INTRODUCTION
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Many investigations have been carried out on the reproductive cycle of male fishes during the past few years (Ghosh and Kar, 1952; Nayar and Sundararaj, 1970; Sehgal, 1971; Swarup and Srivastava, 1978 and Agarwal, 1982). The gross morphology of the testis has been studied in detail for some teleostean fishes like, *Mugil cephalus* (Stenger, 1959); *Channa gachua* (Sanwal and Khanna, 1972; Shanbhag and Nadkarni, 1979); *Barbus leuteus* (Bhatti and Al-Dham, 1978) and *Glossogobius olivaceous* (Asahina, 1983). The histology of the testis of gobiod fishes have been described by Tavolga (1955) on *Bathygoblus soporator*; Stanley et al. (1965) on *Gobius paganellus*; Saxena (1980) and Murthy (1981) on *Glossogobius giuris*.

Considerable work has been done on the arrangement of endocrine tissues in the teleostean testis (Courrier, 1921; Craig - Bennet, 1931; Marshall and Lofts, 1956; Lofts and Marshall, 1957 and Henderson, 1962). The distribution of the endocrine (interstitial/Leydig) cells of some teleosts has been reported by Sundararaj (1960) on *Heteropneustes fossilis*; Lehri (1967) on *Clarias batrachus*; Swarup and Srivastava (1978) on *Channa striatus*; Gupta (1980) on *Puntius sophore*; Agarwal (1982) on *Puntius conchonius* and Joshi and Joshi (1989) on *Puntius dukai*. 
The testis of the goby, G. giuris has a unique feature in which the glandular tissue (a mass of Leydig cells homologue) is surrounded by the seminiferous tissue (Murthy, 1981), as in other gobiid species, Gobius paganellus (Stanley et al., 1965) and Gobius j最后一 (Colombo and Burghiel, 1974).

Potter and Hoar (1954), Marshall and Lofts (1956), Stanley et al. (1965) and Guraya (1976) have reported that the interstitial cells secrete steroid hormones which regulate the development and maintenance of secondary sexual characters of some or all the teleostean fishes.

Among teleosts, interstitial cells have been shown to contain lipid which undergo cyclical seasonal changes. Such lipoidal changes are seen in the testis of Monopterus albus (Chan and Philips, 1967); Epseletorix galii (Mackay, 1973) and Glossogobius giuris (Murthy, 1981). However, studies on the actual site of steroid synthesis are limited only to a few teleostean species (Stanley et al., 1965; Yaron, 1966; Mackay, 1973 and Murthy, 1981). The secretory activity of interstitial cells have been described in testis only by a few authors (Eckstein and Eylath, 1968 on Mugil cephalus; Colombo, et al., 1974 on Gobius j最后一 and Asahina, et al., 1985 on Glossogobius olivaceus). These cells are shown to contain sudanophilic lipoproteins, cholesterol positive
lipid droplets and lipid fuchsia pigment granules under certain physiological conditions (Colombo and Burghiel, 1974; De Vlaming, 1974 and Guraya, 1976 b and c). The cyclic changes in the interstitial cells have been reported by Remotii (1923) and Van Oordt (1925) in Selachii species and Xiphophorous hellerii respectively. The interstitial cells in most fishes show seasonal accumulation and (prenuptial) depletion of cholesterol. Wiebe (1969) has reported (in Cymatogaster aggregata) a depletion of cholesterol with a simultaneous active synthesis of steroid hormones and an increase in the 3β-hydroxysteroid dehydrogenases (3β-HSDH) activity. However, such an increase in 3β-HSDH activity has not been confirmed on different seasons of the year in G. paganellus (Stanley et al., 1965).

The testis of Indian teleosts undergo cyclic changes both in the morphology and histology. Murthy (1981) divided the reproductive cycle of the male gobiid fish, G. giuris into six phases viz., (a) resting phase, (April-early May), (b) slow spermatogenesis (May-June), (c) rapid spermatogenesis (July-August), (d) spawning phase (September-December), (e) post-spawning phase (January-February) and (f) depletion phase (March-April); the changes occurring in the testis during different periods on the annual reproductive cycle has also been studied.
The morphology of the seminal vesicle of the gobiid fish, *Gobius niger* was first described by Rathke (1824). Since then the structure of the seminal vesicle has been described in other gobiid fishes like, *Gobius minutes* and *Gobius paganellus* (Hyrtl, 1850); *Esox lucius* (Disselhorst, 1904); *Opsanus tau* (Gudger, 1908); *Gillicthyes mirabilis* (Weisel, 1955); *Gobius giuris* (Saxena and Bhargava, 1975 and Murthy, 1981). Eggert (1931) and Viven (1938) have made detailed studies on the histomorphology of the seminal vesicle in *Periopthalmus chrysospinous* and *Gobius paganellus*, respectively. Young and Fox (1937) have presented the physiological aspects of the testicular fluids in the seminal vesicle of the goby, *Gillicthyes mirabilis*.

The changes in the morphological and histological characters of the seminal vesicle during the annual breeding/reproductive cycles have been investigated by Viven (1938) in *Gobius paganellus*; Sundararaj (1958) in *H. fossilis*; Rastogi (1969a) in *Mystus teengara*; Rao and Nadkarni (1979) in *Clarias batrachus* and Murthy (1981) in *G. giuris*.

While various aspects of the teleostean testis and seminal vesicles have been studied in detail, such studies among gobiid fishes are scanty. The present investigation deals with the structure and anatomy of the testis and
interstitial gland, along with seminal vesicles, as well as their seasonal changes in the fish, *G. giuris* have been studied in detail in correlation with the seasonal changes in the hypophyseal activity.

The comparative studies of fish pituitary have been reviewed by Green (1951) and Prasad Rao (1969). Histomorphological details have been reported by Pickford and Atz, (1957); Honma et al. (1965); Sage and Bern (1971); Schreibman et al. (1973) and Holmes and Bern (1974). Histology of the pituitary glands have been made by Kerr (1942 a and b); Sathyanesan (1958) and Sundararaj (1959). That the cellular components of hypophysis of teleosts vary from species to species and in relation to age and maturation of fish have been described by Belsare (1962); Van Overbeeke and McBride (1967) and Tan (1985). The cytology and histology of hypophysis have been studied in *Poecilia latipinna* and *Poecilia formosa* (Olivereau and Ball, 1964 and 1966); *Clarias batrachus* (Lehri, 1966) and *Tor (Barbus) tor* (Rai, 1965b). The histophysiologys of hypophysis has also been reported in a few teleostean fishes by Ball and Baker (1969); Nagahama and Yamamoto (1971); Baker et al. (1974) and Bage et al. (1974).

In teleosts, the adenohypophysis is made up of different types of cells. Each cell type shows specific morphological characteristics, staining properties and
occupy definite regions within the gland (Boddingius, 1975). The functional significance of adenohypophyseal cells have been described by Olivereau and Ball (1964) in Poecilidae; Olivereau (1969) and Baker et al. (1974) in Cyprinidae, Yoshie and Honma (1978) and Murthy (1981) in Gobiidae.

The teleostean adenohypophysis secretes a variety of hormones viz. prolactin, gonadotropin, growth hormones, thyrotropin, adrenocorticotropic and melanophore stimulating hormone (Pickford and Atz, 1957; Bern, 1969; Bage et al., 1974 a and b). Among the adenohypophyseal cells which secrete the above hormones, only the prolactin and gonadotrophic secreting cells show marked cytological changes during different phases of reproductive cycle (Sathyanesan, 1959b; Khanna and Pant, 1966; Baker et al., 1974 and Murthy, 1981) and during changes in external factor (Honma et al., 1967; Leatherland 1970b and Mohan, 1991).

It has been established that the hypophysis in vertebrates function as the regulator mechanism during reproduction. Among fishes detailed investigations on hypophyseal- gonadal relationship are made by Sundararaj (1959 and '60) in H. fossilis; Rai (1966a) in Tor (Barbus) tor; Bisht, et al. (1975) in Schizothorax richardsonii; Agarwal, et al. (1977) in Puntius sophore; Thomas and Sathyanesan (1984) in Amphipnous cuchia and Tan (1985) in Chanos chanos.
As in other vertebrates, gonadotrophs in the teleost pituitary control the reproductive activities (Ball and Baker, 1969; Prasada Rao, 1972; De Vlaming, 1974; Hyder, 1978 and Ueda and Takahashi, 1980); that the gonadotrophs exhibit structural changes in relation to different periods of structural maturity is shown in *H. fossilis* (Sundararaj, 1959 and 1960); *Mystus seenghala* and *Barbus stigma* (Sathyanesan, 1960); *Channa striatus* (Venugopalan, 1962); *Cirrhipha mrigala* (Lall, 1964) and in *Onchorynchus nerkla* (Van Overbeeke and McBride, 1967). Cyclical variations are encountered in the number and potency of gonadotrophs at different periods of the year (Singh, 1970 and Singh and Singh, 1981). A clear correlation exists between the hormone synthesis, its release and the cytological appearance of these cells in various species of teleosts. Still there is a great paucity of information on the basic description and staining affinities of the gonadotrophs of gobiid hypophysis. The histological study of the proximal pars distalis of the gobiid fish, *G. giuris* (Saxena, 1976a and Murthy, 1981) during the reproductive cycle have revealed that the basophils exhibit profound modification following the cytological events in the testis. However, cytological changes in the basophil cells due to treatment with various pesticides, have not been reported so far. Therefore, in the present investigation an attempt has been made to study the
response of the basophilic cells to sublethal concentration of organophosphate pesticide (fenthion) to correlate and compare the functional significance of the cells in relation to the testicular function.

The pattern of distribution of prolactin (eta/acidophils) cells in rostral pars distalis (RPD) of the adenohypophysis has been studied in teleost like Mugil auratus (Olivereau, 1968); Mugil cephalus (Abraham, 1971); Mystus seenghala (Prasada Rao, 1972a); Xiphophorus helleri (Holtzman and Schreibman, 1972) and Salmo irideus (Boddingius, 1976). These cells are mostly involved in the osmoregulation in fish (Ball, 1969a and b; Olivereau and Ball, 1970; Lam, 1972; Schreibman et al., 1973; 1974 and Bern, 1975a and b).

It has been suggested that the eta cells are also associated with some aspects of reproduction in some submammalian vertebrates (Bern and Nichol, 1968 and De Vlaming, 1979).

Though Murthy (1981) has described the structure of the eta cells in the adenohypophysis of G. giuris, detailed investigations on the functional activity of the eta cells in the adenohypophysis has not been studied so far. Hence, in the present investigations, the cytomorphological changes of eta cells in the adenohypophysis of G. giuris has been
made during the annual testicular cycle under laboratory conditions after exposing them to different sublethal concentrations of pesticide (fenthion).

Among teleosts the pituitary gland exercises a decisive control over reproduction (Hoar, 1969; Ball and Baker, 1969; Holmes and Ball, 1974 and Van Oordt and Peute, 1983).

Several workers have reported that pesticidal pollution is toxic and induces variety of changes in fishes (Singh and Singh, 1980; Rashatwar and Ilyas, 1984; Ghosh and Chatterjee 1989). The acute and chronic toxicity of pesticides in the environment affect the reproductive potential and fecundity of animals (Rajkumar et al., 1984). Johnson (1968) reported interaction of pesticides in the aquatic habitats with special reference to the effect on fishes.

Among the various organophosphate pesticides, fenthion (0,0 dimethyl - 0 - (4 - methylmercapto - 3 methylphenyl) - thiophosphate (40)), has been considered to be an important pesticide in controlling the pests and insects. Kapoor et al. (1978); Sadhu and Mukhopadhyay (1983); Singh and Singh (1983); Bela (1988); Sahai (1989) and Mohan (1991) have reported that malathion brings about disorders including the hypersecretion in the gonadotropins impairment of steroidogenesis and gonadal functions, inhibition of gonadal growth and other endocrine functions. On the other hand,
Shukla *et al.* (1984) working on *Sarotherodon mossambicus* has shown that lethal and sublethal concentration of malathion cause significant reduction in gonosomatic index (GSI). Similar results have also been reported by Saxena and Garg (1978) in *Channa punctatus* and Kaur and Virk (1983) in *Cyprinus carpio*.

Studies on teleostean species have shown that even sublethal levels of malathion affect the functional activity of hypothalamus, hypophysis and gonadal system. In *H. fossilis*, exposure to malathion caused significant reduction in size of hypophysis (Jagdeesh and Sahai, 1988). Toxicological effect of malathion has also been observed on the pituitary of fish, (Vajpai *et al.*, 1986; Jagdeesh and Sahai, 1988 and 1989). Sahai (1989) reported cytomorphological changes in the adenohypophyseal cells, viz., prolactin secreting cells and gonadotrophs of pituitary of some teleostean fish after exposure to malathion. Singh and Singh (1982) have suggested that malathion alters the gonadotrophic secretion in the hypophysis which in turn significantly decrease the ovarian activity during all phases of annual reproductive cycle in *H. fossilis*. Ghosh *et al.* (1988) opines that the pesticides impair the activity of hypothalamic nuclei and pituitary gland which in turn might affect the maturation of oocyte, in *Channa punctatus*. Mohan (1991) has reported that the
Malathion exercises an inhibitory role of the gonadal hormones, via brain-pituitary complex.

Pesticides are known to affect the testis in fishes and cause significant reduction in the gonosomatic index (GSI) (Pandey and Shukla, 1980; Lakhani and Pandey, 1985; Saxena and Mani, 1985; Bela, 1988 and Andhare and Kulkarni, 1990). Sadhu and Mukhopadhyay (1985) have reported cytomorphological changes in *Clarias batrachus* after exposure to malathion and carbofuran. The effect of pesticides on the histology and physiology of testis have been studied in few teleosts *Channa punctatus* by Saxena and Garg (1978); *H. fossilis* by Singh and Singh (1980); *Sarotherodon mossambicus* by Pandey and Shukla (1980 and 1982) and Shukla (1984). More recently Singh and Singh (1987) have reported the impact of malathion on sex hormones during different phases of reproductive cycle in *Clarias batrachus*.

Studies on the effect of pesticides on Leydig cells are limited to a few species only. Among fishes, pycnosis of Leydig cell-nuclei and cytoplasmic vacuolization has been observed following metal treatment in few species of teleosts (Ahsan and Ahsan, 1974; Vani and Latey, 1982; Srivastava and Agarwal, 1983; Katti and Satyanesan, 1985). In *Sarotherodon mossambicus* the Leydig cells become enlarged
and polygonal following treatment with Dimecron for 20 days (Lakhani and Pandey, 1985). Harilal and Sahai (1989) have shown necrotic condition of the interstitial cells in the testis of *Mystus teengara* after treatment with malathion and BHC. Kapur et al. (1978) reported that fenitrothion caused a significant reduction in the 3β-HSDH activity in *Cyprinus carpio*.

Studies on the effect of pollutants on the male accessory reproductive organs in teleosts are scanty. In *Tilapia mossambica* (Pandey and Shukla, 1980) exposed to BHC for 20 days caused thickening of the muscle layer both of seminal vesicles and sperm ducts. The cells of vas deference in *G. mullya* becomes smaller with large intercellular spaces and irregular nuclei due to cadmium (Wani and Latey, 1982).

Biochemical studies on fish tissues are more useful, since they constitute a rich source of nutrition and caloric value. Sufficient work on different tissues are available for *Hippoglossus hippoglossus* by Mannan et al. (1961), and for *Carnax sexfasciatus* by Rao (1965). The biochemical constituents like proteins, glycogen, cholesterol etc., have been studied in different tissues at the time of seasonal changes, spawning migration, breeding season and various stages of maturity (Chang and Idler, 1960; Bentley and Follett, 1965; Siddique, 1966 and Tandon and Joshi, 1974 and 1975). Joshi et al. (1979) have studied the biochemical
changes in the gonads of *Heteropneustes fossilis* during winter. Jayashree and Srinivasachar, (1979) have reported the cholesterol level in the testis of *Clarias batrachus* during different phases of reproductive cycle. All the above biochemical works have been carried out only under the normal environmental conditions. Hence, in the present investigation, the cholesterol level in the testis of *G. giuris* has been analysed during the resting phase, rapid spermatogenic phase and spawning phase under laboratory conditions after the fish was exposed to various sub-lethal concentrations of fenthion.

Although, extensive light microscopic work has been done on the toxicity of organophosphate pesticides on pituitary-testicular axis, very little is known about the ultrastructural cytotoxic changes, especially, during spawning phase. The available investigations largely deal with mammalian testis and pituitary (Gopal Dutt *et al.*, 1979; Gopal Dutt & Kobayashi, 1980). But in fisheries development point of view, it is important to know the effect of pesticide on spermatogenesis. As the observations on the cytotoxic damage of sperm are scanty, an attempt has been made at the ultrastructural level, to know the abnormalities occurring during spermeogenic processes with reference to sublethal short-term exposure and their effects
on pituitary (prolactin and GTH cell), testis (sperm and interstitial cell) and seminal vesicle of *G. giuris*.

It is certain that pesticides affect reproduction in all vertebrates but their mechanism of action is not clearly understood in many cases. In fishes, pesticides seem to retard gonadotropin secretion (Singh and Singh, 1980 and 1981) thereby, causing regression of the gonads. Corresponding, light and ultrastructural studies on other teleostean species are lacking. Hence, in the present investigation, cytomorphological and fine structural changes in the hypophysis, testis and seminal vesicles of *G. giuris* has been made during the annual reproductive cycle under laboratory condition after exposing the fish to different concentration of fenthion.