summary

The objective of present study was to investigate the internal systems of *Neoscorpiops deccanensis*. Three major systems i.e. Nervous system, Reproductive system and Venom system of *Neoscorpiops deccanensis* are studied for anatomy and histology of these systems.

*Neoscorpiops deccanensis* is a local species of scorpion found on fort Singhagd above the height of 4300 ft. The specimens of *Neoscorpiops deccanensis* collected in warm months of the year, as it has behavior of hibernation. Collected specimens are brought to the laboratory of Zoological Survey of India for future procedures of the study. Information of Location of Singhagd provided from Gazetteer of Bombay State volume xx Poona District. Collection is followed by instant killing, it is experienced that instant killing of the individual gives good results of histological observations (Conn H. J. 1969). Animals were killed and fixed using Carnoy's fixative Dissections done using Ringer's solutions for better results of histological slides. The tracing of systems and minute nerves made using binocular microscope and fine needles. Traced systems were drawn into Camera Lucida diagrams. Histological slides of tissues and organs under study were made by paraffin embedding method (Godkar P. B. and Godkar D. P. 2003). Microphotography was done with LIECA camera CCTV. Haematoxyline Eosion method preferred for good results during study. Haematoxyline and Eosion are the principle stains used for demonstration of nucleus and cytoplasmic. It is a double staining method. Here alum acts as Mordent and Haematoxyline stains the nucleus light blue which turns red in the presence of acid. The cell differentiation achieved by treating the tissue with acid solution. The counter staining is performed by using Eosin solution, which gives pink colour to cytoplasm (Gray, P. 1954, Farzanpay R. 1982). Slides were studied and evaluated with light microscopy.

Nervous system consists of large cephalothoracic mass and double ventral nerve cord. Nervous system of both female and male Scorpions under study show anatomical difference in the shape of the protocerebrum. In females protocerebrum is small sized pear shaped and pointed anteriorly. In males protocerebrums is broad at base and kidney shaped. Size of protocerebrum in male is 1.35 mm in length and 2 mm in width. Protocerebrum in female is 1 mm in length and 2.5 mm in width. There
is no other differences in the anatomy of remaining part of the systems of both male and female *Neoscorpiops deccanensis*.

Cephalothoracic ganglionic mass consists of anteriodorsal supraesophageal ganglion (Protocerebrum and tritocerebrum) and posterioventral large suboesophageal ganglion. Both ganglia are connected with circum oesophageal connective. Supraoesophageal ganglion is divided into protocerebrum and tritocerebrum. Two pairs of nerves arise from protocerebrum namely median optic nerves and lateral optic nerves to median eye and lateral eyes respectively. Protocerebrum shows presence of globuli cell packets. The tritocerebrum consists of pairs of chelicera ganglion at the base of cheliceral nerve pair.

The suboesophageal ganglion of *Neoscorpiops deccanensis* is spherical in shape. It gives nerves to pedipalps, walking legs, and vegus nerves. Suboesophageal ganglia give out a pair of ventral nerves in the mesosoma. In histology it shows various nerve centers for pedipalp, ambulatory nerves, vagus nerve and ventral nerve cord centers.

The paired ventral nerves after entering in mesosoma gives out dialations in each segment. These dialeled part is called as ganglion. Double ventral nerve cord has total 7 pairs of ganglia, situated in each segment of mesosoma and first four segments of metasoma. Last segment of metosoam does not have seperate ganglion. Each pairs of ganglion is formed 2 hemiganglia. Hemiganglions are joined together by small connective, which is clearly seen in slide of T. S. of segmental ganglion.

Anatomically each ganglion gives out pair of nerves in respective segment. The seventh ganglion gives out 4 pairs of nerves, innervating into anterior ventral nerves to 4th segment pair of nerves to telson, and a single alimentary nerve to rectum.

Histological observations show bilaterally symmetrical patches if the groups of nerve cells. At the center of each nerve track neurophils are present and the cells are called as ganglionic cells.

Female reproductive system of *Neoscorpiops deccanensis* consist of three longitudinal ovarian tubules, two lateral in position and one midventral region. Three ovarian tubules are interconnected by 4 transverses tubules. Thus 6 ovarian loops are formed. The ovarian loops form ovariuterus in *Neoscorpiops deccanensis*. Anteriorly ovariuterus proceeds as oviduct and form a dilation called as seminal receptacle.
Seminal receptacles of both sides fuse together to form common genital aperture, opening outside.

In Histological observation, ovary of *Neoscorpiops deccanensis* show uniform layer of cuboidal epithelium i.e. germinal epithelium. Germinal epithelium under goes oogenesis. During study of reproductive system all females collected were having one of the phases of embryogenesis, indicating pre and post hibernating period of embryo development is present in this species. The gestation period is of 7 months.

The egg of *Neoscorpiops deccanensis* is spherical, alecithal and with prominent nucleus at the centre. *Neoscorpiops deccanensis* discoidal cleavages of embryo development. 1\(^{st}\) cleavage in fertilized ovum is vertical, equal holoblastic, but at 90\(^{0}\) angle to the 1\(^{st}\) cleavage plane. Follicular cells feed the embryo up to blastula stage. Ovary during this phase invades into the surrounding hepatopancreas forming hundreds of diverticula, these diverticula has developing embryo at the tip. All diverticula in due course of development disappear and the developing embryos appear in the form of ovarian bulges. Histologically it is observed that each bulge has gastrula attached with the wall of ovariuterus to form two layers of blastoderm, a trophocyte cell layer forming hypoblast and discoidal blastomers forming epiblast. Blastocoel is formed in-between the two blastoderms. At this stage embryo shows free space at one side and attachment with trophocytes at another side. Hepatopancreatic cells provide nourishment to the developing embryo at this stage. The position of embryo at this stage is fixed. Embryo feeds on the hepatopancreatic mass and material from regressing embryonic growth and developed rapidly. Hepatopancreatic mass is utilized for the feeding of developing embryo. These ovarian puffs are formed of follicular cells present at both the ends of the embryo. The follicular cells modify to form large sized nutrient cells loaded with nutrient granules. These nutrient granules are spherical ball of 5 \(\mu\)m size. At the tip of ovarian puff each lobe of cells show specific site for feeding. At this site 10 cells form microvilli at a time, releasing the feeding nutrients into the embryonic cavity. Each follicular cell become deciduous cell elongates and reaches to the site of rupture. From single side puff 20 cells release their nutrients in the embryonic cavity. At this 18 somite stage embryo detach from the ovariuterus and swims freely in the surrounding fluid. The extra embryonic membranes are clearly visible at this point, the outer serosa and inner amnion. Serosa is modification of oviduct itself in the embryonic sac region. The
follicular puffs reach at the size of 1 mm and keep on feeding till the parturition. (PT.5.16)

At the time of parturition the specific elevated pegs are formed at the anterior ovarian puff to give way to the moving embryo towards genital aperture. The embryo oriented head towards the anterior of ovarian puff position. It indicates, at the time of parturition embryo is delivered head as first position. All 13 embryos are delivered by contraction of ovariuterus. The post parturition ovariuterus shows remnants of embryonic membrans, indication the embryos are not enclosed in the membrane at the time of birth. The post parturition embryonic sac forms corpus leuteum.

Male reproductive system of Neoscorpiops deccanensis consist of paired reticulate testis. Each testis has 3 loops extending from segment 3 to segment 6 of mesosoma. Testies tubules anteriorly proceed to form vas deference at both sides. Each vasa differentia is highly convoluted and reaches at the capsular region of spermatophore. Vas deference opens into the seminal vesicle which is attached with the ejaculatory duct of paraxial organ. 3 pairs of glands are present in the capsular region of both spermatophores. The glands are namely albumen gland, bulbouretral gland and seminal vesicle. One pair of unknown gland is visible in front of bulbouretral gland joining with the ejaculatory sac. In Neoscorpiops deccanensis paraxial organ is Lamelliform.

Histologically testis show well explanatory spermatocytes in the all stage of meiosis. The lumen of vas deference also shows process of spermeiogenesis.

The spermatogenesis occurs in testies, spermeiogenesis occurs in vas deference and the sperm packets are formed in seminal vesicles. Mature sperm has cylindrical head, middle piece and tail. It is 38 μm in length.

Anatomically venom gland of Neoscorpiops deccanensis is covered with elastic tough cuticle. Cuticle is made up of three layers, outer epicuticle, middle exocuticle and inner endocuticle. Cuticle encloses connective tissue and striated muscles, closely attached with it.

Venom gland is type one, pyriform, secretory gland with two types of cells Gland encloses poison duct which leads to the tip of telson. In aculeus the ducts of both the glands open independently and inject their secretions in the body prey. One gland is secretory and another is at resting phase at a time.
It is an apocrine gland i.e. while formation of poison the glandular cells do not destroy themselves. Numerous goblet cells, giant fibers, muscles, smooth muscles and circular muscle are compactly arranged in the telson.

There is no previous attempt to study the anatomy and histology of nervous, reproductive and venom gland systems of *Neoscorpiops deccanensis* by any researcher. Significant finding in the present studies are as follows:

1. Nervous system of female and male show structural difference. Protocerebrum in female is small pear shaped, while protocerebrum in male is twice in size to that of female and bean shaped.

2. Female reproductive system shows discoidal cleavages during embryo development. Embryonic feeding is done from hepatopancreas in earlier stages of development up to blastula stage embryo get nourishment through surrounding follicular cells after blastula stage ovariuteurs feeds the embryo by hepatopancreas by simple diffusion of nutrients through the uterine wall

3. After gastrulation special feeding apparatus is formed to feed the developing embryo. It is in the form of a ovarian puff at both the ends of oviducts. Ovarian puffs are bifid structures formed by the modifications of both layers of follicular cells of ovariuterus. Thus ovary feeds the developing embryo by follicular cells, ovariuterien wall and ovarian follicular puffs.

4. After the parturation ovaries show corpus leuteum formation within the collapsed embryonic sac.

5. Ovarian epithelium is retained for next brood

6. Male paraxial organ is lamilliform structure with spermatophore and capsular region. It shows three types of glands i.e. albumen gland, seminal vesicle and Bulbo urethral glands.

7. Venom gland is type one type, simple, pyriform gland with apocrine features. Both ducts open independently in the aculeus.