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Revision of ocular anomalies in epigean spiders (Arachnida:Araneae) with notes on four new records

Ocular anomalies in spiders are more frequent than other deformities of external features (Ono & Kudo 1996. *Acta Arachnologica 45*(1):73-75. The lack of or reduction in eye size in epigean spiders has been recorded in about 76 species around the world, in 22 families, most frequently in members of the family Lycosidae (Denis 1939. *Enseignement des Sciences 12*(116):163-171; Kaston 1962. *Bulletin of the Brooklyn Entomological Society 57*:17-21; Kaston 1982. *Journal of Arachnology 10*:279-281). The morpho-funtional meaning of these findings in epigean spiders is not well defined and it has been explained in only some species (Rovner 1993. *Memories of the Queensland Museum 33*:635-638; Rovner 1996. *Journal of Arachnology 24*:16-23). These phenomena are more frequently seen in hypogean spiders, as an adaptive response to total darkness environments, where all eyes or at least some of them are not necessary (Gertsch 1979. Van Nostrand Reinhold Co. 274 p.; Sanocka 1982. *Zoologica Poloniae 29*(1-2):13-21).

The first teratological record in epigean spiders dates from 1925, and it describes a protuberance located in place of a left posterior lateral eye of one specimen, probably of the subfamily Erigoninae (Bishop 1925. *New York State Museum Bulletin 260*:39-41). Since then, diverse anomalies have been found. Denis (1939 *op. cit.*) recorded 35 cases, and Kaston (1962. *Bulletin of the Brooklyn Entomological Society 57*:17-21) found nine cases and later six more (Kaston 1982 *op.cit.*). The most recent works on anomalies belong to Jacunski & Mroz-Wolosowics (1991. *Przeglad Zoologiczny 34*:423-425), Gregory (1992. *Newsletter of the British Arachnology Society 63*:3.), Ruffell & Kovoor (1994. *Newsletter of the British Arachnology Society 70*:12-13), Kenny (1996. *Newsletter of the British Arachnology Society 76*:6), Ono & Kudo (1996. *Acta Arachnologica 45*(1):73-75) and Garb (1999. *Journal of Arachnology 27*:539-541).

In this study, we analyzed ocular deformations of spiders that belong to different families, with the object of finding tendencies in frequency that relate to these anomalies. Finally, we discuss specimens recently found in North America.

The ocular anomalies of 75 epigean spiders were analyzed; 71 of them were found in previous studies (Denis 1939 *op. cit.*; Roth 1954. *American Museum Novitates 1678*:1-7; Kaston 1946. *American Museum Novitates 1306*:1-19; Kaston 1962 *op. cit.*; Kaston 1972. *Entomological News 83*:117-118; Kaston 1982 *op. cit.*) and four unpub-

lished specimens in North America. Spider searches are made with some accompanying hazard, so there is no method specifically designed to find new cases, except for the meticulous review of collected specimens. In this research, we establish a nomenclature in order to classify all the variants of anomalies found to the present. The anomalies listed below (Table 1) refer to individuals of different species, with the exception of five specimens that belong to the genus *Trochosa* (Lycosidae), one specimen of *Meta* (Tetragnathidae), and one of the genus *Oonops* (Oonopidae).

The number of anomalies is greater than the number of specimens because one specimen can hold several malformations. For instance one specimen lacks the anterior median eyes and has reduced posterior median eyes and posterior lateral eyes. Therefore, three types of deformities in the same individual, absence, bilateral, and unilateral reduction.

Ocular anomalies are recorded in epigean spiders of the families Lycosidae, Linyphiidae, Tetragnathidae, Amaurobiidae, and Agelenidae. Lycosidae represents 20% of the individuals with deformities, mainly in the genera *Trochosa*, *Hogna*, and *Arctosa*, with a trend towards a decrease in number of anterior eyes. Specimens of *Trochosa pratensis* (Emerton 1885) had five anomalies (Denis 1939 *op. cit.*; Gregory 1992. *Newsletter of the British Arachnology Society 63*:3; this work). Ocular anomalies are also common in Linyphiidae (12%), Tetragnathidae (8%), Amaurobiidae (7%) and Agelenidae (7%). Ocular anomalies do not represent any specific species or a definite pattern, with the exception of *T. terricola* Thorell 1856, *Meta segmentata* (Clerck 1757) and *Oonops pulcher* (Denis 1939 *op. cit.*; Ruffell & Kovoor 1994 *op. cit.*). These frequencies correspond to the number of cases of anomalies published to the present, but obviously this does not mean that these families display these frequencies in their general populations.

With the exception of Lycosidae and Linyphiidae, which are very diverse, the results given in ocular anomalies do not coincide with the relative abundance in these families.

From the 98 ocular anomalies recorded, the highest frequency (9.3%) was related to the lack of posterior median eyes (APME) and nonspecific anomalies (NSA); followed by 8.3% without lateral eyes (ALEs) and 7.3% belong to the lack of two to six eyes on different locations (AEs) and the absence of the posterior lateral eye (APLE) (Table 1). Records where the number of eyes were greater than normal were rare (INEs). There were only two records of this kind of anomalies; one for *Latrodectus hesperus* Chamberlin & Ivie 1935 (Kaston 1968. *Entomological News 79*:113-124), other one for *Oonops pulcher* Templeton 1835 (Ruffell & Kovoor 1994 *op. cit.*).The presence of a bulge in place of an eye or within the ocular area (PH)(Bishop 1925 *op. cit.*; Denis 1948. *Bulletin de la Societe Scientifique de Bretagne 22*:111-112) and the fusion of the anterior median eyes (FAMEs) (Kaston 1962 *op. cit.*; this work) are less common, having been recorded only two times for each case. Extremely rare was to find eight eyes in the ophistosoma of *Misumenops anguliventris* Simon 1900 (OE)(Garb 1999. *Journal of Arachnology* 27:539-541), and also those instances

Table 1. Ocular deformities in epigean spiders: **APME**. Absence of one posterior median eye; **ALEs**. Absence of lateral eyes; **AEs**. Absence of two to six eyes; **APLE**. Absence of one posterior lateral eye; **AAMEs**. Absence of anterior median eyes; **AALE**. Absence of anterior lateral eye; **AALEs**. Absence of anterior lateral eyes; **APMEs**. Absence of posterior median eyes; **APE**. Absence of one posterior eye; **AAME**. Absence of anterior median eye; **AMEs**. Absence of median eyes; **APEs**. Absence of all posterior eyes; **RPME**. Reduction of one posterior median eye; **RPMEs**. Reduction of posterior median eyes. **RAE**. Reduction of anterior eye; **RALEs**. Reduction of anterior lateral eyes; **RPLE**. Reduction of one posterior lateral eye; **RPLEs**. Reduction of posterior lateral eyes; **RAEs**. Reduction of anterior eyes; **ROA**. Rotation of ocular area; **DPMEs**. Duplication of corneas or posterior median eyes; **FAMEs**. Fusion of anterior median eyes; **TAEs**. Total absence of eyes; **PH**. Presence of a horn; **INEs**. Increase in number of eyes; **OE**. Ophistosomal eyes; **NSA**. Nonspecific anomalies.

Family	Anomalies	Number of cases	Source
Leptonetidae	APME	1	Denis 1939
Linyphiidae	"	1	Kaston 1982
Tetragnathidae	"	1	Denis 1939
Tetragnathidae	"	1	Kaston 1962
Araneidae	"	1	Denis 1939
Amaurobiidae	"	2	Denis 1939
Amaurobiidae	"	1	Kaston 1937
Zodariidae		1	Denis 1939
Lycosidae	ALEs	1	Denis 1939
Lycosidae	"	3	This work
Dictynidae	"	1	Denis 1939
Clubionidae	"	1	Denis 1939
Gnaphosidae	"	1	Denis 1939
Linyphiidae	"	1	Denis 1939
Lycosidae	AEs	1	Kaston 1972
Lycosidae	"	1	Gregory 1992
Agelenidae	"	1	Kaston 1982
Hahniidae	"	1	Kaston 1962
Amaruobiidae	"	1	Kaston 1962
Prodidromidae	"	1	Kaston 1962
Gnaphosidae	"	1	Ono & Kudo 1996
Oonopidae	APLE	1	Denis 1939
Araneidae	"	1	Kaston 1982
Agelenidae	"	1	Roth 1954
Clubionidae	"	1	Denis 1939
Philodromidae	"	1	Kenny 1996

Table 1. Continues.

Family	Anomalies	Number of cases	Source
Amaurobiidae	"	1	Kaston 1937
Oecobiidae	AAMEs	1	Denis 1939
Nesticidae	"	1	Denis 1939
Lycosidae	"	1	This work
Gnaphosidae	"	2	Denis 1939
Lycosidae	AALE	2	Kaston 1962
Lycosidae	"	1	This work
Lycosidae	"	1	Kaston 1982
Philodromidae	"	1	Kenny 1996
Lycosidae	AALEs	1	This work
Segestriidae	APMEs	1	Denis 1939
Theridiidae	"	1	Denis 1939
Linyphiidae	"	1	Denis 1939
Philodromidae	"	1	Kenny 1996
Lycosidae	"	1	This work
Lycosidae	APE	1	Denis 1939
Heteropodidae	"	1	Kaston 1982
Lycosidae	AAME	1	Denis 1939
Agelenidae	"	1	Jacunski & Mroz-Woldsowics 1991
Dictynidae	AMEs	1	Denis 1939
Gnaphosidae	"	1	Denis 1939
Thomisidae	"	1	Denis 1939
Tetragnathidae	APEs	1	Kaston 1962
Lycosidae	"	1	Denis 1939
Tetragnathidae	RPME	2	Denis 1939
Nesticidae	RPMEs	1	Denis 1939
Oecobiidae	"	1	Denis 1939
Amaurobiidae	RAE	1	Kaston 1937
Heteropodidae	"	3	Kaston 1982

Table 1. Continues.

Family	Anomalies	Number of cases	Source
Nesticidae	RALEs	1	Denis 1939
Oecobiidae	"	1	Denis 1939
Lycosidae	RPLE	1	Kaston 1962
Agelenidae	"	1	Kaston 1982
Clubionidae	"	1	Denis 1939
Philodromidae	"	1	Kenny 1996
Thomisidae	"	1	Denis 1939
Lycosidae	RPLEs	1	This work
Nesticidae	"	1	Denis 1939
Oecobiidae	"	1	Denis 1939
Tetragnathidae	RAEs	1	Kaston 1962
Philodromidae	"	1	Denis 1939
Hahniidae	ROA	1	Muma 1943
Linyphiidae	DPMEs	1	Denis 1945
Lycosidae	FAMEs	1	Kaston 1962
Lycosidae	"	1	This work
Theridiidae	TAEs	1	Kaston 1946
Theridiidae	"	1	Boggild 1962
Linyphiidae	"	2	Denis 1939
Agelenidae	"	1	Denis 1939
Linyphiidae	PH	1	Bishop 1925
Linyphiidae	"	1	Denis 1948
Theridiidae	INEs	1	Kaston 1968
Oonopidae	"	1	Ruffell & Kovoor 1994
Thomisidae	OE	1	Garb 1999
Pholcidae	NSA	1	Denis 1939
Linyphiidae	"	1	Denis 1939
Clubionidae	"	1	Denis 1939
Linyphiidae	"	1	Denis 1939
Ctenizidae	"	1	Ohshimo 1953 & Kageyama 1966
Atypidae	"	1	Ohshimo 1953 & Kageyama 1966

Table 1. Continues.

Family	Anomalies	Number of cases	Source
Uloboridae	"	1	Ohshimo 1953 & Kageyama 1966
Mimetidae	"	1	Ohshimo 1953 & Kageyama 1966
Clubionidae	"	1	Ohshimo 1953 & Kageyama 1966

where several anomalies are combined in a single individual, as in *N. riparia* (Keyserling 1887) (Muma 1943. *Bulletin of the Natural History Society of Maryland 13*(5):80-81), which shows a rotation of the ocular area. The specimen showed the absence of an anterior lateral eye and in its place there was a posterior median eye. There are other rare phenomena, such as *Entelecara congenera* O.P.-Cambridge 1879, which shows a trace of a pair of small corneas on the posterior median eyes (PPMEs) (Denis 1945. *Bulletin de la Societe Zoologique de France 69*(4-5):153-154).

The causes of these deformities are unknown. Nevertheless we agree with Denis (1939 *op. cit.*) that they can be attributed to injuries or illness during the juvenile stages. Their great diversity, diverse behavior, and lack of specific studies on this topic, makes it impossible to say if they are exposed to these risks.

It is difficult to explain the rare case of one specimen of *Castianeira cingulata* (Koch 1841) whose left chelicera, which depends on the same ganglion that innervates the missing left posterior lateral eye, was hypertrophied and developed a palp-like, two-segmented appendage (Kaston 1937. *Bulletin of the Brooklyn Entomological Society 32*:104). In another study, the number of eyes was affected during embryonic development, with duplication of a portion of the cephalic region of a speciment of *Latrodectus hesperus* Chamberlin & Ivie 1935 (Kaston 1968. *Entomological News 79*:113-124). In these two cases, we agree with the authors that the anomalies are the result of an embryonic duplication. Other possibility, such as homeotic gene expression, is not admissible because these anomalies only were present in the cephalic area, and not in other regions, as in the case of *Misumenops anguliventris* Simon 1900, which had a second set of eight eyes on its ophistosome, a phenomenon considered by Garb (1999 *op. cit.*) as an alteration in a major regulatory gene.

Ocular anomalies in spiders most often involve reduction or absence of the secondary eyes (Table 1). Another trend is the relatively high frequency of such anomalies in some species of the Lycosidae, particularly those that are active at night.

Wolf spiders tend to rely more on their mechanoreceptors for detection of prey and for communication (Rovner 1989. *Animal Behaviour* 38:526-533; Lizotte & Rovner. 1988. *Animal Behaviour* 36:1809-1815). It might be that these anomalies are more tolerable for nocturnal spiders than for diurnal ones, therefore they ap-

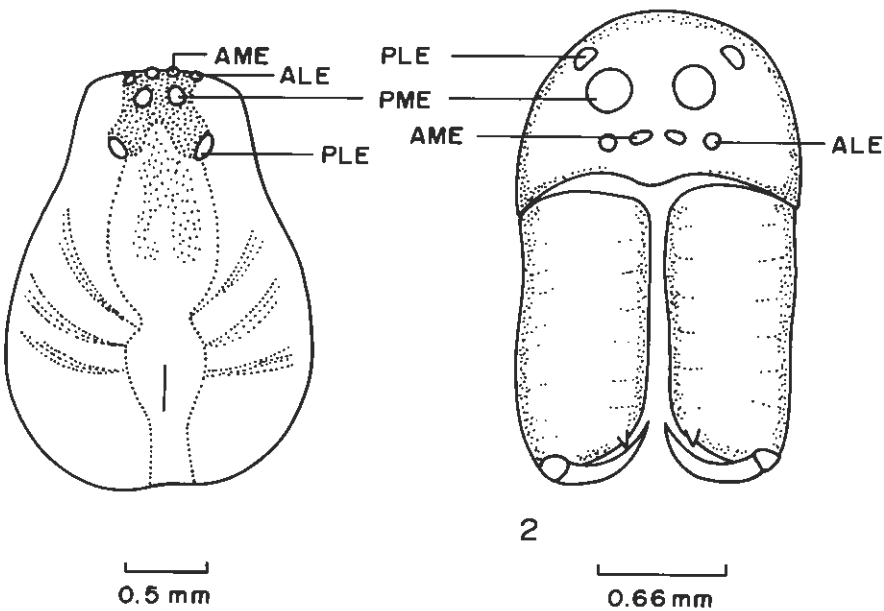
parently appear in higher frequency in nocturnal spiders. The eyes and tactile and chemical receptors have been studied in lycosids by Rovner (1993. *Memories of the Queensland Museum 33*:635-638, 1996. *Journal of Arachnology 24*:16-23), showing that these spiders are well provided with sense organs so that a perceptive loss can be accommodated in adverse situations.

In most of the spider families, sight is not of vital importance for the capture of prey. With the exception of the Salticidae and Lycosidae, this sense plays a minor role in courtship and mating behavior. This is particularly true of nocturnal spiders, which are more dependent on tactile or chemical stimuli than on their sight (Foelix 1996. Oxford University Press 330 p.). Loss of sight in these spiders would probably not strongly modify their behavior.

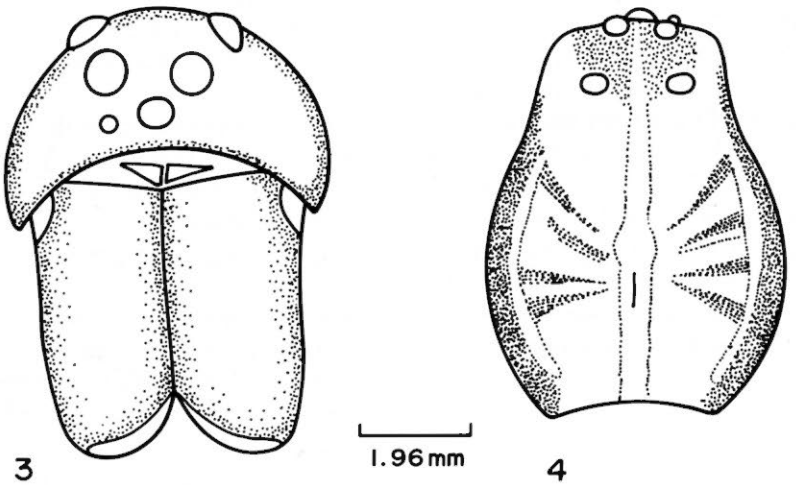
The ocular anomalies in spiders recorded to the present are the result of fortuitous findings during taxonomic reviews. Only a few cases have been recorded. It is necessary to carry out specific studies in order to judge anomaly frequencies in spider populations and trends in some families, as our results suggest.

The following descriptions are intended to add evidence to this phenomenon. Figures 1-2 show normal number of eyes in Lycosidae.

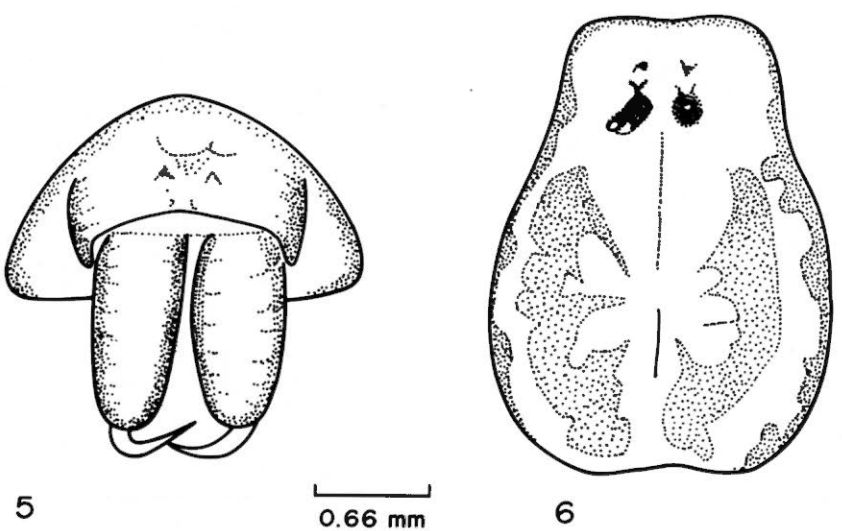
Hogna ca. *helluo* (Walckenaer 1837)



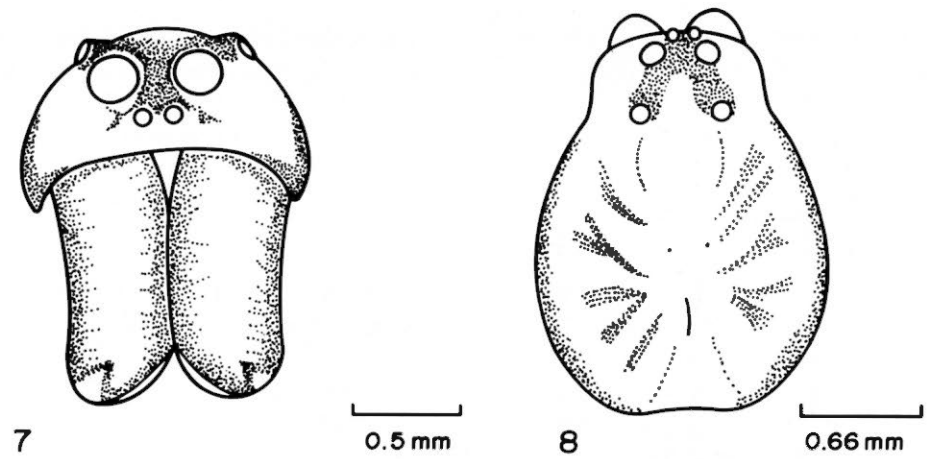
Figures 1-2. Female *Trochosa terricola* Thorell from Ontario. (1) Prosoma dorsal view; (2) Prosoma, frontal view. AME. Anterior median eyes; ALE. Anterior lateral eyes; PME. Posterior median eyes; PLE. Posterior lateral eyes.



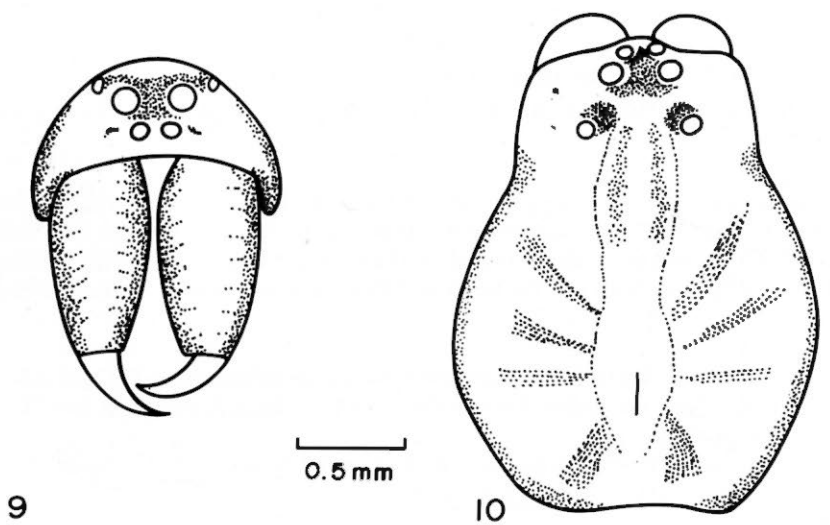
Figures 3-4. Female *Hogna ca. helluo* (Walckenaer) from Louisiana. (3) Prosoma, frontal view, Posterior ocular row is lightly rotated toward the left. Anterior median eyes area united, left anterior lateral eye is absent. (4) Prosoma, dorsal view.



Figures 5-6. Immature *Arctosa sp.* from Baja California Sur. (5) Prosoma, frontal view, median and anterior lateral eyes are absent, posterior median eyes are represented by dark spots. (6) Prosoma dorsal view, left posterior eye is represented by a reduced cornea.



Figures 7-8. Male of *Hogna ca. frondicola* (Emerton) from Texas. (7) Prosoma, frontal view, anterior lateral eyes are reduced as two comma-like spots. (8) Prosoma, dorsal view.



Figures 9-10. Female of *Trochosa terricola* Thorell from Connecticut. (9) Prosoma, frontal view, anterior lateral eyes are reduced as light marks of pigment. (10) Prosoma, dorsal view.

(Figs. 3-4)

Female collected in St. Gabriel Parish, Louisiana, United States, by F.W. Howard, with pitfall traps in Bermuda pasture, 13. VII. 72. This specimen shows a light rotation of the posterior ocular row toward the left in frontal view (Fig. 3). The anterior median eyes are united, forming only one eye which is almost the size of the posterior median eyes. The left anterior lateral eye is absent (Fig. 4).

Arctosa sp.

(Figs. 5-6)

Juvenile collected in Las Pocitas Region (24°23'-24°53'N, 110°47'-111°14'W), Baja California Sur, México, by M.L. Jiménez, in a small burrow under stones of the bank of a spring, 24 IV 95. It lacks the median and anterior lateral eyes, and posterior median eyes are represented by spots of dark pigment. Of the left posterior lateral eye, there is only a reduced cornea, surrounded by dark pigment. There is a dark spot in the place of the right eye (Figs. 5-6).

Hogna ca. *frondicola* (Emerton 1885)

(Figs. 7-8)

Male collected on the ground in Archer County, Texas, United States, by R.C. Vogtsbeger, 7 IV 87. This specimen lacks anterior lateral eyes and in its place there are only two comma-like spots (Figs. 7-8).

Trochosa terricola Thorell 1856

(Figs. 9-10)

Female collected from under rocks in Storrs, Conn. United States, by L.N. Sorkin, 16. V. 96. It lacks anterior lateral eyes and in their place are light marks of pigment (Figs. 9-10).

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