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OBSERVATIONS

ON

PLANARIÆ,

A GENUS OF AQUATIC ANIMALS.

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OBSERVATIONS

ON

SOME INTERESTING PHENOMENA

IN

ANIMAL PHYSIOLOGY,

EXHIBITED BY SEVERAL SPECIES

OF

PLANARIÆ.

ILLUSTRATED BY COLOURED FIGURES

OF

LIVING ANIMALS.

BY

JOHN GRAHAM DALYELL, Esq.

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PREFACE.

THE following Observations are chiefly extracted from a journal of incidents in natural history, kept as occasion offered, during several successive years. Many interruptions opposed their progress; the concurrence of circumstances indispensible for connected detail were frequently wanting; experiments were rendered abortive by casualties; and hence the imperfections which they now exhibit.

Nothing is referred to but what has actually been witnessed, which is a better means of promoting the progress of science than resorting to the auxiliary authority of other naturalists. Dates are given to aid the illustrations, not to claim any priority of observation, were such even worthy of

appropriation. Possibly, analogous enquiries have long ago been instituted by those more qualified for the task; and, what has appeared obscure in the nature of the animals now brought under consideration, may already be elsewhere satisfactorily explained.

The Figures, which will elucidate the subject where verbal description fails, have invariably been drawn from living Planariæ in motion, and generally after having fed, as the most ample view of their organization is then presented. Naturalists, who take these animals indiscriminately from their native abodes, may therefore find discrepancies, resulting from a state of abstinence; and variations still more conspicuous may appear, from the unequal evolution of nascent parts. But experience will speedily inculcate, where, after passing all the successive stages, perfection at length is gained. Nevertheless, the size is somewhat less than life, because Planariæ always decline in a state of confinement.

The name of any species distinctly recognized is retained; and if a new one is bestowed on those where this is doubtful,

it is only to put their identity beyond future dispute. It cannot but appear remarkable, that peculiar difficulty should have been experienced here; that a certain genus should be instituted, and a number of species, all distinguished by individual characteristics, brought under it, which scarcely, in a single instance, demonstrate the place to which they belong. Yet this will appear less surprising, when we reflect that the site of an organ, the most important assuredly, the mouth, has hitherto been referred to the anterior extremity in all, instead of the middle of the belly, its general position.

Although the Observations which occupy these pages lead to very different conclusions from what such eminent naturalists as Linnæus, Cuvier, and perhaps the learned and indefatigable Muller, have endeavoured to deduce for the purpose of systematic arrangement, names so celebrated ought not to be mentioned without the utmost deference. Had the genus Planaria engaged their protracted investigation, the phenomena now exposed would not have remained so long in concealment.

The errors which have darkened the beautiful science of Natural History, are principally to be traced to superficial observation: and if this be true with regard to the larger animals, how is it to be expected that the smaller have received that scrupulous care and attention, by which alone their habits can be illustrated? Scarce deemed worthy to hold a place in existence, they have been obscured by more conspicuous objects, those whose properties it required less time and labour to unfold. But the real Physiologist, who knows the universal balance preserving the scale of animation, and who feels the imbecility of his own understanding, in scrutinizing the operations of Nature, will not presumptuously depreciate what are called her meanest works. Each has its appointed place, and its appointed purpose. Patient enquiry is the only unerring guide; and even this may be defeated, unless a combination of incidents shall favour the observer.

Perhaps it is less from the number of animals, than the accurate examination of those brought under review, that benefit

accrues to science: nor can simple reference to a particular class, from external conformation, be accounted of equal importance to watching the properties disclosed by living nature. Hence the great necessity that animals shall be preserved in that condition where all the vital functions, unrestrained, can be fully displayed; where we shall be enabled to behold the united operation of instinct and organization. Though reasoning on facts which can admit of no mistake be thus reduced to the result of time and industry, our cares are rewarded by banishing precipitation, which is ever prejudicial to philosophical enquiry, and hostile to the discovery of truth.

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OBSERVATIONS

ON

PLANARIÆ.

On descending from terrestrial objects to the inhabitants of the waters, infinitely new and interesting matter is presented for the contemplative physiologist. Myriads of beings, alike singular in structure and properties, appear in their peculiar element, all actuated by the resistless impulse of nature; avoiding danger, seeking subsistence, rendering the weaker a prey. But figure, habits, and instinct, are not their sole characteristics; they enjoy privileges besides, which we might be prone to account so many aberrations from the laws of organiza-

tion; while the test of experiment unfolds latent phenomena, which the utmost efforts of human ingenuity find it difficult to illustrate. Certain animals, though liable to perish by simple evaporation of their surrounding fluid, can, in other circumstances, endure privations apparently inconsistent with life itself. What prove deadly wounds to the majority of the creation, only serve to awaken in them the active principle of an inexhaustible reproductive power. The perpetuation of their race is effected by means the most remote from those that usually regulate the origin of animated existence. A shapeless fragment is disjoined from the body of the parent; it remains in quiescence more resembling the state of death: but new organs are gradually evolved—motion is resumed—and all the qualities successively displayed which belonged to the primitive whole.

Such are some of the admirable prerogatives conferred on the creatures about to be described. Let us not anticipate them

farther, lest, in obscuring the fragility of their texture, we may be erroneously led to deem them, of all others, the chosen works of the universe.

Animals with soft bodies, wanting bones, are divided into several subordinate tribes, one of which, either from external configuration, or a smooth gliding motion over even surfaces, has been denominated *Planaria*. All the species with which we shall be occupied are strictly aquatic; the presence of water is equally indispensible to their safety and preservation; for contact of the atmospheric element, though during the shortest period, is irremediable destruction. Some dwell in the sea; others inhabit lakes, marshes, and such streams as are almost still or undisturbed: and it is also said that they may be found in humid meadows; but none of that description have come within the sphere of my research.

Perhaps the genus is as yet insufficiently characterized; nor will the subsequent remarks do more than approximate it to its

proper place, in the order of nature. Certain species now excluded, ought obviously to be annexed to it; and possibly several which are there comprehended, should be detached. Adjusting this point, however, would involve discussions which it may be desirable for the present to avoid.

The planaria, on external inspection, seems allied both to the leech and the snail, but more akin to the latter, and, at the same time, possessing parts and properties belonging to neither. Intermediate genera probably remove it from each; for, as our knowledge of the creation extends, subordinate distinctions produce an interval between analogous races of animals, occupied by shades always becoming slighter and slighter, until the original characters are lost in some common object. One comprehensive division, that which shall engage most of our attention in this place, may be defined, "naked, flattish in a state of abstinence, provided with a proboscis protruding from the mid-

dle of the belly or under surface; swimming supine." Another division may be defined, "body in a state of repletion, resembling a double cone; mouth in the anterior extremity."

Division I. *Planaria Flexilis*, Fig. 1, 2. Near to low-water mark on the shores of the Forth, we find a species of these animals, universally of a dull whitish or pale ash colour, about an inch long, and a quarter of an inch across at the extreme breadth. The whole body is quite flat, especially below, almost as thin as paper, and endowed with singular flexibility. The head is semicircularly obtuse; and, from near its anterior extremity, the body decreases to the termination of the posterior part or tail, which is also obtuse, but proportionally much less so than the head, and is sometimes diminished to a point. The contour of young planariæ tends to the outline of a spherical triangle, which gradually alters with their increment. By an uncommon distribution of the most important organs, the

aperture of the mouth, unlike that of terrestrial animals, is remote from the head of the planaria. Situated in the belly or under surface, nearer to the tail than to the anterior extremity, it receives the necessary aliment to be transmitted to the viscera. Some remarks will afterwards occur on the singular proboscis with which this division of the genus is provided, when treating of those species where its structure has been more easily examined. Towards the anterior part are two blackish spots on the upper surface of the body, which being subjected to the microscope, are discovered to be two groups or clusters of minute jet black specks, of unequal size, and likewise of unequal number in different animals. In one planaria, each cluster consisted of eight specks; in another, of fourteen or sixteen; and in a third, which was very small, of eighteen or nineteen, several being deeper seated in the body than the rest. These specks approach to a globular figure; some are apparently confounded together; and they occasionally appear

singly, advanced in a straight line from the respective clusters. Microscopical observations are attended with extreme difficulty, owing to the incessant motion of the creatures, and the necessity for their being kept in water; and they contract so much when exposed to cold, that rendering them torpid is of little utility.

It may here be remarked, that the examination of pale and pellucid animals with lenses, is greatly facilitated by their interposition between a dark ground and the magnifier, as also that it should uniformly take place by day. All the artificial light which the combination of combustible substances can produce, is infinitely inferior to the slightest gleam of sunshine, or even what is transmitted from a clouded sky. The higher the magnifying power, the greater the consequent obscuration of the object, which proves how dependent our knowledge of its structure is on the degree of illumination that it receives.

Whether these specks be truly eyes, or

what is their peculiar use, is uncertain; nor can we determine whether the impressions received, or the functions performed, rest on their united operation. Their remoteness from the mouth may be thought unfavourable for aiding the animal to the capture of its prey; and their position so far from the portion first advanced, seems ill calculated for enabling it to avoid danger. Naturalists are prone to ascribe the same faculties to those organs of the smaller tribes, which bear a distant resemblance to the place and appearance of eyes in the larger animals. But the precise nature of vision in all aquatic and terrestrial insects, and likewise in the whole mollusca and vermicular race, is exceedingly obscure; and, notwithstanding our readiness to bestow it on many of them in perfection, there is certainly ground to dispute, whether we are acquainted with any particular organ appropriated for it. Perhaps this sense is not indispensible to their security or preservation: many animals seldom approach

the sphere of the solar rays; all the wonderful operations of the bee are conducted in the dark. Most planariæ court the light indeed; but the flexilis rather inclines to shun it, less, we may conjecture, from being warned of its presence by the specks or eyes, than from some disagreeable sensation produced on the body. Apparently, the vicinity of food is recognized more from an analogous impression, whatever sense may be affected, than from vision.

The body is surrounded by a smooth narrow margin, paler in colour than the rest, and of a different texture, participating, in a minor degree, of the gelatinous consistence which composes the general substance of the whole genus. From these characteristics, the species can hardly be mistaken, particularly as there is no other animal known to us that resembles it.

The size of each individual is materially affected by the external temperature, and the food absorbed. As the day is warmer, the planaria is larger, and it sensibly di-

minishes with the approach of cold. Thus, the specimens delineated in the annexed Engravings are not of the extreme dimensions, which may unquestionably be augmented by a copious and regular supply of aliment, independent of the temporary increment attained. Temperature and food must always be taken into account, in speaking of size, for both contribute to enlarge the contour of the body. Besides, it essentially merits consideration, that the colour of the entire animal is principally regulated by the tinge of the aliment received; and if we say it is naturally of a dull white, this means in a state of abstinence. Its proper abode, however, being among mud, that substance promotes a tawny hue; for, on removal from it, planariæ become much clearer, and, in common with some other animals under similar circumstances, almost white. As the tide recedes, they recede along with it; and if accidentally left behind, take shelter beneath stones on the shore.

Planariæ, like most marine animals, desert their haunts at night, and range actively around in quest of prey. An incredible change is produced in their appearance by the immoderate quantities they devour, insomuch that they can scarce be recognized for the same beings.

I was particularly unsuccessful in endeavouring to discover the proper food of the planaria flexilis; every different substance was rejected; and, in the interval thus occupied, all the animals successively procured gradually wasted away to extenuation. It occasioned me the greater regret, from their rarity in the districts within my reach; and experience had taught me, that the most essential condition which can aid investigations into the phenomena of animated nature, is ascertaining the aliment whereby life is preserved. A new opportunity having occurred on the 31. of August 1809, three planariæ, after an abstinence of several days, were supplied with the heart and liver of a perch; the sea wa-

ter was changed, and a quantity of mud put into a glass jar along with them. Next morning a material alteration had ensued: the colour of the largest was altogether altered from its original dull and tawny white, to dark reddish brown. Numerous ramifications, beautifully interlaced, were distributed throughout the body, proceeding from the centre to the interior of the narrow margin, into which they did not penetrate, and the size of the body was augmented. This could be ascribed to the quality of the food alone; and it also shewed, that the animal was carnivorous. Other experiments followed; and some time afterwards, the same planariæ having devoured a green marine *nereis*, a creature of soft consistence as themselves, their bodies became of a greenish hue, which three or four days were required to obliterate. It is alike with each variety of food: the colour is constantly imparted to the animal; and nothing can be more elegant and interesting than its dissemination among the

numerous pinnate and delicate shaped vessels performing the functions of nutrition.

But the naturalist cannot be sufficiently guarded against yielding to appearances: none are better calculated to mislead his judgment than those which are now exposed. I have oftener than once taken planariæ of several kinds, embellished by complicated ramifications below, and above exhibiting a tinge different from what had been seen in any other species. Neither did their size correspond with the dimensions of those which might be deemed most analogous; and I even thought there was a sensible peculiarity in their motion. These facts would have warranted the addition of another species, or at least a variety to the genus; yet, having preserved the individuals a day or two, an alteration both of figure and colour augmented the difficulty of condescending on their proper place, until the further lapse of time brought them to my knowledge as animals quite ordinary and familiar. Whence did the discrepancies arise? From the quality

of the food alone, and its subsequent assimilation with the substance of the planariæ. The peculiar colour impressed on the observer, was from at first sight confounding the infinite ramifications with the general mass of the body: the size had been affected by a copious supply of aliment; and as motion is accelerated or relaxed by the pressure of necessity and external temperature united, some unusual combination had operated here. Along with the disappearance of the food, the colour vanished; the size was, from the same cause, reduced to its accustomed limits: hunger stimulated to action; and animals, identically such as I was wont to behold, were before me. This is a cogent illustration of the advantage of leisurely awaiting the alteration which may be undergone by beings so susceptible of change. All the planariæ that have come under my inspection, would seem, to a superficial observer, quite different species in a state of abstinence from what they are in a state of re-

pletion. Probably the acute and intelligent Muller, to whose researches naturalists are so eminently indebted, did not escape that liability to error which accidental appearances are calculated to produce; for what are in some instances given by him as permanent characteristics, would most likely have been obliterated with long intervals of observation.

The alimentary matter absorbed, is immediately received into large viscera, and distributed entirely throughout the body, as is proved by the ramifications being coloured: and in this the nature of planariæ differs from that of the larger animals. It is not the sensible parts of the food taken into the stomach which are transmitted to the extremities of the latter; but, by some mysterious process, their beneficial influence is universally disseminated. In planariæ, on the contrary, instead of a nutritious principle only being diffused from the intestines, or the organs analogous to those connected with a stomach, portions, and these in considerable quantities, of what

has actually been received, reach from the center to the margin.

Planariæ, in the natural state, perhaps feed on the mucilaginous parts of vegetables; they are likewise carnivorous in the highest degree, greedily devouring animal substances, particularly the softer kinds, as mussels, oysters, and others of the mollusca tribes. Unless a certain temperature prevail, all aliment is rejected; and when the thermometer stood at 45°, with chill winds, it has been necessary to remove them to a warmer atmosphere, where they readily fed. Nevertheless, they sometimes refuse food for weeks together, though in a favourable situation. Their voracity is incredible: the whole flexile body is employed in firmly infolding the prey: if living, its struggles are vain to get free; it is gradually absorbed, until the capacity of the viscera can receive no more. But, contrary to what is witnessed in other animals, of which the belly protrudes with repletion, the back of the planaria rises in proportion to the

contents of the stomach, and frequently it carries a hump a quarter of an inch high.

One of three planariæ which had been copiously supplied with food, proved incapable of swallowing the whole quantity that it had attempted, whence some part remained protruding from the body. In this condition, the animal, as well as the others, which had manifested nearly equal voracity, sought the surface of the water, where they lay supine and motionless. About thirty hours afterwards, two of them exhibited a singular spectacle: a wide rent appeared in the middle of the body, tearing it almost asunder; while each endeavoured to liberate itself of the half-digested food; and incipient rending nearer the edges was also perceptible in the upper part of the third. Previous to so unexpected a consequence of repletion, indications which I have never been able to verify, induced me to suspect the probable existence of apertures in different parts of the animal, whereby the food proving incommodious or

indigestible, might escape before its natural dispersion among the vessels. The three planariæ at length literally seemed burst from their excessive voracity; and a portion of the tail of one was tore away in its struggles. Notwithstanding every precaution for their preservation, all perished within two or three days; and putrefaction rapidly dissolved their lacerated bodies.

Some animals, especially those whose success is uncertain in capturing prey, can survive wonderfully long entirely devoid of aliment. But when the opportunity comes, their voracity is proportioned to the abstinence endured. Adhering to the same spot, the polypus and sea anemone can only extend their retractile tentacula to seize whatever victim may occasionally stray within their compass. A wide mouth expands beyond the diameter of the base to receive it; the capacity of the body is dilated infinitely above its ordinary dimensions, which are again reduced as the food is consumed by digestion. No ani-

mal, however, in so far as I have witnessed, except the planaria, actually sacrifices its life to its inordinate appetite.

These planariæ dwell in society: they are of an extremely pacific nature among themselves, and very inactive, unless when in pursuit of prey. Then they may be seen traversing their element with a remarkable motion, produced by the successive opening and closing of the broad anterior part of the body. They generally live half buried in mud, a substance with which the vermes and molluscæ should constantly be provided, particularly those undefended by any external covering; but it should be pure and unmixed with fragments of vegetable matter. The smoothness of its surface peculiarly corresponds with the soft and delicate texture of such creatures; and they should also be kept in glass vessels, as earthen-ware, though fine in quality, is often too rough and unequal for them to pass over, without suffering. A frequent change of sea-water is beneficial, and it should al-

ways be renewed soon after the planariæ have fed, for an insensible putrescent principle is imparted to it by their most salutary aliment. On the water becoming fetid, they rise to the surface, and endeavour to escape; thus pointing out an easy method of dislodging marine animals from their recesses. By rendering sea-water noxious, from the gradual decay of putrefying substances, they desert their haunts, otherwise inaccessible, in quest of some more genial element; or, if a tall glass jar be filled with a promiscuous mixture of mud and vegetables from a fresh water marsh, many of its inhabitants will be seen ascending the sides towards night, though, on the approach of day, they return to places of concealment.

The natural mode of propagation by the Planaria Flexilis, seems from eggs: whether each animal is a hermaphrodite, I have not been able to ascertain; nor, indeed, all the peculiarities attendant on the perpetuation of their race. Some, which had been

kept several months, appeared in unusual agitation on the twenty-fourth of December; and then a small spot of very minute eggs, as I conceived them, was seen on the side of their glass, near the surface of the water. Between that day and the tenth of May, the Planariæ continued laying, until the eggs amounted to thousands produced by each. They were preserved with much care, but I could not be sensible that any young were hatched; and at length I conjectured that many of the eggs were devoured by the old ones. Circumstances have prevented a repetition of this observation, which demands to be further illustrated, as the nature of the Planariæ was affected by the heat of an apartment, and they were not isolated. For a long time, the original spot was resorted to; the eggs, if they may truly be considered such, were afterwards affixed to various other parts of the vessel. Whether more would have been produced after the tenth of May, is uncertain, as all the Planariæ perished about that period. A premature season

was probably hastened by their artificial situation.

The Planaria Flexilis is one of those beings so eminently privileged, as to preserve animation when divided into sections: If cut asunder, each half acquires the defective organs. At first the posterior portion is quiescent; and a considerable interval elapses before its motion and activity are resumed: the anterior division suffers little; it traverses its element as if scarce affected by the mutilation; a thin triangular vegetation proceeds from the wound, which is gradually enlarged, and at last acquires the exact figure and proportions of the severed parts.

The longest period during which I have at once preserved these marine Planariæ, has exceeded eight months. As accident then deprived me of them, we are not to conclude on the brevity of their existence. Indeed, the life of most aquatic animals is by no means short; and perhaps the terrestrial molluscæ, and some apterous in-

sects, infinitely survive the term which we generally conceive appropriated to them. It is accident that abridges life; seldom the simple decay of nature.

Planaria Nigra, Fig. 3. 5. 15. During the sunshine of summer, a small jet black velvet-skinned animal may be often seen crawling near the edge of fresh-water ponds and ditches, with a lively, smooth, and gliding motion. This is the Black Planaria, which has already been characterized and described by different naturalists; but, unfortunately for that accuracy which should mark the progress of science, their superficial observations concerning it have led to those numerous errors which darken the history of the whole genus.

Sometimes it is found in slow running waters, and there of the largest size, but usually when they are almost stagnant, and, in particular, where aquatic plants abound. On these, numbers crowd together as the colder season advances, each

contracting into an elliptical spot, and then affording the most favourable opportunity for many being taken with facility at a time; or they fix on the under surface of pieces of slate and smooth stones somewhat elevated above the mud. They live in numerous pacific societies, associating with every other species: and are so generally dispersed, that none has occurred to me of such frequency in Scotland.

An animal so well known as the Black Planaria scarce requires description; nor, considering its external uniformity of appearance, does there seem much room for commentary. It is found of all different sizes, from extreme minuteness to above half an inch in length, and about an eighth of an inch in breadth. When very large, it has a dull and sluggish aspect, and is chiefly roused to action by light and heat. On the under part, or belly, are what naturalists have designated two *ventral pores*, one of which,—perhaps both,—is more conspicuous at certain seasons. The first is

lower down than the middle of the body, and the second still nearer the extremity of the tail. The opacity of the animal precludes us from accurately distinguishing its internal organization; nevertheless, enough may be discovered to infer, that it is far from simple. Among black Planariæ, some occasionally occur of the ordinary size, figure, and proportions, but, instead of the jetty colour proper to the species, they are of a dark grey. By interposing them between the eye and concentrated rays of light, the internal structure may be obscurely recognized in many vessels, branching from about the middle of the body, and terminating in obtuse extremities near the margin. These are certainly analogous to the pinnate ramifications already described; and they bear much resemblance to the viscera of leeches. Facts do not warrant our concluding that the grey Planariæ are indubitably a different species, or that they are only varieties; their contour seems more ovate, indeed, and they are seldom if

ever seen of the largest size. One taken in October was of light grey and mottled, or streaked with deeper transverse bands: it was very broad in proportion to its length. Yet it must be admitted, that repletion always affects the colour of the leading species, which regularly darkens according to age and increment. Probably, from distension of the vessels, shades of difference may prevail, which temporary causes render more prominent.

The Black Planaria is endowed with wonderful tenacity of life, a property which materially aids the researches of the physiologist. The truth is forcibly demonstrated, by the dreadful lacerations with which it appears in its natural element. Sometimes a large section from the neck is wanting, sometimes a semicircular wound almost divides the animal asunder, or one half of the body has been tore from the other, and still it survives the mutilation.—This was a sufficient guide. The genus had been partitioned by nomenclators, according

to the number of eyes, or their total absence; and a place from the latter was assigned to the black planaria. It was probable, however, if eyes were present, they should not be sought in the full grown animal, which might be of equal opacity to themselves; or, in other words, they would more easily be detected in regenerating parts: and, if such lacerations as I had witnessed did not destroy the animals, neither would artificial separation of important organs be fatal. Several planariæ were therefore decapitated on the tenth of September; and, in nearly three weeks, the wounds of some being examined by a magnifier, appeared not only completely heal, but a conical reproduction of the defective parts protruded. The regenerated organs of all animals are light and colourless; and I thought that a row of minute marginal specks, such as are usually called eyes in the vermes and molluscæ, was discernible. This proved no illusion, for, on the twenty-ninth of the month, they were distinctly

visible, of a jet black colour, seated in a pale ground. Other experiments corroborated the fact; whence, one characteristic of the species under discussion, is a row of numerous minute black specks or eyes, situate in the very margin of the anterior part. The same reserve in ascribing the faculty of vision to these specks, is as necessary in this instance as before; nor can we affirm, on denying them that peculiar province, that they are void of all analogy to spiracula, or organs connected with respiration. A subsequent examination of those planariæ just mentioned as a possible variety, shewed that the head is sometimes so light, as faintly to expose the site of the specks. Thus, if the genus is to be partitioned according to the presence or absence of eyes, the black planaria will be removed from the place hitherto assigned to it.

In the course of my earlier observations on this animal, many unsuccessful experiments were made to discover its food, which seems chiefly derived from the under sur-

face of aquatic plants in vigorous vegetation; and animal substances are likewise voraciously consumed.

The sexual union takes place with the black planaria, though rarely to be witnessed; nor had I complete conviction of the fact before August 1812, notwithstanding preceding incidents had led to such an inference. Long anterior to that period, I knew that this species propagated by eggs, which, for the most part, are laid by those of larger size, and usually in the course of autumn; but they may occasionally be found throughout the year, or obtained in winter by the more genial temperature of an apartment. No external characteristic distinguishes the male and female planaria, if there be actually a difference of sex between them: that which is represented here, produced an egg, which entitles it at least to the character of female; and what I supposed the male, was probably not quite so large. The egg is imbued by a yellowish viscous matter, attaching it to any twig

or straw selected for the deposit, or the side of the including vessel. It is of a perfect oval figure, of a dark brown or chocolate colour, provided with a hard shell, and in every respect exactly resembles a bird's egg in miniature. Those of the largest size, for great inequalities prevail, are about a tenth of an inch long; and one of this description is seen, somewhat magnified, Fig. 4. I cannot confidently affirm that more than a single egg is produced by each planaria; but each egg contains several young, of the palest grey, or almost white: their anatomical structure is then best disclosed, as they speedily darken by succeeding increment. Some, hatched in the second week of September, were deep grey on the fourth of October. The specks or eyes may be recognized at an early stage, by a magnifier, Fig. 5. which also exposes slight discrepancies in shape, between the young and the adult animal. A considerable interval elapses before exclusion of the young planaria; but observations on the

period seldom coincide. By the most recent, four were detected in the very act of issuing from the egg, on the eleventh of April, twenty-five days after it was laid: all lively, the marginal specks very distinct, but not of equal number. An egg of the same species was at the same time hatched in twenty-one days: but a fortnight later, a third of the like age was still entire. Therefore, the period required for exclusion, is to be calculated at twenty-one days, or longer; and it is certainly affected by the temperature of the atmosphere. The oviduct and relative organs appropriated for perpetuation of the species, are most likely situated in the second ventral pore: neither this nor the first is conspicuous in all planariæ; in many they are scarcely perceptible, and appear connected in some by a lighter line on the abdomen.

But, independent of propagating by eggs, the black planaria, from that indestructibility of life preserving it under mutilation, is privileged to multiply its species in pro-

portion to the violence offered to its otherwise delicate frame. It may almost be called immortal under the edge of the knife. Innumerable sections of the body all become complete and perfect animals: if the head be cut off, a new head replaces it: if the tail be severed, a new tail is acquired: nay, if one half of the whole animal be longitudinally separated from the other, the defective portion is speedily repaired.

A grand and leading law of nature is invariably to fulfil her original object; whence we must conclude, that the permanence of accidental lacerations, which we occasionally witness, results from some unknown condition opposing the progress of reproduction. In the artificial mutilations, whose advances can be watched, the period of renewal is strictly commensurate with the temperature of the atmosphere. Regeneration is retarded, or altogether suspended, by the cold of winter; promoted by the heat of summer; and still further accelerated by augmenting the natural

warmth of the air. A number of planariæ mutilated on the twentieth of January 1803, had become entire animals in the succeeding April: but all the new parts were of a lighter colour, which was long of approaching the sable hue of the old: and it may be questioned whether they ever grow equally dark as those regularly deepened by age. Thus we see a black head, with a light coloured tail; a dark body, with a white head; and one longitudinal half black as jet, while its corresponding portion is of clear grey. The elementary parts of all animals seem colourless: their future opacity is derived only from certain assimilations of extraneous substances, the atmospheric influence, or supervening rigidity of the parts. Pellucidity marks the rudiments of life: fishes are transparent on exclusion from the egg; insects are pale on leaving the chrysalis; their organs are infirm, and their senses obtuse. But scarce have they experienced the genial effects of the air, when their members expand, strength is acquired, and instinct becomes

active; all as the universal shade of the body darkens. Yet exposure to the atmosphere, unmixed with another fluid, is inevitable destruction to the planaria. If, chancing to wander beyond the confines of its native element, its endeavours to return be interrupted, it contracts and grows distorted, a kind of gluten issues from the whole body, and death speedily ensues. Should it be hastily removed, it may recover, and then the gluten comes off like a sheath, or integument, investing the body; but the transition must be immediate. Whether this substance be provided by nature, to avert the baneful effects of unguarded exposure, or exudes in consequence of the sufferings of the animal, is uncertain.

In the natural state, the planaria probably survives the cold of congelation; yet it perished during the course of an observation, where the thermometer stood at 26°, and where it was imbedded in a solid mass of ice. Perhaps the change was too sudden; for numerous societies dwell in shal-

low waters, affording an insecure retreat from the rigour of the atmosphere; nor are they diminished in succeeding seasons. The bodies of those which perish thus, are distorted, stiff, and invested by a very thick coating of gluten. In a few hours after solution of the ice, they become soft and relaxed, and are quickly decomposed.

Monstrosities sometimes occur in the black planaria, and frequent distortions from casual injury. In 1808, one was found with the tail bifid; a ventral pore appeared in each portion, both of which might be considered members of the same body. Accident may give birth to superfluous parts, as well as the skill of the experimentalist; but this species, perhaps from the energy of its reproductive powers, seems less adapted for acquiring them.

In addition to what has been said of varieties, we may observe, that a few are taken in places inhabited by the black planaria, of smaller size, the head rather more obtuse, and the tail suddenly drawing to-

wards a point; whereas it ordinarily forms a regular elliptical outline, unless when produced to an acute angle by extreme extension. Possibly, however, the difference may centre in the progress of reproduction, whereof the commencement has not been seen. Very minute dark or light grey planariæ sometimes dwell along with the rest, of which the tail is more acute in proportion than that of the larger ones. Three of these, a line and a half long, being subjected to the microscope, traversed the glass slider with great rapidity, much exceeding the usual progression of the black planaria. A scanty row of very dark specks environed the anterior margin; and the internal organisation was sensibly exposed through the gelatinous texture of the body. But a series of experiments would be required to entitle us to deny their identity with the young of the common species; first, because the accelerated motion might be excited, from the susceptibility of a small quantity of water, of an increased atmospherical

temperature; and secondly, from it not being improbable, that the number of marginal specks is augmented with age.

Superficial observation of such diversities only create embarrassment; for as the shades of distinction are fainter, there is the more difficulty in condescending on, or rejecting identity. The planaria, Proteus like, incessantly assumes a variety of forms and appearances, which, without due and careful appreciation, will lead the naturalist farther and farther from the truth.

Planaria Panniculata, Fig. 6. 7. There is a species of planaria, narrowly resembling the former in size and figure, but different in colour, and frequenting different aquatic plants, on which it always appears as having enjoyed a copious supply of food. When recently taken, it is of a flattish semi-cylindrical shape; the head forms an obtuse triangular outline, and is smaller than the body; and the neck is smaller than the head. The whole animal is of a deep dusky brown,

so dark, as in some individuals to approach to black; and on accurate examination, it proves to arise from short black lines in a lighter ground. Many of these planariæ are distinguished by one or more large irregular patches of white, either above or below, and at times traversing the entire substance to both surfaces. This, however, is not a universal characteristic, and when at either extremity, may readily be taken, by inexperienced observers, for regenerating parts. A broad dark line below, apparently denoting the site of an intestine, proceeds from the origin of the head to the second ventral pore, which, as well as that above it, is extremely conspicuous; but, as has already been stated with respect to the preceding species, neither orifice is equally displayed at every season. The verge of the anterior extremity is environed by a row of most minute black specks, or eyes, scarce discernible by a magnifier of moderate power. One of the planariæ having occurred with the patch so situated as to

engross a number within its limits, admitted of their inspection by the microscope; and, when greatly enlarged, they exhibited an irregular figure, and uncommon inequality of size.

This planaria is not one hundredth part so common as the former, in places to which I have had access, perhaps from its favourite plants being rare; and I remember when pursuing such investigations, that, in a certain pool where the black planaria was numerous, it never occurred among them, though occasionally found in their joint aquatic abode at some little distance. But there the plants in question vegetated.

The planaria panniculata receives animal substances with less avidity than most other species, and seems more liable to decline in bulk, when removed to an apartment. Its proboscis is of singular length, and exactly trumpet-shaped at the extremity. Probably leaves are punctured by it to extract nutritious matter.

This species is also akin to the former,

in propagating by eggs; from which, according to experiments made in the month of September, the young were excluded exactly in twenty-one days. The eggs are deposited on leaves; and the plexus of the common marsh iris prove a favourite receptacle, where the vicinity of the plant admits of it. These eggs are originally of a light colour, which speedily darkens with exposure, until becoming brown, but not so deep as that of the eggs of the black planaria. Applied to the microscope, each is discovered to be an exact ovoid, of the most perfect and regular figure, with a smooth shining shell. I have not ascertained whether more than one is produced by an individual planaria; but the number of included young varies in different eggs, and they are, compared with others, of large dimensions at the moment of exclusion. Four young issued from one egg, while from another only a single animal, uncommonly large, was hatched. At first they are almost white to the naked eye;

nevertheless pinnate interanea are perceptible by the microscope, which renders it probable that a nutritious substance is there received. The colour daily alters, and in the lapse of three weeks from their origin, some whose progressive increment had been studied, were changed to brown. About twenty marginal specks were visible in the earliest stage.

The planaria panniculata is rather more inactive than the rest. Penetrating the folds and recesses of decaying vegetables, it lurks entire days in absolute immobility. In common with its kind, it is liable to the attack of a disease which always proves fatal, and extirpates numbers, almost before the observer becomes aware of its ravages. A swelling commences at the posterior extremity, which rapidly ascends to the head, destroying the texture of every part in its advances; and the whole animal is suddenly resolved into a kind of whitish flocculent matter.

Planaria Felina, Fig. 8. Hitherto our attention has principally been occupied by those facts in the general nature of planariæ, which irresistibly obtrude themselves on observation; and although they cannot be denied singularity, they do not seem far removed from the common operations of animal physiology. Now, however, a species claims animadversion, possessing peculiar and exclusive properties, and such as are deemed anomalous in the ordinary features of Zoology. But let us not abuse the meaning of these expressions. It would be presumptuous to affirm, that what is *ordinary* in nature, is comprehended by the mind; or that what is of rare occurrence may not even be more easily susceptible of explanation. We are deluded by frequent appearances into the belief of knowledge, and long before being able to reason satisfactorily concerning them, we are attracted to what is judged remarkable, merely because it has not been perpetually in view.

In still or stagnant waters, for the most

part abounding with aquatic vegetables, and rarely in springs, there is found a dark brown planaria, of uniform colour, which attains considerable size. The largest which I have seen, were at least five-eighths of an inch in length, and somewhat less than one in breadth; but in general they are smaller, perhaps not above one in a thousand being of these dimensions. The colour is lighter than that of the *panniculata*, but some are of a dull, dark, dirty brown.

The figure of the animal differs from that of the two former species; therefore, if we are to found on slight external discrepancies, a division of the genus may be made, including it, and others of similar organization, particularly with regard to the specks or eyes. By this latter characteristic, it is distinguished from the two subsequent species, to which it is allied by shape, and united to the two preceding. A short triangular tentaculum, or feeler, terminates each side of the head, susceptible of such contraction and dilatation, as absolutely to disappear or

be extended to a point. When fully displayed, the tentacula bear no imperfect resemblance to the ears of a cat. The neck, which is narrower than the head, gradually enlarges downwards, until the extreme breadth of the animal is attained, and then a regular diminution ensues, terminating in a pointed tail. In the under surface, which is paler than the upper, one ventral pore can with difficulty be recognised; but the vicinity of an important organ, the proboscis, is usually indicated by an elliptical spot, clearer than the general hue.

By microscopical observation, or even with acute vision, here also a numerous row of jet black specks may be discovered, environing the anterior margin, and proceeding about half down the body on either side. Their number varies in different individuals; sometimes they are nearly equidistant, sometimes irregularly arranged, or two appear quite close, and almost confounded together. I have counted between thirty and forty in several; and the margin

of a very minute planaria, subjected to the microscope, disclosed twenty-four. The real purpose of these characteristics, I have not been more successful in establishing, than their use in other species. But it may, perhaps, be less difficult to institute a series of experiments with that view on the felina, than on those planariæ where they are not equally conspicuous.

Protected by its native element, the planaria felina reposes inactive on the inner surface of aquatic plants, on fragments of decaying wood, or the under part of stones. It can with difficulty be dislodged from crevices where it takes up its abode, pertinaciously adhering to different substances, until removed by a soft feather, or washed off by repeated immersion in water. The societies in which it lives, include those of every age; and should the fluid containing them accidentally evaporate, all appear crowded together, contracted into a small regular ellipse. If a number be confined in a glass vessel, the whole

assemble in a quiescent state, on the side next the light. Some others, which naturalists have classed in the genus, repose on the side opposite the light;—so decided are the characters which regulate the disposition of animals.

This planaria, like the rest of its genus, is powerfully excited to motion by the presence of light. Then it traverses the sides of its glass with a lively gliding progression, or swims supine at the surface of the water; but neither it, nor any which I have seen, except the flexilis, ventures to commit itself entirely to that element. If dropping from the surface to the bottom, which is a characteristic of all this and the next division of the genus, it seems to exercise a faculty belonging to the caterpillar, of spinning a silken thread, visible only when so much aggregated as to interrupt the rays of light. Its use is evidently to check the rapidity of descent; and a complete view of its effect may be obtained by including a plant of Veronica, crowded with

planariæ, within a tall glass jar. Their numerous descents from the upper leaves, quickly form a perceptible column, owing to the infinity of glutinous or silken lines. The animal being extremely sensible of cold, a considerable temperature is required to promote its activity. On the seventh of August 1812, though the thermometer in the heat of the day stood at 62°, a certain chilness from a breeze at east pervaded the air, which led planariæ to retreat under stones for shelter.

The mucilaginous part of decaying vegetables probably constitutes the ordinary food of this species; but animal substances are also voraciously consumed, especially the soft and bloody portions. Mussels and oysters are peculiarly grateful; and after feeding copiously, the whole body of the planaria rises from a flattened form almost into a semi-cylindrical shape. In this condition, its various proportions are best exposed, in consequence of the universal organization being expanded. Sometimes,

in conformity with others, it refuses food for weeks, and then receives it with avidity. However, its usual readiness to feed, renders it the most favourable subject of all for experiment and observation.

These circumstances, which are a sufficient guide to recognition of the animal, being premised, we have next to consider certain admirable phenomena by which it is more eminently distinguished.

Though I have possessed hundreds of the planaria felina at every season of the year, I am ignorant whether its propagation results from the sexual union, and whether it multiplies by eggs or living fœtuses. I have anxiously investigated the point; but no experiments have had a satisfactory issue, nor has any circumstance whatever, either immediate or remote, tended to the most distant elucidation of it. Once, indeed, I thought that some minute, whitish, elliptical bodies, which afterwards disappeared, were discernible at the bottom of a vessel in October 1811. Nothing followed,

however, and the like never recurred. Yet I confess myself inclined to believe that these planariæ are perpetuated by eggs, notwithstanding I have not been fortunate enough to obtain the parent animals at the proper period, or to seize the moment of production.

On removing a quantity of plants frequented by this species into a glass jar, and filling it with water, the observer will soon discover many planariæ, complete and perfect in all their parts, vivaciously traversing the sides of the vessel. But others he will also distinguish, exhibiting strange and unseemly mutilations. The tip of the tail, or a large portion of the body, is wanting; the structure of the head itself is impaired; distorted stumps are united to regular organs, and the colour of one part apparently denies its continuity with another. In repeating his examination, the observer will next find several shapeless fragments, unlike any thing he has previously beheld, adhering motionless to the bottom and sides

of the glass; and although he watches them whole days, he will scarce be sensible of their animation. The defective configuration of the animals bears so little relation to those entire, as to afford strong grounds for doubting their identity with the species; and, assuredly, except in the general hue, in the similarity of motion, and in a triangular head armed with tentacula, scarce the faintest resemblance exists. All this, however, is the consequence of an important operation, by which nature is engaged in perpetuating the race. Spontaneous division of the body has taken place; each separated portion is in its progress to perfection as a complete animal, and either extremity is in the course of repairing what it has lost.

The majority of the mollusca tribe, perhaps the whole with which we are acquainted, as also the numerous vermicular race, propagate only at certain seasons of the year, and most commonly after the summer heats have declined. But the spon-

taneous separation of parts ensues at all times with these planariæ; in every situation, and indifferently, whether the individuals be large or small. Having confined four on the third of November 1810, I remarked on the ninth and tenth, that two of them had lost a fragment at the extremity of the tail. Some were taken on the thirteenth of January 1811, which, about a week afterwards, shewed defective organs. Numerous spontaneous divisions appeared among those removed from the waters during the September succeeding; and an opportunity occurred of remarking the like throughout the month of August 1812.

There seems no exact rule or limitation, in respect to the quantity separating. Sometimes it is a minute fragment; sometimes as much as leaves the proboscis exposed, or towards a third of the body. The largest portions are always heart-shaped, and opaque, both from size and consistence; thus obscuring the interior, if any thing is

there to be discovered. A portion delineated soon after separation, is represented somewhat magnified, Fig. 9. which, subsequently, became a perfect animal. But the paleness of the lower extremity denotes that a previous disjunction, though then completely repaired, had taken place. Among those observed in August, one had lost the head, either by accident or spontaneous division: while an oblique section had carried away nearly the whole anterior part of another. Only the point of a tentaculum remained. From this and various examples better illustrated, separation is not peculiar to the posterior extremity. It can as little be ascertained that there is any previous preparation for division. No indications are betrayed; and in so far as I have witnessed, it takes place just as an ordinary incident in the animal's existence. But there is a material difference in the consequent state of the two severed portions. The anterior part scarce seems to suffer from its loss; while the fragment

disjoined is condemned to absolute quiescence. The life, habits, and motion of the former, are unimpaired; whereas nothing, unless a painful sensation, can stimulate the latter to a mere change of position. Its animation is as if suspended, until the defective organs be renewed. When inspecting one of these animals on a summer evening, I saw the head separate from the body, without any apparent struggle, and crawl away. And at another time, when exhibiting to a friend the remarkable mode in which the creature feeds, a portion of the tail was detached, while in the act of simple extension. The remainder did not seem in the least affected; and the sustenance provided was readily received. It must be admitted, however, that more rigid observation might discern some obscure anticipation of division, though such has not fallen under my notice.

Notwithstanding the absolute quiescence of the severed fragment, an essential process is going on. From the moment of se-

paration, a new head prepares to vegetate from before; and all the subordinate organs are successively developed. But during its advances to perfection, this regenerating animal cannot be known to pertain to its proper species; and on slight, nay, on attentive inspection, no one would hesitate in pronouncing it different. The vacuity that formed the recess of the heart is soon filled up by a reproducing substance, from which a clear light-coloured papilla next arises, and gradually protrudes into a long slender organ, while the general shape and size of the original fragment are retained. Thus a clumsy and distorted animal is presented, equally remote from the parent whole, from the portion detached, and from the figure which it will ultimately attain. But in progress of time, the diameter of the body decreases; the regenerating protrusion is enlarged; its extremity is fashioned into a head; the eyes and tentacula appear; all the parts are bounded by a regular outline;—a perfect animal is

produced. Such, in few words, is the mode in which the simple renewal of organs is accomplished. Along with their redintegration, quiescence is abandoned, the necessities of the creature return; it vivaciously traverses its element, alternately feeds and reposes, and at length exhibits every property of the entire animal, whereof it so lately formed a shapeless fragment. Again it must, in its turn, lose a portion, which undergoes similar transitions from immobility to action, from rudeness to perfection; and then, what originally constituted part of the organization of the parent, is transmuted into two complete and entire animals.

In regard to the mutilated trunk, a similar operation, though marked by fewer singularities, is going on. The wound heals; a prominence buds forth, which, by degrees, is prolonged into a well-defined regular tail, of lighter colour than the rest of the body. The reproduction is fulfilled, and the animal resumes its integrity.

This kind of regeneration seems universally diffused among the species; most of those, removed from their native abode, unequivocally shew the acquisition of the posterior extremity. But these facts merit more explicit detail.

On the tenth of November 1810, a small fragment was detached from the tail of each of two planariæ. Next day, as sometimes happens, they had removed from the spot of separation, to await in quiescence the exercise of their reproductive powers: which were not slow of being unfolded. On the twenty-second of the month, both had acquired complete heads, and were vigorously traversing every part of their element; though still very small, being hardly one-fifth of the size of the original animals. The regeneration of each defective trunk was likewise now so fully accomplished, that it could with difficulty be known which of the planariæ, compared with others, had lost the fragments. The new animals had at that time resumed their

pristine motion; but their figure had none of its proper proportions; nor was it before the twenty-eighth of November, or eighteen days from separation, that it could be called regular and well defined, and resembling the shape of unmutilated planariæ. Their size was always inconsiderable; and if ever a portion thus sundered by the hand of Nature grows as large as the trunk which has lost it, I can affirm that it is not in a state of confinement.

Probably a fragment successively separates as the new tail is completed; a fact which deserves investigation, as elucidating the great extent of generation by spontaneous division. The mutilated trunk seems as well adapted for reproduction after losing its extremity, as when entire.

Many may perhaps conceive, that the defective organs exist in miniature in the severed portions; and that dissection, aided by powerful magnifiers, might bring them into view. It would be hardy to maintain an opposite doctrine; for extreme

delicacy in separating the component parts, and the nicest observation in other cases, have detected those rudiments of organization, which are wont to be exposed only in the perfect state. Here the like evolution succeeds; but the experiment seems beyond human ability. Microscopical observation discovers nothing more in the separated fragments, than what unassisted vision has seen. There is no indication of specks or tentacula: no symptom of an aperture for the protrusion of the future proboscis. The anterior not being reduced to an edge, remains of considerable thickness; it is smooth, even, and resembles a piece of flesh divided by a sharp knife.

It has before been explained, that all animal reproductions being materially influenced by the heat of the atmosphere, the renewal of defective parts is accelerated or retarded accordingly. Some fragments, therefore, are perfected earlier than others; but increment advances even where the temperature is low. It would be interest-

ing to institute a series of experiments, for the purpose of ascertaining the relative progress of regeneration, during a variety in the permanence of temperature. Is every kind of vegetation, both in plants and animals, accomplished by the same quantum of heat, though unequally distributed with respect to time? Will 800° applied in ten days, at the rate of 80° daily, have the like effect in renewing the defective organs of a planaria, as 800° continued for twenty days, at the rate of 40°? Two points would necessarily be kept in view; first, the degree of cold when vegetation cannot advance; secondly, the degree of heat injurious to the species. It appears to me, that planariæ soon begin to suffer. One which had been exposed to the heat of 99° survived; but higher degrees seem fatal. The success of the experiment would thus depend on chusing a proper medium.

If this be the sole and natural mode of propagation among planariæ, it presents a

phenomenon in the history of the animal creation. I have, as already said, kept hundreds of the species in question, at every season of the year, and subject to almost every condition, yet none other has at any time been witnessed; and, so far as my observations go, no individuals are exempt from dismemberment of the body. It succeeds alike in the large and small, whether abstinence or repletion prevails; and as well with those extenuated, as when copiously supplied with nutriment; in a state of liberty, and one of confinement. Still, this is not enough to deny, that the race may be also perpetuated by the ordinary means which nature has chosen for the preservation of animals. Possibly the fact is already proved by authors, with whose works I am unacquainted. The knowledge of man is scanty; his understanding is imperfect: and the humble enquiries of one may long be directed in vain, to what the more brilliant talents of another conquer without difficulty.

Propagation by spontaneous division into parts, and the subsequent evolution of wanting organs, are not altogether unexampled. Among creatures which almost elude human research, the Animalculæ of infusions, there are certain species that partition asunder, and each of two severed portions quickly becomes a perfect whole. Others separating into more numerous parts, give birth to so many animals resembling themselves; and the young of the polypus buds like a scion from its mother's side. But observations on the progress of animalcular generation are embarrassing to the physiologist. He must resort to the highest magnifiers to reach what his simple vision cannot penetrate; and he will too often feel dissatisfaction instead of confidence from his investigations. The nascent polypus is not independent of its parent; its sustenance is thence derived; its locomotion is the result of will in common; and its incorporation is complete, until expanding organs admit of separation. Here, on the

contrary, spontaneous division succeeds in animals, a thousand, nay, a million times exceeding the inhabitants of infusions in size; of which the parts and proportions being visible to the naked eye, contribute to the dissipation of doubts, and display in detail the progress of regeneration. Besides, the severed portion, condemned to quiescence, and destitute of alimentary organs, survives independent of the mutilated trunk, until their evolution follows by the regular and gradual operation of nature.

Such remarkable phenomena, incessantly offered to my notice, afforded ample scope for speculation. If these animals, I began to reflect, be endowed with so powerful a reproductive principle, it is not impossible that some singular and interesting monstrosities may be obtained by artificial means; and my confidence in its practicability was corroborated, by having occasionally found deviations from the ordinary figure in the natural state. One of those was truly wonderful. The planaria itself, in relation to

others, was of small size; its tail was bifid, and out of the cleft grew a body, quite separate and distinct from the main trunk of the animal, and preserving an erect posture, while the two tails were applied to the plane of position below. In reasoning from simple appearances, two conclusions might be deduced: first, that the posterior extremity of this planaria had been accidentally cleft into three parts, but all having separated by spontaneous division, only two were renewed by the ordinary course of reproduction; and the third, situate between them, had, by some strange and anomalous process, been developed into a body, surmounted by a head, smaller than the principal body, indeed, but lively and well defined. Secondly, if the parts had not been cleft asunder by accident, so as to give birth to this inexplicable renewal, the peculiarity could probably be ascribed to an original monstrous conformation of the germ, or fœtus, whether expanding in an egg or in the bo-

dy of the parent, if such modes of propagation belong to planariæ.

Unequivocal symptoms demonstrated, that the inclinations of the superfluous head were not always in unison with those of the remainder of the animal; that it preferred quiescence, when they chose motion; and that it would willingly have traversed its element, could its strength have predominated over the inactivity of the major parts.

In subjecting this planaria to the microscope, the preceding phenomena were still more clearly illustrated. Numerous black specks, the supposed eyes, or spiracula, appeared surrounding the larger head; some were disseminated over the upper surface; and they environed the margin of the smaller head also.

In the course of a week, or little more, after the planaria had been taken, which was in the heat of summer, the posterior head had separated by spontaneous division from the principal body, and had disappear-

ed. But soon afterwards, a kind of projection occupied its place; and it was not without amazement, that I beheld this projection vegetate into a new head, resembling the one which had been lost. About a month having elapsed, it was well shaped and entire; marginal specks were perceptible by the aid of the microscope; and, like its precursor, it shewed a tendency to motions different from those of the rest of the body. In about three weeks more, this secondary trunk was so large, as to constitute rather above a third of what an animal of corresponding proportions, in the natural state, should have been. Then, instead of following its own will by crawling along the bottom of the including vessel, it was frequently seen bending in a curve over the plane of position, while carried along with the other parts, whose propensities it was incapable of resisting.

The monster now described, having thus been provided with three different heads, fed copiously, and lived several months in

my possession. Its reproductions are particularly to be admired, because I observed one of the same species, with a bifid tail, lose both parts by spontaneous division; and although each fragment acquired a new head, and became perfect in its kind, the mutilated trunk regenerated only a single new extremity.

These circumstances contributed still further to corroborate my belief in the probable effect of experiment. They proved that superfluous organs, however they originated, might exist, without injury to planariæ. Therefore, if separating parts became complete animals; if a mutilated trunk regained the defective portion; and if a head, the most important of all organs, was evolved from every inconsiderable fragment, it was reasonable to conclude, that, by some particular operation, supernumerary parts might be produced. Yet it was long before reiterated trials were rewarded with success, and I had almost determined to abandon the enquiry, conceiving that a cer-

tain nicety, of which I was not master, should be practised: and that it had been beyond my ability to detect the secret cause of failure.

But the powerful reproductive principle which continually vegetates upwards, the invariable acquisition of a head by the neck from which it is severed, added to a similar production in spontaneous division, gave ground for conjecture, that if part only of an incision healed, some generation still upwards would ensue. On the other hand, should the whole incision heal, matters would remain entire. It was also most likely, that the regenerating portion would become a head, and that more than one might thus be produced on the same animal.

With this view, an incision, considerably lower than the head, was made in three planariæ, on the twenty-eighth of September. It completely healed in two, and the animals appeared almost as if untouched. One of them survived above a year,

when nothing except the slightest indication of a scar was perceptible. But with regard to the third, it was evident, after a certain period, that the lower part of the incision had not healed, as in the others. An unnatural prominence interrupted the general contour of the side, which continued protruding into something unlike any organization peculiar to planariæ. Its progress advanced; the outline was more and more impaired, and at length, about the twenty-fifth of October, nearly four weeks after the operation, the superfluous reproduction was clearly recognized to be the rudiments of a new head. The order of the experiment, however, was now disturbed; for the original head had separated close to the neck, by spontaneous division, and remained independent of it. A doubt might thence have arose,—would the new and superfluous organ springing from the under part of the incision, supply the place of that which had just been lost, or would a head, the third in number, including the

one artificially produced, vegetate from the mutilated neck, to restore the integrity of the planaria? I certainly did anticipate that such would be the case, because the principal end of reproduction is to repair wanting parts, that the animal economy may be preserved entire; and so in fact it happened.

On the eighteenth of November, the operation of Nature was fully accomplished; a new and perfect body, crowned by a head, had grown out of the side of the parent animal, distant about two-thirds of the total length from the extremity of the tail. Marginal specks, the eyes or spiracula, were quite perceptible on the twenty-second; the superfluous organization was complete and well defined, and its increment continued still advancing. Though provided with only one proboscis, both bodies were immediately enlarged by the absorption of food, which plainly proved nutritious.

I could not contemplate this creature

without admiration, heightened, perhaps, by the difficulties that had been surmounted in its production. The order of nature had been disturbed; something which was not essential to preserve the animal functions had been generated; and a being now appeared, to whose existence the laws of organization were adverse. Reproductions are permitted, indeed, to some favoured animals; but they are only for the purpose of supplying parts originally perfect, and they seldom, if ever, attain the utmost limits at first assigned. As supernumerary organs are unnecessary in fulfilling the ends of creation, it may be conjectured, that they can never appear without some malconformation in the rudiments of an animal; from some violence, which displaces one part, represses its expansion, or admits its union with another; and the same may be accomplished by the injuries of disease. Here the planaria first lost its head by spontaneous division, a phenomenon peculiar to the race; next a new one had

been evolved from an incision in the side; and lastly, though this would have restored the integrity of the animal, the separated head was replaced by that law which ordains the renewal of a wanting part.

Though the sensorium of the animal world be more pre-eminently distinguished in the head, we cannot altogether reject its universal diffusion, to a certain degree, throughout the body. What was before remarked, concerning the different condition between a separating fragment and the trunk it had left provided with a head, probably establishes the residence of the sensorium, however low in quality, proper to planariæ. The truth was forcibly impressed by the propensities of this double-headed animal, coinciding with those of the monster already described. Sometimes when the body was in motion, the new organ advanced as if in willing participation: but on other occasions, it was reluctantly dragged along. Then, instead of preserving the same direction as the rest, it bent

into a curve, and abandoned the plane of position. Yet it was always subservient to what properly constituted the parent whole; that being the consequence of its subordinate size.

In the subsequent months of December and January, the three portions composing the total animal, namely, the two heads and the tail, were nearly of equal length, which created no little embarrassment in its progression. When the inclinations of any two were in unison, they overpowered the resistance of the third, which could only disturb the regularity of their course.

Experiments of a similar description having been repeated on the thirtieth of October 1811, several years after my attention had been first directed to the subject, they proved abortive for the most part, or the planariæ perished. But on the twenty-fourth of November, I observed a minute head vegetating from the side of each of two that survived. One inclined considerably downwards, in the direction of the tail; the an-

terior angle formed by the body, or rather between the bodies of the other, was more acute. The relation of the generating parts, nevertheless, always gained greater uniformity with the general outline and figure of a planaria in the natural state. As their dimensions continued to enlarge, their action became more lively and distinct, and soon corresponded with the external properties of an entire unmutilated animal.

A head thus protruding from the left side of a planaria artificially rendered monstrous, is represented, according to its real increment on the tenth of December, or about six weeks after the operation, Fig. 10. Its growth, it is true, continued long afterwards, and until very nearly equalling the size of its fellow; but the apprehension of accident, to which the tender substance of such creatures is so much exposed, induced me to obtain this premature delineation.

It is therefore proved beyond controversy, that an incision in the side of the planaria felina, executed in a particular manner,

will generally, if not invariably, give birth to a new and additional body, which, in progress of time, approaches the dimensions of the integral animal, and exhibits the same functions and properties by which it is distinguished.

Where the chief object has a partial failure, other gradations of monstrosity are unfolded, which undergo successive alterations. In watching the result of an experiment, I saw two rude and mis-shapen heads, united close by the neck, protrude from a severed fragment, which had once constituted the posterior part of a planaria. The fragment bore an imperfect resemblance to a circular arc; whence its motion, instead of being in a direct line, described irregular curves. Five weeks after this remark, the regeneration of the two heads, still in intimate union, was completed, but the distortion of the body remained. However, a greater interval having elapsed, the whole grew into shape. The two heads were then seen farther apart:

each had acquired a longer neck; the body was taper and well-defined, pursuing a smooth and gliding progression, like that of a planaria which had never suffered mutilation.

Hitherto the source of generation has been veiled in impenetrable mystery. The universe changes its tenants in endless succession: scarce is the parent mature, when it is supplanted by its offspring, and still the origin of both is lost in obscurity. No lucid reasoning aids the philosopher; no delicacy of experiment leads to conviction. Nature seems to have willed, that the means by which animation is excited, preserved, and transmitted, shall not be disclosed. But is it wonderful, that the vigorous industry of the human mind should have been so unsuccessful here? Let us remember that the most ordinary incidents, those of constant recurrence, and which are ever patent to view, remain unexplained, or that an ill-judged anxiety has substituted conjecture for truth.

Our difficulties are not lessened by the phenomena which just have been exposed. Whence does it follow, that when either an accidental or an artificial incision in the side of a planaria is sufficiently large, a superfluous body must shoot forth, while, if the lacerated parts approach, those organs, which would have protruded, to become separate and distinct, are merged in the general whole? Is there a universal diffusion of germs, or the elementary principles of living matter always in readiness for developement, each moment that opportunity shall admit? Yet nature does seem to labour more, and her powers to experience greater difficulty, in accomplishing this kind of reproduction, than in the renewal of organs lost by spontaneous separation. Apparently, few conditions are requisite for the one; it is enough that the division have taken place, and that a certain temperature of the atmosphere shall succeed: but for the other, some essential and secret quality is indispensible, to which we know that

the union of the lacerated parts will prove fatal. To the rest there is no clue whatever. In simple privation of the head, we are more easily reconciled to conjectures on the cause of it being replaced, from the efforts of nature to supply a defective part; but it is difficult to comprehend, why, in experiments for the production of superfluous organs, it is only the anterior, and never the posterior portion which protrudes, that the upper division of the laceration produces nothing.

In pursuing these remarks, we may affirm, that there is perhaps a certain point of the body where a head ceases to vegetate upwards, and whence a tail will vegetate down. It would be interesting to ascertain where that point is placed, and whether it may not be connected with some organic structure, which will tend to elucidate the cause of monstrosities. My own experiments regarding the fact have not been conclusive; probably from being too few in number, or too little diversified. A

prominence growing from the side of a planaria a long time, that is, months after an operation, resembled the stump of a tail. The termination was acute, and there were no tentacula, by which the anterior is always characterised; but marginal specks, which, if regular, also distinguish the head, appeared, and its movements were more active than belongs to the subservient quiescence of the lower extremity. Thus it was seen on the eighth of February, while it was a mere stump on the first of December preceding. Perhaps the operation here took place very near the spot from whence either a head or a tail would proceed; or almost in that manner which may give birth to either. However, had the animal lived, I was induced to think, that the more probable issue would have been the former; consequently, that the incision was somewhat higher than the position of the point in question.

I remember, that after another experiment made on the twenty-eighth of Sep-

tember, a projection perceptibly vegetated from the side of a planaria in the end of the subsequent month. The animal fed abundantly, and on the tenth of December I was sensible that it was about to become a head. These reproductions of uncertain issue are longer of demonstrating their real character, than those which, from an early stage, leave no opportunity for doubt: the one is completed before the other assumes its leading features. They are not totally dependent on the art of the experimentalist; though examples in the natural state are extremely rare. In the first week of August 1812, I took a number of planariæ. Some time afterwards, my attention was attracted by the protrusion of an organic substance from within about a third of the posterior extremity of one of them, which, as it enlarged, exhibited active motions and inclinations, resembling those, as in the former case, proper to the anterior portion. Circumstances compelled me to abandon my observations, by which I was then led to

conjecture, that the production would be analogous to a head. Such regenerations, for the most part, bear a general cast and appearance which guide to anticipations of their ultimate issue, and my belief was founded on what I had previously beheld; for although analogical reasoning is not to be trusted, if single and unsupported, still, when combined with a series of facts, all uniform, clear, and distinct, it is impossible to reject it in our conclusions of events. Being unexpectedly enabled to resume inspection of the planaria now alluded to, I discovered that my conjecture had not been altogether fallacious. The origin of the protrusion on the eighth of September was rather more than half way down the side; the whole anterior part was surrounded by specks or stigmata, and still greater activity testified in its movements. Nature was evidently labouring in the production of a head, though tentacula were wanting: and if another unseasonable interruption had not taken place on the fifteenth of the same month, I should

probably soon have witnessed the further advance of that organ to perfection.

It is thence to be concluded, that wherever a strong tendency to action is displayed by a shapeless reproduction or vegetation from an entire planaria, an organ, the most important to all animals, the head, will finally be developed.

Doubts frequently occurred, whether a duplication of the tail would invariably be produced by an incision towards its extremity. Notwithstanding such seems to be the general law of nature, anomalies here bewilder the observer. In one planaria, the portion generated was much longer than the original tail; it was endowed with more activity than is peculiar to that organ, and, as in the former instance, its motions had greater similarity to those of a head. No marginal specks appeared. Another experiment of this kind was made on the twenty-seventh of November 1811. A new extremity accordingly protruded; but about the eleventh of February 1812, the origi-

nal tail separated by spontaneous division. It might have been expected, that the other, which seemed capable of fulfilling all the organic functions, would have effected the purposes of nature; nevertheless a reproduction of the first extremity ensued.

A monstrosity of a very extraordinary kind occurred just about the close of my whole observations on planariæ. On the thirtieth of March, I took between thirty and forty of the species, two of which exhibited some peculiarity at the very termination of the tail; there seemed to be an unnatural redundance of organization. A few days after, on inspecting one of them, I was surprised to see this deformity consist of a minute animal, in progress to complete regeneration, attached to the extremity by a slender ligament. Its head was pale, not perfectly shaped, but the marginal specks were perceptible; and its position, when at freedom, was almost at right angles to the larger planaria. How had the creature been formed? Probably an

accidental injury had severed a fragment of the original tail from the body, all except the slight ligament by which the nascent planaria was now connected to it. The reproductive operation ensued; a new head vegetated from the anterior part; while the clearness of the tail of the larger animal proved it to have regenerated from a wound. In time, however, and as the young planaria gained greater strength, it was to be anticipated, that its forcible adhesion to the plane of position would tear asunder the ligament. Its shape was nearly entire on the ninth of April, and it had visibly begun to exert that faculty. The second monstrosity consisted of a planaria, whose posterior extremity terminated in another smaller animal, united at right angles to it, and what seemed the tail of the latter protruded from the right side: thus the larger planaria, properly speaking, had no tail, or it merged in the body of the other.

The source of monstrosity is an abstruse

and difficult enquiry; less so, however, in endeavouring to understand how the original superfluities or imperfections of organization appear, than the subsequent redundancy of parts. Assuming that the elements of the future animal pre-exist fecundation, and are perfect, it is more easy to comprehend how excoriations in an early stage of life may admit such a union from the powerful tendency of animated matter to vegetation, as to produce monstrosity by excess; and as the whole aberrations of nature are perhaps reducible to two divisions only, we can in like manner conjecture how an injury to some unfolding organic principle shall repress its completion, and occasion monstrosity by defect. We can also ascribe the renewal of parts to that law which strives to maintain the integrity of an animal, and preserve to it the means of carrying on functions necessary to its existence, though it be unaccountable why the reproduction never exceeds the proper limits.

All this, however, will prove of little assistance in explaining how monstrosities by excess are artificially produced, while we should rather conclude that they ought to terminate in defect.

Planaria Arethusa, Fig. 11, 12, 13, 14. Naturalists have affirmed that some planariæ are entirely destitute of any semblance to eyes; an opinion which, in one well-known species, we have proved to be fallacious, and possibly it might be found equally so respecting all others, or almost all, were they rigorously examined. Reflecting on the transcendant privileges which a sense of inestimable value confers, we shall cease to wonder at the solicitude of physiologists to ascertain whether it has been dispensed with in the structure of the smaller animals.

But there are various planariæ whose visual organs are better characterised, both in site and appearance, than by clusters of specks on the upper surface, as in the Flex-

ilis, or by their numerous dispersion singly around the margin of the Nigra, Panniculata, or Felina. Two specks, as if in orbits, occupying the middle of the neck, or four distributed in a regular quadrangle in the vicinity of the head, seem to denote a special purpose relative to external objects. In nothing is there greater diversity than in the disposal, power, and faculties of the organs of vision among the inhabitants of the air, the earth, or the waters. They are adapted either to aid the discovery and capture of prey, to shun the enemies of the race, or to that peculiar medium in which their natural dwelling has been assigned.

In the years 1802 and 1803, a planaria occurred to me of this description, which was then the subject of diversified experiments. But when desirous of repeating them more recently, I found that it had altogether disappeared from its wonted abode; and being unable to discover it elsewhere, a section, once designed for its history as the planaria *rufa*, shall now be suppressed, especially as

no delineation of it was obtained at the time. I may just observe, that in figure, colour, and position of the eyes, it seemed closely allied to the *Planaria auriculata* of Muller, described and represented in the *Zoologia Danica*, vol. ii. page 37. Plate lxviii. Figs. 16, 17. The latter, however, was scarcely perceptible by the naked eye, and an inhabitant of the sea; whereas mine dwelt in fresh water, and nearly approached the former species in size.

The sudden disappearance of animals without any sensible cause, is not unexampled. I have witnessed it myself among the smaller tribes; and the same is recorded by the most celebrated naturalists. There are reiterated proofs that those of gigantic proportions have become extinct; and it is probable that others are daily vanishing from the surface of the earth, which none excepting hybrids can be said to replace. Several sources, equally effectual, may contribute to the extirpation of animals; the preponderance of enemies, cessation of the

accustomed food, or the ravages of disease; and it is not unlikely that some fatal attack, such as that which resolves the planaria panniculata into a flocculent substance, has eradicated many of the kindred species.

In three pure springs, and also at the bursting of a very faint discharge from the ground, I have obtained a planaria in certain respects analogous, which I never observed in stagnant waters. Above, it is generally of a leaden grey, deeper in proportion to its size; the under part is pale, with a line of different hue, proceeding from the origin of the head to within a third of the opposite extremity, which denotes the site of a large intestine. Its figure is more slender and delicate than that of any of the other fresh water species here described; flattish like them when in a state of abstinence, and forming the segment of a cylinder if feeding copiously. It is about half an inch long, and the twelfth part of an inch in breadth:

and is further characterised by being provided with two eyes.

On the seventeenth of September 1809, I took between twenty and thirty of these animals, the larger four or five lines in length, and of the usual colour; but the smaller of a lighter shade, and some even whitish. The diversity of hue excited embarrassment concerning the identity of the latter with the species: Nor was this removed by taking a number of the same planariæ, in the course of the succeeding year, among which were several almost white, though exactly similar to the rest in size and proportions, while they were too large to be considered young. Further observations have shewn, that there is little restriction with respect to size, some being seen thus distinguished, which, if not equal to the largest, are scarce inferior to them; and it yet remains to be explained, whether the paleness be accidental, whether it characterises an additional species, or only a variety. I am rather

disposed to condescend on the last, and to lay down, that the leading species is always grey in its original abode, and darker as it is larger. Very fine specimens of both inhabit a spring at the north-west base of the rock surmounted by the castle of Edinburgh, close to its issue from a ruin called the Well-house Tower.

I have also, but rarely, found a planaria almost exactly of the same description as what is denominated the leading species, except in being of deeper grey, the body somewhat of a more slender, equal, and vermicular form, the tentacula less prominent, and the head broader at the extremity. The frequency of the animal has not been sufficient, nor the distinctions so evident, as to enable me to prove whether it is a variety, or should be disjoined from the species. Possibly such discrepancies may originate in sparing aliment, the absence of light, or the temperature of the atmosphere. It is inconceivable on how many conditions the real external aspect of these

animals depends; the mere passing of a cloud before the sun will produce so material and sudden an effect, that a total change in shape and motion, consequently in colour, ensues. Nor is it difficult to comprehend that it must be so, by reflecting on the extreme dilatability and contractility with which every portion of a planaria is endowed; that in progression its length is at least quadruple as much as when at rest; that its tentacula can disappear at will, and that the whole proportions of its body can be changed. Want or abundance of food will occasion analogous alterations in colour, size, and figure; new approximation or separation of parts arises, and the animal is hardly seen twice identically the same in every thing. Repeated observation is therefore the sole means of appreciating the relation of all these combinations.

In searching for the permanent characteristics which might distinguish the planariæ now described, I subjected two of

pale colour, selected from the rest, to the microscope by candle light. Nothing resembling eyes, stigmata, or marginal specks, could be detected. At a future period, however, on repeating the investigation by day, two minute black specks were discovered in the middle of the upper surface of the neck, nearly in the same position as they are to be seen in the planaria auriculata. This is an observation, like some others on animals which elude our controul, exceedingly difficult to be accomplished, both from the corporeal opacity and incessant motion of the planariæ; and in those of dark colour, it is scarce possible by any means to obtain a view of the eyes. Whether they are simple or compound, is not absolutely certain. More probably each is a single speck, deep sunk in an orbit or socket, where perhaps it is susceptible of some movement or alteration of figure. They appeared differently in different observations. Both were not always of the same shape; frequently they resembled a cres-

cent, and by a constriction in the middle, occasionally seemed almost divided asunder. Their position appears in Fig. 13. which represents one of the pale animals somewhat magnified. An instance occurred, where, by a monstrous conformation of the head, a planaria had a third eye situated to the right of the other two.

The organ of vision, if it be truly such, is not the only one whose site or operation is obscure in planariæ. I had studied the history of several species of this tribe during successive years, without being able to discover the precise manner in which they fed, though repeated experiments were made for that purpose. But I cannot deny my having been partly misled by the authority of nomenclators, who, founding their conclusions on superficial and precipitate remarks, too often forget the nature of an animal, in their anxiety to give it a name. Nomenclature, so useful when appropriately employed, ought to rest on a general combination of the structure and

habits of living creatures, not on isolated features only.

Five of the planariæ arethusæ being supplied with fish containing a quantity of clotted blood, in a short time evidently appeared to have fed voraciously. The largest, instead of a thin, flat, meagre figure, resulting from scanty aliment, now exhibited a semicylindrical shape, and was converted from the predominant leaden tinge to a dull brown colour. Transverse streaks of black or deep grey, constituting the darkening shade of the animal, became very conspicuous by the enlargement of the body, which had apparently augmented in length as well as in breadth. Something similar to an elliptical intestine, which I conjectured to be the stomach, was, besides, perceptible; and this having also been seen in others, induced me to think that here it was certainly so, more especially as its termination might be in that point designed by naturalists the ventral pore.

Therefore I sought the upper orifice or mouth, but in vain.

It cannot fail to excite the surprise of intelligent observers, that any difficulty should attend a matter of such incontrovertible simplicity as seeking the position of the mouth of an animal, of that organ which must be constantly in action for the very preservation of life; in one also where minuteness is no obstacle to discovery. But, so great is the diversity between most of those familiar to our notice, and others more rarely the subject of contemplation, that the arrangements of nature seem purposely calculated to bewilder our acutest judgment.

All planariæ immediately become sensible of the vicinity of food, though whether by means of vision, may be disputed. Their motions then displayed, certainly have rather an opposite tendency; and hence the likelihood of an olfactory power resident in them, such as may be peculiar to other animals not receiving the immediate rays of light. Nearly a month subsequent to the

preceding observation, several planariæ of the species at present described, were supplied with the soft part of an oyster; a substance which they generally receive in preference to the fleshy parts of animals. Some lighter particles floated at the surface, and I saw, with infinite surprise, a planaria also swimming supine in their vicinity, quickly protrude a long, milk-white, tubular proboscis, by which they were greedily absorbed. No wonder, indeed, that my search after any analogous organ had been fruitless. Unlike that of all other animals with which it is allied, or which come within the sphere of my knowledge, its aperture, instead of belonging to the head, is in immediate approximation to the tail. Situated in the under surface, and towards the lower extremity, it proves to be what naturalists have so erroneously denominated the ventral pore. Although this may be deemed a trivial fact in the grand scale of observation, it impressively warns us to distrust analogical reasoning for which we are ena-

bled to substitute experiment. Of such infinity are the ways adopted by nature for the perpetuation, welfare, and conservation of her creatures, that analogies in their organization appear unnecessary for the subsistence of life. The rest of the planariæ then, aware of the presence of food, in like manner began to issue forth their long slender trunks, and either insinuate them into the larger portions of fish lying at the bottom of the water, or absorb the particles suspended upon it.

In imitation of the name bestowed on the trunk of the elephant, the extensile organ serving to imbibe the nutriment of many of the smaller animals, is called a proboscis, whether it simply unfolds from the root, protrudes from a sheath, or unwinds from a regular series of volutions. But in none is the designation equally strict and appropriate as in the planaria. There it is absolutely the organ of the elephant in miniature, with this exception that it is neither annulated, nor composed of seg-

ments. It is of surprising length, being little, if any, shorter when fully extended than the whole animal. Its contractility is in proportion, which renders it susceptible of diminution into its respective share, when a voluntary reduction of its owner's size ensues. If employed, it is either simply cylindrical, flattened, or trumpet-shaped at the extremity, as the planaria inclines; and when stretched to the uttermost, the root becomes an apex of the slenderest cone. It seems of greater consistency, harder, and tougher than the rest of the body, so as to admit insertion into decaying vegetables; but it is still of a gelatinous, and not of a cartilaginous substance. Accordingly, the leaves of plants, before becoming quite soft and mucilaginous, may be seen studded with punctures over the surface, proceeding, as is probable, from the operation of the proboscis.

If this organ neither consists of rings nor segments, and at the same time alternately lies in concealment within the body, and

is protruded far without it, a question will arise, how is so remarkable a change accomplished? In a state of rest, the proboscis occupies the place denoted by an elliptical spot externally visible; and then it is a short hollow cylinder, of greater diameter at the mouth. Its extreme dilatibility is effected by reducing the sides of the tube in extension, which reduction is perhaps chiefly manifested towards the extremity, where the substance is more accumulated; and we must observe, that while, from facility of expression, it is called a hollow cylinder, the whole interior circumference is probably in contact. This is a wise provision of nature. The structure of the proboscis intimately corresponds with the general structure of the body; it is susceptible of the same expansion and contraction; and the incessant change of shape in the one is attended by a similar alteration in the other. If, by a dexterous operation, the extended organ be severed from the animal while feeding, an experiment

which it cannot be desirable to repeat, the aliment continues to be absorbed for a very considerable time, and is discharged from the mutilated end. Regular contractions and dilations are all the time performed as if the proboscis were untouched. On dissection, the upper part seems to communicate with other vessels, traversing the body or branching to each side; but the gelatinous consistence of the animal, and its invariable contraction when dead, unite in opposing the researches of the physiologist. Probably this is the only part of a planaria which is not reproduced into a new animal, though it be regenerated where defective.

The proboscis of the whole individuals which I have examined, is of a milk-white colour from the root to the mouth. It is entertaining to observe the operation of its functions. The power of the planaria over it seems almost unlimited, and by its singular flexibility, it can be extended, bent, and contorted in every possible direction. Sometimes it is protruded from the tail to

meet the head; sometimes it curves over the back; and in those mutilated by spontaneous division, it may be seen issuing far behind, in a direction diametrically opposite to the ordinary site of the mouth of animals. On supplying a portion of flesh, the trunk is immediately buried among its fibres; or if the planaria can find a worm sufficiently small, it is slowly and gradually absorbed, the proboscis ensheathing it by a cylinder half as long as the body. Should a number fix on the same object, their trunks, all in action, and greatly extended, are often curiously intertwined; for each is stretched out by the planaria on becoming sensible of the presence of food, while it remains stationary itself at a considerable distance. It is exceedingly interesting, also, to witness the immediate dissemination of soft alimentary substances absorbed by the proboscis, bringing the delicate interanea into view, and changing the hue of the animal; nor is it less singular to contrast the milky whiteness of the organ with the body of

some which is black as jet. The mouth of the proboscis appears at *c* in Fig. 15. of the planaria nigra, viewed by a magnifier.

The perplexities occasioned from discoloration, were illustrated by various examples, which shew the difficulty of guarding against error. On the twenty-eighth of January 1813, I took a number of planariæ indiscriminately from the spring at the Well-house Tower. None of the arethusæ could be detected among them; but several bearing an exact resemblance except in colour. All the latter were brown of different shades; the head, margin, and site of the proboscis clear; and in some, pinnate ramifications, filled with a bright red substance, appeared. The exemption of the head, margin, and proboscis, from the colour, led me to conjecture that it was accidental, for no perceptible vessels traverse these parts; but in every respect the deception was complete. On the fifth of February, so great an alteration had ensued as to verify my anticipations; yet it was

not until the thirteenth of that month, that the doubtful animals were restored to their original grey.

Though the proboscis be naturally single, I once saw three in a monstrous planaria of another species than what is treated of in this section, which were all actively employed at the same moment. Apparently no portion of it is lost by spontaneous division of the body; but how a new aperture is made for its protrusion in a regenerating fragment, I am ignorant.

After taking the uses and properties of this organ into view, we must henceforth denominate that the orifice of the mouth, which has hitherto been designed by naturalists a conspicuous ventral pore in planariæ.

The mode of propagation peculiar to the *Planaria arethusa*, is no less involved in mystery, than the perpetuation of kindred species, whose eggs and fœtuses have been sought in vain. Notwithstanding I have carefully kept the same individuals for a

period exceeding a year, and though I have removed many from their natural abode at all different seasons, I never could be sensible of finding either eggs or living young. Not long ago, however, I concluded that the fact was at last ascertained. In a vessel containing these planariæ, and little else than pure water, several rows of small bright yellow eggs were observed, each row being in a straight line, and consisting of about twenty-four. The like was found, under similar circumstances, in another vessel; and I anxiously watched the exclusion of the expected young, for the eggs were in no respect dissimilar from what might have been produced by planariæ, except in size: and besides there not being any general rule in this particular, their smallness was a satisfactory reason why they had been detected with so much difficulty. But soon after, the same was exhibited in a third vessel, certainly containing no planariæ, which immediately betrayed the fallacy; and on more minute investigation, the eggs

proved to have come from a species of the entomostraca, a small shelled animal, which, according to my calculation, should not have laid an egg one-third as large, and whose presence in the water had been overlooked. Thus if these planariæ propagate by eggs, they are still undiscovered.

Yet here also the wisdom of Nature has not failed in providing for the preservation of the race;—spontaneous division ensues, whereby, as before, a fragment detaching itself from the body of the parent, becomes a perfect animal, while the mutilated portion of the trunk is repaired.

The diversity of colour in the same planariæ first excited my conjectures, that reproduction after spontaneous separation had taken place. Six animals were therefore selected for farther observation, four of large, and two of small size. The second day subsequent, which was the fifth of November 1810, I remarked that one of the larger had lost a fragment from the tail, not exceeding a sixth part of the length of the

whole planaria. In six days, its motion was manifest, and on the eighteenth of the month, a white papilla was vegetating from the summit. The organic reproduction appeared complete on the twenty-second; the new animal traversed the surrounding element, though its figure neither was so well defined, nor were its motions so lively as displayed by two regenerating fragments of the planaria felina which had separated later. On the twelfth of November, it had nearly acquired the shape of a full grown planaria; and the two specks or eyes were conspicuous with the microscope on the twenty-third. Perhaps they might have been found earlier, had my attention been so directed.

The fragments thus separating and becoming perfect animals, never attained the dimensions of the parent whole. While in possession of the observer, they always remain infinitely smaller. It should also be remarked, that no feeding will preserve the size of any planariæ when removed from

their native abode; for they gradually, though slowly, decline and waste away. Perhaps this may partly be ascribed to the inconsiderable quantity of water devoted to their use, compared with what they enjoy in their natural state; thence rendering them more liable to be affected by external causes; or it may arise from an exhaustion of those principles adapted for the preservation of life. The want of mud and other substances into which they might retreat from the impressions of the light and air, may also operate their destruction; but its chief source centers in some noxious principle contracted by water. If remaining a considerable time unchanged, the planariæ decrease more rapidly, they become languid, scarcely moving either by the influence of light or heat, and at last adhere entirely to the side of the containing vessel, where they perish. Relative to this subject, I remember that when engaged in experiments on these animals in the city of Edinburgh, though thriving well, and

feeding readily when supplied with the water on the south of the town, they languished and died when transferred to the opposite quarter. There the water commonly used by the inhabitants proved insalubrious. The naturalist should therefore always search for what is already inhabited by animated beings visible to the naked eye, before consigning those to it in whose preservation he is interested.

The subsequent alteration of proportion in the different parts of a fragment separating in the species arethusa, is not dissimilar from what is witnessed in the progress of the felina. Between the eleventh and seventeenth of January, a portion detached itself from the extremity of another of the six animals selected for observation. On the tenth of February, its figure and proportions approached to those of a planaria in miniature; the original breadth was greatly diminished; the head, instead of being a shapeless projection, was connected to the body by a well-formed neck; and the

general contour was distinguished by a regularity which belongs to perfection only. On the thirty-first of March, a considerable enlargement had succeeded, and the young planaria possessed all the properties and characteristics of full grown animals. At this period, also, the tail of the parent was completely renewed, but the substituted part marked by a certain pellucidity invariably indicative of reproduction. Both the original animal, and the offspring which constituted the separating fragment, are represented from life, Fig. 11. 14.

Propagation in this way is a much more rare occurrence, than with the preceding species, in which it is described. A number of the felinæ being indiscriminately taken from still water, on the twentieth of July, some proved of the largest size, others minute, and several had undergone spontaneous division; they either wanted the lower extremity, or portions detached were in progress of acquiring the defective organs. The following day, I

fished up a number of the arethusæ now under discussion, from a spring well about half a mile distant. All were entire; no separated fragments appeared; nor had I for long observed any divisions among those kept in my apartment. On the whole, it rather seems to me, that the circumstance of removal from the place of their natural origin, renders these animals more subject to spontaneous division of the body; and in general it succeeds soon afterwards. There are exceptions, it is true, which are not easily susceptible of explanation; and conjecture alone can ascribe them to age, sex if there is sex, or the distinction of it in the arethusæ, or to their preservation from any kind of constraint or suffering. Those of certain waters are, besides, apparently less liable to it than the planariæ of others, which may infer a difference in the species difficult to be recognised by observers. But with the planariæ felinæ such partition is incessant in every different size, and in all

seasons, conditions, and situations. Scarce has it happened once, when it seems ready to happen again, and still with impunity to the remainder of the animal. Hence the increase of this species advances with incomparably greater rapidity than that of the other.

Although it has not been my fortune to find the eggs either of the felina or arethusa, those which have chiefly been subjected to observation, I must repeat, that it is not here affirmed there are none. The difficulties opposing the solution of problems far more simple than the secret operations of nature, are a sufficient warning against gratuitous assumptions. Yet in contrasting the various species among themselves, it is certainly very singular that I have never witnessed spontaneous division among those which produced eggs in my possession, or which were discovered in the waters. Should this distinction be proved absolute by future observation, it forms an additional phenomenon

in the history of the genus, no less remarkable than those distinguishing the individual species that compose it. Still, it is a conclusion which we should beware of adopting, without the test of rigorous experiment.

The powerful reproductive principle resident in the various parts of the arethusa is seen in its multiplication, from artificial sections. All are speedily regenerated into entire animals, their progress and perfection being dependent on the usual laws which regulate the evolution of defective parts. Monstrosities are sometimes found, of which an example has been already quoted; and at another time, one was taken with two complete tails of considerable length, neither of them resembling an accidental production; so that it was doubtful which was original, or if either had preceded its fellow. Bifurcation of the tail is the most common kind of monstrosity in the genus, but it is probably to be in general ascribed to accident; and we can more

easily comprehend why it may be so, than we can hazard an explanation of its ascending to original conformation.

This species of planaria is not so often seen in a state of repletion as the rest; nor does it dwell indiscriminately among them. I have on no occasion observed it in stagnant water; whether from being less congenial to it, or because its ordinary food belongs to springs, I shall not presume to determine. Certain boundaries are assigned by nature to all her creatures: the largest quadrupeds and the minutest insect are alike restrained within the respective barriers of place and climate, which may not be safely left behind. The elk cannot dwell with the elephant; the foot of the camel is formed for the parched and sandy desert; while that of the goat is fitted for climbing alpine mountains. The flight of the tropic bird is confined within the limits from which it derives its name; and many inhabitants of the vast Pacific Ocean are banished from the northern seas. The

numbers of the scorpion, and the deleterious activity of its poison, decrease as it removes from under the line; and the nectarious collections of the bee are adapted to those regions only which admit the bloom of flowers. Let us traverse the shores of our native islands; within a determinate boundary, we shall find a particular tribe numerously disseminated, and in vigorous life; proceeding a little onwards, fewer appear in their haunts; and advancing still farther, the race totally vanishes.—Then another is seen, which, from at first being scantily associated, becomes at length the sole tenant of the territory.

Division II. *Planaria Graminea*, Fig. 16. —It must not be conceived, that all the animals hitherto ranked under the genus planaria by naturalists, bear a common resemblance, either in organization or propensities. So wide a difference in both appears among them, that one intermediate tribe, somewhat more approximate to the

leech, might perhaps be constituted, and others analogous to worms. Trivial distinctions, indeed, should be disregarded, not only to avoid the multiplication of genera, which would thus be extended to infinity, but to simplify the arrangements of Natural History, and render them comprehensible from prominent features. Yet to include in the same class creatures provided with organs totally wanting in those associated with them, subsisting on food of opposite qualities, and living in different elements, which would reciprocally be fatal to their existence, certainly does seem an anachronism, and is not easily reconcileable to strict and logical reasoning.

The precise place which the animal that shall be here denominated planaria *graminea* should occupy in the system of nature, has been controverted by observers. Some have called it a planaria, others a leech, and in truth it perhaps participates of the general characteristics of both. Therefore, to shun the perplexity which the multipli-

cation of genera creates, it is now retained as constituting a second division of the genus planaria. The distinction is principally founded on the shape of the animal, the position of the mouth, and number of eyes.

The planaria graminea is of a beautiful grass green colour, and by the aid of a magnifier, perceptibly speckled with black; but to the naked eye, the surface of the skin is uniformly green. Its figure is a double cone, truncated at one extremity the head; and the termination of the tail is the opposite apex. Thus the planaria is not flat, and the head is obtuse. Near to the termination of the truncated part are two very black specks or eyes, far asunder, one being on each side of the head. I have not been able positively to ascertain whether there are none other of smaller size; for it is not impossible that, under favourable circumstances, the most powerful magnifiers might bring such into view. In the leech, at least, with respect to certain species, particular difficulty sometimes attends the discovery

of the smaller eyes, and naturalists ought not hastily to conclude that those exposed at the first glance, or even by a moderate magnifier, are all which that singular animal possesses. The voluntary contraction that every portion is highly susceptible of, and the casual obscuration of parts by intervening shades, tend to withdraw the minuter organs from observation. If the two black specks of the planaria graminea be designed for the purposes of vision, as their position and appearance would indicate, their operation is assuredly of a different kind from that of the eyes of terrestrial animals. Sometimes these planariæ rush against obstacles which they are apparently desirous of avoiding; nor when two are close together, do they always seem sensible of their mutual presence, and on accidental contact, they suddenly contract, and reciprocally retreat in alarm. The whole body, which is scarce two lines in length, and half as thick, in the middle, where perfectly round, is invested with a thin transpa-

rent integument, especially conspicuous at the head and tail.

Compared with the motion of the larger planariæ, that of the graminea is surprisingly swift, to which its peculiar figure, in rendering it more buoyant, contributes. But unlike the others, its adhesion to surrounding substances is slight; and when replete with food, its ascent on the side of a glass vessel is accomplished with difficulty. The tail, though quite taper and acute, is principally employed for adhesion; however, it has no resemblance to the corresponding extremity of the leech, notwithstanding there is some general analogy of motion, contraction, and dilatation, between the two animals.

Trusting to the classification of the graminea by nomenclators, along with the species of planariæ most familiar to me, I supplied it with various kinds of food, expecting the speedy protrusion of a retractile proboscis. None, however, appeared; nor was it possible, on the strictest scruti-

ny, both with the naked eye and magnifiers, to discover the wonted aperture of the mouth in the surface of the belly. The position of such an aperture, known under the name of a ventral pore, is, as before remarked, a principal feature in the organization of planariæ. There were few vegetables in the water containing those of which I speak, nor any approaches to maceration, neither did it include the decaying remains of animal substances; and meanwhile the planariæ, contrary to the nature of all that had been previously examined, continued equally plump and large as when originally taken. From this it was probable that they did not subsist on vegetable aliment; and their constant action as if in pursuit of prey, inferred that it might consist of aquatic animalcula. The head in their courses, was frequently directed against those that lay in the way. They long rejected every different substance presented, until supplied with the soft parts of oyster, which had proved so grateful to the rest. Then, when in

a favourable situation, instead of a proboscis issuing from the belly, a wide mouth was seen to open towards the anterior extremity, which greedily swallowed the food, and the animals acquired a sensible augmentation of size. Unless from the usual green being of the faintest dusky shade, the position of the mouth, when close, is scarce, if at all to be recognized. Therefore, should the learned Muller by *ora candida*, refer to this organ, his planaria *helluo* is different from the graminea; nor, indeed, is there the smallest speck of white on any part of the whole animal. In the latter, the mouth lies under the most prominent part of the head, which may aptly be denominated a snout. The planaria snaps at its prey like a fish, and if unsuccessful, crouches away under evident discomfiture, to await a better opportunity. It does not hesitate thus to attack animals twenty times its own size, and is continually attempting to swallow those infinitely too large for deglutition. The site and figure of the mouth

of the graminea, therefore, remove it from the same division of the genus comprehending those provided with a proboscis; and there is still another line of distinction, in the visible corrugations or inequalities sometimes exhibited by the body, whereas the others are perfectly smooth. Like them, it swims supine at the surface of the water.

These planariæ are hermaphrodites, in the strictest sense; but whether impregnation originally results from the sexual union, may be called in question, not perhaps as to the vivifying principle, but with respect to the formation of the egg.

Some years ago, the animal was not uncommon; and in the course of casual inspection, I had frequently remarked an egg within the body; in as far as recollection serves, the species was the same. Its supervening rarity, however, of later years, partly arising from the progress of agriculture, so inimical to the pursuits of the na-

turalist, impeded further researches in the vicinity of my usual country abode.

Two being taken on the twenty-fourth of September, were carefully preserved in a glass vessel, and for some time regularly supplied with water from the place whence they had been removed. Both were of a beautiful uniform grass green colour, attended by a pellucidity at the extremities denoting the investing integument. In six days, the interior began to darken; and in seven more, four dusky ovuli were perceptible within the larger of the planariæ, for the two animals were of unequal size. On the eleventh of October, they had increased to the number of six, and some were also at that time visible in the smaller animal. They were differently disposed, however, in their respective ovaries; all belonging to the latter being ranged on one side of the lower extremity, while those of the former were distributed in both.

Soon after, the sexual union took place, during which the two animals, adhering by their tails to the upper part of the glass, performed a singular conjoint revolution, resembling the spokes of a wheel. Similar gyrations are occasionally exhibited by them singly in the water. The eggs, now visible by the naked eye, appeared in various stages of maturity, and in greater number; they were still ranged on one side of the smaller planaria, and some which had recently been near the opposite extremity, rose so high as to approach within a third of the snout.

Subsequent remarks established, that the animal, in assuming different positions, can bring other eggs than those at first most conspicuous into view; and it even seems endowed with the faculty of altering their place in its body. Instead of the regular arrangement preserved in an early stage, they gradually became more confused, separating, as it were, into detached groups and clusters; and on the eighteenth of Oc-

tober, one in the larger planaria, had rose towards the site of the mouth.

A few days afterwards, this latter circumstance attracted farther notice; for in the smaller animal, two eggs were so close to its mouth on the twenty-fifth, that I anticipated their production from some oviduct in its immediate vicinity; and next day one of them was almost between its eyes. Description can convey but an imperfect picture of these successive changes; nor can their singular appearance, their force, and effect, be adequately conceived by naturalists unacquainted with the subjects of observation. But such an alteration of position was the less to be accounted for, from not being the result of too restricted space in the body of the planaria. Various interstices separated the eggs themselves, or their clusters from each other, whereby the animals seemed speckled to the naked eye.

When the truth was just about to be realised, the smaller one unfortunately pe-

rished on the twenty-eighth of October, and the larger on the thirtieth, without any sensible cause for the death of either.

We know that there are certain animals whose life draws to a conclusion on the attainment of maturity; and there are some which die in giving birth to their young. Many, among the insect tribes, which have passed a protracted interval in successive stages, have but a transient enjoyment of existence in the perfect state. The butterfly, whose gaudy colours announce the approach of summer, seldom witnesses its termination. When the immutable laws for the conservation of the species are fulfilled, the males of the honey-bee are destined to perish by violence, at an appointed season; and the ephemera of the morning scarce survives the close of day. Nay more; the volvox globator, a beautiful green spherical animal, includes several successive generations at once within its body. All the vital functions are performed; it originates, grows, and reaches perfection. Then

it bursts to allow an exit to its young; and the investing integument, scattered in the surrounding element, disappears. Such is the unalterable condition of its own existence. But this is only a single race. The offspring, now independent, swim through their native fluid, each revolving on its centre as an axis, the whole undergo the same gradations, and each is destined to be extirpated by the same fate which destroyed its parent.

By the death and subsequent decay of the planaria graminea, eighteen eggs escaped from its body. I do not affirm, however, that, like the volvox, the life of its offspring is decreed to result from its own destruction; for circumstances have prevented researches which might corroborate the fact. No visible cause of death, indeed, was shown: Yet if life in the larger animals hangs by so slender and delicate a thread, that its perpetual rupture insensibly ensues, even when danger is anxiously warded away, how infinitely greater is the

liability of those diminutive inhabitants of the waters to perish! Not only is the warfare eternally waged by the stronger, fatal to the weaker without resource; but some deleterious principle suddenly imparted to their native element, may sweep them off in legions, or prove their absolute eradication.

Judging by the apparent maturity of the eggs, I entertained hopes that part of them might have been hatched, and thus furnish a new colony for observation. Possibly this would have followed, had all that care and attention been bestowed upon them, which objects so minute require. However, though long retaining their original hue and appearance, none produced young.

Planaria Velox, Fig. 17.—It has been said, that the vegetable creation is more diversified and luxuriant on some solitary hill, amidst wide-extended plains; and so it has seemed to me with respect to animal life in marshes far asunder in a fertile re-

gion. Is it because such an infinity of the insects with which the universe teems must first have an aquatic abode, preparatory to the perfection of all their organs? or because the abundance of decaying matter, whose maceration is promoted by humidity, affords an uninterrupted nutritious supply? or, finally, because the receptacles being fewer, the aggregate is greater in proportion?

Towards the latter end of September 1812, several capacious vessels were filled with water from a marsh situated in the centre of a cultivated district. As the contents subsided, uncommon variety of animals appeared. Numerous aquatic insects complete, or larvæ advancing to their successive metamorphoses, performed their agile evolutions, or sluggishly dragged their members along. Beautiful hydrachnæ, decked in velvet colours, were ardently occupied in the pursuit of prey; many defenceless beings sought shelter amidst the weeds and slime; and myriads of minute

anguillæ suspended in the fluid, fell like a flocculent substance, to whiten the dusky deposit below.

While viewing the incalculable millions here concentrated together, I observed some diminutive animals quickly ascending the sides of a vessel, which on gaining the boundaries of the element, committed themselves to its surface in swimming supine. Being separated from the rest, they proved, on more intimate investigation, to belong to that tribe with which we have been so long engaged, and possessed of properties denoting their alliance with the species last described.

The planaria *velox* exactly resembles a weaver's shuttle, and were it not from certain peculiarities specified by Muller, it might be considered the same which he has designated *rostrata*. Whether these peculiarities are temporary or permanent, has not been explained; sometimes the simple difference of the season of inspection may persuade us, though erroneously, to insti-

tute an additional species, as if different from those already known. From the anterior part of the body, the head is protracted into a long pointed snout; and the tail, almost equally long and slender, terminates in an angle proportionally acute. On the upper surface, at a considerable distance behind the head, are two blood-red eyes, which may almost be said to sparkle in the sunshine. The body seems of a fleshy consistence, more so than that of the others, and it is invested by a transparent integument, through which the interanea are conspicuously exposed. A dull white colour pervades the whole exterior; and the entire length of the animal is about two lines, or a sixth part of an inch.

In searching for the mouth of this species, a part of its organization, which will tend to establish its real place in the arrangements of nature, I have hitherto been unsuccessful. But most probably its site is analogous to that of the former, and

somewhere under the projection of the snout.

It is a lively, active animal, swiftly traversing the surrounding substances, with its snout incessantly in motion as if in quest of prey; and as its size is not speedily reduced by confinement, it possibly subsists on aquatic animalcula.

The planaria velox is distinguished by remarkable timidity; its adhesive faculty is so slight, that the containing vessel can scarce be touched without the consequent cessation of its hold. The same, indeed, is a leading characteristic of all other planariæ, though in a far inferior degree; they suddenly abandon the plane of position, and drop through the water, with contortions of the body, as if to break their fall, while they are evidently aided by a filament invisible to the naked eye.

This planaria propagates by eggs, which are arranged in an ovarium of two rows, one as if belonging to each side of the body. Their number is exceedingly various,

consisting, in the different animals, of from one to sixteen; but their origin and progress were not observed, and as all are not produced at once, I cannot affirm how many are peculiar to the species. A planaria separated from others on the second of October, had next day laid twelve eggs, while one remained in the body some time longer. These eggs are of a dark brown colour, and perfectly spherical; those of the former species are of a long ovoid, and of a clear, transparent, reddish brown: they are attached in a cluster either to the sides of the vessel, or to any floating substance in the vicinity. Probably weeks are required for their exclusion. Such seemed the result of observations made in November, when I found the shell broke, and the young that had escaped.

Minute crimson specks were perceptible in one of the parent planariæ, and having previously remarked the same appearance in several individuals, I was induced to consider them the incipient evolution of an ova-

rium which another season would bring to maturity.

Prosecution of this enquiry was interrupted, from the total evaporation of the marsh where the animals had been found, by an uncommon drought during summer 1813. Thus the race may be extirpated there, unless, which is not improbable, the revival of humidity shall promote the exclusion of eggs accidentally preserved, and which have not lost the latent principle of vitality.

Planaria Edinensis, Fig. 18.—The different genera of animals are constituted by uniting individuals bearing the greatest reciprocal analogies in habits or conformation under some common characteristic. But a subordinate distribution into species soon becomes necessary, from more attentive examination discovering peculiarities in one which are wanting in another. The planariæ of the former division are united by structure, in a proboscis protruding from

the belly, and by general correspondence in figure and motion: the species are distinguished by the variety, number, and position of eyes, the presence of tentacula, and mode of propagation. A second division arises from the appearance of the animals, conjoined with the site of the eyes and mouth, in which a prominent characteristic is the want of a proboscis, so far as can be ascertained. Though nearly the same leading features belong to the subject of this section, perhaps it might more correctly have preceded the two already described, or stood as an intermediate race.

The planaria Edinensis, so called from inhabiting the discharge from the Well-house Tower, near the castle of Edinburgh, is about a quarter of an inch in length, and slightly tapers upwards from the lower extremity, which terminates abruptly in a point; while the head is obtuse, and void of tentacula. In an ordinary state, the body is flat below, convex above, and with a longitudinal ridge, apparently elevated,

down part of the back; but after feeding copiously, the whole, from distension, assumes a conical form, and the pointed tail is obliterated. The body is smooth and shining; its general hue is the palest carnation, the anterior is rose colour, and the ridge in some tends to cream colour or dull white. Two black eyes are seated near the front, in the rose-coloured part, which in young planariæ are ovoids, but in grown animals considerably magnified, appear irregularly globular. In the under surface, a little behind the corresponding position of the eyes, there is a long slit situated in the centre of an indistinct ellipse clearer than the rest of the body, which seems to contain the mouth, and perhaps also the termination of an oviduct or excretory canal.

This planaria, like the others, is carnivorous: it feeds voraciously on flesh, after which it is so greedy as to leave the water when in the immediate vicinity. On such occasions, it has received no injury; and

the planariæ of the division to which it pertains, seem to support slight and transient desiccation with greater impunity than the rest. The body is much enlarged, and distended into an utricular shape by feeding; it seems hollow within, and the interanea are apparently lodged in the circumference. Globules of air are frequently absorbed along with the food, which reduce the animal's specific gravity so much as to render it incapable of descending in its fluid. It sucks its food like the leech, which, contrary to the general opinion, is an animal highly carnivorous; and the examples daily given of its surviving incredibly long in pure water, instead of being admitted as demonstration that food is unnecessary, ought rather to be ranked with other prodigies of living beings enduring abstinence. Marsh water, frequently renewed, will always prove a salutary supply.

The planaria Edinensis propagates by eggs, which are invariably seen in the same situation near the orifice of the mouth.

though only one be visible at a time. A planaria which had retreated among the mud during the winter months, appeared on the side of its vessel on the thirteenth of February, bearing a single egg of light chocolate colour, extremely conspicuous through the thin integument below. In three days it had been laid, and its place was vacant; but on the twentieth of the month, another egg was seen in the site of the former, or within a third of the anterior extremity. I then removed the animal into a watch-glass, where it might always be accessible, in expectation of obtaining the egg, and found it accordingly at the bottom, on the following day. There was now no appearance of any more in the parent; and on the twenty-third, a very minute planaria of the same species, as nearly as could be determined, was vivaciously traversing the liquid. In the evening, however, the planaria exhibited a third egg, situated exactly as the two preceding, of which also it had next morning divested

itself. The sudden appearance of an egg always in the same stage, without my being able to observe its progress, and seldom being capable of discovering it when deposited, induced me to suspect that it might possibly be taken up into some pouch or cavity by the neighbouring aperture. But this proved an erroneous conjecture; for the eggs, amounting to six or more, are successively produced at certain intervals; and notwithstanding their sudden attainment of maturity, and one only being visible at a time, they are sometimes to be observed previous to coloration, of an opaque white. Probably they successively ascend towards the head, in conformity with those of the planaria graminea, rising from an ovarium somewhere in the side.

The egg is void of any viscosity, unlike that of the black planaria, which I have seen floating at the surface of the water, imbedded in a lump of transparent jelly: it has a hard shell, and is perfectly globular. Most minute objects, however beautiful and

symmetrical to the naked eye, are rude and deformed under the microscope; but it is otherwise with the egg of the planaria Edinensis, which still remains a regular and equal sphere when viewed with the highest magnifiers.

One young animal is excluded in twenty-eight days from each egg, at first milk-white, and endowed with uncommon vivacity.

The reproductive powers of this planaria have much less energy than those in the species above described of the other division. Artificial sections are long of acquiring the defective parts; and when they do vegetate, they are not so well defined. During a mild season, neither the head nor the eyes were evidently in progress to reproduction during fourteen days.

This animal is of a shy and timid disposition; for months it dwells constantly in the mud, nothing except the snout being protruded above it. If venturing to traverse the surface, it hastily retreats to concealment on

the slightest motion or alarm; and with me it remained completely buried from October until the subsequent February or March. Planariæ are totally defenceless; their progression is ill adapted for withdrawing them from sudden danger; their bodies yield even under gentle pressure; their senses are not eminently acute, nor is their instinct active;—thus they seem incapable of resisting an enemy. We are wont to assume, that nature has formed no animal without providing it with the means of protection; but it cannot be denied, that although many are endowed with fleetness on the earth, or flight in the air, and that some are possessed of tusks, or horns, or a deadly sting, greater solicitude appears testified for conservation of the species, than for the security of individuals. The planaria Edinensis may find shelter from its enemies in mud, or its sustenance may be derived from what is usually precipitated along with it.

Among the general conclusions which may be deduced from the preceding observations, it appears that the genus is susceptible of subordinate divisions, according to peculiar organization; though analogous properties are seen where the structure is different. In one extensive class, the aperture of the mouth is remote from the head, and under certain circumstances, is even diametrically opposite to it. This aperture is the extremity of an exsertile tube, by which the food is conveyed into numerous viscera, distributing it by delicate ramifications throughout the body. Should the substances which are voraciously absorbed, be coloured, the hue of the whole planaria, except the head and a marginal band of the remainder, is altered. By means of an organ probably situated towards the tail, a glutinous or silky matter is prepared in threads, which are singly invisible to the naked eye, but become perceptible when accumulated in numbers.

However, it is not ascertained that such a property is common to every species. Propagation is effected in two distinct modes, void of any relation or analogy to each other; being either by an egg containing one or more young, or by the spontaneous separation of a fragment of the tail, which becomes a perfect animal. But no disjunction of parts takes place in those species producing eggs, nor have eggs been discovered where the race is perpetuated by separating fragments. The reproductive principle is enjoyed in the highest perfection by the genus, whereby not only the most dreadful lacerations are speedily healed, but wanting portions are repaired, and, by a strange anomaly from the laws of organic life, the duplication of essential organs may be artificially obtained.

The preceding remarks are far from exhausting the history of planariæ. Phenomena equally singular and interesting are displayed by other species inhabiting the

sea, or lakes and marshes, though not enumerated here; and many have yet to be withdrawn from their native abodes, whose nature will further unfold the genuine principles of animal physiology.

EXPLANATION

OF THE

FIGURES.

1. The upper side of the Planaria Flexilis, wherein the specks or eyes may be discerned.

2. The under side, exhibiting a faint indication of the site of some of the viscera.

3. Planaria Nigra, viewed from below.

4. Its egg magnified.

5. One of the young magnified, to shew the position of the marginal specks or eyes. The cylindrical appearance denotes the situation of the proboscis.

6. 7. The upper and under surface of the Planaria Panniculata.

8. Planaria Felina, as seen from above.

9. A fragment of the same animal, which has detached itself by spontaneous separation, to become a new Planaria, magnified.

10. A Planaria Felina with two heads, the second of which has been artificially produced; seen from below.

11. 12. The upper and under surface of the Planaria Arethusa.

13. The upper surface of another of these animals, somewhat magnified, to shew the position of the eyes. The clear line indicates the site of the proboscis; the lower extremity being its aperture on the other side.

14. A complete animal, reproduced from a fragment such as 9. which separated from the tail of 11. 12.

15. The Planaria Nigra, magnified, to shew the site and operation of the proboscis.—*c*, its mouth; *a*, the head of the animal; *b*, its tail. The Planaria is somewhat more contracted when this organ is so much extended as represented here.

16. Planaria Graminea of the natural size, and as seen by a magnifier.

17. Planaria Velox, of the natural size, and magnified.

18. Planaria Edinensis, magnified.

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ERRATA.

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