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POSTEMBRYONIC DEVELOPMENT OF THE OPTIC LOBE IN *LESTES EURINUS* SAY AND *AESHNA MIXTA* LATREILLE: VOLUMETRIC GROWTH (ZYGOPTERA: LESTIDAE; ANISOPTERA: AESHNIDAE)

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The postembryonic development of the optic lobe was studied from the early larval instars to the adult stage. The volumetric growth of the lobe and some of its structures were analyzed in relation to the growth of the brain and the compound eye. The evidence obtained indicates a continuous growth of the optic lobe throughout larval life, some structures developing at a faster pace than the others. Some differences have also been noted between Zygoptera and Anisoptera, particularly with reference to the lamina.

INTRODUCTION

In Anisoptera the postembryonic development of different structures of the visual apparatus has been studied, among others, by MOUZE (1967, 1972a, 1972b, 1974, 1975, 1978a, 1978b, 1979, 1980). According to LERUM (1968) and Mouze (1972a), the optic lobe in Anisoptera is growing especially during metamorphosis and it is during that period that there is a reorganization of the lamina.

In Zygoptera, some authors have studied the compound eye (NINOMIYA et al., 1969; LAVOIE et al., 1975, 1978a, 1978b; LAVOIE-DORNIK, 1983; LAVOIE-DORNIK & Pilon, 1984). However, there are in this suborder few detailed studies on the histology, morphology and growth of the optic lobe (LULL, 1975). MARULLO (1984) and MARULLO et al. (1987) have studied the morphology of the optic lobe of *Lestes eurinus* and its development from early instars to the adult stage.

The objectives of the present study are to analyze the volumetric growth of the optic lobe of *Lestes eurinus* and *Aeshna mixta* in relation to the growth of the brain and the compound eye; to verify whether some structures develop more rapidly than others; to evaluate the importance of the changes taking place during metamorphosis and to determine whether there are any differences between Anisoptera and Zygoptera in this area.

MATERIAL AND METHODS

Specimens were obtained from laboratory rearings where larvae hatching from eggs were individually reared at room temperature in the case of *A. mixta*, and under constant conditions of temperature and photoperiod (PELLERIN & PILON, 1978) in the case of *L. eurinus*.

Histological techniques and preparations for examination with a light microscope and a scanning microscope have been described by MOUZE (1967) and MARULLO (1984).

For the volumetric growth studies, the measures of the relative surface of the different larval instars and of the adult stage were obtained with a camera lucida, coupled to a magnetic table connected to a Zeiss video Plan. Measures obtained were surfaces of the structures. In order to obtain their volumes, the thickness of the histological cuts was multiplied by the surface. In the case of *L. eurinus* histological sections of uniform thickness for the first four instars could not be obtained because the larvae were too small.

OBSERVATIONS AND DISCUSSION

To compare the postembryonic development of the different structures of the visual apparatus of Zygoptera and Anisoptera, the volumetric growth of the brain, the compound eye and the optic lobe was measured.

Table I

Measures of the volume of the brain and of different components of the visual apparatus of *Lestes eurinus*

Larval instar	Brain (10^5 µm³)			Optic lobe (10^5 µm³)							
	Half brain	Half neuropile	Central body	Optic lobe	Medulla and lobula and c.g.	Lamina and c.g.	Neuropiles: Medulla	Lobula	Lamina	MAE[3]	Compound eye (10^5 µm³)
5	13.2	5.0	0.1	23.7	15.0	1.9	3.1	0.9	0.5	5.3	13.8
6	16.2	8.1	0.1	78.6	66.5	8.0	12.7	3.2	2.1	6.3	68.8
7	26.2	13.9	0.4	96.0	81.4	7.3	18.2	4.6	1.9	6.9	88.6
8	28.4	17.0	1.9	144.5	126.6	15.7	43.8	7.9	6.1	8.1	120.0
9	34.7	21.3	1.1	143.1	121.4	16.0	32.8	9.6	5.5	4.7	187.5
10	83.9	46.7	1.6	370.5	314.4	48.2	85.6	29.6	22.7	8.0	448.3
11	130.7	63.5	2.1	498.6	402.6	56.2	107.9	33.4	21.0	18.4	707.3
12	111.3	64.2	2.5	490.6	406.0	59.9	111.5	33.1	29.1	14.4	795.0
13	142.9	85.6	3.5	623.1	532.8	83.2	142.3	40.8	30.9	14.8	922.5
14	137.1	77.5	3.2	606.4	517.3	76.1	141.7	41.8	32.1	12.9	939.2
15	174.7	100.0	3.1	744.6	665.6	83.7	172.6	50.9	33.6	17.0	1115.1
Adult	700.7	507.9	13.8	6041.0[4]	3298.2	–[4]	1434.6	236.0	1150.8	–[4]	10846.4

(1) Neuropile + ganglion cells (c.g.); — (2) Optic lobe: 3 neuropiles (lamina, medulla, lobula) + outer optic anlage + ganglion cells; — (3) MAE: outer optic anlage; — (4) Outer optic anlage and ganglion cells of the lamina have disappeared in the adult stage.

BRAIN

In Tables I and II are given the values of the volume of the brain for each larval instar or adult stage studied. In *L. eurinus* the mean growth rate of the brain from one larval instar to the other is 1.35 while it is 1.32 in *A. mixta* (Tab. III). In both species, during metamorphosis, this rate is four times higher (Tab. III) than the mean larval growth rate. In both suborders there are then no great differences in the volumetric growth of the brain throughout the postembryonic period.

COMPOUND EYE

The development of the compound eye is a continuous phenomenon throughout the postembryonic period through an increase in the number and in the size of the ommatidia (LAVOIE et al., 1978a, 1978b). In *L. eurinus*, during the period of larval development, this volumetric growth is of the order of 85 times the volume of the 5th instar eye with a volumetric increase from one instar to the other varying between 1.0 and 5.3 (Tab. I). At metamorphosis, this volumetric increase is much more important since the adult eye is 10 times the volume of the eye of the last instar larva (Tab. I). In *A. mixta* (Tab. II), in the last instar larva, the volumetric growth of the eye is close to 600 times the one measured in the first larval instar.

Table II

Measures of the volume of the brain, the compound eye and the optic lobe of *Aeshna mixta*

Larval instar	Half brain ($\times 10^5\ \mu m^3$)	Optic lobe ($\times 10^5\ \mu m^3$)	Compound eye ($\times 10^5\ \mu m^3$)
1	79.7	122.7	58.4
2	145.6	302.4	203.5
3	181.6	446.6	261.7
4	320.9	1145.9	844.4
5	375.0	—	1315.8
6	448.6	2145.4	1578.6
7	601.6	2174.5	2843.5
8	849.8	5599.4	10109.2
9	1034.5	7449.6	8557.1
10	948.0	10154.6	33560.9
Adult	4883.0		

Table III

Mean growth rate of the brain, compound eye and optic lobe of *Lestes eurinus* and *Aeshna mixta*

Species	Stage	Brain	Optic lobe	Eye
L. eurinus	Larval instar 5 to last	1.35	1.5	1.8
	Last instar to imago	4.0	8.1	9.7
A. mixta	Larval instar 2 to last	1.32	1.55	1.92
	Last instar to imago	4.0	—	—

In *L. eurinus* the larval ocular volumetric growth, when expressed in relation to the brain volumetric growth, is represented by a linear relationship with a slope of 6.85 (Tab. IV). In *A. mixta* this slope is 2.23. This would indicate that the larval volumetric growth of the compound eye is faster in Zygoptera than in Anisoptera, although the mean growth rate in the two suborders is of about the same order, 1.8 versus 1.92 (Tab. III).

OPTIC LOBE

The growth of the optic lobe is a continuous process throughout the larval period of both species examined (Tabs I, II). The mean growth rate is in fact 1.5 in *L. eurinus* and 1.55 in *A.mixta* (Tab. III).

However, according to MOUZE (1967) and MARULLO et al. (1987), it is during metamorphosis that the greater changes in form, structure and position are taking place. Our study also shows that it is during metamorphosis that the greatest development of this nervous centre is taking place, as is illustrated in *L. eurinus,* where the growth rate is 8.1 instead of a mean one of 1.5.

When the growth of the optic lobe is compared to that of the brain, (Tab IV), it can be shown that the volumetric growth of the optic lobe in *Lestes* is faster than in *Aeshna* (a slope of 4.32 versus a slope of 1.67). It should be emphasized that these figures are only valid for the larval period. In both suborders, when comparing the growth of the brain as reference (1) to that of the compound eye (6.85 : 2.23) and the optic lobe (4.32 : 1.67), it is interesting to note that the growth of the optic lobe is intermediary between that of the brain and that of the compound eye.

Table IV

Comparisons between the slopes of the straight lines describing the growth of the brain, the compound eye and the optic lobe in *Lestes eurinus* and *Aeshna mixta*

	Brain			Optic lobe							
							Neuropiles				
Species	Brain	Neuropile	Central body	Whole	Medulla + lobula + c. gang*	Lamina + c. gang*	Lamina	Medulla	Lobula	MAE**	Compound eye
L. eurinus	1	0.57	0.02	4.32	3.71	0.53	0.22	0.99	0.30	0.08	6.85
A. mixta	1	—	—	1.67	—	—	2.09	1.92	1.80	—	2.23

* c. gang.: ganglion cells; — ** MAE: outer optic anlage

In both species studied, the growth rates of the different neuropilar structures are not identical when compared to that of the brain. In *L. eurinus,* the medulla (slope of 0.99) is developing faster than the lobula (slope of 0.30) while the lamina (slope of 0.22) develops at a slower pace. In *A. mixta,* the situation is not the same: the lamina (slope of 2.09) is developing at a faster rate, the medulla is growing at an intermediary rate (slope of 1.92) and the lobula at a slower rate (slope of 1.80) (Tab. IV).

CONCLUSION

The study of the growth of the optic lobe in *L. eurinus* and in *A. mixta* indicates that the volumetric growth is a continuous process during the larval period. However, certain structures in the optic lobe grow faster than the others.

The growth rate and the volumetric growth of the optic lobe are intermediary between those of the compound eye and the brain in both suborders. In the zygopteran as well as in the anisopteran species it is the compound eye which shows the fastest growth.

When analysing the growth of the different structures of the optic lobe, it can be shown that there are some differences between the two suborders. In Zygoptera *(L. eurinus)* the lamina grows slower than the medulla and lobula, the medulla presenting the fastest growth. In Anisoptera *(A. mixta)* it is the lamina which shows the greatest rate of growth rather than the medulla.

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