DUCTLESS GLANDS AND HUMAN PERSONALITY

By Dr. Ivan Maxwell

A Meeting of the Medico-Legal Society was held at the Medical Society Hall on the 4th April, 1937. The President, Dr. Ernest Jones, occupied the chair.

Dr. Ivan Maxwell delivered an address on "Ductless Glands and Human Personality," and illustrated many aspects of his address by reference to lantern slides. In his address Dr. Maxwell said:

Some three years ago your Secretary, Mr. Barry, and I were sailing together on a clear blue sea amidst coral-fringed islands. We were within the Great Barrier Reef. Despite the spell of this beautiful sub-tropical environment our conversation drifted to a consideration of the ductless glands. As an outcome of this conversation Mr. Barry invited me to speak to the Medico-Legal Society of Victoria and this explains my presence here to-night.

The ductless or endocrine glands are so named because they have no special duct conveying away their secretions such as one finds leading from the salivary glands and carrying saliva into the mouth. Nevertheless the ductless glands form secretions which pass directly into the blood or into the lymphatic system. In these secretions there is dissolved one or more chemical substances which are carried to other organs of the body and may have a profound influence upon them. Such chemical messengers have been named hormones. Several of these hormones have been isolated from organs by bio-chemists and their exact chemical constitution determined and furthermore it is now possible to artificially produce in the laboratory the hormones of some of these glands, notably those of the thyroid and suprarenal.

The chief endocrine organs are:

1. *The pituitary gland.*
2. *The thyroid gland.*
3. *The parathyroid glands.*

4. *The suprarenal glands.*
5. *The thymus gland.*

Other organs containing an internal secretion which we shall discuss are the ovaries, the testes and pancreas, but each of these has in addition a secretion which is conveyed from the organ by a definite duct. From the ovary ova are liberated, from the testes spermatozoa pass by the duct known as the *vas deferens*, and from the pancreas a fluid having special properties concerned with digestion flows along the pancreatic duct to be discharged into the intestine.

Many physical attributes are dependent for their development on hormones from the endocrine glands. Examples of such are size of skeleton, condition of the skin and hair and even the size of the pupils of the eyes. A person's interests, his emotions and intellect are modified by chemicals found in the ductless glands.

With these preliminary observations let us now turn to consider what has been aptly styled the leader of the endocrine orchestra. It is sometimes referred to as "The Pasha in the Turkish Saddle," owing to the resemblance to a Turkish saddle of the bony depression in the base of the skull in which the gland is situated. Being almost encompassed by bone there is little opportunity for the gland to enlarge in health or disease. Despite the small size of this gland—it is only the size of a small cherry—it has a most profound influence on the body. It is divided into an anterior and posterior lobe and a small intermediate portion. The anterior and posterior parts have an entirely different embryological origin in the body and totally different functions. The anterior lobe alone is credited with having at least seven distinct hormones which influence respectively—

(a) Growth of the skeleton.
(b) Activity of the sex organs.
(c) Secretion of the thyroid gland.
(d) Secretion of the parathyroid glands.

(e) Secretion of the adrenal cortex.
(f) Secretion of insulin.
(g) Growth of the mammary gland.

It should be noted that the pituitary or any other of the endocrine glands when diseased may have profound effects on one or more of the other ductless glands so that a polyglandular syndrome may occur with very complex pathological manifestations.

The growth factor is formed in the anterior lobe and when secreted in excessive amounts in early life before the bones have become "set" it causes gigantism and if this excessive secretion occurs in later life gross changes may occur in stature and in the facial appearance of the individual (*acromegaly*). Evans in the United States has been able to produce experimental gigantism in rats by injecting extracts of the anterior lobe of the pituitary gland. Diminished secretion of this hormone causes diminished growth and infantilism with a slim, slender appearance like that of a graceful child even although the person may be thirty or forty years of age. Sometimes the lack of secretion involves other functions of the glands as well as the growth factor and the person may be stunted, stupid and with diminished sexual feelings. One of the best-known types is the fat boy of Dickens; fat, slothful and sleepy. Injections of anterior lobe extracts in undergrown children have not achieved much success in stimulating growth but it is almost certain that when this growth factor is obtained in a pure form such children may be stimulated to grow by the appropriate injection. The mere fact of being a dwarf or a giant may entirely alter the person's general conduct in life. A case in point is that of a gigantic youth who ultimately became 8 feet 3 inches in height and who was so embarrassed by his enormous stature that he played truant from school. Many pituitary giants or dwarfs become associated with travelling circuses, curiosities for the multitude to see.

The next hormones of the anterior lobe to be considered are the gonadotropic hormones or factors influencing the

sex organs. It is thought that there are two distinct substances formed in the pituitary gland which act on the ovary, one called the follicle stimulating principle which liberates the ova and the other called the luteinizing hormone which is responsible for the development of the corpus luteum. These pituitary hormones initiate and control the ovarian cycle and they cause the liberation of two ovarian hormones, one of which, *oestrone,* is responsible for the development of the secondary sexual characteristics at puberty—growth of hair on the body, alteration of the pelvis, alteration of the voice and enlargement of the breasts. In the male the gonadotropic hormones stimulate the development of spermatozoa and the secretion of the male sex hormone (*testosterone*) which in its turn causes the secondary sexual changes. How profoundly the pituitary gland affects the human organism will be realized when it is stated that if as a result of pituitary disease these hormones fail to be secreted in the human child the sexual organs will fail to develop at puberty; and if they cease to be formed in the adult, sexual desire ceases completely. If the pituitary gland is removed from young animals the sexual organs entirely fail to develop at puberty. Without doubt the pituitary gland contains the most important chemical stimuli to the sex organs in the body. Without these gonadotropic hormones all sexual desire is lost in men and in women, their sex life simply does not exist. Many psychologists regard the sexual impulse as if it were primarily and solely psychogenic—that is to say, produced in the mind. Endocrinologists claim that no sexual desire can occur in the absence of the gonadotropic hormones of the pituitary gland.

The action of specific hormones of the anterior lobe of the pituitary gland on the thyroid, parathyroid glands, adrenal cortex and pancreas has been experimentally established.

Before considering other glands reference must be made to the functions of the posterior lobe of the pituitary. Briefly it forms hormones which regulate the flow of

urine, control the tone of capillaries and hence blood pressure, have a profound influence on the uterus at parturition and probably have an effect on the general metabolism (energy and chemical changes) of the body. Some authorities think that diminished posterior lobe function may give rise to gross adiposity and mental dullness, whilst other investigators maintain that such adiposity is due either to damage to neighbouring nerve centres in the base of the brain or to diminished function of the anterior lobe. It is certain that the grossest form of adiposity—such that the person may become thirty or forty stones in weight—is due to some form of pituitary disorder. Very complex clinical syndromes may be produced by pathological conditions of the pituitary gland in which there may be increased or decreased secretion of one or more hormones of the anterior lobe and concurrently an increased or diminished secretion of the posterior lobe.

Turning from this gland that is so wonderfully protected from injury by the deep depression of bone in which it is situated at the base of the skull we now consider the superficially situated thyroid gland in the neck. Owing to its situation this gland has been the subject of observation not only for generations but for centuries. It is only in recent years that accurate knowledge of its hormone has been obtained, largely due to the work of *Kendall* in America and *Harington* in England. Suffice it to say that the all important chemical messenger (*thyroxine*) prepared by this gland is a relatively simple chemical substance containing iodine as an essential component. In certain parts of the world particularly in the valleys of Switzerland and Southern Germany there is iodine deficiency in the soil and diminished formation of the hormone thyroxine of the thyroid gland. If this should occur in infancy the child becomes stunted in growth and mentally deficient even to the extent of idiocy. Such a child is called a cretin, and can usually be restored to normal by administration of thyroid gland by mouth. In adult life diminished iodine intake may be associated with the enlarge-

ment of the gland and lowered metabolism and diminished mental activity. Again this sluggishness of mind may be successfully combated by the administration of thyroid in suitable doses. In contrast to the person who forms too little thyroxine is the individual who secretes too much of this hormone and shows hyper-excitability of the nervous system with rapidly beating heart, dilated pupils, protruding eyes, and perhaps considerable loss of weight. By suitable removal of a portion of the thyroid gland the surgeon may restore such a patient to normal. It is remarkable what small quantities of iodine are present in the blood of the normal person, only about one-hundredth of a milligram of iodine being present in a hundred cubic centimetres of blood. Nevertheless this small quantity is all-important as a person deprived entirely of iodine from infancy would develop into a dwarfed idiot. Only a few milligrams of iodine stand between the normal individual and insanity. There are thus two types of thyroid personality; (a) The hypothyroid type with low metabolism, tendency to adiposity and mentally dull, and (b) the hyperthyroid type whose metabolic furnace is burning brightly and rapidly using up the body fuel whilst the intellect is usually correspondingly alert.

Within the last two decades research has indicated that the anterior lobe of the pituitary gland has a definite control over the secretion of the thyroid hormone.

For many years several tiny structures lying in close apposition to the thyroid gland were neglected by the physiologist but more recently these bodies known as the parathyroid glands have been shown to have a marked influence upon the calcium content of the blood. Disorders of the parathyroid glands may give rise to marked alteration in the structure of bone. If the parathyroid glands are accidentally removed during the operation of partial removal of the thyroid gland then severe nervous changes may occur constituting the condition known as tetany which must not be confused with tetanus which is caused by the toxin of a micro-organism. The pituitary gland is thought

to have some controlling influence over parathyroid secretion.

Though perhaps the pituitary gland is probably the most remarkable of all the endocrine glands the suprarenal gland falls little short of it in its extraordinary functions. It has two divisions, an inner portion, or *medulla* and an outer portion or *cortex*. Investigation has shown that the cortex is essential to life. Not only is this part of the gland necessary for our very existence but it has a very interesting relationship to the sex organs and incidentally to human conduct. Tumours of the suprarenal cortex may give rise to extraordinary precocious sexual development and virilism. In the female excessive adrenal cortical activity determines the exhibition of masculinity, growth of hair on the body and face and a deep voice. The cortex is influenced by a special hormone from the pituitary gland.

The medulla or interior of the gland secretes a most powerful hormone known as *adrenaline*. The adrenal medulla is sometimes referred to as the gland of emergency. Self-preservation largely depends on the activity of this part of the adrenal gland. Under the influence of exercise adrenaline is formed in greater quantity than when a person is resting. In very severe exercise it causes dilatation of the pupil and greater increased visual acuity, it increases the strength and rate of the heart-beat so that blood circulates freely to the muscles involved in exercise the blood pressure being raised at the same time. It dilates the bronchial tubes so that air may be more readily drawn into the lungs, and furthermore it increases the sugar content of the blood so that the muscles will be supplied with an abundance of readily combustible material. All these functional activities are seen to the best advantage when, in the presence of an enemy, the person is called upon either to fight or to flee. As an example of the very powerful influence of this hormone one may refer to the fact that a few drops of a solution of 1 part of adrenaline in 1,000 parts of saline is sufficient to more than double in a few moments the blood pressure of a dog if the injection is given directly

into a vein. The sympathetic nervous system exhibits its action on various organs in virtue of the fact that its nerve fibres when stimulated liberate adrenaline. Despite the extraordinary importance of the medulla of the gland in everyday life, it is not absolutely essential to life itself. Although necessary for strong outbursts of energy a person or animal can live a quiet existence in the absence of the suprarenal medulla. The hormone adrenaline has not only been isolated from this gland but it has been prepared by the biochemist in the laboratory quite apart from the animal body. This is another example of the triumph of the laboratory worker.

Little is known of the functions of the thymus gland. From puberty onwards it slowly atrophies, but if an animal is castrated in early life the thymus gland tends to persist. There seems to be an antagonism between the thymus and the sex organs. No hormone has yet been isolated from the thymus gland.

The pancreas will be only very briefly discussed, but even this organ may have a medico-legal interest. One of its functions is to deliver a powerful digestive secretion into the intestine. The other important function is to form *insulin,* the hormone which is so well known in the treatment of diabetes. This substance does not pass along the duct of the pancreas, but directly into the blood stream. In diabetes the percentage of sugar in the blood is higher than normal. Insulin has the power when injected into the body of bringing the percentage of sugar back once more to the normal figure. If, however, it is injected in excessive amounts the blood sugar may become extremely low, a condition known as hypoglycaemia, and this may be accompanied by very marked nervous symptoms; the patient loscontrol of his ordinary activities and actually may become unconscious. The abnormal behaviour following such an overdose of insulin may be responsible for the person being presented in court on various charges, which may on further investigation be explained as due to the excessive lowering of the blood sugar. For example, he may tempor-

arily lose control of the steering of a motor car and become involved in an accident. If by any chance he had recently taken sufficient alcohol for it to be detected in his breath he might be charged with driving a car while under the influence of alcohol, while the real cause of his inability to control the car was an excessive injection of insulin. Not only can this excessive fall of the blood sugar occur after an overdose of insulin, but it may also be observed accompanying certain types of tumours of the pancreas which are associated with excessive secretion of insulin, and which may cause all the nervous symptoms of hypoglycaemia.

Reference has already been made to the fact that gonadotropic hormones from the pituitary gland initiate the sexual cycle in the female. Without these primary stimulating hormones the sex organs fail to mature at puberty. On the other hand if a small portion of the anterior lobe of the pituitary gland is grafted into the body of an immature mouse (before puberty), rapid development of the ovaries occurs. Once the ovaries have gained maturity under the influence of the pituitary gland then they produce their own special hormones, which not only cause the development of the various secondary sexual characters already described, but regulate the monthly sexual cycle. If the ovaries are removed in the adult this monthly sexual cycle ceases. Experimentally in animals the ovaries can be completely removed and the sexual cycle restored by the injection of an ovarian extract. If the ovaries are grafted into an ovarectomized subject they may function for a time, usually about twelve months. Voronoff has grafted the testes of the higher apes into men with diminished sexual powers and claims that his patients show some degree of rejuvenation of sexual function following such an operation. Remarkable experiments have been performed on the reversal of sex in animals. If a young male rat is castrated and several weeks allowed to elapse so that the animal has time to become sexually neutral, or indifferent, and the ovaries are then transplanted from a female of the same species into a suitable area in the abdominal wall, the graft is fre-

quently successful, that is the ovaries function in their new situation and the following results may be obtained:

1. The mammary glands which are normally rudimentary in the male may show increased growth and actually secrete milk.
2. The body development will proceed along the lines of female conformation.
3. The nervous system is eroticized in the female direction and the animal is treated as a female by the males—he has sex inversion and shows homosexuality.

It must be remembered that this is occurring in a male animal into which the ovaries have been introduced. It is due to the hormones from the transplanted ovaries and shows how the personality and conduct of the animal can be completely changed by chemical stimuli from its sex organs. Human beings are actually bisexual, the female sex hormones overwhelmingly preponderating in the normal female, and the male hormones in normal men. Normally the male organs in the female are extremely rudimentary as are the female organs in the male. The grosser aspect of bisexual development is seen in the human hermaphrodite. Here the male or female characteristics and feelings of the individual are due to the relative preponderance of the male or female sex hormones. Cases have been known in which the sex characteristics have been entirely reversed during the life of an animal or a human individual.

A striking example is recorded of a fowl which showed the usual female characters and laid eggs, but later developed tuberculosis of its ovaries, and gradually acquired male plumage and behaved as a male and fertilized the ova of fowls.

Occasionally a woman with male characteristics and exhibiting homosexuality is found at autopsy to have testicular tissue in the body instead of the normal ovarian tissue. It might be thought that castration or removal of the testes in man or the ovaries in women would lead to loss of all sexual desire. This is not so in many cases. If in the male the testes are removed some years before puberty then

sexual desire is usually very slight indeed in adult life, but if they are removed after puberty then the sexual act can be accomplished, but without, of course, the danger of fertilization of the female. So well is this fact known in Eastern countries that the eunuchs not only have the testes removed but the penis is also amputated. They frequently still have sexual desire, but it cannot be accomplished in fact. Normally sexual desire and its accomplishment is under various nervous and chemical controls. Firstly it is normally under control of the cerebral cortex. The animal instinct layer is known as the infra granular layer of cortical cells and this layer in the civilized community is largely controlled by the intellectual layer or layer of the supragranular nerve cells. It has been thought in the past that sexual psycho-pathology was largely a question of failure of the supra-granular layer to inhibit the sexual urge of the infra-granular layer of cells. It is true that if the spinal cord is completely severed no voluntary sexual act can occur because the nerve messages from the cerebral cortex can no longer pass by way of nerve fibres to the sex organs. Nevertheless unconscious (involuntary) erection of the penis and emission of semen can occur as a result of local nervous spinal reflex action, just as involuntary evacuation of the urinary bladder can occur after transection of the spinal cord in man. Thus the sexual act in a normal intact person is largely controlled by the nervous system, but all this nervous control comes to naught if the pituitary gland is destroyed. All sexual desire then disappears and the sexual act is completely in abeyance. The pituitary gland is the master of the situation. It might be asked: does excessive secretion of the gonadotropic hormones of the pituitary gland cause excessive sexual activity? The answer is almost certainly Yes. Again, have these hormones a direct effect upon the sexual organs or an eroticizing effect on the nervous system? Probably, chiefly, the latter because as has been explained the removal of the sex organs can still leave the psychic stimulus effective in causing the sexual act. The pituitary gland eroticizes the nervous system

which is incapable of sending effective stimuli to the sex organs in the absence of the gonadotropic hormones of the pituitary gland. In man the sexual act is dependent upon the harmonious working of the pituitary gland and other endocrine glands in co-operation with the nervous system. It seems then that sexual control is not only a function of the nervous system, but is profoundly influenced by the pituitary gland, the thyroid gland and the suprarenal gland. In fact, the nervous factor may be completely inhibited by diminished pituitary or thyroid secretion or may be excessively stimulated by the hormones of the suprarenal cortex. There is no doubt that the ductless glands have a most important medico-legal bearing whenever sexual offences have to be considered. Excessive neuronic sexual stimuli may be due actually to uncontrollable pathological excess of hormones from the ductless glands.

It is of some interest at this stage to consider briefly the influence of the ductless glands in determining the personality of some well-known figures in history.

There seems little doubt that in early life Henry VIII had a very actively functioning pituitary gland, particularly the anterior lobe, for he grew to be very tall—6 feet 4 inches in height—and furthermore he showed undue sexual activity, no doubt due to excessive secretion of the gonad stimulating hormones from his pituitary. In later life he became very obese. This may have been the result of several causes. In the first place he was an enormous eater. Again it is thought that he suffered from syphilis, and this disease involving the base of the brain close to the pituitary, may have caused partial failure of function of this gland with subsequent development of adiposity. Furthermore, in portraits painted during the closing years of his life, he showed evidence of thyroid deficiency. The quiet phase of his life when married to Katharine Parr seems to have been associated with diminished activity of his endocrine system, particularly the thyroid, pituitary, and sex organs.

Turning next to his daughter, Elizabeth, we find a woman who exhibited many masculine traits in her character. It

has been emphasized in the preceding observations that every human being is fundamentally bisexual. In the normal female the male sex hormones, though present, are in practically complete abeyance, and in the normal male the female sex hormones, although also present, are of minor importance compared with the male hormones. However, in the world there are to be found many women who have male characteristics strongly in evidence, whilst many men are such as to be described as effeminate. The former have the male factor in their bisexual nature more than usually emphasized, and the latter (effeminate men) have the female element more than usually developed. Elizabeth had many masculine characteristics, no doubt due to excess of male hormones in her bio-chemical constitution.

A very long list of persons of great historical interest and having evidence of endocrine disorders could be reviewed, but it will suffice to mention only one more—Napoleon Bonaparte. In early life he apparently possessed a normal endocrine equipment. In later life there is abundant evidence that his pituitary gland failed. He became obese with the distribution of fat characteristic of pituitary failure; his sexual glands atrophied and he became impotent. With these physical changes there developed *pari passu* a failure in his extraordinary brilliance in intellect. Despite the fact that he died of cancer of the stomach he retained to the end an extraordinary degree of hypopituitary adiposity.

Finally we may conclude that human conduct may be remarkably modified by the influence of the endocrine glands. Great varieties of mental states may be induced by their diminished or excessive function. Mental states that vary from that of complete idiocy through every grade of mental dullness to the extreme alertness associated with hyperthyroidism. Furthermore, sexual activities may range, in disorder of these glands, from that of complete suppression to one of uncontrollable activity.

DISCUSSION

Mr. John Bloomfield said that he was impressed by the speaker's observations, and he was startled to learn of the remarkable effects which the ductless glands exercised upon our personalities. The dividing line between sanity and insanity seemed to depend upon a very small quantity of iodine. He was impressed by the thought that the regulation of personality and the correction of defects such as aberrant sexual impulses and forms of delinquency might ultimately be achieved by improvement in the technique of the endocrinologist.

Dr. J. Williams pointed out that the subject upon which Dr. Maxwell had addressed members raised the interesting questions, How far are we the slaves of our endocrine make-up? Are we controlled by environment or by our glands? We still control the conditions of upset. There can be no doubt that glandular disurbances sometimes produce homosexuality. The connection between the ductless glands and human conduct is of great importance.

Mr. Barry said there were a number of psychologists present, and as a lawyer who had to bear with judges who got little assistance from the psychiatrists when called by counsel, he hoped to hear the claims of the students of the mind vindicated against the challenge by the students of the glands. Lawyers were very fond of mechanical and demonstrable explanations, and he saw great hopes for the endocrinologists as witnesses. Counsel could call an endocrinologist to say that the prisoner's pituitary gland was responsible for the crime with much more confidence than he could call a psychiatrist to tell about the workings of the mind. Most judges were expert psychologists, or thought they were, and resented being told in technical language what they considered they already knew. With an endocrinologist, however, counsel would be back on safe ground, for most judges claimed little knowledge of endocrinology.

Professor Gunn (Psychology) said he considered that the study of glands should be pursued with the utmost diligence, and that psychology should be taught in connection with physiology. We are really tremendously ignorant about the inter-relations of body and mind. The address had raised the perplexing problem, Is there a mind which can have actual influence on one's body, or are we dependent entirely upon our physiological processes?

Professor Paton (Law) said that our present knowledge justified the employment of means other than those tradi-

tionally judicially used, and it was to be hoped that the Society would enable that very important question to be discussed at some future meeting. With a revision of the traditional judicial means would come the revision of many theories thought to be fundamental in our legal system.

Mr. Justice Lowe proposed, and Dr. Adey seconded, a vote of thanks to the speaker. The vote was carried by acclamation.