In the following list many of the species are poorly represented, and many are confined to the sea shore, while none of them have attained the same extent here as in other parts of the province :—

Carduus lanceolatus, *Linn.* Helminthia echioides, *Gærtn.* (rare). Cerastium vulgatum, *Linn.* Sherardia arvensis, *Linn.* Anagallis arvensis, *Linn.* Euphorbia peplus, *Linn.* Erodium cicutarium, *Sm.* Stellaria media, *With.* Polycarpon tetraphyllum, *Linn.* (abundant on the sea-shore). Geranium molle, *Linn.* Fumaria officinalis, *Linn.* Apargia hispida, *Willd.* Leontodon taraxacum, *Linn.* Hypochæris radicata, *Linn.* (not common.) Sagina procumbens, *Linn.* Rumex viridis, *Sibth.* Rumex maritimus, *Linn.* Rumex acetosella, *Linn.* Lythrum hyssopifolia, *Linn.* Nasturtium officinale, *Br.* Plantago lanceolata, *Linn.* Centaurea solstitialis, *Linn.* (spreading on the sea-shore). Prunella vulgaris, *Linn.* Rosa canina, *Linn.* (not common). Cytisus scoparius (yellow broom), *DC.* (confined to one patch near Maupui Pa). Ulex europæus, *Linn.* (furze). This dangerous weed is limited at present to a small patch on the shore of Evans Bay, and another near the old Pilot Station.

Of useful plants as pasture, the following were collected :—

Melilotus officinalis, *Linn.* (spreading over blown sand, and acting as a binder by its deep rooting.) Medicago lupulina, *Linn.* Trifolium repens, *Linn.* Holcus lanatus, *Linn.* Lolium perenne, *Linn.* Festuca bromoides, *Linn.* Gastridium lendigerum, *Beauv.* Lagurus ovatus, *Linn.* Poa annua, *Linn.* P. pratense, *Linn.* Anthoxanthum odoratum, *Linn.* Dactylis glomerata, *Linn.* Bromus commutatus, *Schrad.* B. arvensis, *Linn.* B. mollis, *Linn.* Ammophila arundinacea, *Host.*

Some are probably omitted from want of flowering or fruiting specimens to determine the species.

Art. XLVII.—*On the Fertilization of the New Zealand Species of* Pterostylis.

By Thos. F. Cheeseman.

(With Illustration.)

[*Read before the Auckland Institute, 14th October,* 1872.]

Perhaps the most interesting study connected with the structural peculiarities of Orchids is that of the varying means by which, in the majority of the species, fertilization by insect agency is secured. The wonderful co-adaptation of all the parts of the flower to effect this end, the degree in which organs have become modified to uses widely different from their normal functions, and the general fertility of contrivance exhibited, can never fail to excite our admiration and surprise.

Although none of the New Zealand Orchideæ exhibit a mode of fertilization, founded on such complexity of structure and specialization of parts, as occurs in some of the tropical American and Asiatic genera ; and although probably none equal in this respect the British species of *Orchis* and *Ophrys*, yet several kinds present interesting and noteworthy peculiarities. These are so strongly marked in *Pterostylis*, that I have ventured to draw up the following account of my observations on that genus. I have been the more induced to do this from the fact that Mr. Darwin's book "On the Fertilization of Orchids," which is deservedly considered to be the standard work on the subject, does not contain an account of a similar method of fertilization; nor is any species described, included in the sub-order Arethuseæ to which *Pterostylis* belongs.

The genus *Pterostylis* is represented in New Zealand by seven species. Of these, six (*P. banksii*, *P. graminea*, *P. micromega*, *P. foliata*, *P. trullifolia*, and *P. puberula*,) constitute a closely connected series of forms, and seem to present no differences of importance in their fertilization. The seventh species (*P. squamata*) belongs to another section of the genus, and (judging from descriptions) differs in several respects from the others. It is stated in the "Handbook" to have been discovered near Auckland by the late Dr. Sinclair, but I have not been fortunate enough to find it, nor has the plant been seen by any New Zealand botanist of late years. I shall now proceed to describe the mode of fertilization in *P. trullifolia*, the species on which my observations are the most complete. The accompanying illustration (Pl. XX.), containing magnified drawings of the most important parts of the flower, will perhaps cause my meaning to be more easily understood.

The upper sepal and petals connive and form a kind of hood, inclosing and arching over the column. The lateral sepals are placed in front of this hood, and being united for fully half their length, partially close the entrance to it. The column (see figs. C. and D., and *c.* in fig. B.,) is bent backwards at the base, so as to lie close to the upper sepal, with which for some distance it is united; it then becomes erect, and towards the summit is furnished with two broad membranous wings, each of which is extended downwards into a blunt lobe, and upwards into an erect horn-like appendage. The stigma (*s.* in Figs. C. and D.) is a bilobed prominence about the middle of the column. The anther (*a.*, Figs. C. and D.) is terminal, hinged on to the summit of the column, two-celled, the cells opening while the flower is still unexpanded. The pollinia (*p.*, Figs. D. and E.) are four in number, two in each cell, linear in shape. They lie loose in their cells, having no caudicles, and do not become attached to the rostellum. The rostellum (*r.*, in Fig. D.) is an erect, somewhat triangular projection, placed immediately below the anther. Its anterior surface is slightly concave, and consists of a thick mass of highly viscid matter, portions of which can easily be detached.

The lip, consisting of a linear, somewhat fleshy lamina, with a curious curved appendage at its base, is clawed on to the bottom of the lateral sepals by a delicate ribbon-like membrane. It is extremely sensitive, so that, although in its natural position it has its apex exserted between the free points of the lateral sepals (see *l.*, Fig. B.), yet the slightest touch is sufficient to cause it to move quickly up to the column, when it occupies the position shown in Fig. C. On this movement of the lip the fertilization of the plant depends.

If we take a flower, and gently touch the lip, so as to cause it to perform the motion just described, and then examine the position of the parts, we see that each side of the flower is narrowed inwards in a curved line parallel to the position now occupied by the margins of the lip, so that the posterior part of the flower forms a chamber, to which the lip, resting against the wing-like appendages of the column, is a tolerably close fitting door.

Now let us suppose that an insect were to enter a freshly opened flower. The only entrance is between the tips of the lateral sepals, and here the apex of the lip is placed exactly where our visitor would probably alight. At first the weight of the insect would most likely counteract the natural tendency of the lip to move inwards, but as the insect crawls further into the flower, this would have less effect, until at length the irritability of the lip would enable it to overcome the resistance offered, and to spring back to the column. If no capture is made the lip soon regains its former position, but if the insect is imprisoned it remains firmly appressed to the column while its prey continues to move about. For the prisoner there is now only one mode of escape. This is by crawling up the column, passing over the stigma and viscid rostellum, and finally emerging from between the appendages of the column, directly in front of the anther. This passage, however, is so narrow and confined that it would not be possible for an insect to pass through without brushing against the rostellum, and detaching portions of its viscid surface. If the insect were now to touch the anther, and it is difficult to see how it can escape without doing so, one or more of the pollen-masses, lying loose in their cells, would become glued to the viscid matter on the insect's back, and consequently be withdrawn from the flower. To understand the mode of fertilization we have now only to suppose that the insect, with the pollinia attached to it, visits another flower, and is again imprisoned, when it is evident that in its efforts to escape it would pass over and in front of the stigma, which is sufficiently adhesive, when touched, to draw off a portion of a pollen-mass, or even a whole one, from the back of the insect.

After careful and repeated examinations of living plants, I adopted this view of the fertilization of *P. trullifolia* as the only one explaining the various facts I had collected; bnt, in order to satisfy myself that the lip really plays the important part I had supposed, I selected twelve flowers which were just expanding, and removed that organ from the whole of them. After a week or two, when they had closed and commenced to wither, I gathered them and examined their stigmas and pollinia. Not one flower was fertilized, and not a single pollen-mass had been removed.

On several occasions I have artificially inclosed small insects in the flower. Most escaped by crawling up the column and passing between the appendages, and some, but not all, carried pollen-masses away with them. It can hardly be expected, however, that insects selected at random would remove the pollinia with the same ease and certainty as the species to whose requirements the flower has no doubt been profoundly modified by natural selection, acting during long periods of time.

Although I have often watched the flowers I have never seen insects directly enter them. It occurred to me, however, that I should be more successful if I were to examine every plant noticed with the lip drawn back against the column. Acting on this idea I soon found three, each inclosing a small dipterous insect. Two of these had no traces of pollen on them, and the flowers were not fertilized. The third was dead, apparently not having been able to find the passage out of its prison. It had the remains of two pollinia attached to its back. The stigma of the flower was also plentifully covered with pollen, which had evidently been conveyed from another plant, for all four pollen-masses were intact and undisturbed in their cells.

The fact of this insect being unable to effect its escape led me to examine a considerable number of flowers which had commenced to wither, and in which the sepals and petals had closed together, with the view of ascertaining if this circumstance was of frequent occurrence. The results were important. Out of 110 specimens examined seventeen contained dead insects, and nine of these insects bore traces of having had pollen attached to them. Some had followed the passage between the wings of the column until they had reached the anther, and then becoming glued to the pollen-masses had not been able to drag them out of their cells, thus perishing on the threshold of their prison. Many of the flowers which did not inclose insects exhibited signs, besides the removal of the pollinia, of having been visited by them, from the presence of hairs, etc., adhering to the stigma and rostellum; and in one instance the antenna of some insect was found glued to the rostellum, proving that its owner had escaped by crawling through the passage in front of that organ.

All the insects proved to be Diptera, and all are probably referable to one species. I am not, however, entomologist enough to be able to indicate its name. What inducement there is to visit the plants I cannot conjecture, for even with the most careful examination I have not been able to detect the presence of any nectar, or nectar-secreting organs.

The comparatively large number of insects retained in the flowers examined appears at first sight to show a serious imperfection in the contrivances for insuring fertilization, as it is evident that it is a loss to the plant when its visitor cannot escape and carry away the pollinia. On a closer examination, however, it probably only proves how carefully the passage for the exit of the insect has been modified to suit the relative size of the species by which the plant is fertilized, for if the passage had been of a size sufficient to allow the largest individuals to escape with ease the smaller ones would perhaps have been able to pass through without touching the rostellum, and consequently would not remove the pollinia.

It seldom happens that all the pollinia are removed. Out of 110 withered flowers twenty-eight had all the pollinia remaining in their anther cells, twenty-nine had lost one, thirty-four two, thirteen had three withdrawn, while only six had all four removed. Seventy-one of the flowers were fertilized, but it must not be forgotten that a large number of the unfertilized ones drop off before commencing to wither, so that the proportion fertilized is really much less than this. Probably not one quarter of the flowers ever produce capsules.

Of the other species of *Pterostylis*, *P. banksii*, *P. graminea*, and *P. puberula* are fertilized in exactly the same manner. There are, of course, slight differences in the size and arrangement of the parts of the flower, but it is hardly worth while describing these in detail here. In *P. puberula* nectar appears to be often present on the outside of the lateral sepals, near the point of their coalescence, serving, no doubt, to attract insects to the flower. *P. banksii* also has two minute papillæ at the base of the column, which may secrete nectar, but I have never observed any. The insect which fertilizes this species is nearly twice the size of that which performs the same office for *P. trullifolia*. I have seen an insect enter the flower of *P. graminea* and become entrapped by the lip. With *P. micromega* I am imperfectly acquainted, but believe the fertilization to be on the same plan. Of *P. foliata* I have only seen dried specimens, but as the structure of the flower is in the main the same as in *P. trullifolia* I have no doubt that it will prove to be fertilized in a similar way.

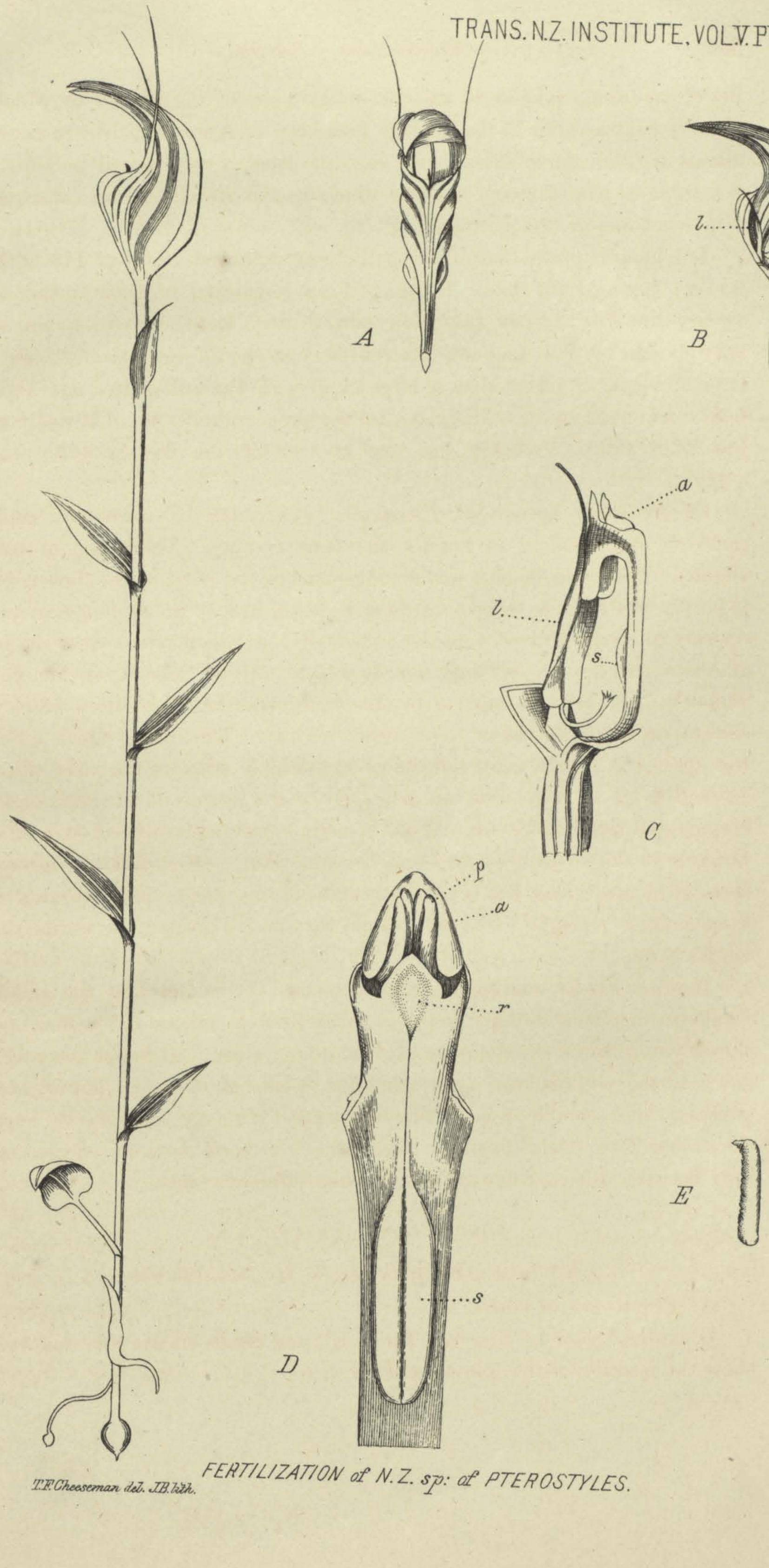
It seems hardly necessary to draw attention to the fact that the elaborate structure displayed in this genus is solely used to insure the pollen of one flower being placed on the stigma of a different one. It is not too much to say that the pollinia can never reach the stigma of the same flower, except, perhaps, by a combination of circumstances extremely unlikely to happen. As all our New Zealand species have solitary flowers, the cross effected is not only between different flowers but between different plants.

Description of Plate XX.

Pterostylis trullifolia, Hook. f. Natural size.

A. Front view of flower.

B. Lateral view of flower. The sepals and petals on one side removed to show the position of the column and lip.



FERTILIZATION of N.Z. sp: of PTEROSTYLES.

T.F. Cheeseman del. J.B. lith.

C. View of column and lip, showing the position taken by the lip when touched.

D. Front view of the upper part of the column, with the appendages cut off, so as to show the rostellum, and pollinia loose in their anther-cells.

E. Single pollinium removed from the anther.

a., anther; *c.*, column; *l.*, lip; *p.*, pollinia; *r.*, rostellum; *s.*, stigma.

A. and B. natural size; C. D. and E. magnified.

ART. XLVIII.—*On the Growth of* Phormium tenax. By the Hon. Col. HAULTAIN.

[*Read before the Auckland Institute, 24th June,* 1872.]

THE growth of the *Phormium* plant, the period of its decay, the increase of its off-shoots, and more particularly the rate at which the leaves are produced, and the time required to bring them to maturity, are questions of great importance to those interested in the manufacture of the fibre.

The attention of the Flax Commissioners, when making their inquiries last year, was directed to these points; the mode of growth, and its increase under cultivation, were ascertained with some approach to accuracy, and are stated in the pages of their report;* but as that report has not yet been generally circulated (though I am glad to say that it has just been reprinted with the latest information that can be obtained), and as I have procured specimens to illustrate what they have noted, I will repeat the substance of their observations.

The plant when full grown consists ordinarily of a rhizome or prostrate stem, from the under side of which numerous fibrous rootlets strike into the ground, and from the extreme end a number of leaves proceed in succession, decaying and falling off after arriving at maturity. At a certain period a flower stem shoots up from the apex, after which the whole of the leaves and their rhizome having completed their functions die away; but every year various fresh side shoots have started from the main rhizome, forming separate fans with roots and leaves, receiving at first nourishment from the parent stem, and gradually becoming independent plants, producing further shoots, and dying away after perfecting flower and seed. In dry, hard ground the rhizome is but imperfectly developed, and amongst sand-hills it becomes a vertical stem several feet in length, seeking its nourishment at that depth where abundant moisture is to be found.

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* App. to Journ. H. of R., 1871, G. No. 4.