able. Even if regeneration does not show itself for years, hope should not be entirely abandoned, for regeneration may ultimately take place. This was true in several instances, where new hairs grew even after a decade or more from the beginning of the malady. It is my experience, however, that if a patch remains quite free from lanugo hairs for several months, it shows that the follicles are probably destroyed and that there will be a permanent alopecia. The older the patient, and the longer the area has been affected, the graver becomes the outlook as to recovery. The possibility of relapses must not be forgotten.

Treatment.—On account of the fact that recovery is often spontaneous, it is exceedingly difficult to appreciate the value of any therapeutic agent otherwise than by means of a long series of observations. A host of remedies has been recommended. Internally, arsenic, cod-liver oil, tonics, and jaborandi should be tried in connection with dieting, physical and mental hygiene. While such a therapy may not have any direct effect upon the cause of the lesions, it may help to render the system more resistant to the disease. Tinctura jaborandi is administered to produce a local hyperæmia of the pale patches whose blood-vessels are abnormally contracted.

The older methods of local treatment were addressed to stimulate the nutritive processes of the part; to-day, when the parasitic theory prevails, parasiticides are used. Chrysarobin, in my opinion, stands out far above any other remedy. It is most effectual when incorporated in vaselin or lanolin; much more so than when combined with liquor gutta percha or traumaticin. As a rule, a six to ten per-cent. preparation is applied daily for one or two weeks, and then stopped for a short time to observe if the disease has stopped. If lanugo hairs do not appear soon, or if the hairs at the periphery continue to fall out or can be easily pulled out, the treatment is continued. Care should be taken that the application does not reach the eyes, as a severe conjunctivitis might follow. Because of this possible danger it cannot be used upon the eyebrows. Jessner (*Monatshefte f. prakt. Derm.*, 1900) recommends for these that carbolic acid be applied bi-weekly. The slight mahogany discoloration observed around the neck and in the face, after the use of chrysarobin, is the first danger signal of an approaching dermatitis. The remedy should now either be stopped at once, or the strength of the ointment be reduced. The hairs around the periphery should be removed as soon as they become loose. Croton oil, which is a pure irritant, may be of benefit in chronic cases. It should be used with olive oil, equal parts, and applied every day until a dermatitis is produced.

Balzer and Storianowitch (*Journ. des practiciens*, 1899; *Monatschrift f. prakt. Derm.*, 1900) have obtained good results with a fifty-per-cent. solution of lactic acid in water or alcohol. The affected parts are first freed from oil with alcohol and ether, and the remedy is then applied with a swab of cotton until slight redness appears. Besides this the scalp is washed with a one-per-cent. bichloride solution. After the stimulation has become well marked, the applications of lactic acid are interrupted for a few days. Boric acid vaseline is spread upon the surface in the intervals. The alcoholic solution is said to be the less painful.

Recovery was obtained fifteen times out of nineteen cases, in from two to three and a half months. Lanugo hairs made their appearance at the end of the second week, at the earliest. McGowan (*Journ. of Cut. and Genito-Urinary Diseases*, 1899) recommends trikresol used pure upon the scalp, and upon the face in a fifty-per-cent. solution. He was led to use this remedy from his experience with pure carbolic acid.

Scarification, with subsequent application of a solution of corrosive sublimate 1:2,000, as in erysipelas, seems to be a rational mode of treatment, but still there is some danger here of infection with pus organisms. Injections of bichloride 1:40, made at different points, are recommended by Moty, of Paris.

Lately, Finsen, of Copenhagen, who obtained such brilliant results, especially in lupus vulgaris, with the application of concentrated violet light rays, has been successful in treating alopecia areata by the same method (*British Medical Journal*, 1899). Jesild (*Annales de derm. et de syph.*, 1899), who has followed Finsen in his treatment, states that it cures alopecia areata in two months, instead of the three to six months necessary by the use of older methods.

Brisquet uses oil of cinnamon (Chinese) and sulphurous ether 1:3. He avoids washing the scalp to exclude humidity (after the hairs have ceased to fall). The sulphur preparations are often of prompt and decided value; *e.g.*, an ointment of one to two drachms of precipitated sulphur to an ounce of vaseline, rubbed well into the scalp daily, after a thorough washing of the whole scalp with soap and water.

In my opinion, as already stated, cures can be obtained more quickly, and with greater certainty, from the use of chrysarobin than by any other method. After the hairs have ceased to fall out, some stimulating and antiparasitic application should be applied for a few months.

(*d*) *Folliculitis Decalvans.*—Within the last decade French authors especially have called attention to the hair follicles being attacked by some affection whose nature still remains obscure. Each authority in turn has considered the individual disease before him as a new one, and has stamped it with a new name, so that in wading through their literature, we meet with a formidable array of names, "the sum of which has brought despair to every humble reader" (*vide* my article in Morrow's "System of Genito-Urinary Diseases, Syphilis and Dermatology, 1894). Some of these affections are identical, some represent only novel aspects of well-known diseases.

The following are a few of the titles given: "Folliculites et perifolliculites agminées destructives du follicle pileux" (Brocq); "folliculite épilante" (Quinquaud); "folliculites et perifolliculites décalvantes agminées (Brocq); "alopécie cicatricielle innominée" (Besnier); "acné dépilante cicatricielle" (Besnier); "acné décalvante" (Besnier, Lailler, Robert); "lupoid sycosis" (Milton, Brocq); "ulerythma sycosiforme" (Unna).

A description of a few of these types may suffice.

(*a*) "*Pseudo-Pelade.*" *Simple Folliculitis Decalvans.*—This affection somewhat resembles alopecia areata, but on close inspection a mild folliculitis and perifolliculitis may be noticed. There are rose-colored, inflammatory tumefactions, soft to the touch; the hairs fall out, and are easily plucked out; they are not broken; there is a marked atrophy in the older spots; these are depressed, shiny, and, unlike those of alopecia areata, hard and irregular, and, as a rule, smaller. The disease spreads in an irregular manner.

(*β*) "*Folliculite Épilante*" *of Quinquaud.*—This form corresponds to the acné décalvante of Lailler and Robert. It resembles the former with the addition of suppuration in the follicles. Besides the scalp, the beard, axillæ, and pubic regions may be involved. Permanent alopecia appears also, caused by the cicatricial destruction of the hair-producing areas. The bald spots are round or irregular; along "their periphery or in islands of healthy hair within them, small pustules, perforated with a hair, are usually to be seen." Quinquaud found micrococci, but was unable to establish their causative effect.

(*γ*) "*Alopécie cicatricielle innominée*" of Besnier is almost identical with Quinquaud's disease. It is slightly more superficial, more chronic, and more obstinate; the cicatricial changes are greater; the margins are not sharply defined; the disease spreads by continuity. Besnier himself considered both diseases the same, but Quinquaud stated that they are not identical.

(*ε*) "*Dermatitis Papillaris Capillitii.*"—Under this name Kaposi has described a follicular disease appearing at the junction of the nape of the neck and the scalp, invading the latter often as far as the vertex. It is doubtful whether this affection is a clinical entity, or simply a variety of some other disease. According to

Kaposi it commences in the form of an isolated papule of the size of a pin's head. These papules later on aggregate to form elevated red plaques, which are quite hard and from which the hairs project in brush-like bunches. The hairs are not readily removed; they break and are atrophied; pustules may be noted in places. After the disease has invaded the scalp and lasted a long time, papillomatous vegetations are formed, 2 to 3 cm. in diameter, covered with crusts from which oozes a foul-smelling secretion. Abscesses may develop also.

Microscopical examination shows an extremely vascular papillary outgrowth, very much resembling granulation tissue. The disease finally progresses to the formation of connective tissue and scar tissue, with the subsequent death of the invaded hair follicles. Nothing is known positively as to its *etiology*. It occurs at all ages and in both sexes.

Diagnosis.—The disease would have to be differentiated from a papular syphilide. Coccogenic sycosis and eczema do not show such a firm induration, and their clinical history is different.

Prognosis.—The disease has no tendency to spontaneous recovery, but it is usually slow in its progress. The general health remains unaffected. The lesions may return after excision of the affected area.

Treatment.—Mechanical removal of the growth is the only means of treatment so far as we know. Curetting, excision, and cauterization with chemical, electric, or actual cautery must destroy the base of the disease or there will be recurrences.

II. Alopeciæ Symptomaticæ Sive Secundariæ.

1. Alopecia Toxica.—In the course of some infectious diseases there are noticed grave disturbances of nutrition from the toxins in the system, disturbances which also affect the growth of hair. It seems as if the toxins themselves can produce baldness, when it occurs *during* the attack of the infectious disease, as in alopecia syphilitica. The loss of hair may be *subsequent* to the general grave nutrition disturbances, as when it appears during convalescence after typhoid fever. This form of alopecia is also seen in the cachexiæ that occur with malignant disease, chlorosis, etc. Some drugs may produce it, as mercury and acetate of thallium. S. Giovannini (Turino) (*Derm. Zeitschrift*, 1899), and others, have observed general loss of hair following the administration of doses of 0.1 of this latter remedy given for the suppression of tuberculous night sweats.

Alopecia syphilitica is perhaps of sufficient interest to warrant a short description, on account of its comparative frequency, its often very typical course, and the importance of making a correct differential diagnosis. We refer here only to that variety that is noticed at the beginning of the secondary period. It may be complete, all the hairs of the scalp, the pubic region, and the axillæ disappearing, or the hair may fall out in larger or smaller patches which are usually symmetrical. It is highly characteristic of this affection that it invades especially the outer border of the scalp, the temporal, parietal, and occipital regions, and, unlike alopecia pityrodes, avoids the top and front of the head. What is stated by Fournier to be almost typical of syphilitic alopecia is the falling out of the outer halves of the eyebrows on both sides. Any concomitant syphilitic lesions will aid in distinguishing it from alopecia areata, which it often resembles.

Its *prognosis* is good, even the complete alopecia yielding to proper antisyphilitic treatment. Alopecia pityrodes, however, often follows in its wake. It is obvious that attention must be paid to this according to the rules prescribed for this disease. The prognosis in all the alopeciæ due to toxins is very favorable. *Cessante causa, cessat effectus.* The underlying cause should therefore be removed, if possible.

2. Alopecia Dynamica Sive Destructiva.—Loss of hair may be caused by toxins in connection with local destructive processes. It is then purely mechanical, due to the loss of tissue or to pressure atrophy. This may occur in severe or deep local inflammations, as in long-continued sycosis, aggravated forms of acute eczema, erysipelas, impetigo contagiosa, or in inflammations accompanied by ulceration spreading over the surface, as in pustular, tubercular, and gummatous syphilides, lupus vulgaris, lepra, the kerion of tinea trichophytina, and ulcerating neoplasmata, most frequently epithelioma. Finally, the hair follicles may be choked to death, so to speak, by some chronic inflammatory processes which do not suppurate, but have a tendency to scar-tissue formation, causing atrophy, due to the mechanical cutting off of the blood supply. Lupus erythematosus, scleroderma, lichen planus, and the keratosis follicularis of Brocq belong in this class.

The *prognosis* depends upon the severity of the local primary disease. In most of them the resulting alopecia is permanent. The treatment is that of the underlying affection.

3. Alopecia Neurotica.—Traumatism to an individual nerve, or to the central nervous system, as a fractured skull, concussion of the brain, shock, or their combinations, may cause loss of hair—a loss which may be complete, as in the three cases cited by Michelson, one of which showed not even a single lanugo hair after a fall, followed by a period of unconsciousness lasting for a year. It may be unilateral, or partially limited to the area of distribution of a single nerve; in the latter case the resulting bald spot is, as a rule, triangular.

Fisher observed complete alopecia of the extremities following gunshot wounds. These cases were remarkable from the fact that they were preceded by a decided increase in hair growth.

The so-called functional psychoses and neuroses, such as melancholia, migraine of long standing, hemiatrophy of the face, produce discoloration and falling out of the hair. Persistent neuralgias do the same, but here the alopecia is never complete. There always remain lanugo hairs in the affected area. Some cases that are looked upon as examples of alopecia areata undoubtedly belong in this category. *A. R. Robinson.*

ALPENA MAGNETIC SULPHUR SPRINGS.—Alpena County, Michigan.

Post-Office.—Alpena. Hotels.

This celebrated spring or well is situated in the city of Alpena, on Lake Huron. It is reached by vessels on the Great Lakes and by numerous lines of railway. The vein of water supplying the well was discovered in 1869 by prospectors boring for salt. The present well was not fully developed, however, until 1891. At a depth of 105.2 feet the drill struck a stratum of lodestone which so profoundly charged the drill with positive magnetism that great difficulty was experienced in removing it from the iron casing. It is said that a piece of steel will at once become magnetized if held in the flowing water of the well. A sumptuous bathing establishment has been erected, which in point of elegance, comfort, and equipment is not easily surpassed. The building is delightfully located on Thunder Bay, at an elevation of 585 feet above the ocean level. It is abundantly supplied with facilities for Turkish, Russian, vapor, and electric baths. The surface of the country about Alpena is undulating, and the soil of a sandy loam, such as is found in pine regions. Dr. A. M. Miller, of Alpena, informs us that the winter temperature ranges from 58° to 27° F., and the summer from 98° to 34° F. The average for the year is 41° F. The temperature of the water ranges from 40° F. in April to 67.6° F. in August, falling again to 36.1° F. in November. The following analysis was made in 1892 by Professor Edwards, of the University of Michigan:

One United States Gallon Contains:

Solids.	Grains.
Sodium carbonate	1.67
Sodium chloride	243.89
Magnesium chloride	78.22
Sodium sulphide	28.05
Calcium sulphide	182.56
Total	534.39

Sulphureted hydrogen gas, 7.38 cubic inches.

This is a saline sulphureted water of considerable potency. It has been used with favorable results in cases of rheumatism, syphilis, neurasthenia, dyspepsia, Bright's disease, and certain skin affections, notably eczema, psoriasis, and lichen. The internal use of the water has been found advantageous in constipation, diabetes, and vesical catarrh.

Alpena now contains a population of 17,000 or 18,000. It is in all respects a city of progress, and contains all the advantages of the recent inventions in electricity, as well as gas, water-works, etc. *J. K. Crook.*

ALPS.—The extensive and lofty group of mountains occupying the central region of Europe, in Switzerland, Savoy, Southern Bavaria, and Western Austria, and separating Italy from the colder countries which lie to the north of it, presents to the invalid a great variety of places of resort, some chiefly serviceable during the summer months, some during the winter season, and some of them available as sanitaria at all times of the year. For a discussion of the peculiar properties and advantages of the more elevated of these health stations, see article on *Altitudes, High*; for description of the special features of individual stations of the more truly Alpine class, see *Davos, Wiesen, St. Moritz*, etc.; for accounts of individual resorts lying on a lower level than those just mentioned, see *Vevey, Meran, Montreux*, etc. *H. R.*

ALTERATIVES.—An alterative is a term applied to a group of remedies which exert a very decided action in removing morbid conditions of the system, and improving the patient's general well-being. The term was formerly understood to mean a remedy which "would re-establish the healthy functions of the animal economy, without producing any sensible evacuation." Modern advance in physiology and therapeutics, and the recognized importance of excretion as a factor in promoting health, require a change in this definition, and our interpretation of the term is better expressed as "agents which alter the course of morbid conditions, and modify the nutritive processes while promoting waste." By many the use of the term is frowned upon, and it is described as a cloak to hide ignorance, but its employment will be continued until we possess a much greater knowledge of the action of such drugs.

We are unable to explain the action of this class of remedies, and their employment is entirely empirical. Their therapeutic value, however, is assured. We are certain of the effect of mercury or of the iodides in syphilitic affections, and of arsenic in improving the general health; but we cannot say how the result is effected, or why one is beneficial in one condition, and the other in another. Until we know how the disease affects the system we cannot explain the cure. At present we must picture the tissues as being constructed of inferior material. We must see them impregnated with syphilitic, malarial, or other similar poisons, or depraved by retained excrementitious matter; if we can do this, we can readily understand how the alterative remedy counteracts and removes these poisons, the result being purer material and in consequence a healthier tissue.

The most important and best-known alteratives are mercury, iodine, and arsenic. We have also sulphur, antimony, gold, calcium chloride, potash, guaiacum, colchicum, and a host of others which are more or less correctly grouped under this comprehensive title.

These remedies are all active and require to be administered with care. They are rapidly absorbed and carried to the tissues, where they become intimately connected with the vital processes. Escaping with the products of metamorphosis, they are excreted by the various secreting surfaces. Their prolonged or excessive use proves injurious: they cause depression and weakness and often produce much irritation during their passage from the system, as in salivation.

Alteratives are often of more service when combined, as in the case of the iodide of mercury, or as in Donovan's solution—a combination of mercury, arsenic, and iodine. The addition of taraxicum and sarsaparilla to iodides and mercury, although of doubtful value, is very general, and with many practitioners the value of one is almost as great as that of the other. The combination of alteratives with tonics and hæmatinics is of great importance. Arsenic and iron, and iodide of iron, with or without vegetable bitters, are standard remedies.

To augment the value of alteratives, more active eliminants are indicated. In conditions of the system in which the products of malnutrition have accumulated, when the blood is anæmic, and the liver, bowels, and kidneys inactive, a course of salines preceding and accompanying the alterative will greatly increase its value; so also will the combination with colocynth, podophyllin, or rhubarb. The waste material must be removed before a new healthy growth begins, and the more actively this is carried on the more rapid will the improvement be.

In addition water must not be forgotten. It is nature's alterative. It bathes and washes all the tissues of the body, it assists at tissue growth and decay, and renders all the emunctories active. To it is due the great value of specific treatment at the various mineral springs and spas, when the free use of alterative drugs, with abundance of water and fresh air, rapidly restores the invalid to health and strength. *Beaumont Small.*

ALTITUDES, HIGH.—This term is usually applied to those places which are situated not less than 4,500 feet above sea level. While the effects of altitude are noticeable in a minor but increasing degree from 1,000 feet up, yet it has been found most convenient by climatologists arbitrarily to place the lower limits of high altitudes at 4,500 feet. The climates of the various resorts at high altitudes naturally vary on account of their proximity to the equator, to the ocean, and to mountain ranges, and moreover, they vary by reason of local peculiarities. They have, however, one climatic factor peculiar to themselves, and upon which depends for the most part their special therapeutic value, that is, diminished barometric pressure.

With respect to temperature the air is as a rule cooler than at places of low levels in the same latitude. It may be stated broadly that the temperature decreases one degree for every three to four hundred feet of elevation. This applies to the temperature in the shade and at night; the sun temperatures, however, are, as a rule, higher than at low level places of the same latitude, with the exception of certain desert countries.

The humidity of the air at high altitudes is usually less than at sea level, even when comparison is made with places which are situated an equal distance from the ocean.

There are, of course, exceptions during certain seasons and in most valleys and on mountain slopes upon which the clouds gather. The humidity is much less on the lee side than on the windward side of the range, which is exposed to the moisture-laden winds from the nearest ocean.

The precipitation is generally less at high altitudes, especially on the lee side of the mountain ranges and below the snow line. This is true also of the number of rainy and cloudy days.

The dew point is low and the evaporative power of the air great, so that while heavy storms are not infrequent, the air and ground become quickly dry. On account of this quality of dryness, a greater degree of temperature can be borne than at low levels without suffering, because the evaporation from the surface of the body is greater, and, therefore, as has been demonstrated by Professor Greely and others, the "sensible temperature" is less. Moreover, the cool nights give rest after hot days. It is probably because of the cool nights, cool shade, and dryness of the air that sunstroke is practically unknown in high climates, even when the solar temperatures are very high.

The sunlight is more brilliant, and the sun heat more intense.

The aspect, the vegetation, the nature of the soil, and the configuration of the ground all modify the climate. With regard to the configuration of the ground, lofty plateaux are drier and warmer, and generally more windy than mountain slopes and valleys.

Owing to the mountainous character of high altitudes, their comparative inaccessibility, and the scarcity of water, they are but sparsely inhabited, and the ground is but little cultivated; in consequence of this, there is an abundance of pure air; so that the climate of the altitudes resembles in this respect that of the ocean and of the desert.

The physiological effects of diminished barometric pressure are very striking. The most important is, first, the change in the condition of the blood, second, the increased respiratory capacity and activity, and third, the increase in the size and strength of the heart. Nerve power and activity in the healthy are also increased, while in certain classes of invalids, however, the nervous energy is markedly depressed or unduly excited. The blood changes referred to are a large increase in the number of red cells, which fact is now universally accepted by all observers, though the cause is still somewhat in dispute. Moreover, it has lately been proven that the size of the red cells is also increased. The hæmoglobin, specific gravity, and iron are all increased. While it is true that such changes as described may be brought about in a greater or less degree by certain of the climatic factors which high altitudes enjoy in common with other climates, yet they are invariably produced, except under a few abnormal conditions, in all animals and human beings when they are transferred from low to high altitudes, and as a general rule in proportion to the elevation above sea level. Moreover, that these universal changes are primarily produced by diminished barometric pressure, has been proven by numerous laboratory experiments, notably those of Paul Regnard.*

Professor Regnard, in his laboratory at the Sorbonne in Paris, placed a rabbit under a bell glass in which the air pressure was kept constantly reduced to an equivalent of the barometric pressure at an altitude of 9,500 feet. When cleaning and disinfecting were necessary, the rabbit was transferred to another bell glass in which the air pressure was the same. The rabbit continued to live under these conditions for a month, and when removed was somewhat fatter and in a healthy condition. On testing its blood before placing it in the bell jar, it was found that it could absorb only 17 c.c. of oxygen, which was the case with the blood of the control rabbits, and was normal for sea level. On removal of this rabbit its blood was found to absorb 21 c.c. of oxygen; thus proving that the increased capacity of the blood for the absorption of oxygen at high altitudes was primarily due to the diminution of the barometric pressure. Much work has been done by numerous eminent observers confirming this conclusion.

With regard to the question whether a true, or only an apparent blood regeneration occurs, this matter has, in the writer's opinion, been settled by the experiments of Drs. Ossian Schaumann and Emil Rosenquist, of Helsingfors, Finland,† who conducted their inquiries especially to solve this question. Rabbits, dogs, and pigeons were kept in bell jars at reduced barometric pressure (450–480 mm. Hg) according to the methods of Sellier, Regnard, and others, for periods varying from nine to thirty-three days.

The blood was examined in each case at intervals of several days. This examination consisted of (1) a count of the red cells (Thoma-Zeiss apparatus); (2) the estimation of hæmoglobin (Fleischl); (3) the measurement of the diameters of the red cells (these were dry preparations, and the average was based on 200 to 500 determinations); (4) microscopic examinations were made, especially to determine the number of nucleated red cells (Ehrlich's triacid stain; also eosin and hæmatoxylin were used). The blood was taken from the neck in the pigeons and from the ears of the rabbits and dogs. Blood from the liver and aorta was also examined in a few cases before the animal was killed. In two cases the gross changes in the marrow of the long bones were also observed.

In every case the number of red cells was increased from 20 to 50 per cent. As the relative humidity of the air in the bell jars stood at 87 to 100 per cent., the temperature at 21°–26° C., the increase could not have been due to an inspissation of the blood, as some observers have assumed.

The hæmoglobin was also markedly increased, but not in as great a proportion as the red cells. In all cases during the first eight to eleven days there was a temporary decrease in the hæmoglobin, and, in about one-half of the cases, a like temporary decrease in the number of red cells.

To determine the effect of a return to normal barometric pressure (760 mm.), after the animals were released from the bell jars, the experimenters continued to examine the blood for periods varying from three to ten months; these examinations showed that there was an immediate decrease in the number of red cells, followed by a marked rise, which, after a number of fluctuations, remained in almost all cases at a decidedly higher figure than that which was reached by the blood count previous to the experiment. In the opinion of these observers, the investigations of others had not demonstrated these facts because they were not extended over a sufficiently lengthy period. Leuch,* however, in his experiments on anæmic school children, confirms this point. Children were sent by him to the mountains for several weeks after their blood was tested, and the test was then repeated, on their return, from time to time, during periods of from two to four months.

Schaumann and Rosenquist, by exact measurement of the red cells, show that the average diameter of the cells is always increased, which is contrary to the opinion previously held. Under the low pressure the nucleated red cells slightly increased in number, but returned to the average amount after the normal air pressure was resumed.

In two animals confined in bell jars, and from two control animals the blood was simultaneously taken from the skin, liver, and aorta; and in each locality the number of red cells per cubic millimetre was found to be exactly the same.

With regard to Schaumann's and Rosenquist's views on the other theories of the cause of these blood changes, the following abstract of their opinions is valuable:

Two of these theories assume that the increase in red cells is real. Miescher, Egger, and others support the view of increased proliferation of blood cells in the blood-forming tissues, while Fick's theory is that there is a prolongation of the life of the individual cell along with a normal proliferation.

The other four hypotheses contend that the increase in red cells is only apparent. Thus, Grawitz considers it to be entirely due to an inspissation of the blood; while Bunge believes it to be the result of an exudation of plasma into the lymph spaces of the tissues.

Winternitz supposes that red cells become aggregated in certain of the internal organs, and are forced into the general circulation by changes produced upon the latter by altitude; and Zuntz finally refers it to vasomotor control, which is influenced by certain factors of high altitude.

In the light of the results of this investigation, the following criticisms of each theory are made. The authors consider that their results support the theory of new formation of blood cells, but are forced to make changes in the terms of its form.

Vaso-motor Theories.†—1. **Zuntz's hypothesis:** The authors point out that in their own experiments no factors exist which could give rise to the required nervous

* "La Cure d'Altitude," Masson et Cie., Paris, 1897.
† "Ueber die Natur d. Blutveränderungen i. Hohenklima." Zeitschr. f. klin. Med., Bd. xxxv., Heft 1-4, pp. 128, 170, and 315-349, 1898.

* Leuch: Correspondenzblatt f. Schweizer Aerzte, No. 21, p. 657, 1896.
† Schumburg u. Zuntz: Pflüge's Archiv f. Physiol., Bd. lxiii., pp. 461-494, 1896.

irritation, that their animals were removed from the bell jars for each examination, and that, according to the theory, the irritation should quickly disappear.

With reference to the theory that the number of red cells is increased in the capillaries and decreased in larger vessels, it is pointed out that in former investigations blood from both the capillaries and the larger vessels had been examined, with the uniform result of an increase in red cells; that the simultaneous increase in red cells and decrease in hæmoglobin (at the beginning of the experiments) cannot be explained by this theory. That a purely vasomotor change should produce no change in the size of the red cells; that the overstimulated nerves would eventually relax; that a return to higher pressure should produce an immediate fall in the number of red cells to normal, which is not the case.

2. Bunge's theory * is met with the same objections.

3. Winternitz's theory † the authors oppose by reference to their examination in two cases of blood taken simultaneously from the skin, liver, and aorta, in each of which localities they found the same count. (Corroborated by Breitrustrin.)

4. Grawitz's theory of inspissation: ‡ This theory is invalidated by the experiments of Schaumann and Rosenquist in which the respired air was almost saturated with water vapor; by the fact that loss of water by the blood is rapidly compensated for by the tissue fluids, and that a true inspissation of the blood is always accompanied by a proportionate loss in weight of the animal; and, further, by the fact that in true inspissation of the blood the diameter of the red cells is always decreased.

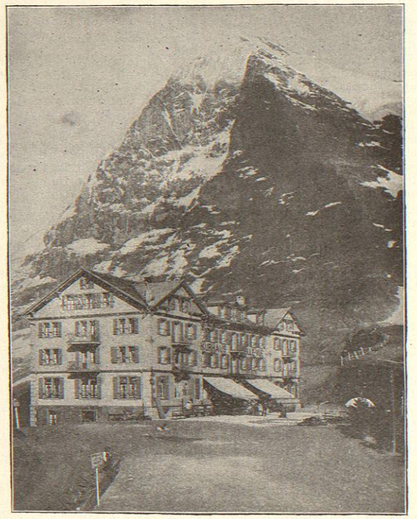

FIG. 90.—Kurhaus on the Little Scheidegg, at the Foot of the Eiger. Elevation, 6,770 feet. (From Regnard's "Cure d'Altitude.")

Theories Assuming a True Increase in Red Cells.—1. Fick's theory: § This theory, which premises that the absorption of oxygen is slower than normal at high altitudes and the consumption of hæmoglobin is decreased, is discredited because it has been conclusively shown that metabolism is more rapid at high altitudes than at sea level, and must, therefore, especially increase the consumption of hæmoglobin.

2. The theory of regeneration of Miescher, Egger, ‖ and others is based on the two premises (1) that microcytes appear during the period of increase in red cells, and (2) that the increase in hæmoglobin does not keep pace with that in the number of red cells. The last point the authors grant, and they call attention to the fact that it has been regarded generally (Otto, Hoffmann, and Limbeck) as an evidence of regeneration. The first assumption is disputed, and attention is called to the fact that Ehrlich, Quincke and von Limbeck look upon microcytes as products of degeneration of red cells, and also that one of the authors (Schaumann) has found in secondary anæmias that microcytes are most numerous at the height of the disease, and that they disappear as convalescence sets in, and give place to macrocytes. To determine this point experimentally, two animals (a rabbit and a dog) were bled, and a differential count was made of red cells of various diameters, with the result that microcytes were seen to diminish markedly in number immediately after the bleeding when regeneration is most active. It was found, moreover, that an increase occurred in the number of macrocytes, and that this, instead of an increase in microcytes, is an accompaniment of regeneration. In accordance with this finding, it follows that the increase in macrocytes met with in the blood in the author's first experiments indicates a regeneration of red cells. This conclusion is strengthened by the occurrence of nucleated red cells in the mammals, of mitotic figures in the red cells of the birds employed, and of "shell shadows" in the blood after release from the bell jar.

Schaumann and Rosenquist, therefore, conclude that all changes which occur in the blood, due to diminution of barometric pressure, are best and most easily explained by the assumption that there is an increased proliferation of red cells.

The authors claim that this theory holds also for the explanation of the results of the *clinical* observations made in high altitudes. They reach this conclusion by a process of elimination, having shown in their criticism of the other theories that causes other than a diminution of atmospheric pressure are insufficient for the production of the hæmatic phenomena. As positive proofs from clinical material, they refer to the following: The hæmoglobin does not increase in proportion to the increase in the number of red cells; the increase in the average diameter of red cells, and the presence of normoblast nuclei found free in the blood. (The last two points are dependent on the findings in the blood on Schaumann's journey to Norway.)

Experiments are needed to prove whether or no the germicidal power of the blood is increased. Clinical and other evidence makes it most probable that this is the case.

"At high altitudes the special effects of decreased pressure are not directly produced by the scarcity of oxygen in the atmosphere, but by the diminished oxygen pressure; for even at the greatest heights ever reached by man the amount of oxygen in each breath is always in excess of that needed to sustain animal life. It has

* Bunge: Verhandlungen d. 13 Cong. f. inn. Med., 1895.

† Winternitz: Centralbl. f. klin. Med., Bd. xiv., No. 49, pp. 1017–1022, 1893.

‡ Grawitz, E.: "Klin. Pathologie d. Blutes," pp. 333–343, Berlin, 1896. Limbeck, R. v.: "Klin. Pathol. d. Blutes," 2 Aufl., p. 207, Jena, 1896. Ehrlich: "Untersuchungen z. Histol. u. Klinik d. Blutes," p. 99, Berlin, 1891. Quincke: Deutsch. Arch. f. klin. Med., Bd. xx., pp. 1–31, 1877.

§ Fick, A.: Pflüger's Arch. f. Physiol., Bd. lx., pp. 589–593.

‖ Miescher: Correspondenzbl. f. Schweizer Aerzte, pp. 809–832, 1893. Egger: Verhandlungen d. 12 Cong. f. inn. Med., pp. 262–276, 1893.

been demonstrated by experiment that blood can absorb only a certain percentage of the total amount of oxygen present in the air to which it is exposed, and so, when the barometric pressure is reduced, the blood may be unable to extract sufficient oxygen from the air, because the oxygen pressure is reduced below the required point.

"Mountain sickness is a malady caused by this oxygen starvation. If this were all, it would follow that when the oxygen pressure was sufficiently reduced animal life would be impossible from continual mountain sickness; but there is developed a wonderful compensatory process whereby the blood's power of absorbing oxygen is increased, so that a given weight of blood in a living animal can absorb more oxygen in proportion to the reduction of the barometric pressure. This is brought about by a growth in the number of red corpuscles through which oxygen is absorbed.

"While these blood changes, which need some three or four weeks for their completion, are progressing, the breathing becomes more rapid, so that while less oxygen is taken in at each breath, it is received into the blood more frequently; and with this more rapid respiration there is increased heart action, the heart pumping more blood through the lungs in a given space of time.

"This increased rapidity of heart beat and respiration is, however, only temporary, and gradually disappears. The amount of air taken in at each breath increases in volume as the chest expands, and the air cells, many of which, at lower altitudes, are often unused, become enlarged. The heart's cavities, having been stretched, are also hypertrophied, so that more blood is propelled at each stroke. Thus the blood's capacity for absorbing oxygen, the lung's capacity for taking air, and the heart's capacity for pumping blood are increased: the rapidity of respiration and pulse diminishes, but this rate becomes normal again as soon as this process of compensation has effected a balance.

"These changes in the blood, lungs, and heart continue during a residence at high altitudes, but disappear again upon a return to low ground. However, they are occasionally so incompletely carried out in certain individuals, owing to age, feebleness of reaction, or disease, that an attempted ascent into the upper air is exceedingly dangerous and continued residence on high ground impossible."*

There are striking differences between the temporary and the permanent physiological effects of high altitudes. When persons or animals are transported from low levels to a high altitude, the influence is marked in proportion to the rapidity of the ascent, as is shown by the contrast in the effects produced upon those who ascend rapidly, and upon those who are slowly carried up by rail or carriage. In mountain climbing the effects are increased by exertion. The more vigorous and healthy the individual submitted to these experiences, the more rapid and complete is the acclimatization. Speaking broadly, the acclimatizing continues through the first four weeks, after which time a healthy visitor can do about the same amount of work on level ground, and feel as well, as he did at home; at least until he attempts to climb still higher, when the symptoms of mountain sickness will again occur, but in a modified form.

In the various experiments and observations that have been made upon the ability of a healthy man to undertake muscular exertion in high altitudes, it has been found that visitors, after the first few weeks, can usually accomplish as much within a short space of time as on low ground, but they are not equal to as prolonged exertion, and their pulse rate and respiration are always increased above what it would be at sea level under like circumstances. It is, therefore, important for invalids and even for healthy visitors, on first resorting to high altitudes, that they reduce their accustomed exercise to at least one-half of that which agreed with them at sea level; particularly on going uphill.

With respect to our knowledge of the permanent effects of high altitudes, we are especially indebted to Drs. Herrera and Lope of the City of Mexico, who have, in their very valuable treatise entitled, "La Vie sur les Hauts Plateaux," given us a vast amount of information. One of the results of their laborious and conscientious scientific inquiries is that plants, animals, and human beings soon accommodate themselves to the peculiar conditions of life at high altitudes, and that healthy residents and natives thrive. The portion of their inquiries which is especially interesting to the therapeutist is that there is a marked development of the thorax, and that even under unfavorable local hygienic conditions, the average rate of morbidity and mortality is lower than under the same conditions at sea level. In short, for those who have acquired or inherited accommodation to the peculiar conditions, there is a more than usual amount of health and physical prosperity.

While, physiologically, all these changes of the blood, lungs, and heart are simply compensatory, yet to the properly selected invalid they are much more, because they give a stimulus and open up avenues through which health returns, and the changes in an appropriate invalid are even greater than they are in a normal being. For instance, in an anæmic person the blood changes are proportionately in excess, and this is true not only when they are in the high altitude, but also when they return to their home at sea level.

The nervous depression and anæmia accompanying most cases of neurasthenia are markedly and rapidly relieved. And the general improvement in the phthisical who are suited to altitude treatment is especially marked. It is often pointed out that the food which is usually consumed supplies sufficient iron for the needs of the human body; yet we have abundant clinical experience to show that in most anæmics iron given artificially is of the greatest necessity and service. So that while it is undoubtedly true that a normal man can extract from the air of his locality at sea level all that he needs to keep himself in health, yet when a certain depression of health occurs, he is unable to do so, and often needs to gain the same elements in a somewhat sudden and novel form. It is, therefore, no argument against the therapeutic value of high altitudes as a tonic and alterative in certain conditions of ill health, to urge that the physiological changes whereby these tonic effects are brought about are merely compensatory.

It must, however, be remembered that in using high altitudes for therapeutic purposes, we are taking into our hands a two-edged sword, and if they fail to do good, they may often do much harm. It is, therefore, of vital importance that the therapeutist should study not only the individual and his individual sickness, but also the properties and peculiarities of the climatic remedy he proposes to apply to his disease.

Much interesting and valuable information from a physiological standpoint, the study of which should always precede any therapeutic application, can be obtained from such works as the following: "La Cure d'Altitude," by Paul Regnard; "La Vie sur les Hauts Plateaux," by Drs. Herrera and Lope; "Man in the High Alps" (translation), by Prof. Mosso, of Turin; and many books of travel, such as "Climbing in the Himalayas," by Sir Martin Conway, and "Travels in the Great Andes of the Equator," by Edward Whymper.

Each of the four quarters of the globe has its various high altitude climates. It is only necessary here to refer to those which are at present available for the civilized invalid. On the continent of North America, the Rocky Mountains, extending from British Columbia to the borders of Mexico, have been extensively used; especially on the eastern slopes, for the reason that it is drier and warmer on the lee side, rather than on the western slopes, where the climate is influenced by the damp winds from the Pacific. The climate of these mountain plateaux varies greatly, that of the Canadian portions being comparatively cold and harsh, while that of the more southerly portions, in New Mexico and Arizona, is warm and mild. In Mexico we have lofty plateaux exhibiting the

* S. E. Solly: "Handbook of Medical Climatology," Lea Brothers, p. 42.