by Prof. A. A. Breneman, formerly of Cornell University, with the following results:

ONE UNITED STATES GALLON CONTAINS:

Solids.	Grains.
Calcium sulphate	60.42
Magnesium sulphate	4.34
Potassium sulphate	6.76
Aluminum sulphate	11.34
Manganese sulphate	2.86
Iron sulphate with cobalt and nitric acid	Trace.
Sodium chloride	1.36
Silica	1.44
Iodine with sodium	Trace.
Vegetable and volatile substances	8.24
Total	96.76

This water, as shown by the analysis, is exceptionally rich in manganese, besides containing a large amount of alum. The following facts relating to its therapeutic effects are gathered from an article contributed to the New York *Medical Times* by Dr. Samuel Swift. This water, he says, possesses undoubted tonic and diuretic properties. It also acts as a sedative to the gastric mucous membrane, and in virtue of this fact it is highly extolled in cases of gastric irritability. It acts well in the nausea and vomiting of pregnancy, and has been found useful in chronic diarrhœa. In Bright's disease and in anæmia and chlorosis it has seemed to possess decided remedial value. The water is not unpleasant to the taste, and has no disagreeable after-effects. The Irondale Spring salts, made by evaporating the water, are also on the market. *James K. Crook.*

IRON LITHIA SPRINGS.—Tazewell County, Virginia.

POST-OFFICE.—Tazewell. Hotel.

ACCESS.—Viâ Clinch Valley Division of the Norfolk and Western Railroad to Tip-Top Station, thence by private conveyance two miles to the springs.

These springs are charmingly located in the Alleghany Mountains at an elevation of 2,700 feet above the sea-level. They were but recently discovered, but have already become well known. A hotel has been erected capable of accommodating fifty guests. The many advantages of climate, mineral springs, scenery, etc., which are found here will doubtless bring the place into prominence in the near future. The springs are five in number and discharge about 1,000 gallons of water per day. An analysis by Dr. Henry Froehling, of Richmond, in 1890, shows the following ingredients:

ONE UNITED STATES GALLON CONTAINS:

Solids.	Grains.
Magnesium sulphate	4.71
Calcium sulphate	1.71
Barium sulphate	.09
Strontium sulphate	Trace.
Iron sulphate	5.08
Manganese sulphate	.36
Aluminum sulphate	8.05
Potassium sulphate	.51
Sodium sulphate	.25
Lithium chloride	.18
Sodium	.39
Sodium iodide	Trace.
Aluminum phosphate	.11
Sulphuric acid (free)	.51
Silicic acid	1.60
Total	23.55

Carbonic acid gas, 5.20 cubic inches.

This water is distinguished by the not inconsiderable quantity of manganese which it contains. This remedy has been found valuable in certain female complaints, especially in functional amenorrhœa. In addition it contains a very large proportion of iron and alum, and a considerable amount of sulphate of magnesia. Taken altogether, it may be pronounced a very valuable mineral water, and will be found useful in a large class of cases requiring a local astringent, a general ferruginous tonic, or a uterine detergent. *James K. Crook.*

IRON, ORGANIC COMPOUNDS OF.—The following preparations are used to replace the inorganic salts of iron, as many believe that these organic combinations are better borne by the stomach and more certainly absorbed.

Carniferrin is the iron compound of phospho-carnic acid prepared from meat. It contains thirty per cent. of iron and is compatible with acids or alkalies. Dose 0.2–0.5 gm. (gr. iij.–viij).

Carniferrol is a liquid preparation of iron and meat peptone.

Ferratin is an artificial ferrated albuminic acid designed to represent the natural iron compound of the hog's liver. It contains about seven per cent. of iron and its dose is 0.3 to 1 gm. (gr. v.–xv.).

Ferratin-sodium is a soluble form of ferratin which may be added to milk or other liquid foods.

Ferratogen is an insoluble yellowish powder made as follows: yeast is grown on a medium containing iron, the nuclein thus formed being isolated and digested with gastric juice, then washed with alcohol containing hydrochloric acid. It represents one per cent. of iron and is said not to be affected by the gastric juice, and to be well absorbed in the intestine.

Ferrinol is an iron nucleid containing about six per cent. of iron.

Ferropyrin is an orange-colored powder made by acting on antipyrin with ferric chloride. It contains 64 per cent. of antipyrin and 12 per cent. of iron, is soluble in water and alcohol, and is said to have remarkable styptic properties without caustic effects. It is used in 20 per cent. to full strength as styptic in uterine and other hemorrhages, in 1- to 3-per-cent. solution as an astringent in gonorrhœa, and in dose of 0.3 to 1 gm. (gr. v.–xv.) internally for anæmia and chlorosis.

Ferrosol is a saccharated ferrous oxide with sodium chloride.

Fersan is an acid albumin obtained from blood corpuscles, and is a ferruginous nutritive containing a high percentage of phosphorus. It is said to rank high as a hæmatinic and as an albuminoid food. Dose 1 to 2 gm. (gr. xv.–xxx.) three times a day.

Hæmalbumin (*Dahmen*) contains hæmatin, hæmoglobulin, paraglobulin, serum albumin, and the inorganic constituents of blood.

Hæmaticum is a red-brown, clear hydroalcoholic liquid containing indifferent compounds of iron.

Hæmatogen (*Bunge*) is a nucleo-albuminoid preparation.

Hæmatogen (*Hommel*) is defibrinated blood from which the serum has been removed and a minute quantity of creosote added.

Hæmatogen (*Marfori*) is a soluble ferrated albuminic acid similar to ferratin and containing 0.7 per cent. of iron.

Hæmatol is a sterilized hæmoglobin containing glycerin and brandy.

Hæmogallol is an indifferent preparation of iron obtained by the reducing action of pyrogallol on the hæmoglobin of ox-blood. It is a red-brown powder the iron of which is not changed to chloride by the gastric juice. Dose 0.3 to 1 gm. (gr. v.–xv.).

Hæmol, a congener of hæmogallol, is obtained by the reduction of hæmoglobin with zinc dust. This substance has been combined with various metals forming:

Arseno-hæmol containing one per cent. of arsenous acid.

Bromo-hæmol containing 2.7 per cent. of bromine.

Copper-hæmol containing two per cent. of copper.

Hydrargyro-iodo-hæmol containing 12.35 per cent. of mercury and 28 per cent. of iodine.

Iodo-hæmol containing 16.6 per cent. of iodine.

Zinc-hæmol containing one per cent. of zinc.

Triferrin is a compound introduced by Salkowski, containing iron, phosphorus, and paranucleinic acid obtained from the casein of cow's milk. It contains about 2.5 per cent. of phosphorus and 22 per cent. of iron, is insoluble in acids (gastric juice) and soluble in solution of sodium bicarbonate. With doses of 0.3 gm. (gr. v.) three times a day, Klemperer had good results in twenty-one cases of anæmia.

Other organic iron preparations are the albuminate, peptonized albuminate, ammonium arseno-citrate, caseinate (nucleo-albuminate), dextrinate, glycero-phosphate, inulate, peptonate, and vitellinate (iron and egg yolk) of iron, iron and sodium albuminate and citro-albuminate, hæmatin-albumin, hæmochromogen, hæmoferrum, hæmoglobin, methæmoglobin, pepto-ferro-mangan, and ferrosomatose (two per cent. iron). *W. A. Bastedo.*

IRON, POISONING BY.—Metallic iron and those compounds of iron which are insoluble in water are not poisons. The soluble salts, however, though not active poisons, have an irritant action, and are capable of destroying life when taken in large doses and in a concentrated state. The continued administration of even medicinal doses produces, after a time, decided gastric disturbance. It is probable that all the soluble preparations may act as irritant poisons when administered in large doses. The most important, however, from a medico-legal point of view, are ferrous sulphate (copperas, green vitriol), ferric chloride (perchloride), which is used medicinally in the form of tincture, and the tannate in the form of ink.

The salts of iron are rarely administered for criminal purposes. Most of the reported cases of poisoning have been the result of accident, or of the use of the sulphate or the tincture of the chloride of iron in attempts at abortion. The symptoms which follow the administration of large doses of the preparations named are essentially similar to those produced by the irritants in general. There are a styptic taste in the mouth, nausea, vomiting, pain in the stomach and intestines, and purging. The evacuations are black, owing to the conversion of the iron salt into a tannate by the tannic acid of the food, or into a sulphide by the sulphureted hydrogen resulting from decomposition in the intestines. Irritation of the genito-urinary passages is sometimes observed. The tincture of the chloride of iron is more corrosive in its action than the sulphate, by reason, apparently, of the free hydrochloric acid which it frequently contains. Its injection into the cavities of the body, for the purpose of arresting hemorrhage, has proved fatal.

The amount of any of the preparations of iron required to endanger life is not accurately known, but appears to be quite large. In most of the cases in which the sulphate has been taken the amount was unknown. Recovery has taken place after a dose of 31 gm. (℥ i.) of the sulphate (Christison). A case is reported in which 48 gm. (℥ iss.) of the tincture of the chloride of iron proved fatal in about five weeks (Christison). Recovery has taken place after doses of 32 to 96 gm. of this preparation. The favorable issue is probably due, in many cases, to the early occurrence of vomiting.

The results of experiments on animals are not uniform. Gmelin states that 7.7 gm. (℥ ij.) of the sulphate of iron administered to dogs by the mouth caused vomiting only; that 2.6 gm. (gr. xl.) administered to rabbits produced no injury; and that 1.3 gm. (gr. xx.) injected into the veins of a dog produced no symptom whatever. Dr. Smith, however, states that 7.7 gm. will prove fatal to dogs when administered by the mouth or applied to a wound.

The post-mortem appearances are those of a simple irritant, and are confined, so far as has been observed, to the stomach and upper part of the intestines. In acute cases the contents of the intestines will probably present a black appearance, owing to the presence of the tannate or the sulphide of iron.

Iron is eliminated to some extent in the urine. A small amount only is absorbed in any event, the greater part escaping in an insoluble form with the fæces.

Treatment consists in the use of the stomach pump, or of emetics, if necessary. Magnesia or dilute solutions of alkaline carbonates should be administered as antidotes, and these should be followed by demulcents.

William B. Hills.

IRRADIATION is the diffusion or, as one might say, "the overflowing" of the nerve impulse over the boundaries of the pathway within which it usually travels.

If a local cardiac condition gives rise to pain not only in the region of the heart but also in the arm, the latter pain is an irradiated one, belonging as it does to quite another territory than that supplied by the nerves of the heart. This irradiation of visceral pains into cutaneous areas follows definite laws which have been laid down by Head in his classical researches on this subject.

But a pain may irradiate not only from a visceral or sympathetic to a cutaneous or other cerebro-spinal nerve territory; it may also irradiate from one nerve to the other or from one branch of a nerve to the other *within* the cerebro-spinal system. For instance, pain arising from a partial lesion of the second branch of the fifth nerve (toothache) may spread not only over the entire second branch, but even over the third branch of that nerve. A pain may also irradiate from one side to a (usually symmetrical) point on the other side of the body.

While it has thus been customary to apply the term irradiation to conscious sensory impressions, which need not necessarily be painful, there is no reason why it should not be applied to motor and reflex innervation as well, the physiological process and its anatomical basis being probably the same. For instance, if tapping of the patellar tendon which normally causes a contraction only of the quadriceps muscle of the same side, produces also muscular contractions in the other lower extremity, as is the case in many organic cerebral and particularly spinal lesions, we certainly have the right to speak of it as irradiation.

Similarly the associated movements often accompanying motor acts, for instance, movements of the jaw accompanying the act of cutting with scissors or of cracking nuts, should also be classed under the heading of irradiation.

The small space allotted to this article does not allow us to enter on the mechanism of irradiation further than to say that it must take place at the points of passage from one neuron to another, the multiplicity of connections of each neuron giving a wide range of possibilities in this direction, especially if it is considered that in every case a chain of at least two neurons must be passed before the stimulus reaches its final destiny.

B. Onuf (Onufrowicz).

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Henry Head: Die Sensibilitaetsstoerungen der Haut bei Visceralerkrankungen. Translated by Dr. Wm. Seiffer. Berlin, 1898, Verlag von August Hirschwald. Also articles in Brain, vol. xvi., part i., 1893; vol. xvii., part iii., 1894; vol. xix., part ii., 1896, and vol. xxiv., 1901.

IRRITABILITY.—Irritability may be defined as the quality possessed by living tissues, animal as well as vegetable, of reacting toward stimuli* with manifest dynamic changes. These changes† may become apparent directly or indirectly, in the form of muscular contraction, glandular function, sensory perception, amœboid movements, flagellate movements, or streaming of protoplasm, or in other ways.

The dynamic changes produced by the stimulation may manifest themselves in the stimulated tissue itself or be inferred indirectly by the effects upon other tissue. For example, the dynamic alterations wrought by stimulation of a motor nerve may find an indirect expression in the form of a muscular contraction; but their presence in the nerve may be demonstrated also directly by the so-called "current of action" or "negative variation," produced in the nerve by the stimulation, and demonstrable with a galvanometer.

This latter direct method is the more accurate one, giving a truer measure of the irritability of the stimulated

* A definition of *stimulus* is given in a later section of this article.

† The nature of these changes in the case of the nerve protoplasm has been made a subject of special study by A. F. Mathews, the result of whose researches was published in the New York Sun. He concludes that "nerve protoplasm" is stimulated (*i.e.*, excited) by the passage of colloidal particles from a condition of solution to that of gelatination. The irritability of a nerve is diminished whenever the solution of the colloids is rendered more permanent. It increases as the nerve approaches the state of gelatination.

tissue. A study of the action of curare convincingly demonstrates the truth of this statement. Curare acts on the motor nerve endings in such manner as to abolish the faculty of transmission of the nerve impulse from nerve to striated muscle. Stimulation of the nerve remains, therefore, without effect on the muscle, but the muscle continues to respond promptly to direct stimulation. That the nerve too retains its irritability is shown by the fact that its stimulation, be such of a mechanical or chemical or electric or other nature, gives rise to a "current of action" demonstrable by a galvanometer.

In a case of slight curare poisoning the faculty of transmission of the impulse from nerve to muscle is not entirely abolished, but only impeded more or less according to the severity of the poisoning, so that strong stimulation of the nerve will produce only a slight muscular contraction. Nevertheless the irritability of the nerve remains unimpaired, as shown by the "current of action." Consequently if in this case we were to measure the degree of irritability of the nerve by the effect of its stimulation on muscle, we should clearly come to a wrong conclusion.

However, the method of direct measurement of the irritability of a tissue is often practically not feasible, and we then have to resort to the *indirect* method in spite of its fallacies.

The degree of irritability of a tissue is expressed by the inverse proportion between the strength of the stimulus and the demonstrable or manifest dynamic change produced. It may be expressed by the formula: $I = \frac{D}{St}$ in which I denotes irritability while the denominator St represents the stimulus, and the numerator D the demonstrable dynamic change produced by it.

In many cases the disproportion between the strength of the stimulus and the amount of demonstrable dynamic changes wrought by it is very great, the amount of energy evolved by the stimulation being often ten times or even hundreds of times greater than the amount of energy represented in or spent by the stimulus itself.

Verworn gives the following interesting instance in substantiation of this statement: "A nerve-muscle preparation is suspended on a myograph, the muscle is loaded with a weight of 100 gm. and its nerve is laid over a glass plate supported by a stand (Fig. 2965). Upon the nerve rests a small aluminum pan having a sharp keel on the lower side, and into this a weight of 10 gm. falls from a height of about 10 cm. At the moment of stimulation the muscle contracts and raises the 100 gm. about 1 cm. Here the quantity of energy that corresponds to the work of the muscle is approximately ten times greater than the quantity of energy that has operated as a stimulus upon the muscle."

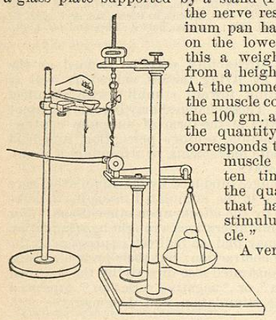


FIG. 2965.—Mechanical Contrivance for Demonstrating the Disproportion between Stimulus and Effect of Stimulus. (From Verworn.) For details see the text.

A very striking parallel fact from the inorganic world is familiar: The spark from a small battery which, applied to the human body gives a hardly noticeable sensation, is sufficient to blow up a whole house if applied to a definite quantity of nitroglycerin in the proper manner.

In accordance with the law of the preservation of energy this disproportion must be explained, not by the addition of energy not before existent, but by the transformation of one form of energy into another form—for instance, of chemical energy into physical energy.

However, while in the instance of the spark exploding the nitroglycerin, the produced effect is to a great degree independent of the size of the "stimulus," inasmuch as a small spark applied to a certain quantity of nitroglycerin will produce no less explosive effect than a large flame applied to the same quantity, this does not hold true or at least is not the rule for the phenomena of irritability in animal and vegetable life. Here—and this is especially true for the nervous and muscular systems—very frequently the manifest dynamic change produced by a stimulus increases with the size of the latter, but only up to a certain point; beyond that point it rapidly diminishes and the stimulus then rapidly reaches that size which causes death of the tissue.

Here a definition of the term *stimulus* is in order. In harmony with the definition of irritability, a stimulus may be defined as any agency which is capable of producing manifest or demonstrable changes of dynamics in the tissue on which it acts; changes that may be directly demonstrable in the stimulated tissue itself or indirectly by the effects on some other tissue, as has already been explained in the case of nerve and muscle.

This definition comes very near that of Verworn, who distinguishes the vital phenomena as spontaneous phenomena—when all the external conditions remain unchanged, and phenomena of stimulation—when other influences act upon them, and who accordingly defines a stimulus as every change of the external agencies that act upon an organism. This definition has been slightly modified by us in view of the fact that, as Verworn himself remarks, a strict dividing line between spontaneous phenomena and phenomena of stimulation cannot be drawn. Wherein our definition corresponds with that of Verworn, however, is that both depressive as well as exciting agencies are included in the definition of stimuli, and this is perfectly appropriate if one considers that in many cases it is very difficult, if not next to impossible, to state whether the effect of the stimulation is depressive or exciting. In this connection the existence of inhibitory nerve fibres and nerves should be called to mind, the excitation of which produces a depressive instead of exciting effect on the tissue (muscular, glandular, etc.) which it innervates, and yet the agency which thus acts on said nerve or nerve fibres must be called a stimulus.

As to the kinds of agencies that may act as stimuli, such are very numerous and may be, according to Verworn, classified into chemical, mechanical (including sound vibrations), thermic, photic, and electrical.

Another distinction to be made is between the *exciting* and the *depressing* effects of a stimulus, by which is meant the increase or diminution respectively of the activity or function of the stimulated tissue. Almost every kind of stimulus probably may have either effect, according to the intensity, duration, and other attributes of the stimulus.

The responsiveness to all kinds of stimuli can be traced down to the lowest forms of life in the animal scale and is seen also in plants. As an instance of the irritability of certain plants to mechanical stimuli, one may mention that of Mimosa pudica, the leaves of which fold together when the plant is shaken; or, again, electrical currents have been seen to increase granular streamings in protoplasm of plants, such as Nitella and Tradescantia (quoted from Verworn).

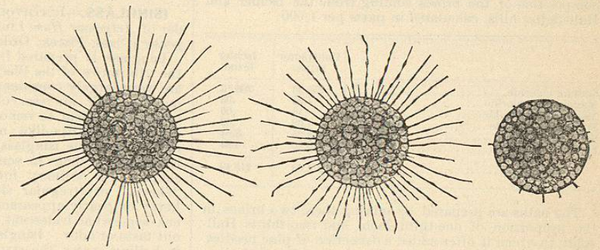
No less interesting is the narcosis of plants as observed by Claude Bernard, who found that under the influence of chloroform certain Algæ (spirogyra) cease to evolve oxygen, certain Diatomeæ cease to secrete, and growth and division of plant seeds become arrested; while Mimosa pudica, when under the influence of ether, entirely loses its above mentioned responsiveness to mechanical stimulation.

The effect of mechanical stimulation on bacteria was shown by Horvath (confirmed by Meltzer), who observed not only inhibition of growth but even death and granular disintegration of these micro-organisms as the result of regular vibrations.

That bacteria too may be excited by light is shown in the Bacterium photometricum, the flagellum of which moves under exposure to light, but ceases to move when the amount or intensity of light diminishes beyond a certain level.

In amœbæ and amœba-like rhizopods responsiveness to all kinds of stimuli—chemical, mechanical, thermic, photic, and electric—has been seen by Engelmann, Max Schultze, Kühne, Verworn, and others. (See Fig. 2966.)

The ciliary and flagellar motion of infusoria too has been found to be influenced by all the above kinds of stimuli in the direction of acceleration as well as that of retardation. Narcotics, such as ether and chloroform, retard this movement (Engelmann); high temperatures up to a certain point accelerate and low temperatures retard it.



a. b. c.

FIG. 2966.—Actinospherium Under Chemical Stimulation. (From Verworn.) *a*, Unstimulated; *b*, slightly stimulated; *c*, strongly stimulated.

An adaptability of amœba-like organisms to stimuli of all classes, brought about by gradually increasing the amount of stimulation, has been demonstrated by Engelmann. This author noticed particularly that Actinospherium, a rhizopod, if placed in salt solutions of gradually increasing strength, could finally be made to extend its pseudopodia in solutions of such concentration as would have made it contract immediately to a ball and eventually would have produced death, had it been brought into them directly.

A parallel phenomenon in higher animals is observed in the adaptability of the organism to such poisons as morphine and the like.

However, this adaptability is by no means the rule, since in the case of the rectal and vesical sphincters, for instance, as Verworn points out, the response continues the same in spite of the prolonged stimulation to which they are subject.

In the course of evolution of the animal series the use of organs or tissues for particular purposes leads to such a differentiation that each organ or tissue becomes excitable particularly by a definite kind of stimulus. An instance of this is the retina, the exquisite responsiveness of which to photic stimuli makes it adapted for the purpose of vision. This is, however, not due solely to the photic responsiveness of the retina, but is greatly furthered by the refractive apparatus of the eye and the arrangement of the retinal elements, which make it possible to concentrate, differentiate, and isolate the stimulations in the most perfect manner for the particular purpose of vision.

Moreover, experiences with the Roentgen rays have convinced us that even in the highly differentiated organism of man the retina is not the only tissue that can be stimulated by light. The deep trophic cutaneous disturbances following long exposures to this kind of light bear out this statement; and similarly, sound vibrations, although finding a particularly responsive recipient in the peculiarly constructed auditory apparatus of the labyrinth, evidently also have some effect on other tissues.

The irritability par excellence of nerve tissue is shown among other things by comparison with that of amœbæ, since nerve fibres are put into activity by extremely feeble galvanic currents, while amœbæ demand much stronger currents for this effect.

Threshold and Threshold Value of Stimulation.—Very feeble stimuli cause no visible or demonstrable effects on the stimulated or other tissues. By gradually increasing the intensity of the stimulus a point is finally reached when its effect becomes just perceptible or demonstrable. This point is called the threshold of stimulation and the intensity of the stimulus producing this minimal effect is called the threshold value of stimulation. This threshold value is not an immutable entity but dependent on the demonstrable effect that is expected, as well as on other factors.

For instance, the threshold value for a stimulation of the planta pedis might be that degree of stroking which is sufficient to produce a plantar reflex; or it might be that degree of stroking which just suffices to give a conscious tactile impression. The first would be the threshold value of reflex, the other the threshold value of conscious perception for the tactile stimulus.

For a motor nerve the threshold value of stimulation is usually measured by the intensity of the stimulus required to produce a minimal contraction of the muscle supplied by it; but we have seen in the instance of curare poisoning, which, by a paralysis of the endings of a motor nerve, prevents or impedes the transmission of the impulse from nerve to striated muscle, that the degree of muscular contraction does not give us any true measure of the irritability of the nerve and consequently not of the threshold value of stimulation of the nerve.

Another factor influencing the threshold value is the amount of "charging" existing in a given nerve or nerve-cell group previous to the stimulation. If, for instance, a cell group from which a motor nerve takes its origin is acted upon from some source or other by a temporary nerve impulse or by a continuous stream of nerve impulses (tonus) just weak enough not to produce a muscular contraction, then a very small amount of additional stimulation, whether such is a voluntary nerve impulse, a sensory stimulation acting by way of reflex, or an external direct stimulus, would suffice to transform the latent into potent energy and thus to cross the threshold of stimulation.

On the other hand the nerve impulses acting on a given cell group at the moment of an intended stimulation may be antagonistic to the latter and thus increase its threshold value in a corresponding degree.

B. Onuf (Onufrowicz).

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ISCHL is one of the most frequented spas of Austria, being often visited by the Emperor and many of the nobility. It is situated in the centre of the "Salzkammergut," in a beautiful Alpine valley, at the point where the little river Traun empties into the Ischl. Its elevation is about fifteen hundred feet above the level of the sea. It possesses a mild, moist climate, the average temperature from May to the end of September being 61° F. Showers are very frequent during the early part of the summer, but the sandy soil absorbs the water quickly, so that