confirmed as a fact, that, as Prof. Schellen says, "luminous nebulæ actually exist as isolated bodies in space, and these bodies are masses of gas." Thus, clusters, groups, stars and planets, are in process of genesis from primeval cosmic matter, and Cosmology may be regarded as a science, established by the aid of art in the construction of larger telescopes, and their new associate in the field of stellar research, the spectroscope; these bring within the scope of observation new facts, and confirm the generally received theory of the nebular constitution and the genesis of the stellar and planetary systems from such original cosmic matter.

The conservation of all the lower departments of science to the wants of man, in his individual and social relations, gives a vast superiority of rank to Anthropology. In recent times, the chief points of practical importance in the progress or development of this science have pertained to Sociology. Researches in special lines of investigation have furnished many facts of great interest pertaining to antiquities, archives of ancient cities, inscriptions upon rocks, hieroglyphics and monuments, which have yielded abundant fruits to explorers, and vastly increased the knowledge of particular races and languages; while increasing evidences are furnished that the antiquity of the human race is much greater than that indicated by the generally accepted chronology.

In the department of Philology, great progress has been made during the period of our own times. Comparative Philology is no longer confined to the Latin and Greek of the ancient languages, and two or three of the modern languages, but every language of the globe is yielding rich fruits bearing upon history as well as philology; especially has the Sanscrit, the mother of all the Indo-European languages, received special attention, resulting in the establishment of professorships of the Sanscrit in several colleges.

But questions of the highest interest pertain to Psychology, especially relating to our psychical nature and its connection with our physiological constitution, to the phenomena of "Unconscious cerebration," and other facts which have elicited research in the modes of receiving and retaining sensations and the memory of facts, and into the medium of transmitting such impressions. Such inquiries have led to the adoption of the following theory of accounting for these phenomena, viz.: that the psychical constitution is not simply mental or spiritual, but is *dual* or two-fold, consisting of two substances we may conveniently term respectively *etheral* and *spiritual*. The following rational deductions are given as the only satisfactory hypotheses pertaining to our interior being, viz.: That the great rapidity of the transmission of impressions, being at least 100 feet per second from the extreme parts of our physical system to the brain, or requiring but one-fifteenth of a second to produce a sensation, involves the necessity of the existence of an ethereal substance permeating the nerves, and hence called "nervous ether," which forms the elementary substance of the formal psychical nature. That, as the physical germ is the initial organism of the future physical body, "potentially alive," in the germinal state, so this nervous ether contains the psychical germ or initial organism of the future psychical body, potentially perfected, and which emerges, in its real or developed form, upon the death of the physical body, or properly its separation from the soul, or interior being. That the psychical nature, while connected with the physical, forms the basis of vital action, continuity and identity; and that the mechanism of thought and feeling involves the necessity of two psychical centres of activity, corresponding with the brain and heart, viz.: the psychical *sensorium*, which is the seat of intellectual action, the basis of sensation, memory, etc., and the psychical *cardium*, the seat of the emotional and sympathetic affections.

Scientific progress has both increased the number of special sciences and extended the limits of those previously known. This has created the necessity of the division of scientific research, inducing students to pursue single lines of inquiry, the result being more thorough and extensive knowledge of the respective departments, which have become the common heritage. Examples of this devotion to special sciences are now numerous in every department, as in the case of the late Prof. L. Agassiz, who devoted many years to the study of animalculæ. In the history of plants and animals, species, genera, and even classes have been multiplied, as individuals have devoted their lives to these subjects, with all the helps at command, leaving no depths unexplored. The anatomist and physiologist no longer confine attention to the human structure, but find in comparative anatomy and physiology many types and characteristics brought forward and perfected in the higher orders, or old forms substituted by new, till finally, in the human constitution the completed form best adapted, not to the lower purposes of physical strength and endurance, by which the animal subserves human ends, but the best form for the higher ends of intellectual, moral and social natures by which man is evidently distinguished above the brute.

This division of labor has been found essential in application to the numerous sciences now demanding vastly increased forces of professional teachers in colleges and universities. Now, a college can scarcely claim the name of a liberal institution of learning in which one professor is required to associate sciences so unnaturally connected as Mathematics and Moral Philosophy, or Chemistry, Botany and Pharmacy, as in some European colleges a century ago. A comparison of the courses of study and the professorships in colleges in our country during the past thirty or forty years will exhibit the marked advancement of the sciences, and the increased requirements of the present time. In 1837, Geneva College, now Hobart College, Geneva, N. Y., of which the writer was a student, contained a professorship of "Mathematics and Natural Philosophy;" of the "Latin and Greek languagess;" of "Modern languages, History and Belles-Lettres," to which was added Rhetoric and two other mixed professorships. For the year 1849—1850, the catalogue of Western Reserve College, Hudson, O., of which the writer had been a theological student, exhibits the following: The institution embraced three departments: General Science, Medicine, and Theology, besides a preparatory department. Five professors gave instruction in General Science, or the Literary department; one of which was the professor of the "Latin and Greek;" one of "Chemistry, History, Medical Jurisprudence (in the Medical department), and Natural History,"—the latter embracing several branches, including Geology! and one professor of "Modern Languages." Great advancement upon this order is now exhibited in the principle colleges of our land. I here name only three: In 1875, Lafayette College, Easton, Pa., had twenty professors and adjunct professors, besides tutors, assistants and lecturers—twenty-seven in all. The University of Wooster, O., in 1876, had thirteen instructors in the Literary department, and the same number in the Medical department. The Michigan University, Ann Arbor, Mich., in 1877, had, in all departments, fifty-five instructors.

CAUSE OF THE BLUE COLOR OF CERTAIN WATERS.

By PROF. JOHN LE CONTE.

The consideration of certain facts clearly indicates that the real cause of the blue tints of the waters of certain lakes and seas, is to be traced to the presence of finely-divided matter in a state of suspension in the liquid. We have seen that Sir I. Newton, and most of his successors as late as 1869, ascribed the blue color of certain deep waters to an inherent selective reflecting property of its molecules, by which they reflected the blue rays of light more copiously than the other rays of the solar spectrum. Since the researches of Soret, Tyndall and others, this selective reflection has been transferred to the finely-divided particles which are known to be held in suspension in greater or less abundance, not only in all natural waters, but even in the most carefully distilled water. When the depth of water is sufficiently great to preclude any solar rays reaching the bottom, then the various shades of blue which are perceived under similar conditions of sunshine, will depend upon the attenuation and abundance of materials held in suspension; the purity and delicacy of the tint increasing with the smallness and the degree of diffusion of the suspended particles. Moreover, it is evident that Tyndall is quite correct in assigning to "true molecular absorption" some agency in augmenting "the intense and exceptional blueness" of certain waters; for it is obvious that the "blue of scattering by small particles" must be purified by the abstraction of the less refrangible rays, which always accompany the blue during the transmission of the scattered light to the observer. It seems to be very certain that were water perfectly free from suspended matter and coloring substances in solution, and of uniform density, it would scatter no light at all. "But," as Tyndall remarks, "an amount of impurity so infinitesimal as to be scarcely expressible in numbers, and the individual particles of which are so small as wholly to elude the microscope," may be revealed in an obvious and striking manner when examined by a powerfully concentrated beam of light in a darkened chamber. If the waters of the lakes and seas were chemically pure and optically homogeneous, absolute extinction of the traversing solar rays would be the consequence if they were deep enough. So that to an observer floating on the surface, such waters would appear as "black as ink," and apart from a slight glimmer of ordinary light reflected from the surface, no light, and hence no color would reach the eye from the body of the liquid. According to Tyndall, "in very clear and very deep sea water, this condition is approximately fulfilled, and hence the extraordinary darkness of such water." In some places, when looked down upon, the water "was of almost inky blackness—black qualified by a trace of indigo." But even this trace of indigo he ascribes to the small amount of suspended matter, which is never absent even in the purest natural water, throwing back to the eye a modicum of light before the traversing rays attain a depth necessary for absolute extinction. He adds: "An effect precisely similar occurs under the moraines of the Swiss glaciers. The ice is here exceptionally compact, and owing to the absence of the internal scattering common in bubbled ice the light plunges into the mass, is extinguished, and the perfectly clear ice presents an appearance of pitchy blackness" ("Hours of Exercise in the Alps;" "Voyage to Algeria to Observe the Eclipse," Am. Ed., N. Y., 1871, pp. 463-470). In like manner the waters of certain Welsh tarns, which are reputed to be bottomless, are said to present an inky hue. And it is more than probable that the waters of the Silver spring, whose exceptional transparency has been previously indicated, would, if they were sufficiently deep, present a similar blackness, or absence of all color by diffuse reflection.

It remains for us to explain the cause of the green tints which the waters of certain lakes and seas assume under peculiar circumstances. These green colors manifest themselves under the following conditions, viz: (*a*.) In the finest blue water, when the depth is so small as to allow the transmitted light to be reflected from a bottom which is more or less white. Thus, a white sandy bottom or white rocks beneath the surface of the Lake of Geneva, or the Bay of Naples, or of Lake Tahoe, will, if the depth is not too great or too small, impart a beautiful emerald green to the waters above them. (*b*.) In the finest blue water, when a white object is looked a through the intervening stratum of water. In the blue waters of the sea this is frequently seen in looking at the white bellies of the porpoises, as they gambol about a ship or steamer. In a rough sea, the light which has traversed the crest of a wave and is reflected back to the eye of the observer from the white foam on the remote side, sometimes crowns it with a beautiful green cap. In March, 1869, I observed this phenomenon in the magnificent ultramarine waters of the Carribbean sea. A stout white dinner plate secured to a sounding line, presents various tints of green as it is let down into the blue water. Such experiments were made by Count Xavier de Maistre, in the Bay of Naples, in 1832; by Prof. Tyndall, in the Atlantic ocean, in December, 1870, and by the writer in Lake Tahoe, in August and September, 1873. (*c*.) In waters of all degrees of depth when a greater amount of solid matter is held in suspension than is required to produce the blue color of the purer deep waters of lakes and seas. Thus, Tyndall, in his "Voyage to Algeria to observe the Eclipse," in December, 1870, collected 19 bottles of water from various places in the Atlantic ocean between Gibraltar and Spithead. These specimens were taken from the sea at positions where its waters presented tints varying from deep indigo blue, through bright green to yellow green. After his return to England, he directed the concentrated beam from an electric lamp through the several specimens of water and found that the blue waters indicated the presence of a small amount of suspended matter; the bright green a decidedly greater amount of suspended particles, and the yellow green was exceeding thick with suspended corpuscles. He remarks: "My home observations, I think, clearly establish the association of the green color of sea water with fine suspended matter, and the association of the ultramarine color, and more especially of the black indigo hue of sea water, with the comparative absence of such matter." ("Hours of Exercise in the Alps;" "Voyage to Algeria to observe the Eclipse," Ed. cit. ante, pp. 464 et 467.)

There is one feature which is common to all of the three above indicated conditions, under which the green color manifests itself in the waters of the lakes and seas, viz: When a white or more or less light-colored reflecting surface is seen through a stratum of intervening water of sufficient purity and thickness. Condition (*c*,) is obviously included; for it is evident that a background of suspended particles may, under proper conditions, form such a reflecting surface.

Inasmuch as under these several conditions, more or less of transmitted light is reflected back to the eye of the observer, it is evident that the rays which reach him carry with them the chromatic modifications due to the combined influence of the selective absorption of the water itself, and the selective reflection from the smaller suspended particles. Hence, the chromatic phenomena presented, being produced by the mingling of these rays in various proportions, must manifest complex combinations of tints, under varying circumstances relating to color of bottom, depth of water, and the amount and character of the suspended matter present. In the explanations of the green color of certain waters by the older physicists, we recognize the full appreciation of the influence of selective reflections in the productions of the phenomena; but they seem to have overlooked the important effects of the molecular absorption. We have seen that Sir I. Newton regarded the green tints of sea-water as due to the more copious reflection of the violet, blue and green rays, while those constituting the red end of the spectrum are allowed to penetrate to greater depths. ("Optics, loc. cit. ante.") Sir H. Davy ascribes it, in part, to the presence of iodine and bromine in the waters, imparting a yellow tint, which, mingled with the blue color from pure water, produced the sea-green. ("Salmonia, Collected Works," Vol. 9, p. 201.) In like manner, Count Xavier De Maistre ascribed the green tints to the yellow light, which, penetrating the water and reaching the white bottom or other light-colored submerged objects, and being reflected and mixed with the blue which reaches the eye from all quarters, produces the green. ("Bibl. Univ.," Vol. 51, pp. 259–278, Nov., 1832; also Am. J. Sci., first series, Vol. 26, pp. 65–75, 1834.*). On the other hand, after Bunsen, in 1847, had established that chemically pure water extinguished the rays of light constituting the red end of the solar spectrum more copiously than those of the blue extremity, so that the transmitted tints were more or less tinged with blue, some chemists were inclined to attribute the green color of certain waters to the presence of foreign coloring substances. Thus Bunsen himself explained the brown colors of many waters, especially of the north-German inland lakes, as produced by an admixture of humus; but he considered the green tints of the Swiss lakes and silicious springs of Iceland as rising from the color of the yellowish bottom. (Vide. loc. cit. ante., p. 44, et seq.) Similarly we find that Wittstein, in 1860, from chemical considerations, concluded that the green color derives its origin from organic admixtures, because the less organic substance a water contains the less does the color differ from blue; and with increase of organic substances the blue gradually passes into green, and ultimately into brown. This is likewise the view taken in 1862, by Beets, for he insists that in all waters the observed color of the liquid is that of the transmitted light, and not, in any case, of the reflected light. Moreover, he maintains that Newton, De Maistre, Arago and others were mistaken in classifying water among those bodies which have a different color by transmitted light to that which they have by reflected light. (Loc. cit, ante.)

We have already shown that if the waters were chemically pure and perfectly free from suspended particles, the red rays of the traversing solar light would be first absorbed and disappear, while the other colored rays pass to greater depths, one after the other being extinguished in their proper order, viz., red, orange, yellow green, blue and violet, until at last there is a complete extinction of the light in the deeper mass of the liquid. But the presence of suspended particles causes a part of the traversing solar light to be reflected, and according as this reflected light has come from various depths, so will the color vary. If, for example, the particles are large, or are abundant and freely reflect from a moderate depth, and prevent reflection from a greater depth, the color will be some shade of green.

When the water is shallow and a more or less light-colored bottom, or a submerged object reflects the transmitted light to the observer through the intervening stratum of liquid, it is evident that the chromatic tints presented must be due to the combined influence of the selective absorption of the water itself, and the selective reflection from the smaller suspended particles.

In other terms, under these conditions, the tints are produced by the mingling of the blue rays with the yellow, orange or red; so that the resulting hues must generally be some shade of green. In short, all the facts established by modern investigations seem to converge and point to the admixture of the blue rays reflected from the smaller suspended particles with the yellow orange and red rays reflected from the grosser matters below, as the true physical cause of the green tints of such waters.

The establishments of the very important function of solid particles held in suspension in water, in producing chromatic modifications both in the scattered light and in the transmitted light, serves to reconcile and to harmonize the apparent discrepancies and contradictions in the views of physicists who have investigated the color of water.

We have already seen that Sir I. Newton and most of his successors, as late as 1847, regarded water as belonging to the opalescent class of liquids, in which the diffuse reflected light and the transmitted light present more or less complementary tints; the former partaking more of the colors constituting the blue end of the solar spectrum, while the latter presented more of the hues belonging to the red extremity. On the contrary, the more recent and more accurate experiments render it quite certain that in distilled water the rays of the red end of the spectrum are more copiously absorbed than those of the blue extremity; so that the emergent transmitted tint is yellowish green or greenish blue. At first view, these results appear to be discordant and irreconcilable; but, it will be recollected, that while even the most carefully distilled water contains a sufficient amount of suspended matter, to scatter enough light, to render the track of the traversing concentrated solar beam visible, yet, in this case, the selective reflection of the blue rays, due to the suspended particles, is not adequate to neutralize the selective molecular absorption of the rays toward the red end of the spectrum. Nevertheless, as has been previously shown, the addition of very minute quantities of diffused suspended matter confers on distilled water the dichroitic properties of an opalescent liquid.

The presence of an extremely small amount of suspended solid corpuscles, by selectively reflecting the shorter waves of light, is sufficient to neutralize and overcome the selectively absorbent action of the molecules of water on the longer waves; and thus, to impart yellow, orange or red tints to the transmitted beam. Moreover, it is very questionable whether any natural waters are sufficiently free from suspended matter to deprive them of these dichroitic characteristics.

Under this aspect of the subject, the views of Newton, derived from the observations of Halley, those of Hassenfratz deduced from his own experiments, as well as the explanations of the green tints of certain waters given by De Maistre, Arago and others, completely harmonize with the conclusions deducible from modern researches, provided the property of selective reflection is transferred from the aqueous molecules to the finely-divided particles held in suspension.

As a striking illustration of the slight causes which sometimes transform the purest water into an opalescent or dichromatic liquid, it may be interesting to detail one of my own experiences. On the 21st of Dec., 1878, the series of glass tubes employed in my experiments (as previously indicated), being filled with distilled water, the transmitted solar beam presented when received upon a white screen in a darkened room, the usual yellowish-green tint of my winter observations. On the 24th of December, or after an interval of three days, durwhich all parts of the apparatus had remained *in situ*, I was much surprised to find that the transmitted solar beam was enfeebled, and presented an orange red color with no tinge of green. Puzzled to discover what could have produced so marked a change in the optical properties of the liquid, the "scientific use of the imagination" pictured the possible development of ultra-microscopic germ, infusoria, *bacteria*, *confervæ*, etc. The next day (December 25th), the same phenomenon presented itself, when I called the attention of my assistant, Mr. August Harding, who had kindly prepared the arrangement of the tubes, to the anomalous change that had taken place in the color of the transmitted beam. He suggested that as he had used alcohol in cleaning the glass plates, closing the ends of the tubes, and as the plates were secured to corks by means of Canada balsam, the alcohol absorbed by the corks, being gradually diffused, dissolved some of the balsam, which solution, mingling with the water, might produce a fine resinous precipitate, which might stifle the transmitted beam and

* Similarly, Arago has very ingeniously applied the same principles to the explanation of the varying colors of the waters of the ocean under different circumstances, showing that when calm it must be blue by the reflective light, but when ruffled the waves acting the part of prisms, refract to the eye some of the transmitted light from the interior, and it then appears green. ("Comptes Rendus," tome vii., p. 219, July 23d, 1838.)

scatter the rays of shorter wave length, thus leaving the orange-red rays predominant in the emergent light. This view was speedily verified by a critical examination of the track of the traversing beam. A sensible turbidity was visible, in the darkened room, at the extremities of the column of water adjacent to the corks securing the glass plates; and the light diffused latterly at these portions, when examined by Nicol's prism, was found to be distinctly polarized. The emergent beam examined by the spectroscope, exhibited orange and red in full intensity; but the yellow and green were greatly diminished. Ten days later (January 2, 1879) the solar beam traversing the same column of water emerged much brighter than on Christmas day, and the tint was orange tinged with yellow and red. This long repose caused, doubtless, some of the resinous precipitate to become more generally diffused, or to subside, and thus diminished the turpidity of the liquid. The recognition of the dichroism imparted to water by the presence of finely-divided particles in suspension, serves, likewise, to harmonize the conflicting views promulgated by physicists who have studied the chromatic phenomena presented by this liquid. Some claim that the rays of higher refrangibility are more copiously withdrawn by absorption; while others maintain that the rays of longer wave lengths are more absorbed. In many cases the chromatic tints ascribed to selective molecular absorption are unquestionably due to selective diffuse reflection from the ultra-microscopical corpuscles which are held in suspension. (Vide Jamin's "Cours de Physique," 3d ed., tome 3, p. 447, *et seq.*)

ON THE IMPORTANCE OF ENTOMOLOGICAL STUDIES.*

"Occasionally, at the present day, we may hear insects and entomologists spoken of as 'bugs' and 'bug-hunters'—epithets applied in derision to what are regarded as petty objects and trivial pursuits. Such views only betray an ignorance which is equally pi iable and inexcusable. The study of insects has assumed an importance in its direct application to agriculture, horticulture and sylviculture, second to no other department of natural history. It has called to its aid some of the best intellect of the country. Its literature has become extensive and assumed a high rank. Our State governments, in response to demands made upon them, are appointing State Entomologists. Our General Government is making liberal appropriations for entomological work in the Department of Agriculture at Washington, and also for sustaining a special United States Entomological Commission, now in the third year of its operations, charged with the investigation of a few of our more injurious insects.

"The study of insects assumes an importance in this country far greater than in any other part of the world. No where else does mother earth yield in such variety and in such abundance her agricultural products; after supplying to repletion our own people, the excess is distributed to every quarter of the globe. Few, surprisingly few, of these varied products are native to our soil. Nearly all of our fruits, grasses, cereals and vegetables, and perhaps three-fourths of our weeds are of foreign importation—mainly from Europe. With their introduction, very many of the insects that preyed upon them were also introduced, or have been subsequently brought hither. But unfortunately for us, the parasites which preyed upon them and kept them under control, have for the most part, been left behind. As the result, the imported pests, in their new home, find their favorite food-plants spread out in luxuriant growth over broad acres, where they may ply their destructive work without hindrance or molestation, until some native parasites acquire the habit of preying upon them.

"The grand scale upon which our crops are grown as no where else in the world—demanding for their gathering the invention of special mechanical contrivances, and that horse power should be replaced by steam—has also as its attendant inevitable evil, an enormous increase of insect depredations. This may be illustrated by a reference to our apple-tree insects. * * * * * * "In like manner, any and every crop cultivated on a large scale offers strong invitation to insect attack, and wonderfully stimulates insect multiplication."

PROFESSOR J. A. LINTNER.

* From an address before The Farmers' Club, Onondaga Co. N. Y.

CLOUD COLORS.

This P. M., from about 3.30 to sunset, I was witness to a remarkably vivid display of cloud-colors; and thinking that a full description of the phenomena may perhaps help to the understanding of the conditions of the higher atmosphere, I have written out what I saw. The day had been the warmest of the season. The night before was cloudy, and the temperature hardly fell below the freezing point. Light clouds prevailed through the day; at 3.30 the standard and maximum thermometers stood together at 62°, while the maximum sun thermometer registered 119°. The day had been quite still, the direction of the very light wind being from the S. E. The clouds in the neighborhood of the sun were of two varieties, the lower a fleecy and tufted cloud of the cumulus order, moving pretty rapidly from a little north of west, and frequently exhibiting a rapid spiral movement in the filaments, the other would be called cirro-stratus, though not precisely the typical cloud of that name, as portions were quite free from any appearance of structure. In the less dense portions an arrangement in parallel fibres was, however, quite apparent,—one set nearly horizontal, the other inclined at about 45°, the south end upward. The horizontal arrangement predominated, while the other was visible here and there in a detached streamer and occasionally in striæ upon the longer belts, which, hence, were not, as is usual with this cloud, striated perpendicularly to the direction of the bands. These cirro-stratus clouds, which also moved from the west, though with a much less velocity than the lower ones, were the only clouds which showed the rainbow colors. These were exceedingly intense, and changing every moment with such rapidity as to make it very difficult to decide upon the order of the colors, the more so as every filament had its own rainbow, and all were shifting. The red was, however, generally nearest the sun, though sometimes bordered inwardly with intense yellow. The most perfect succession of colors which I caught was in a cloud extending horizontally northward from the sun, in which for a brief interval all the seven colors could be traced following one another, not in the direction of the sun, but vertically, the red uppermost. The violet was, however, so very brilliant as to suggest the beginning of a new rainbow at its bottom, and in a moment this cloud had adopted the form which was most common throughout,—bands of red above and below, with a broader band between of yellow or green or blue. This blue tint was often exceedingly brilliant, tipping both ends of filaments, which were of dull hue in the centre, and bordered above and below with parallel stripes of red. A purple shade was occasionally distinct, surrounded by other colors. This undescribably beautiful display continued over the whole S. W. quarter of the sky, until the sun had been out of sight behind the mountains for more than half an hour.

Though the clouds upon which the colors were observed were of the order in which halos are formed, yet the appearance had very little in common with the halo,—of which we have had a good example within a week. The colors were not only not concentric, but were exhibited successively by different clouds in every direction from the sun, and *at all distances*, from 30°, or, perhaps, 40°, to