothria on hind legs.

The third group consists of specimens with 5 to 7 setae on the pedipalps and legs I and II. The number of trichobothria on tibia III and IV is 5 to 8, respectively.

Spiders in the second and third groups have a similar size but are larger than those in the first group. They are also more pigmented with differentiate protuberances.

Juveniles with a number of setae between 7 and 9 represent the fourth group of specimens. This group of immature specimens is similar in morphological appearance to adults and has developed but nonfunctional sexual organs. It could be presumed that they represent the subadult level.

All the juveniles have only one trichobothrium on the dorsal side of metatarsi I and II. It seems that metatarsal trichobothria on legs I and II appear early during postembryogenesis, and the number of setae on these segments remains constant until spiders reach adult level.

CONCLUSIONS

The trichobothrial patterns in all examined specimens of *Cyclosa conica* have a similar arrangement. However, adult spiders have a larger number of trichobothria, which could prove helpful to distinguish mature and immature stages.

Adult males and females show similar setae arrangements with the exception of the pedipalps.

There are detectable differences in intra-juvenile tibia trichobothrial arrangement which could be an important indicator for instar determination due to the greater variability in the number of trichobothria on this segment. This preliminary study shows that trichobothriotaxy may provide some additional morphological evidence for accurate instar determination, not only for *Cyclosa conica,* but also for other spider species.

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REFERENCES

Barth, G. F. (2002). A Spiders World: Senses and Behavior. Springer-Verlag, Berlin, 1-387

Bonaric, J. C., Emerit, M., and *R. Calderon* (1986). Utilisation des baremes trichobothriotaxiques comme critère d´âge chez la mygale *Tryssothele pissii* (Araneae, Dipluridae). *Mém. Soc. r. belge Ent.* **33**, 37-46.

Emerit, M., and *J. C. Bonaire* (1988). Contribution a l'etude du developpment postembrryonnaire de *Filistata insidiatrix* (Forskoel): la trichobothriotaxie et son evolution. *Col. europ. Arachnol., Bull.Soc.sci.Bretagne*, **59**, 53-63.

Emerit, M. (1964). La trichobothria et ses variations du developpement postembryonnaire chez 1'araignée *Gasteracantha veriscolor. C. R . Acad. Sci., Paris*, **258**, 4843-4845.

Kaston, B. J. (1948). Spiders of Connecticut. Bull. *Connecticut Geol Natur. Hist. Surv*, **70,** 25-60.

Nayrolles, P., and *J. M. Betsch* (1993). Pour une théorie de la description chétotaxique chez les colleboles. *Annales de la Société Entomologique de France (N.S.),* **29**, 5-15.

Pomorski, R. J. (1996). The first instar larvae Onychiurinae - a systematic study (Collembola: Onychiuridae). *Genus,* **7,** 1-102.

Scioscia, C. L. (1992). Evolución de la tricobotriotaxia durante el desarrollo de tres Salticidae neotropicales (Araneae). *EOS.* **68**, 99–206.

Tomić, V. T. (2006). Diverzitet paukova (Aranea, Arachnida) Avale i prirodnog rezervata "Obedska Bara": uporedno-morfološka obeležja, polimorfizam i evolutivna sistematika. Doktorska disertacija, Biološki fakultet, Univerzitet u Beogradu. Beograd, 1-228.

Vachon, M. (1972). Sur l'établissement d'une nomenclature trichobothriale uniforme convenant à l'ensemble des Scorpions (Arachnides) et l'existence de trois types distincts de trichobothriotaxie. *Comptes Rendus des Séances de l'Académie des Science, Paris, (D),* **275**, 2001-2004.

Vachon, M. (1974). Étude des caractères utilisés pour classer les familles et les genres de Scorpions (Arachnides). 1. La trichobothriotaxie en Arachnologie, Sigles trichobothriaux et types de trichobothriotaxie chez les Scorpions. *Bulletin du Muséum National d'Histoire Naturelle, Paris*, **3(140)**, 857–958.