abundance on the open grassy flats, almost every flower that I have examined has been fertilized.

In another species of *Habenaria* found on the Kagaberg, in February 1869, and on my farm "Brooklyn" in February and March 1869, the whole caudicle, when *in situ*, is relatively much shorter than in any of the preceding species, and does not contract on withdrawal, but is nearly rigid. The viscid disk is seen to be oval on its outside, with a slight extension laterally.

The caudicle at its juncture with the disk is somewhat triangular, the outer angle joining the projecting portion of the disk. This triangular appearance is produced by its being folded over on itself, something like a T-hinge; at the same time, as if this fold had not produced a sufficient shortening of the caudicle, a thin tail-like portion projects beyond.

I was, at the time when I first examined it, inclined to think that the thickened fold was the homologue of the drum-like pedicel of *H. chlorantha* mentioned by Mr. Darwin; but the structure under the microscope appeared to indicate that it is really a thickened portion of the caudicle corresponding to the discal extremities of the caudicle in the two former species.

I watched very carefully to see whether any movement took place on removal, and was at first inclined to think so: but on more careful examination I found that I was mistaken; in fact the incurved portion of the pollen-masses is quite sufficient to place them in a proper position for the fertilization of the flower. I found considerable difficulty in removing the viscid disk, although its prominent position seemed to offer as great facilities as in the other species; and the constant fertilization of the flowers throughout a whole spike leads me to suspect that my pin had too smooth a surface for the viscid disk to adhere to.

Observations on the Mode in which certain Species of Asclepiadeæ are fertilized. Abstract of a paper by J. P. Mansel Weale, B.A. Oxon. (Communicated by Charles Darwin, Esq., F.R. & L.SS.)

[Read November 3, 1870.]

On placing the blossoms of *Gomphocarpus physocarpus* in water, I noticed that numbers of flies, attracted by the sweet nectar con-

tained in the cucullate folioles, got attached to the stigmatic glands and appeared unable to release themselves.

On allowing the flowers to remain until completely withered, I ascertained that the flies had not sufficient strength to extricate themselves and eventually perished with the flowers.

That other insects also frequented the flowers to their own detriment was abundantly visible from the remains of legs, belonging to small moths and other insects, detached and adhering to the stigmatic glands.

After leaving Port Elizabeth my researches were for some time abandoned, and were resumed partly at the Koonap and partly at Bedford. At the latter place I found that the same insects frequented *G. physocarpus*, with the important addition of several large wasps.

It was here that I first observed that the pollen-masses were inserted in the fissures of the anthers; but in most instances they seemed to have been pushed down instead of being regularly inserted after withdrawal.

In two other species of *Gomphocarpus* common at Bedford I found the pollen-masses removed, and in some instances inserted, and I also captured several species of winged Hymenoptera with pollen-masses attached to their tarsi.

Besides these, I may mention a beetle belonging to the genus *Lycus*, some moths, and *Pyrameis cardui*.

At Ettrick I observed some plants of *Gomphocarpus fructicosus* and *G. physocarpus*, the first a true denizen of the Karroo, the latter confined to the grass-country, which two kinds of soil join hereabouts.

Both plants were visited by large Hymenoptera; and their flowers and pollen-masses resemble each other very closely in structure. I gathered in the neighbourhood specimens which appeared to partake of the characteristics of both plants in a modified degree, such as the distribution of tomentum, the colouring of the foliage and flowers, and the shape of the folicles. I regret to state that, owing to several days' incessant rain, these specimens were destroyed by mould during desiccation, yet I am almost convinced that they partook of a hybrid nature, and am inclined to think that, under favourable circumstances, they may be fertile and be established as permanent varieties.

Later observations have tended to confirm this opinion; for it is

not uncommon for plants of most dissimilar genera in this Order to become fertilized by alien pollen, although in such instances the fruit is not matured.

? *Xyomalobium linguæforme* ? Harv. MSS.

This plant grows abundantly near my house, and flowers from November to January. The calyx is small. The corolla is large, and the segments curve upwards over the edge of the large stigma. The segments are parted nearly to their base, so that there are large openings between them. Each segment is directly opposite the fissure of the anthers, so as to prevent access from the sides of the flower. The folioles are 3-lobed and fleshy. The lobes are stout and pointed; they curve outwards and inwards, like the corolla. The central lobe is the longest, and stands up on one side of the stigmatic gland between each anther. The smaller lobes of each foliole point upwards beneath each stigmatic gland. The bases of the folioles within secrete a sweet juice very attractive to Hymenoptera.

The stigma is large and flat, and stands high up in the flower, so that the alæ of the anthers project forwards between the central lobes of the folioles. The lobes are very convex and widely open at their base.

It will thus be easily understood that while access to the stigmatic glands and fissures of the anthers is extremely difficult from the sides, from above the flower the same is tolerably easy, as the long central lobes of the folioles stand up between each gland, while a pair of the smaller lobes of two folioles meet immediately below the rounded projecting alæ of the anthers.

The folioles and stigma are pale yellowish green, nearly white, with a few brownish markings; and the corolla is green. The flowers are consequently inconspicuous although of moderate size. They have no scent, and do not secrete a large quantity of nectar at a time, although I imagine the flower continues its secretion for a long time until fertilized.

This species is constantly visited by a large black-and-yellow wasp, which, from the neuration of the wings, belongs apparently to De St.-Fargeau's genus *Pallosoma*, one of the *Pepsidæ*.

I have observed as many as six of these insects on one plant busily sucking the drops of nectar from the base of the tongue-shaped folioles. When thus engaged, they are exceedingly restless and active, straddling with their long legs across the flower

and pushing their proboscides eagerly into the flower. While thus scrambling over an umbel of flowers many of the pollen-masses are extracted, by the claws of their tarsi catching in the notched stigmatic glands.

In the prime of their flowering most of the plants have their masses withdrawn before withering, and sometimes as many as two pollen-masses inserted in one fissure, although it is seldom that pollen-masses are inserted between all the alæ of one flower.

The stigmatic glands* and arms to which each pair of pollinia are attached are edged by a delicate pale yellowish transparent membrane, which I am inclined to think is viscidulous.

The stigmatic gland is deeply furrowed in the centre, narrow at the apex, and widely open towards the base. The arms, which are rather short, are bent upwards at their junction with the gland, then again downwards in a rather deep curve, and again upwards. The edging membrane is carried beyond to the point where the pollen-mass is attached. The pollen-masses themselves are somewhat truncated and quadrate.

In the following descriptions the margins of each pollen-mass will be named in reference to their position in the anther-cells; viz. that which faces the inner extremity of the cell will be called the *inner margin*, and that facing the fissure of the alæ the *outer margin*.

From the above description it is evident that if an insect, while scrambling over the plant, inserted the claws of its tarsus or any other hooked portion of its body, such as its mandibles &c., beneath the gland, or if the claw got inserted towards the base and was then drawn upwards in the contracting channel of the gland, it would become firmly attached and easily withdraw the pollen-masses.

Although the pollen-masses are often withdrawn by the tarsi of insects belonging to the Coleoptera, Hymenoptera, Hemiptera, and Lepidoptera, I am much disposed to doubt whether in most instances this mode would ensure the replacement of the gland in the fissures formed by the alæ of the anthers.

* In the description of the stigmatic gland and arms the latter are described relatively to the gland, and not to their position in the anther-case. Thus when they are spoken of as extending outward, it is in reference to the position of the gland, and not to the anther-case. I mention this in order to render the description plainer, the margins of the pollen-masses themselves being spoken of in an inverse manner.

On the wasp already mentioned I have found pollen-masses attached to the tarsi, to the long hairs of the sternum and coxæ, and to the spines of the leg; but I have never found more than a single pair thus attached, and have never found glands separated from their masses.

On the other hand, it is by no means uncommon to find several combinations of the glands attached to the unremoved pollen-masses, as also to those inserted in the fissures of the antheræ. I once found and figured a portion of the head of an insect attached to a pollen-mass, but I unfortunately lost it in removing it from the pollen-mass to which it was fixed. I have twice observed these wasps with several pollen-masses attached to some portion of the head, but failed in capturing the specimens. I noted this especially as occurring on the 23rd of January of this year, when I observed numbers of these wasps frequenting the plants. I am myself thoroughly convinced of the correctness of this view, as without it there can be no explanation of the structure of these plants. I have repeatedly watched wasps with the pollen-masses attached to their tarsi; and although they have visited many flowers, I have in no instance seen the masses inserted, although it is not uncommon to see them thus withdrawn. Although numbers of pairs of pollinia are withdrawn, very few in comparison are inserted.

I have already stated that in *Gomphocarpus fruticosus* the pollen-masses close together inwardly on withdrawal, so as to clasp tightly the leg of the insect.

In this species there is a similar movement, only in a slighter degree. The arms bend inwardly, so that the two pollen-masses are nearly parallel, but somewhat apart from each other.

I have not ascertained the structure which produces these and other movements in the pollen-masses of Asclepiads, as, owing to their diminutive size, they require close and careful examination, for which I have not had sufficient leisure.

It is a curious matter for observation that in some Asclepiads this movement never takes place, in some only slightly, while in others, as in *Periglossum* and *Aspidoglossum*, the movement takes place in an entirely different direction.

In this species I have found most curious combinations of the pollen-masses. I have seen five glands attached together, in the first of which an arm was still inserted, showing that the com-

bination was originally greater. From these, four pollen-masses had been detached, eight still remaining attached to the glands.

In another instance four glands were attached together, from which six pollen-masses had been removed, two only remaining attached to the unremoved gland. In this case also an arm was left disruptured in the upper gland, showing that the combination had been formerly larger.

Towards the close of their flowering-season a careful examination of these plants would probably result in many more curious combinations.

As an illustration of the probable correctness of this species not being fertilized by the tarsi, I have never met with a gland attached by itself to the tarsus; yet in most cases the presence of a disruptured arm would show that one gland at least remains attached.

When the *Pallosoma* visits these flowers, as I have frequently observed, it plunges its head in between the middle lobes of the folioles to their base, busily sucking the nectar; but in so doing the smaller lobes, projecting upwards, interfere with it in some measure, and, as I have noticed, caused considerable annoyance to the insect. To this and the exciting influence of the nectar I, in some measure, attribute its restlessness; although it is, apart from these, an active and watchful insect. I have also noticed that it sometimes sucks round the gland itself; and as Robert Brown states that the gland, in the species which he examined, continues to secrete after the opening of the flower, I am disposed to think that this secretion may be of essential service to the flower in attracting the wasps when the more abundant store of nectar at the base of the folioles is exhausted.

It is probable, too, that the adherence of so bulky an object as any of the combinations already mentioned to any part of the head would cause much discomfort to so agile an insect, to release itself from which the fissures of the anthers offer a ready means.

The attentions of this insect are paid to several other Asclepiads, such as *Periglossum*, as also to a *Cissus* and a *Eucomis*. These flowers are, most of them, dull-coloured and of very different size, but afford, apparently, a quality of nectar peculiarly pleasing to this wasp; for there were in blossom at the same time Asclepiads quite as conspicuous and more so than *Periglossum*, affording, too, an abundance of nectar, but which I have never seen it visit, although they appeared attractive to some other Hymenoptera.

Lastly I have to advert to the singular fact of the pollinia of other Asclepiads being often inserted in different species—a fact the more strange, as in *Periglossum* I have always found the *exterior pellucid margin* of the pollen-mass inserted instead of the inner, as in most other Asclepiads; and it is on this margin that the rupture and protrusion of the pollen-cells takes place, which is the normal mode of fertilization in this plant.

I have on many occasions found the pollen-masses of *Periglossum* inserted in the fissures of the anthers of this species; and not merely are they inserted, but the masses are disrupted and give out tubes which appear to penetrate the ovarium of the flower.

This noticeable fact, combined with my remarks on *Gomphocarpus fruticosus* and *G. physocarpus* lead me to suspect that such accidents may occasionally lead to results of which we are at present but faintly aware, but to elucidate which a series of repeated and careful experiments would be requisite.

In the first plant, out of 6 flowers open, 4 had pollen-masses inserted, and 2 had 4 pairs of pollen-masses extracted. If it be reckoned that each flower has 5 pairs of pollen-masses and 5 fissures, it will be seen that this plant has very few withdrawn, —much fewer than is usual, so far as my observations go.

Thus $6 \times 5 = 30$ pairs pollen-masses,
4 „ withdrawn,
26 „ *in situ*,

$6 \times 5 = 30$ fissures,
6 with masses inserted,
24 unfertilized.

In the second plant, not reckoning that destroyed by insects, out of 8 flowers, 7 had pollen-masses inserted, and one had foreign pollen inserted, and 7 had 19 pairs of pollen-masses extracted.

Thus, not reckoning the foreign pollen,

$8 \times 5 = 40$ pairs pollen-masses,
19 5 withdrawn,
21 „ *in situ*,

$8 \times 5 = 40$ fissures,
16 with masses inserted,
—
24 unfertilized.

As I have collected seed of this and other Asclepiads, I hope next year to supply the Society with some statistics more satisfactory than those inserted in this paper.

Pachycarpus.

This plant, which is almost as abundant on my farm as the last, produces many and larger flowers, but very seldom fruit, and then generally only one follicle on a plant. The corolla is brown, and widely open. The folioles are horizontal and expanded, as in the genus generally, and contain a good deal of nectar in the furrows. The stigma does not project as in the last species. The alæ of the anthers project outwards, are widely open, and acute at the base, where they turn slightly upwards. The pairs of pollinia are widely expanded and the masses oblong. The stigmatic gland is large and channelled, very narrow in the centre, and broadly open at the apex and base. The arms are curved downwards, and outwards, upwards, and downwards, at their junction with the masses. Where they join the gland there are two small expansions of membrane, and the arms themselves are slightly edged with membrane. On removal the arms and masses are never inflexed, but remain as rigid as when in the anthers. I have only very seldom found masses inserted in the fissures, although I have examined many plants on different occasions.

Periglossum.

The flowers of this plant are arranged in dense umbels, and are greenish and very inconspicuous. The plant itself has much the aspect of a *Carex*, and grows among rank herbage by the banks of streams. The corolla is not very widely open. The folioles adhere closely to the stigma, are broad above, and rounded, somewhat like a half moon, with the horns bent downwards like hooks.

Below the half-moon expansion the foliole is much contracted.

The pollen-masses are remarkable for the minute size of their glands and the length of their arms. The arms are bent downwards, outwards, upwards, and downwards from the junction with their gland to the pollen-masses. The pollen-mass itself is very small compared with the length of the arms. The arms are

expanded where the masses join. The masses bend outwards, are elongated and considerably curved. Their last third is pellucid and much attenuated. It is on this *pellucid outer* margin that the rupture and protrusion of the pollen-tubes take place. The alæ of the anthers project but little, and extend low down in the flower. They are widely open at the base, and then suddenly contract, so as to form a sort of sharp notch. The whole gynostege is closely enveloped by the folioles and corolla. On withdrawing the pollen-masses with a pin, the movement, which is very curious, can be easily seen. On lifting up the gland a short distance, it bends inwards towards the centre of the stigma, and the arms outwards and away from it. On withdrawing it entirely, the long arms bend out completely, and hang loosely from the small gland. The pollen-masses somewhat resemble the long curved-up hoofs which sheep acquire when feeding on marshy soft ground. The disruption of the pollinia generally takes place where the arms are joined to the gland, and not at the junction of the pollen-masses to the arms, as is usually the case. I have, on one occasion, seen them disrupted in this place.

I think it not improbable that the long thin dangling arms of the pollen-masses may render the fertilization of this flower somewhat difficult, and that the hooked folioles delay an insect by the long upcurved pollinia being caught in them, in which case it would push downwards in order to extricate itself, and the end of the pollen-mass would almost certainly be caught in the sharply notched fissure of the anther, and become detached. The hooked portion of the foliole is widely curved, and thus the pollen-mass would be prevented from becoming detached as it does in the bootjack-like fissure.

The *Pallosoma*, already mentioned, is a very constant visitor of this plant; and had it not been for its conspicuous visitor I should have often missed a plant. I think this affords a useful hint to collectors, as many small and inconspicuous Asclepiads would otherwise have often escaped my notice.

I have never observed pollen-masses attached to the tarsi of this Wasp, nor have I on any occasion seen combinations of the glands; nor do I see how such a combination could be possible, as the arm is so attenuated at its junction with the gland that it is very easily ruptured, whereas, at the other extremity, the width of the arm is greater than that of the pollen-mass itself. The wasp, when visiting the plant, greedily sucks nectar from the

base of the folioles, although it is apparently secreted in very small quantities. Like the other species already described it is destitute of scent.

Cordylogyne.

The pollen-masses are oblong and bend outwards. On removal the arms bend slightly in. Combinations take place between the glands and pollen-masses in the usual manner, viz. by the insertion of the arms in the furrows of the gland. The flowers are very extensively visited by some insects unknown to me.

This concludes my present examination of the order; but although imperfect, my observations lead me to expect great results from future investigations, and that we shall find in the other subdivisions of the order, viz. the Tribes *Periploceæ*, *Secamoreæ*, and *Stapelieæ*, as wonderful contrivances graduating into each other as in the different tribes of Orchids.

In conclusion, I would remark that sufficient evidence has been obtained to show that insects extensively fertilize these plants, and that there appears to be an adaptation between the form and movements of the pollinia, the alæ of the anthers, and the position and shape of the folioles and corolla.

The secretion of nectar, and the powerful scent, so offensive in some, so sweet in others, are probably by no means the least important functions of the plants.

As a rule these plants are dull-coloured; but there are many conspicuous exceptions among the *Stapelieæ* and others.

From the very small quantity of mature follicles produced in each plant, so disproportionate to the number of flowers, it is highly probable that these plants require to be impregnated by several pollen-masses; and when we take into consideration how many pollen-masses are removed in proportion to those inserted, it would seem that in most species nature is less economical in her adaptation of means to ends than she is in most instances. It is also a singular fact that although all the flowers have two carpels, one is almost universally abortive.

A general view of all these facts would lead to the conclusion that the adaptation of the several parts of the flower, in such Asclepiads as have been examined, is inferior in its perfection to that attained in Orchids. Perhaps some sort of compensation is obtained by the relatively large size of the seeds and the tufts of silken hair with which they are provided, by means of which they are wafted away by the slightest breeze.

Orchids are manifestly inferior in this respect. They produce, as remarked by Mr. Darwin, a prodigious quantity of fine seed which rarely germinates.

Notes on the Styles of Australian *Proteaceæ*.

By George Bentham, F.R.S., P.L.S.

[Read April 6, 1871.]

(Plates I. & II.)

In the Proteaceæ, as in the Compositæ and some other Orders, it had been observed that the anthers in most cases open and discharge their pollen upon an enclosed pubescent papillose or glutinous portion of the style, usually described as the stigma, before the flower expands; and it was therefore concluded that fecundation then and there took place. This has now long been shown to be a fallacy in the case of Compositæ; for, as Lessing and others have pointed out, the really stigmatic portion of the style is always on the inner face and often only at the base of the style-branches, which remain hermetically closed until the flower has opened and they are protruded beyond the anthers. Then, and then only, do these branches open so as to render the stigmatic surface accessible to any pollen which may be shed upon them. In the Proteaceæ the case is different; the style is undivided, the stigmatic surface is superficial even in the bud, and the contrivances to screen it more or less from the action of the pollen which is then being scattered around it, reserving it for the pollen of other flowers after it has been released from the enclosing perianth, are very various. Those which I have observed in the course of my examination of the Order for the Australian flora are chiefly the following. These observations, however, are made almost exclusively on dried specimens, as I was only able to examine a very few *Grevillea* and *Hakea* flowers in a living state, and the notes I could collect from previous observers were but very few. They will require, therefore, to be supplemented and probably in several instances corrected by those who can watch the process of ripening and mutual action of the anthers and stigma on the living plants.

As a general rule, the anthers in the bud form a close cylinder round the papillose portion of the style, which has probably some stimulating influence on them; for immediately before the opening of the flower we find the anthers open inside and the pollen-