V SUMMARY AND CONCLUSION

'Mangrove' is a general term used by Davis (1940) for the plants living in muddy, loose, wet soils in tropical tide waters. According to Macnae (1968), mangroves are nothing but trees or shrubs that grow in the region between high spring tide mark and low neap tide mark. Depending on structure, osmotic pressure of cell-sap etc. mangroves are classified as (a) Excreting type - *Avicennia*, *Aegiceras*, *Acanthus*; (b) Accumulating type - *Sonneratia*, *Lumnitzera*, *Salvadora*; (c) Excluding type - *Rhizophora*, *Ceriops*, *Bruguiera*.

Acanthus ilicifolius is an excreting type of mangrove. It gives out excess amount of salt due to which it can grow in saline soils. With this background it was thought worth studying the excretion in *Acanthus* and *Avicennia*. The culture experiments were conducted during different months of the year. It was found that the survival of both plants is best when soil salinity is low due to rain. Possibly the seedlings have a specific age for transplantation. Further the present investigation shows that without Na and Cl, Acanthus does not grow in Hoagland nutrient solution.

Acanthus ilicifolius and Avicennia marina both have got special structures in the upper surface of leaves, the salt glands, through which excess salts are given out. As leaf age increases, leaf area increases and so also the salt glands on leaf. Fully expanded leaves have 12 salt glands per mm^2. Diameter of salt gland is about 40 μ. Although structure of salt gland varies greatly in different plants, it is strikingly similar in plants of same genus or even within one family. In Acanthus and Avicennia, gland is 5-9 celled.

The glands in mangroves are almost entirely enclosed by cuticular layer except for small regions, the transfusion zones between the innermost gland cells and the sub-basal cells. Between the secretory cells and the cuticle, collecting compartment is there. The cuticular layer extends over the gland and inward along the lateral sides of the gland where it abuts with the walls of the collecting cells or sub-basal cells. Characteristically, numerous plasmodesmata occur in transfusion zone wall between the inner secretory cells and the collecting cells. The secretory cells of the gland are also interconnected by plasmodesmata. Collecting cells have large vacuoles often containing electron dense materials, well developed chloroplasts and a peripheral cytoplasm with mitochondria and other organelles. The main gland cells are characterized by a dense cytoplasm, many mitochondria, large nuclei and small vacuoles frequently with an electron dense content.

Salt gland secretion shows variety of mineral elements. It includes cations Na, K, Ca, Mg and the anions Cl, SO_4, PO_4, NO_3 and HCO_3, including free amino acids and proteins in the secretions of some glands. Review of structural and physiological studies of salt glands indicates that due to the enclosure of the glands by a thick impermeable cuticle, apoplastic transport was not possible and only symplastic transport occured between the collecting cells and the innermost cells of the gland. Though it has been shown that plasmodesmata are involved in the passage of ions to the gland, the question of how ions move to the glands, whether through the apoplast, symplast or both is still not answered.

Cavities, just like collecting cavity in mangroves, have been observed in other types of glandular trichomes and hairs. It has been assumed that the secretions collect in the sub-cuticular cavity and when a sufficient hydrostatic pressure develops, the fluid is released through pores which are valve like and possibly pressure sensitive. Most hypotheses recognize that once the salts are released into the walls of the secretory cells and the sub-cuticular cavity, back-flow into mesphyll tissue is blocked. According to some botanists, the vesicles and small vacuoles of the cytoplasm of the secretory cells are involved in secretion.

It is of great interest to mention that the processes of salt secretion of various glands of one leaf or even small portions of it are not synchronized. In some cases secretion was found to be sensitive to temperature and metabolic inhibitors. Several studies indicate that salt secretion follows a diurnal pattern of high activity during the day and low activity at night. However, there is little evidence, for most plants, that the secretion is directly related to photosynthesis.

In present piece of work A. ilicifolius has been analysed for its inorganic status only in the leaves. It has been shown that Na, in saline plants ranges from 1.23% to 9.9% on dry weight basis. A. ilicifolius shows seasonal variations for Na ranging from 2.19 gm to 3.47 gm. The present value falls within this range. Na and other ions have a double role, namely (a) the maintenance of a sufficiently high internal osmotic pressure to prevent dessication of cells bathed by a solution of high osmotic pressure and (b) Specific nutritional requirement.

The problem of mangroves is to absorb enough K in presence of excess sodium. In any of the mangroves the values of K do not exceed 3%. The present investigation indicates 2.09 g of K for A. ilicifolius leaves. This value is within the range of K reported for A. ilicifolius by different investigators from different localities.

Saline soils are calcium-rich. However, in halophytes Ca cantent is low which can be attributed to higher Na content. Value recorded for Ca in A. ilicifolius in present study is 0.80% on dry weight basis.

Chlorides have been shown as an essential element in plant metabolism. Cl is required for the growth of higher plants and the accumulation of Cl in older parts has also been observed. Many investigators have recorded different Cl values for different mangroves. The present value is in confirmity with earlier records and differs slightly because of different habitat.

Phosphorus plays a key role in bioenergetics of metabolism and in biosynthetic reactions. Seasonal variations show that highest value for P in mangroves is during monsoon. P values for A. ilicifolius from different localities range from 0.116 to 0.187%. In present study A. ilicifolius has 0.130% P which is slightly low, possibly due to different habitat.

Mangroves have special mechanisms for salinity regulation like salt excretion, salt accumulation, and salt exclusion. A. ilicifolius and A. marina are salt excreting type of mangroves which maintain low levels of salts in metabolic environment by throwing out excess salt. Study of Na, K, Ca and Cl from salt excretion per day of *A. ilicifolius* cultured in Hoagland nutrient solution shows that though Na and Cl are predominantly excreted, Ca is also one of the cations excreted out in higher concentration. Na, K, Ca from salt excretion has been studied for 6 days which shows that

1) Na does not show constant trend, instead fluctuations are observed. Plant with daily change of N.S. also shows fluctuations.

2) K in excreted solution decreases slowly and finally it becomes zero. Na/K ratio goes on increasing showing increase in Na secretion and decrease in K.

3) Ca shows constant rate at first but it increases and then falls abruptly. However, this trend has not been observed in plant with daily change of N.S.

Chlorides from salt excretion have been studied for 12 days. Results show that amount Cl from salt excretion decreases first and remains constant afterwards. The same pattern has been observed in the plant with daily change of N.S. In the present study order of preference of excretion is Ca > Na > K. Initial observation for Na, K, Ca in N.S. and observation after six days culture of _A_. _ilicifolius_ shows increase in Na, in N.S.

_A_. _ilicifolius_ and _A_. _marina_ have also been cultured in soil and were treated with different concentrations of NaCl (0.05, 0.1, 0.2, 0.3 and 0.5 M). After three treatments, _A_. _ilicifolius_ shows highest secretion of Na, K and Cl at 0.1 M NaCl treatment. Ca shows fluctuations but highest Ca in salt excretion has been observed at 0.3 M NaCl treatment.

For chlorides, _A_. _ilicifolius_ shows fluctuations. More Cl has been excreted out at 0.1 M NaCl treatment. Na/Ca and Na/K ratios show fluctuations.

Salt excretion after 4th salt treatment shows that highest amount of Na, K and Cl have been excreted out when plants were treated with 0.1 M NaCl. Further treatments shows fluctuations for Na, K and Cl. Highest amount of Ca has been observed in excreted solution when plants were treated with 0.3 M NaCl solution. Here also Na/K and Na/Ca show fluctuations. More Ca is excreted out than Na.

In case of A. marina excretion study after 3 treatments shows that Na, K, Ca concentration in excretion solution increases as NaCl concentration in soil increases upto 0.3 M. For K and Cl this happens upto 0.2 M NaCl. Na/Ca ratio is more or less constant for all treatments Na/K ratio varies from 76.45 to 112.9. Further treatments show decrease in K and fluctuations for Cl.

Excretion after 4th treatment indicates that all Na, K, Ca, Cl are excreted out in higher amount when plants were treated with 0.2 M NaCl. Na/K ratio shows fluctuations; Na/Ca ratio more or less remains constant for all NaCl treatments.

Study of labelled chloride with A. ilicifolius indicates that plant roots show more chlorides than leaves and stems. As compared to leaves, stem has very less chlorides. It indicates that chlorides are readily transported to leaves from roots. Chlorides do not remain with the conducting system. Many investigators have shown that excretion of chloride is an active process which takes place against concentration gradient. It seems that excretion of Cl depends upon the level of Chloride present in the plant tissue.

Productivity of A. ilicifolius and A. marina has been calculated on dry matter basis. It has been observed that productivity goes on increasing upto 0.1 M NaCl in case of A. ilicifolius and for A. marina it increases upto 0.3 M NaCl. Further the same decreases in both cases. A. ilicifolius plants were grown in Hoagland nutrient solution. Here productivity is 12 mg per plant per day.

From all above discussion it can be concluded that :

1) The survival of plants, both Acanthus and Avicennia is best when soil salinity is low.

2) Values for Na, K, Ca and Cl in leaves of A. ilicifolius are in confirmity with earlier work. The littlebit difference in this is due to different habitat.

3) In the present study order of preference of excretion regarding the cations in

A. ilicifolius (Hoagland Culture) is Ca > Na > K. This is due to difference in values of Na, K, Ca and Cl in N.S. and in soil where plants were growing initially. Because of the same reason the excreted solution shows presence of K and Ca rather in more amounts and increase in Na in N.S. after survival of plants in N.S. for 6 days.

4) *A. ilicifolius* plants lose control over functioning of salt excretion process after 0.1 M NaCl treatment. For *A.marina* it is true when plants were treated with 0.2 M NaCl solution.

5) Study of chlorides from excreted solution explains the ecological distribution of these two plants. Even though both are excreting type of mangroves, *A. marina* is found as pioneer plant at many places whereas *A.ilicifolius* is found little away from the low tide water level.

6) Radio-active study indicates that chlorides are readily transported to leaves from roots. They do not remain with the conducting system.

7) For maximum dry matter production treatment of 0.1 M NaCl and 0.3 M NaCl is best suited for *A. ilicifolius* and *A. marina* respectively.