SUGGESTIVE ROLE OF EYE-STALK OF *MACROBRACHIUM GANGETICUM* BATE, 1868 IN REGULATION OF ITS REPRODUCTIVE BEHAVIOUR.

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ABSTRACT

Role of eye-stalk of *Macrobrachium gangeticum* Bate, 1868 in its reproductive behaviour has been examined by conducting deletion and addition experiments. Eye-stalk ablation induced gonadal maturity in both sexes, leading to change in colour and size of ovaries and increase in GSI and oocyte diameter in females and increased length of testes and diameters of seminiferous tubules in males. Injection of eye-stalk extracts tended to at least partly restrict the effects in both sexes. The experiments thus suggested that the eye-stalk of *M.gangeticum* released some gonad inhibiting factors.

Key words : *Macrobrachium gangeticum*, Eye-stalk, Gonads.

INTRODUCTION

The eye-stalk of crustanceans possesses X-organ-sinus gland complex which is an important neuroendocrine organ of crustaceans, (Cooke, 1982; Bliss, 1971 and Passano, 1951.) The histoarchitecture and seasonal variations of the X-organ sinus gland complex of *Macrobrachium gangeticum* Bate, 1868, have earlier been reported, (Gupta, 2007 a & b) and the present communication deals with the role of this organ in regulation of the reproductive behaviour of the species.

Twenty immature specimen each of male and female *M. gangeticum* (ranging in size 13-15 cm) were collected from Ganga river near Buxar and Ballia in the month of March (2004-2005) and brought to the laboratory. Morphological characteristics of gonads were noted and they were then fixed in Bouin's solution and sections (5-6 µm thick) were stained with eosin/hematoxylin.

The animals were grouped under 8 groups (I-VIII) with five prawns in each group (groups I-IV include females and V-VIII include males)

Groups I & V - Control (female and male)

Groups II & VI - Eye-stalk ablated (female and male)

Groups III & VII - Normal females and males injected with eye-stalk extract.

Groups IV & VIII - Eye-stalk ablated females and males injected with the eye-stalk extract.

Eye stalk ablation was done in animals kept under ice cold water. The homogenate of the eye-stalk was prepared according to the methods described by

Nagabhushanam and Diwan, (1974), Twenty microlitres of the eye-stalk extract, prepared by homogenizing 2 eye-stalks in 20 µl distilled water, (equivalent to two eye-stalk/prawn) were injected on the 3rd, 6th and 9th days in the abdominal musculature of prawns of groups III, IV, VII and VIII with the help of hypodermic microsyringe. Prawns were sacrificed on day 15 and examined.

OBSERVATIONS

Effects of eye-stalk on ovarian maturation:

The eye-stalk ablated females showed a noticeable change in colour of their ovaries-from pale greenish to green, a significant increase in mean GSI and also in oocyte diameter at the termination of the experiment as compared to the corresponding values of controls. The females of group III showed the values of mean GSI and oocyte diameter to be somewhat lower than those of group II (eye-stalk ablated) counterparts. Similarly, when the eye-stalk ablated animals were injected with eye-stalk extract (Group IV), the above values were reduced as compared to those of group II females and were nearly touching the corresponding values of control animals (Table-1).

Effects of eye-stalk on testicular maturation:

The testes of eye-stalk ablated animals showed somewhat advanced stage of maturity both in physical appearance as well as in histology at the termination of the experiment. The colour was white with pink spots, the average length measured 3.21 ± 0.59 cm. against the control value of 2.41 ± 0.54 cm and the average seminiferous tubule diameter was 44.31 ± 4.55 µm against the control value of 30.54 ± 3.52 µm. While the seminiferous tubules of control animals had spermatocytes and few spermatogonia as their dominant cell types, those of eye-stalk ablated animals had spermatids and spermatozoa. The animals of group VII, exhibited opposite results. Length of testes as well as tubule diameter showed much reduced values, nearly approaching the control values. Normal/Eye-stalk ablated animals, when supplemented with eye-stalk injections (Group VII & VIII), exhibited reduced testicular maturity. Length of testes and tubule diameter were only a little more than the corresponding values of control animals. Spermatocytes were dominant in their seminiferous tubules (Table-2).

Table-1

Effects of Eye-stalk on ovarian maturation of *M.gangeticum*

Animal groups (size range 13-15 cm)	GSI mean ± SD	Oocyte diameter ±SD(µm)	Colour of the ovary at the end of experiment
Group-I	2.87±0.24	24.91±2.41	Pale Greenish
Group-II	3.32±0.31	35.95±0.23	Green
Group-III	2.95±0.25	28.51±3.54	Pale Greenish
Group-IV	2.90±0.29	26.33±2.51	Pale Greenish

(All the data represent values at the termination of experiment)

Table-2

Effects of eye-stalk on testicular maturation of *M.gangeticum*

Animal groups (size range 13-15 cm)	Length of testes (cm)	Diameter of seminiferous tubules (µm)	Dominant cell types
Group-V	2.41±0.54	30.54±3.52	spermatocytes, few spermatogonia
Group-VI	3.21±0.59	44.31±4.55	spermatids and spermatozoa
Group-VII	2.53±0.41	33.45±3.45	spermatocytes and few spermatogonia
Group-VIII	2.82±0.34	35.24±4.21	spermatocytes

(All the data represent values at the termination of experiment)

DISCUSSION

Deletion and addition experiments have revealed the physiological role of the eye-stalk of *M. gangeticum.* Eye-stalk ablation of females led to change in the colour of ovaries from light green to dark green and increase in GSI and oocyte diameter. All these changes indicated accelaration of the ovarian maturity. However, when normal or eye-stalk ablated animals were injected with eye-stalk extracts, the above changes were, more or less, restricted.

Almost similar effects were produced in males post eye-stalk ablation. Length of testes as well as diameters of seminiferous tubules got increased. Presence of spermatids with few spermatozoa in the testes of eye-stalk ablated animals indicated precocious maturity. As in case of females, the effects of eye-stalk ablation in males too were more or less restricted following injection of eye-stalk extract.

Thus, in case of both males and females, eye-stalk ablation leads to advancement of gonadal maturity. However, specimen of groups III and VII, which include normal females and males injected with eye-stalk extracts, show values somewhat higher than that of groups I and V (controls). However, the differences are not very significant. But the values of groups II and VI (eye-stalk ablated females and males) are significantly higher than those of the other groups of males and females respectively.

These observations, clearly indicate that the x-organ sinus gland complex located inside the eye-stalk exerts some gonad inhibiting effects. This conclusion is in agreement with the findings of Rangnekar and Deshmukh, 1968. John and Sivadas, 1979 noted early maturity of ovary in eye-stalk ablated estuarine crab, *Scylla serrata.* Similar reports were made by Panouse, 1943 in *Palaemon serratus.* Mirajkar *et al.*, 1985 reported high ovary inhibiting activity of the

eye-stalk in spawned prawn *Macrobrachium kistensis*. While Adiyodi and Adiyodi, (1974) were of the opinion that the ablation effect on reproduction of crustaceans depends on the maturation stage of the ovary, Bomirski and Klek, (1974) suggested that the ovary inhibiting hormone of eye-stalk is responsible for the resting phase of the ovary and controls the role of vitellogenesis. Han and Kim, (1993) also found the gonad inhibiting effect of x-organ of *Macrobrachium nipponense* to be stronger in resting period. Other studies showing the gonad inhibiting effects of eye-stalk include those by Mirajkar, (1980) on *Macrobrachium kistensis*, Kumar and Pandian on *Macrobrachium nobilii*, Rajender Rao, (1987) on *Macrobrachium lammarrei*, (1987) Biswas, (1991) on *Macrobrachium dayanum,* Wilder *et al.*, (1994), Perez-Cruz *et al.*, (1995) and Kumar and Pandey, (2003) on *Macrobrachium rosenbergii* and (Upadhyaya, 2000) on *Macrobrachium malcomsonii.*

In the present study, the precocious ovarian maturity following eye-stalk ablation did not lead to oviposition. This is in accordance with the finding of Sarojini *et al.*, (1982 & 1983), Sambhasiva Rao (1986), Biswas, (1991) *etc.* Eye-stalk is also not reported to affect the process of hatching, (Saigusa, 2000).

Several studies also confirm the present observation that the factors released from eye-stalk bring about precocious maturity of testes as well. Mirajkar, (1980), Sarojini *et al.*, (1982), Rajender Rao, (1989), Biswas, (1991) and Upadhyaya (2000) have reported early maturity of testes of various *Macrobrachium* species after eye-stalk ablation. However, the findings of Carlisle, (1954) and Aoto and Nishidha, (1956) do not correspond to the present view. Eye-stalk ablation is also reported to increase the intermoult period as well as the growth rate.

REFERENCES

Adiyodi, R.G. and Adiyodi, K.G., 1974. Sustained neurosecretory activity of brain implants in *Paratelphusa hydrodromous* (Herbst). J. Ker. Acad. Biol., 3 (1) : 48.

Aoto, T. and Nishida, H., 1956. Effect of removal of the eye-stalk on the growth and maturation of the oocytes in a hermaphroditic prawn, *Pandalus kersleri.* J. Proc. Sci. Hokkaida Univ., 12 : 412-424.

Biswas, R., 1991. Development biology and correlative cycle changes in the neurosecretory cells and gonads of freshwater prawns *Macrobrachium dayanum.* Ph.D. Thesis, B.U. Bhopal, India.

Bliss, D.E., 1971. Metabolic effect of sinus gland of eye-stalk removal in the land crab, *Gecarcinus lateralis.* Anat. Rec. 111 : 502-503.

Bomirski and Kelk-Kawinska, 1974. Action of the eye-stalk on ovary in *Rhithropanopeus harrisi* and *Crangon crangon* (Crustacea : Decapoda). Mar. Bio., 24 : 329-337.

Carlisle, D.B., 1954. Studies on *Lysmata seticudata* Risso, VIII. The lack of influence of eye-stalk ablation and of injection of eye-stalk extract on testicular weight and degree of development of the male genital ducts. Publ. Staz. Zool. Napoli, 24 : 241-245.

Cooke, J.M. and Sullivan, R.E., 1982. Hormones and neurosecretion. The biology of crustacean and Neurobiology structure and function, VIII (Editors, Harold L Altwood and David C. Sande man) : 205-278.

Gupta, Akhilesh Kumar and Roy, D., 2007. Histoarchitecture of x-organ-sinus gland complex of *Macrobachium gangeticum*. PROC. NAT ACAD. SCI. INDIA, 77 (B).

Gupta, Akhilesh Kumar and Roy, D., 2007. Seasonal changes in the neurosecretory cells of the x-organ-sinus gland complex of *Macrobrachium gangeticum*, J. Adv. Zool. 7 28 (2) : 89-92.

Han, C. and Kim, D.J., 1993. Studies on the x-organ of the eye-stalk and photoperiod for the control of gonadal maturation in freshwater prawn, *Macrobrachium nipponense* (De man). Bull. Korean Fish. Soc., 26 (1) : 76-90.

John, S. and Sivadas, P., 1979. Morphological changes in the development of the ovary in the eye-stalk ablated estuarine crab, *Scylla serrata* (Forskal). Mahasagar Bull. N.J.O. 11 (1&2) : 57-62.

Kumar, S.S. and Pandian, T.J., 1987. Effect of Unilateral eye-stalk ablation on moulting, growth, reproduction and energy budget of *Macrobrachium nobilii* Sch. Bio. Sci. Madhurai Kamraj Univ. 1 : 1-17.

Kumar A. and Pandey, A.K., 2003. Neuroendocrine regulation of ovarian maturation in the Giant freshwater prawn. *Macrobrachium rosenbergii*. Fishing chimes. Vol. 23 No. 7 : 10-17.

Mirajkar, M.S., 1980. Studies on the reproductive biology and Neurosecretion of freshwater prawn, *Macrobrachium kistensis*, Ph.D. Thesis, Marathwara University Aurangabad, India.

Mirajkar, M.S., Sarojini, R. and Nagabhushanam, R., 1985. Ovarian maturation and inhibition hormone activity in freshwater prawn *Macrobrachium kistensis* (Crustacea : Decapoda : Natantia) Comp. Physiol. Ecol., 10 (4) : 223-226.

Nagabhushanam, R. and Diwan, A.D., 1974. Neuroendocrine control of reproduction in the female crab, *Barytelphusa cunicularis* Marath Univ. J. Sci., 13 (6) : 59-67 ;35-39.

Panouse, J.B., 1943. Influence de I ablation, de pedoncule oculaire Sur la croissance de I ovarie. Chez la crevette Leander serratus C.R. Hebd. seanc. Acad. Sci. Paris, 217 : 253-255.

Passano, L.M., 1951. The X-organ sinus gland neurosecretory system in crabs, Anat Rec., 111:502.

Perez-Cruz, E., Diaz-Hermera, F. and Lunna-Figueroa, J., 1995. Effect of unilateral eye-stalk ablation and photoperiod on energy budget of *Macrobrachium rosenbergii* (Crustacea Palaemonidae). Riv. Ital. Aquacult. 30 (2) : 87-91.

Rajender Rao, K., 1989. Reproductive biology of the freshwater prawn *Macrobrachium lammarrei,* Ph.D. Thesis Marathwada University Aurangabad, India.

Rangnekar, P.V. and Deshmukh, R. D., 1968. Effect of eye-stalk removal on the ovarian growth of marine crab, *Scylla serrata* (Forskal). J. Anim. Morph. Physiol., 15 : 116-126.

Saigusa, M., 2000. Hatching controlled by the arcatidal clock and the role of the medulla terminalis in the optic peduncle of the eye-stalk, in an estuarine crab *Seasarma* haemotochei. J. Exp. Biol., Nov. 205 (pt 22) : 3487-504.

Sambasiva Rao, S., 1986. Endocrinology and reproduction in the marine shrimp *Metapenaeus affinis*. Ph.D. Thesis, Marathawada Univ. Aurangabad, India.

Sarojini R., Mirajkar, M.S and Nagabhushanam, R., 1982. Neuroendocrine control of the spermatogenesis in the freshwater prawn *Macrobrachium kistensis* (Tiwari). Add. Bios. 1 (1) : 60-67.

Sarojini R., Mirajkar, M.S. and Nagabhushanam, R., 1983. Bihormonal control oogenesis in the freshwater prawn *Macrobrachium kistensis*. Acta. Physiologica, Hungaria, 6 (1-2) : 5-12.

Upadhyaya, R. K., 2000. Correlative cyclic changes in neurosecretory cells and gonads of a freshwater prawn *M. malcomsonii* (H.Milne Edward) & its fishery in Weinganga river, Ph.D. Thesis Berktullah University, Bhopal, M.P.

Venkitraman, P.R. and Jayalakshmi, K.V., Balasubramonium, T., Maheshwari Nair and Nair KKC, 2004. Effect of eye-stalk ablation on moulting and growth of penaeid prawn *Metapenaeus dobsoni* (de man). Indian Journal of experimental Biology Vol. 42. April, pp. 2/03. 412.

Wilder, M.N., Okumura, T., Suzuki, Y., Fusetani, N. and Aida, K., 1994. Vitellogenin production induced by eye-stalk ablation in juveniles of giant freshwater prawn *Macrobrachium rosenbergii* and trimethyl fornesoate administration. Zool. Sci. 11 (1) : 45-52.