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Original Article

Seasonal changes in the secretory activity of seminal vesicles of the Indian fruit bat *Rousettus leschenaulti* (Desmarest 1820)

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Abstract

The epithelium of the seminal vesicles of *Rousettus leschenaultia* shows cyclical pattern in the secretory activity during the reproductive cycle. During the sexually quiescent phase, the seminal vesicles are regressed; the cytoplasm of the epithelial cells contains coarse secretory granules and the lumina of the tubules are empty. The secretion is in the form of secretory blebs in this species of bat. The formation of secretory blebs from the columnar epithelial cells is initiated during the recrudescent phase and is at its peak during the active breeding phase. These secretory blebs are discharged into the lumen of the tubules. Lumina of the tubules are filled with secretory blebs during the recrudescent and active breeding phases. Later on these blebs disintegrate and dissolve to form a homogenous material in the lumen of the tubules. Thus, the mode of secretion in the seminal vesicle of *Rousettus* is apocrine. The functional significance of the secretion of the seminal vesicles in reproduction of male bat is discussed.

Key words: Bat, Epithelial Cells, Reproductive Cycle, Seminal Vesicles, Secretory Activity

Introduction

In spite of the worldwide distribution and immense diversity of species of order Chiroptera, there has been very limited attention given to understanding reproduction in male bats (Krutzsch1979, 2000). Gopalakrishna and Chaudhari (1977) studied the reproductive cycle of *R. leschenaulti* and stated that there are two peak periods of male activity, first in October-November and second in February-March. The male genitalia of this bat have been described by Gopalakrishna and Murty (1976). Description of seminal vesicles is available for a number of bat species, *Minioptrerus schreibersii* (Krutzsch and Crichton, 1990); *Pipistrellus herpestus* (Krutzsch, 1975); *P. dormeri* (Gadegone and Sapkal, 1983); *Mormopterus planiceps* (Krutzsch and Crichton, 1987); *P. giganteus* (Rajalakshmi and Prasad, 1970); *H. lankadiva* (Gadegone et al., 2007); *Artibeus planirostris* (Puga et al., 2012) and *Molossus molossus* (Christante et al., 2015).

The present research was undertaken to study the secretory activity of seminal vesicles of the Indian fruit bat *R. leschenaulti* (Desmarest 1820) during the sexually quiescent and the active breeding phases to infer about the role of seminal vesicular secretion in the physiology of reproduction of this bat.

Materials and Methods

The specimens of Indian fruit bat *R. leschenaulti* (Desmarest 1820) were collected from Nagpur (MS), India, throughout the year representing different reproductive states. Adult males were trapped and brought alive to the laboratory with minimum stress and constant supply of food and glucose water. Five bats each of the sexually quiescent, recrudescent and sexually active males were sacrificed under anesthesia for light microscopic study of the seminal vesicles. For histological studies, the gland was fixed in different fixatives viz., aqueous Bouin's, Calcium Acetate Formalin (CAF), and neutral formalin. After fixation for 24 hr, tissues were washed with 70% ethanol, dehydrated through graded series of ethanol, cleared in xylene and embedded in paraffin wax. Thin sections of 3-5 μm thickness were cut in a Leica 2417 microtome. The seminal vesicles were stained with Ehrlich's hematoxylin and eosin for microscopic observation.

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Results

In *R. leschenaultia* the seminal vesicles show cyclical changes in the secretory epithelium during different stages of the reproductive cycle. Each seminal vesicle can be recognized into a cranial enlarged glandular part and a caudal tubular part which makes a single lateral curve on each side. These are covered with a thick fibrous capsule. This capsule wall is composed of an outer fibrous connective tissue layer, a middle muscular layer and an inner lining layer formed of glandular epithelium. The capsule wall extends into the mass of the seminal vesicles in the form of thin partitions or septa. These septa divide the gland into numerous tubules of different sizes. The tubules are separated from one another by connective tissue partitions. The lining layer of each tubule is formed of glandular epithelium. The connective tissue folds permit the distension of the seminal vesicles when they store the secretory material during the breeding phase. The tubules join with each other and finally drain into the main duct which is situated in the centre of the gland. The duct finally passes the secretion onto the urethral canal. The secretory activity of the seminal vesicles during the different phases of the reproductive cycle is presented here.

Seminal vesicles during the quiescent phase

The seminal vesicles during the quiescent phase are regressed. The tubules are surrounded by considerable amount of intertubular connective tissue. The tubules are lined by pseudostratified columnar epithelial cells. The nuclei are basally or centrally placed, round and darkly stained. The cytoplasm is basophilic, containing fine or coarse secretory granules. Lumina of the tubules are empty (Fig. 1, 2).

Seminal vesicles during the recrudescent phase

During the recrudescent phase, the seminal vesicles increase in size as compared to the previous phase. There is also an increase in the size of the tubules. The tubules are lined by tall columnar epithelial cells with large spherical nucleus located basally. The cytoplasm is filled with basophilic granular secretion. The formation of blebs is initiated during this phase. In some cells the apical portion bulges out in the form of blebs which are spherical. The blebs are seen to detach from the epithelial cells as many of them are still attached to the apical

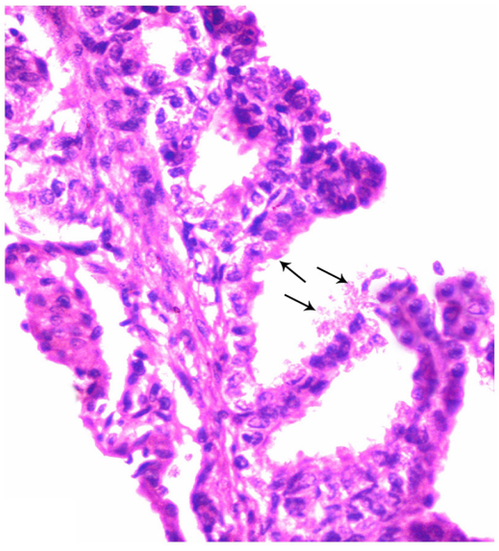

Fig. 1. Transverse sections of the seminal vesicles during the inactive phase. Tubules are lined by pseudostratified columnar epithelial cells (CE). Nuclei (N) are round, darkly stained, basally or centrally placed. Cytoplasm is basophilic containing fine or course secretory granules in the cytoplasm. Lumen (L) is empty. ICT, intertubular connective tissue; LP, lamina propria, SM, smooth muscle. H&E,x 320.

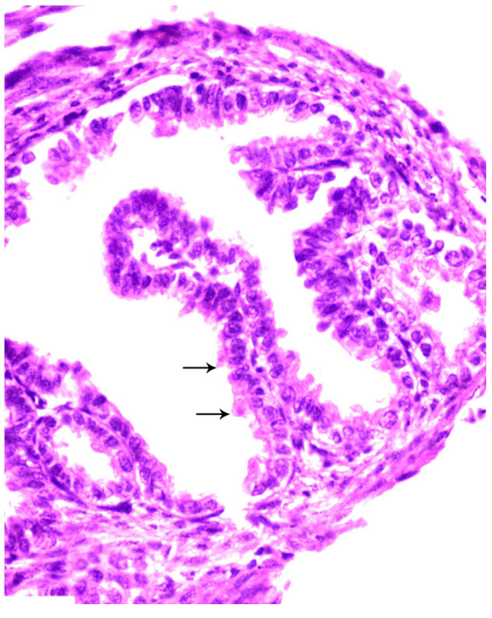

Fig. 2. A portion of Fig 1 magnified. Other details as in Fig 1.

surface of the secretory cells by a narrow connections. The blebs grow to the largest size, detach from the cells and are released into the lumen. Thus, the secretory material is packed in the form of numerous small globules. Lumina of the tubules are filled with spherical seminal blebs, and homogenous eosinophilic secretion is also observed in the lumen. The mode of secretion in the seminal vesicles of this bat is a pocrine and sometimes the entire cell along with the nucleus contributes to the luminal secretion. The intertubular connective tissue stroma is reduced due to enlargement of the tubules (Fig. 3,4).

Seminal vesicles during the breeding phase

During the breeding phase, the seminal vesicles are hypertrophied. There is further increase in the size of the tubules. The tubules are lined by low columnar to cuboidal epithelial cells because of loss of cytoplasm due to bleb formation. The process of bleb formation is continued during this phase also. Blebs are released from the cells and the lumina are filled with spherical seminal secretory blebs. The intertubular connective tissue layer also becomes thin due to increase in the size of the tubules (Fig. 5, 6).

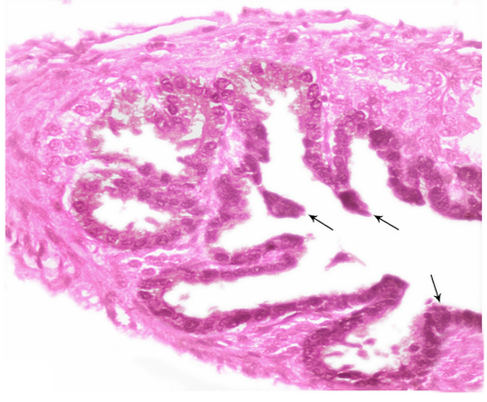

Fig. 3. Transverse section of seminal vesicle during recrudescent phase. Tubules are lined by tall columnar epithelial cells with large spherical basally placednucleus. Cytoplasm is filled with basophilic granular secretions. Note bulging out (AB) of the apical part of the cytoplasm in the form of secretory blebs which are spherical and are released into the lumen (RB). H&E,x 320.

Discussion

The seminal vesicles of *Rousettus* are greatly hypertrophied during the reproductively active phase. The tubular lumina are filled with

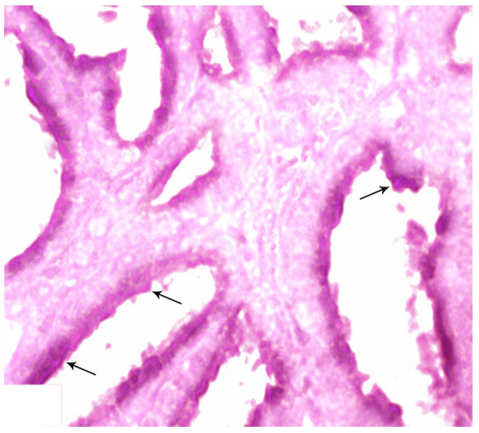

Fig. 4. A portion of Fig. 3 magnified. Other details, as in Fig. 3.

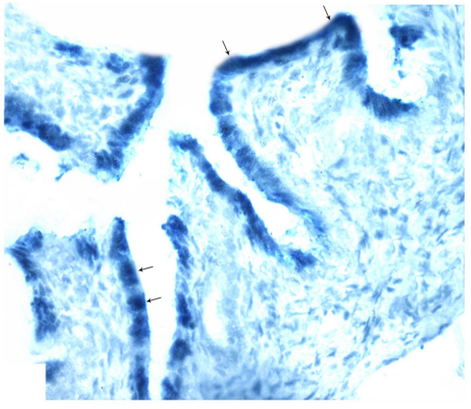

Fig. 5. Transverse section of seminal vesicles during active breeding phase. Note the lumina are completely filled with spherical seminal blebs. H&E,x 320.

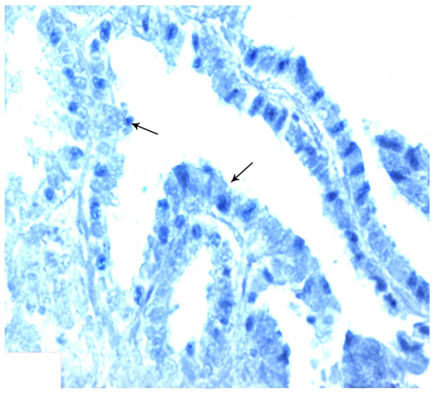

Fig. 6. Transverse section of seminal vesicles during active breeding phase. Tubules are lined by low columnar to cuboidal epithelial cells. Some blebs are seen attached to cell (AB) and some are released from the cell (RB) and the lumina (L) are filled with spherical seminal blebs. H&E,x 800.

highly granular, eosinophilic secretion that emanates from columnar epithelial cells. The reproductively inactive glands are much reduced in size and are lined by low columnar or cuboidal epithelium. The cytoplasm shows coarse granular secretory material and lumina of the tubules are empty. The cyclic histological changes in the eminal vesicles of *Rousettus* are almost similar to those reported in other species of bats, *Pipistrellus herpestes* (Krutzsch, 1975); *P. dormeri* (Gadegone and Sapkal 1983); *Taphozous longimanus* (Krishna and Dominic, 1982); *Myotis lucifugus* and *M. velifer* (Chrichton et al., 1981); *P. giganteus* (Rajalakshmi and Prasad, 1970); *Macrotus californicus* (Krutzsch et al., 1976); *Hipposideros lankadiva* (Gadegone et al., 2007); *Artibeus planirostris* (Pugaet al., 2012) and *Molossus molossus* (Christante et al., 2015). However, the secretion of seminal vesicles of *Rousettus* is in the form of seminal blebs which are released into the lumen and disintegrate and dissolved to form the homogenous luminal content.

The secretory products of seminal vesicles of *Rousettus*, a mega-chiropteran bat, are in the form of secretory blebs and these blebs then get discharged from the secretory columnar cells. Similar product is elaborated by the seminal vesicles of other mega chiropteran bats, *Cynopterus sphinx* (Mokkapati and Dominic, 1977), *Pteropus* species (McGuckin, 1988), Vespertilionid bat, *Miniopterus schreibersii* and Phyllostomid bat, *Desmodus rotundus* (Krutzsch, 1979). In these bats, the seminal vesicles generate and store massive number of defined droplets, in contrast with the amorphous secretion produced by seminal vesicles of many other mammals including insectivores, rodents and primates. Light microscopic analyses have suggested that in the fruit bats *Rousettus* (Gopalakrishna and Karim, 1974), *Pteropus* species (McGuckin, 1988) and *Cynopterus* (Mokkapati and Dominic, 1977), the spherical droplets stored in the seminal vesicles result from a pocrine secretion.

In the mega-bat, *Rousettus,* the vagina is filled with a mass of these individual droplets for some days after copulation and appear to act as vaginal plug. In the microbat, *Miniopterus* also, the groups of membrane-bound granules in the vesicular gland dissociate at some point after ejaculation, the bodies so released form the basis of a copulation plug in vagina (Krutzsch,1979), supporting the present observations.

The secretory products of seminal vesicles of *Rousettus* may participate in various reproductive processes of the male such as physiological modulation of sperm function during transport and participation in the defence mechanism of spermatozoa against reactive oxygen species as suggested in boar by Strzezek (2002).

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