The present investigation has been programmed to find out the impact of phytopesticide, Piperidine on the adult male, *Odontopus varicornis* in relation to reproduction. The summary of the findings of the investigation are given below:

6.1 The acute toxicity of the phytopesticide Piperidine has been evaluated to determine the median lethal dose (LD$_{50}$) and their 95 per cent of upper and lower confidence limits of insect was calculated for 24, 48, 72 and 96 hours of administration of the phytopesticide, Piperidine. The toxicity graph of phytopesticide, Piperidine was constructed and the mode of action of the toxicant was regular, systematic and also significant to the test insect, *Odontopus varicornis*.

Histopathological and biochemical studies were carried at the end of 96h exposure period in *Odontopus varicornis* to understand the over all physiological process.

6.2 The fat body cells have centrally located spherical nucleus distinct cytoplasmic vacuoles with nutrient substances. Fat body also consists of trophocytes which contain numerous lipid vacuoles.

In the phytopesticide, Piperidine treated insects, the fat body showed marked histological changes such as changes in the fat
body cells, vacuolization of cytoplasm, cell wall disintegration, scattered nuclei and hypertrophy of nucleus and less granular cytoplasm. The hypertrophied nucleus indicated an higher synthetic activity, to produce more nutrients to avoid stress by the test insect, *O. varicornis*.

6.3 The testis of treated insects showed the presence of the ruptured testicular follicle, disintegrated apical cells, primary and secondary spermatocytes, pycnotic and necrotic spermatids and sperms, reduced length of spermatids and sperms, decreased volumes of primary and secondary spermatocytes, disorganized sperm bundles with broken tails and more space with less packed spermatozoa in the lumen of the follicle. These histopathological changes may be attributed due to the phytopesticide, Piperidine which directly inhibits the process of spermatogenesis.

6.4 The seminal vesicle of the control insects showed a single layer of columnar epithelial cells surrounding the lumen. Based on, it is believed that the secretory substance of seminal vesicle may be used for the nourishment of stored sperms. In phytopesticide, Piperidine treated insects, the seminal vesicle showed a highly disintegrated epithelial cells with weakly stained cytoplasm and nuclei. The cytoplasm also showed many vacuoles. The size of the nucleus was decreased and
negligible quantity of secretory substances were detected in the lumen. These histopathological changes revealed that the phytopesticide, Piperidine affects the secretory nature of the seminal vesicles. The sperm mass in the lumen were comparatively less than the control. The seminal vesicle has dual function not only storage but also secretory nature.

6.5 The vas deferens of control insects showed a basement membrane with short columnar outer cells with distinct nuclei. The lumen contained secretory substances and sperm. The vas deferens of treated insects showed the presence of a disintegrated basement membrane with disorganized epithelial cells. The lumen contained less amount of secretory substances with more vacuoles and space, may be suggested these led to impairment of reproductive potentiality of the male insect, *O. varicornis*.

6.6 The accessory reproductive glands of the Piperidine treated insects showed certain histopathological architectures such as necrotic and karyolysed columnar epithelial cells, decreased nuclear size and its volume, clumping of chromatids and less amount of secretory substance with less packed sperm bundles in the lumen of the MARGs. These observations revealed that the phytopesticide, Piperidine prevents the secretory nature of
the MARGs, therefore, no nourishment, motility and activation to the stored sperms.

6.7 It has been observed that characteristic SEM changes in the fat body of treated insects than the control insects such as shrunken ruffled membrane with small pinocytotic pits. These changes may be attributed due to treatment with median lethal concentration of Piperidine on *Odontopus varicornis*. The disorganized cytoplasmic invagination indicates the less amount of storage substances probably be utilized for the insects to avoid stress during treatment.

Several SEM changes have been observed in the male reproductive organs of *Odontopus varicornis* when exposed to Piperidine for 48h such as the tubular testis follicle became highly pycnotic with folded cuticle, disorganized and disintegrated secretory granules. The spermatids of the treated insects have shrunken with numerous vacuoles, which interfere with the reproductive potentiality of the treated insects than the control insects.

There were numerous changes have been noticed in the rest of the reproductive tissues such as in the seminal vesicle, vas deferens, and MARGs. The following SEM change were observed in the treated insects like shrunken tube with thick myoepithelial cells, the rope like structure of the plasma
membrane, which observed to be highly pycnotic and disintegrated cuboidal epithelial cells. The muscular layer was also found to be thickened and highly pycnotic. The pinocytotic vesicles were found to be disintegrated with less organized microvilli. These SEM changes perhaps attributed to interact with the Piperidine. The pesticide intoxication led to disturbance in the specific mode of secretion by these pseudo stratified epithelial cells than that of the control insects.

In the treated insects, it has further been revealed that the secretory vesicle and granules with more vacuoles and pits were not observed in the control insects, suggested that the mechanism of secretion may become impaired in the treated insects.

The SEM changes in the MARGs of the treated insects have shown numerous folded cuticle and the epithelial cells were not distinct. The secretory granules were found to be less, which may be attributed due to less amount of secretory substances in the lumen, consists of less packed sperms. These changes might be disturbed the reproductive physiology of *Odontopus varicornis*.

6.8 The glycogen content were decreased in the fat body, testis seminal vesicles, vas deferens and MARGs of the phytopesticide exposed insects which may be attributed to the increased
breakdown of tissue glycogen to meet the energy demand caused by the phytopesticide, Piperidine.

6.9 The glucose contents were increased in the fat body, testis, seminal vesicles, vas deferens and MARGs of the phytopesticide treated insects. The increased glucose level in the tissue may be due to a sudden breakdown of glycogen and less utilization of glucose content.

6.10 The protein contents were decreased in the fat body, testes, seminal vesicle, vas deferens and MARGs of the treated insects and such depletion in protein content may be due to a rapid utilization of protein to meet the extra energy demand during phytopesticide, Piperidine intoxication.

6.11 The total free amino acid level has been shown to increase in all the selected tissues of treated insects. It is believed that a rapid proteolysis in the tissues followed by less utilization of amino acids to the cellular metabolism during phytopesticide, Piperidine intoxication usually elevate the amino acids levels in the selected tissues.

6.12 The lipid level thus, enhanced during the median lethal dose of phytopesticide, Piperidine caused severe hispathological and biochemical changes in the fat body, testes, seminal vesicle, vas deferens and MARGs of Odontopus varicornis when it
exceeds the required concentration of regular biological functions.

6.13 The activity of LDH in the fat body, testis, seminal vesicle, vas deferens and MARGs of treated insects have shown very less activity than the control insects. From the findings, it may be suggested that the decreased LDH activities is probably due to conversion of lactate in the tissues.

6.14 The activity of SDH levels showed inhibition in all the reproductive tissues during treatment with the phytosticide, Piperidine when compared to the control insects, suggesting that the decreased amount of glycogen and increased level glucose signified their utilization for energy requirement during the period of stress.

As SDH is a key enzyme in the TCA cycle, it is logical to assume that the inhibition of SDH activity, the metabolic pathway might switch over from aerobic to anaerobic to meet the increased energy demand during the Piperidine toxicity. The decreased level of SDH has been observed in all the tissues of Piperidine intoxicated insects *Odontopus varicornis*. It is known that each cell relies on numerous enzymes for catalyzed activities to maintain its metabolism.

6.15 The pattern of activity of the respiratory enzyme MDH is found in the fat body, testis seminal vesicle, vas deferens and MARGs
treated with the phytopesticide Piperidine increased than the control insects. These changes might be due to the supply of energy by the TCA cycle for the treated insects, which require energy during Piperidine intoxication.

6.16 The dynamic nature of an increase in GDH activity is found in the reproductive tissues of treated insect than control insect. These changes suggest that the glutamate may be utilized for the conversion of α-keto glutamate to meet an extra energy demand by *Odontopus varicornis* during Piperidine intoxication. On the basis of these observations made in the present study, it is evident that the inhibition of LDH and SDH activities and stimulation of MDH and GDH activities in all the target tissues of the reproductive system of *Odontopus varicornis* reveals that the metabolic pathway has shifted towards anaerobic side rather than aerobic side to meet the increase in energy demands during the Piperidine intoxication.

6.17 The significant reduction in the SOD, CAT and Glutathione activities in the fat body and all reproductive tissues like testis, seminal vesicle, vas deferens and MARGs of insects *Odontopus varicornis* were intoxicated with sub lethal doses of Piperidine may be due to toxic impact of this pesticide.

It has been inferred from the present study that the median lethal concentration of the phytopesticide, Piperidine brought
about some changes in the antioxidant enzymes to reduce the
detoxication mechanism which in turn cause physiological
impact of this insect, _Odontopus varicornis_

6.18 In the present FT-IR study, it has been observed that in all the
chosen tissues, the amount of protein content were found to be
decreased whereas the amount lipid content were increased
than the control insect, may be suggested that due to the
Piperidine compound caused drastic changes due to more
proteolytic more and lipolytic activity.