IX. *On the Reproduction of lost parts in Myriapoda and Insecta.*

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The reproduction of parts of the body that have been accidentally lost or removed, is an occurrence of so much interest, in relation to the laws of nutrition and development, that I am induced to trespass on the attention of the Royal Society with an account of some experiments on this subject in the Myriapoda and Insecta. It has long been known to every naturalist that the Crustacea and Arachnida are capable of reproducing their limbs; and it has also been stated that a similar reproduction of parts takes place in some of those insects which are active throughout their whole life, and do not change their form, but merely cast their tegument and increase in size. But it has been questioned whether any reproduction of lost parts can take place in those insects which undergo a complete metamorphosis, and change their form, their food and mode of life in passing from the young to the adult state. No investigations have hitherto been undertaken to decide the question in insects that undergo these changes, nor have any experiments been made to show that a reproduction of lost parts is common also to the whole of the Class Myriapoda.

At a meeting of the Entomological Society in November 1839*, I exhibited a specimen of *Scolopendra sub-spinipes*, which had the eleventh leg, on the left side of the body, so much smaller than the corresponding one on the right, although otherwise perfect in regard to the number of its articulations, that I regarded it as a marked instance of reproduction of the limbs in that class. As no experiments had then been made to prove the fact, this opinion was disputed, and the instance pointed out was considered as merely one of an arrest of development†. Since then it has been shown‡, as first noticed by Müller§, that a reproduction of the legs most certainly takes place in the *Phasmidæ*; but it is still doubted whether it can occur in the Lepidoptera, and other tribes that undergo a complete change.

In the summer of 1841, and also in 1842, I made a series of experiments on this subject, on the Myriapoda; and during the present summer have completed a similar

* Transactions of the Entomological Society of London, vol. iii. part 1. p. 33.

† Idem. Journal of Proceedings, Nov. 2, 1840, p. 14.

‡ Id. January 1, 1844. President's Address, 1844, p. 5.

§ Elements of Physiology, Dr. Baly's translation, Edit. 1. 1837, p. 405.

series on Lepidopterous insects, the results of which I have now the honour to communicate to the Royal Society.

Myriapoda.

The facts already ascertained respecting the periodical development of new segments to the body in this class, led me to anticipate a favourable result in experimenting on the reproduction of the antennæ and legs. In the spring of 1841, I had placed about thirty nearly full-grown individuals of *Iulis terrestris* and *Iulis niger* in a closed vessel filled with clay and mould. Many of these individuals deposited ova, some of which I succeeded in rearing.

During the time these Iuli were confined together, I found several of them deprived of one of the antennæ, and also of some of the legs, which I attributed to their attacks on each other. This circumstance led me further to believe that these organs when lost are reproduced. In order to put this conclusion to the test, I cut off one of the antennæ and some of the legs of an individual that had not yet attained to more than two-thirds of the adult size of the species, and confined it in company with others of the same age. A few weeks afterwards all the specimens had changed their skins and grown much larger, having also gained an addition of segments to the body; but the antennæ and legs of the mutilated specimen had been so completely reproduced, that I could not identify the individual that had been the subject of the experiment. As, in consequence of this, the experiment was not entirely satisfactory, although it sufficiently proved to me that reproduction had actually taken place, I cut off one of the antennæ, and some of the legs, from each of three specimens that had much nearer approached their adult state. These were confined together in the same vessel, and were nearly of the same age. After watching them closely for about three months, without discovering any signs of regeneration of the lost parts, I began to fear that there must have been some error in my previous observations. However, I allowed them to remain undisturbed during the whole of the spring and commencement of summer, giving them constantly a fresh supply of food, the decaying inner bark of trees.

They continued in this state until the middle of June, when the whole of them entered the earth, and each made for itself a little circular cavity, in which it lay coiled up in a spiral form, and passed into a state of what has been designated summer hybernation, and remained until the end of July. This I found is the usual habit of the species, and did not depend on the mutilations, as during the same period I discovered many Iuli similarly concealed in the earth in their native haunts: many individuals die at this period in their estivatories, but these appear to have arrived at their full maturity, and become aged, having already deposited their ova in the spring. Those which are not yet matured now cast their teguments, and have their lost parts reproduced. The casting of the skin is a difficult and tedious occurrence. For several days after it has taken place the Iuli are unable to venture forth from their

cells, but remain coiled up until their new covering has acquired strength and consolidation. When the specimens that had been deprived of their antennæ again made their appearance, I found that the experiment had been entirely successful. Each individual now had its antenna and legs reproduced; but the new parts were much shorter and smaller, and of a more delicate colour, than the uninjured corresponding parts in the same animal. The new antenna was but little more than one-half the length of the original one, and was very rarely used for touching and exploring objects, but seemed to be carefully preserved by the animal from coming into contact with anything. In two of the individuals the new organ had but six joints (Plate XIV. figs. 1 and 2.), but in these instances nearly the whole organ had been reproduced, having been cut off close to the basal joint (*a*). In the other instance the new antenna had seven joints, like the original one, but in this case the antenna had been divided, and reproduction commenced in the middle of the third basal joint (fig. 3. *b*). The joints of the new antennæ were much thicker in proportion to their length than in the perfect organ. They were thickest at each extremity, each joint resembling a figure of eight, or an elongated hour-glass. The apical joint of the antenna was very minute, and sunk into the preceding one. Each joint was encircled with hairs at its distal extremity, while the joints of the original antennæ had only a few scattered hairs on their under surface. In addition to this, the articulations of the new joints were less perfect than in the old, the intussusceptions or reduplications of the tegument forming the articulations being exceedingly slight.

There was one circumstance in connexion with these reproductions that seems especially worthy of notice. In the antenna (fig. 3.) that had been divided in the middle of the third basal joint, the junction of the new with the original part of the organ was clearly indicated by a marked difference of colour in the two portions of that joint, in which the reproduction commenced. Thus it was not the whole organ that was reproduced, in this instance, but only so many joints of it as were deficient,—part of the third, the fourth, fifth, sixth and seventh. It does not appear necessary, therefore, that, when one part has been lost, the entire organ must be removed before reproduction can take place, as is believed to be the case with the limbs of Crustacea; but reparation begins in the part in which the injury occurs, and the new structures produced are only sufficient to replace those which have been removed. In the other two instances of reproduction of the antennæ, the reparation commenced at the articulation of the first basal joint with the second (fig. 1. *a*), the basal joint of the original organ being left attached to the head in each experiment. In these two instances, as already stated, there were only six joints to the new antennæ. This deficiency I am inclined to attribute to the circumstance that the individuals had very nearly approached the time when the power of reproducing parts of their own bodies had greatly decreased, and would soon altogether cease, as was shown in the circumstance, that they had so nearly reached their adult state, that each acquired only one new segment to its body at this change of tegument, the next change of which would perhaps have been the last.

It is thus proved that the legs and antennæ of the Iulidæ are reproduced at the change of skin. Since making these experiments, I have met with many instances in which these parts have been reproduced, as indicated by comparison with corresponding parts in the same animals. In no instance has the fact been better exemplified in the Iulidæ than in a specimen of *Spirostreptus microsticticus**, Newp., from the coast of Africa, now in the cabinets of the British Museum, in which most of the legs on the left side of five segments of the body, from the thirty-ninth to the forty-third, have been reproduced, while the animal was living in its natural haunts. In most of these the entire limbs, including their basilar or coxal joints, have been restored, each limb being perfect in all its joints, even including the terminal claw, although not more than one-half the size of the corresponding limb on the opposite side of the same segment. From these facts, it appears that the reproduction of a lost part in the Iulidæ may take place either in connexion with some portion of the original organ, or may be entirely independent of it, as when every portion of the original organ is removed.

The reproduction of lost parts in the Chilopoda differs a little from that of the Chilognatha. Although I do not intend on the present occasion to give a detailed account of the changes and growth of animals of this order, I may state that the *Lithobii* differ a little from the Iulidæ in the mode of development of their segments and legs. Like the Iulidæ they change their tegument in the young state very frequently, and at each change, two pairs of legs, which have previously made their appearance at the sides of the new segments as very minute projecting appendages, are elongated and assume the structure and function of legs. The young Lithobius very frequently loses some of its limbs, probably from being attacked by others of its carnivorous species, as frequently occurs when several of these are kept together in confinement.

It was a specimen of *Lithobius vulgaris,* Newp. that had previously acquired its tenth pair of legs, but had very recently suffered the loss of the eighth, ninth, and tenth pairs of those organs, that formed the subject of this part of my investigations. At this period of its life the little animal is very delicate, but active, and endowed with all the ferocious habits of the adult. It was now scarcely more than one quarter of an inch in length. I had feared that at this early period the young Myriapod might not be able to support so much injury, and be able to reproduce so many pairs of lost organs. But it moved about with the remaining seven pairs of legs with its usual activity, as if in an uninjured state, and did not appear to be at all inconvenienced by its loss; but it carefully avoided coming in contact with others of its own species that were confined with it in the same phial. On this account I removed it to another phial, in order to watch its progress more accurately. Each of the legs that were lost had been removed at the articulation of the femur with the coxal joint,

* List of the Specimens of Myriapoda in the Collection of the British Museum, by John Edward Gray, printed by order of the Trustees, 1844, p. 14.

and from the enlarged condition of the latter part I at once suspected that new limbs were about to be produced.

On the 10th of September 1842, a few days after the commencement of my observations on this individual, the young Lithobius changed its skin, and, to my great satisfaction, not only developed two additional pairs of legs, but also reproduced three other pairs in the place of those that had been lost. Thus three pairs of organs were developed at this change, besides those which make their appearance in the usual course of growth. These three pairs of reproduced legs made their appearance at the sides of the segments, without having previously been developed in a more rudimentary form, as is always the case with the legs of Lithobius when first produced. But they were exceedingly delicate, and were much smaller than the others. They gradually increased in size, and continued to grow for a short time after the casting of the skin. The two pairs of additional legs developed at this change, and now constituting the eleventh and twelfth pairs of the body, were at first larger than the reproduced ones, and continued to grow until the next change. On the 15th of September the three pairs of reproduced legs seemed to have attained their maximum of development until the next casting of the skin, but they were not so large by one-third as the legs immediately anterior to them.

On the 24th of October the young Lithobius again lost one of its legs. This was the twelfth one on the left side that had been developed at the preceding change. Nothing further took place, either in this individual or in others of the same age, with twelve pairs of legs, until the 7th of November, when it again changed its skin, and acquired three additional pairs of legs,—thus completing the adult number, fifteen. At this time it was nearly half an inch in length. I now found not only that the first reproduced legs had very nearly attained their proper size, but also that a new leg had been developed in the place of the one that was lost on the 24th of October, but this was very much smaller than the others. The two posterior pairs of legs, at this period, were scarcely so long as those immediately anterior to them, were applied very closely together, and were entirely useless. They continued to grow in length and size, and gradually acquired a power of motion. On the 18th of November the posterior segments and legs in the young animal had nearly attained their relative proportions. On the 30th of November the posterior legs were widely separated from each other, and were occasionally employed by the animal in its retrograde movements. In this condition it remained till the end of January, having passed the interval in a state of partial hybernation. It did not again change its skin until the middle of April. During this interval the posterior pairs of legs continued to be elongated, and the reproduced legs, acquired at the two preceding castings of the tegument, were also enlarged, but still continued smaller than the others. I attributed this in part to the animal not having been supplied with a sufficiency of food. On the morning of the 22nd of May it again changed its skin, and the reproduced legs had now acquired their full size. On the

3rd of August it underwent another change of covering, after which no difference could be perceived in the size of the reproduced and of the original legs. At this time my observations were discontinued.

These facts sufficiently show that a power of reproducing lost parts is quite common to the Lithobii, and the frequent occurrence of legs that have not their full size, in specimens of foreign *Scolopendræ*, lead to the conclusion that it is equally common to those animals. There are many instances of this in the collection in the British Museum, in the majority of which it is one of the posterior legs that has been reproduced. From the number of specimens I have met with in which this is the case, I have been enabled to arrive at the conclusion, that although reproduced limbs in these animals may ultimately attain the full size of the normal structures, they never acquire a perfectly normal development of all their parts, which are sometimes supernumerary, but more frequently are deficient in number, and are almost invariably atrophied. This is strikingly illustrated in the development of the spines with which the basal joints of the posterior legs of the Scolopendræ are armed. This fact is of consequence in a zoological point of view; as these parts have recently been much depended on in the determination of species. It is also, perhaps, of some value in relation to the laws of development, since it is found to be equally constant, as I shall presently show, in the reproduced parts of the true Insecta.

Insecta.

Some experiments formerly made by Dr. HEINEKE* on the Blattæ, have already shown that these insects, which do not undergo any metamorphosis but a change of tegument, have a power of reproducing the antennæ in their young state. But no experiments were made by that naturalist to prove that the legs also are capable of being reproduced. Professor MÜLLER†, however, first showed that the *Phasmidæ*, which likewise undergo no transformation, can reproduce their legs, when lost at an early period. This has recently been fully confirmed by Mr. FORTNUM, in the *Diura violescens*, GRAY, of Australia, as communicated by letter to the Rev. F. W. HOPE‡. I may also remark, that I have recently found a specimen of Phasma in the cabinets of the British Museum, in which the right anterior leg has been reproduced, in a large species (fig. 4.), *Alopus cocophages*, GRAY, MSS., an insect from Navigator's Island, destructive to the young buds of cocoa-nut trees. This instance affords a striking exemplification of the usually incomplete development of reproduced organs. Not only is the whole limb in this specimen much shorter than the corresponding one on the opposite side, but its third tarsal joint is absent, and the other joints are imperfectly formed.

In order to ascertain whether reproduction of the limbs can take place in insects that undergo a complete metamorphosis in form, in habit, and mode of life, I have

* Zoological Journal, vol. iv. p. 422. † *Loc. cit.* p. 405.

‡ Proceedings of the Entomological Society of London, January 1, 1844.

instituted a series of experiments on the larvæ of the common Nettle Butterfly, *Vanessa urticæ*.

On the 24th of May, in the present summer, I removed with the scissors two of the true legs of the caterpillar, on the left side of the body, from each of twelve specimens that had not yet passed into their last stage as larvæ, but were still in their *fourth* period. These legs were either entirely removed at their base, close to the body, or in the tibial or femoral joints. On the following morning I removed the intermediate, or the posterior leg, on the left side, from each of sixteen other specimens which had already entered their last larva skin, or *fifth* period. Six of these were nearly full-grown, and would have entered their pupa state in the course of a few days. The remaining ten had only recently entered their last skin. The whole of these twenty-eight larvæ were confined together in a glass vessel, and well supplied with food. Some of the specimens seemed to be but little affected by the operation, as they immediately began to feed very actively; but on the following morning several of them had died from its results. In the whole of those which had the legs removed at the base the hæmorrhage was at first very considerable; but in those which had the limb removed at the tibial joint it was not so profuse. In the specimens in which the limb was removed at the tibio-tarsal joint the hæmorrhage soon ceased, but in those in which the wound was more serious, it was less readily suppressed. But even the individuals that were most injured began to feed with avidity immediately after the operation, notwithstanding the excessive hæmorrhage that was going on. One of these specimens had not only lost the whole of its meso-thoracic leg, but was also punctured on the back, and from both wounds the green transparent circulatory fluid flowed in large quantity; but the insect still continued to feed very eagerly. In less than half an hour I had the satisfaction to find that a coagulation of the effused blood was taking place over the wounds, although at each contortion of the body the fluid gushed forth afresh. In three quarters of an hour the blood had become somewhat more firmly coagulated, and formed a dark black patch, or eschar, over the injured parts. In this way, by a coagulation of the effused fluid, the hæmorrhage from wounds in insects is first arrested. The rapidity with which this coagulation takes place seems to depend greatly on the temperature and comparative dryness of the atmosphere; since if the air of the locality in which the insect is confined be loaded with moisture, the hæmorrhage continues for a long time, and the individuals often die, as was the case with some of my first series. It was in consequence of not being aware of this, at the commencement of my experiments, that a greater number of specimens died than would otherwise have been lost from the operations. On the fourth day only twenty-two were still living; but this great mortality was clearly attributable to the cause I have stated. At the expiration of nine days, one of the six larvæ that were nearly full-grown when the experiments were commenced, changed to a chrysalis. At that time only seventeen specimens remained out of the original twenty-eight. Those which died were chiefly the youngest ones. By the thirteenth day, June 5th,

the remaining specimens of the same brood had also entered the pupa state, leaving only five out of the twelve individuals first operated on, which had not then entered the last state of larvæ, still surviving the operation. By the 9th of June, the seventeenth day after the operation, these also had changed to chrysalids. It was thus evident that a removal of the limbs does not necessarily prevent the insect from undergoing its natural transformations.

During the growth of these specimens there were several circumstances that appeared well worthy of notice. It soon became evident that even in those instances in which the insects survived the operation their development was considerably retarded by it. This was shown by comparing the length of time that elapsed in their different states, with that required by other specimens of the same age, that had not undergone any operation before they changed to chrysalids,—the circumstances, in regard to age, quantity and quality of food, temperature, and locality in which they were placed, being in all exactly the same. In every instance the uninjured specimens prepared themselves for transformation very much earlier than those experimented on; and they also passed much quicker into the state of pupæ. Thus, while uninjured specimens, which had not cast their last larva skin, all underwent their changes on the 29th and morning of the 30th of May, those of the same age that had been first subjected to experiment did not undergo a corresponding change of skin until late on the 31st. Precisely the same thing occurred with the more matured larvæ, all of which were retarded in their change to the pupa state beyond the time at which others of the same age entered it.

It was thus evident that although mutilations do not necessarily prevent, they certainly arrest the natural period of change, both as regards that of the larva, and also its passing into the pupa state.

I have already stated that at the commencement of the eighth day from the operation, May 31st, only five specimens remained out of the twelve of the younger individuals first operated on. At this time they entered their last skin as larvæ. The condition of these specimens after casting their skins was exceedingly interesting. One of them had had the whole of the three legs on the left side of the body either partially or entirely removed. This individual changed its skin during the time I was watching it. No hæmorrhage whatever occurred from either of the injured limbs, the wounds in which had become completely healed. But no new legs had yet been formed, although there were indications that new parts might perhaps make their appearance at the next change, as the basal joint of each leg had become slightly elongated. In a second specimen the intermediate leg on the left side had been removed almost close to the body, and the remains of the basal joint in this also was slightly enlarged. In a third instance the intermediate leg on the left side had been cut off quite close to the body, and yet the larva had undergone its change without any hæmorrhage; the wound was completely healed, but there was scarcely any development of the injured surface. In the fourth example also the first and second

legs on the left side had been cut close off, but the basilar joints in these were elongated, and the insect cast its skin without difficulty. In the fifth specimen, which cast its skin during the very moment I was examining it, the facts were still more satisfactory. The middle leg on the left side had been removed, but the basilar joint, as in the other instances, had become elongated. Besides this, a portion of the posterior leg on the same side had been removed at the tibial joint, and this *had now been reproduced with the tarsus and claw*. It now formed a short leg, very obtuse at its extremity, with the minute black claw sunk in its apex. This fact sufficiently proved to me that a power of reproduction exists in insects which undergo a complete metamorphosis, as well as in those which do not change their form, and it led me to watch with greater assiduity the passing of these individuals into the pupa state.

At the expiration of nine days from the commencement of the experiments (June 1st), one of the larvæ, that was nearly full-grown when operated on, suspended itself to enter the pupa state. At that time there were only seventeen specimens still living out of the twenty-eight originally employed, and four of these died soon after. There then remained two of the oldest, six of the next age, and, as above stated, five of the youngest. The eight oldest specimens had all changed to pupæ by the 5th of June; but the remaining five continued to feed until the 6th, between which and the 9th, the seventeenth day after the operation, these also had become pupæ. I was now much gratified to find that most of them gave distinct evidence of reproduction having taken place. In some of them the *tibial* and *tarsal portions* of the legs had been restored; in others *entire limbs had been reproduced* (fig. 5. *f. g.*), while in two or three instances the experiment appeared to have entirely failed. I waited, therefore, with much eagerness for the development of the perfect insects.

The first specimen came forth early on the morning of the 14th of June, the twenty-second of the experiment, having remained in the pupa state only eleven days and seventeen hours, during which the temperature had ranged from 61° FAHR., at which it entered the pupa state, to 76° FAHR., being 71° FAHR. at the time the insect came forth; from that time to the 17th of June, the twenty-fifth of the experiment, eight perfect insects made their appearance. The longest period that any of them remained in the pupa state was eleven days seventeen hours, and the shortest ten days fourteen hours; thus most directly proving the influence of increased temperature in hastening development; the usual length of time which this insect remains in the pupa state, at a medium temperature of 60° FAHR., being fourteen days. In two of these specimens no reproduction of the limbs had taken place, but in the six remaining ones the reproduction was complete. In one specimen (fig. 6.) the entire intermediate limb had been reproduced (*g*), but it was much smaller than the other limbs. In the other specimens the tibial and tarsal joints had been restored, and always the minute claw. In some instances the tarsal joints were very short, but their number and relative proportions were usually maintained, while in others the tibia was developed to its full extent, but *without its articular spines* (fig. 6 to 13.);

thus coinciding precisely with what I have already stated in regard to the irregular development of the armature of reproduced limbs in the Myriapoda.

The remaining five specimens were developed between the 18th and 20th of June, the last individual having made its appearance at an early hour of the morning of the present day (June 20), having remained eleven days and four hours in the pupa state, which condition it entered at a temperature of 71° FAHR., and left when it was only 63° FAHR. In two of these instances also there was only an abortive attempt at reproduction; the limb was microscopic in size, and imperfect (fig. 15 to 16.), but in the other three the reproduction was very complete.

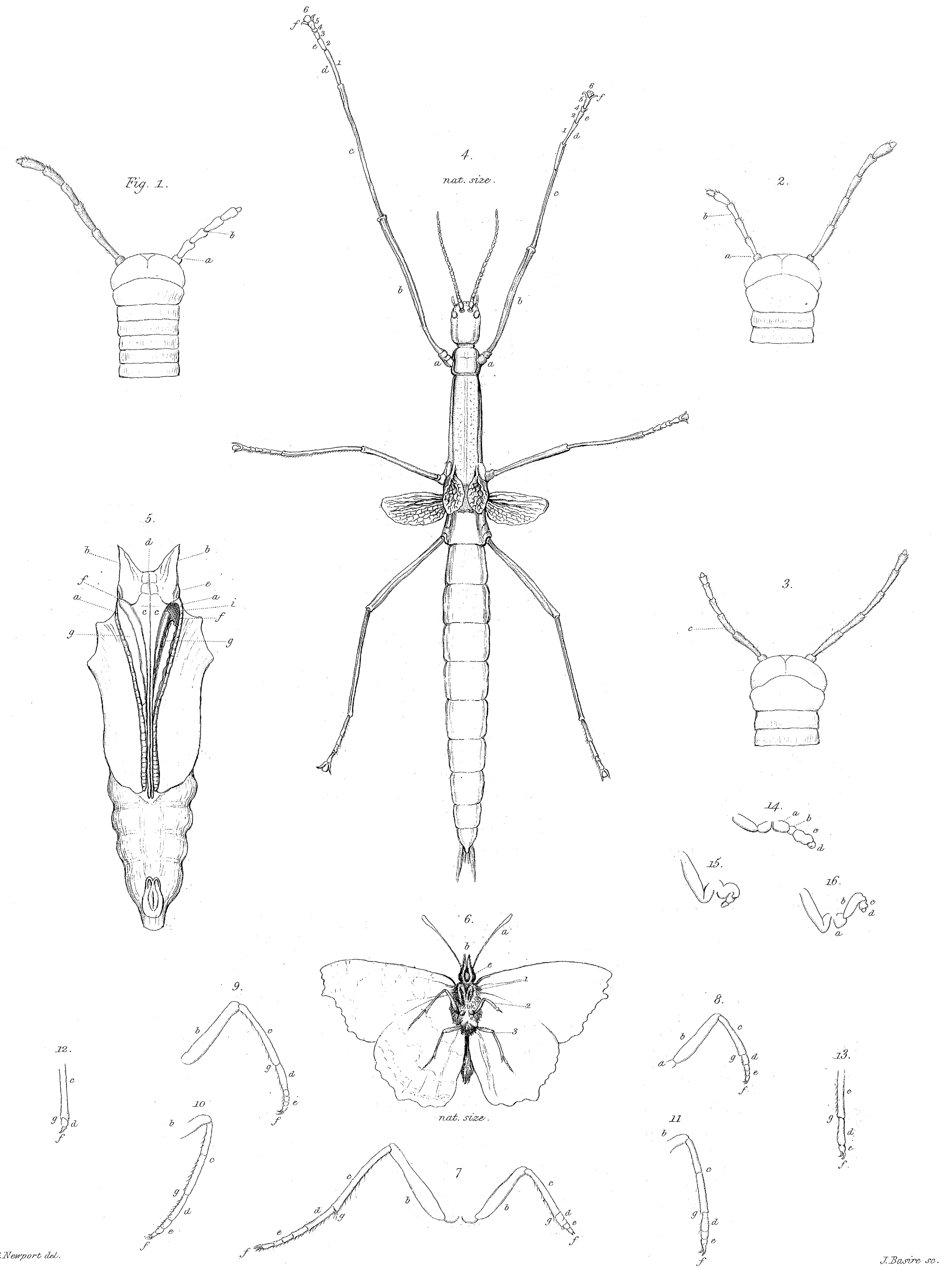
It is a matter of great interest to ascertain to what the non-production of the legs in some of these instances is to be attributed, while a complete reproduction took place in others. Thus, in the last developed specimen the second leg on the left side was reproduced, but the third one was not. This fact appears at first to support the opinion that the reproduction of lost parts depends on the existence of special structures, situated in some portion of the base of the limb, the removal of which prevents the redevelopment of the lost part. But this conclusion is opposed by the fact, that even in those instances, in these experiments, in which the entire limb, with the coxa or basilar joint was removed, a new limb was afterwards produced, or the merest possible rudiment of a limb was developed, while in others there was no indication of it whatever.

When an entire limb is reproduced it is always composed of its *essential* parts (fig. 4.),—coxa, femur, tibia, tarsus and claw. Besides being inferior in size, the tarsus is often deficient in the number of its joints; and the *subsidiary* parts of the limb, the articular spines, are almost always absent. This is more especially the case when a limb has been divided in the femoral or tibial joints, and the reproduction of the limb has, in consequence, been only partial. But in all of these cases the terminal part of the organ, the *claw*, is invariably reproduced. This was strikingly shown in some specimens of partial reproduction, in which the claw was formed at the extremity of a metatarsal joint, or when one or more of the tarsal joints were wanting.

It is thus sufficiently clear that a power of reproduction of lost parts is common to the whole of the Insecta and Myriapoda; and that it may take place in insects that undergo a complete metamorphosis, as well as in those which do not change their form. It yet remains to be shown in what way this regeneration of parts takes place. The fact that it commences in insects and Myriapoda in any portion of an organ that may be wounded, or that it may occur, as in Spirostreptus and other *Iulidæ*, where the entire organ with its basal portion has been removed, seems to lead to the inference that it is not confined to special parts, but exists equally in the whole of the organized tissues.

The general conclusions to which I have been led by these investigations are,—*First*, that slight wounds of the body in larva are always healed, except when there is any protrusion of the viscera, or, as in the higher Vertebrata, when hæmorrhage

Reproduction of lost parts in Myriapoda and Insecta.



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takes place to a very great extent. *Secondly*, that very severe wounds also are frequently healed; as, for instance, those attendant on excision of an entire limb. *Thirdly*, that protrusion of the viscera takes place from small wounds when these are in the line of action of the principal muscles of the body. *Fourthly*, that the healing of wounds in these animals depends, in the first instance, on an arrest of the hæmorrhage by coagulation of the effused blood, and the formation of a clot, as in the Vertebrata. *Fifthly*, that coagulation is a property of the blood in these Articulata, exactly as in the Vertebrata. *Sixthly*, that coagulation is not so complete in the former, but begins to take place in nearly the same time as in the latter. *Seventhly*, that a complete union of the wounded parts takes place beneath the eschar formed by the clot on the wounded part. *Eighthly*, that after this union the injury begins to be repaired by the development from the injured surface, of parts corresponding to those which have been removed. *Ninthly*, that at least one change of skin is necessary to the production of a new limb, when the injury has been severe, or the entire limb has been removed. That the removal and reproduction of a part, and the healing of the wound, do not *prevent*, although they certainly *retard*, the natural changes of the animal; and that reproduction of lost parts takes place in the metabolic as well as in the ametabolic Articulata.

Note.—Since this paper was delivered to the Royal Society I have repeated these experiments on the larvæ of *Vanessa Iö* with precisely similar results. The original specimens illustrating this paper are now in the cabinets of the British Museum, together with others showing the same facts in *V. Iö*.—G. N., Sept. 24, 1844.

Description of Plate.

Fig. 1. Head of *Iulus terrestris* with the right antenna reproduced.
- *a*. The original basal joint.
- *b*. The reproduced joints.—Magnified.

Fig. 2. Head of *Iulus* with the left antenna reproduced.
- *a*. The original basal joint.
- *b*. The reproduced joints.—Magnified.

Fig. 3. Head of *Iulus* with a portion of the left antenna reproduced.
- *c*. The point at which the original antenna was divided, and the reproduction of the new parts commenced.—Magnified.

Fig. 4. *Alopus cocophages*, Gray, MSS. (natural size), with the right anterior leg reproduced.
- *a*. Coxa.
- *b*. Femur.
- *c*. Tibia.
- *d*. Metatarsus.
- *e*. Tarsus
- *f*. Claw. The third tarsal joint in this foot is not developed.

Fig. 5. Front view of a pupa of *Vanessa urticæ* one hour before the development of the perfect insect (fig. 6.), exhibiting the condition of the first and second reproduced legs in the pupa.

a. The antennæ.

b. The palpi.

c. The elongated maxillæ or proboscis.

d. The front.

e. The eyes.

f. The anterior, or palpiform leg of the insect reproduced, and very much the smallest on the left side.

g. The middle, or meso-thoracic leg, reproduced and diminutive on the left side.

i. A deep excavation on the left side of the pupa which the reproduced limbs are too minute to fill up. This specimen is magnified three diameters.

Fig. 6. The under surface of the perfect insect developed from the pupa, fig. 5. (natural size), the letters as before. The reproduced legs 1 and 2 are not more than one-half the size of the corresponding ones on the opposite side. In 2, four of the tarsal joints exist, but are exceedingly minute.

Fig. 7. The meso-thoracic or middle pair of legs in the same insect magnified three diameters.

Fig. 8. Reproduced meso-thoracic leg of another individual a little more complete.

Fig. 9. Reproduced meso-thoracic leg of a third individual, with the whole of the tarsal joints, and nearly perfect, but without the tibial articular spines (*g*).

Fig. 10. Meso-thoracic leg of a fourth individual still more complete, with the claw (*f*) almost as in the normal state. In this instance the leg of the larva was divided in the tibial joint (*c*), and the reproduction commenced in that part, but even in this instance the articular spines (*g*) are absent.

Fig. 11. Leg divided in the tibial joint, in the *fifth stage* of the larva, and reproduction commenced in that part.

Fig. 12. Leg divided in the fifth stage of larva with the claw formed at the extremity of a mesotarsal joint.

Fig. 13. Leg reproduced in the tibial portion, further advanced.

Fig. 14. Abortive attempt at reproduction of the leg in a specimen in which the limb was removed after the larva had entered its fifth stage.

Fig. 15. Abortive attempt at reproduction of the posterior or meta-thoracic leg in a specimen in which the limb was removed while the larva was in its *fourth stage*, and in which an entire new limb (fig. 9.) was formed in the same insect.

Fig. 16. Rudimentary abortive leg in a specimen operated on its fourth stage as a larva.

All the figures from 7 to 16 are magnified three diameters.