ON THE FERTILIZATION OF *GOODENIA HEDERACEA.* (Sm.)

By Alex G. Hamilton, Esq.

Plate XXI.

My attention was drawn to this subject by reading Mr. Haviland's paper on *Goodenia ovata*, in the Society's Proceedings for June, 1884, and I examined a large number of specimens of *G. hederacea* in all stages of growth, to ascertain if the method of fertilization was similar to that described by Mr. Haviland *(i.e.)*, accomplished by insects, or other extraneous means. I have so far, collected the following plants of the *Goodeniaceæ* in this (the Mudgee) district; *G. hederacea, G. heteromera, G. paniculata, Velleia paradoxa, V. macrocalyx*, and *Dampiera stricta.* Of these *V. paradoxa, V. macrocalyx* and the species under consideration are very generally distributed over the district; but the others are local in occurrence, *G. heteromera* being only found in scattered patches on the banks of the Cudgegong River, and *G. paniculata and Dampiera stricta* being confined to sandstone at the head of Cooyal Creek and on the Goodaman Range.

I have selected *G. hederacea* for experiment on account of its being plentiful in my immediate neighbourhood.

On taking a very young bud, and carefully removing the calyx and corolla, so as to expose the style, filaments and anthers, we find the anthers, five in number, a little longer than the style and closely clustered round it; the style itself is in a rudimentary condition as regards the indusium which is represented by a slight shelf on the front and back of the flattened termination of the style. The superior surface of this flattened part is the stigma (see fig. 1). Taking a slightly older bud, we notice no alteration

except that the ledge representing the future indusium has grown up higher in the centre and extended to the ends (see fig. 2). In a still farther advanced bud the only change in the relative position of the style anthers is that the latter are slightly higher than before, but in the style itself, a great deal of alteration is perceptible, the indusium being now higher than the stigma, and the edges showing the hairs which are so striking a feature of the mature organ (see fig. 3). We now examine a bud nearly ready to open. Here we find the anthers full grown but not mature, and leaning over the indusium (fig. 4) their bases being on a level with the top of that organ, and the upper part of the filament developed into a point which projects beyond the anther itself (see fig. 5). The indusium is developed into a deep cup, the edges being densely clothed with short thick hairs, and the outside inferior surface having a quantity of longer and thinner hairs on the centre (see fig. 6). At the bottom of the cup is the stigma, now almost ready to receive the pollen. For the next stage, it is necessary to choose a bud just beginning to show slits at the sides. On removing the corolla the anthers will be found clasping the indusium and the points (figs. 7 and 8) turned over into the cup of the indusium, which is quite full of pollen. The anthers will be seen to be quite empty, and if the parts be exposed to the air for a short time (as would happen naturally by the fuller opening of the bud) the filaments contract and twist and the anthers shrivel. It will immediately strike the observer that the style must have lengthened considerably and rapidly, as in all younger specimens the *bases* of the anthers were on a level with, or above the cup, and here it is the *points* of the anthers which are level with it. Another noticeable feature is the *packing* of the pollen into the cup—a point of which I shall have more to say presently. Our next step is to examine a fully open flower. The basal portion of the style is bent upwards so as to protrude the indusium through the slit between the two upper lobes of the corolla. The anthers are entirely empty, withered, and bent back through the slit, so that they are outside of the flower—with them we have done. The slit between the upper divisions of the corolla widens in the centre,

to permit the indusium to come out of the tube, but contracts again beyond that, so that the edges are close together, and each half of the lobe bulges forward so as to make conjointly, a hemispherical cavity just in front of the indusium, to which it forms a cover, completely cutting the indusium off from the outside of the flower, as shown in the diagrammatic section (fig. 10). On examining the mouth of the indusium, it will be found to be narrower and more slit-like than in the last specimen. Now examine a series of full-blown flowers of increasing ages, and the mouth of the indusium will be found to close more and more on its load of pollen, while it still remains behind the barrier formed by the upper lobe. At last it will be found quite closed, and then the flower withers and the edges of the lobe shrink away from each other allowing the indusium to once more project into the flower, but its mouth is closed against all intrusion. In this stage the indusium has a flattened shape as in fig. 9.

From examining a very large number of the buds and flowers in this way, I have come to the conclusion that fertilization is effected in the following manner:—When the anthers are full sized, and ready to burst, they bend towards each other over the indusium so that their bases form a ring above the mouth of it, the ring being a trifle less in diameter than the mouth. The style at this time begins to lengthen rapidly forcing its way up through the anthers, and by means of the fringe of hairs on the edge scraping and brushing all the pollen out of the anthers, the pollen drops into the cup as the latter quickly grows upwards. This packing of the pollen puzzled me greatly at first, for insects could not possibly do it, and neither could the mere dropping in of the pollen cause it to cohere so tightly as it does. As soon as the anthers have discharged all their pollen, they wither and twist outwards through the slit in the corolla; and when the indusium is filled with pollen, it begins to close and assume a flattened shape, while at the same time the fringe of hairs slope over the mouth so as to cover the pollen and retain it within the cup. Insect interference is provided against by the cover formed by the back lobe

of the corolla ; and by the time the flower is withered and the indusium once more projects into the tube, the cup is completely protected by its closing.

On the whole this flower seems to me to exhibit a most elaborate and beautiful series of contrivances to ensure fertilization by its own pollen ; and not the least remarkable feature is the fact that the same set of organs which in *Goodenia ovata prevent* self-fertilization, in *G. hederacea* ensure it. I am struck by a remark in Mr. Haviland's paper to the effect that in *G. ovata* when the indusium is outside the corolla, a touch in the tube brings it into the proper position for insect fertilization. I tried the experiment in the flower under consideration, by pushing a camel hair pencil, the point of my finger and various pointed and blunt articles into the tube of the corolla, but in no instance would the back lobe open unless a considerable amount of force was used. One thing puzzled me a good deal, and does so still, viz., in two young buds the anthers were *shorter* than the style, and in this case the brushing out of the pollen could not occur ; but these being only found twice in the large number of buds I dissected, I am inclined to think them merely accidental malformation. It is a significant fact that neither full anthers nor empty indusia are ever found in open flowers.

I may say that to observe all the stages, it is necessary to examine a very large number of specimens, and even then but few buds will be found just at the critical point when the anthers are being emptied by the elongating of the style. This leads me to think that the latter stages of the process are gone through rapidly. As examination and note taking in the field are irksome I always collect all the flowers and buds procurable and keep them in small bottles or homœopathic medicine tubes with a piece of wet lint. If then tightly corked they will keep for days and can be examined at leisure. In conclusion I may be allowed to express a wish that some of the other members of the Society would examine this flower and see if their experience tallies with mine. Dr. Woolls' mentions it as being found in the County of Cumberland,

and it would be interesting to discover if there is any difference between the same species in coast and inland specimens.

REFERENCES TO PLATE XXI.

Fig. 1.—From young bud showing rudiment of indusium, St. Stigma in. indusium, x 20.

Fig. 2.—Side, front, and top of indusium in further advanced bud, x 10.

Fig. 3.—Front and side in older bud, x 8.

Fig. 4.—Arrangement of anthers and indusium in nearly full-grown bud, x 8.

Fig. 5.—Anther showing point which afterwards hooks over indusium, x 10.

Fig. 6.—Mature indusium, x 10.

Figs. 7 and 8.—Arrangement of anthers in full grown bud just opening; indusium full of pollen, x 8.

Fig. 9.—Fertilized and closed indusium, x 8.

Fig. 10.—Diagrammatic section of open flower, showing fold of upper lobe of corolla, which forms a cover for indusium, cx, calyx an. anthers; in indusium; bl. upper lobe; cv. cover; ul. under lobe, x 2.