ON THE OCCURRENCE OF GLANDULAR HAIRS (SALT GLANDS) ON THE LEAVES OF SOME INDIAN HALOPHYTES

BY

D. P. MULLAN, B.A., B.Sc. (HONS.),

St. Xavier's College, Bombay.

A marked feature of the leaves of some of the Indian halophytes is the occurrence of glandular hairs. The latter are especially well-developed in some plants of the salt swamp. The glandular hairs are confined to one or both the surfaces of the leaves and are protected either by being sunk in pits or confined to grooves, or by being covered over by a thick felting of trichomes. As a rule, each gland consists of a short stalk-cell and a multicellular spheroidal or discoidal head. The latter holds granular contents which appear yellowish or brownish in preserved material.

Out of eight plants of the mangrove formation that were examined, four—*viz. Rhizophora mucronata*, Lamk., *Ceriops Candolleana*, Arn., *Bruguiera caryophylloides*, Blume. and *Sonneratia apetala*, Ham.—show no glandular hairs; while in the rest—*viz. Aegiceras majus*, Gaertn., *Acanthus ilicifolius*, Linn., *Avicennia officinalis*, Linn. and *Avicennia alba*, Blume.—the glands are very prominently developed. The glands show, as can be seen from the following descriptions, a remarkable general similarity in their structure, differing mainly in the shape of the head and in the number of the cells composing it.

In *Aegiceras majus*, Gaertn. the glandular hairs are very conspicuous and are equally abundant on the two surfaces of the leaf. Each gland is composed of a stalk-cell and a more or less disc-shaped, multicellular head (Fig. 1 A). The latter presents a circular outline in surface view (Fig. 1 B) and is very prominently developed, having a diameter of nearly 0.06 mm. The glands are all seated in pits, the external surface of the head being either flush with or slightly sunk below the surface of the lamina. The head is divided into a number of cells by vertical walls. Solereder [1] remarks: "the glandular hairs of *Aegiceras* are especially peculiar in having their lateral walls almost fused with the wall of the depression and in the arrangement of the ray cells in surface view, which reminds one of certain corals (*Cyclolithes* or *Fungia discus*)."

In *Acanthus ilicifolius*, Linn. the glands occur on both the surfaces of the leaf, but are more numerous on the upper surface. The glands are depressed and each consists of a short stalk-cell and a disc-like head (Fig. 2 A) which is divided by vertical walls only. In surface view, the head assumes a circular or oval outline and is usually composed of eight cells (Fig. 2 B).

The glandular hairs of *Avicennia officinalis*, Linn. are more numerously developed than those of the previous plants, and are differently placed on the two surfaces of the leaf. On the upper, glabrous surface of the leaf, the glands are sunk in pits and resemble those of *Acanthus ilicifolius*, Linn. Thus each gland consists of a short stalk-cell and a disc-shaped head (Fig. 3 A). The latter is divided by vertical walls and, in surface view, is seen to be composed of four to eight cells (Fig. 3 B). Scattered among these large glands are other smaller ones which are unicellular and are sunk in pits (Fig. 4 A, B). These small glandular hairs hold some contents which stain deeply with methylene blue and seem to be mainly mucilaginous. The smaller glands are more abundant, being about twice as numerous as the large glands. The lower surface of the leaf is densely covered with trichomes. Glandular hairs similar to the large glands of the upper surface are also present on the lower surface of the leaf. The glands on the lower surface of the leaf are, however, fewer in number and differ from those on the upper surface in that they are not depressed but stand out from the outer surface of the lower epidermis (Fig. 5 A, B). Thus the large glands are seen to be protected on the upper, glabrous surface of the leaf by being placed in pits, while on the lower surface they are covered over by the thick felting of trichomes.

Besides being present on the leaf blade, in *Avicennia officinalis*, Linn. glandular hairs also occur on the petiole. On its adaxial surface, the petiole bears a groove which is lined with long trichomes and glandular hairs. The glands on the petiole are thus mainly confined to the groove. Each gland (Fig 6 A) consists of a short stalk-cell and a head. The latter is spheroidal and is divided both by vertical and transverse walls into a varying number of cells. Though the glands stand out prominently from the surface of the petiole, they are efficiently protected by being confined to the groove and by being roofed over by the comparatively very long trichomes. Beyond the groove the adaxial surface of the petiole bears very few glands, which are, however, peculiar in that (since they are no longer protected by the groove and the trichomes) they are sunk in pits (Fig. 6 B) like the glands occurring on the upper surface of the lamina.

In *Avicennia alba*, Blume. the upper, glabrous surface of the leaf bears depressed glandular hairs. Each gland is composed of a short stalk-cell and a disc-shaped head (Fig. 7 A). The latter is divided by vertical walls and, in surface view, is seen to be composed of as a rule. eight cells (Fig. 7 B). The lower surface of the leaf is densely covered with trichomes among which glandular hairs occur. The glands on the lower surface differ from those on the upper in: (*a*) that they are not sunk in pits but arise from the general surface of the leaf, and (*b*) that they are smaller, the head being usually composed of four cells (Fig. 8). The glands are completely covered over by the comparatively long trichomes.

The petiole in *Avicennia alba*. Blume. is also grooved on the adaxial surface. The groove is thickly lined with long trichomes and glandular hairs. Each gland consists of a short stalk-cell and a head which is divided both by vertical and transverse walls (Fig. 9 A). The head of the gland is mostly spheroidal, but in some cases it is oblong (Fig. 9 B). The spheroidal head is composed of two horizontal rows of cells, while the oblong one consists, at times, of four such rows.

The glands found on the leaf blades of the four plants of the mangrove formation described above seem to act as salt-secreting hydathodes. The present writer has noted that on visiting these plants during the hot hours of the day, the leaves (*i.e.* the surfaces bearing the glands) are seen to be covered with patches of salt incrustations; while on visiting the same plant in the early hours of the day, the leaves are seen to be dotted with drops of liquid salt. The latter dries up under the rising sun and once again the leaves get covered with patches of saline incrustations. The excreted salts thus appear to be hygroscopic, for, during the night, owing to the increase in the atmospheric humidity they attract moisture from the air and deliquesce. These glands, occurring on the leaves of the four plants of the salt swamp, seem thus to resemble the salt glands, observed by Volkens (5), on the leaves of *Tamarix articulata*. Vahl, *Cressa cretica*, Linn. and other desert plants. Volkens (5) is of opinion that the parts bearing such glands are enabled to absorb water from the saline solutions which form during the night, and this view is adopted by Kerner (2). On the other hand, Marloth (3) regards the saline incrustations as a coating that reduces transpiration. He believes that the saline solution formed during the night, serves by evaporating during the day, to counteract the heating effect of the sun. Haberlandt (1) agrees with Marloth (3) and regards the salt glands as of the nature of hydathodes which serve as "a device for obviating the accumulation of mineral matter within the plant body.

It is interesting to note that of the eight mangroves examined, the salt glands are seen to be developed on those plants which live farther inland, away from the seaward fringe of the swamp, and which thus seem to be less adapted to a salty habitat; while in the plants (*e.g. Rhizophora mucronata*, Lamk., etc.) which grow typically on the outward and seaward edge of the swamp, and which thus seem to be well adapted to the saline substratum, the salt glands do not develop.

The occurrence of similar glandular hairs is also a marked feature of the leaves of some psammophilous halophytes, like *Ipomoea, pes-caprae*, Sweet., *Clerodendron inerme*, Gaertn. and *Neuracanthus sphaerostachys*, Dalz. As can be seen from the diagrams (Figs. 10-15), the glands of these psammophilous halophytes are constructed on the same plan as those of the mangroves previously considered, each being composed of a short stalk-cell and a discoidal head which is divided into a number of cells by vertical walls. As in the case of the mangroves, the glands of these psammophilous halophytes are also sunk in pits and hold granular contents.

For example, in *Ipomoea pes-caprae*, Sweet. the glandular hairs occur on both the surfaces of the leaf, being larger and more numerous (nearly twice as many) on the lower surface (Figs. 10 A, B) than on upper (Fig. 11). In *Clerodendron inerme*, Gaertn. the glands occur on both the surfaces of the leaf, being about twice as many on the lower surface (Fig. 12) as on the upper (Fig. 13). Similar glands also occur on the petiole of *Clerodendron inerme*, but these are smaller, the head being composed of four to eight cells (Figs. 14 A, B). In *Neuracanthus sphaerostachys*, Dalz. the glandular hairs (Figs. 15A, B) are confined to the lower surface of the leaf, the head being composed of, as a rule, four cells.

In order to study whether a change of habitat has any effect on the glandular hairs, two halophytes, *viz. Acanthus ilicifolius*, Linn., and *Clerodendron inerme*, Gaertn., were removed from their natural habitat and grown under mesophytic conditions for nearly ten months. The leaves of the two plants which developed under these conditions showed the presence of glandular hairs which were rather feebly developed in that they showed a tendency towards reduction in the number of the head cells. Furthermore, under mesophytic conditions, the typical granular contents of the head cells become very meagrely developed and in some cases even completely disappear. The salt incrustations which form such a characteristic feature of the leaf of *Acanthus ilicifolius*. Linn. in its natural habitat, fail to appear under mesophytic conditions.

Summary.

1. Glandular hairs are seen to form a marked feature of the leave, of some Indian halophytes.

2. These glands occur on one or both the surfaces of the leaf and are protected by being placed in pits or by being covered over by a dense felting of trichomes.

3. As a rule, each gland consists of a short stalk-cell and a spheroidal or discoidal multicellular head which holds granular contents.

4. The structure of the glands occurring in four plants of the mangrove formation is described.

5. These glands seem to act as salt-secreting hydathodes, for incrustations of salts were actually observed on the leaves of these four plants during the day.

6. The excreted salts seem to be hygroscopic, for, they were observed to deliquesce during the night.

7. The glands thus resemble the salt glands observed by Volkens (5) in some desert plants.

8. Out of eight plants of the mangrove formation that were studied, it is noticed that the salt glands develop on those individuals which live, as a rule, away from the seaward fringe of the swamp; while in the case of those mangroves which are more adapted to a salty substratum, and live on the outward and seaward fringe of the swamp, the glands are absent.

9. Glandular hairs similar in structure to those of the mangroves are also to be met with in a few psammophilous halophytes.

10. In order to study the effect of a change of habitat on the glands, two halophytes were grown under mesophytic conditions when it is observed that, under such circumstances, the glands develop feebly and the head cells hold meagre contents.

Literature Cited.

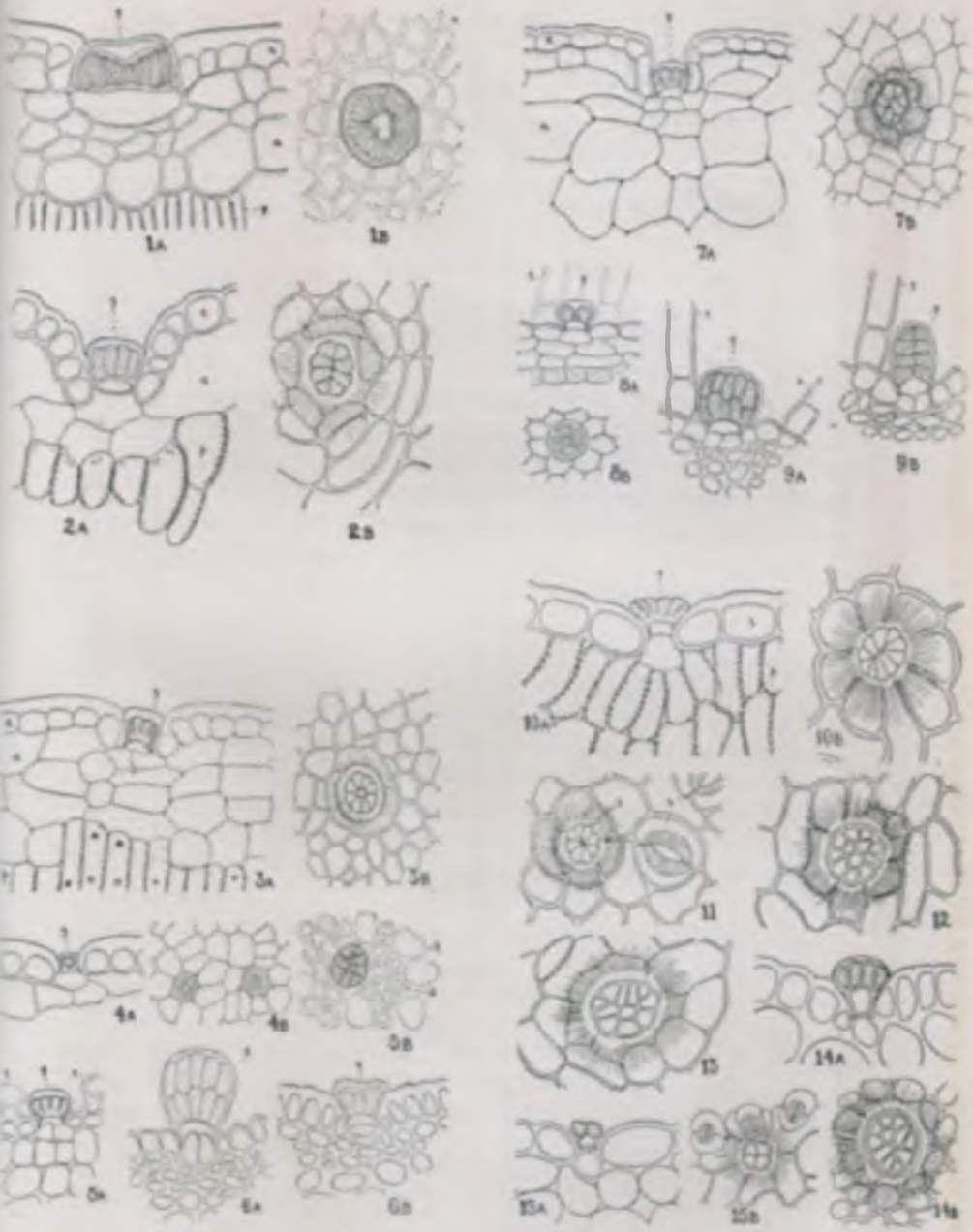
1. Haberlandt, G.: Physiological Plant Anatomy. English edition, 1928, p. 500.

2. Kerner von Marilaun, A.: The Natural History of Plants. English edition, 1894, p. 236.

3. Marloth: Zur Bedeutung der salzabscheindenden Drussen der Tamarisconeen. Berichte de deutschen botanischen Gessellschaft, Berlin, V, 1887.

4. Solereder, H.: Systematic Anatomy of the Dicotyledons. English edition. Oxford, 1908, p. 511.

5. Volkens, G.: Die Flora der agyptisch-arabischen Wuste. Berlin, 1887, pp. 27 *sqq*.


1A
1B
2A
2B
3A
3B
4A
4B
5B
5A
6A
6B
7A
7B
8A
8B
9A
9B
10A
10B
11
12
13
14A
15A
15B
14B

Explanation of Plate.

All figures have been drawn to an initial magnification of ×500 and have been reduced to one-fourth in reproduction.

Fig. 1. Glandular hair from the leaf of *Aegiceras majus*, Gaertn. A, in transverse section; B, in surface view; e, upper epidermis; g, gland; a, aqueous tissue; p, palisade cells.

Fig. 2. Glandular hair from the leaf of *Acanthus ilicifolius*, Linn. A, in transverse section; B, in surface view; e, upper epidermis; g, gland; a, aqueous tissue; p, palisade cells.

Fig. 3. Glandular hair from the upper surface of the leaf of *Avicennia officinalis*, Linn. A, in transverse section; B, in surface view; e, upper epidermis; g, gland; a, aqueous tissue; p, palisade cells.

Fig. 4. Mucilage gland (*g*) from the upper surface of the leaf of *Avicennia officinalis*, Linn. A, in cross section; B, in surface view.

Fig. 5. Glandular hair from the lower surface of the leaf of *Avicennia officinalis*, Linn. A, in transverse section; B, in surface view; g, gland; t, trichome; s, stalk-cells of trichomes.

Fig. 6. Glandular hair from the petiole of *Avicennia officinalis*, Linn. A, gland (*g*) occurring in the groove; B, gland occurring outside the groove.

Fig. 7. Glandular hair from the upper surface of the leaf of *Avicennia alba*, Blume. A, in cross section; B, in surface view; e, upper epidermis; g, gland; a, aqueous tissue.

Fig. 8. Glandular hair from the lower surface of the leaf of *Avicennia alba*, Blume. A, in transverse section; B, in surface view; g, gland; t, trichome.

Fig. 9. Glandular hair from the petiole of *Avicennia alba*, Blume. A, gland with spheroidal head; B, gland with oblong head; g, gland; t, trichome.

Fig. 10. Glandular hair from the lower surface of the leaf of *Ipomoea pes-caprae*, Sweet. A, in transverse section; B, in surface view; l, lower epidermis; g, gland; p, palisade cells.

Fig. 11. Glandular hair (in surface view) from the upper surface of the leaf of *Ipomoea pes-caprae*, Sweet. g, gland; s, stomata.

Fig. 12. Glandular hair (in surface view) from the lower surface of the leaf of *Clerodendron inerme*, Gaertn.

Fig. 13. Glandular hair (in surface view) from the upper surface of the leaf of *Clerodendron inerme*, Gaertn.

Fig. 14. Glandular hair from the petiole of *Clerodendron inerme*, Gaertn. A, in transverse section; B, in surface view.

Fig. 15. Glandular hair from the lower surface of the leaf of *Neuracanthus sphaerostachys*, Dalz. A, in transverse section; B, in surface view.