The Structure of the Ovular Integuments and the Development of the Testa in Cleome and Isomeris.

BY

MATTHEW YOUNG ORR,

Assistant in Laboratory, Royal Botanic Garden, Edinburgh.

With Plate CLXVII and four figures in the text.

In the course of an investigation on the anatomy of the ovules and seeds of the Capparidaceae, certain interesting features * were disclosed in the Cleomoideae section of the family, which may or may not be characteristic of the family as a whole, but which certainly appear to be sufficiently distinctive to merit a separate detailed description.

The species upon which this research was carried out were *Cleome spinosa*, Jacq., and *Isomeris arborea*, Nutt., and the material was obtained from living plants grown in the Royal Botanic Garden. The ovaries and fruits were fixed in chrom-acetic acid, and the microtomed sections were variously stained, the best results being secured with a combination of gentian-violet and eosin.

The general features of the campylotropous ovules and seeds of these species are so well known that they will only be referred to in passing, the main purpose of this paper being to direct attention to two of the outstanding anatomical features, namely, the genesis of the fibrous testa, and the occurrence of stomata in the outer integument of the ovule. In these points *Cleome* and *Isomeris* have so much in common that the detailed description will be confined to the former, and merely a brief note of the points of difference will be made in the case of *Isomeris*. Apart from the anatomical peculiarities, it will be observed that the physiological aspect of the structures described is also suggestive.

* The features described in this paper were not noted by Brandza in his dissertation, "Développement des Téguments de la Graine" (Rev. gén. bot., iii, 1891, p. 73), or by Guignard in his researches on the "Tégument séminal" (Journ. de bot., vii, 1893, p. 57). Both these authors included the Capparidaceae in their works.

[Notes, R.B.G., Edin., No. LX, January 1921.]

Cleome spinosa, Jacq.

The ovules of *Cleome* possess two integuments which originate from the base of the ovule in the usual way. At maturity, the outer integument consists of two layers of cells, while the inner integument is composed of one outer layer of comparatively large thin-walled cells with sparse protoplasmic contents, and three layers of small cells on its inner side. The outer layer, with its large clear cells, has the appearance of aqueous tissue,

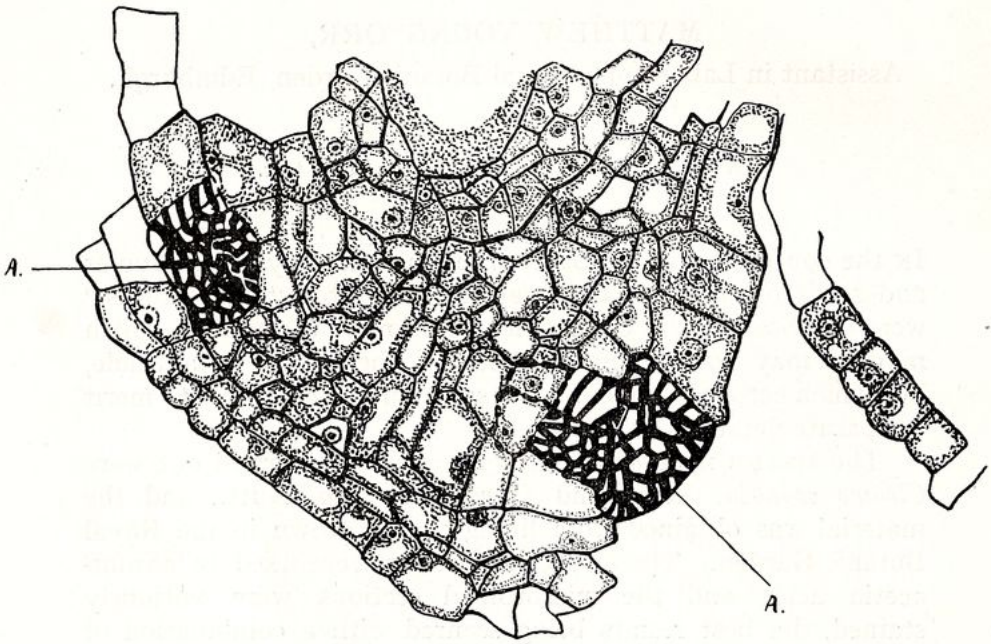

FIG. 1.—Micropylar region of the ovule of *Cleome spinosa*, showing at A the initiation of the lignified tissue. × 350.

and no doubt does function at this stage as a distributer of water.

An examination of longitudinal sections of the young ovule revealed, further, the presence of conspicuous patches of relatively large thick-walled elements, characterised by spiral and reticulate thickening of the cell walls. These lignified elements were confined entirely to the tissue of the inner integument in the region of the micropyle (fig. 1). In the older ovules, these thick-walled cells extend from the outer margin of the integument inwards to the micropyle, abutting directly on the slit, and giving to the ovule a somewhat unusual appearance (fig. 2). Sections cut transversely through this region, at this stage, show that these lignified cells are disposed in the form of a broad ring completely encircling the micropylar pore. These

cells retain their living contents even after lignification of the cell membrane is completed.

In the mature ovule this tissue extends upwards to a point just above the apex of the nucellus, where it merges, somewhat abruptly, into the enveloping layer of aqueous cells. For a

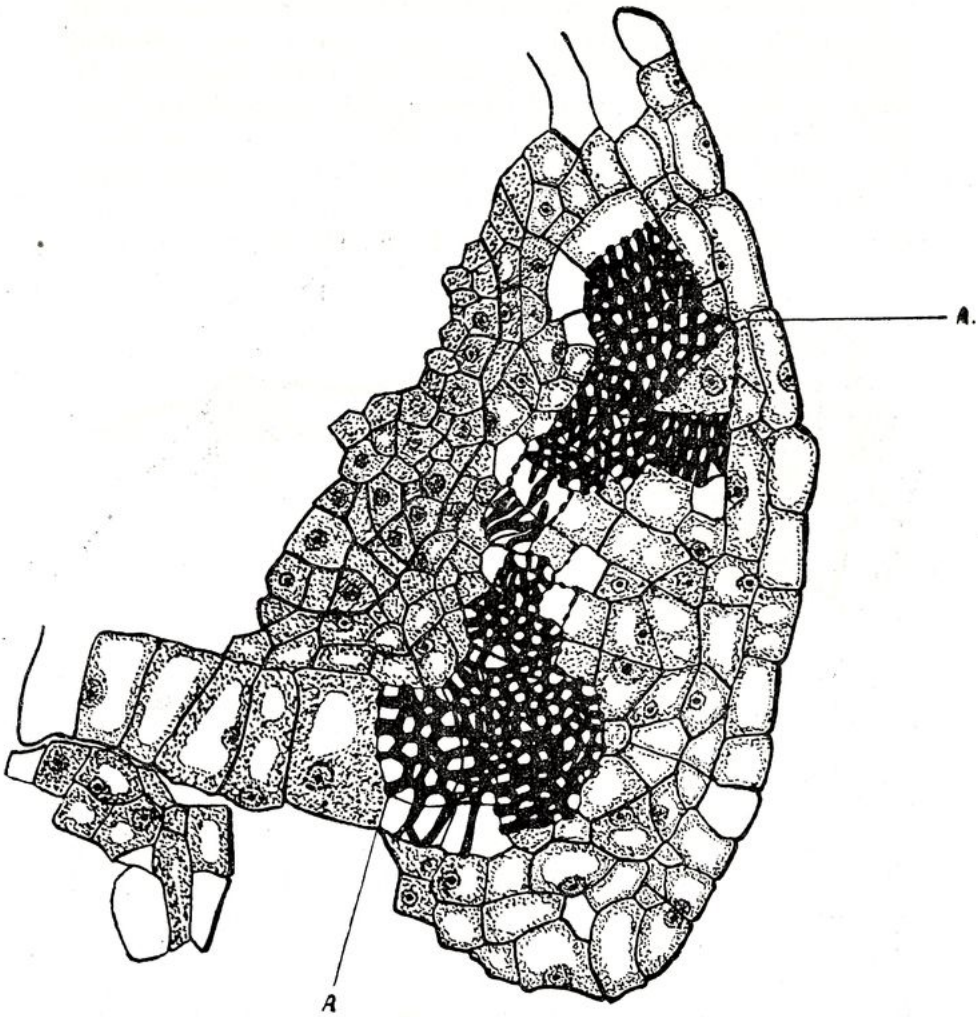

FIG. 2.—A later stage in the development of the lignified tissue in the inner integument of the ovule of *Cleome spinosa*. × 350.

time there is apparently no change in the amount of lignified tissue produced, but the ovule itself increases considerably in bulk.

What particular function these elements serve at this period in the development of the ovule is a matter for speculation. The presence of this specialised tissue round the micropyle certainly ensures that the pore will be preserved, but at the same time this pronounced metamorphosis of the apical cone of the inner

integument, at a relatively early stage in the development of the ovule, seems to imply a more definite purpose.

At a later stage the thick-walled tissue extends upwards in the inner integument, the large cells of the aqueous tissue becoming thick-walled and fibrous in character, this change in configuration extending gradually backwards to the base of the integument, until ultimately a compact fibrous testa is formed which completely envelops the seed. The fibres composing the testa are long, narrow, pitted elements, differing markedly from those of *Capparis*, which are extremely irregular in shape. The original thick-walled tissue developed in the region of the micropyle has now become sclerotic in character, but, as is also the case with the fibres of the rest of the testa, the protoplasmic

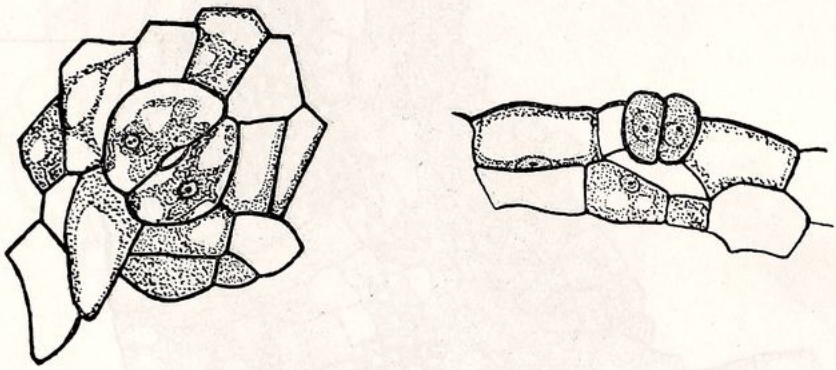

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FIG. 3.—Stoma from the outer integument of the ovule of *Cleome spinosa*, in (1) surface view, and (2) section. × about 500.

contents are still visible, and it is difficult to say definitely at what stage they disappear.

In the seed the function of this fibrous envelope is obviously that of protecting the embryo and preventing desiccation; but its genesis in the organic apex of the inner integument in the immature ovule, its interrupted development, and the retention of the living contents by the thick-walled cells round the micropyle all seem to predicate another function at the time of its inception.

In the mature ovule, as already indicated, the outer integument is double-layered, except at the micropyle, and in the outermost layer stomata occur. These stomata are comparatively numerous, and are identical with the similar organs in the leaf of *Cleome*. Where a stoma occurs, the two layers of the integument are separated, and an intercellular space is formed into which the stomatal pore opens, thus bringing the underlying tissue into direct communication with the ovarian cavity.

It may be noted in passing that stomata are also present in the inner ovarian wall in relatively large numbers.

The occurrence of stomata in ovules has been recorded by various authors—by Schleiden * in *Canna*, by Czech † in *Tulipa Gesneriana*, and by Guérin ‡ in *Dipterocarpus*, among others, but the physiological significance of their location in the ovule is not referred to.

If the outer integument be removed from living material and appropriately stained, the presence of conspicuous starch-grains in the guard-cells of the stomata, and in the cells of the underlying layer, can be clearly demonstrated. This fact is suggestive of the possibility of photosynthetic processes being carried out in the

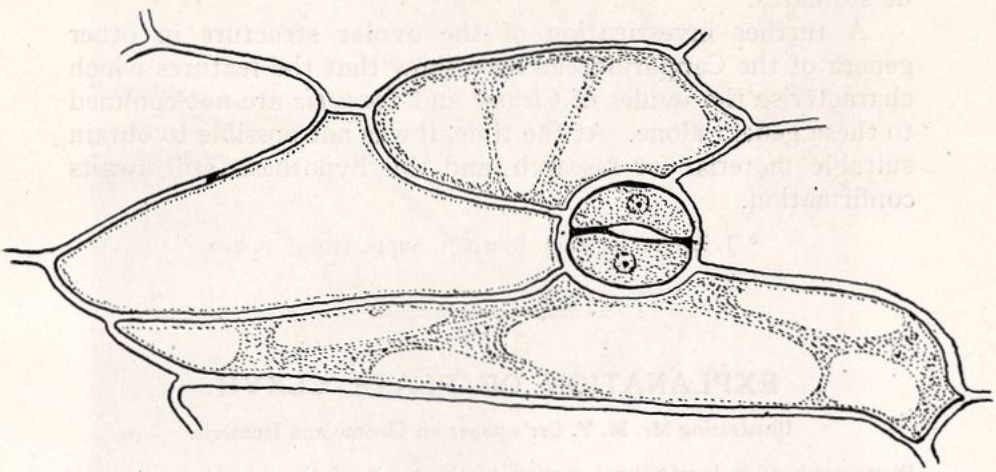


FIG. 4.—Stoma from the outer integument of the ovule of *Isomeris arborea*, in surface view. ×about 500.

ovule, though the quality of the light which filters through the ovarian wall must be appreciably diminished.

In the seed the outer integument becomes tubercled, the stomata then being found mainly on the multicellular excrescences. Starch-grains were again discernible in the guard-cells and in the cells of the hypodermal layer of immature seeds.

Isomeris arborea, Nutt.

The outer integument of the ovule of *Isomeris* is double-layered, as in that of *Cleome*, but the inner integument is many-layered, the aqueous tissue being two to three cells broad, while on its inner side there are four or five layers of smaller cells.

The fibrous layers have their origin in the same region as in

* M. J. Schleiden, Beitr. zur Botan. (1844), p. 10.
† Dr. Czech in Bot. Zeitg., xxiii (1865), p. 104.
‡ P. Guérin in Bull. Soc. Bot. Fr., lviii (1911), p. 12.

Cleome, but their subsequent development is more continuous, and, as might be expected from the greater size of the seed, the amount of fibrous tissue present is relatively increased. The fibres are larger in every way than in the preceding species, and they retain their protoplasmic contents even in the fully developed seed.

Stomata are present in the outer integument and are still evident in the seed condition, but the excrescences typical of the seed of *Cleome* are, of course, absent from the seed-coat of *Isomeris*. The inner walls of the ovary and fruit also possess numerous stomata, contrary to the statement of Briquet,* who, describing the inner fruit-wall of *Isomeris*, writes : " Il n'y a pas de stomates."

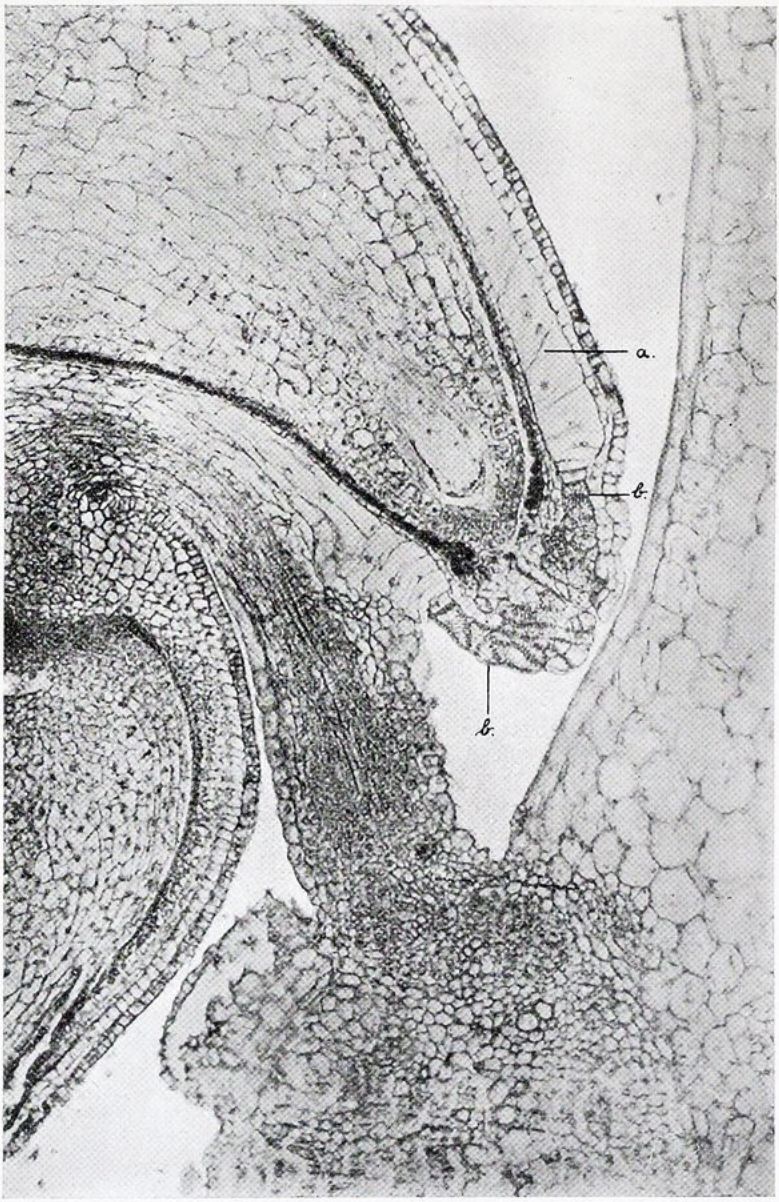
A further investigation of the ovular structure in other genera of the Capparidaceae may show that the features which characterise the ovules of *Cleome* and *Isomeris* are not confined to these genera alone. At the time, it was not possible to obtain suitable material for research, and this hypothesis still awaits confirmation.

* J. Briquet in Engl. Jahrb., l, Suppl. (1914), p. 440.

EXPLANATION OF PLATE CLXVII.

Illustrating Mr. M. Y. Orr's paper on Cleome and Isomeris.

Photograph of a longitudinal section of the ovule of *Cleome spinosa*. *a*, the aqueous layer in the inner integument; *b*, the lignified tissue round the micropyle.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