high elevation, so much so that persons staying at Davos can enjoy a sun bath in a sheltered spot even in the cold of winter, although wearing much thinner clothing than at home.

It takes a visitor at Cerro de Pasco, in Peru, which lies at an elevation of 4,500 meters, 10 or 12 days to thoroughly regulate his respiration to the conditions of the atmosphere. In case his suffering is greater at first, it often happens that he is compelled to make a temporary change of residence to a point some 1,000 meters nearer the level of the sea. Even during the descent he begins to breathe more easily and feels brighter and stronger.

The inhalation of air which has been artificially condensed, as in a pneumatic cabinet, produces quite similar sensations. An asthmatic patient placed in an atmosphere where the pressure has been augmented by nearly one-half will immediately be enabled to breathe more freely; respiration becomes slower; his excited nerves are quieted, and he feels imbued with renewed vigor.

The mechanical action of condensed air as it affects respiration is the reverse of the action which takes place in rarefied air. A higher atmospheric pressure facilitates the expansion of the lungs, and the condensed atmosphere, by delaying the egress of the air expelled during exhalation, finally effectuates a distended condition of the lungs. The pulse beats become slower at the same time, and the veins, which were surcharged with blood under a diminished pressure, are now emptied more thoroughly. This is the cause of the decrease of congestive conditions in a pneumatic cabinet. The amount of oxygen which we inhale is increased in proportion to the increased condensation of the atmosphere, thereby enriching the blood. If the treatment is continued, this soon makes itself manifest by an increased appetite and a healthier complexion. The invalid gains in strength and vitality. Respiration is facilitated even outside of the cabinet, and by such observations we perceive that the employment of condensed air has after effects, which supposition the spirometer confirms. A deeper and more quiet respiration has been observed in some cases after the elapse of one and even two years.

The air which is admitted into the pneumatic cabinets by means of air pumps can be kept at any degree of condensation. The cabinets, which are of various sizes, are arranged to admit from three to fourteen persons, and naturally great care is taken to have a good ventilation. They generally stand in the center of a lighted hall; their walls are composed of sheet iron and provided with windows which admit ample light for reading. The cabinets are used exclusively for the cure of catarrhal diseases, to facilitate the respiration of asthmatic patients and to improve the condition of the blood of anæmic persons, in which cases the condensed air frequently proves beneficial after all other remedies have failed.

The first pneumatic cabinet was established somewhere in the thirties at Montpellier by a physician named Tabarie, who later gave the management of it into the hands of a physician. Pravaz soon followed his example at Lyons, and the reports of the two scientists as to their observations made on healthy and diseased persons were presented before the French Academy and to the medical world in quick succession. About thirty years later the idea of putting condensed air to this use spread from France to other countries of Europe, and the largest institution of this kind at present is at Reichenhall, the property of E. Mack, in which fifty-three persons can make use of the heightened pressure at the same time.

In 1841 M. Triger, a civil engineer, introduced in France the idea of using a heightened atmospheric pressure in building subaqueous works, and this gave an opportunity to observe what effect an atmospheric pressure which was much higher than that of a pneumatic cabinet would have upon the workmen. The work under pressure is carried on in an iron shaft, the sides and top of which are airtight. It is sunk to the bottom like a diving bell, while the upper end protrudes above the surface of the water. The fresh air which is continuously pumped in from above expels the water below, leaving the bottom free to be worked upon. The shaft sinks deeper and deeper as the earth is removed, until there may be a pressure of three and one-half or nearly four atmospheres. A pressure of ten meters of water is equal to about one atmospheric pressure.

The effect of the condensed air upon the laborers was found to be surprisingly favorable up to a pressure of two atmospheres. The hard work was accomplished more easily and with less fatigue than in the open air, and in such exertions as running up a ladder they did not get out of breath. Even after working hours the men felt stronger and in better spirits.

But when the pressure exceeds that of two atmospheres the men begin to have certain unpleasant sensations, such as itching and pains and swelling of those muscles which are strained the most. These symptoms do not, however, appear while under the heightened pressure, but make themselves felt during the time that the men are under the normal pressure, and pass away again as they return to their work. The overseers are exempt from these effects. They receive instead a mental stimulus which is manifested by an increased impulse to talk.

If the atmospheric pressure is still further increased, the resistance against exhalation becomes stronger. The action of the respiratory apparatus is weakened by the increased distension of the lungs until it finally becomes almost imperceptible: speech is difficult and whistling impossible. The result of the too rapid contraction of the lungs under a diminished pressure which prevents whistling is the same as that which follows when the egress of the air expelled by the lungs is delayed.

The enlivening influence on the workmen is diminished as soon as the pressure exceeds that of three atmospheres. The slow and imperfect performance of the respiratory function begins to have a detrimental effect upon the gaseous interchange which takes place in the lungs by causing the carbon dioxide to be retained in the blood. The laborers become more easily fatigued, and a decrease of appetite is followed by loss of flesh, if they continue the work. We find, therefore, that there is a limit to the condensation of air, which a man cannot overstep without detriment to himself, but there is a wider limit in this direction than in that of rarefied air.

Experience proves that a temporary change from the normal pressure to an increased or diminished pressure is pleasant and also benefits vitality in various ways. We are able to ascend to any altitude at which the air is rarefied to the desired degree, but the privilege of choosing a denser atmosphere in which to live is denied us. It is only from a few places at very high elevations that convalescents can be sent down to a lower altitude, where they quickly recover by inhaling air which is more condensed and contains a larger proportion of oxygen. The inhabitants of the lowlands are confined to the pneumatic cabinet in their search for these benefits. From what has been said regarding the mechanical change which respiration undergoes, we gather that a temporary employment of condensed air, besides its various other effects, would be a good preparation for the proper performance of the respiratory function in a more rarefied atmosphere.*

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THE ZODIACAL LIGHT.

By Lieut.-Col. E. E. MARKWICK, F.R.A.S.

THE season when this phenomenon is visible after sunset is now approaching, and it may be interesting to take stock of what we know about it, which, after all, seems to be surprisingly little. It is generally dismissed in the text books with a pretty short notice, and sometimes is not mentioned at all. Although it can hardly be called a popular object in the sense that Mars or Jupiter is, still there must have been a great number of observations made of it at different times, and one looks for a corresponding definite advance in our knowledge of its interior economy. But the conditions of its visibility in our latitude render exact observation extremely difficult. Like the inferior planets, Mercury and Venus, it is seldom, if ever, seen more than three or four hours after sunset or before sunrise, and cannot be observed on the meridian. Again, its tenuous and ethereal character renders it a difficult matter to note definite particulars of its shape, size or position. In these respects no instrument is of the slightest service; but the observer should be one with a keen eye, which can take in a large area of the sky, and is quick in apprehending differences in brightness of particular areas. No telescope can do this, and, even with a binocular, the field of view commanded is far too small. The best way is to sweep the eye rapidly right and left, up and down—that wonderful faculty of “averted vision” assisting to note very faint degrees of light.

My own experience, based on some sixteen years of observation in different latitudes, is that, provided one has a clear country horizon remote from the glare of towns or electric lights, with a dark clear sky in January or February, there is no difficulty to the ordinary observer in England in detecting, soon after sunset, the pearly cone of the zodiacal light sloping upward from the sun's place. The boundaries are generally ill defined, and the apex has usually to be imagined more or less, so exceedingly delicate is the glow toward the extremity of the cone. Guillemin, in “The Heavens,” has a very delicate plate of it, as seen in Japan. In this picture it looks fainter than it is sometimes seen in England.

For all practical purposes the axis coincides with the plane of the ecliptic.

An open horizon has a good deal to do with its visibility. For years I looked carefully for it in England without success, and I think the reason was that trees and other prominent objects, dark against the western sky, must have put my eye out of focus for the faint light. There are some who have not the power or capacity for this class of seeing, and I have before now, when in southern latitudes, pointed it out, quite blazing, to a friend, who, however, could make nothing of it, although it was literally staring him in the face.

Humboldt, in his “Cosmos,” has some most interesting remarks on the subject, the more so as they are based on personal observation and considerable literary research.

My first observation of zodiacal light was in Natal, where it was at once palpable. It was in the dry, clear air of the uplands of South Africa, however, that it was seen to the greatest perfection; while in the Transvaal and in Bechuanaland the light was almost blazing—at least, it seemed so to an eye accustomed to astronomical phenomena, not to bonfires. Unless one has been in these circumstances of latitude and climate, it is impossible to imagine what an exquisitely delicate and ethereal object the light is. For there one has great advantages, notably in the transparency of the atmosphere, and the fact that the light is perpendicular, or nearly so, to the horizon. It is extremely difficult, when it slopes at the angle it does in England, to judge of the relative sharpness of the margins; a point which I have studied of late in connection with Dr. Veeder's theory of its duplicity. At Gibraltar, whence I write, it is often most beautifully seen as a whole, and Humboldt refers to its greater intensity in Spain, on the coast of Valencia, etc. From our coign of vantage we have the privilege of looking across the Bay of Gibraltar, with the range of hills beyond Algeiras in the distance, and, except for occasional shipping, this view is free from artificial illumination or glare.

Humboldt thinks that the zodiacal light was unknown to, or at least not mentioned by, the ancients. The word *trabes*, occurring in Pliny, which some consider means the phenomenon in question, refers to meteors, bolides, and comets. According to Humboldt, it is first explicitly described by Childrey, chaplain to Lord Henry Somerset, in his “Britannia Baconia.”

Dom. Cassini was the first to investigate the phenomenon in its relations in space in 1683. Cassini, Humboldt says, maintained that a phenomenon observed by him at Bologna, also by Chardin in Persia, in 1668, was the zodiacal light, but that really this was the tail of the comet of 1683, whose head was at the time below the horizon. This calls to mind the great comet of 1882, which I first saw after perihelion in the beautiful sky of Natal about 4 A. M. The head was below the horizon and the tail sloped upward for many degrees—a most extraordinary vision. Never can that

supremely beautiful sight be forgotten, as the comet majestically rose and displayed himself, surrounded by a gauze veil more ethereal than any bride's.

But no one could for a moment mistake the comet of 1882 for the zodiacal light. On the contrary, the view of the great comet of 1880, which I also got in Natal, might have been easily confounded with it, on account of its exceeding faintness and delicacy.

Humboldt considers that a remarkable light seen in 1509 for forty nights consecutively, in the elevated plains of Mexico, was the zodiacal light. He found a notice of this light in an ancient Aztec MS. preserved in the Royal Library of Paris.

Humboldt proceeds to inquire into the nature of the zodiacal light, and considers “a very compressed annulus of nebulous matter revolving freely in space, between the orbits of Venus and Mars, as the material cause” of it. Coming to more modern times, Sir J. Herschel thinks it is “that medium which resists the motion of comets, loaded, perhaps, with millions of tails of these bodies.” Still later, the idea is that it consists of myriads of small meteors, each revolving round the sun in its own path, the light reflected from which impresses itself on our eyes as the zodiacal light. This is the opinion of Prof. Pickering, who, in vol. xix of “The Annals of Harvard College Observatory,” has discussed many observations with his usual acumen.

It would seem certain from the observed angular distance of the apex from the sun that these meteors extend beyond the earth's orbit; and as the light lies in, or very close to, the ecliptic, we must be perpetually cutting through them as we revolve round the sun. Do we see in our atmosphere the falling meteors which have originally formed a portion of the zodiacal light? We are of the opinion this question can only be settled when that of the relation of comets to meteors is settled, and we know what a dubious matter that is in its purely physical aspect.

Dr. Veeder, of New York, considers that the zodiacal light “does not conform to the plane of the earth's orbit, but to that of the equator of the body which it surrounds, which in this case is the sun itself. As viewed from the earth, these coronal extensions are at times foreshortened, and at times opened out, so as to become more plainly visible. In the spring months, the south pole of the sun is inclined toward the earth, so that the latter is almost exactly in the heliocentric zenith of the southern sunspot belt and coronal extension. Consequently, the particles composing this extension are in a direct line between sun and earth, and, shining as they do by reflected light, like the new moon, they become almost invisible. Coincidentally the coronal extension overlying the northern sunspot belt is opened out to its widest extent, and reflects more light earthward than at any other time. Hence, if these extensions become visible as the zodiacal light, the southern edge at this season should be the more sharply defined, and more exactly included within the plane of the ecliptic, because of the lack of illumination described; and the northern edge, on the other hand, should shade off very gradually, departing more widely from the plane of the ecliptic, and this is precisely what has been found to be the case.”

My own observations made at Gibraltar most certainly support this view.* It has also been observed by Cassini and others. Dr. Veeder further observes that it is probable that “these coronal extensions serve as conductors of electrical impulses,” and are therefore connected with the appearance of auroræ.

The question of the variability of the zodiacal light has been much discussed. Humboldt says: “I have occasionally been astonished, in the tropical climates of South America, to observe the variable intensity of the zodiacal light. As I passed the nights, during many months, in the open air, on the shores of rivers and llanos, I enjoyed ample opportunities of carefully examining the phenomenon. When the zodiacal light had been most intense, I have observed that it would be perceptibly weakened for a few minutes, until it again suddenly shone forth in full brilliancy. In some few instances I have thought that I could perceive, not exactly a reddish coloration, nor the lower portion darkened in an arc-like form, nor even a scintillation—as Mairan affirms he has observed—but a kind of flickering and wavering of the light.” These rapid apparent changes, however, he thinks, may be partly due to causes acting in the upper strata of our atmosphere.

Olbers convinced himself that “the light is very different in different years, often for several successive years being very bright and diffused, while in other years it is scarcely perceptible.” This, of course, is a different sort of variation from the temporary or momentary changes just mentioned. Some modern observers think it decidedly variable in the way mentioned by Olbers—that is, more brilliant on some occasions than on others. But we must bear in mind two things in considering this question. First: as seen in England the total apparent length of the cone decreases gradually as the season of visibility goes on. Thus, for the evening apparition the length as observed in March and April is nearly always markedly less than when seen in January and February.† Hence, because the length of the cone appears different as seen at dates separated by an interval of (say) a fortnight, it is not necessarily to be inferred that the brilliancy has changed in that interval of time. Second: we all know how clear a spell of dull or wet weather an unexpectedly clear night suddenly turns up. On the last occasion of a clear but “poor” night, the zodiacal light perhaps looked poor too. Now, on the very clear evening, it is seen under fine conditions, and naturally the finer and more delicate parts stand out clearly. But this is not variability. We cannot focus our sight on this delicate object as on a variable star, and the circumstances are such as do not admit of the application of exact photometry to the case. To decide this question we need a regular series of systematic observations made in some clear and serene sky, like that of Peru or the Transvaal, night after night and year after year. Such observations should give, according to a fixed method, the length and breadth; also the brightness, say at certain fixed altitudes, as compared with the Milky Way. It is only from such a record that the question of variability can be settled. Very possibly, changes

* See English Mechanic, No. 1625.

† See observations of Prof. Pereira and self in Journal Brit. Ast. Assoc., vol. v, pp. 361, 421.

* Translated from the author's MS. by Henriette Weber, Columbus, O.

in the density of different parts of the zodiacal meteors or cosmic dust may take place from time to time, and, consequently, changes in brightness. But I do not think that so far they have been fairly proved.

Some observers have noted a ruddy tint, but I confess that I have never detected this.

Good observers, like Admiral Smyth, acknowledge many disappointments of not catching it; and to anyone who has not yet seen the light, but wishes to do so, I would offer the following suggestions: Time, middle of January to middle of March; locality, remote from any large town or collections of lights. From some of the breezy commons and downs of Surrey or Sussex, well to the south of the metropolis and free from trees, one can command a grand sweep of sky. Better still if the observer has a sea horizon to the west, for then, provided there is no shipping, he may be absolutely certain that no artificial glare exists. Choose a brilliant evening, such as sometimes comes after heavy rain. There must be no trace whatever of moonlight, which blots out our faint subject. Keep on the lookout, say, from a quarter of an hour after sunset. Do not strain the sight by looking fixedly at a star or in one place. Cast the eye occasionally over the western sky toward the horizon, and with the above circumstances favorable, you should have no difficulty in "catching" the phenomenon and "holding" it, too. I am not quite prepared to say whether nearsighted persons would be handicapped in this search. Possibly spectacles may in some way impede vision in sweeping over a large area of the sky. There must be a slight loss of light, even through one lens only. Personally, I am blessed at present with a long sight, which does not need any assistance in the way of glasses. When

er can hardly hope to detect this or the zodiacal band.—Knowledge.

FISHING DURING THE TRIP OF A MERCHANTMAN.

A SLIGHT breeze is blowing. With all its sails set, a three-masted merchantman is plowing its way through the blue waters of the Atlantic. Astern, upon the poop, some of the crew are at work making foot ropes fast to a new mainsail. The captain is striding the deck, casting a glance at the sails, at the steersman and at the sea, and punctuating his promenade with orders: "Keep your eye on the helm!" says he to the steersman. "Tauten the sails there!" exclaims he to the sailors. But see yonder, in the distance, those black objects that are leaping upon the sea and marking their passage with a streak of foam! "Aha! they are porpoises! Boatswain, get out your harpoon, quick! And the rest of you there, come to the fore-castle!" At the captain's exclamation every one raises his head, the cook comes out of his galley, the cabin boy leaves his table utensils in confusion, and all run to the fore-castle. The harpoon is provided with its line and handed to Loic, the most expert of the crew in this sort of fishing. Loic climbs down beneath the bowsprit, and here, his feet firmly planted upon the backstays, his left hand grasping the martingale, and his right brandishing the harpoon, he waits.

In the distance, the porpoises tack about and point their noses toward the ship, and then, turning in the opposite direction, put the patience of the fishermen to a severe test. Loic whistles in order to attract them. Finally, three of them separate themselves from the

more, and then betraying his presence by his fin. On board, he is being watched, in order to see if he will notice the bait. Finally, the odor of the pork attracts him. He pounces upon it, rubs his nose against it in order to ascertain the nature of the thing, turns about suspiciously, makes a point seaward, then suddenly returns, and, his resolution having been taken, turns upon his side, opens his jaws and swallows the bait. Then the hook operates, and the shark begins his dance. His formidable bounds make the stern of the ship tremble amid splashes of foam. The line is paid out a little, and then, when the motions of the shark become slower, the ship proceeds smoothly. Now that he is taken, and well taken, there is nothing to be done but to tow him along for a few hours, and with the eight knots that the vessel is making he will soon be mastered.

The next morning, before washing, the captain comes to take a glance. "He can be hauled in now; the old fellow is half dead. Pull in the line to see!" says he. The line is pulled in, and the shark no longer gives any sign of life. It is the moment to take him on board. The brigantine is brailled up and the sheets of the main boom are secured. A winding tackle coming from the mizzen mast is attached to a strong ring of cordage surrounding the main boom, and to the latter is hooked a pulley block through which the line is passed. Then all hands begin to haul, and the shark comes under the taffrail. "Hoist away, my hearties!" The head now comes out of the water, and gradually the body makes its appearance. Sometimes the shark seems to take a new lease of life, and lashes the water with furious blows of his tail. In such a case, he is submerged again. Master Shark this time does not budge. A

PORPOISE FISHING.

once seen, it is comparatively easy to see it again another night, as we then know what sort of a thing it is we are looking for.

It is curious that the zodiacal light has not been seen during a total eclipse of the sun, and it would therefore seem that its light is decidedly inferior to that of the corona. At the same time, in such a consideration one must not omit to take account of the vast area of illuminated earth and sky which surrounds the moon's shadow cone. The darkness of an eclipse is not that of night.

Would an observer from Neptune, supposing he could do without any atmosphere himself, see the sun as a "nebulous star," with the zodiacal light extending on either side like a delicate comet? Very probably—with many a comet plowing through it, which our own atmospheric veil prevents us by its brilliant glare from seeing. Take as an instance the comet seen close against the sun during the total solar eclipse visible in Egypt in 1882.

There are two other phenomena connected with the zodiacal light, viz., the gegenschein, or counter glow, and the zodiacal band. The first is a faint patch of light seen very nearly opposite the sun's place; the other is a prolongation of the zodiacal light to the gegenschein. Both these are excessively delicate phenomena and require the finest sight and sky. Although I consider I have a good eye, I have never seen either. Even Prof. Pickering can only say that "the evidence for the actual existence of some light opposite the sun becomes tolerably strong." Still, there can be but little doubt of the existence of the gegenschein from the observations of Brorsen, Schmidt, Heis, Backhouse, Lewis, Barnard and others. But the ordinary observ-

group and come direct for the ship, to which they are attracted by its copper shining in the sun.

"Attention, Loic! there they are!" and the three cetaceans pass by as quick as a flash in leaping at a couple of yards from the vessel's stem. Loic's uplifted arm shoots forward like a released spring, and one of the porpoises, pierced through and through by the harpoon, struggles at the end of the line and makes desperate efforts to escape in tinging the blue water of the sea with its blood. "There he is!" cries Loic in regaining the fore-castle.

The animal is allowed to struggle and exhaust itself for a moment, and is then gently hauled up alongside, where a line with a slip noose is made fast to its tail, so that it may be lifted on board by means of a capstan. From the fore-castle it is sent to the deck, where the harpoon is removed, and it becomes the temporary property of the cook. Under his expert hand, the porpoise is converted into savory steaks and into huge meat pies that will somewhat vary the mess of pork and beans and hardtack and salt mackerel that forms the basis of the food of the crew of merchantmen.

Shark Fishing.—A shark has been following the ship for a couple of days, awaiting some windfall or other, perhaps the fall of a man from a mast. Its proximity is annoying, and, although the catch is not worth much, an endeavor is to be made to capture it. At the captain's order, the boatswain goes to get a huge hook provided with a chain six feet in length used for this sort of fishing. A rope is attached to this, and the hook having been baited with pork, the whole is trailed astern. Master Shark is always on hand, disporting in the blue water, swimming around the ship, passing under the keel, sometimes disappearing for an hour or

strong slip noose is passed under the caudal fins, the main boom is braced leeward, and the end of the line is hauled by hand, and guided by pulleys to the capstan upon the fore-castle. Then all hands heave at the capstan until the shark is hauled up and laid upon the poop. From there it is dragged to the deck.

There is often a terrible awakening. Then, beware of the blows of the tail and especially of the snapping of the teeth. The animal struggles in opening and closing its formidable jaws with a sharp click, while its tail pounds the deck planks. The men, armed with axes, then attack it and aim especially at the head and tail. Finally, cut and slashed, the shark no longer budges. A few slices of its coriaceous and oily flesh are set aside for the crew, while the captain reserves for himself the vertebral column, which, once arranged and a ramrod inserted in the interior, will serve as a cane, and, at all events, as a trophy. As for the remains, these, thrown overboard, will regale the bonitas and other fishes.

Capture of Albatrosses.—The capture of the albatross, like that of the shark, is, upon the whole, merely a pastime, its oily flesh, smelling like fish, not proving a very agreeable and delicate food. The albatross furnishes the pipes and tobacco pouches of merchantmen sailors. It is also a sort of certificate of the passage of the Cape.

The process of capturing the bird is as follows: To the end of a strong line is fastened a hook of the size of those used in trailing for tunny. This hook is carefully concealed in a piece of thin canvas cut into the form of a fish, or is baited with some sort of detritus or other, and the whole is thrown into the sea. The albatross, which is voracious by nature, never fails, whenever it