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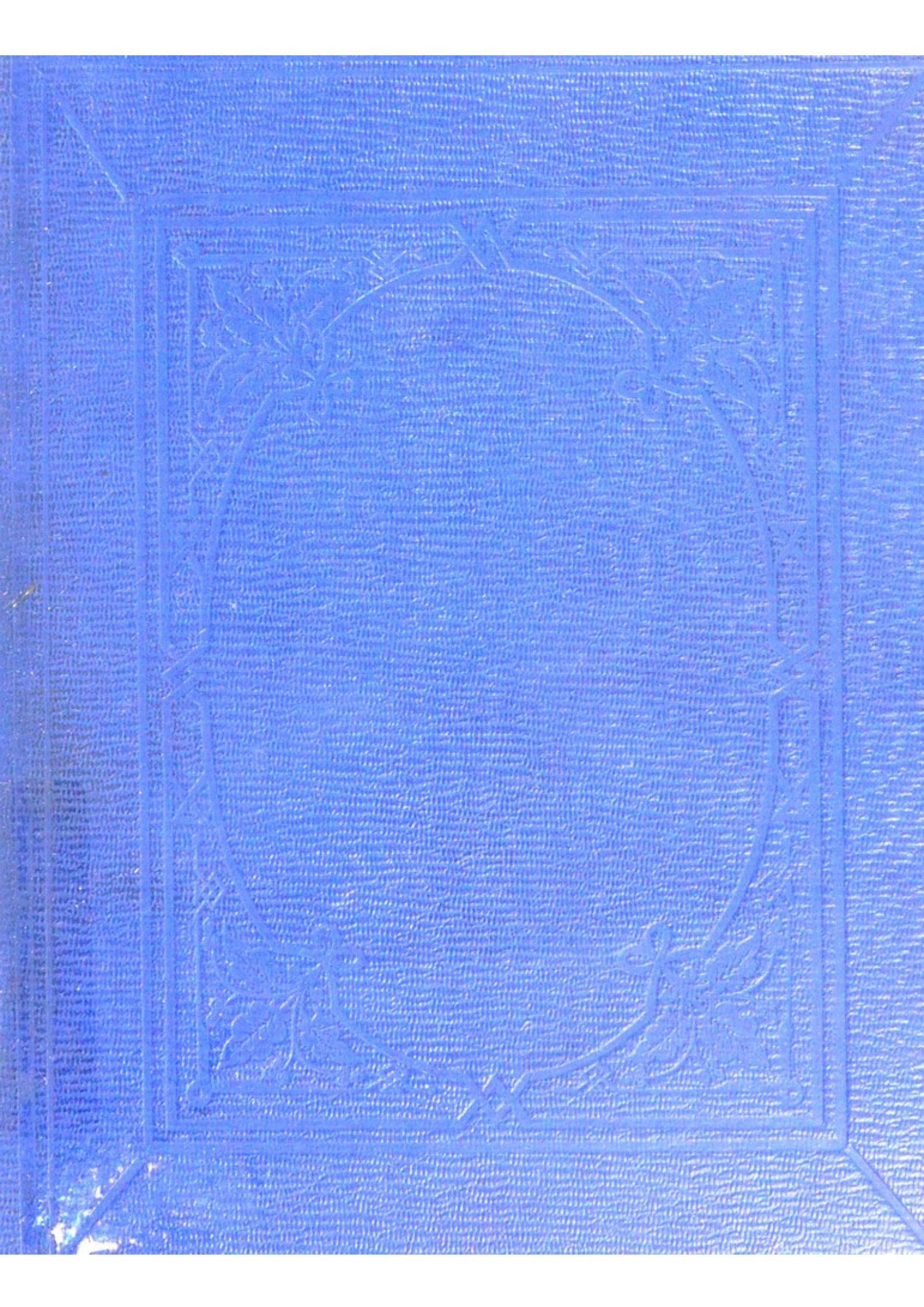
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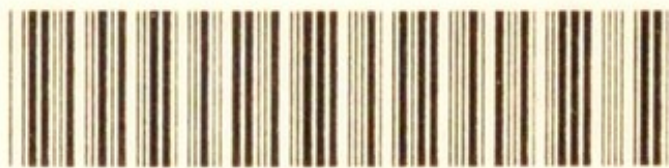
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Drawn from Nature by Prof. Sanders

Vincent Brooks Lith. London.

THE DROP OF WATER.

THE CRYSTAL SPHERE;

ITS FORCES AND ITS BEINGS:

OR,

REFLECTIONS ON A DROP OF WATER.

BY

J. MILTON SANDERS, M.D., LL.D.,

PROFESSOR OF CHEMISTRY IN THE ECLECTIC MEDICAL INSTITUTE OF
CINCINNATI, OHIO.

" Let the Moon
Shine on thee in thy solitary walk;
And let the misty mountain winds be free
To blow against thee; and in after years,
When these wild ecstasies shall be matured
Into a sober pleasure—when thy mind
Shall be a mansion for all lovely forms,
Thy memory be a dwelling place
For all sweet sounds and memories; Oh, then,
If solitude, or fear, or pain, or grief,
Should be thy portion; with what healing thoughts
Of tender joy wilt thou remember me,
And these my benedictions."

WORDSWORTH.

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TO THE MEMORY
OF
GIDEON ALGERNON MANTELL, LL.D., F.R.S.,
OF LONDON,

THIS VOLUME IS INSCRIBED,

BY HIS AFFECTIONATE PUPIL,

THE AUTHOR.

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NOTE.

SINCE these lines were written, England has been called upon to lament the death of one of her most gifted men. GIDEON ALGERNON MANTELL is no more on this earth ; but who shall say that his great mind is not partaking of that progress which appears to be universal ? In referring to this lamentable event, I feel that the language of one who is his compeer in intellect, is more appropriate than anything I can write :—
“ What he has done since his death, what he has thought, and what discovered, is recorded, not on earth, but in some sphere less contracted—fitter for the correction and satisfaction of his mighty capacity ; where, it is scarce doubtful, he has been rising, ever rising, even like the bird of Jove—sailing through his native element, and satiating his eager spirit by gazing over and more closely on those pure fields of Light which surround the Throne of God.”*

The great mind of MANTELL has departed ; but, although his progress on this earth has ceased, still, we believe that there are brighter spheres beyond it, whither he has gone to gather fresh stores of knowledge ; and where the chaplet upon his brow will bloom still more brightly than ever. During the life of my illustrious preceptor, he was kind enough to

* Professor J. P. NICHOL, LL.D.

consent that so unpretending a work as this should go forth under the auspices of his honoured name. In one of his letters to me, dated "19, Chester Square, Pimlico, London, March 6th, 1850," Dr. MANTELL, in reference to this volume, says—"I should rejoice to know that you have set about the work you contemplate; it would not fail to be most interesting, and of great utility."

Inspired by the encouragement of such a man as Dr. MANTELL, I began this volume with confidence; and, although it has proved less voluminous than the beauty and extent of the subject would justify, still, I found myself forced to bring it to a conclusion, only after touching upon a theme as boundless as it is fraught with wisdom and instruction; for to extend it into anything like detail, had been to convert this essay into a volume, in size and pretension, far beyond its merits.

It was only with the permission of my illustrious tutor, Dr. MANTELL, that I ventured to dedicate this unpretending volume to him. Since it was written, he has left this earth; but, although he has departed, I allow the inscription to remain, as a sincere, although feeble, testimony of the affection I bore him while living, and the deep reverence I entertain for his memory.

J. M. S.

NEW YORK,

September, 1856.

PREFATORY REMARKS.

HAD it not been for the thoughtless remark of a little child, perhaps this Essay had not taken its present form. One younger than herself—a little creature who still claims that anxious care and affection which are extended to early childhood—was sitting nigh to us with a tear-drop glittering upon her long, silken eye-lash: it matters not whether it were the tear of joy, or that of

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7 trouble; for this transient offspring of
blithesome and capricious childhood, like the
glittering rainbow, arched up beauteously
between the storm and the sunshine—is but
the creature of evanescence. It was but a
tear—"only a drop of water"—exclaimed
another equally thoughtless child, as she
dashed the bright intruder from her sister's
dark eyelash: but that drop of water did
not impress my mind so evanescently as
that of the gaysome and careless creature
who uttered the above expression; for I
began to reflect upon the vast properties
and importance of a drop of water: and

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the more I thought, the more I was impressed with the beauty of the subject, till, finding my mind took cognizance of it in a not dissimilar form to that which the reader will peruse in this little volume.

There is no harm in contemplation or in meditation, even upon the most trivial subject; for this telling of the mind must bring forth rich fruits, even as the soil yields its choicest productions. To meditate "Upon a Pebble," brought forth the charming little work of Dr. MANTELL; and to speculate "Upon an Old Log," gave birth to an enchanting didactic lecture which I once

heard from Mr. JOHN W. VAN CLEVE, of Dayton. To write "Upon a Drop of Water," after such able precedents as those referred to above, is, at least, hazardous, and, perhaps, not politic, in one of my capacity ; still, I have dared to venture, and now cast my little volume fearlessly upon the waters, conceiving that, if it contain a single *Truth*, it will be received with congratulation by those who are thoughtful, good, and wise ; and, perused with attention by those who would steal away from the harassing incidents of active life, or would avoid the morbid excitement of the modern novel, to

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devote one hour to the contemplation of a subject so pregnant with calm and pleasing instruction as is furnished by a Drop of Water.

J. W. S.

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NEW YORK,

September, 1856.

THE CRYSTAL SPHERE;
ITS FORCES AND ITS BEINGS.

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HAS poetry a nobler theme than this?
Agencies are seen—like winged spirits of
infinite power, each one working in its own
peculiar way, and all to a common end—to
produce, under the guidance of Omnipotent
rule, the waters of the rivers and the seas.
As the great ocean mirrors the bright heaven
which overspreads it, and reflects back the
sunlight and the sheen of the midnight stars
in grandeur and loveliness, so every drop of

water, reviewed with the knowledge which science has given to us, sends back to the mind reflections of yet distant truths, which, rightly followed, will lead us upward and onward in the tract of higher intelligences—

“To the abode where the eternal are.”

PROF. ROBERT HUNT.

A drop of water ! What is there in a little drop of water adequate to supply the materials for a long essay ? and such an one as is calculated to interest those thoughtful persons who, perchance, may be induced to peruse this unpretending little volume ? It is true that a drop of water is apparently a thing of small moment—almost too unimportant to come within the cognizance of

that active mind which is proned to grasp at the vast and the sublime, to the total exclusion of what is minute and apparently trifling. Although a small thing, still, like all minute objects when scanned with the eye of science, this drop of water reveals laws, whose operations are involved in the phenomena that attend mightier objects. Although a small thing, science has scrutinized it rigidly; and we find it a reservoir for those potent forces which govern matter, and effect its constant changes. We find that its ponderable constituents consist of two invisible gases; one of which is the pabulum of animal and vegetable life, and the other an indispensable constituent of their organisms. We

t/ find that these two invisible substances possess most powerful energies in respect to each other, and to all other bodies; and that their deportment, when brought in contact with them under certain conditions, is attended with phenomena of the most wonderful and important nature. We learn that these two substances, which compose the ponderable part of this drop of water, have powerful affinities for each other; and, that when mixed and brought in contact with an ignited body, are susceptible at their instant of combination of producing consequences of the most fearful nature.* This drop of water is apparently

* The late profound investigations of Messrs. FREMY and BECQUEREL have proved that what has been termed *Ozone*, and

unworthy your attention ; but still there lies hidden within the crypts of its gaseous atoms a peculiar force of enormous power—that of electricity. What is more grand and terrific than the lightning's flash, as, with tremendous fury, it is sped to the earth in its irresistible

was thought by many to be a peculiar and isolated substance, is oxygen in an allotropic condition. By passing an electric spark repeatedly through oxygen gas, it acquires a very distinct odour (that characteristic of ozone), and possesses strongly marked oxidising properties which did not previously belong to it. This electrified oxygen, which has only acquired peculiar properties of chemical activity—or which is that gas in an allotropic condition—should no longer be termed ozone, as this name implies the transformation of the oxygen into a new body. No doubt but that some of the most energetic combinations of oxygen are effected while in this allotropic condition, as, for instance, when an electric spark is passed through a mixture of oxygen and hydrogen gases, alluded to in the text.

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might, rending to atoms every object which impedes its course ? It is a thing which creates an ungovernable terror, and causes the stoutest heart to quail and tremble ; so awfully mysterious is its visitations, and so instantaneously does it snatch away life, without a note of premonition.

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An incident which transpired several years ago will ever present itself vividly to my recollection. It happened immediately after the prevalence of a violent thunder-storm. The dark clouds had passed away to the north-east, apparently conveying with it its dense charge of fierce lightnings. The deep roar of the thunder, growling in the distance, could be distinctly heard ; and the wind,

in / which a few moments previous had been roused to fury, and had torn up the largest trees by the roots, had now died away to a gentle zephyr. Who would suspect that death, in its most awfully mysterious form, lurked in the impassive air? That the glorious rays of the sun, as they danced from the golden-fringed clouds which lay piled up at the far west, could win from the spirit such responses of applause and gladness, while the fierce messenger of death was gathering its shafts to strike a human soul into eternity. And such a gentle spirit it was! so innocent, so free from alloy of sin, so pure, immaculate, and unspotted of earth!

At that moment of fancied security, when

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tranquillity had apparently usurped turmoil, a flash of lightning of inexpressible vividness ensued, and instantaneously upon it a crash of thunder, as if the granite earth itself were riven asunder. The large three-story brick-house, which stood close me, was shivered to pieces. Its windows were ground to powder; its costly mirrors, and its beautiful ornaments, were fairly pulverized; its plastering was torn off and scattered in dust over the rooms; and utter devastation marked the progress of the electric fluid. But what was the destruction of insentient matter compared with what immediately followed? One, whose intellect and beauty had won the love and admiration of all those who can discern

and appreciate those rare qualities which adorn and add grace and elegance to woman, was instantly stricken to the floor. I gained her side almost immediately after she had been prostrated.

“Are you hurt?” I asked; for so instantaneously had the spirit been snatched away, that the clay had apparently not yet sustained its departure. Her large, dark, lustrous eye gazed upon me with such eloquent and touching sadness, that its peculiar expression can never be effaced from my memory. The damask still glowed in lovely tints upon her cheek; and her lips, slightly separated, retained their ruby. Her features were still moulded into the expression which her gentle

spirit had stamped upon them ere it had taken its sudden departure. She gazed upon me with an expression of touching sadness, as if she were about to utter some word of youthful hope, yet mingled with a shade of its transcient sorrow. But, as I took the inanimate form in my arms, a rapid change came over the features. The lips lost their ruby, and faded away to an ashy paleness. The carnation of the cheeks yielded to a deathly palor, and the eye lost its intelligence, and now looked upon me with the insensible stare of death ; then I realised that the fair creature I held in my arms was dead ; that the electric and the vital spark had fled away together. Oh, what a vast

change was effected here in one brief moment! The strong structure of man shivered and ruined instantaneously, and the wondrous spark, which God alone can create and breathe into a living, imperishable thing, had left its tabernacle of clay and had fled to its everlasting and its mysterious home. And all this was effected through the electricity which lies hidden within one drop of water! What a mighty, a terrific thing is a little drop of water!*

* Through the profound investigations of Prof. FARADAY, we are taught that a single grain of water contains as much electricity as could be accumulated in 800,000 Leyden jars, each requiring thirty turns of the large electrical machine of the Royal Institution of Great Britain to charge it—a quantity of electricity equal to that contained in the brightest and most destructive flash of lightning.

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When viewed in its chemical relations, it is equally wondrous. It contains, beside the thunderbolt, other forces of great moment ; for we can evoke from its crystal chambers enormous quantities of light, heat, and actinism, or the chemical force : besides which, we can trace the existence of other forces too subtile even to admit of investigation, and doubtless as equal in power and importance to those just enumerated. We learn, that this little drop of water is really a great magazine of latent and specific heat ; that this principle lies secreted in it in vast quantities, and can be obtained from it in such volumes, as would really astonish those who would scarce expect to find it in that

little, cold crystal sphere. We learn, that within its crypts, locked up there unperceived, exists a large quantity of light, the beams of which, if released from their fetters, would be adequate to illuminate the most capacious chamber, and to fling a thousand irradiations amid the jewels of its fair inmates. And yet a drop of water is generally considered too minute and trivial a thing to merit the serious attention of the unlearned and superficial, although enriched with lessons of wisdom quite sufficient to chain the wonder and the admiration of the thoughtful and the profound. For it appears that the Almighty has deemed it necessary to link with a drop of water a large quantity of those co-ordinate

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forces which keep the atoms of this sphere in constant action, sustain their integrity, and govern the revolution of planets :

“ The very law that moulds a tear,
And bids it trickle from its source,
That law preserves the earth a sphere,
And guides the planets in their course.”

We learn, that a drop of water has been selected as the great reservoir of those principles; and that heat, light, electricity, actinism, and perhaps other forces equally as potent, have made this little pellucid sphere pre-eminently their dwelling place, whither they bask until it is necessary they shall be awakened to life and activity, to the fulfilment of that great task in the economy of nature which God has so wisely allotted to them.

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What a wondrous thing is a little drop of water, when we view it in all its conditions! What is more charming to gaze upon than the precious and regal opal? Observe its peculiar play of delicate tints, now emitting the lovely cerulean which tinges the clouds that lag behind the setting sun. And now, as ye shift its position in the sight, displaying beams of red and yellow flame, like the flickering lips of the dying dolphin. What a strange and lovely creation is this opal! Yet these brilliant colours, so highly valued by men, owe all of their existence to a little drop of water which has secreted itself within the gem, and, combined with the dull flint, has given rise to these valued qualities.

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Little do we imagine, as we gaze with wrapt admiration upon the statue, so cunningly fashioned by the inspiration of genius to mirror the plenitude of youthful and voluptuous loveliness, that it owes all of its properties of receiving and preserving such delicate impressions, to a few drops of water which have secreted themselves amid the lime. Withdraw these drops of water, and this figure which so faithfully delineates the contour of symmetry and loveliness, will crumble before the eyes into a pile of unsightly dust.

The bright gems which sparkle on the form of beauty, and display such a variety of characteristic tints,—the topaz, the amethyst,

the sapphire, the tourmaline, the onyx, and all of those elegant crystals which so exalt the loveliness of woman as she moves with such bewitching grace amid the voluptuous dance, owe all of their valued properties to a little drop of water, which, lodging itself within the gem and associating itself with some dull powder, mostly of flint, confers upon it these promethian qualities.

The great mountain chains which rib our earth and add grandeur and sublimity to its scenery, owe their present state of durability to water, which solidified in their substance, combined with earths, give stability to what would otherwise be but monotonous and unsightly dirt.

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Everything we see is associated with the little drop of water, for even the translucent air is highly charged with myriads of exceedingly minute ones.* With every breath we inhale, we take into the lungs a quantity of this water, which gaining ingress to the system is soon decomposed, and ere long has converted itself into a part of our organism ; is susceptible of sensation, of motion, of vitality ; is, in truth, converted from inanimate to sentient, percipient matter—into that susceptible of eliminating thought—has left its condition of a drop of water, and gone

* If the moisture which generally exists in the air were to condense upon the earth, it would form a stratum of water of about five inches in depth.

into that of the organism of a human being. Still, how little important is a drop of water to the majority of mankind, and is scarcely noticed as they hurry along amid the busy scenes of life ! But still the little drop of water is ever active in the protean task allotted to it from the beginning of creation ; and, although we scarcely deign to notice it, the little thing is ever engaged in the fulfilment of its task in the preservation of our system from the action of the oxygen of the air ; in the production of the vital heat ; in the preservation of the form's contour ; in keeping up the integrity of the blood and the secretions ; as a vehicle in the eduction of the excretions, and in the assistance of

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almost every phenomenon which transpires in the system.

We said that the air, transparent and free as it appears to be of moisture, is the residence of myriads of little drops of water. Here they lurk invisible, but fraught with their inherent activity ; and when the burning sun of the tropics has withered and scorched the vegetation through a long and cloudless day, and almost dried from it the very life-blood itself, the little drop of water leaves its home in the lucid air, and, like a good Samaritan, relieves the parched leaves with its life-giving balm.

As one ancient people worshipped fire, so did another, with equal philosophy, worship

water ; and although we may apply the epithet of Pagan to their devotion, and stigmatize it as idolatry, still there is a philosophic spirit invoked in their veneration for such a benificent gift as water ; for observation must have taught them, that to trace the little drop of water through its labyrinthine task, was to derive lessons of the infinite wisdom and goodness of Him who ordained the drop of water as one of the most eloquent exhorters of his beneficence.

It is through the drop of water that we derive some of our most significant lessons in the world of sentiment which sways the human heart with such singular power. We have beheld a strong man struggling with

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herculean energy against the tortures which swayed his almost bursting heart. The cold perspiration stood upon his brow, and his ashy lips trembled with the emotion he strove so sternly to subdue ; but the fountains of his soul were heaving from their depths, and all the power of his almost inflexible will could scarce resist their strength. But the crystal drops started from his eyes, and, like a healing balm, they tranquillized the contending commotion of his soul. What a wondrous solace are tears to the afflicted ! The heart, which is struggling like a giant against the overpowering storm of the soul, is, like the elements, soothed down, and sleepeth in peace, after the assuaging fall of the tear-drop !

And then, again, when the heart grows blithesome and buoyant with the strange and mysterious vista which the spirit is ever and anon allowed to have of the glories which await the good, the noble, and the virtuous in the future; how instantaneously the crystal tear clouds the eye, and, like an angel of mercy, reveals the bright hope which lies concealed within the human heart! I have beheld the sparkling tear drop start into the eyes of the noble and the generous as the recital of some great and good action sent a thrill to the heart, and awakened a sympathetic and harmonising response within it.

Yet how small and trivial a thing is a drop of water, but still what a wondrous one! It

is true, that it is but a pellucid crystal sphere ; but still it is the messenger of grief, the bearer of joy, and reveals, in its own brightness, the harmonising emotions of the soul.

Not only has the Almighty exhibited in the little drop of water these qualities, but He has chosen it as the vehicle through which to reveal his mercy and his wisdom. What is more refreshing and more invigorating to the invalid, parched with the burning fever, than the clear, cool drop of water.

“ It is a little thing,
To give a drop of water, yet its draught
Of cool refreshment, drained by fever'd lips,
May send a shock of pleasure to the soul
More exquisite than when nectareous juice
Renews the life of joy in happiest hours.”

How quickly it imparts to his enervated system renewed vitality, rouses up the slumbering powers, gives impulse to all of the secretions, steals from the diseased organs their ailment, and restores health and vigour where there existed disease and weakness.

It is the little drop of water which dispenses gladness, and health, and life over the earth; which contains within its bosom the vitality of every created organism, whose presence is rosy health and robust vigour, whose absence is pallid death.

Through this little drop of water, the Almighty has preached to man, for long ages past, a *promise* of hope and joy; and in the refracting properties which He has imparted

to the little drop, it is eloquent in His praise with each refreshing shower, adding to this cheering hope the indescribable loveliness of the rainbow.

It is the little drop of water, as it playfully dances to the earth, which inspires in the contemplative mind sentiments of thankfulness and silent, heart-felt adoration ; for we reflect that in this glittering little sphere the destinies of all created things are implicated, and that the sparkle of this little globe is the renewal of gladness upon the face of the earth, while the bright flower, which modestly diffuses its fragrance in the air, silently responds to its joyful kiss ; and that the great staples of human industry are directly depen-

dent upon it, and that the wealth and greatness, or the poverty and downfall of nations, are connected solely with its visitation. The poet who exclaimed that "There are sermons in [^]running brooks," had associated with his fervid fancy the axioms of philosophic wisdom ; for he saw, that the drop of water, in its silent way, illustrates and preaches most eloquently those great truths which exhibit themselves, in grandeur and majesty, in the progress and revolutions of suns and planets ; and he, too, must have felt, that within this little sphere a wise Creator has implanted such significant sermons, that he who observes cannot be otherwise than a devout worshipper.

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97 I remember, that one bright, summer day, I strolled into the forest to meditate, or perchance to mitigate the profound grief which preyed upon my heart. It had been but a day previously that one, whose bright blue eyes and silvery voice had lightened many a sorrow, and inspired my heart with joy and pride, had been laid in the grave to her silent repose. I say, that a feeling of deepest gloom and despondency clung about my heart ; for the future to me was bereft of its beams of hope, and it appeared as if the Great God had withdrawn from me those bright gems of consolation which are vouchsafed to all of His frail and erring children. At that moment of affliction, as

I stood, with hands folded, in broken and ineffectual prayer ; with a heart trembling with subdued emotion, and harrowed with the anticipation of a cheerless future, a fugitive beam of light stole within a little drop of water, and in a flood of coloured pencils, was refracted into my eyes. And as the frail gossamer, from which the crystal globe depended, swung to and fro, agitated by a gentle zephyr, the dew-drop, ever and anon caught this beam of light, and as often flung it into my eyes, like a ray of silvery hope upon the heart of youth. And mine, as if inspired by a spirit of transcendent power, with a start awoke to life and to tranquillity ; and I became cognizant, that

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even in the gloomiest moments of despair there is an ever-watching Providence ready, through some frail and apparently unimportant thing of creation, to teach us, that all, which are most dark and most desolate, which contain within them apparently the elements of eternal gloom, are rich in the germ of light, and life, and happiness ; and that to grieve in the anticipation of a hopeless future, is but to implicate the Creator in those qualities which would delight to torture and to torment, where He would but chasten and purify. That was but a trivial instance ; but it transfused such a flood of hope into my heart, that, to this day, the consolation derived from that little, depending

drop of water, has never ceased to influence it.

Turn not, therefore, from the monitions which a drop of water can furnish, nor from the wisdom which it can silently inculcate; for although it may be but the voiceless creature that receives its birth from the midnight air, still that little globe of dew may some day hence, as it did to me, teach you the lesson of hope, and of steady, unfluctuating reliance upon the wise purposes of Him, whose ordinances may not at all times appear wise and just, yet whose purposes always terminate in their certain fulfilment.

It thus appears that a wise Providence, ever solicitous for the happiness of His crea-

tures, has selected the drop of water as the vehicle by which much of our enjoyment may be derived. To gaze upon the creations of beauty, to worship the æsthetic, is to the well-organized mind a source of happiness. What can be more lovely than the gorgeous hosts of clouds, as they appear marshalled upon each other in the path of the declining sun, and gleaming after him myriads of his scattered and decomposed rays? What is more glorious than the superb metallic hues which those fleecy mists collect and refract in such magnificent floods? Yet these refined creations, apparently too brilliant for this earth, are but an aggregation of little spheres of water, each one of which, in accordance

with the special property with which the Creator has endowed it, refracts and decomposes the beams of light, separating its many pencils into brilliant colours, perceived agreeably to the position of the drops from the eye.

To write out the various offices which a drop of water subserves in the currency of nature would swell this unpretending essay into a large volume. We scarcely have a chemical change unless the little drop is implicated in one way or another with it. And then almost every change which ensues in nature is attended with the decomposition or the recomposition of water. These little drops of water have been chosen to manifest in

nature what has been erroneously deemed an anomaly, or a deviation from a general law in the expansion and contraction of bodies. When the air gets cold, it chills the surface of the water, and that fluid, obeying the general law, that cold condenses and heat expands, becomes heavier than the water beneath, and, condensing, sinks below, while the warm water rises to the surface. This, in turn, becomes chilled and sinks, the warmer water below rising again to the surface in its place. This circulation continues till the whole bulk of the water falls to the temperature of 40°F. , when a reverse process ensues. Now, after this, if the cold be continued (or heat abstracted), the water does not continue

to become denser, but, on the contrary, lighter. The consequence is, that the water rendered colder than 40°F. remains on the surface till it is reduced to 32°F. , when it commences to get solid, or to freeze.

We at once perceive the consequence of this in the economy of nature. When cold weather sets in, the surface of our lakes and rivers is chilled. The superficial water sinks and gives place to the warmer water from below, which, cooled in its turn, sinks likewise. But this circulation downward and upward ceases as soon as the whole of the water has reached the temperature of 40°F. , or eight degrees above the freezing point. After this, the cooled surface expands instead

of contracts, and from its lightness remains on top, while the heat—from the imperfect conducting properties of water—is propagated upward but slowly, or scarcely at all. The surface finally freezes, and the ice may become thicker, but at the depth of a few inches below it, the water remains at 40° . If it were not for this wise provision of an infinite Intelligence, our lakes and rivers would soon become frozen solid to the bottom, for if water continued to condense as it got colder—as do all other bodies in nature—it would continue to sink as it chilled, till when the whole body had lost its heat and sank down to 32°F. , it would solidify into a mass of ice, to the utter destruction of every thing

which inhabited it. Upon such delicate and beautiful adjustments in the drops of water do the order and harmony of the universe depend!

But were it not for the little drop of water, there really could ensue but few changes upon this earth. Chemical investigation has proved that almost every change, within either the inorganic or the organic departments of nature, is accompanied with the decomposition or the recomposition of water. Scarcely has the breath left the body ere there is a rapid play of elementary affinities, one of the most inevitable and important of which is, the combination of the hydrogen and the oxygen of the tissues into water. This water, escaping in little drops into the air, is soon called upon

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to fulfil its destiny in the economy of nature. It soon gains ingress to the tissues of the vegetable and animal organisms, and then again undergoing decomposition, contributes to the formation of organs gifted with vitality—but only to remain in that state a time, and then again to combine as water, preparatory to another task in the building up of forms.

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The drop of water appears to be the transferer, or the conveyor, of the seeds of vitality from dead to living forms, and, while in their transition state, appears to be the magazine in which they are stored until required. Containing, as it does, two of the most necessary constituents of the vegetable organism, it

therefore becomes involved in all those changes which it undergoes, either in the formative process, or that of the entire separation of its elements. There is not a vegetable or animal organism in existence which does not contain the constituents of water, and likewise that fluid already formed. Were muscular flesh to be entirely desiccated, it would thereby lose 80 per cent. of its weight, or if one hundred grains of it were thoroughly dried, there would be but twenty grains left. If the hydrogen and oxygen, or the constituents of water, were withdrawn from it, there would only be a little carbon and nitrogen left, the latter escaping as gas, and the former remaining as charcoal.

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We find, on taking cognizance of the arrangement of the various substances upon the globe, that there is a peculiarity in their constitution, which, by their dissimilarity, contributes to the harmony of nature. Were the constituents of the atmosphere—that is, the two principal constituents—to be combined chemically, all living things would perish. On the contrary, were the two constituents of water (oxygen and hydrogen) to be mere mechanical mixtures, then equally disastrous results would follow. The elements of the air, through their non-combination, allow plants the facility of restoring the oxygen which the breathing of animals had converted into carbonic acid. It is necessary

that all the volatile and gaseous bodies thrown into the bosom of the air should exist there as a mere mixture with its constituents, otherwise the rains which fall would be unable to separate them and bring them to the earth, there to subserve the purposes of vegetation. Besides, were they not mere mixtures, vegetation would be unable to separate the carbonic acid and ammonia from it required for their nourishment.

But, on the contrary, from the chemical combinations of the constituents of water, a series of special reactions follow in organic nature. Chemists are well aware, that when a substance is decomposed, that others in its vicinity are liable to be effected by that dis-

turbance, and to undergo decomposition likewise. Thus, when water in the capillaries of vegetables undergoes decomposition, all substances situated within the circle of its action are liable to undergo a similar change.

n/ Perhaps the most important task of water is, that it serves to moisten all living organisms. Without water, therefore, no living thing could long survive. Witness, for instance, the effects of a long drought, where the vegetable world becomes parched and dried from the partial deprivation of water for only a few weeks. The foliage becomes pallid and withered, and hangs wilted upon the stems, and the process of death and decay has commenced. Thus water is absolutely necessary

to preserve the fleshy soft parts of plants and animal's moist to enable them to grow and to be fed. Those plants, therefore, which are young, are generally softer, and contain a greater quantity of water, than older plants, in order that their development and growth may be more rapid. The presence of water in the atmosphere is a wise and beneficent contrivance, and exhibits, in a striking light, the pre-vision of that Allwise Being, whose ordinances are instituted for the well-being of all sensuous organizations. The existence of water is inseparable from that of life, for no change can transpire within either the animal or the vegetable organism without the aid of water. It is only through the circulation of

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water through the capillaries of the organic body that growth or life can be obtained.

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The various combinations of the four organic elements which transpire within plants, could not ensue were it not for water; for by its means those substances which re-act upon each other, are brought into contact, and thus we have those innumerable changes and productions of new compounds, so characteristic of the vegetable world.

The evaporation of water through the stomata of the leaves, subserves a great purpose in the economy of Nature; for as the water is excreted pure, of course the substances it bore along with it are either deposited in the body of the plant, or else in the leaves.

Pure water seldom exists on the earth's surface. It generally holds in solution inorganic substances, which are indispensable to the life of animals and plants. In fact, the serum of the blood is not unlike natural or spring water in the substances it holds in solution, and many of those substances are really derived from the water we drink ; thus, the chloride of calcium and magnesium, the carbonates of soda, lime, and magnesia, the sulphate of soda, and the potash and phosphate salts, are all derived, more or less, through the water we drink. These considerations indicate to us that pure water is not so healthy to drink as natural water ; for we must conclude that as the latter so plenti-

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fully abound[^], almost to the exclusion of the former, that the health of animals and vegetables depend[^] more upon it in that state than if it were pure.

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But let us trace out the little drops of water in whatsoever direction we choose, we are only impressed with the indispensableness of that fluid. We said, that nothing can possibly live without the presence of water; for its quality of moistening everything it comes in contact with, renders it absolutely necessary to all living organisms. Chemically speaking, it conveys, whithersoever it goes, two of the principal constituents of all animal and vegetable organisms, oxygen and hydrogen. It is principally through the decompo-

sition of water that these two indispensable elements are derived—elements which form a large portion of our own bodies, and the absence of which would involve at once the life of all living things. Wonderful and indispensable is the little drop of water—that crystal sphere which implicates the destiny of all living creatures! There is scarcely anything which is free from the drop of water, or its constituents, although no appearance of moisture would indicate it. When lime is slaked, it absorbs one-third of its weight of water, which is concealed within it in a solid form; still the lime, after slaking, appears quite as dry as when it was in the condition of quick-lime. In all the hydrates the little

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drop of water lies concealed—solidified—in like manner, so that, although the water is there, one would not suspect it from the appearance of the salt. Many of the natural crystals and stones, as the quartz, sapphire, garnet, topaz, and even the diamond itself, owe their intense hardness to water alone; for, if they be deprived of that water by heat, they lose their indurated and crystalline appearance, and fall into powder. In what a solid and dense state must that water exist in those brilliant stones! Little dreams the tradesman, that in purchasing one hundred pounds of soap, he is paying perhaps for fifty pounds of water, which the cunning manufacturer has secreted there, and which only

manifests itself in the solidity and beauty of his productions! In truth, when we take cognizance of symmetry and beauty, whether in the geometrical arrangement of a crystal, or the contour of an organism, we must attribute it all to the little drop of water; for without its presence, all solidity, all graceful curves, or geometrical angles would cease to exist. Withdraw the drop of water from the crystal, and it will instantly lose its characteristic colour, sparkle, and beauty; its lovely refracting and reflecting properties will be gone: it will be bereft of its power of polarizing the rays of light, will lose its crystalline form, its transparency, its density and lustre, and will fall into dust.

Withdraw from the air the infinitesimal drops of water which are diffused through it, and all animated things would quickly perish; the sun would sink down in the west like a great red-hot ball, unenlivened by crystal clouds, or by the exhibition of any colour, save that of its own lurid hue; while the order and the harmony of this beautiful world would soon be usurped by chaos.

The drop of water, we say, is a wondrous creation, and really bears within it the expression of all that is bright and beautiful on this sphere, and contains within its crystal atoms not only the integrity but the vitality of all living things.

Thus we perceive a vastly important instru-

ment in a drop of water. We learn that it contains within it the property of developing the liveliest tints which give beauty to natural objects—that it contains locked within its transparent atoms enormous forces, which, aroused to activity, and released from their concealment, are capable of rending to splinters the stoutest oak, of upheaving mountains, and destroying continents. That it is a great instrument in the moral world, and subserves in the realm of thought and feeling an important destiny in the furtherance of incalculable good.

We must now take cognizance of a drop of water in another relation; and we now perceive that although a small thing, it

furnishes an asylum for worlds of living creatures, so infinitesimal that millions of them dwell within it, with ample room to move about—a mass of creatures nearly equal to all the human beings on the globe.

We learn that these little people, like ourselves, have the power to move about at will, to feel and to see—that they possess their likes and their dislikes, and their moments of pleasure and of pain. Like ourselves, they, too, have their destinies to work out, their cycles of existence to pass through, their allotted time to fret on this earth's stage, and their time to die.

But as a drop of water is a little thing compared with this great sphere we claim

to be lord of, so, correspondingly, is the duration of life of its inhabitants narrowed down in accordance to the area of the theatre of their existence ; and while man exists to the average of sixty years, they pass through all the phases of their life, and die, sometimes in as many minutes, and seldom live more than as many hours.

I have often been struck with the great analogy which exists between monadal life and that of man, although the latter comprises years, where the former occupies minutes. Frequently I have placed a drop of water under the microscope, and found it teeming with life. Its whole area was densely peopled with busy beings, each one

following eagerly its occupation, nor dreaming that death and destruction were so nigh.

But when we take cognizance of time in the abstract, is not man placed in the same perilous situation ? What are sixty years in the great cycles which are involved in the movements of suns and of galaxies ? They are but a moment ; but the brief hour allotted to the monad !

I observed, too, that these busy little people resided in the most delightfully umbrageous retreats, comprised of minute cryptogamous plants, whose reticulated branches formed refreshing arbours and shady recesses, in which I could perceive little beings enjoying a secluded and placid existence, with every

demonstration of that appreciation of it which we manifest. Who can tell but that, within those shady recesses, there flourished the sentiment of love; that here the heaven-born passion, whose inspirations suffuse a golden hue over life's sombre realities, existed as with us of larger mould. For here, these little creatures, sequestered within those refreshing grottoes, were evidently experiencing their moments of quiet happiness—of tranquil joy.

And this little trifling drop of water really contains a world, not only of animal, but of vegetable forms, each inhabitant of which was seeking and finding that enjoyment, that unalloyed happiness, which we so eagerly

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chase after during our more prolonged space of existence. Here, in this minute world, I found that the great elements which exist in ours are equally as potent, and that existence there is composed likewise of alternate impulses of happiness and of misery ; that life is as active and as busy, and death as inevitable and as rapid.

I examined that drop of water several hours subsequently, and what a change had ensued ! Centuries had elapsed. The beautiful umbrageous cities had gone to decay, and were now but the crumbled remains of their former beauty. Ruins lay scattered about on every side ; and of that vast busy multitude, not one being existed to tell the

tale of their former prosperity; but they had all passed away in the lapse of time, and their cities presented but a melancholy picture of ruins and of desolation. What mattered it now, whether these little cities were those of man scattered over the plains of Palmyra or Thebes, or the *débris* of a microscopic city existing within a little drop of water. Time hath done its work with both, and silence and desolation reign among them all. What is the difference between that drop of water and a globe like ours? The difference exists significantly only in *time*; for while the changes in the one are cognizable by minutes or hours, those of the other require corresponding years: but the same fate is inevit-

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able with the inhabitants of both, for, to sustain the vicissitudes of life, to pass through its cycle, and to die, appear to be the destiny of all created things, whether they be man with the Godlike intellect, which can pierce millions of miles into the planetary space, or the little monad whose perception is limited to the boundaries of a drop of water.

To this little creature, whose eternity is comprised within a few hours, what must a duration as great as our average life of sixty years appear? To its finite conception, this distance of time would be wholly incomprehensible were it gifted with reason in accordance to its size ; still to man there are epochs and distances which are as equally over-

whelming to his mind as would be sixty years to that of the little inhabitant of a drop of water. The great universes, stretching out along their co-ordinates, Time and Space, call forth the powers of man's mind, till it is fairly stunned with the attempt to form a conception of the distance which separates them, and of the durations comprised in their changes. When we learn that nebulæ are situated so far away from us, that light, traversing space at the amazing velocity of 200,000 miles each second of time, would consume millions of years in winging its flight through the vast abyss which intervenes between them and us, we admit that a distance so great is totaliy beyond our

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powers of comprehension ; and that, as we are removed so far above the monad in our power of grasping time and distance, so must there exist a Being as far transcending us in all which is powerful and intellectual.

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A little drop of water furnishes a theme for contemplation even to the profoundest thinker ; for he must perceive that it contains a vast amount of the agents which impart to nature her creative energy ; and it is the receptacle of those great governing laws, which, so far as human comprehension is concerned, are co-ordinate with eternity itself.

Accompanying this little volume is a faithful drawing of a drop of water, as I actually observed it under the microscope

on the 28th day of September, 1850. You will perceive that it is closely crowded with living beings of a great variety of curious shapes and sizes. It is not often that an isolated drop of water, even in the south, can be obtained which will contain so great a number of creatures of such a variety of genera and species. The location where I obtained this drop of water, is prolific in infusorial creatures. It is, so far as monadal conception is concerned, a vast lake, whose almost illimitable area extends several feet in one direction, and several inches in the other. Its depth extends to the almost unfathomable profundity of half a foot, varying, however, to one inch.

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J/ In gazing through the microscope at a drop of water, we soon begin to assimilate ourselves to the infinitesimal perceptions of the infusoria. With an objective lens of deep power, we can include within the field of view but an exceedingly minute area of that drop of water; but still this little surface soon appears to expand, till we begin to conceive of it as a boundless sheet of water of unfathomable depth, and its minute inhabitants as creatures of enormous size and power. This feeling grows upon us, till really the hundredth part of a drop of water becomes an important lake, nourishing within its bosom various sub-aquatic plants, and furnishing an asylum for a greater variety

of animal existences than we are able to perceive with the naked eye, were we to penetrate to the depths of the most prolific lakes of the Indies.

I have searched for hours in the hope of again viewing some strange creature which, with lightning velocity, had darted across the field of view; but after that tedious search, I was necessitated to give up the task in despair, so expansive is a drop of water! The creature was certainly there, but while I was traversing one portion of the lake for the object of my search, doubtless it was in another location busily devouring some less creature which it had captured.

The rapidity of progression of these little

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creatures also becomes magnified correspondingly ; and that progress which would require several minutes for an animalcule to traverse the diameter of a drop of water, would occupy the field of view (say about five inches) so inconceivably brief a time, that the eye would scarcely be enabled to detect the creature's contour.

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Before describing the animals figured in our drop of water, I wish to make some few remarks upon the nature and habits of infusoria in general. If any vegetable or animal matter be placed in water, and macerated for several days, some varieties of animalcules will make their appearance. It appears almost impossible to arrange

circumstances so that the development of these creatures shall be avoided. Even if the water be boiled, and the maceration be excluded from the air, still infusoria will make their appearance. Mr. Crosse, of England, has tried these experiments perhaps more thoroughly than any other person, and the results of his labour have with many persons revived the obsolete doctrine of spontaneous generation; but as this, in the present state of science, is inadmissible, we must be led irresistibly to the conclusion, that some source must have been left open, by which the introduction of the ova of animalcules into the medium experimented upon ensued. Therefore, under every circumstance which

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the reader would be likely to introduce, animalcular life will respond to the maceration of animal or vegetable matter in water.

These creatures will present genera depending upon the nature of the infusion. In that of hay, *Rotatoria*, or wheel animalcules, will abound, together with great numbers of *Monads*, and other *Polygastria*. But the most beautiful and rare species are not to be obtained in that manner. They invariably abound in pure running water, and are generally found associated with vegetable matter, or else in the mud at the bottom, or attached to the stems, leaves, and twigs, of aquatic plants. It was upon such water, among the vegetable matter floating on the

surface, that the drop was obtained which furnishes the magnified illustration to this little volume.

These creatures will be observed in constant motion ; so perpetual indeed, that some microscopists have given it the designation of automatic or involuntary, similar, for instance, to the action of the heart. I cannot conceive wherefore we should form a conclusion not countenanced by analogy. We have every reason to suppose that animalcules require the recuperative influence of rest and sleep equally with all other living creatures ; and, because we never observe them only under strong illumination, we should not suppose that they do not rest

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nor sleep in darkness.* This little drop of water furnishes us with modes of animal increase which have no analogue *on land*,—

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* Some experiments I tried last summer appear to support the supposition that, like all other living things, animalcules require sleep. I so adjusted the mirror and slide of the microscope, that in an instant a beam of light could be darted upon the latter. I likewise arranged a candle so that none of its light could reach the slide, only when its rays were thrown upon it by means of the mirror. In a drop of water in the slide I had several animalcules of the genera *Brachionas* (see the drawing No. 21). They were very active creatures, apparently never at rest, but constantly engaged in feeding upon some *Monas Termo*, of which genus the drop abounded ; or upon some vegetable matter at the bottom. After allowing the drop of water to remain in the dark for a few minutes, I placed my eye in the proper position, and then darted the light upon the slide. The animalcules, even the Monads, were all quiet, but instantly assumed their characteristic activity. I tried this a number of times, and invariably with the same result. This appears to substantiate the supposition that these creatures, even those of simplest organization, require

viz., those of propagation by gemmules and by fissuration. In the former case, buds grow from the creature and increase in size, and in resemblance to the parent, till they arrive to maturity, when they become detached, and commence a separate existence. In the latter, a slight fissure will be observed, at first resembling a line across or down the body of the animalcule, and which soon grows more perceivable and deeper, till finally sleep or rest. It has been asserted by the ablest of physiologists, that during the night vegetables sleep. This is the opinion of SCHLEIDEN, and of others who are his compeers in intellect. If this be true, should we not suppose that creatures still more highly organized require rest likewise? Night appears to be the time for a universal cessation of labour, when the exhausted power of the organism requires recuperation, through rest, and it is unphilosophical to except the smallest being from this general law.

the creature appears double. The two bodies gradually separate, and then become detached, each animalcule swimming off in an opposite direction. This fissuration takes place longitudinally in some species, and transversely in others. In others, both gemmation and fissuration take place. Others increase by double germs, as the genus *Closterium*. Others are viviparous, or produce their young alive from their bodies ; while others are oviparous, or produced by eggs. In some instances the egg is retained within the creature till hatched (ovo-viviparous). Several species have one or more eggs attached to them—as the Brachionous—which they carry about with them till

hatched. Some retain their eggs within a sheath till hatched, as the *Floscularia*, &c.

Many of these little creatures, although reduced in size to a mere point, are enveloped by a *lorica*, or shell, some of which are composed of silex, or flint, and others of lime. Others are enveloped by a soft membranous covering, which adopts itself to the state of repletion of the creature. The shells of the former, in the most beautiful state of preservation, are found fossil, forming in some places strata of many yards in thickness. Some of the infusoria are enveloped in a lorica resembling a pitcher, or a box, while others are protected by a carapace, or shield, not unlike that of the *Chilonia*, or turtle tribe.

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It will be perceived by their various methods of propagation, that animalcules increase with amazing prolificacy. I have computed as many as seven hundred millions of the spirillum in one drop of water. I have also found as many as five hundred millions of monads in each drop of water, which was furnished me by the proprietor of Castle Garden, New York, in 1845. None of these creatures attain a greater size than the twelve thousandth of an inch. In a cubic inch of a species of slate, or mould, which Ehrenberg found, he estimated that it consisted of not less than forty thousand millions of distinct shells. It has been calculated that a single animalcule, invisible to the naked eye, will,

in four days, increase to the number of one hundred and forty *billions*.

The rotatorial animalcules are propagated from eggs, but these eggs hatch with such rapidity, that millions are produced in the course of a few days, and, perhaps, with some species, in as many hours, from a single individual. These little creatures are highly organized, many of them possessing a number of stomachs, and eyes of a deep red colour. They also have teeth, and organs of prehension, or for the purpose of capturing their prey.

I am well aware that it is the fashion to consider these little creatures as belonging to the scale of simplest organization. It has

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been asserted by those who have not, perhaps, investigated the subject thoroughly, that the infusoria are of the simplest organization; many of them, it is asserted, being but a single cell possessed of animation. It is doubtful with me whether the monads even, although they present, through our present lenses, the appearance of single cells, are really such. I suspect that they, too, are highly organized; but such is the extreme delicacy and minuteness of their tissues, that our highest powers cannot reveal or define them. It is even asserted by some naturalists that the single cell of animal and vegetable organisms are analogous; that, in fact, the one may be the germ of the other, depending

upon circumstances: such is, in my opinion, inadmissible. Each cell is the depository of its own inherent and specific energy; has its own individuality as strongly marked as the egg of the hen, or that of the eagle. The single cell of the lowest vegetable organism could no more be made to produce the organism of the lowest animal, than the egg of one bird could be made, by a particular mode of incubation, to produce the young of another. Each germ, even of the lowest organism, is gifted with its own specific energies, and which will develop[^] themselves when that germ meets with those conditions which are calculated to secure that development. We must not suppose that because

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the simple cell of the animal and the vegetable appear alike under our highest powers, that they are really so. On the contrary, they as widely differ as do their matured species, and that difference will soon become manifest if the two germs are placed in conditions compatible with their growth and maturity. It does appear to me that the idea of the cell of the animal and the vegetable being analogous, and the one susceptible of conversion into the other, proceeds from a too superficial view of the subject.

The larger species of animalcules are certainly highly organized, and appear to be gifted with as much of the percipient faculty as animals which are generally considered

more thoroughly constructed. The animalcules, or at least many of them, are very tenacious of life. Ehrenberg, whose unremitting and arduous study of these creatures have rendered his name justly illustrious, has exsiccated many of them until they were, to all appearances, perfectly dry and dead. But in this little point of arid matter the mysterious principle of life was still sustained; for when the animalcules were moistened, or placed in water, they soon swelled out, gave indications of life, and finally revived, swam about, and captured their prey as usual.

It is not my purpose to write a history of the little creatures which dwell within a drop of water, as this, to do it anything like

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justice, would occupy more space than is assigned to this little volume.

I have rapidly and cursorily gone over such portions of the history of animalcules as will render the description of our drop of water intelligible. The drop of water, which accompanies this volume as a magnified illustration, is represented as it appeared under a high power of the microscope, and, therefore, but a small portion of the area of the drop is represented. The drawing contains, it will be perceived, a number of curious creatures, belonging to different genera. It was procured from a little sheet of water in the vicinity of Memgahis, in the state of Tennessee. The surface of this pond was

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densely covered with vegetable matter, while there flourished within it a variety of sub-aquatic plants which furnished food and an asylum for a vast number of infusoria. The creatures, faithfully figured in this drawing, were all found in a single drop of water, and were examined by several other persons, besides myself, for several hours.

I am aware that some microscopists may assert, that it is impossible to detect all of these species of infusoria, at the same time, in a single drop of water, as some of them are figured and described by authors as spring animalcules, while others are described as abounding only in the autumn or summer. I will remark that in the southern states,

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I have observed no defined season for animalcules, but that I am just as likely to find those which are described as abounding most plentifully in spring, in the summer, or autumn months, as in the early parts of the year. It is usual for me to find the *Euderina*, which is described as most plentiful in the spring, in company with the *Volvox Globater* (autumn or winter) in the same drop of water.

It is probable that in countries whither the seasons are more marked and contrasted, the appearance of infusoria correspond with their vegetable productions; but when the climate approximates that of the tropics, in which there is but little difference in the temperature of the seasons, it is natural to

suppose that the animal creation should resemble the vegetable [^] in flourishing and producing the entire year. /

It is, therefore, not surprising that I should find so many creatures belonging to different genera, or even families, in the same drop of water; for in every condition which offers them an appropriate asylum, I find them teeming in vast numbers. They are found in a fossil state even to great depths in the earth, and the bottom of the ocean. I have some beautiful species of animalculites, furnished me by our eminent observer, Professor Bailey, of West Point, which were dug from an artesian well 135 feet below the surface of the earth. But there is no locality offering *

the least condition for animal existence, but that will furnish us with animalcules, either recent or fossil :—

“ Full nature swarms with life ; one wondrous mass
Of animals or atoms organized,
Waiting the vital breath when Parent-Heaven
Shall bid his spirit flow. The hoary few,
In putrid streams, emits the living cloud
Of pestilence. Through subterraneous cells,
Where scorching sun-beams scarce can find a ray,
Earth animated heaves—and upon the pool
Stands mantl'd o'er with green, invisible,
Among the floating verdure millions stray.
Each liquid too, whether it pierces, soothes,
Inflames, refreshes, or exalts the taste,
With various forms abounds. Nor is the stream
Of purest crystal, nor the lucid air,
Though one transparent vacancy it seems,
Void of their unseen people.”

The smallest of living creatures, so far as
the present condition of our achromatic lenses

will inform us, is the MENAS CREPUSCULUM, or TWILIGHT MONADS* (fig. 1). It exists in one

* I would take the occasion here to remark, that the objec-tions that I made use of in these observations are those of Mr. ANDREW ROSE, of London. The excellency of Mr. ROSE's lenses requires no eulogy from me, as the verdict of Europe and America has been pronounced in their favour. Should this little work, inefficient as it is for that purpose, induce others to visit the Invisible World, I certainly would advise them not to commence their observations with common lenses. Begin at once with the best of achromatic lenses, such as those of ROSE, of London, or SPENCER, of America, or all the observations you make will amount to nothing, and be just so much time and trouble thrown away. Eleven years ago I asked Mr. PRITCHARD, of London (one of the fathers of Micrology), what I had better do with my common lenses? He answered, "Procure a good achromatic lense, and pitch yours behind the fire-place." I did so, and the substitution was so satisfactory, that I would extend the advice to all those who use common objectives. Procure the best of achromatics at once, and then go to work. Don't be afraid of a little pedestrian exercise, nor of a little moisture, but be industrious and fearless, and success will reward your spirit.—See Appendix.

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drop of water highly magnified. They are spheroidal and nyoline, or present a glassy or transparent appearance ; but when aggregated closely together, the water appears of a milky hue. They are very active little creatures, and are carnivorous, as they feed upon animals as well as upon fungoid substances. As an illustration of their extreme minuteness, I would mention that those figured in our drawing, are magnified 800 diameters, or that the entire animalcule, as presented in the plate, is six hundred and forty thousand times larger than its natural size. As a more striking illustration of the minuteness of these little creatures, I will mention that it would require a person

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(counting at the rate of four each second of time) to count, without an instant's rest, for the prolonged lifetime of nearly one hundred years, to enumerate the number of twilight monads contained within a bulk represented by a grain of sand the one-tenth of an inch in diameter; or [^]a grain of sand the size mentioned, would equal in bulk a group of these creatures comprised of thirteen thousand millions of them. Still each of these minute beings is furnished with an organ of progression, being a cilium, or hair, which issues from the mouth. With this delicate organ it progresses through the water with considerable agility. It is an exceedingly active little creature, constantly

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moving about in search of prey or food. Although its body is so small as to be comprised within a mere point, even when magnified many millions of times, still it possesses several stomachs, and, in fact, is highly organized.

The twilight monad is found in Tennessee, at all times of the year, among the vegetable matter which floats upon the surface of the water.

THE SPIRILLIUM VOLATOUS, OR THE TWIRLING SPIRILLIUM (2).—This little creature is likewise termed the *screw vibrio*. I have never seen a drop of water so crowded with these infinitesimal creatures ; it contained about as many inhabitants as there are human beings

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on this earth. By careful micrometrical measurement, I have calculated that water I have obtained in Tennessee contained about seven hundred millions of these restless creatures. Still they had ample room to move about, which was effected by rolling through the fluid with a screwing motion, and presenting the appearance of a concentric or Archimedean screw. This screw, under a power of 800 diameters, appears to consist of a series of globules attached side to side, but, perhaps, forming a single animalcule, although possibly it may be a series of creatures attached together through imperfect self-division. A few of them may be perceived in the upper portion of the drop of

water. They are drawn really larger than they appeared; for many of them, although so highly magnified, were scarcely visible unless examined with close attention.

THE MONAS TERMO (3).—This animalcule is of an elliptical or egg shape, and is transparent and colourless. It is a very active creature, moving freely through the water in search of its food. It is exceedingly small, never attaining a greater size than the two or three hundredth of a millimeter.* When in New York several years ago, the proprietor of Castle Garden presented me with

er/ * The French millimetre is about the twenty-fifth of an English inch, and the hundredth of a millimeter, therefore, about the $\frac{1}{25000}$ th of an inch.

some water of a milky hue, which smelt quite foetid. Upon examining this water with the high power of the microscope, I found it teeming with the *Monas termo*, so closely crowded together, that, upon measurement and computation, I found that a single drop contained about four hundred millions of them. The number that the ounce vial contained would have been totally beyond conception.

THE STENTOR, OR TRUMPET ANIMALCULES (4).—These creatures belong to the family *Vorticellaria*. Pritchard describes nine species; but I saw only one in the drop, partially resembling the description as given under that of *Stentor mülleri*. It was of a brown

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colour, or, perhaps, yellowish-brown, and very active, and constantly feeding. It attached itself to the glass slide, or to some vegetable matter, by the posterior extremity of its body. Its body is entirely covered with cilia, while a spiral wreath surrounds its mouth. These organs enable the Stentor to move rapidly through the water, and to draw the living atoms, upon which it feeds, into the vortex whose apex terminates into its mouth. It was almost continually in motion, as if it required constant feeding to appease its voracious appetite. It feeds on monads, oscillatoria, rotatoria, and numerous creatures smaller than itself. These victims can easily be discerned in the stentor's stomachs, which

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are arranged like the beads of a necklace, these stomachs, beginning near the mouth, extend through the length of its body, and, returning, unite with it in a spiral-shaped cavity. Pritchard says that the nutritive apparatus consists of numerous berry-like stomach-cells, connected together, and presenting a moniliform or necklace-like alimentary canal, which proceeds from the mouth along the body, and returns, uniting with it in a spiral-shaped cavity.

Stentors increase by self-division, either longitudinally or obliquely. They increase also by ova, which form near the stomach-cells a net-like granular mass, varying in colour in different species. Those Stentors

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which have generally come under my observation are brown, or yellowish-brown, although the specimens given in the drop of water was of a pale blue. Pritchard also says, that they have likewise a gland-like sexual body, resembling the soft roe of fishes, the shape of which is band-like, moniliform, or round, and a contractile bladder.

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The stentor which appears so numerous in the southern waters, does not agree with any one described by Pritchard or Mantell; still it approximates more nearly to Pritchard's drawing of the *Stentor mülleri* than any other. The one figured in our drop of water, is of a pale azure colour. It is larger than either of those given by the above authors, and

appears more active and voracious than any I saw in Europe.

THE VORTICELLA, or BELL-SHAPED ANIMALCULES (5).—At the right border of the drop of water, a cluster of Bell Polypes will be observed. Each little creature is attached to a filament, or little cord, which possesses great contractility. They are represented extended, while the cilia which fringe the mouths of the polypes, are in rapid motion. Should any cause for disturbance ensue, each little creature instantly contracts its cord—by means of a muscle extending down its entire length—which draws it down close to the base to which it is attached. But, in an instant afterwards, it may be observed

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gradually encircling its filament and elongating it, till stretched out to its utmost length. Thus are they continually engaged; at one moment all stretched out to the full extension of the little pedicle to which they are attached; and the next, each individual of the whole group, is closely nestled to the others, around the place to which their cords adhere.

These little creatures belong to the genus VORTICELLA. Their anterior portion, a mouth—forming the open portion of the bell—is fringed with cilia. It is by means of these cilia that the creature progresses through the water; for after a certain time it ceases to be pediculated, but breaking its thread, com-

mences a separate existence. After the first self-division this pedicle is wanting.

Ehrenberg says, that at certain periods, a second wreath of cilia is said to be produced at the posterior part of the body. I have seen wreaths of cilia, both at the posterior portion of the body, and also surrounding it about the middle.

These animalcules possess many stomachs, and some genera, as the *Epistyles* and *Opercularia*, possess an intestinal canal. When in search of its prey, the vorticella stretches out its stem, and by means of a vibrating motion communicated to the cilia, it agitates the water, and occasions a current towards it; this conveys to it small particles of matter

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on which it feeds. If the water is disturbed, or a larger animal approaches, it instantly retracts, bending its stem into a number of coils ; this operation is performed so quickly, that the eye cannot detect it ; in a few seconds the creature may again be observed slowly uncoiling its stem. The Bell-polypes are androgynous or hermaphrodite. Many increase by longitudinal self-division ; others increase by gemmation, or buds which shoot out from their sides. When the propagation is effected by longitudinal division, the bell increases in breadth, a separation then commences, and two circles of cilia are formed ; the body of the animal then divides, and by constant whirling, one or both of the bells

separate from the stem, and commence swimming through the water with lively motion.


These Bell-polypes are a beautiful microscopic object, especially when congregated in large clusters, and will richly repay a few hours observation.

THE CARCHESIUM POLYPINUM (6).—These beautiful animalcules can be seen at the bottom of the engraving. They are closely allied to the preceding genus, but differ from it by having the pedicle longer and branched, in consequence of imperfect self-division. Like the bell-polype, their margins are fringed with cilia. Another row of cilia can at times be observed fringing the posterior portion of the body. The pedicle, like the preceding

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[genus, is contracted, and which is effected by a muscle extending down its whole length. It will be perceived that imperfect self-division has taken place with several, and that they present the appearance of little bell-shaped flowers growing from the same stem. The entire tree, of which that in the engraving represents but a small portion, was a beautiful object, and furnished amusement and instruction to several friends for a whole evening.

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Those curious, looking creatures, marked 7, 8, and 9, are nondescripts. I can find them neither in Pritchard nor Martell. They are a faithful representation of the originals, as they appeared in the drop of water. No. 8 is

a sluggish creature, seldom moving about, but continually contracting its body in places, so as to change its shape, the most usual one being that figured. There is at its left side a bright round spot, the office of which I could not ascertain; but I satisfied myself that it was not a stomach.

Nos. 7 and 9 are rather active creatures, and are constantly moving about in search of food. They are, as the preceding, of a light brown colour. They have eyes, and an alimentary canal running down the length of the body. One individual (No. 7) is figured  as they often present themselves, with deep lateral concavities. These often commence at the head, and proceed, like a wave, down each

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side of the body to the tail. They are voracious creatures, and were constantly moving about among the vegetable matter in search of food. They abound in the south plentifully among duck-weed and vegetable *débris*.

THE ENGLENA SANGUINA (10).—I have seen the surface of a pond, in the vicinity of Memphis, Tennessee, so densely crowded with these animalcules as to present the appearance of being covered with blood. They are exceedingly sluggish, but often move through the water, slowly rolling over laterally as they progress. They are spindle-shaped, and have a beautiful red eye. They often assume a globular shape, then slowly change to pear-shape, or into some other

form, but the normal one is that of a spindle. Their colour is at first green; but, as they become older, it finally assumes a blood[^]red colour. Some of them, during this change, present the most beautiful objects for the microscope that I have ever seen. They then assume a variety of tints, the green and red predominating, till finally they become of a deep crimson. I have observed several species of the family *Astasia*; but these are the most beautiful of them all. Brocklesby, in his charming little volume, "Views of the Microscopic World," presents this creature under the name of "*The blood[^]red eye animalcule*;" but his description of it is correct[^] so far as my observation has gone.

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The Englena progresses through the water by means of a celium, by which it rolls around its longitudinal axis, as it slowly moves along. But it is fond of rest, and will be generally seen rolled up into a ball, or changing, with sluggish motion, from its spherical shape to one of those figured in the plate.*

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ANTHRODESMUS CONVERGEUS (11). — The description given of this creature by Pritchard agrees in every particular with my own

* This animalcule, and several others, have lately been ascertained to be the young of some larger and more interesting creatures. They go through several very curious transformations previous to reaching their mature condition, but the space allotted this note will not admit of a more extended notice of those wondrous changes.

observations. The animalcules comprised in this genus are distinguished by being free (no pedicle being present), and in having a simple univalved compressed lorica. They multiply by spontaneous self-division in the form of tables, or compressed and articulated ribbons, each animalcule being contiguous to its neighbour. They are possessed of no locomotion, and no opening to the lorica has been seen. The chief animal character is self-division, and their close alliance, through Micrastercas and Enastrums, to Navicula, rather than to any known plant.* The

* It is contended by many naturalists whose opinions bear great weight, that many of the lower order of animalcules (or which have been received as such) are vegetable. They base

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internal green colouring matter of their parchment-like lorica consists of minute homogeneous granules, resembling ova, each cell-like lorica containing from one to three bright bodies, analogous to fecundating glands, which are often accompanied with crystalline vesicles, like polygastrica stomachs.

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THE DESMIDIUM HEXACERAS, THE SIX-HORNED DESMIDIUM (12).—These are likewise termed

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their opinion upon several facts, one of which is the want of motion; while the self-division, given by EHRENBURG as a proof of their animal nature, is equally prevalent among the lowest plants. The green corpuscles which EHRENBURG asserts are eggs, are likewise found within the *Conferva*. We are still inclined, even after perusing the able paper of Dr. MEZEN'S, to regard these minute objects as belonging rather to the animal kingdom than the vegetable; although further observations may modify that opinion considerably.

"*the chain-wanded animalcules.*" The genus to which this animalcule belongs is described by Pritchard. The lorica_^ of a simple triangular box-like form, with a single aperture in the centre, in texture it resembles parchment. The animalcules possess the power of slowly transporting themselves from one place to another; but no organ of locomotion has been discovered. Green, ova-like granules are observable in all the species, and among them, *D. Swartzii*, *orbiculare* and *aculeatum*, colourless vesicles, probably digestive cells. It is doubtful, says Dr. Ehrenberg, whether they are developed singly or in pairs. The *Desmidium hexaceras* are generally connected in pairs; hence it is usual to see six cornu_^

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or horns. This species never forms a long chain-like body, four being the greatest number attached. The body is green ; but the lorica, when empty, is colourless, and then exhibits a distinct central opening. The size of this animalcule is the five hundred and seventieth of an inch.

THE EVASTRUM, THE STAR-DISKED ANIMAL-
CULE, THE PEARL ENASTRUM (13).—Pritchard describes these animalcules ; and, as his description coincides with the one in the drop, I give it in his own words. “These animalcules are distinguished by their members being free, inclosed in a simple compressed lorica, composed of only one piece, and by their adhering in pairs, which are disposed

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in the form of a two-lobed disc or table. Whether a lobe can be regarded separately from its companion, or a distinct organism, is not determined ; but, by cutting or destroying the one, the other empties itself at the same time, although the lorica appears detached in the middle. No openings have been seen in the ends, as in *Micrastenas*, but it is probable such exists in the middle, where they are connected. The lorica is membraneous, firm, colourless, and combustible ; it contains the crystalline and contractile body of the animalcules, filled with green granules. Its propagation, by self-division, is peculiar and highly interesting. The middle elongates, from which two new ones are

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formed, one uniting and forming the companion to one of the old ones, and the other producing the same with the remaining old one, when the newly formed individuals separate, and two pairs is the result. From this method of self-division, specimens having equal lobes are produced by some accidental rupture before the remains in the middle are fully developed." The species figured in the drop are generally found among the vegetable matter which floats on the surface of running water.

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THE GOVIUM PECTORALE. THE TABLET
ANIMALCULES (14).—This genus belongs to the family Volvocina. We often observe, floating through the water, while under the

microscope, a curious siliceous tablet, resembling a breast-plate, upon the surface of which are arranged sixteen little animalcules, of a bright green colour. These little creatures are connected together by very attenuated filaments, or threads, which are invisible in the drawing. The four centre ones are generally larger than those which surround them, as can be seen when the plate is viewed laterally. After they arrive at maturity, the plate divides in lines across it, and at right angles to each other. It then separates into four clusters, each of which consists of four individuals. These small clusters soon begin to increase in size, while the surface of each animalcule appears decussated or inter-

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sected. They then begin to form regular clusters, like the parent ones. These groups form a beautiful and interesting microscopic object, and are well worth an attentive study.

There were several in the drop of water figured, some of which consisted of the usual number, sixteen, while others move in groups of four. There were, likewise, several which had become entirely detached from the parent groups, and were enjoying a separate existence. They, however, did not enjoy it a great while, for the larger creatures soon devoured them.

n/ The Goyium is found in our southern waters in great numbers, and at all times of the year. It is interesting to observe the

provision that nature has made for the preservation of the various species of her creation, even down to the invisible animalcule. Had not these little creatures been gifted with their plate of silex for the purpose of self-protection, they would soon have been devoured by some larger creature. But the area of their carapace, or shield, together with its hardness, prevents even the most voracious monster from engorging it. "United, we stand—divided, we fall ;"* is pregnant with significance to those frail creatures, for while they remain attached to their plate, they are impregnable ; but I have seen one become detached from its companions,

* The motto of the State of Ohio.

when it was immediately swallowed by a Nateus.

THE VOLVOX GLOBATOR (15).—These creatures are located within a hollow globe, which is propelled through the water by its tiny inhabitants by means of their cilia, each monad possessing two. The inside of this rolling sphere is closely studded with animalcules. Each one of these little creatures is furnished with a bright red eye, with two cilia, and is connected to the ones adjacent to it by delicate fibres, varying in number from three to six. The colony of little creatures located in the inside of this siliceous globe, is composed of tens of thousands of individuals, which bear the same relation to

their hollow shell that the govium does to its equally transparent plate. As each individual monad projects its cilia through orifices in the globe, the latter, consequently, appears bristling with them, and is thus propelled through the water, rolling on its axis, but with the same part always foremost.

These creatures increase in a very curious manner. By a voluntary separation, new spherical clusters are thrown off from the original, or parent globe, but always from the inside. From half-a-dozen to as many as twenty of these little globes I have frequently observed within the parent one. When the young globes have increased sufficiently in size, the larger one opens

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and permits their egress. Here we have a still more striking provision made for the safety of these little creatures, than for that of the govium. Even the young ones are not allowed to leave the parent globe, until they have grown sufficiently large and strong to resist the attacks of the larger creatures. Thus we perceive, that, even with the minutest creatures, the same provident care is extended that we observe with those of higher organizations and, apparently, of more importance in creation. Nothing is too minute or trivial to escape the care of the Creator, for whithersoever we direct our observations, even to the beings too minute for our visual organs, we discern evidence of that fatherly care

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which is extended alike over all created things.

THE EUDORINA ELEGANS. THE ELEGANT EUDORINA (16).—This beautiful animalcule may often be found in such vast numbers, as to tinge the water of a green colour. There are generally from fifteen to fifty individuals in a cluster. Each animalcule has a bright red eye. Its body is composed of green corpuscles of a globular shape. Sometimes hundreds of these little clusters may be seen rotating, in various directions, so closely crowded together as to impart their own colour to the water. These Eudorina, and the succeeding, are much more plentiful than the yolvox in our

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southern waters. Pritchard says, that these animalcules abound most in the spring. They are exceedingly delicate, so much so, that it is difficult to preserve them alive for more than a day or two. Whenever it is attempted to retain them in large quantities, the second day will generally exhibit a thick mass of dead ones at the bottom of the vessel. When a few only remain alive, if the water be poured away frequently, and the creatures removed into a vessel of clear water, they will live for weeks.

PANDORINA MORUM. THE GREEN PANDORINA (17).—There are but three species of this animalcule. The body is simple and enclosed within a simple lorica. The pro-

boscis is thrice as large as the body. These beautiful globes abound in great numbers in the south at all times of the year. The characteristics of the genus *Pandorina* are, that they are destitute of a tail and eye, but are provided with a box-like lorica, of a globular shape, and with the filiform proboscis. During the process of self-division, the internal development gives the creature the appearance of a mulberry. A simple proboscis is present in both of the species (at least [^]ours here) as the organ of locomotion, &c., and transparent vesicles, seemingly the nutritive apparatus, may be observed. There are three species only, a green, and the others colourless. The former existed only in the drop.

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NAVICULA VIRIDIS (18).—The Navicula can be seen at the upper right hand portion of the drop, where a cluster of them are together, some being straight and others crescent-shaped. These beautiful, loricated creatures abound in great numbers in the south. Those figured, it will be observed, are the crescent-shaped, the spindle-shaped, and those of a rectangular form. I have only in a few instances seen the brown Navicula, those most abounding in our waters being green. These creatures belong to the *Bucillaria* family, and are thought by Dr. Mantell, and some other naturalists, to be vegetable productions. Dr. Ehrenberg says, that they are true animals. I have

seen enough of their nature, to cause me to suspect that they deserve a rank in the animal creation. Brocklesby describes the golden Navicula. I have never seen it in the south.

CLOSTERIUM CYLINDRUS. THE CYLINDER-SHAPED CLOSTERIUM (19).—This creature can be seen at the left portion of the drawing. Its lorica, or shell, is ovalo-cylindrical, constricted at the middle, and obtuse at both extremities. It contains some granules mixed with green matter. It may be seen generally motionless, although I have frequently seen them move slowly along the bottom among the vegetable matter. The shells of this animalcule, and of the pre-

ceding, are found fossil in great quantities, and form a very interesting and instructive microscopic object.

ICHTHYDIUM PODURA. THE CILIATED FISH ANIMALCULE (20).—There was found one of these pretty creatures in the drop of water. It excited considerable interest among my friends, as it is rather a rare animalcule, and being the first that they had seen. It was while viewing this little creature, that the suggestion was made to sketch the entire creatures within the drop of water, and to write a brief description of those curious little people.

It moved slowly about in the water in search of its food ; but, if alarmed, it darted

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through the fluid with great force, dexterity, and rapidity. Pritchard describes the *Ichthydium* as colourless, but this one—and several which I have seen subsequently—was of a brown colour. I have found it generally among vegetable *débris*; but the most elegant one I have seen, was found playing about the stalks of duckweed.

These creatures belong to the family *ICHTHYDINA*, of the *ROTATORIAS*. The body of the *Ichthydium Podura* (the one figured in the drop) is straight, rather oblong, and slightly constricted antennores. The ventral surface is flat and ciliated; the dorsal arched and smooth. Pritchard says that it creeps oftener than it swims; but, from my own

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observations, I think it seldom creeps, unless the water is too shallow to allow it to swim freely.

UVELIA GLANCORNA, THE GRAPE MONAD (21).—These creatures derive their name from their habit of uniting in clusters, not dissimilar to a bunch of grapes. Fig. 21 is a natural group of these monads. Each of these animalcules has two cilia issuing from the mouth, and some of them have as many as twelve stomachs. They live on creatures more infinitesimal than themselves, some of which have been described in their stomachs. They increase from eggs, and also from self-division, which takes place both transversely and longitudinally. With a high power, a

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number of colourless granules, having the appearance and form of eggs, may be discerned lying between the nutritive sacks. But their most usual mode of propagation is by self-division.

THE BRACHIONAS (22).—The species found in the drop of water resembles Pritchard's delineation of the *B. Bakeri* more closely than any other I can discover. But it differs considerably from that one. The Brachionas is inclosed within a lorica or shell, which opens like that of a tortoise. Within this lorica the creature can completely withdraw itself. It is an active creature, always darting after its prey, or, while stationary, being busily engaged devouring it. There are

several species in our southern waters, the one figured in the drop being the most common. The rotatory organs are situated in lobes in front. Some of these lobes amount to three, and others to two. They carry their eggs attached to their posterior extremity—as in the figure—amounting often to eight or ten ; but in the *B. pola* we must not mistake the eggs of other creatures, which are attached to it, and which adhere till hatched. This animalcule has a beautiful red eye, and muscular æsophigal head, with jaws containing several teeth, generally five. It is an interesting microscopic object, as its activity, its voracity, and its continued contortions keep up the interest of the observer

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for hours at a time. The one in the drop measured the .08 of a millimeter.*

MONOSTYLA QUADRIDENTATA, THE FOUR-
HORNED MONOSTYLA (23).—These creatures abound plentifully in the waters I have examined. The one marked 23 is a faithful drawing of that found in the drop of water. Pritchard says, that it is generally of a pale leather colour, but that Ehrenberg has seen it colourless. I have never seen any except those which were colourless. The Monostyla has a single foot-like tale, which it freely

* The above was written several years ago. Since that time, the Author has frequently met with the *Brachionas*. He is now inclined to suspect, that the individual seen in the drop of water, from the description given of it, and from his recollection of it, was the species termed *Noteus quadricornis*.

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moves about with a vibratory motion. It has an æsophigal head, with four muscles, and strong jaws with teeth. They abound plentifully along with Brachionas, Vorticella, &c.

TRACHELOCEREA ALBA (24).—The body of this curious animalcule is spindle-shaped. What most attracts the attention of the observer is the enormous length of its neck. I have seen them with necks ten times the length of their bodies. This neck is extremely flexible, and is constantly entwined about among the conferva and vegetable *débris* in search of food. It is a very interesting microscopic object.

THE AMPHILEPTUS MARGARITIFER, THE PEARL AMPHILEPTUS (25).—The body of this little

creature is white, slender, and spindle-shaped. The proboscis is about the length of the body, acute like the tail, which is very short. Pritchard says, that its most striking features are the swollen margin of the mouth, and ~~x~~ necklace-like series of vesicles disposed along the body. It feeds upon green monads.

THE DOXOCOECUS (26).—They are the small globular bodies delineated at the upper right hand of the drawing. They are the *D. ruber*. They are of a deep red colour, and opaque. Pritchard says, that Ehrenberg doubts whether this animalcule is a true Doxocoecus, or a Trachelomonas. It is an active creature, progressing through the water with a rolling motion. It is uncertain whether they possess

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27 1/ a lorica or shell, as even Ehrenberg could not satisfy himself upon this point. The opacity of the creature will doubtless prevent a thorough examination. I have spent considerable time in striving to determine this question, with both Ross's and Spencer's best objectives, but without satisfying myself whether it was enveloped by a membranous covering, or a lorica.

27 -/ At the lower left hand portion of our drawing of the drop of water are several species of Algæ, or Conferva. These will be found in almost every drop of water examined, especially if the water should be taken from the surface of a pond during a bright sunny day. Some of these conferva

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are beautiful microscopical objects, as they are marked in the most delicate manner. The green scum which collects on the surface of our ponds and pools is a species of Algæ. Although, when seen with the naked eye, they appear as a scum of green matter, disgusting and slimy to the touch; still, when examined under the microscope, we find that this scum is composed of a mass of reticulated fibres of the most beautiful appearance. Among them we occasionally see one of a most vivid azure colour, and which presents a fine contrast to the deep green colour of the others.

I have now taken a very rapid and cursory survey of the various little people which I

actually detected at one time in an isolated drop of water. But they are necessarily crowded in the drawing ; for it should be recollected that the area there given is not the fiftieth part of the entire drop of fluid, but only that portion very highly magnified.

It will now be perceived that a drop of water, although a trivial thing, is really an unbounded world, and full_x large enough for the Creator to exhibit to us, in a striking light, an illustration of the beneficence and wisdom which pervade throughout every department of nature. The poet Shelley, whose philosophic mind has adorned many beautiful subjects, has thus written upon the

little beings which feel and enjoy life within the space of a mere point :—

“I tell thee that those living things,
To whom the fragile blade of grass,
That springeth in the morn
And perisheth ere noon,
Is an abundant world.—

I tell thee that those viewless beings,
Whose mansion is the smallest particle
Of the impassive atmosphere,
Enjoy and live like men ;
And the minutest throb
That through their frame diffuses
The slightest motion,
Is fixed and indispensable
As the majestic laws
That rule yon rolling orb.”

“ In the leaves of every forest,” says the eloquent Chalmers,—“ in the flowers of every garden,—in the waters of every rivulet,—there

are worlds teeming with life, and numberless as are the glories of the firmament." And the learned Mantell has written the following beautiful paragraph in illustration of our subject :—" But a fact not less startling than would be the realization of the imaginings of Shakspeare and of Milton, or of the speculations of Locke and of Bacon, admits of easy demonstration,—viz., that the air, the earth, and the water, teem with numberless myriads of creatures, which are as unknown and as unapproachable to the great mass of mankind, as are the inhabitants of another planet. It may, indeed, be questioned whether, if the telescope could bring within the reach of our observation, the living

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beings that dwell in the worlds around us, life would be there displayed in forms more diversified, or organisms more marvellous, under conditions more unlike those in which animal existence appears to our unassisted senses, than may be discovered in the leaves of every forest, in the flowers of every garden, in the waters of every rivulet, by that noblest instrument of natural philosophy, the microscope."

Thus it will be perceived that the noblest intellects that have existed, have deemed a drop of water not too minute nor trivial to claim their serious study, and their pens. It will be seen that they, too, have observed for days and years ; have thought and reasoned ;

and, from that little drop of water, have derived those lessons of wisdom which have rendered their names illustrious.

There is really nothing which embodies such lessons of wisdom as the apparently insignificant drop of water which depends from the leaf in the morning air ; for we see that the Creator has conferred upon it the exalted destiny of being a special vehicle of his goodness and wisdom. He has spoken his will to man through the drop of water, and he has conferred upon that little crystal sphere, a task the most important of any other in creation. To it he has consigned the task of vivifying and of invigorating all living things. Without it, all animal

and vegetable organisms would perish ; the solid rocks themselves would lose their indurated condition ; the beautiful crystal, which refracts so powerfully in the diamond, would lose its geometrical symmetry, and disappear as the bright glittering gem ; and all the solid and most beautiful form of this earth would revert to that chaotic state, in which the bright and the lovely would be but the insentient dust, or the viewless gas.

A drop of water is, then, a wondrous thing ; a magazine of enormous forces ; an engine of tremendous power in the economy of nature : for secreted within its cold pellucid chambers lie those energies which cause the little acorn to expand into the towering oak,

97 the delicate flower to bloom, and to secrete its indescribable fragrance, and its inimitable hues ; which urges impercipient matter to group itself into organs of thought and feeling, and into forms of beauty ; which urges planets around their centres, and suns and galaxies through the abyss of space ; and which is the cause of every motion, and every change in the universe.

There is, indeed, contained within the little drop of water the most instructive and eloquent lessons. As the thoughtful person gazes forth upon the expanded fields, and witnesses the great staples of human industry parching beneath the summer sun, and then beholds the refreshing shower poured upon

it, giving it fresh vitality, and bringing it to maturity,—how his grateful heart yearns towards the blessed little drop of water which contains within its bosom the seeds of plenty and happiness! He who does not concede that the drop of water contains lessons fraught with profound wisdom, evinces conclusive evidence of that want of reflection which distinguishes the low and grovelling from the lofty and exalted; of that freedom from thought and observation which is the characteristic attribute of the vulgar and the vitiated: for the more we reflect upon the works of the Creator and his infinite purposes, the more we are impressed with the beneficence and the wisdom displayed in every minute

thing of creation. We learn that no object, however trifling or small, is unimportant ; but that every grain of sand fulfils its destiny in preserving the delicate balance and equilibrium of the forces of nature. Deeply impressed with the subject, Lavater exclaims :—“ Every grain of sand is an immensity ; every leaf a world ; every insect an assemblage of incomprehensible effects in which reflection is lost.”

With the same spirit awakened, the eloquent author of the “ Contemplations of Nature ” says, that “ There is no picking up of a pebble by the brookside without finding all nature in connection with it.”

Each little grain of matter contains a share

of those forces which balance and impel the planets around their suns, and the satellites about their planets. Each little molecule is the abode of those forces which urge it to enter into these wondrous combinations which result in the organization of sentient matter, or in the formation of those lovely creatures of the floral world which so excite our admiration.

And there again we behold these same forces which are excited with such peculiar effect in the formation of beauty and symmetry, now equally as active in that of decomposition and destruction; and these objects, which excited our wonder, soon crumble into dust, and silently disappear. Scarcely has

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the rosy cheek paled, and the eye lost its lustre and expression of intelligence and vitality, ere the work of destruction begins, and progresses with great rapidity. With every moment of time we behold a change in those livid features ; the eye becomes sunken, the muscles shrivel and waste away, and the development of aeriform bodies from those which were solid, of gases from those which were beauty, and conveyed to us the expression of affection and intelligence, soon awaken us to the reality that those forms which are lovely appear soonest to pass away ; that the more fragile and tenderly organized bodies are those most subject to destruction ; and that, therefore, a most fatal warfare is

waged against those forms whose delicate structure and fragile texture attract most our admiration.

And still the atom is a trifling thing ; and even the drop of water, composed of millions of atoms, each of which is highly gifted with activity, is scarcely worthy the serious attention of the mass of the people, as they continue to gaze upward in wrapt wonder to the host of worlds balanced in space, and, inspired with the reflections which their magnitude presents, cease to think that there are conceptions equally as exalted to be derived from the atom, or their aggregation in the drop of water ; that there is wisdom equally displayed, and beneficence fully as existent

in it, as is manifested in the cognate spheres above us.

We must learn to banish the idea of the uneducated, that there is no grandeur, no poetry, to be derived from the minute ; for the laws of chemistry have developed the truth, that an atom of dust is the repository of all those energies which manifest themselves in the formative processes of nature, and in the motions of worlds in space. And we are taught by that mighty talisman, the microscope, that a great world, as unbounded as our own, teems with active inhabitants, whose progress through life is attended by the vicissitudes which characterize ours, and whose deaths are fraught with equally as

great results in the economy of Him who causes no material disturbance without important results following from it.

Then let us learn from the contemplation of a drop of water some of the greatest lessons which can be presented to the human mind; and as we ponder over the series of correlative causes flowing from its creation, and its position in the chain of natural phenomena, we should feel more deeply impressed with the conviction that the true method of gaining a conception of the wisdom of the Creator is through a close study of the coordinate forces which dwell within a drop of water.

And let us, from the study of this drop

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of water, become cognizant of, and deeply impressed with, the knowledge it so eloquently teaches. We feel assured that he, who rules the myriad of worlds grouped in space, whose power is infinite, and whose grandeur and glory is beyond our conception, is not unmindful of the minutest thing of his creation ; that the smallest change or disturbance which transpires on this earth is not unknown to him, and doubtless that the slightest perturbation or emotion of the mind is equally the creature of his cognizance ; and that, as his searching eye can fathom the deep recesses of the human heart, and scan its mysterious emotions, observe its weakness, and its erring nature, that he is ever ready to extend

forgiveness and mercy to those frailties which so urgently require it.

We have briefly gone over a portion of the information connected with a drop of water. We perceive that its contemplation is fraught with instruction, whether we take into consideration the forces which reside within it, or examine it as an isolated world of animated beings. We ascertain that the study of the drop of water leads us to the acquisition of a great amount of collateral information, wherein the correlative depen-

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dencies of certain forces upon others, apparently not connected with them, leads us to the review of a wide field of natural phenomena.

It is well that we should begin our investigations with so small a thing as a drop of water, but as we assiduously trace out, with unwearied progress, the various links of the intricate and interminable chain which presents itself, we soon begin to feel, that to delve with success into nature's almost unfathomable crypts, we should really possess the faculty :—

“ Even as one
Who, by some secret gift of soul or eye,
In every spot beneath the smiling sun
Sees where the springs of living waters lie.”

It is only after sustaining the toil incident upon scientific inquiry, after having mastered its drudgery, and gone into the portals of the temple, that we experience the significance of the poet's words :—

“There is a language by the lonely shore,—
There is society where none intrude,—
By the deep sea—and music in its roar.”

It is then that we begin to feel that the deep waters, as they give out their unceasing anthem, not only present music to the ear, but are eloquent with harmonies to the mind ; and that that solitude, where none intrudes, is blessed with the society of a thousand intelligencies more welcome and grateful often than the dearest friends. For we

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soon learn the instructive lesson that, "there is not a mote in the beam, not an herb on the mountain, not a pebble on the shore, not a seed far-blown into the wilderness, but contributes to the law that seeks in all the true principles of life,—the beautiful, the joyous, the immortal."*

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Look upon that rolling leaf, and think of the wonderful changes at work within it—energies, whose activity would build up a universe. There are forces aroused within it which are working it into another existence—which are weaving its components into forms of beauty, into things of fragrance, and shapes of symmetry. Rotten and abhorrent as it is,

* Bulwer.

there is within those foetid cells a wondrous struggle of creative energy,—an activity of elementary play, pressing for the freedom of that choice which shall result in new organisms, and which will involve new fates, and implicate new destinies.

Are these things to be cast aside, even by the proudest intellect? Should we disregard these slight changes, when they are attended with such great results? For these changes, silently as they are effected, are felt throughout created nature, so delicately is the balance of forces, and so correlated the one with the other.

Change the position of that pebble at your feet, and, howsoever slight that disturbance,

it will be felt at our system's remotest frontier, and for ever recorded there in the corresponding disturbance which it would occasion in the delicately adjusted balance of the plants.* Ay, should a world move but the breadth of a hair from its allotted position, the disturbance would be reciprocated by a corresponding and relative perturbation of all the planets in our system. How wonderfully delicate are all those orbs related to each other, and how true and unchanging the forces which actuate them ! Cast into space that little pebble, even beyond the limits of far-off Neptune, and it will commence its continued and undeviating progress,

* See NICHOL'S "Architecture of the Heavens."

carving out for itself its own prescribed path. But the philosopher secluded in his study, and buried in figures pregnant with meaning, traces and measures its path through space with the plummet of science, which he casts far in advance of its progress, and predicts its true course, to the breadth of a line, for centuries to come.

Yet, that Power which is so potent and unchanging in the guidance of planets is cognizant in a drop of water; for the sphericity of the one, and the motion of the other, are the result of the energies of the same force.

Review it, then, first in the little pellucid sphere, thence follow it out into the profundities of illimitable space, or the complex

motions of our satellite. We find that it accompanies the filmy comet through its extended and erratic wanderings ; that it prescribes the motions of the double and triple atom, and indicates the paths of the innumerable atoms swung in space. And amid these stupendous galaxies which bespangle the firmament, we learn that this force, which we first detected exerting its energies in preserving the cohesion of the particles of a drop of water, is thus omnipotent, undeviating, and atomal.

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If we first recognize it in the little crystal sphere, exerting its power in the preservation of its integrity and sphericity, we must find ourselves necessitated to follow it upward,

till we take cognizance of its potency and universality among worlds ; but still it is the same undeviating power, whose energy is susceptible of being scanned and followed by the eye of science, and the results of whose operations can be calculated to seconds of time, during periods of thousands of years.

Trace it in the perturbations of our moon. As singular and complex as are this orb's wanderings and twistings about this earth, still the philosopher traces it faithfully throughout all its elliptical curves for thousands of years. Little dreamed the wily Brahmins, as they recorded the pretended antiquity of their race by a long list of forged eclipses, that the unchanging power residing

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in a drop of water would reveal the specious imposture.

Wondrous drop of water! Thou enjoyest the plenitude of eternal youth, yet thou hast witnessed the dawn of creation! Thou didst bathe the form of the old Plesiosaur and the Dinotherium, and, amid thy sparkling youth, sported the gigantic Ichthayosour and the hundred eyed Trilobite; and, as the new breezes sighed their matin hymns, thou didst toy with the long lost Ammonite—

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“Time writes no wrinkles on thine azure brow,—

Such as creation's dawn beheld thee, thou art now.”

Time, with thee, is meaningless; for death to thee is but the renewal of thy primeval youth in the birth of a fresh creation; and

its dissolution again revives thee, thou pellucid little sphere, in the glittering dew-drop. How wondrous art thou, creature of perpetual life, for thou canst defy the passages of time, which ages all things else; and millions of years to thee are but as a bright moment in the thoughtlessness of buoyant youth. “Time writes no wrinkles on thine azure brow;” centuries will roll by thee, and still thy brilliancy will remain undimmed, thine activity unimpaired. Thou art still the lucid drop of water which depended, in ages long gone by, from the fronds of the *Lepidodendron*, and flung from thy crystal cells the new-born light.

Changes innumerable have ensued since

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then. The solid earth hath been disrupted, the old ocean hurled from its bed, the granite mountains upheaved, and the whole crust of the earth convulsed and changed—and still thou survivest! And plastic nature, with her unceasing activity, hath brought forth, from her prolific womb, innumerable new forms to play their parts on this changing earth—and still thou liveth in perpetual youth! Even now I behold thee, mysterious visitor, as from the bosom of the lucid air thou hast revealed thy limpid form, fraught with the mighty energies which were gifted to thee at thy creation. As in ages gone by, thou didst sport with the rays of the new created light, even dost thou dally

with its aged beams now, for thou and it
are twins in eternal youth, thou wondrous
and immortal creation !

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APPENDIX.

THE powers that I made use of in the observations recorded in this volume, were the $\frac{1}{2}$ inch, $\frac{1}{4}$ inch, and $\frac{1}{8}$ th inch objectives of Mr. Ross. To observe the entire animalcule, I generally use the $\frac{1}{2}$ inch objective, and for minutiae, I resort to the $\frac{1}{8}$ th and $\frac{1}{4}$ inch lenses. The high powers, as the $\frac{1}{8}$ th and $\frac{1}{12}$ th, are more appropriate for the examination of test objects, as for instance, the scales from the wings of the *Hipparchia Janina*, the *Podura Plumbea*, the *Lapisma Saccharina*, and the *Pontia Crassica*; or the shells of the *Navicula Hippocampas*, the *Navicula Angulata*, the *Navicula Spencerii*, or the *Grammatophora Subtillissima*, &c.

The powers which I used most for the observation of the creatures figured in the drop of water, were

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the $\frac{1}{4}$ and $\frac{1}{2}$ inch lenses, the latter for viewing the entire animalcule, or groups of them, and the former for the examination of details. I certainly would recommend the student to commence his observations with Ross's lenses at once, or those of one of the opticians mentioned below; for although they cost considerably more than a common lens, still nothing satisfactory can be acquired, unless the observer resorts to a first class achromatic objective. The lenses of Mr. Andrew Ross, of London, or of Powell and Zealand, or Smith and Beck, of the same city, or Natchet, Oberhausen, and Chevalier, of Paris, are unobjectionable.

The works which I would recommend to the student who wishes to penetrate into the invisible world, are: Hogg's work on the Microscope; Pritchard's "Infusoria;" Mantell's "Thoughts on Animalcules;" Quecket's "Treatise on the Microscope;" "The Microscopist," by Joseph W. Wythes; and "Views

of the Microscopic World," by John Brocklesby, &c. To those who read the German language, Ehrenberg's great work upon animalcules will be almost indispensable. Those who study the microscope with a view to its application solely to histology, will find several useful works lately out of the press. But, after all, books do but comparatively little good. As a chemical experiment will impart to the student, in a few moments, more lasting information than the perusal of hours of description; so the actual observation of an animalcule will give the student a clearer conception of these little creatures, than all the descriptions and engraved illustrations given in the books.

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I shall never forget the sensations of exquisite delight which the first view I had of an animalcule conveyed to me. I had perused volumes upon the subject, and had thus pictured to my mind the appearance of these little creatures; but the actual

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view transcended all of my preconceived ideas of them. The extreme delicacy of their organization, their wonderful activity and voracity, and their strange shapes and marvellous changes,—ensuing as a living reality before me,—so far transcended the meagre descriptions and comparatively rude illustrations given in the books, that I was transported beyond language to describe. What I saw I never forgot, as the chemist never loses the information derived through an experiment. I would, therefore, suggest to the student, that although the study of works upon the microscope is useful, the actual observation of animalcules beneath the instrument itself, is the only method by which he can acquire a thorough and efficient knowledge of those inhabitants of the invisible world.

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The study of animalcules, like every other department of natural history, requires, not only an active mind, but an active body. If the student is at all

inclined to indolence, he had better give up the pursuit, or rather not enter into it. He must not permit that constitutional infirmity to take possession of him, which interdicts long walking. He must not possess that fastidiousness of taste which precludes its victim from approximating a pond, or wading, if needful, right into it; but, with a boldness and independence of appearance, which distinguish the true naturalist, he must not hesitate to go whithersoever the rarest and most beautiful specimens abound.

Stagnant ponds and impure water contain many specimens of animalcules; but the rarest ones are only found in running or clear fresh water. In ponds, which are fed by springs, and from which the water is emptied out as rapidly as it is replaced, there may be procured a vast number of beautiful infusoria. Among the vegetable matter floating on the surface of such water, or adhering to the sub-

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aquatic plants, may be found many varieties of beautiful creatures. The more pellucid and pure the water, the more rare and beautiful are the animalcules; for, although many of them are *green*, still they are no fools, and know how to appreciate pure and good things as well as we. Like people, the most common and roughly organized are found in impure and vitiated places, while the more gifted, and delicate, and beautiful are only to be discerned associating whither the medium about them is pure and refined.

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The student should provide himself with several large-mouthed vials, such as those used for containing opodeldoc. Several of these should be skimmed over the surface of the water, thus accumulating in them the scum or vegetable matter which floats thereon. The vials should then be corked; but the cork must not be kept there too long, as the animalcules will perish for want of air.

Other vials should be pressed beneath the surface of the water, with their mouths downward, by which the inclosed air will prevent the ingress of the water. When the mouth of the vial is in contact with the stalks of the plants, it should then be slightly turned, when the air will rush out, and the water, in the immediate vicinity of the plants, will take its place, carrying with it the animalcules attached to them. A small portion of the vegetable substance, among or upon which they are found, should be placed in the vial along with them. Too much, however, must not be used, or its decomposition will destroy the infusoria.

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The temperature of the water, contrary to the belief of some persons, exerts but little effect upon animalcules. Some of the rarest and most beautiful infusoria I ever collected were found attached to plants in shallow ponds, under the ice. They, therefore, increase and flourish, when the

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water is at 32° , perhaps nearly as prolifically as when it is heated by the summer sun up to 76° . Winter, therefore, need not offer an obstacle to the study of the invisible world, unless the student is too timid and delicate to brave the cold. In that case he will progress but tardily; for he will undoubtedly require that enthusiasm and ardour necessary to constitute a successful naturalist.

To study any department of human knowledge successfully, an ardent temperament is certainly required. Apathy and indifference cannot insure success, as they will never stimulate to application, nor create that inflexibility and pertinacity of purpose necessary to the faithful performance of any task.

To study nature, the student must become impressed with the beauty of the work before him. With the poet he must feel that:—

“Light is Truth, and God is Light,”

and that, in order to acquire this light in its greatest effulgence, ardent study is necessary. It is only when we feel the full force of the poet's language, that the acquisition of science begins to exert its proper and beneficial effects upon the mind:—

“ My heart is awed within me, when I think
Of the great miracle which still goes on
In silence round me—the perpetual work
Of Thy creation, finished, yet renewed
For ever ! ”

There is a light which shineth afar, appearing in the great distance like the dim nebulosity of the filmy comet to those who have sought but little its rays. As the faculties expand gradually, this light approximates, until finally its full effulgence floods the mind of the ripe student. An accomplished and elegant writer, in speaking of the physical light, thus expresses himself: “ The glowing sunshine, painting the earth with all the brilliancy

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of colour, and giving to the landscape the inimitable charm of every degree of illumination, from the grey shadow to the golden glow; the calm of evening, when, weary of the excess of splendour, the eye can repose in tranquillity upon the 'cloud-land' of the west, and watch the golden and the ruddy hues fade slowly into the blue tincture of night; and the pale refulgence of the moon, with the quiet sparkles of the sun-lit stars, all tend to impress upon the soul the great truth, that where there is light, organization and life are found, and beyond its influence death and silence hold supreme dominion."*

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Yet, how much more glorious is that mental light, which peoples the mind with its millions of aesthetic forms and lovely inhabitants, substituting for that "death" and "silence," of the intellect, the brightly peopled thought, and the harmony, of

* Prof. ROBERT HUNT, F.R.S.

the angels! What is true of the physical light, is equally so of that mental illumination which still more exalts our souls to God, and imparts to us the power of appreciating His wondrous gifts, when they are humbly and faithfully sought after:—

“If music, with its mysteries of sound,
Gives to the human heart a heaven ward feeling;
The beauty and the grandeur which is found
Wrapping in lustre this fair earth around,
Creation’s wondrous harmonies revealing,
And to the soul in truth’s strong tongue appealing,
With all the magic of those secret powers,
Which, mingling with the lovely bond of Light,
The Sun in constant undulation showers,
To mould the crystals, and to shape the flowers,
Or give to matter the immortal might
Of an embracing soul—should from this sod
Exalt our aspirations all to God.”

As has been previously mentioned, this little volume was written not for the purpose of presenting a history of animalcules, but as the history, more correctly, of a drop of water. The creatures

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figured in the plate, are not arranged agreeably to the fancy of the draughtsman, but they present a faithful delineation of the drop of water as it was seen under the microscope, all of the forms figured being then present, as they are in the engraving.

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But, should the author have the health, it is his intention to prepare another volume upon the same subject, in which he will enter more into detail in regard to the animalcules of the southern states. In order that the reader, who is not furnished with a good microscope, may have as correct and definite an idea as possible of the actual appearance and shapes of the infusoria, that volume will be illustrated with solographs of them. As these pictures will be painted by light, and drawn by the little creatures themselves, there will be more satisfaction in viewing those illustrations than if they were the bungling work of man's hand.

No doubt the figures and descriptions given in

Ehrenberg's great work are correct. If so, the same species, or at least genera, of animalcules differ considerably in this country from those observed in Germany, while we undoubtedly have a great variety of species, and perhaps genera, which have not been observed there, and doubtless do not exist in latitudes farther north.*

* Several years ago there was a little lake, near Memphis-Tennessee, which was peculiarly prolific in animalcules. The lake was about fifty feet in length, varying to ten and twenty feet in breadth. It was fed by springs, which bubbled up at the bottom, and supplied the lake with pure cold water, just about as rapidly as it was evaporated, or sunk into the earth at the margins. This lake furnished me for several years with the most beautiful specimens of infusoria, some of which were very rare; so much so, that since the lake has been destroyed to make way for the railroad, I have seen none of their genera since.

During all of these observations I was assisted by a lady, whose enthusiasm and industry were a sure guarantee that nature had organized her for an accomplished naturalist. In the destruction of that little lake—totally valueless to others—the author has met with a loss, which all his subsequent industry has not been able to repair. It was a small sheet of water, and, probably, a great nuisance to those living in its neighbourhood—especially had they

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Bookmaking at the present day is a trade. The purpose, therefore, which most authors have to consult is, whether the work will sell, and not whether it will be useful. It is true, that occasionally an author presents himself who consults the *utile* instead of the *dolce*; but, in perhaps the great majority of cases, the only purpose taken cognizance of, is whether the book will bring money, and not whether it will do good. The author hopes that, although he has sacrificed much valuable matter to space, that still he will not be accused of striving after the dollar, instead of that

been gifted with that faculty which delights not in the harmony of frogs—but its destruction was severely felt, and equally so, by the writer and the frogs; for, while the latter lost a most desirable home, the former lost an inexhaustible reservoir of knowledge, which all his subsequent researches have not been able to replace. The writer and his fair co-labourer lament deeply the loss of their favourite little lake, for they fear that they never again shall come in possession of another which will furnish them with such a variety of infusoria, in so small a space.

nobler motive—the desire to be useful. He hopes that even so unpretending a volume as this may stimulate the desire in many of its readers to observe for themselves what they have only seen roughly figured.

There is no nobler, more useful, nor more deeply interesting study, than that of animalcules. It can be prosecuted at all times and seasons—in winter or in summer, by day or by night,—and always with the pleasing certainty of finding something new. Whether we take a drop of water from the nearest pond ; or a piece of chalk or flint from the earth ; the sand from the seashore, or at the greatest depths of the ocean ; the clod from the surface of the earth, or at the bottom of the deepest mines or wells ; whether we examine animal or vegetable substances—organic or inorganic—still the microscope reveals wonders. Nothing is too worthless or trifling to escape its wondrous scrutiny ; for place

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what we may beneath its deep-searching powers, there instantly starts before the vision a world of wonders which had otherwise remained for ever concealed from our senses. It is truly the "mighty talisman of wisdom,"* and its revelations are equally wonderful with those of the telescope, while its aid is accessible at all times.

The gifted Mantell once remarked to me, that he could dispense with all other pursuits, but that to forsake the study of the invisible world would be impossible. He could yield up all other apparatus and instruments, but that no inducement could prevail upon him to part with his microscope. The great philosopher only gave expression to those feelings, which can readily be comprehended by the majority of those persons who have been permitted to enter the threshold of the temple of science. To relinquish that which is fraught with

* DR. MANTELL.

beauty and wisdom, and is replete with wonders innumerable, would indicate a depravity of taste little consonant with the spirit and progress of this age. As wisdom and science become more diffused among the people, so does the study of microscopy spread in a corresponding ratio. Eleven years ago, when the writer of this volume commenced the study of the microscope, in England, assisted by Dr. Mantell, there were scarce a dozen persons in this country engaged in the same study. Then the microscope was regarded by the majority of people as a mere toy,—a plaything for children. But since the introduction and perfection of achromatic lenses, the microscope has become one of our most powerful and efficient instruments of research. Its aid is now indispensable to the naturalist, the anatomist, and the physician.* Some of our most

* Since the great perfection of achromatic lenses has been effected, the new science of *Histology* has had its origin, built

certain means of diagnosis are obtained through the revelations of this instrument; and to deprive the world of it now, would be one of the most disastrous events to science.

By it we learn that there is a world of living beings which would be as inaccessible to our senses without its aid as are the inhabitants of far-off

entirely upon the revelations of the microscope. This science has progressed rapidly, and its great success and popularity has given rise to its kindred science, *Histo-Chemistry*, which has added another chaplet to the great science of Chemistry. Thus, we perceive that a little instrument, which only a few years ago, was looked upon as a plaything for boys, has given rise to two branches of science, which have progressed more rapidly, and have, perhaps, given birth to more real valuable knowledge than any other branch of science extant. It was only eleven years ago that the author of this little work was derided by his friends for bringing with him, on his return from Europe, a microscope, which cost 1,050 dollars. As an illustration of the progress of the human mind upon the subject, the author would mention, that the very persons who derided him so sharply for his foolish expenditure of so large a sum for a microscope, afterwards purchased the instrument of him at a still increased price ! Thus does the mind and taste progress, and may it ever continue to do so.

Neptune. But the microscope has brought these wonderful creatures directly to our senses; and we are thus taught that worlds exist around us densely peopled with inhabitants, which, for delicacy and perfection of organization, and for diversity and strangeness of shape, have no other parallel on this earth. The ancients drew largely upon an active imagination for monsters whose shapes and qualities might create terror and wonder in those who read of them, and thus arose their "gorgons and hydras and dragons dire;" but they little dreamed that the waters of each little pond which lay about them contained, not only exact resemblances of their terrible creations, but that they likewise harboured others still more strange and wonderful. They little thought that their fabled hydras, which were gifted with the prolific quality of producing new heads from the mutilated necks of those which had been severed, were realized with all of these qualities, and

still more wonderful ones, in the waters of each little pond about them.

Until the revelations of the microscope taught us differently, we were not aware of the great diversity of animal organisms which surrounds us. But this little instrument has supplied us with the means of penetrating into realms whose existence a few years ago were not suspected. By it we have been taught the wise lesson, that even the smallest thing in creation is not beneath the provident care of him who rules universes, and prescribes the paths and destinies of worlds; that the infinitesimal infusoria, too minute to come within the powers of our visual organs, is the creature of his care, and presents in its organization the most striking illustration of the perfection and beauty of creation. We learn that God's tender care is extended alike to all created things; and that nothing, howsoever minute, and apparently unimportant,

is too insignificant to escape that protective care.

As the study of the microscope is, therefore, fraught with lessons of the deepest instruction, presenting an inexhaustible fund of amusement combined with it, I sincerely hope that this little volume may induce some investigating intellect, far superior to my own, to devote a few hours each day to so pleasing a branch of human knowledge.

It has been asserted by several naturalists that putrefaction is caused by the presence of animalcules; but this assertion has evidently been made previous to having devoted sufficient attention to the subject. If animalcules are the cause of putrefaction, what causes the animalcules themselves to putrefy? We know that they do putrefy when in masses, with as much readiness and rapidity as those substances, the putrefaction of which is ascribed to them. We know that the atmosphere is the great

reservoir of animalcules and their eggs; for nothing can be exposed to it, that offers the proper conditions necessary to the life and growth of these little creatures, but that is soon full of them.

It is true that their presence accelerates the destruction of animal and vegetable matter; but this is simply through the great voracity which these creatures possess, whereby they devour such vast quantities. Any person who has witnessed the incessant voracity of these creatures will readily perceive the significance of our remark.

But the great purpose, doubtless, which animalcules subserve in the economy of nature, is the power they possess of eliminating pure oxygen, not unlike that of vegetables. Experiments have been made by several eminent persons which substantiate the remarks of Rumford, made seventy years ago, that the water containing animalcules gives out nearly pure oxygen gas. The green, slimy matter

found at the bottom of the salt-pans at Rodenberg, was ascertained to give out nearly pure oxygen gas, ^κso very nearly pure, than an ignited splinter would burst into flame if put into it.* This green matter, when placed under the microscope, revealed a mass of animalcules of the species *Navicula* and *Gallionella*, such as are found fossilised in the siliceous strata of Franzensbad, and in the paper-like formations of Friburg.* Water, which contained masses of *Glamidomonas polviscalus*, gave out a gas containing 61 per cent. of pure oxygen. The experiments of Liebig have proved beyond a doubt, [^]that water, containing animalcules, gives out such pure oxygen, that an ignited stick bursts into flame when dropped into it.

We are thus taught that these little creatures, which appear so insignificant at first thought, are really the instruments of great good. They prevent

* See LIEBIG'S "Letters on Chemistry."

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the escape into the air and water of such gases as would prove deleterious to the health of their inhabitants, while they eliminate in their stead pure oxygen. They are, therefore, the instruments for the fulfilment of great purposes, which involve the life of all the beings which exist in the air and the water. Although so insignificant in regard to size, as scarcely to attract our notice, still these minute creatures are gifted with a task which is only second to that of vegetation itself. Heretofore, animalcules were regarded as but a wonderful manifestation of the infinitesimal, whether viewed in the light of size or usefulness; but these late discoveries have placed them much higher in the scale of beneficialness, and have invested them with a dignity of which they have heretofore been deprived.

THE GREAT TENNESSEE LAKE.

It often happens that great discoveries are made, which upon becoming known, create no little wonder that they had not been discovered before. Zinc, copper, and saline or acid substances have been known from time immemorial, still it was but quite lately that two wondrous powers of the galvanic battery have been discovered. Although the property of the voltaic fluid to communicate, under certain conditions, magnetism to soft iron has been known for years, still it was long after the discovery of this property, that some fortunate genius thought of applying it to such a useful purpose as the telegraph. Water has existed, directly under man's nose, from the day of his first creation, still but a few years have gone by since he discovered that it is composed of two invisible gases, one of which is eminently combustible, and the other two grand

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supporters of combustion and of life. It was but a short time ago that philosophers (as we must term them by courtesy) thought that air, earth, fire and water₂ were the only elements; but it is now known that the very substances under our feet, including this very earth itself, are composed of more than half a hundred different elements, while the vast variety of animal and vegetable structures which present themselves about him in such innumerable forms, are really composed of but four substances, called carbon, hydrogen, nitrogen, and oxygen, nearly or quite all of which are invisible gases. In fact, with due deference to those who imagine nothing true, or worthy, or valuable, without it has the dust of antiquity sticking to it—it has been but a few years₂ since the most important discoveries known₂ have been found out.

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But I began this desultory sketch with the intention of recording a great discovery which I

have lately made in Tennessee; but lest the reader should feel a little credulous as he peruses my descriptions, I will here assure him that I shall describe only what I have absolutely beheld myself, and have shown to several friends of known veracity, who will be responsible for the truth of all I write. I speak of a great lake, of whose existence, no person, so far as I am aware, is cognizant—a lake so hid away, that no person perhaps who has ever visited Tennessee, has ever beheld it, or for a moment suspected the nature of its inhabitants. It was one day this summer, that I accidentally stumbled on this lake. Its margin is thickly set with vegetation of the rankest species, and so closely matted together as to exclude almost everything from approaching it; still, by means of a plan only thought of by myself, I succeeded in gaining a position in view of this lake, when objects met my sight, the bare description of which will doubtless

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bring a smile of incredulity upon the lip of the reader; but I repeat that the truth of what I shall say can be proved by several respectable gentlemen who have witnessed what I shall now describe, as existing in that lake. Lest the reader should marvel that no other person had discovered this lake previous to myself, I shall state that its discovery is no light trick, involving, as it did, some scientific skill, which others, who had approached in its vicinity, did not happen to possess. It is situated in an exceedingly wild place, where nothing encroaches to break the uninterrupted silence which reigns supreme. No deep-mouthed frogs are there to render night hideous with their terrific carols; no owl perches near to interrupt the profound stillness which reigns around; but the demon of silence has here erected his throne and located his kingdom; and the awful solitude which ever presides, is evidence of his eternal presence. The vegetation is not such as we are

used to beholding about us, but it is of an entirely different species,—more rank and poisonous—slimy and luxurious in appearance, and possessed of a power of growth and reproduction not to be seen in our vegetation. Thickly matted is this vegetation—vines entwining their tendrils in such luxuriance and rankness and hardness of growth, that to penetrate through them would be attempting the task of progressing into the heart of Gibraltar. The trees had grown so closely together, and so thickly matted are their foliage overhead, that to attempt to progress without the assurance of becoming utterly confused and lost, would be to assume the qualities of Dædalus himself. And then these wilderness fastnesses are the homes of innumerable creatures of such voracity and destructiveness, that danger of the most imminent kind constantly beset[^] the adventurous discoverer. Still, as I said before, by aid of means not necessary to describe here,

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I succeeded in reaching this lake so closely as to behold the strange and terrific nature of its inhabitants—and now I shall describe them to the reader just as I beheld them.

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The first that I beheld was a creature of gigantic size, but to describe its shape would be quite impossible, for it had the power to change its form, so that it was scarcely of the same shape any two minutes. Now it would stretch out its immense proportions, till they were elongated like a mighty serpent, beset over its whole circumference with spines of iron strength and dagger sharpness. Throwing itself into violent contortions, it would suddenly encompass some large creature, and extending its mighty jaws, it would seize the struggling victim, and crushing it to death, swallowed it at one effort, entirely whole. The spray flew in every direction, as this great creature contorted itself in the water, and all the smaller

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animals escaped with every indication of terror. The voracity of this animal was truly appalling. It appeared as if its great stomach could never be filled, but victim after victim went writhing down its throat, and still its stomach appeared to swell but little. While I was gazing with fear and trembling at the dangerous and voracious animal, I saw a great splash at the right, and turning my attention in that direction, I beheld, rolling with immense force and velocity towards me, a huge green ball.

I was not a little surprised at this, as there appeared to be no propelling power attached to this globe, still with such force did it progress, that I felt assured an immense power must be exerted about it, or it could not plunge through the water with such force. Now the huge shapeless animal, which had at this moment assumed the form of a gigantic bottle, stretched open its mouth, and strove with

vehement efforts to devour this globe, but, it being formed of solid flint, the creature was necessitated to desist the effort to crush it every time it made the attempt. By looking a little closer, I now beheld that this globe, although made of flint, was transparent, and that within it there dwelt a colony of animals who had ingeniously constructed this globe that they might be protected from the voracity of the great monster. I also saw that, through small perforations made in this globe, they protruded long slim strong oars, with which they propelled the great ball along. And I likewise noticed that there were several larger holes in the globe, and that, as it rolled through the water, every animal which was so unfortunate as to get drawn in at these holes, was immediately devoured by those within. While I was gazing curiously at this strange mode of protection and progression, I started back with affright, and I could scarcely resist the impulse to

fly with terror, for a gigantic monster suddenly arose from the deep bosom of the lake, and, stretching out its long arms like so many huge boar-constrictors, joined to a strange body one hundred times larger, it grasped the changing monster. In an instant a bright flash of lightning darted from those great arms, and, striking the changing animal, paralyzed it in a moment.* Then wrapping its great arms around its helpless victim, this creature drew it close up, and opening a mouth of formidable dimensions, ingorged it in an instant. I gazed with terror at this latter creature, for it was totally unlike anything I had ever heard, or read, or conceived of before. Its arms, a dozen times the length of its

* The idea was suggested by Prof. ROGET, I believe, that the hydra killed its prey by the aid of an electric stroke, not unlike that of the gymnotus. I have seen large worms paralyzed in an instant when between the arms of the hydra, which caused me to believe, with Prof. ROGET, that the hydra is gifted with electrical power.

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body, were armed with spinous processes, from which doubtless the lightning issued. It had half a dozen heads, each of which devoured indiscriminately; and I now saw that the fabled hydra of the ancients was here realized in a living creature. While I gazed, the great creature caught and swallowed others almost as large as itself; but, previous to engorging its victim, it invariably killed it with a stroke of lightning. I now observed that this huge monster had others of its species actually growing out of its own body; for, while I looked, one of the young ones extended its arms, and caught an animal, which it swallowed; and that, finally, it broke loose from its parent, and commenced an independent existence. At times this great monster would sport about in the water when something was near to attract its attention. During these moments it would contract, till its arms and body appeared like a globular mass; and then, suddenly, it would
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unroll its gigantic dimensions, expand its long arms, and seize some unsuspecting creature which had ventured in the vicinity by the harmless appearance of the monster. This great animal appeared to be more voracious than the other; for, having devoured the latter and several others, its appetite only appeared to be sharpened for a regular meal, which it seemed inclined to make upon every living thing which came within reach of its serpent-like arms.

Not far from the vicinity of this hydra-headed monster, there arose another, but not so large. It appeared to be protected by a long sheath or case. This was made of solid flint; and, being transparent, I could perceive the animal actually within it. Its body was pyriform or pear-shaped, and of a light brown colour, with lenticular bodies arrayed over it, perhaps to further protect it from the encroachments of its enemies. It soon after rising to the surface, protruded four lobes, which expanded like

gigantic flowers, and presented every hue of the rainbow. It gave me great satisfaction to behold in this terrible lake one creature which appeared to be inoffensive and beautiful. I gazed with delight at the beautiful flower which appeared so suddenly to grow out of this strange animal, and to radiate such lively colours. While I gazed, a small creature came swimming along, and soon arrived in the vicinity of this flower-animal, when my sensations of delight were changed to alarm, for in an instant these beautiful and alluring flowers were changed to great muscular arms that caught the poor animal in their grasp, and which was soon devoured by the encased monster. While this animal was at work devouring its prey, I observed, not far from it, another similarly encased, but somewhat differently formed. Instead of flowers, it had four long arms, protruded by spines of great sharpness, which it protruded from its case, and caught all smaller

creatures than itself. While I looked at this, the great hydra-monster had discovered it, and, with one or two tremendous bounds, reached it, and in a moment swallowed it. As the solid flint case went down, the animal in it contracted itself into a small ball, whither it lay protected by its siliceous covering. The great monster soon discovered that it could not digest what it had swallowed; so, opening one of its great mouths, it disgorged the case, whose inside protruded itself, and, totally unharmed by the rough treatment it had just received, began again to capture and devour animals suited to its capacity.

I noticed, during all this time, quite a number of small animals, whose curious formation attracted my attention. They consisted of a single cell, like a blown-up bladder, with innumerable arms projecting from their hollow bodies. They were in constant activity, searching for and choosing animals smaller

than themselves, which, when captured, they devoured with the greatest avidity.

But what now attracted my attention was several curious creatures of great size, whose organization was so strange as to arouse all my curiosity. From a gelatinous mass, as they at first appeared, they would suddenly start out into elongated pitcher-shaped creatures, so voracious in their habits as to seize any living thing within their reach, and devour them in a moment. At their heads, and arranged around their mouths, were several wheel-like appendages, which rotated in the water with the greatest velocity—in fact, so much so, that whirlpools of great force were created, and whose apex were directly towards their mouths. Innumerable were the smaller creatures which got within the influence of these maëlstroms, and, becoming involved in the rushing waters, were drawn headlong and struggling down into the monster's mouth. This new process of

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capturing prey was continued with the greatest vehemence, till these animals heard the approach of the great hydra-headed monster, when, aware of the proximity of a stranger, a fiercer and larger creature than themselves, they would roll themselves, into a globular mass, and sink down to the bottom of the lake.

But there were a number of animals which relied greatly upon the armour with which they had clothed themselves. This armour consisted of a sub-cylindrical shell or carapace, from which sharp spines projected, so that they were ready enveloped by an armour of solid flint, with projecting swords of the same material. But these creatures were not so secure as they might imagine ; for the great dragon, mentioned above, did not hesitate a moment to swallow them down, shell and all ; and, as it did not disgorge them, it is quite probable that they were digested. In fact, this latter conclusion of

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mine was rendered the more probable from the fact that this great creature frequently threw up masses of shells entirely empty. Some of these latter animals were pitcher-shaped, others had shells scabrous or rough, with eight projecting swords, and huge jaws, which crushed every animal small enough to come within them. These creatures had but one eye, ~~but~~ it was large, of a deep lurid red, but shone like fire. They were congregated in great numbers in one corner of the lake, whither they busied themselves in capturing prey; but, at the least intimation of the approach of one of the monsters mentioned above, they dived down into the bottom of the lake, and hid themselves among the thick rank vegetation which grew there.

I noticed among the thick masses of water-plants, which grew in such profusion at the bottom of the lake and extended to the surface, a great number of strange creatures, which did not appear to be carni-

vorous, like those I had heretofore seen, but to be entirely herbivorous. They fed with voracity upon the water-plants, tearing them furiously up by the roots with their teeth, and devouring them with the greatest avidity. They did not appear to interfere with each other, but were constantly interrupted by other monsters, which made eruptions in_^ their part of the lake, not failing each time to capture several of them. I could not but notice the peculiar manner in which many of these monsters propagated their species. It was entirely unlike anything we are used to seeing, they appearing to be neither viviparous nor oviparous. Most of them I noticed while I was there would change their appearance. A fissure could be observed running longitudinally down their bodies. This increased in size and depth, till finally the monster actually split into two parts, each part swimming off in opposite directions, an entire and fully developed animal.

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While observing these strange denizens of this great lake, I could not help but observe a number of animals that had attached to themselves long tendrils, or spirally contractile ropes, which admitted of their moving for some length, but still confined them to the rock to which they were fastened. These curious animals had immense jaws which they extended wide as they seized their prey. They had arrayed around their jaws a great number of strong arms which they vibrated furiously, producing eddies or whirlpools that drew in their vortex a number of small animals. Some of these monsters were green, some were rose-colour, some yellow, and others were deep blue. They sported about in the water, apparently enjoying themselves greatly, although they could not go beyond the tendrils or ropes which confined them. In many of them, which were transparent, I could see a number of the bodies of smaller animals which they had devoured.

I also saw near these creatures what I at first mistook for an extremely long and slim snake, but upon closer examination I perceived that each chain was composed of a number of strange creatures, which were attached to each other by pedicles or small cords, but in such concert did they appear to act, that one might be easily deceived into the belief that the whole colony was but one long, single creature.

But what now attracted my admiration was by observing a number of creatures with great mouths and voracious appetites. As their bodies are quite soft, and would therefore make an acceptable meal to some of the larger creatures, they had adopted a very ingenious method of avoiding their great jaws. They had made them a wide table of solid flint—so wide that none of the monsters mentioned above could swallow it. Upon this tablet these creatures had attached themselves side and side. If

to / they perceived one of the large monsters approaching them, they immediately turned it the opposite side of their flinty tablet, and as it was too large to swallow, and the creatures being hid on the opposite side, the monster would turn aside and go on its way, leaving them unmolested. This was extremely ingenious and answered the purpose admirably. A number of these curious tablets, with their colony of shrewd inhabitants, were scattered over the lake; but so large were their great flint plates that none of the monsters—although several tried—could swallow them.

What now attracted my attention was an enormous creature, which was almost circular. It had armed itself with a large shell which was made of flint and was transparent. The carapace or shell appeared lenticulated, or arranged like the tiles in mosaic-work, which gave solidity to its structure, and thus resisted the encroachments of several monsters which

were sporting about in its vicinity. This shell had a hinge like that of the common clam or mussel, which admitted of its being opened at pleasure. This great monster—for it was one of the largest inhabitants of this lake that I had yet seen—appeared to be entirely herbivorous, and fed voraciously upon the rank plants at the bottom of the lake. But what attracted my attention was the fact of its having about it several young ones, whose shells had not been made. If any danger menaced, the old one would open her shell and the young ones would take refuge within, when she would close it up, and thus keep them in security till the danger had passed.

Close by this creature was another equally as large. It appeared in shape like a gigantic flea, but was encased in armour not unlike that worn by the warriors of the middle ages. This armour appeared to be formed of flint, and was so hard

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as to effectually resist the roughest usage. This creature had long, flexible horns, encased in solid flint, and several long legs, which being broad, enabled it to swim with the greatest facility. It had a bicaudal process, or double tail, of great length, which it swept about through the water with immense force. But the most curious appendage of this great creature, was two large bags situated each side of the tail. As the integument which covered these bags was transparent, I could perceive that they had within them a number of eggs, which the animal laid among the weeds at the bottom of the lake, till the heat of the sun should hatch out the young. This animal did not swim like the others, at a steady, even pace, but it moved by starts, springing or leaping through the water like a flea on dry land. I saw, likewise, a number of other strange creatures in this great lake, but as the sun was going down rapidly toward the western horizon,

I thought it time to leave; but before I did so, I made a correct measurement of this great lake, and I found that its diameter was just one quarter of an inch, its depth one sixteenth of an inch, and what enabled me to discover all of these strange creatures which I have faithfully and correctly described, was the Microscope.

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