vention of the disease. *Thorough* cooking must kill the trichinæ in pork; but how rarely is pork, especially in the form of sausages, thoroughly cooked! More particularly, how prone are the poor to eat this and other meats more or less underdone! *Thorough* salting, again, seems to kill the trichinæ; but then it is to be kept in mind that many persons object to bacon and ham that have been thoroughly salted, and instances of infection by these preserved meats have been recorded, probably because bacon and ham are not saleable at a high price if too salt. It is a question of importance whether the State should not place itself between the pig-feeder and the public consumer, and demand from the former a guarantee that the meat supplied is not of a nature to originate disease.

The only other worm which we shall notice here is the guinea-worm, the *Dracunculus medinensis*, and we shall say very little about it. The "time-honoured" method of extracting the worm is as satisfactory as it is ancient; but now, perhaps, above all, the rule should be observed of not throwing away the worm to become the source of infection to others, but of consuming it entirely by fire. Prophylactically speaking, also, persons who travel in the districts infested by the larvæ of this worm should carefully protect the feet and legs during the rainy season, and after washing or bathing should take the precaution of drying their bodies most thoroughly by means (if possible) of warm or hot towels.

We must now conclude our notice of Dr. Cobbold's book; but before doing so we must express the obligation we are under not only to Dr. Cobbold, but to his publisher and printer, for presenting the profession with so really handsome a volume. People who regard books only from a strictly utilitarian point of view, may be content with the miserable blotting-paper and flimsy covering of the works which issue from the continental press; but good printing on good paper, attractive and artistic coloured illustrations, and an elegant and substantial binding, go far, in our observation, to popularize any subject, and especially such a subject as Dr. Cobbold discusses, in itself to some minds a somewhat repulsive one. In this instance also we can commend all concerned in the preparation of the work, inasmuch as the contents of the book are eminently worthy of the extrinsic attractions which have been thrown around it. The sixty pages of bibliography which complete the book are alone worth the purchase-money to anyone who would make himself familiar with the literature of the entozoa.

Review IV.

1. *On the Two Forms or Dimorphic Condition in the species of* Primula, *and on their Sexual Relations.* By Charles Darwin, M.A., F.R.S. ('Journal of Linnean Society,' vol. vi., Botany. 1862. p. 77.)

2. *On the Existence of Two Forms, and on their reciprocal Sexual Relation, in several species of the genus* Linum. By Charles Darwin. ('Journ. of Linnean Soc.,' Botany, vol. vii. 1864. p. 94.)

3. *On the Sexual Relations of the Three Forms of* Lythrum salicaria. By CHARLES DARWIN. ('Journal of the Linnean Society,' Botany, vol viii. p. 169.

4. *Observations on the Functions and Structure of the Reproductive Organs in the* Primulaceæ. By JOHN SCOTT. ('Journal of Linnean Society,' Botany, vol. viii. p. 197.)

5. *On the Individual Sterility and Cross Impregnation of certain species of* Oncidium. By JOHN SCOTT. ('Journal of the Linnean Society,' Botany, vol. viii. p. 162.)

6. *Notes on the Sterility and Hybridization of certain species of* Passiflora, *&c.* By JOHN SCOTT. ('Journal of the Linnean Society,' Botany, vol. viii. p. 197.)

7. *On a Sexual Monstrosity, consisting in the Development of Polleniferous Ovules in two species of* Passiflora. By S. J. A. SALTER, M.B., F.R.S. ('Trans. Linnean Society,' vol. xxiv. p. 143.)

IN a former number of this Review (October, 1862) we drew the attention of our readers to the remarkable researches of Mr. Darwin on the fertilization of orchids; these have been followed up by a series of elaborate experiments on other plants by Mr. Darwin and others indicated at the head of this article. The results of these experiments are so curious that little apology is needed for again introducing the subject. It will be remembered that Mr. Darwin supplied the solution of what had long been an enigma to botanists—viz., the occasional production of two or three extremely different forms of flowers on the same plant among certain tropical *Orchideæ.* These differences were shown to depend upon the different sexual functions performed by the flowers in question. How little these functional differences were suspected, even by good botanists and keen observers, is shown by a paper of M. Duchartre on the polymorphism in the flower of certain *Orchideæ,*[1] wherein the author, after an examination of these peculiar flowers, considers them simply as accidental productions, freaks of nature independent of all laws and incapable of explanation!

It seems, however, that we have not to travel to the South-American forests to find illustrations of equal physiological importance to those just cited. The paper first mentioned in the list at the beginning of this notice is devoted to the two forms that occur in the genitalia of the common primrose. In the one form the style is so long that the stigma protrudes beyond the corolla; in the other the style and stigma are wholly concealed within the corolla. With the long style are associated (structurally but not functionally) short stamens; while on the other hand, in the short-styled flowers the stamens are either so long, or they are attached so high up, that they project from the mouth of the flower. The existence of these two forms in primroses, and indeed in numerous other plants—some of which will hereafter be alluded to—has long been known, but, as in the case of the *Orchideæ,* little or no attention was paid to them. We shall have to allude to

[1] Bull. Soc. Bot. France, ix. p. 113.

the subject more fully under the head of *Lythrum;* hence at present we merely broadly state the results of Mr. Darwin's experiments on those two forms of primroses, and which are that, to ensure the most perfect fertility, the largest number of perfect seeds, it is necessary that the pollen from the short stamens of the one form should be applied to the short style of the other, and *vice versâ.* Thus the application of the pollen to the stigma of the same flower, or, as Mr. Darwin calls it, the "homomorphic union," is much less efficient in its results than is the contact of the pollen of one flower with the female organs of another flower, "heteromorphic union."

Mr. Scott has confirmed and extended Mr. Darwin's observations on the species of primroses and of allied genera. He has experimented upon 54 of these, and of these 54, he finds 36 truly dimorphic, 5 monomorphic; while in the remaining 13 (dimorphic species) his means of observation have not been complete. Not only does Mr. Scott amply confirm all that his predecessor has published, but he shows that functional differences occur in certain of these plants, unattended by any appreciable change of structure—e.g., *Primula verticillata,* a monomorphic species, is more perfectly fertilized when the pollen from one flower is placed on the stigma of another, than when it falls upon its own stigma, although, as has been just stated, there is no structural difference in the male or female elements of the flower. Mr. Scott's tables also show that much greater fertility is obtained in some of these species by applying to the stigma pollen from a distinct species even, than by securing the action on the stigma of a flower's own pollen!

Mr. Scott shows this to be the case not only in *Primula,* but also in *Oncidium,* in *Passiflora,* &c. In *Oncidium,* it is shown that the male element of one species will fertilize the female element of two distinct species, and yet be completely impotent upon its own female organs; and, nevertheless, those very same female organs are fertile when pollen from another individual of the same species is applied to them, and also when pollen from a plant of another species is employed. Among passion flowers it is also shown that the pollen of one species is inoperative upon its own stigma, but abundantly fertile when conveyed to the stigma of another flower of the same, or even of different species. Facts of a similar nature have long been known to hybridizers and cultivators of plants; and in the works of Gaertner, Kolreuter, and others, detailed experiments are recorded in confirmation of them; for instance, one of the commonest cases is where the pollen of one species A, will fertilize B, while on the other hand the pollen of B will not fertilize A. Mr. Scott has gone beyond this, and has in the dimorphic primroses demonstrated that of the two forms of A, the pollen of one, but not that of the other, will fertilize B. But while heteromorphic unions are more productive than homomorphic ones, the curious fact comes out, that both are sometimes surpassed in fertility by the union which takes place in the monomorphic forms—i.e., those in which the pistils and stamens are of equal length in the same flower, so that here true hermaphroditism seems more potent than the diœcious or heteromorphic condition.

Similar results have been obtained in some species of *Linum* (flax),

but we hasten on to the most curious and complex case of the whole series, that of the purple loose-strife *Lythrum salicaria,* so beautiful an adornment of our river-banks in late summer. *Three* forms of flower, then, are found on different individual plants of this species, differing one from the other, in the proportionate length of the styles and stamens, the size and colour of the pollen, and other minor points. Each form has one style of great, medium, or small length; there are thus three distinct kinds of style; there are, moreover, three distinct sets of stamens, corresponding in length to the three forms of style—long, medium, and short stamens. The individual flowers, however, only possess two out of these three sets of stamens, thus:

No. 1. Long-styled form has six medium stamens, and six short stamens.

No. 2. Mid-styled form has six long stamens, and six short stamens.

No. 3. Short-styled form has six long stamens, and six medium stamens.

In addition to these variations in size, there are other differences in direction, having special reference to the facilities afforded to insects in visiting the flowers, diversities in the colour of the pollen, differences in the number of seeds produced by each form, and in other points of more or less importance, but for which we must refer the reader to the original paper. When fertilization takes place naturally in this plant, it is effected in the following manner: the insects alight on the upper side of the flower, and insert their probosces along the upper and inner side of the calyx, because, owing to a peculiar deflexion of the base of the filaments, the nectar secreted around the ovary is more easily accessible from this side of the flower than from any other.

In immediate connexion with this arrangement is the upturning of the anthers and stigma, which are necessarily swept by the hairs on the lower surface of the insect's body, as it enters the flower in search of food. Incidentally Mr. Darwin remarks, that in most flowers whenever the stamens and pistils are bent, the direction of the curvature is towards that side where the nectar is secreted in greatest abundance, or where it is most easily accessible. We can confirm this by observation on the normal flowers of *Viola, Corydalis,* &c., where the styles are bent in the way just mentioned, but when these flowers become regular by Peloria, as they occasionally do, the nectar is as easily reached on the one side as on the other, and the style is then straight. In the case of *Lythrum,* Mr. Darwin shows that when bees visit the flowers, the green anthers of the long stamens of Nos. 2 or 3, or the long style of No. 1, as the case may be, come into contact with the abdomen and hinder legs of the insect, the medium stamens and the medium style brush against the under side of the thorax and the forelegs, while the short stamens and the short style rub against the proboscis and chin of the insect. Hence the bees would chiefly carry to the stigma of each form pollen from the stamens of corresponding length in another flower. Of course, they must also carry the other kinds of pollen also, but still they act not only as general carriers of pollen, but as special carriers of the right kind.

In the primroses and *Linums,* as we have seen, these structural vari-

ations correspond with diversities in function; and Mr. Darwin set himself to ascertain if this holds good in *Lythrum.* With this view he experimented on the relative fertility of these forms, and in doing so he had to fertilize No. 1 with its own two kinds of pollen, and with the two kinds of pollen produced respectively by Nos. 2 and 3. It was not sufficient to try on each stigma the green pollen from either of the sets of stamens producing it, although no perceptible difference in the pollen could be found, but it was necessary to try all six kinds of pollen on each stigma. More than two hundred experiments were made in this way, and with these results among others:

"First: That as in structure, so in function, there are three female organs, for when all three receive the same pollen they are acted on most differently; and conversely the same holds good with the three sets of stamens. Secondly, only the longest stamens fully fertilize the longest pistil, the middle stamens the middle pistil, and the shortest stamens the shortest pistil."

These are spoken of as "legitimate unions." Of course, there are two such for each pistil. All the other "illegitimate" unions (four for each pistil) are more or less sterile, and the greater the inequality in length between the pistil and the stamens, the greater the sterility. Although the stigmas must be dusted over with each kind of pollen, yet the legitimate pollen is pre-potent and neutralizes the effect of the illegitimate pollen, even though the latter had been applied to the stigma some time before the legitimate pollen. A similar result has frequently been noticed by experimenters.

The mid-styled form has the highest capacity for fertilization, as it produces more seeds than the others; but, on the other hand, the potency of its two kinds of pollen is less than that of the corresponding stamens of the other two forms. The green pollen from the long stamens of the short-styled flowers No. 3, and that from the long stamens of the mid-styled flowers No. 2, is identical to all appearance, but its action is very different. So also, although the pollen from the short stamens of No. 1 and that from the short stamens of No. 2 is precisely similar, its effects are far from being the same, so that not only does *Lythrum salicaria* habitually produce three females different in structure and function, but also five kinds of pollen, differing in a marked manner in potency.

Such, then, are the principal results obtained at present from these researches. It is evident that similar observations must be greatly multiplied and extended in order to reconcile discrepancies, and especially to throw light on the fact that in some cases the structure and arrangements of the flower are such as to promote cross-fertilization, and check or neutralize self-impregnation; while in other cases—in the same species even—equally stringent means are taken to secure close breeding, and to prevent cross impregnation. Of this latter class are such instances as those afforded by species of violet, of balsam, wood sorrel, &c. &c., wherein some of the flowers—the ordinary ones—are adapted to insect agency and cross fertilization, while on the same plant are produced other small flowers whose development in some points appears to be arrested, which never open, and yet they are very prolific, sometimes more so than are the ordinary flowers.

Why all this complexity in sexual arrangements in a single species? Why are some species so endowed, and others not? These are questions urgently demanding solution.

Again, one of the most important subjects raised by these researches is of course the question of species. Of all the tests proposed for the discrimination of species, those founded on sexual differences, such as are above detailed, are esteemed by physiologists as the most searching and the most satisfactory. It is quite evident that in the present state of our knowledge those physiological tests are of no higher value than the structural ones.

Have these variations in the sexual organs any relation to the variation that takes place in other organs of the plants—e. g., in the arrangement of the leaves, the form of the stem, &c.? Does cross breeding tend to promote these variations, and close breeding on the other hand check variation? On a first consideration, the answer to this question would probably be an affirmative one; but the opposite view, that close breeding favours variation, while cross breeding tends to restrain it, has at least as much evidence to support it. "Cross-breeding," says Professor Asa Gray,[1] "keeps down variation by repeated blendings; but while close breeding tends to keep a given form true, in virtue of the ordinary likeness of offspring to parent, it equally and in the same way tends to perpetuate a variation once originated from that form, and also along with selection, natural or artificial, to educe and further develop and confirm the said variety."

On the other hand, free crossing of incipient varieties *inter se* and with their original types is just the way to blend all together, to repress salient characteristics as fast as the mysterious process of variation originates them, and to fuse the whole into a homogeneous form.

Not only are there variations in form, which may possibly be accounted for by sexual peculiarities, but there are variations in constitution so to speak, which are at present wholly unexplained, but which may perchance be dependent on the same peculiarities in sexual function. For instance, *Lythrum salicaria* naturally occurs in wet places, and yet it flourishes equally well and is equally fertile in dry garden soil. There are numberless instances of this kind; and on the other hand there are cases of a different kind, not without value in such a matter. For instance, Nolte of Copenhagen says that *Stratiotes aloides* produces hermaphrodite flowers only between 52° and 53° north latitude, north of that female plants are alone met with, south of that males alone. This plant increases rapidly by offshoots, and it may, like the hop, hemp, and other diœcious plants, occasionally produce male and female flowers on the same plant. Knight, an accurate and careful observer, noticed that a high temperature favours the formation of stamens; a low one that of pistils. Some of the *Caryophylleæ*, diœcious in America, are not so in this country. Among facts of this nature may also be mentioned that of a willow, *Salix repens*, growing partially under water; the blossoms produced above the water were female, while those twigs that had been under

[1] Journal of Botany, vol. i. p. 147.

water and produced flowers, when the water was dried up, produced only male blossoms.[1]

We have lingered so long over these points that we can do little more than mention the very singular case recorded by Mr. Salter. The most important circumstance here is the accidental production of pollen within the *ovules* of a kind of passion-flower. The pollen appears to have been formed in the nucleus of the ovule, possibly in the embryo sac itself:

"For an ovule to develop pollen within its interior," writes Mr. Salter, "is equivalent to an ovum in an animal being converted into a capsule of spermatozoa. It is a conversion of germ into sperm, the most complete violation of the individuality and unity of sex; and it involves the idea of a mutation of gender."

The bearing of this case upon parthenogenesis, or virgin reproduction in flowering plants, is obvious and important; and it must certainly be borne in mind as a possible source of fallacy, to be carefully examined in any future case of the kind that may come under observation. As to the existence of parthenogenesis or not, although new cases of the kind have been lately recorded by Mr. Hanbury in '*Xanthoxylum*,' and by Dr. Anderson in '*Aberia*,' &c., yet the general tendency is towards disbelief in so flagrant an exception to the ordinary rule in flowering plants.

Those of our readers who take an interest in this matter will do well to peruse Karsten's elaborate paper on the subject in 'Ann. des Sc. Nat.,' iv. sér. xiii. p. 252. We have trespassed so much already, that we forbear from pointing out the important bearings some of the facts and speculations we have noticed have upon animal physiology, upon the good or bad effects of consanguinity on the reproductive powers of animals—upon the perpetuation of certain diatheses and hereditary diseases, &c. &c. In conclusion, we must express our hope that the impulse given by Mr. Darwin to the subject may wax stronger and stronger, and lead to the elucidation of much that is at present mysterious or unknown.

Review V.

1. *Report of the Commissioners appointed to inquire into the Condition of all the Mines in Great Britain to which the provisions of the Act 23rd and 24th Vict. cap.* 151, *do not apply; with reference to the Health and Safety of Persons employed in such Mines. With Appendix.* Presented to the Houses of Parliament by order of Her Majesty—*London*, 1864. 8vo.
2. *Epitome of Evidence taken before the Commissioners.* (Appendix B.)
3. *Copy of a Letter to Captain Charles Thomas, Dolcoath, Camborne, from the Right Honourable Lord Kinnaird, Chairman of Mines Commission.*

The unsatisfactory sanitary condition of the mining population of this country has long received the anxious consideration of statesmen and

[1] Linnea, xiv. p. 367.