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THE INTERNAL SECRETIONS AND HUMAN WELL-BEING[1]

By Professor M. F. GUYER

UNIVERSITY OF WISCONSIN

PERHAPS there is no field of biological investigation to-day that is attracting more attention on the part of both biologists and the public than that concerned with the glands of internal secretion—secretions which do not pass out from their place of origin through ducts as do ordinary glandular products, but which are absorbed directly into the blood or lymph and circulated through the body. The interest of the public has been aroused in this new knowledge through its rather wild exploitation in the press under such captions as "The Chemistry of the Soul," "The Glands of Destiny," "Rejuvenation through Monkey Glands" and other equally sensational titles, together with the occasional truths that filter through from time to time regarding the really remarkable part played by the internal secretions—or hormones as they are technically called—in our physical and mental well-being.

The ductless or endocrine glands which produce these various internal secretions occur in all backboned animals from fishes to man. The secretions themselves are second in importance only to the nervous system in keeping the parts of the body in harmonious operation. They are also necessary for normal development and growth. They can stimulate or inhibit the activity of some organ or tissue in a part

[1] Address given at the forty-fifth annual meeting of the Iowa Academy of Science, May 1, 1931; in substance, a section from the author's forthcoming textbook, "Animal Biology," published by Harper and Brothers.

of the body far distant from the source of the secretion itself. While the modest achievements of the biologist, the pathologist and the biochemist toward an understanding of the nature and functions of the internal secretions do not measure up to the expectation of a public appetite fed mainly on sensationalism, still the facts, unmagnified by the imagination, are certainly both interesting and significant.

Many physical and even mental abnormalities in man are being traced to deficiencies of the endocrine glands, or to upsets of their normal interrelations at different physiological periods in the individual. Height, the general form and external appearance of the body, whether slender or broad, the length of arms and legs, the shape of the face, the quality of the voice, the distribution of hair or of fat on the body, and even the emotions are in greater or less measure conditioned by the relative functionings of these regulative substances during early development and later life. Furthermore, the amount and quality of the internal secretions in various family strains are probably as much the expression of hereditary factors as are many other individual characteristics; hence the problem as it affects existing personality and health is not only one of present physiology but also one of parentage.

The known endocrine glands are the thyroid, the parathyroids, the pituitary body, the adrenals, the sex-glands and special areas in the pancreas, the stomach and the upper intestine. The pancreas, male sex-glands and the glands of the stomach and intestine also form other secretions for the discharge of which ducts are provided. The hormones formed in these glands, however, as in the ductless glands, are absorbed directly into the blood and lymph. The thymus, pineal body, spleen, liver, lymph glands, kidneys and heart have also been suspected of endocrine functions, although the evidence as yet is inconclusive.

The thyroid arises embryologically as an outgrowth from the digestive tract in the neck region; it soon becomes shut off from its place of origin, however, to form a ductless gland. Its final position and appearance vary considerably in different kinds of vertebrates. In man it consists of two lobes attached to the sides of the lower portion of the larynx, connected by a narrow band across the midline. The thyroid of an average sized, normal man weighs from 20 to 25 grams. It is slightly larger per unit of body weight in woman, and still larger in proportion to body size in children. Its secretion plays a very important part in maintaining a proper balance of the nutritional and growth processes. The active principle, known as thyroxin, was first isolated by the biochemist Kendall in the form of an organic iodin compound containing no less than 60 per cent. of iodin. It is now prepared synthetically by chemists; the artificial product is apparently as effective as the natural.

Thyroxin regulates the rate of oxidation in the body. Over-abundance (hyperthyroidism) increases the heart-beat, causes higher temperature, and in general speeds up the body activities. Thyroid insufficiency (hypothyroidism) on the other hand, causes the chemical processes of the body to proceed sluggishly: glandular, muscular and mental activities are impaired; the temperature is lowered, and in adults the skin, especially of the face and hands, may become puffy from the presence of underlying mucus (myxedema). Inadequate development or atrophy of the thyroid in the young child produces a condition known as cretinism characterized by stunted body and imbecile mind. The tongue and abdomen of the cretin tend to protrude and the legs are usually bowed. Such children, if taken in time, often show remarkable improvement, both in body and mind, following administration of thyroxin.

Simple (or endemic) goiter is a pathological enlargement of the thyroid gland. That iodin deficiency is an important and possibly the sole cause is indicated by the fact that many remarkable cures have been effected in early stages through the administration of iodin in some form and by the fact that this form of goiter may be largely prevented through the use of food which contains traces of iodin or by the occasional addition of small quantities of iodin salts, commonly sodium iodide, to ordinary food. That this is an important matter is evident from the fact that in the so-called "goiter belts" some 20 to 30 per cent. of the male and some 50 to 60 per cent. of the female inhabitants show at least traces of thyroid enlargement. Goiter is two to three times more prevalent in females than males. It is very common in the Great Lakes region of our own country and is usually found in glaciated regions where the iodin content of soil and water is low as compared with that of coastal plains. Goiter may occur in any land or fresh-water vertebrate. Animals living in the sea are free from it probably because sea water is rich in iodin. The enlargement is brought about apparently by overwork on the part of the gland in an attempt to secrete enough thyroxin for the use of the body in spite of an insufficient intake of iodin. Such an effect is termed compensatory hypertrophy. It is probable also that at times increased need in the body for the iodin-containing hormone may be a factor in goiter production. It is most likely to occur at the times of life when energy transformations are greatest such as, in man, during fetal life, puberty, in periods of

pregnancy and lactation and toward the conclusion of the child-bearing period in women.

As affecting development some interesting experiments have been performed with thyroid upon tadpoles. Guternatsch discovered that both frog and salamander tadpoles fed on thyroid are forced into premature maturity. Frog tadpoles quickly develop legs, absorb their tails and transform into miniature frogs, sometimes no larger than a fly. Allen has shown, on the other hand, that a young tadpole deprived of its thyroid is unable to become a frog though it continues to live and may grow far beyond the normal size of a tadpole. If at any time such a tadpole is fed thyroid, however, it promptly undergoes metamorphosis. Thyroxin seems to be the same substance wherever found in the vertebrates from lamprey to man.

Although so necessary to the proper operation of physiological processes, only a very small trace—not over 12 milligrams or one fifth of a grain—of thyroxin is present in the normal body at one time. One milligram of thyroxin fed to a man at rest weighing 150 pounds will increase his rate of oxidation 2 per cent. for twenty-four hours. The total amount of this substance needed for an entire year to keep the human body in normal health is only about three and one half grains, yet lacking this, the individual becomes an imbecile. The so-called basal metabolism test is employed to discover if too much or too little thyroxin is present in an individual. A normal resting person who has not eaten for twelve hours produces a remarkably constant amount of energy in a given time as shown by the even carbon dioxide output which results from internal oxidation. In people suffering from goiter or from lack of thyroid activity, the severity of the hyper- or the hypo-thyroidism is judged by the deviation of the rate of internal oxidation from that of a normal person.

The parathyroids (Gr. *para,* near; and *thyroid*) in man exist as four minute glands weighing in all not over two grains. They are closely attached to the thyroid, one on the side and one on the median surface of each lateral lobe. They have been identified in all kinds of vertebrates except fishes. The secretion from the parathyroids controls the calcium content of the blood, and since calcium is of great importance in many physiological processes from clotting of blood and muscular tone to formation of the skeleton, the proper functioning of these glands is all-important to the organism. Complete removal brings about a condition known as tetany, characterized by painful spasmodic contractions of the muscles of the extremities. The calcium content of the blood is greatly diminished. The heart, the respiratory tract and the temperature of the body are also affected. Death results in a few days after the removal of the glands if the condition remains untreated. Injection of a soluble calcium salt will relieve the attack of tetany and restore the sufferer to normal for a time.

The thymus is a glandular structure which in man is located in the upper chest region along the trachea. In lower forms such as fishes it may take the form of a number of separate bodies. Although commonly regarded as a ductless gland its function is a matter of debate. The secretion has never been successfully isolated. By some it is thought to be a structure which functions in the formation of blood. Since, in man, it attains its maximal size and activity in early childhood, the inference is that it fulfills some important function in the young developing organism. After the second year of life, ordinarily it gradually grows less in size until usually at about the end of the thirteenth year it is supposed to disappear. However, cases of "persistent thymus" are not uncommon. At first supposed to be confined to individuals characterized by prolonged childhood, and to be particularly characteristic of feebleminded adults, renewed study of cadavers shows that persistence in apparently normal individuals is by no means uncommon. Young dogs in which the thymus has been completely removed develop a softening of the bones, and surgical removal in a human being is said to produce a disordered development of the skeleton similar to that of a child with rickets.

The pineal gland is a small body in the brain of vertebrates, projecting from roof of the third ventricle, from which it is an outgrowth. In man it is about the size of a pea. The philosopher Descartes regarded it as the seat of the soul! There seems to be some evidence that it secretes a hormone, although it has never been isolated. The gland seems to be most active during childhood and by some endocrinologists is believed to take over the supposedly inhibitive functions of the thymus after the second year of life. Early destruction or degeneration of the gland, as by a tumor, has been found associated with precocious sexual maturity in a few children. Delayed retirement of pineal activity is alleged by some endocrinologists to lead to obesity and retardation of sexual development.

The pituitary gland is a small body of double origin, attached by a stalk to the base of the brain. It occurs in all vertebrates from hag-fish to man. The anterior portion arises embryologically from the roof of the mouth, and the posterior portion is an evagination from the floor of the brain immediately above the mouth. The respective outgrowths fuse to form what is commonly called the pituitary body or gland. The posterior part forms the posterior lobe

or *pars nervosa* of the pituitary gland. The anterior outgrowth ultimately gives rise to three distinct parts—an anterior lobe, an intermediate lobe and a thin layer called the *pars tuberalis,* which comes to surround the stalk and extend upward onto the base of the brain. The different parts have different functions.

In normal man the pituitary body is a small structure about the size of a hazel-nut, weighing approximately 0.6 gram. It lies in a bony depression (*sella turcica*) of the sphenoid bone in the floor of the skull. The earlier work done with extracts from the posterior lobe produced seemingly very divergent results due probably to the fact that such substance is easily injured by the reagents used in its preparation, to differences in size of dose, and probably also to the fact that, as recent investigation has shown, more than one hormone is involved.

The most consistent results obtained from use of the entire extract of the posterior lobe are: (1) extraordinary potency as a stimulant of smooth muscle (hence its use in hastening child-birth by causing powerful uterine contractions); (2) prolonged rise in arterial blood pressure; (3) a diuretic (increasing the secretion of urine) action, or, under some conditions, an antidiuretic reaction; and (4) characteristic cardiac, glandular and respiratory effects. Kamm and his coworkers, however, have succeeded in separating from powdered posterior lobe substance two products, one of which acts powerfully on blood-pressure but has very slight action on uterine muscle while the other does not affect blood-pressure but is a powerful stimulant of uterine contraction. In addition to these substances two materials which lower blood-pressure are known to exist in posterior lobe extracts.

The secretion of the anterior lobe is best known through its growth-stimulating and ovulation-inhibiting effects. Over-activity of this lobe probably leads to gigantism, insufficiency, to dwarfing. Removal of the anterior lobe in young experimental animals results in a marked stunting in size. Injections with anterior lobe extracts, however, cause growth to be resumed. By daily injections of anterior lobe-substance into the body-cavity, giant rats have been produced. In one case a treated animal became more than double the size of untreated litter mates. Gigantism has likewise been similarly induced in various amphibia. Autopsies on various human giants have revealed tumorous and enlarged pituitaries. If the excessive secretion begins in youth while the growth zones of the bones are still unossified, lengthening of the bones, particularly of the arms and legs, occurs, and a form of gigantism is the outcome; but if such overactivity does not appear until maturity a different type of enlargement occurs in certain bones, notably those of the hands, feet and face, and a condition of deformity known as acromegaly results.

As regards sterilization by means of anterior lobe extract, the contradictory reports which have filled the literature for the past few years seem at present in a fair way of being cleared up. Most studies have reported inhibition of ovulation in mice and rats following hypodermic injections of the extract. A few, particularly where minimal amounts were used, have recorded increased ovulation and the precocious maturity of young animals. Miss Claus, however, succeeded in isolating a crystalline product from the anterior lobe which very materially hastens sexual maturity in young mice. The residue left after the removal of such crystals was shown still to contain the growth-promoting and the ovulation-inhibiting substances. Thus there are evidently at least two different hormones in the anterior lobe secretion, and it seems not improbable indeed that this non-crystalline residue may be further fractionated into two, making three in all.

Working with frog tadpoles, B. M. Allen has shown that limb development ceases at a certain point following removal of either the thyroid or the pituitary gland or both. He interprets his results as indicating a close correlation of function between the two. He has demonstrated also that tadpoles from which the pituitary body has been removed lag greatly in growth but that following implants of the anterior lobe alone, growth rises rapidly to normal again. Implantation of either the intermediate or the posterior lobe has no such restorative effect. Striking increase in pigmentation in such tadpoles, however, is produced by implantation of the intermediate lobe.

One of the most spectacular effects of transplanting the anterior lobe is perhaps that obtained by Miss Wolf on the breeding habits of the ordinary leopard frog (*Rana pipiens*). This animal breeds once a year, in April, laying its eggs in lakes, streams and fresh-water pools. However, females treated in the fall or early winter with daily implants of a single fresh anterior lobe taken from another frog may be stimulated in from four days to a week to lay eggs in a perfectly normal manner. Males similarly treated, after the second or third treatment, usually begin to sing as they do during the mating season in spring, and in the course of a few days all the normal mating instincts appear, the eggs are fertilized and normal development occurs. Tadpoles are now secured in this way in our own laboratories at any time we may need them for class or individual work.

Taking pituitary secretion as a whole the available

evidence shows that an excess increases the basal metabolic rate and that a deficiency leads to excessive obesity and retardation of sexual development. Indications of close interrelation between the pituitary and various of the other endocrine glands such as thyroids and ovaries are steadily accumulating.

The pancreas is seemingly a gland concerned primarily with the elaboration of a digestive fluid which is discharged through the pancreatic duct into the upper intestine. Scattered throughout the pancreas, however, among the lobules which secrete the ordinary pancreatic juice, are small independent areas of a very different-looking tissue known as the islets of Langerhans. These cells secrete a substance known as insulin which passes directly into the blood-stream and serves, probably in cooperation with the secretion of the adrenal glands, to control the metabolism of sugar in the body. If these islets are incapacitated in some way an insufficiency of insulin occurs and a condition known as diabetes (*diabetes mellitus*) results. A characteristic symptom of diabetes is increase of sugar in the blood and later the appearance of sugar in the urine. Insulin was discovered, and a method of preparing it from the pancreas of healthy animals was perfected by Banting, Macleod and associates. This preparation is now widely used in the treatment of diabetes and is restoring the general health and prolonging the lives of many diabetics. It is interesting to note in connection with the pancreas also that secretion of the pancreatic digestive fluid does not proceed until the pancreas is stimulated by a hormone known as secretin. Secretin in turn is produced in the walls of the small intestine as a result of the entrance of the acid contents of the stomach following gastric digestion.

The adrenal glands as the name implies (L. *ad,* near; *ren,* kidney) are associated with the kidneys, although in the lower mammals they are not as closely connected with it as in man. Each gland is a double structure of dual embryonal origin. The core or medullary portion springs from certain cells of the adjacent sympathetic nervous system, while the cortical portion which comes to envelop the medulla is derived from the lining of the body cavity. The secretions from the two parts differ in physiological action. Inasmuch as cells giving reactions similar to those of the adrenal medullary cells have been described in annelids and mollusks adrenal secretion or its equivalent seems to be of wide occurrence in the animal kingdom. The adrenal glands of man are two small structures of a yellow color, which cap the kidney and weigh about 4 grams each. They are about the size of a man's thumb.

The secretion from the medullary portion of the adrenal gland, called adrenalin or epinephrin, has not only been isolated in a pure state but has also been synthesized in the laboratory and is widely used as a drug. In the body it is of great importance in maintaining muscular tone; the proper amount keeps the blood vessels suitably contracted and blood pressure normal. It is normally present in blood in about the ratio of only 1 part to 20,000,000.

Insufficiency of adrenalin in the blood results in lowered blood-pressure, lack of muscular tone and the general loss of strength and "nerve" which is characteristic of neurasthenia, "shell-shock" and related ills. In general, adrenalin affects the same structures of the body that the sympathetic nervous system does; namely, the heart, blood-vessels, kidneys and other viscera, and the involuntary muscles. It is widely used in minor surgery because it constricts blood-vessels and thus checks bleeding. Tadpoles fed on adrenal gland become extremely light colored or "bleached," apparently because it produces contraction of the pigment cells. Injection of adrenalin into the blood leads to increase in the quantity of sugar in the blood through release of the sugar from liver glycogen. It apparently counter-balances the action of insulin. It is used medicinally to relieve bronchial spasms in asthma, and in conjunction with local anesthetics for constricting blood-vessels and thus preventing rapid diffusion of the injected substance. It is also sometimes used in attacks of hives or hay fever. Injected directly into the heart in certain cases of collapse, it will sometimes, through its effect on certain nerves, initiate renewed contraction in a heart that has ceased to beat.

Professor Cannon and his associates conclude from their experiments that under stress of such emotional states as pain, suffocation, fear or rage, the adrenals are stimulated to an increased output of adrenalin. Cannon calls attention to what he regards as the remarkable adaptive character of the reactions which follow, in that they supply the body with muscular power to resist or carry out any of the actions that may take place under these emotions for the welfare or preservation of the individual. According to him the sugar of the blood—the most favorable source of muscular energy—increases in quantity; if digestion is in progress its activities are suspended and the blood is shifted to the organs immediately necessary for muscular exertion—the lungs, heart and central nervous system; the blood becomes more coagulable; heart action becomes more vigorous; muscular fatigue is counteracted by the extra adrenalin; in brief, such fundamental readjustments are instituted as are favorable to great feats of strength or endurance—for fight or flight. According to Cannon's view, then, adrenalin is a chemical agent which cooperates with

nervous factors in helping the body meet the emergencies of existence.

Removal of the adrenal cortex results in death in the case of man or such animals as the dog or cat. But injections of cortical extracts will keep such animals alive. A serious malady in man known as Addison's disease, characterized externally by bronzing or pigmentation of the skin, is associated with pathological changes in the adrenal cortex. Such patients, however, show improvement following injections of cortical extracts.

So far no specific secretion has ever been definitely isolated from the cortex, and its functions are therefore not so well understood as those of the medulla. Inasmuch as cortical enlargement (hypertrophy) has been found to be associated with precocious sexual development it is inferred that one of its functions is concerned with determining and controlling sexual maturity. Overactivity of the adrenal cortex apparently causes marked accentuation of the masculine traits. Women so affected acquire masculine characters, such as beard, deep voice and coarse features. Cortical tumors have apparently caused even young children to develop the sexual characteristics of the adult. Some bits of evidence indicate that the cortical secretion serves also to neutralize certain poisonous products of protein metabolism.

It has long been known that the generative glands (gonads) besides forming germ-cells also produce internal secretions which influence the individual profoundly, both mentally and physically. These secretions are indispensable for the proper development of the specific male and female characteristics. Much experimentation has been in progress with the lower animals in this connection in recent years and many interesting facts determined. In certain mammals such as the rat or guinea-pig, for instance, if the ovaries of a female are transplanted into a male which has been previously unsexed, the latter under stimulus of the ovarian secretions assumes a behavior like that of the female. Its hair and skeleton come to resemble more those of the female than of the male, and its rudimentary milk glands become enlarged to functional size.

If the ovary of a mallard duck is completely removed, at the succeeding moult she takes on the very different plumage of the male. Likewise, if the ovaries are removed from very young hens they develop to a greater or lesser degree the more ornate plumage, the spurs, wattles, comb and larger size of the cock. The development of these characteristics will be still further increased if extract of the male gonad is injected, or if the gland itself is transplanted to such castrates.

A remarkable experiment which reveals the importance of the sex hormone in sex differentiation has been discovered by Professor F. R. Lillie in his study of the "free-martin," a sterile female calf born as a twin to a male calf. In cattle when twins, one male, the other female, arise, the blood-vessels in the fetal membranes of the two embryos may fuse in such a way that their blood intermingles. The male gonads develop ahead of those of the female with the result, according to Professor Lillie, that the male sex hormone is the first to pass into the joined circulatory systems. It interferes with the growth of the ovary in the female, causing sterility and modifying more or less profoundly various of her secondary sexual characters so that they tend to assume the male condition. Witschi has shown that such a male influence is also exerted when tadpoles are grafted together in pairs, the females attached to a male being made masculine. Burns has shown that if salamander tadpoles are grafted together in pairs, when the individuals happen to be of different sex the sex hormones of the one—sometimes the female, sometimes the male—are likely to alter profoundly the sexual system of the other.

In the female of the vertebrates, at least, the rhythmical occurrence of ovulation is correlated with rhythmical changes in the secretions of the ovary. In mammals the hormones so far identified with the ovary have been derived from two sources; namely, the follicular fluid which surrounds the egg before it is shed from the ovary and the corpus luteum, a yellowish mass of cells which come to fill the ruptured follicle after the egg has been discharged. The follicular extracts differ decidedly in function from those of the corpus luteum, although there appears to be a reciprocal or supplementary relationship between them. The corpus luteum increases in size for a time and then undergoes retrogressive changes and is finally absorbed. The duration of this growth period depends upon whether or not the discharged ovum has been fertilized and is developing in the uterus. If such development is in progress the corpus luteum increases in size, becoming what is known as the corpus luteum of pregnancy; it persists for a considerable time, depending upon the length of gestation. If development of the embryo is not taking place in the uterus, the corpus luteum disappears shortly and a new follicle gradually accumulates liquid, projects from the ovarian surface and at the proper interval discharges another ovum. Thus the cycle of ovulation (oestrous cycle) is repeated rhythmically unless interrupted by pregnancy. There are indications, however, that the hormone from the anterior lobe of the pituitary body has some part in stimulating the ovary to renewed ovulation. Not only periodic changes in the ovary itself but in the

uterus, mammary glands and other parts of the body are brought about through the agency of the ovarian hormones. Allen and Doisey have succeeded in preparing a hormone from follicular liquid which restores the normal mating instincts and the characteristic sex cycle in rats and mice in which these had been lost as a result of removal of the ovaries. This extract, when used on young animals immediately after weaning, induces precocious sexual maturity. Not only will follicular hormone when repeatedly injected cause development of the mammary glands in females from which the ovaries have been removed but it will likewise stimulate the mammary glands of males to develop. A similar hormone has been obtained from placental tissue and the amniotic fluid which surrounds the developing fetus; also from the urine of pregnant cows and pregnant women.

The corpus luteum hormone seems to have as one of its functions the preparation of the uterine wall for implantation of the fertilized ovum, for if the corpora lutea are destroyed implantation does not occur. Hisaw has shown, however, that what he calls a "one, two" reaction is involved—that the uterine mucosa must first be sensitized by the follicular hormone before the corpus luteum extract is effective. On the other hand, injection of follicular hormone following implantation will cause abortion. Hisaw has also isolated from ovarian extracts a crystalline product which he terms a "relaxative hormone" because it relaxes the pubic symphysis before parturition and thus facilitates bearing the young. That it is not the only hormone of the corpus luteum is shown by the fact that the non-crystalline residue left after removal of the relaxative hormone still retains the other endocrinal functions of corpus luteum extract. Hisaw has recovered this relaxative hormone also from the placenta and from the blood and the urine of various pregnant mammals, including human beings. The corpora lutea of pregnancy also apparently supply a hormone which inhibits ovulation during pregnancy and which stimulates the development of the mammary glands.

As regards the internal secretions of the testes Moore has succeeded in isolating testicular extracts which when repeatedly injected into castrated males restores all the characteristic masculine behavior and structures except the gonads themselves. It is commonly believed that the internal secretion of the testes is furnished by so-called interstitial cells which lie outside the tubules which produce the germ-cells, inasmuch as the latter can be caused to atrophy while the interstitial cells remain unaffected and the animal yet develop or maintain its normal sexual characteristics.

The great importance of endocrine glands in controlling the later development of vertebrates, particularly the rôle they may play in determining the conformations of various parts of the body, opens up the important issue of how much such similarities are to be attributed to direct heredity, how much to endocrinal activities. Certain types of defectives, such as cretins and so-called Mongoloids, even when of different races, often show marked resemblances. The abnormalities in the case of cretins are ascribed to endocrine—particularly to thyroid-deficiency in the affected individual—and those of the Mongoloids are supposedly the result of endocrine disturbances in the mother or to fetal nutritive insufficiency. The Mongolian facial type, however, is also prevalent in cretins and may result from insufficiency of thyroid secretion during the growth period, since such lack is known to have a characteristic effect on the bones of the nose and the base of the skull. Thyroid as well as pituitary insufficiency may also be an important factor in dwarfing. From the standpoint of heredity, therefore, a peculiarity in a particular structure might have its immediate determining cause in the output of an endocrine gland, but if inheritance is involved, the determining genes would be those responsible for the changed condition of the gland in question, not for the visible, finished trait.

That all such developmental anomalies can not be attributed wholly to improper functioning of some endocrine gland of the affected individual, however, is shown by the fact that certain of them reveal their presence far back in the early fetus before its endocrine glands are functional. This is true, for example, of the achondroplastic dwarf, characterized by abnormally short and somewhat twisted arms and legs, with head and trunk of approximately normal size. Such individuals have many of the evidences—disproportionately broad face, low nose-bridge, overhanging forehead, undershot jaw—of thyroid deficiency. This abnormality, furthermore, can not be attributed, in all cases at least, to endocrinal defects of the mother, since pedigree tabulations are known which clearly show that the condition can be transmitted from the paternal side. Such a characteristic shaping-up of the head and face is due to lack of growth of the skull base. Professor Stockard points out the resemblance of this condition in man to that found in certain breeds of the lower animals such as the bulldog and the pug-dog, and maintains that the underlying cause is probably the same in each. He believes, from our knowledge of their inheritance and development, that the primary cause lies in a germinal mutation or sport and that the endocrinal effects are secondary.

The English anatomist Keith is inclined to regard

the primary differences which mark off the races of man as due to the relative activities of various endocrine glands. While his opinions are highly conjectural they are suggestive and show the importance of further investigation in this interesting field. Stature, for example, is largely regulated by the secretion from the pituitary gland, and Keith maintains that the average European is taller than the average Negro or Mongolian because of the more pronounced activity of this gland in the Caucasian type. The pituitary also probably influences the character of the hair, the texture of the skin, and the cast of features. Hormones from the male gonad are apparently responsible for the main secondary sexual differences. Judging from the more heavily haired condition of the body in Caucasians, he likewise infers that this tissue is more active in them than in the Mongolian and Negroid types. Again, he thinks that the lighter color of the paler-skinned races may have been produced by a greater activity of the adrenal glands, since their secretion tends to destroy pigmentary bodies. According to his hypothesis, then, the Caucasian type is characterized by a relatively greater amount of internal secretion from gonads, and from pituitary, thyroid and adrenal glands. Since racial characteristics are inherited, however, it is evident that such differences of mind or body, in so far as they are referable to the influence of internal secretions, must be assigned eventually to the germinal factors which determine the corresponding differences in the endocrinal glands.

In conclusion, then, I think it is evident from even this cursory review of the endocrine system that we have in the internal secretions a series of powerful agents which profoundly influence our body-structure, our health and our whole personality.

SCIENTIFIC EVENTS

DROUGHT IN THE NESTING AREAS OF WATERFOWL OF THE UNITED STATES AND CANADA

THE reports of representatives of the U. S. Biological Survey who have recently returned from expeditions to northern areas of the United States in company with Canadian officials to the principal duck-breeding areas in Canada indicate that severe limitation of the number of waterfowl to be killed during the coming season may be necessary as a result of long-continued drought in the nesting areas. Although federal regulations governing the shooting of ducks and geese were recently amended to reduce the open season throughout the United States by two weeks this fall and winter, still further restriction of the annual kill may be necessary.

Discouraging reports were made of unprecedented drought; of lakes and ponds and marshes turned into dusty barrens with no sign of aquatic life, and of the almost complete absence of water during the period in the great prairie breeding grounds of southwestern Manitoba, southern Saskatchewan as far north as Saskatoon, and Alberta westward to the foothills of the Rocky Mountains and northward to the vicinity of Edmonton.

A marked shortage of breeding ducks and young was noted in the great delta region of the Peace and Athabaska rivers. In tours of several thousand miles the investigators saw only a few dozen small broods of young ducks in an area that in normal years has produced many millions of mallards, pintails, redheads, canvasbacks, bluebills and teals.

The shallow prairie sloughs and lakes of the region have disappeared following about ten years of reduced rainfall and three seasons of persistent drought. A far-reaching inquiry sent out by the Canadian Government has failed so far to show that the ducks have found other more remote breeding areas.

Not all the ducks and geese that come into the United States are bred in the region surveyed but a very large proportion of the wild fowl that make up the great flights know that country as their birthplace, and the shortage of breeding birds and the loss of so many young will have a serious effect upon shooting conditions both in this country and in Canada. Both the Canadian and United States governments under the migratory-bird treaty are concerned over the disastrous conditions that now threaten the wild fowl of the continent.

The two governments are therefore endeavoring to avert shortages by devising methods for saving an adequate supply of breeders for next season. The severity of the limitations that may be necessary will not be determined definitely until after further conferences between the authorities of Canada and of the United States and until more information is received from the nesting grounds.

To avert the grave possibilities of a permanent disaster to the wild fowl, the gunners in all sections of both countries will probably be asked to reduce their duck shooting this winter to a minimum, so that enough mature birds will survive to breed and thus enable the flocks to replenish themselves with the return of water to the parched areas.

THE INTERNATIONAL PASSAMAQUODDY FISHERIES COMMISSION

THE first members of the scientific staff appointed to investigate the Passamaquoddy fisheries for the