

IX. *On the existence of Spiral Cells in the Seeds of Acanthaceæ.* By Mr. RICHARD KIPPIST, *Libr. L.S.* Communicated by the Secretary.

Read March 17th, 1840.

THE existence of spiral cells in the envelopes of the seed, has, as regards several families, been long known among botanists. They were first discovered by Mr. Brown in the pericarps of *Casuarineæ*, and subsequently in the testa of some *Orchideæ*. Lessing detected them in *Compositæ*; Horkel and Schleiden in *Labiataæ*, *Polemoniaceæ*, and *Hydrocharideæ*; and Dr. Lindley has published in the 'Botanical Register' a detailed account of their appearance in the seeds of *Collomia*. As, however, I am not aware that any author has yet noticed their occurrence in those of *Acanthaceæ*, and as I have been fortunate enough to meet with them in many species of that family, presenting, as it appears to me, some peculiar characters, and in some cases attaining an unusual degree of development, I venture to hope that the following account of my observations may not prove unacceptable to the Linnean Society.

My attention was first directed to this subject by witnessing the very beautiful appearance under the microscope of an Acanthaceous seed, forming part of a collection brought by Mr. Holroyd from Upper Egypt, and presented by him to Professor Don. It is of a lenticular form, covered, especially towards the margin, with whitish hairs, which are closely appressed to the surface, and glued together at their extremities, so as rather to resemble corrugations of the testa than distinct hairs; on being placed in water, however, they are set at liberty, and, expanding on all sides, are seen to consist of fascicles of long, cylindrical, transparent tubes, firmly cohering for about one-third of their length, and presenting all the characters of spiral vessels. These fascicles usually contain from five to twenty tubes; each tube inclosing one, two, or occasionally even three spiral fibres, which adhere closely to the membrane.

The fibre may be sometimes seen to divide into two in the upper part of a tube, the branches usually continuing distinct; sometimes, however, after making a few turns, they again coalesce. Towards the free extremity of the tube the fibre is frequently broken up into a number of distinct rings; and in other cases the spire again becomes continuous, after having been interrupted by two or three such rings. In those portions of the tubes which adhere together the fibre is completely reticulated; towards the extremity, the coils, though quite contiguous, are usually distinct, and readily separate by the expansion of the tube; in the intermediate parts they adhere more firmly together, being connected by slender ramifications of the main fibre. The expansion of the hairs in water is accompanied by a copious discharge of mucilage, which makes its escape by distending and finally rupturing laterally the spiral tubes in which it is contained.

The testa, which is distinctly visible in the spaces between the hairs, consists of nearly regular hexagonal cells, each containing an opaque mass of grumous matter, which, not filling the entire cavity, leaves a wide transparent border. Cells similar to these, but more elongated and gradually passing into the form of tubes, immediately surround the base of each hair, which appears to be filled up by a conical mass formed of the transparent tubular portions.

The seeds brought home by Mr. Holroyd unquestionably belong to a species of *Acanthodium*, and were at first considered by Professor Don to be those of *Acanthodium spicatum*, an opinion which seemed to be confirmed by their striking resemblance to the figure and description given by Delile in the botanical part of the great French work on Egypt*; but having been since favoured by the kindness of Mr. Brown with a seed from an authentic specimen of

* The following is Delile's account of the seed of *Acanthodium spicatum* from the work above quoted:—

“ Les graines sont couvertes de poils blancs, couchés de bas en haut et comme collés, qui naissent de la tunique de la graine : ces poils, lorsque l'on met la graine dans l'eau, la retiennent d'abord flottante par l'air qui occupe leurs intervalles ; il se dégage presque aussitôt, et la graine tombe au fond de l'eau ; elle se hérissé de toutes parts par les poils qui se dressent à sa surface : les rangs de poils couchés sur les bords de la graine se séparent les uns des autres et presque simultanément, après ceux des faces de la graine ; ils sont surtout longs et abondans sur ses bords, et sont coudés par leur extrémité libre que l'on voit se déployer dans l'eau du sommet vers la base de la graine. Ces poils mouillés se couvrent et sont agglutinés par un enduit visqueux, transparent.”

Delile's plant, I have carefully compared the two, and although to the naked eye the resemblance both of the seed and capsule is very striking, the result of a careful microscopic examination has left some doubt of their identity. As yet no seedlings have been raised of Mr. Holroyd's plant, and unfortunately he possesses no specimen.

The cells of the testa appear to me to be somewhat smaller in Mr. Holroyd's seeds than in Delile's, but they certainly do not differ very materially in this respect, the principal distinction between them being that in the former the spiral fibre adheres closely to the membrane, whilst it is usually quite free in the latter, the expansion of the fluid within the cell frequently detaching a portion of the membrane and exposing the fibre, which is often singularly confused and entangled: as, however, they agree in every other particular, it may be a question whether the difference observable in Delile's seed be anything more than the result of age destroying the elasticity of the fibre, and thus preventing it from expanding simultaneously with the membrane. What renders this the more probable is, that I find an entire conformity in the fibre of another species of *Acanthodium* gathered many years ago by Mr. A. P. Hove in the Lymree desert of Guzerat, for which I am also indebted to Mr. Brown. This seed bears a very close resemblance to the two already described, in the structure both of the testa and the investing hairs, which here also are formed of partially-cohering cylindrical tubes, containing one or two spiral fibres; but the hairs are more thinly scattered in the Indian seed, and consist of a smaller number of tubes (about 5—8).

The peculiar appearances of these seeds induced me to extend my inquiries to other genera of the same natural family, with the view of ascertaining how far the tendency to develope spiral hairs on the testa prevails among them, and whether that peculiarity might afford any assistance in characterizing genera. Although the presence of spiral cells is by no means universal in *Acanthaceæ*, yet I have met with many examples of them, and with a considerable diversity in the structure and arrangement of the hairs which clothe the seeds.

Besides *Acanthodium*, the only other genus in which I have met with fasciculate hairs is *Blepharis*, of which I have examined three species, two of them natives of India (*B. boerhaaviæfolia* and *B. molluginifolia*), the other *B. rubiifolia*,

for which I am indebted to the kindness of Mr. Brown, being from the banks of the Congo. In all three the structure of the testa and its appendages is very similar to that of *Acanthodium*, but differs in the following particulars:—

First. The testa is less transparent than in *Acanthodium*, the cells being formed of thicker membrane, smaller, and more nearly filled with dark grumous matter, and the cells surrounding the bases of the hairs are precisely similar in form to the rest, not elongated, as in *Acanthodium*. Secondly. The hairs consist of a larger number of tubes (sometimes amounting to fifty), which are quite cylindrical, not compressed, of nearly equal diameter throughout their whole length, and containing a thicker and more loosely coiled spiral fibre. This fibre is very generally single; and instead of being reticulated in the coherent portions of the tubes, it either continues spiral, or is disposed in distinct rings, which are separated from each other by an interval of four or five times the width of the fibre; whereas in *Acanthodium* the coils are usually quite contiguous. The species differ from each other only in a few unimportant particulars, chiefly in the size and number of the tubes composing the hairs, which are smaller and more numerous in *Blepharis molluginifolia* than in either of the others. In *B. rubiifolia* they appear to me to be rather larger, and occasionally, but very rarely, contain two spiral fibres.

Although the fasciculated hairs already described are, as we have seen, of rare occurrence in *Acanthaceæ*, many species of that family have their seeds abundantly supplied with appendages, which, notwithstanding that they do not adhere together, are evidently of the same nature. The most common form of these appendages is that of subulate tubes or hairs, usually so closely appressed as not to be perceptible upon the dry seed, but expanding in water, and often discharging abundance of mucilage from their extremities. They are very generally furnished with an internal fibre, which is disposed either in a spiral manner, or in distinct rings, and both forms frequently occur in the same tube. They sometimes occupy the entire surface of the seed, sometimes they are confined to its margin. Examples of spiral hairs covering the entire surface are afforded by many species of *Ruellia*. In *R. formosa* the hairs are short, thick and blunt, shaped somewhat like icicles; and the fibre, which is always simple, usually takes an annular form, sometimes becoming spiral towards the base of the hair; those of *R. strepens* have the fibre disposed

in rings towards the extremity, but spiral and not unfrequently branched in the lower part. The mucilage is very copious, and may be seen to flow from the extremity of the tube, carrying with it a quantity of granular matter, which slowly dissolves in water. A row of dark spots, apparently formed of the same substance as the granules, may be sometimes seen adhering internally to one side of the tube.

Of the genus *Hygrophila*, whose seeds have a close analogy to those last described, I have examined five species, *H. salicifolia*, *H. quadrivalvis*, *H. obovata*, *H. phlomoides*, and *H. radicans*, and find in all a striking resemblance of structure: the seed is entirely covered with moderately long, blunt-pointed tubes, densely crowded together, and furnished with numerous closely-approximated rings, the fibre being seldom spiral. On the application of water an abundant flow of mucilage takes place from a terminal pore; but when this does not afford a ready outlet, the tubes are frequently detached from the testa by the rapid expansion of the fluid within, and numbers of them may be seen floating about loose in the water.

The seeds of *Dyschoriste cernua*, *D. littoralis*, and *Æchmanthera tomentosa* closely resemble the preceding in the form and arrangement of the hairs, which occupy the entire surface. They are usually short, blunt, and furnished with distant rings, which are very faintly marked, but being much more evident along the outer edge, often present the appearance of a row of dark spots on the side most distant from the surface of the seed. These spots I at first believed to be actual holes, but never having seen any mucilage discharged through them, although it may be observed to escape in abundance from the extremities of the hairs, I am inclined to think that this appearance results merely from the varying thickness of the fibre.

In *Strobilanthes*, *Stenosiphonium*, *Dipteracanthus* and *Ætheilema*, the hairs do not usually, as in all the preceding genera, occupy the entire surface of the testa; on the contrary, they are for the most part confined to the margin, and are found closely appressed in the dry seed, forming a kind of membranous border. The testa itself consists of more or less elongated cells, of a somewhat woody texture, with very thick lateral walls, which are always arranged in a direction parallel to the longer axis of the seed. In *Strobilanthes scabra* and *S. lupulina* these cells are many times longer than broad, cylindrical or com-

pressed, apparently porous, somewhat wavy or bent at their extremities: the marginal hairs are long, slender and tapering, furnished with numerous approximate rings, which are frequently replaced towards the base by spiral fibre. In *Strobilanthes imbricata*, *S. Brunoniana* and *S. monadelpha*, the testa is formed of much shorter cells, but in other respects similar to those of the foregoing species. The hairs of *S. imbricata*, which are short, thick and annular, proceed chiefly from the margin. In *S. Brunoniana* and *S. monadelpha*, the hairs, which resemble those of the last species, except in being longer, occupy a considerable part of the surface of the seed, although much more numerous at the margin than elsewhere. The seeds of *S. fimbriata* and *S. Wallichii* differ materially from those of the other species I have examined in the nature and disposition of the hairs, which are short, blunt-pointed, and entirely destitute of fibre in both; they are distinctly visible on the dry seed, and do not change their position or emit any mucilage on being placed in water. In the former species they are remarkably rigid, and entirely cover the seed, to which they are obliquely attached by a decurrent base; in the latter they are formed of rather thinner membrane, and frequently half filled by a yellow resinous-looking substance: with the exception of a small vacant space round the hilum, they occupy the entire surface of the testa.

The seeds of *Stenosiphonium subsericeum* and *Ætheilema reniforme* bear a close resemblance to those of *Strobilanthes Brunoniana* and *monadelpha*, the border being formed of slender, tapering, annular hairs, whilst smaller ones of a similar construction extend inwards over the greater part of the surface. The testa appears to consist of an outer membrane, formed of nearly quadrangular cells covering a layer of more elongated woody ones.

Of the genus *Dipteracanthus*, I have examined three species, *D. patulus*, *D. erectus* and *D. dejectus*: in the two former the seed is of a lenticular form, concavo-convex, with a narrow membranous border, formed of moderately long hairs, blunt-pointed*, destitute of fibre, and discharging copious streams of mucilage from their extremities. The testa is composed of short thick-walled, woody cells on the surface, and of a transparent membrane beneath,

* Among the mucilaginous fluid emitted by the seeds of *D. patulus*, I observed a number of faint rings, apparently of half-formed fibre: it is not improbable, therefore, that in the fully mature seed the hairs may be either annular or spiral.

traversed by elevated ridges, which inclose irregular areas, often more or less quadrangular in form, with a raised point in the centre: on the concave surface the woody cells are frequently extended into short, rigid, slightly-recurved hooks, very different from the elongated membranous hairs which occur on the edge. The marginal hairs of *D. erectus* sometimes contain a quantity of granular matter, and the hooks on the disc are somewhat longer than in *D. patulus*. The seed of *D. dejectus* scarcely seems to differ in structure from those of the two species already noticed, except in having spiral hairs on the border; but the only specimen I have had an opportunity of examining was very imperfect.

In *Blechnum Brownei* the seed is furnished with a narrow whitish border, formed of short, cylindrical, membranous cells, rounded at their ends, entirely destitute of fibre. These cylindrical cells are arranged in a radiating manner, not appressed like the hairs which compose the border of *Strobilanthes*, *Dipteracanthus*, &c. On being moistened they become greatly distended by the expanding mucilage within, and ultimately assume the form of wide, blunt, wavy tubes, constructed of an exceedingly delicate membrane, without fibre or any very distinct markings, and frequently terminated by a small club-shaped appendage, looking something like the rudiment of a second cell.

In a considerable number of *Acanthaceæ* the seed is invested with very numerous long, slender, tapering hairs, formed of simple membrane, and proceeding equally from every part of the testa, closely appressed, but expanding in water, without any discharge of mucilage. This structure I have found to be very prevalent in the genus *Barleria*, having examined nine species without observing a single exception; it also occurs in many species of *Lepidagathis* and *Goldfussia*, in *Eranthemum** *nervosum*, and *E. Wightianum*, *Phlogacanthus thyrsiflorus*, *Hemiadelphis polysperma*, and *Neurostachys tetragonostachys*.

In *Lepidagathis fasciculata*, *L. mucronata* and *L. hyalina*, the hairs are much shorter and blunt-pointed, but devoid of fibre, and scattered over the whole surface of the testa, as in the majority of the species. Those of *L. scariosa*

* A remarkable difference of structure occurs in the seeds of *Eranthemum crenulatum*, and another species closely allied to *E. bicolor*; the testa in both is entirely destitute of hairs, and reticulated with anastomosing ridges formed of elongated cells; in the areas between the elevated ridges the cells are shorter and nearly hexagonal.

often present a peculiar chain-like appearance, from their being contracted at short intervals, and apparently compressed in opposite directions. In two species of *Goldfussia*, *G. divaricata* and *G. lamiiflora*, they are very long and slender, but distinctly jointed or annular. Those of *G. pentstemonoides* and *G. colorata* are often singularly refracted and waved at their extremities.

Hairs of a very remarkable form occur on the seeds of two closely-allied Chilian plants, one of them being the *Ruellia dulcis* of Cavanilles, the other a new species found at Concon by Mr. Miers, who informs me that they will probably form together a new genus, to which he proposes to give the name of *Micræa*. In both species the testa is entirely covered with moderately long rigid hairs, which are directed upwards, and distinctly visible upon the dry seed, longitudinally striated, appearing as if formed by the adherence of several very slender tubes, and armed with numerous recurved hooks, which are evidently hollow, and seem to communicate with the tubes; each hair is usually terminated by two of these hooks, pointing in opposite directions. The hairs do not discharge mucilage, or change their position materially on being placed in water.

A structure very similar to the above occurs in the seeds of *Rhaphidospora glabra*, whose hairs differ chiefly in being shorter, thicker, and much more closely beset with recurved teeth: as in *Micræa*, they are entirely destitute of mucilage, and may be clearly seen upon the dry seed, which they render perfectly hispid.

Hairs, bearing some resemblance to those of *Rhaphidospora*, although much reduced in size, occur on the seeds of a species of *Dicliptera*, brought by Afzelius from Sierra Leone, and contained in the Smithian herbarium. The testa consists of small, nearly regular, hexagonal cells, and is thickly beset with little rounded tubercles, of a paler colour, but formed of the same kind of tissue as the rest of the testa. Each of these tubercles is produced into a very short hair, terminated by from three to six recurved radiating hooks, and having on the sides a few other hooks similar but smaller. In *Dicliptera Roxburghiana* the hairs nearly resemble those of the preceding, but they do not appear to be seated upon tubercles; whilst in *D. bupleuroides* the seed is covered with slightly prominent tubercles, formed of very minute hexagonal cells, but destitute of hairs.

Nelsonia tomentosa, *Ebermaiera thyrsoides*, and *Erythracanthus prostratus*, all belonging to Nees von Esenbeck's tribe of *Nelsoniæ*, bear a striking resemblance in their seeds, which are very small, nearly globular, usually somewhat tuberculated, and furnished with very minute hairs, closely appressed, sparingly scattered over the surface, and wholly destitute of mucilage. In *N. tomentosa* these hairs expand very slowly when wetted, and present the appearance of short simple tubes, more or less incurved or uncinatè at their extremities, and frequently ending in a double hook. In *Ebermaiera* and *Erythracanthus* the hairs appear to be similar, but owing to their extreme minuteness, and the very slight action which water has upon them, I have not been able to satisfy myself fully upon this point.

Having now completed my account of those *Acanthaceæ* whose seeds I have observed to be furnished with hairs, it only remains for me to mention the species in which no such appendages have been met with, and to indicate such peculiarities of structure as may seem to deserve particular notice, premising as a general remark, that the whole of them agree in being destitute of mucilage.

Acanthus mollis, *Acanthus arboreus*, *Dilivaria ilicifolia*.—The entire absence of hairs on the seeds of these two genera is remarkable, when we consider their close relationship to *Acanthodium* and *Blepharis*, in which these organs are most highly developed. The structure of their testa is totally different, being very thick, opaque, and even woody, whilst in the two latter genera it is thin and membranous.

Crossandra infundibuliformis.—The seed, which is oval and slightly compressed, is covered with numerous flat, scale-like, imbricated processes, which give it some resemblance to a pine-cone; the scales which proceed from the sides of the seed are broad, thin, striated, dilated upwards, and irregularly jagged at their extremities; the marginal ones being usually longer and narrower.

Asystasia coromandeliana, *A. macrocarpa*, *A. Neesiana*, *A. Kunthiana*.—There is much resemblance between the first three species in the size, form, and structure of their seeds, which are unusually large, reniform, much compressed, swollen, and more or less crenated at the margin, with an uneven and furrowed surface. The testa is very thick and opaque, and consists of an outer layer of

polygonal thick-walled cells of very small diameter, covering a loose spongy mass of thinner and more transparent tissue. In *A. coromandeliana* the external cells are very nearly hexagonal and prismatic, like those of a honeycomb. The seeds of *A. Kunthiana* differ much from those of the three former species, being much smaller and concentrically rugose, as in some species of *Rostellaria* and *Rungia*.

Justicia Ecbolium, *J. rotundifolia*, *J. dentata*.—In their large size, incrassated border, and dense woody testa, the seeds of these three closely allied species agree with those of *Asystasia coromandeliana*, but differ in their obliquely-cordate or almost rhomboid form and nearly straight margin, and in being furnished with numerous small radiating tubercles. The testa consists of elongated hexagonal prisms, which, when viewed laterally, bear considerable resemblance to barred or porous vessels. The species differ but little from each other in the form of their seeds; those of *J. dentata* appear to be rather more acuminate, and the tubercles are more prominent than in those of *J. rotundifolia*, which are somewhat rounder and blunter, with a thicker and more strongly-marked border.

Rostellaria procumbens, *R. diffusa*, *R. quinquangularis*, *R. peploides*, *R. Vahlîi*.—The seeds of the above-named species of *Rostellaria* present a great similarity of structure, especially the four first, which are furnished with narrow, concentric, slightly undulated ridges, formed of small, nearly regular, prismatic cells: those of *R. procumbens* and *R. diffusa* have the external ridges nearly continuous, while in *R. quinquangularis* and *R. peploides* they are more or less interrupted, and occasionally anastomose: but in *R. Vahlîi* their place is supplied by a number of short oval prominences, constructed of similar tissue, which are scattered over the seed.

Eranthemum crenulatum, *Rungia repens*, *Andrographis echiodides*.—These, like the preceding, have their testa disposed in elevated ridges formed of thick-walled hexagonal cells, concentric in the two former, reticulated and covered with very minute projecting points or glands in the latter. Similar glandular prominences occur on the seeds of *Rostellaria quinquangularis* and *peploides*.

Hypoestes Wallichii, *H. purpurea*.—The seeds of both species present numerous short blunt tubercles, closely crowded together, and formed of thick-

walled hexagonal cells. In *H. Wallichii* these tubercles are crowned with a ring of very small deflexed hooks, which are wanting in *H. purpurea*.

Gendarussa Neesiana, *G. quadrifaria*, *G. tranquebariensis*, *G. orixensis*, *Adhatoda Betonica*, *A. trinervia*, *A. argyrostachya*, *Rhinacanthus communis*, *Rungia Wightiana*, *R. origanoides*, *R. parviflora*, *Peristrophe pubigera*, *P. montana*, *P. speciosa*, *P. lanceolaria*.—Very little difference of structure is to be observed in the seeds of the above species, which, until the subdivision of that genus by Professor Nees von Esenbeck in his revision of the *Acanthaceæ*, were all placed together under *Justicia*. They are for the most part small, compressed, triangular or cordate, with a loose spongy testa, consisting of nearly hexagonal cells with thick side-walls, and so much crumpled as to form numerous closely crowded hollow tubercles. The tubercles, which occupy the entire surface of the seed, are usually blunt and rounded at their extremities; but in *Gendarussa tranquebariensis* and *orixensis* they are prolonged into decurved points. These characters are less conspicuous in the genus *Peristrophe*: the seeds of *P. pubigera* and *P. montana* differ little, except in their larger size; but in *P. speciosa* and *P. lanceolaria* the testa is thinner and more even; the tubercles also are very small and less numerous in *P. speciosa*, whilst in *P. lanceolaria* they are almost if not altogether wanting.

These observations having been chiefly made on such seeds as could be obtained from dried specimens, many of them in an unripe or imperfect condition, it is scarcely possible that I should in every instance have avoided mistakes: it would, however, be a great pleasure to me could I hope that this very imperfect view of the subject might prove the means of leading to a more accurate investigation of the seeds of this interesting family; and I trust that whoever may pursue the subject further, will make allowance for the difficulty of attaining to perfect accuracy with such materials.

EXPLANATION OF TAB. VI.

Fig. 1. Fasciculate hair from the testa of a species of *Acanthodium* (*A. spicatum*, Del.?), collected in Upper Egypt by Mr. Holroyd.

2. Portions of single tubes of the same, more highly magnified.

Fig. 3. Portions of similar tubes, from the seed of an authentic specimen of *A. spicatum*, Delile.

4. Fasciculate hair, from the testa of *Blepharis molluginifolia*, Juss.
5. Portion of a single tube of the same.
6. Hairs from the testa of *Ruellia formosa*, Andr.
7. Part of the membranous border of *Blechum Brownei*, Juss.
8. Hair of *Ruellia dulcis*, Cav.
9. Ditto of *Raphidospora glabra*, Nees.
10. Portion of the testa of *Dicliptera Roxburghiana*, Nees.
11. Ditto ditto of *Nelsonia tomentosa*, Dietr.
12. Portion of the testa of *Rostellaria VahlII*, Nees.
13. Single tubercle from the testa of *Gendarussa orixensis*, Nees.

The figures are all highly magnified.



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