THE CADUCEUS

JOURNAL OF THE HONGKONG UNIVERSITY MEDICAL SOCIETY.

Vol. 15 August, 1936. No. 3

All medical papers and other scientific contributions intended for the Journal, and all books for review and magazines in excahnge, should be addressed to the Editor, "*Caduceus*," Hong Kong University, Hong Kong.

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ON THE SEDIMENTATION OF RED BLOOD CELLS.

by

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During the investigation of physiological blood standards among Hong Kong Chinese, sedimentation rates of blood samples were recorded using Wintrobe's tubes. The full detail of the technique used will be given together with the results in a later article; here it suffices to say that the method was a photographic one, the tubes being placed in a rack and illuminated from behind and photographs taken every six minutes of the blood column by means of a Leica camera, a device being used whereby the upper level of the corpuscles was constantly kept in the optical axis of the camera. Each sample of blood was under photographic examination for two hours. The films were developed and the height of the corpuscle meniscus read off from the negatives by means of a dissecting microscope and the height of the corpuscle column plotted against the time. A glance at Figure I shows a typical graph obtained, an S-shaped curve.

Fahraeus (1929) states that "the sedimentation velocity is now obtained by measuring the distance passed by the uppermost layer of the red corpuscles from the upper meniscus of the fluid column in a given time." The given time generally used in clinical work is one hour and this can be readily read off from a graph such as that shown in Figure I. But when we come to examine large numbers of blood samples we repeatedly come across examples with similar sedimentation rates as thus measured, and yet one look at the graphs obtained shows that the stabilities of the corpuscle suspensions are grossly different. In Figure II, two extreme cases of actual examples are depicted; at only one instant in the two hours are the corpuscles in these two samples of blood in similar relations to the plasma, i.e., at the end of one hour, and one thing above all others is certain and that is that the

My thanks are due to Drs. K. D. Ling, E. Q. Lim and C. K. Quek for their help in the experiments on which this article is based and to Dr. Ling for help in preparing the figures.

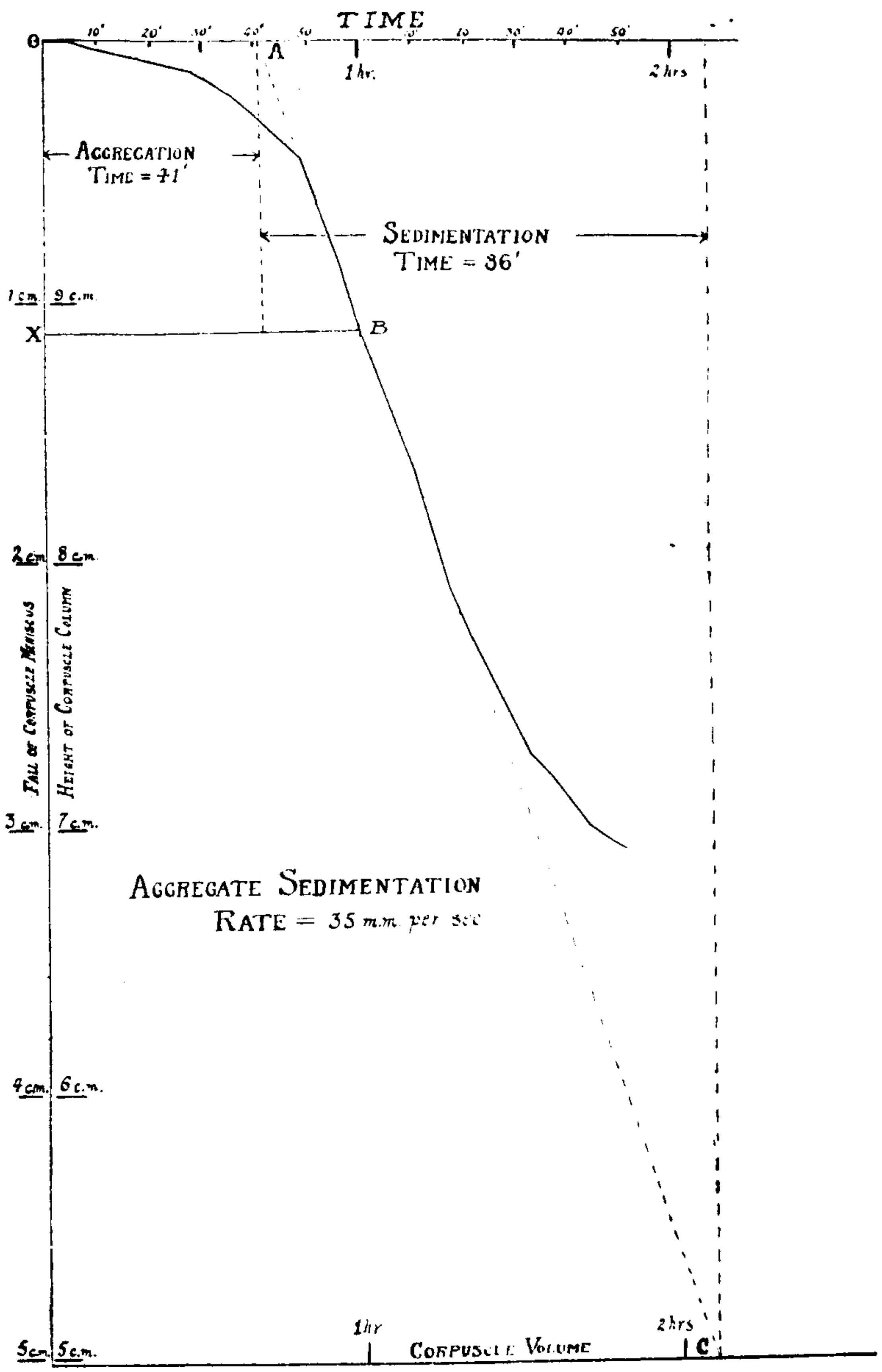


Figure I. A graph showing the rate of fall of the corpuscle meniscus of a column of blood. For detailed description see text.

corpuscles in these two blood samples do not sediment at the same rate. Surely therefore there is something amiss in the procedure whereby we arrive at the conclusion that these two bloods have identical sedimentation rates!

The fallacy becomes apparent when we examine each curve separately, and visualise what is happening in the blood during this two hour period. As stated above, each sedimentation curve is S-shaped and may be divided into three portions; starting from the uppermost part of the curve there is an initial phase where the graph swings away from the horizontal axis and becomes more or less vertical; this is followed by a central straight portion; and the third portion shows the graph flattening out again and gradually becoming more horizontal in direction.

The explanation of this shape is important and has been known for a long time, as reference to the literature will show. When blood cells sediment they do not do so singly but in aggregates, and the larger the aggregates the quicker will the corpuscle meniscus fall. At the beginning of the observation the corpuscles are in a state of minimum aggregation and hence the speed of sedimentation is a minimum and the curve almost horizontal; but as the corpuscles coalesce and the aggregates increase in size and density, the meniscus falls more rapidly. The aggregation of corpuscles proceeds until the clusters are of a maximum size which varies in each blood sample. When this size of the various aggregates is established we get a constant sedimentation rate and hence the corpuscle meniscus falls at an even speed; in other words, the graph becomes a straight line which represents the true rate of sedimentation of the blood sample which rate is numerically equivalent to the tangent of the angle this part of the curve makes with the horizontal axis, angle ABX in Figure I.

The first part of the graph thus represents the accelerating fall of the meniscus during the time that the aggregation maximum is being attained, the second part the fall at the constant rate after aggregation has been completed. The distance the meniscus falls in one hour therefore depends on two things, first the time taken for aggregation to become complete and second the true rate of sedimentation after aggregation is complete. It is thus a composite attribute bearing a complex relation to the true rate of sedimentation of both the corpuscles and the corpuscle aggregates.

The flattening as depicted by the third part of the curve is due to the fact that the tube is of finite dimensions and sooner or later the lower corpuscles begin to pile up on the bottom of the tube and thus, supporting the upper layers, interfere with the free descent of these upper layers through the plasma. This part of the graph nearly always occurs after the one hour period has elapsed and hence does not enter into the determination of the sedimentation rate at all.

It is the thesis of this article that the relatively small use of the sedimentation reaction in clinical medicine at present may be due to the fact established above that the sedimentation rate is in reality a composite attribute, and we should therefore try and analyse it into its simpler components and see whether any or all of these may be of more practical value. The suggested simpler components are the *aggregation time, sedimentation time,* and the *aggregate sedimentation rate,* which terms we shall now proceed to explain.

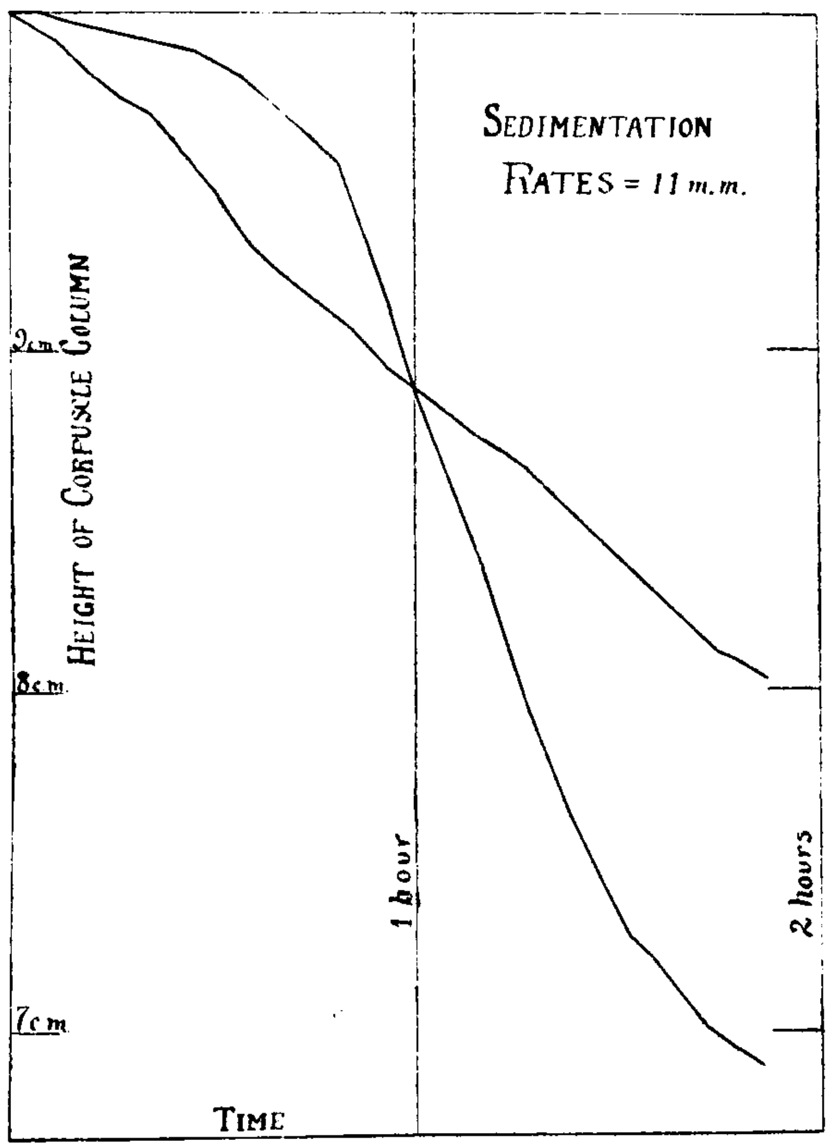


Figure II. Sedimentation graphs of two samples of blood, the menisci each falling similar distances in one hour, yet sedimenting at totally different rates.

If one could so arrange the sedimentation reaction that it took place in dissociated and consecutive stages, the phenomenon of aggregation proceeding to completion first, followed then by the sedimentation of the corpuscle aggregates, the first and second parts of our graph would become converted into two straight lines, OA and AB of Figure I, the former being parallel to the time axis and the latter continuous with the straight part of the original graph. The length of OA would represent the time taken for that particular sample of blood to form its corpuscle aggregates under the conditions of the experiment. This time we call the *aggregation time* and since the line AB in this hypothetical experiment is continuous with the straight part of the graph obtained in the actual sedimentation reaction, the point A can readily be ascertained by producing the straight part of the graph back to meet the horizontal time axis.

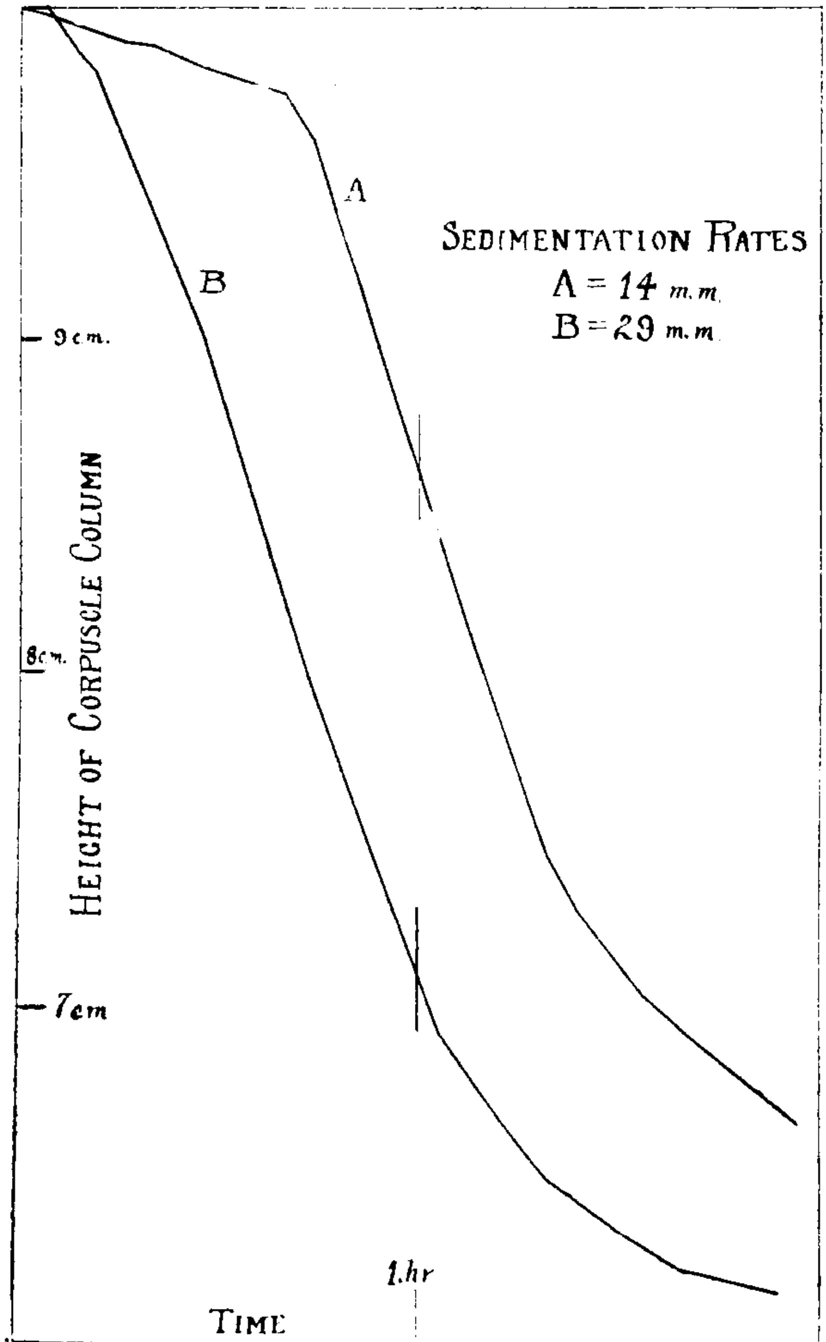


Figure III. Sedimentation graphs of two samples of blood, the menisci falling different distances in one hour, yet at similar rates.

From the angle of the line AB we can estimate the true rate at which the corpuscle aggregates sink. This we call the *aggregate* than that. If after the experiment is completed the tube be centrifuged until there is no further sinking of the meniscus, we obtain a reading which indicates the level to which the meniscus would ultimately fall *sedimentation rate*. But the curve supplies us with more information when the sinking of the corpuscles with its consequent upward plasma displacement has been completed. If we now draw the horizontal axis corresponding to this reading and produce the straight line AB to cut it at a point C (Figure I), then the time elapsing between A and C would represent the time elapsing between the completion of the aggregation and the completion of sedimentation (assuming aggregation to occur first and independently, and assuming the upper corpuscle aggregates could sink independently of those underneath). This we call the *sedimentation time*, which obviously can also be calculated from the corpuscle volume and the aggregate sedimentation rate.

The graphical method of observing the sedimentation of red blood cells thus enables us to measure three new blood characters (*a*) the aggregation time (*b*) the sedimentation time and (*c*) the aggregate sedimentation rate. We have already seen that the sedimentation rate as now measured clinically is not necessarily an index of rate of sedimentation and Figure II gives us an example of two samples of blood, each with very widely different true rates of sedimentation, yet both are classed by the prevailing procedure as having the same sedimentation rate. Figure III shows two further actual examples from our series. The upper levels of the two samples of blood fall very different distances in one hour, yet one look at the curves shows that the rates at which the corpuscle aggregates sediment are exactly the same; the straight parts of the curve are parallel. The real difference between them lies in the aggregation time. One sample takes 45 minutes to form its aggregates whereas the other accomplishes it in 10 minutes.

Conclusion.

It would seem reasonable to suggest therefore that the old method of measuring the sedimentation rate should be superseded by the graphical method from which can be estimated three simpler constants, the aggregation time, the sedimentation time, and the aggregate sedimentation rate. It is hoped to publish in the near future data showing the averages found for these characters amongst Hong Kong Chinese together with their variations under certain physiological conditions.

Reference.

Fahraeus, Robin., 1929, Physiol., Reviews. IX, 241.

SOME CLINICAL ASPECTS OF THE FEMALE SEX HORMONES.

by

Raymond H. S. Lee.

The study of endocrinology can be said to have been initiated by Claude Bernard's discovery in 1848 of the glycogenic function of the liver. But it is only during the last twenty years or so that the greater part of the present enormous literature has accumulated. Hardly a day passes now without some addition to our knowledge; and it is not surprising to say that we are at present living in the age of endocrinology. Yet by far the greatest stride has taken place in the field of sex hormones. In view of this fact, therefore, this paper makes no pretence to be exhaustive, rather merely touches on some salient aspects of clinical importance.

Ovulation.

The ovaries originate, in the five months foetus, as a thickening of the coelomic epithelium from the inner surface of the Wolffian body. It was formerly held that the ova in the ovary are already formed before birth and remained quiescent until maturity when they ripened at definite intervals; but the research of Evans and Swezy (1931) has shown that at and before puberty the ova arise by proliferation from the germinal epithelium in the form of evagination or downgrowths forming the egg tubes of *Pflüger* which are cut off from the surface and undergo further development to form the Graafian Follicle. (Figure 1). One of the cells enlarges and eventually becomes the ovum; the others arrange themselves around it as the membrana granulosa. (Figure 2). Fluid begins to appear in the cells, first as droplets, which rapidly coalesce to form a cavity containing the liquor folliculi, which separates the layers of the granulosa. Rupture of the follicle ensues; and ovulation takes place. In the human female the time at which this occurs varies from twelve to seventeen days after the onset of the preceding menstrual flow. A large quantity of follicular fluid containing a hormone, oestrin, is liberated. It is absorbed by the lymphatics of the peritoneum and is thus carried to the blood stream and to the uterus where its utilisation promotes uterine growth and vascularity. The ovum finds its way into one of the fallopian tubes where, undisturbed, it awaits fertilization. Proliferation and differentiation of the granulosa cells and the ingrowth of the theca lutein cells jointly begin the formation of the corpus luteum, which not only secrets oestrin but also secretes its own specific hormone, progestin. The corpus luteum normally reaches full development on about the nineteenth day of the menstrual cycle, and from then onwards gradually regresses until it finally ceases to function on the twenty-fifth day of the cycle or the first of the next period in the absence of fertilization.

The Uterine Changes.

The uterus reflects the activity of the ovary. The changes observed in the uterine endometrium can be divided into two phases: (1) a *proliferative or oestrin phase* from the day of menstruation to evulation (from about the fifth to the twelfth day), (2) *a progestational or lutein phase* from ovulation to about twenty-four hours before the onset of menstruation.

During the time before ovulation when only oestrin is being secreted by the ovary the uterine endometrium is in *the proliferative phase.* Its glands are long and tubular, and the secretion is almost absent. Its stroma consists of undifferentiated fibrous connective tissue. With the appearance of the corpus luteum and the secretion of progestin after ovulation the character of the endometrium alters. The glands become spirally twisted and produce a fair amount of mucous secretion. The stroma is converted into decidua, which is the characteristic feature of this stage of the menstrual cycle and of early pregnancy. This second half of the menstrual cycle is known as *the progestational phase.* It is dependent for its appearance on the secretion of progestin by the corpus luteum. (Figure 3).

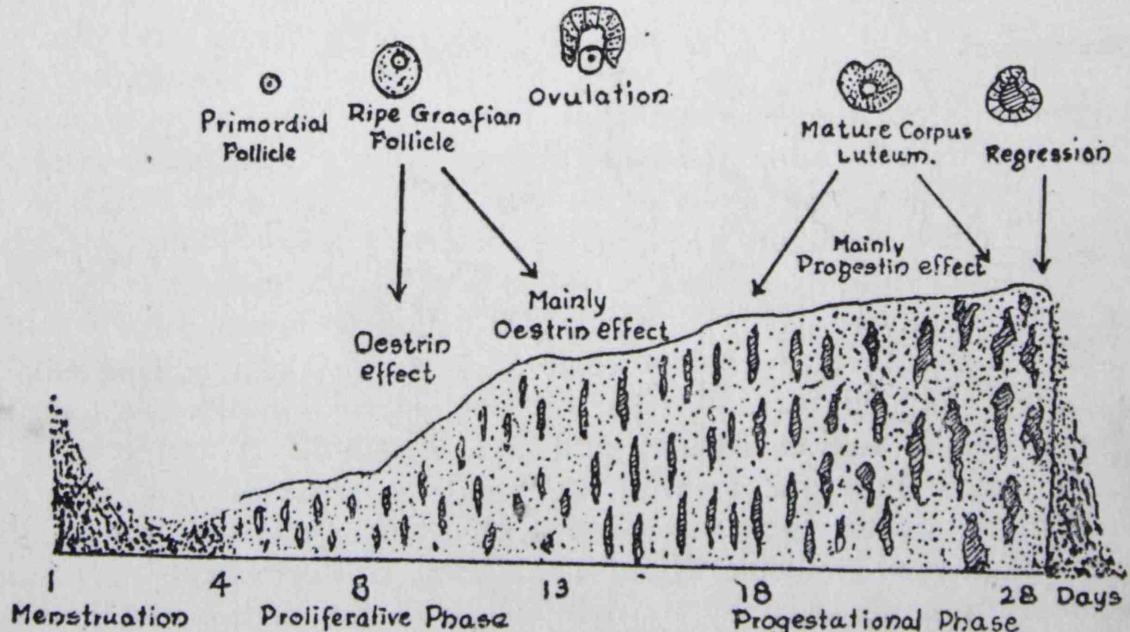
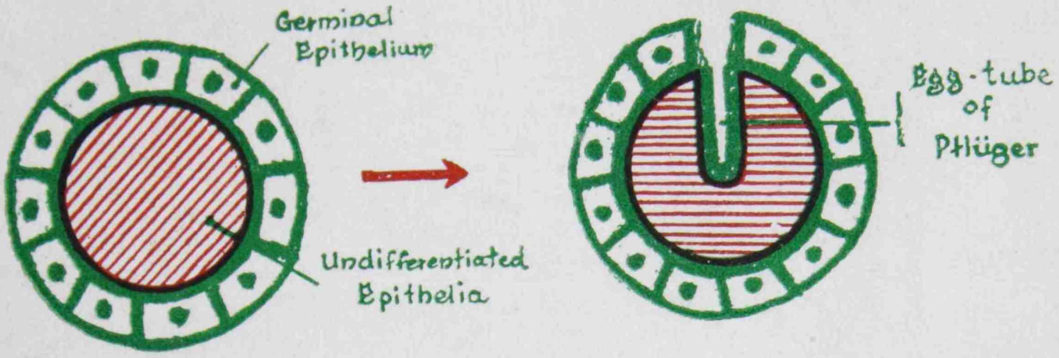
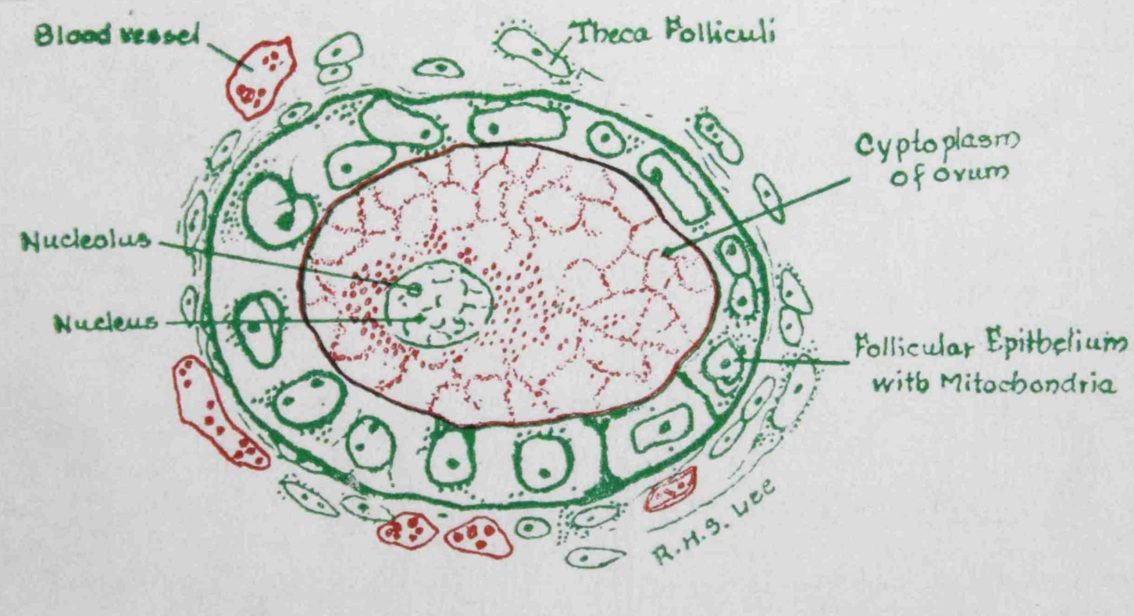


Figure 3. The menstrual cycle.

The ovary is also responsible for the changes which occur in the uterine muscle. The growth and development of the uterus to adult proportions are dependent on the adequate secretion of oestrin by the ovary. The uterine muscle is inherently contractile, and responds to small doses of the oxytocic factor of the pars intermedia of the hypophysis (posterior lobe serves only as a reservoir). (Figure 5). The represents the condition of the muscle during the first half of the menstrual cycle, but with the appearance of progestin the muscle loses its excitability, and much larger doses of oxytocin are required to effect





Figure, 1, (above). Sagittal section of foetal ovary.

Figure 2, (below). Transverse section of Pflüger's egg-tube.

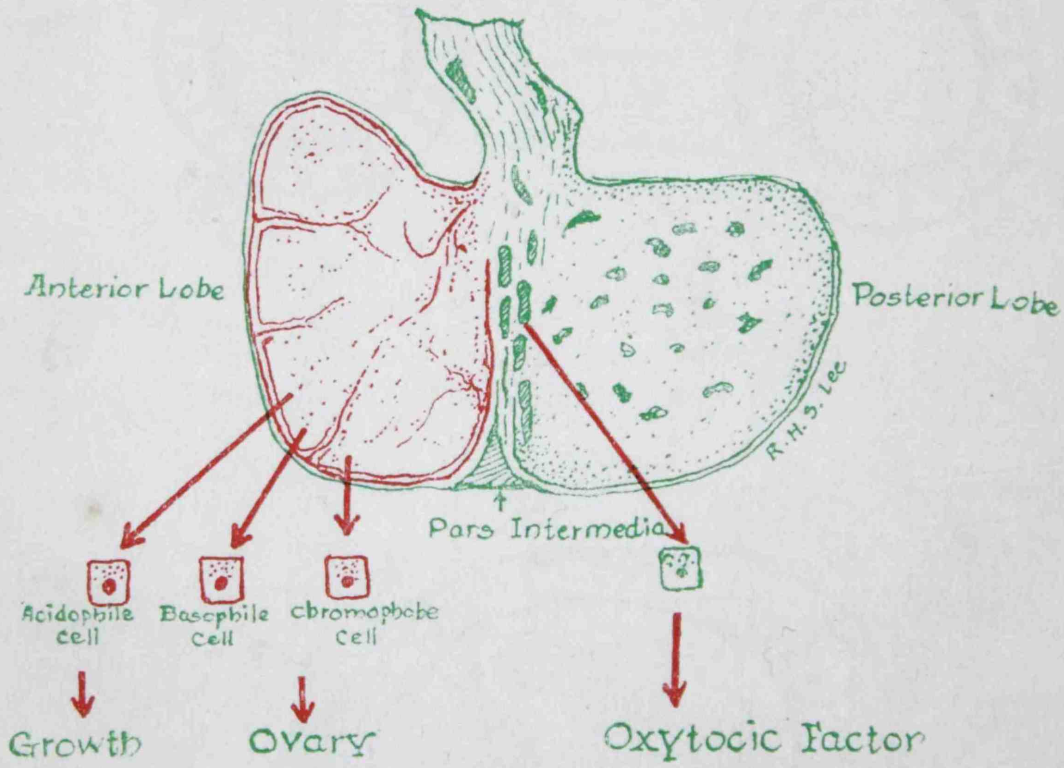


Figure 5. The pituitary gland and its functions.

a response. In other words, progestin inhibits the spontaneous activity and responsiveness of the uterine muscle to oxytocin.

The combination of a progestational type of endometrium and a quiescent uterine muscle is an ideal state for the nidation of the fertilised ovum in the uterine cavity. Once the placenta is fully developed at the end of the third month of pregnancy, the foetus is comfortably established in the uterus and the influence of the corpus luteum is no longer necessary. It consequently atrophies and disappears at the end of the first half of pregnancy. (Figure 4).

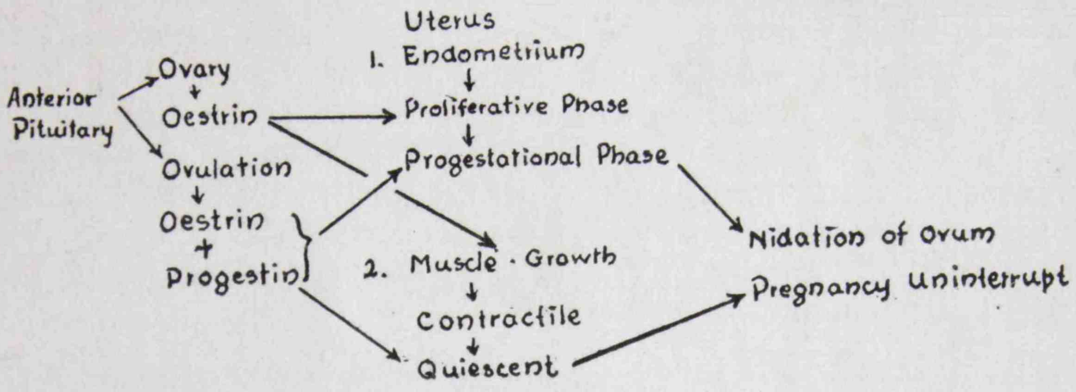


Fig. 4 (From Bishop)

The Gonadotrophic Hormones.

The liberation of these ovarian hormones is regulated by endocrine factors, elaborated by the basophilic and the chromophobic cells of the anterior pituitary gland. (Figure 5). The nature of these factors we, as yet, do not know for certain. Zondek called them Prolan A and Prolan B; but some authorities think that this distinction is ill-founded; and that in reality there is only one prolan. They have no specific influence on both vagina and uterus. (Figure 6). When the breast has been prepared by oestrin they can influence the secretion of milk.

Menstrual Periodicity.

The rhythmic periodicity of the menstrual cycle is an instance of Nature's wonderful contrivances. It can be compared to the working of an automatic valve in that the gonadotropic function of the pituitary is inhibited when the limit of physiologic saturation of oestrin in the circulation is reached; and resumes its activity when the oestrin level falls. Menstruation occurs as the result of corpus luteum disintegration following the cessation of pituitary stimulation. Oestrin is eliminated either by the bowels or through the kidneys. It has been found by Dohrn and Faure that as much as 30,000 M. U. of the hormone have been extracted from one kilogram of faeces of pregnant women. Frank has demonstrated that a regularly menstruating women's daily output of urine yields 4-10 M. U. of oestrin.

The Oestrin Test.

The amount of oestrin in the blood can be measured by means of the Frank and Goldberger Test, which consists of taking 40 c.c. of blood from the patient, dehydrated by anhydrous sodium sulphate, extracted by ether, and emulsified in water. The resultant fluid is injected into a test mouse. Vaginal scrappings are obtained and examined daily. A greater number of non-nucleated epithelial cells denotes a higher positive reading, whilst nucleated epithelial cells declare a negative result.

It has been observed that the concentration of oestrin in the circulating blood varies with the different stages of the menstrual cycle. From sixty-eight blood tests on normal fertile women taken during the last week of their menstrual cycles, Mazer and Goldstein have found that fifty-eight showed reaction; six a threshold quantity; and four negative reaction. The blood oestrin level increases steadily from the first month of pregnancy and reaches its highest at term. After partuition it falls rapidly so that it is no longer demonstrable a week or two later. (Figure 7).

The oestrin test is found of value in the diagnosis of functional sterility in regularly menstruating women, and of ovarian hypo-function whether primary or secondary to pituitary failure. (Figure 8).

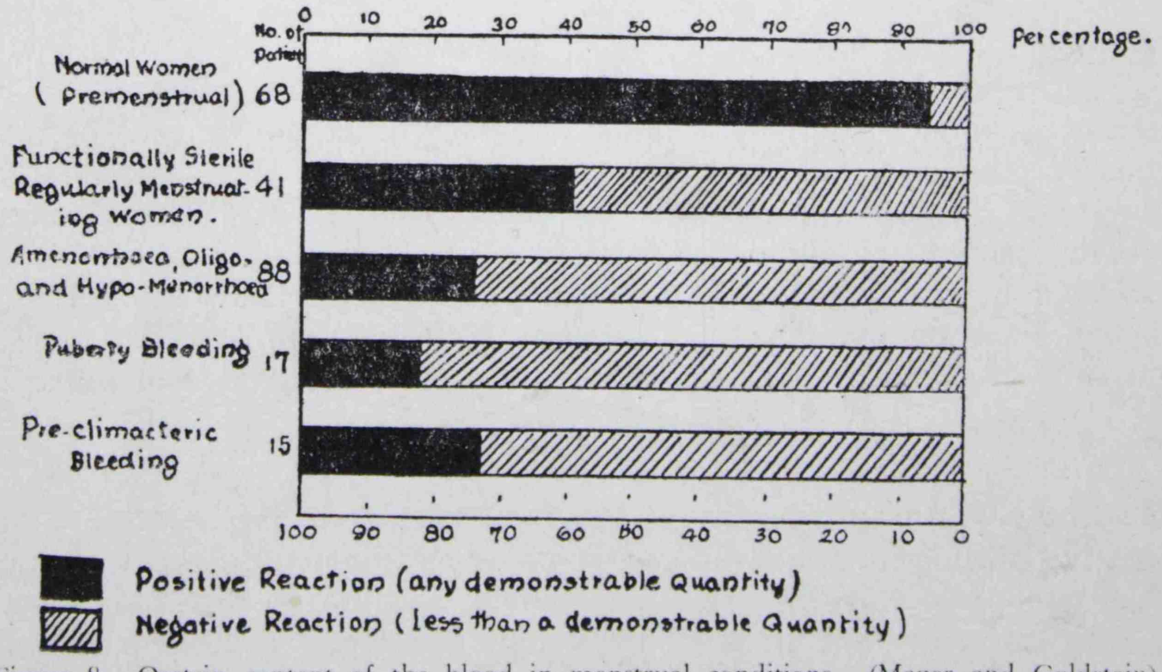


Figure 8. Oestrin content of the blood in menstrual conditions. (Mazer and Goldstein).

The Zondek-Aschheim Test.

Let us now consider briefly the principle of this test. It depends upon the fact that the urine of a pregnant woman contains an active principle, which, injected into a virgin mice, causes the ovary of the injected animal to develop corpora lutea as though pregnancy had occurred. It was formerly thought that the test is due to the presence of prolan in the urine of pregnant women. This theory is now

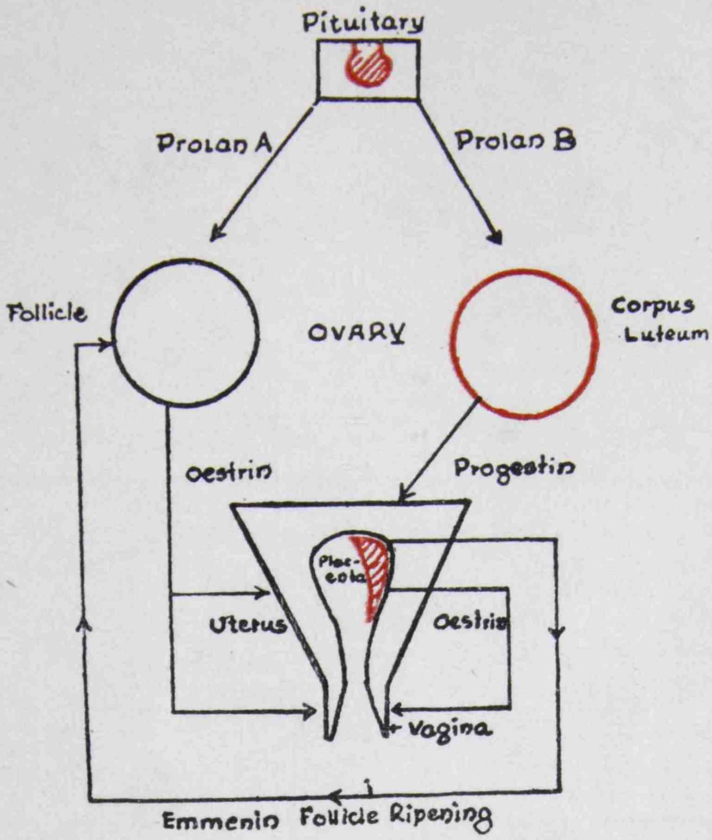


Figure 6. Diagram showing the interaction of the pituitary gland and ovarian hormones.

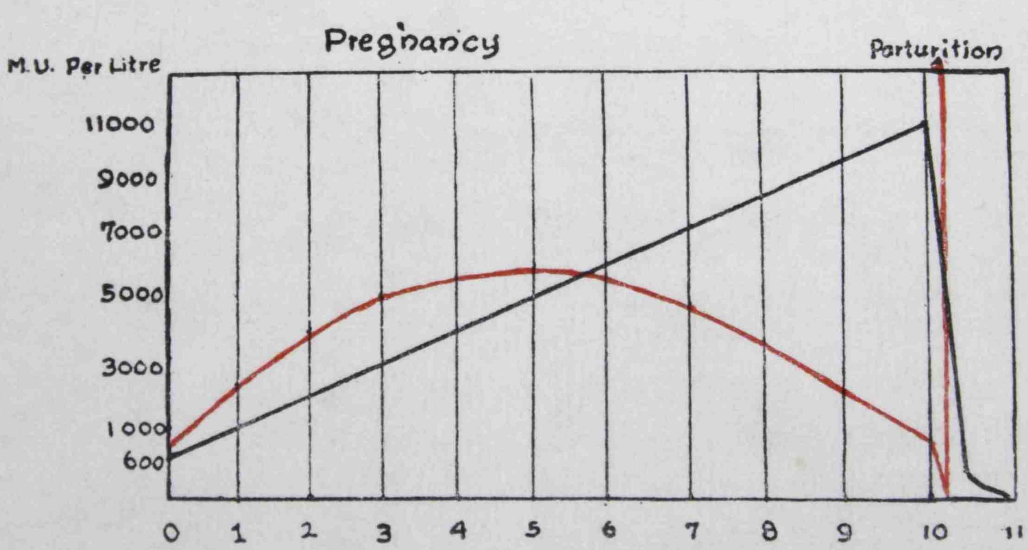


Figure 7. Excretion of sex hormones in the urine during pregnancy. (Modified from Mazer and Goldstein). Oestrin shown in black, and anterior-pituitary-like hormone in red.

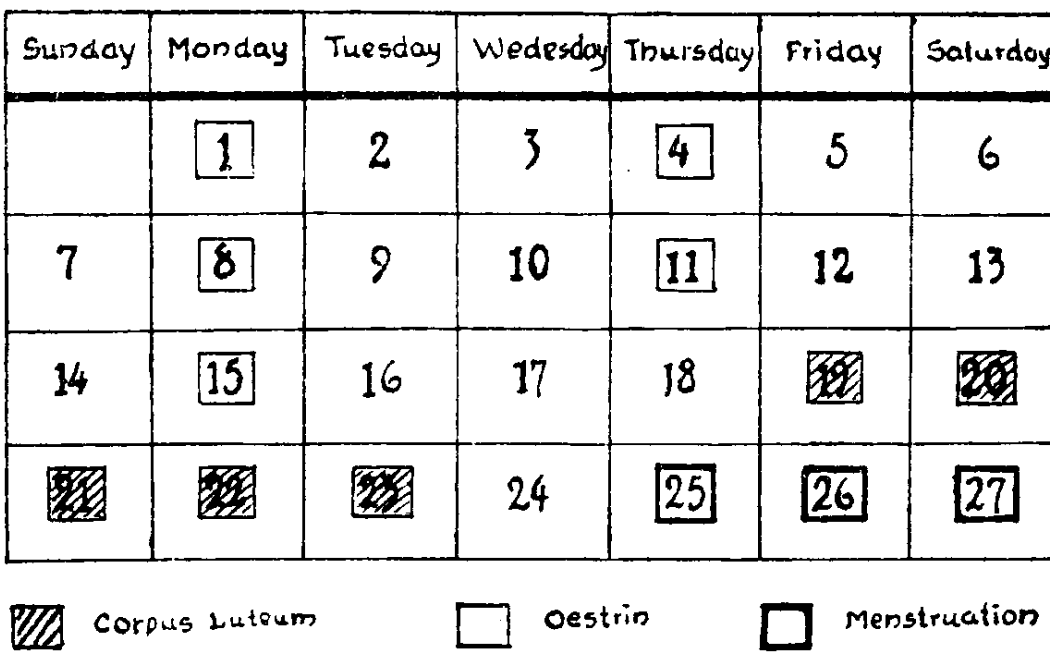


Figure 9. Chart illustrating Kaufmann's technique in treatment of secondary amenorrhoea.

discounted by the fact that there is no pituitary hormone in the urine, and that the effect is due to an anterior-pituitary-like substance produced by the chorionic epithelium of the placenta.* When pregnancy terminates and the uterus no longer contains placental tissue the Zondek-Aschheim test at once becomes negative. But if living chorionic tissue remains in the uterus (retained placenta), the test remains positive. It is markedly positive in cases of hydatidiform mole. When the mole is removed the test becomes negative. If it remains positive, it indicates the development of a chorionepithelioma. It is positive in cases of tubal pregnancy and retained placenta; and the test may be of considerable value in these conditions.

Clinical Applications of Sex Hormones.

The pure clinician may inquire what is the practical outcome of all this work. We may start first with *amenorrhoea.* It can be divided into two types: *primary and secondary amenorrhoea.* When the menstrual flow has not become established it is usual to speak of primary amenorrhoea, whilst premature cessation of the flow after it has once been regularly established is known as secondary amenorrhoea. There are a host of other conditions to account for the amenorrhoea besides ovarian causes. In order to exclude hormonal deficiency as the cause, a blood oestrin test and an endometrial curettage must be performed to determine the oestrin level and the absence of the progestational stage in a microscopic examination of the endometrium respectively.

Primary Amenorrhoea.

Primary amenorrhoea with associated hypoplasia of the genitalia is due to a deficiency of oestrin. As demonstrated by Kaufmann in his classic work on oestrin therapy, small doses of this principle fail absolutely; and he advocates the injection of 500,000 international units of oestrin weekly over a period of months. In one patient he gave as much as 8,750,000 units before menstruation took place; and in another, 15,000,000 units but this case without result.

Secondary Amenorrhoea.

This condition is due to a deficiency of both oestrin and progestin. Before initiating treatment it is best to measure the length of the uterus first so as to guide the result of your treatment, if any. 250,000 international units of oestrin are given on the 1st, the 4th, the 8th, the

* According to Collip, the placenta elaborates three hormones: Oestrin, Anterior-pituitary-like hormone and Emmenin. The action of each is characteristic. Oestrin can produce oestrus when injected into an adult castrated animal; but has no action on an immature one. The A-P-L principle, on the other hand, produces oestrus in an immature animal; but not if the pituitary gland has first been excised. It evidently acts through the pituitary. It produces marked enlargement of the seminal vesicles and prostate in the male. Emmenin differs from the other two in that oral administration will bring on oestrus in the immature animal; and produces no effect on the adult castrate. (Vide figure 6).

11th, and the 15th day of the course, totalling 2½ million units. On the 19th, 20th, 21st, 22nd, and 23rd day, one rabbit unit of progestin is administered. This course of treatment has been referred to as the Kaufmann's Technique. (Figure 9). Under this treatment normal menstruation begins any day up to ten days after the last injection of progestin.

Habitual and Threatened Abortion.

Progestin has been tried with great success in the treatment of habitual and threatened abortion. The former condition is due to premature withdrawal of progestin; and the latter to undue uterine motility. Recently Falls, Lackner, and Krohn have reported a series of cases under this treatment where they claim thirty-four successes out of forty cases. These workers recommend one rabbit unit twice weekly from the time of diagnosis of pregnancy until the thirty second week of pregnancy. They condemn the practice of administering morphia because from their experiments on human subjects they find that morphia, instead of diminishing the oxytocic effect, causes the uterine muscles to contract more.

Functional Menorrhagia.

This condition is due to failure of ovulation and absence of progestin. In treating this condition progestin should be given in combination with anterior pituitary extracts. The latter should be given continuously by injections of up to 500 rat units three times a week in a course of two months duration. In the premenstrual phase and during the actual time of bleeding the anterior pituitary extract should be administered daily, together with one rabbit unit of progestin.

Dysmenorrhoea.

This is due to premature withdrawal of progestin. Bishop and his co-workers recommend one rabbit unit daily, commencing as soon as the pain appears, or a day or two before, if possible and continuing until the period ceases.

The Rationale of Oestrin Therapy.

Oestrin should never be given in

(1) functional uterine bleeding due to antagonised and continued action of oestrin in the blood where progestin is indicated;

(2) amenorrhoea without uterine hypoplasia where you have a normal blood oestrin level. Anterior pituitrin is indicated.

In treating amenorrhoea, oligomenorrhoea and hypomenorrhoea with oestrin, the object is to combat the uterine hypoplasia. The hormone is not capable of stimulating the ovaries themselves, or the extra-genital glands concerned with the menstrual function.

The oral administraton of the hormone is clinically more effective because it can be administered at frequent intervals, and consequently a minimum of loss through rapid excretion. The ratio between hypodermic and oral dose is approximately 1 to 4. The size of the dose is directly proportional to the degree of uterine hypoplasia. Therefore, in all cases of oestrin therapy uterine sounding should be the rule in both preceding and accompanying treatment, as this is the only clinical gauge to adjust the correct dosage for each individual case.

REFERENCES.

Boyd, Wm., Textbook of Pathology, 2nd Ed.

Collip, J. B. & Campbell, A. D., British Med. Journal, Vol. II, 1930.

Falls, Lackner, & Krohn, Journal of American Medical Assoc., Jan. 1936.

Kaufmann, C., Therapeutics with Hormones of Ovary. Proc. Roy. Soc. Med. 27th May, 1934.

Mazier, C. & Goldstein, L. Clinical Endocrinology of the Female, 1932 Ed.

Robson, J. M., Recent Advances in Sex and Reproductive Physiology.

This paper was read before the Medical Society of the University of Hong Kong on 21st May, 1936.

PILLARS OF XIXth CENTURY MEDICINE.*

by

Raymond H. S. Lee.

It is a curious fact how little is known by the medical man in general of the distinguished pioneers of Medicine, who through their unselfish and courageous efforts have found measures whereby untold sufferings can be alleviated, and hitherto incurable diseases have lost their sting. Contrasted with the eruptive forces of the ubiquitous politicians who repeat the follies of the ages, and vaunt the splendour of their regime in the teeth of hellish continuance, we can conceive of no achievement more noble; no life more useful; and no legacy more universal. Think of the disappointments, the mortification which these great souls had undergone; think of the persistent opposition, the indomitable prejudice which they had to depose in the course of wrestling from relentless Nature the secret which enables the stricken one to live, the injured one to walk, and the erst blind one to see! How many had laid down their lives—unhonoured and unsung—in the wake of their discovery so that we may live! The toll is appalling. Yet, they strive not for gain. Were it otherwise, we would remain their debtors to this day. And what price, pray, would deem sufficient for Sir William Jenner's fee? A rich man in this world, I dare say, would appear before him an insignificant creature indeed. But these noble beings sought not the immediate remuneration of man's gratitude; nor solicited the unctuous recognition of the great. Their dearest aspiration was to live in the bosoms of all generations as an honoured member of that galaxy with Hippocrates as father. Are we then not ashamed to acknowledge our errant ingratitude? To every monument that has been erected to the memory of a destroyer of nations, to every volume that has been written about a ravisher of population, there is comparatively not a pebble raised, not a line inscribed to recall the deeds of these men. Holy of unholy! what does it profit mankind to perpetuate the memory of a Napoleon or a Julius Caesar but to inspire another such egoistical homicide. Who was he but not that Physician-Author, Sir Thomas Browne, who wrote:

> "But the iniquity of oblivion scattereth her poppy and deals with the memory of men without distinction to merit of perpetuity. Who can but pity the founder of the pyramids? Herostratus lives that burned the temple of Diana, he is almost lost that built it. Time hath spared the epitaph of Adrian's horse, confounded that of himself."

Such is the inscrutable nature of man: he hallows his destroyer, and forgets his creator.

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* This is the first of a series of articles we hope to publish from the pen of this writer on Medical Biography.—Ed.

No branch of study is more neglected than medical biography. To this charge the whole of the medical profession is subjected more or less. True, we have representative stylists, and even poets in English literature; Smollett, Browne, Keats, Beddoes, Bridges are eminent examples; but these writers took Medicine only as a staff, and their souls were enmeshed in *Letters*. The reply most often given is that we are warriors against diseases, angels who prefer to practice the art of healing silently, and not garrulous minstrels who chant the deeds of their brethren; that we have enough to do as we are, and if we can command the knowledge at our disposal to make ourselves good doctors without the added task of a scribbler, we have done our duty to the world. The argument is irrefutable but the charm which might adorn the profession is non-existing. Besides, there is the great danger of degenerating into mere professionalism, which is contrary to the high calling of past physicians who were withal accomplished scholars and distinguished scientists. And we must not lose sight of the part which culture and aestheticism play in the make-up of a great intellect. Alas! in our eager rush for more scientific knowledge these admittedly difficult but most essential factors have been lamentably neglected by our educationists. Life has many streams: in overflowing some at the expense of training others inundation overcomes the land. Anarchy and revolution prevail. Oppression becomes law, and there is no end to unhappiness. All resources, instead of pooling them together for the common benefit of scientific advancement and the betterment of the people, are consecrated to the god of war: as a result, world-wide conflagration is imminent. In taking a survey of history, how surprising it is to note that our mentality is not much superior to that of the Greeks in spite of the fact that we had nearly three thousand more years to improve it; yet it is the same question: how we can take advantage of our neighbours. The more we know man, the less we think of his ability to rule. If we think less of our material progress, and pay more to the improvement of our mind, there is the highest hope of making this world a better place to live in.

How often we regret that we don't possess a Boswell in Medicine. How much we would rejoice in treading the footsteps of (should we say?) a John Hunter or a Sir James Paget. How much we should be captivated by a refreshing dictum flashed unexpectedly in the course of a clinical round, or expressed unconsciously over a glass of wine. To be sure, some of the world's greatest gems were captured in this fashion. What would we not pay to gain an insight into the working mind of a great investigator prior to his discovery of an important finding. The value of this sort of information to the profession is immeasurable.

At present, there are bigots in this world who hold that Medicine and literature, like water and oil, never mix; and consequently, they disparage those who have the ability to gain distinction in either.

I was once informed by an acting professor that there were certain pseudo-scientists (for it would be an insult to call them scientists) in England who entertained no opinion of Julian Huxley's scientific work because he delved too much in literature! How preposterous! yet we need not go far to seek a complete refutation of this horrid whimsicality. It is to the glory of literature, nevertheless, that we possess the prose works of both Jeans and Bragg, and yet who questions them as scientists? *Origin of Species* is still readable because Charles Darwin really wrote most beautifully. Albeit their contributions to medical knowledge are important, both Osler and Bright are held in greater esteem because of their graphic and delectable style. Therefore, it is urged that more medical participators in literature should take the field. Lest we forget, prosperity is the best judge of man's true greatness. Contemporary opinions tend always to be partial, either through personal animosity or from excessive zeal: It is true that great reputations sometimes suffer from a temporary eclipse; but the scale of proper value returns to normality after a process of time however wide it may at times deviate from its true course. Even England's greatest poet, Shakespeare, was not recognised as such by his contemporaries; and would have been forgotten for a longer period but for the timely appreciation of his true greatness which hailed from Germany. Now

* "Others abide our question. Thou art free.
We ask and ask: Thou smilest and art still,
Out-topping knowledge. For the loftiest hill
That to the stars uncrowns his majesty,
Planting his steadfast footsteps in the sea,
Making the heaven of heavens his dwelling-place,
Spares but the cloudy border of his base
To the foiled searching of mortality;
And thou, who didst the stars and sunbeams know,
Self-schooled, self-scanned, self-honoured, self-secure,
Didst walk on earth unguessed at."

When Raleigh wrote his apostrophe to Death he was not far in sentiment from my present thought:

"O eloquent, just, and mighty Death! whom none could advise, thou hast persuaded; what none hath dared thou hast done; and whom all the world hath flattered, thou only hast cast out of the world and despised; thou hast drawn together all the far-stretched greatness, all the pride, cruelty, and ambition of man, and covered it all over with these narrow words, *Hic jacet.*"

* Matthew Arnold.

EPIDERMAL PATTERNS IN MAN.

1. HAIR PATTERNS OVER THE OCCIPUT.

by

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In the following paper it is intended to record the results of the author's investigations on the hair tracts over the human occiput. The observations were made, some on two expeditions in British North Borneo, others in British Columbia, and the remainder in Hong Kong and on the adjacent mainland and neighbouring islands. The North Borneo data were collected in 1931 and 1932 and consisted merely of frequencies of occurrence of the different types of whorls and their positions on the head and described according as to whether they were to the left of, to the right of, or in, the mid-line.

Some of the North Borneo results have already been published (Ride 1932), but the remainder—those obtained in 1932—are now given for the first time. The data concerning the North American Indians of British Columbia were collected in 1933 and together with blood groups, palm prints and ear pits have been described in detail elsewhere (Ride 1935). While working out the results in this latter paper an improved method of describing the whorl position was introduced, and the Hong Kong investigations were undertaken to test this new method. It is hoped that Tables VI, VII and VIII of this article and the discussion thereon will establish its value. All the author's data were taken with family histories and the next step in the investigation was to try and elucidate the method of inheritance of occipital hair whorls. From the section of this article dealing with these inheritance studies it will be seen that not only is it advisable to modify the method of describing the exact position of a whorl on the head, but it is also necessary to introduce further sub-types to describe the type of whorl more thoroughly. The final studies recorded here were undertaken in order to establish the frequencies of these types and sub-types so that they may be applied in all future family studies.

It is proposed in this article to deal with the subject as follows:—

(*a*) to describe the different types of hair patterns met with and to advance an hypothesis whereby these types may be classified, explained and understood, leading up to the author's method of describing and tabulating the whorls;

(*b*) to give the comparative racial data obtainable here;

(*c*) to discuss the modes of inheritance of the whorls as far as our present data will allow;

(*d*) to discuss the data from additional Hong Kong Chinese investigations carried out according to the new method made necessary by the genetical studies described in the last section.

(*a*) *HAIR PATTERNS AND METHODS OF CLASSIFICATION.*

The work of Schlaginhaufen (1905), Kidd (1903, 1920), Bolk (1924), Wood Jones (1929), and Gray (1935), has given us much accurate information concerning the direction of hair tracts in animals in general and in man in particular. Of all these tracts, those on the head, because of the ease of their examination and their striking distribution, are most liable to be of use in studies of human genetics, especially if they can be shown to lend themselves to accurate description, typing and evaluation.

Before entering into the following discussion, it is advisable to give a general description of the emergence of hair from the skin and to explain the terms used in this type of work.

The point at which a hair emerges from the skin we term the *point of emergence*. Each hair as it emerges, makes an angle with the tangential plane at the point of emergence and this angle is known as the *angle of emergence*. The *direction of a hair* is that which it follows when passing through the epidermis from the root towards the tip and is described by means of the usual anatomical terms caudad, frontad, etc., but it is important to realise that this direction *must be taken at the point of emergence* and that it has nothing to do with the way the hair lies after it has emerged. This is important, for long fine hairs with large angles of emergence are generally found to lie on the body surface in a different direction from that in which they emerge whereas the direction of stiff hairs after emergence is much more likely to be a continuation of the true direction at emergence. A failure to appreciate this leads to difficulty in understanding the difference between a true and an artificial parting, which subject is referred to again later. Adjacent hairs are often found to differ very little in direction and angle of emergence, and all such hairs may be grouped into a *hair tract*. A hair tract is formed by numbers of hairs emerging from points on the skin so that the directions of adjacent hairs are more or less parallel and their angles of emergence more or less equal. If traced back into the skin all the hairs in one tract seem to emerge from a common point known as the *centre of divergence* and this, as we shall see later, is the critical evidence used in deciding whether hairs belong to the same tract or not. The further from the surface the centre of divergence is situated, the less is the difference in direction and angle of emergence of neighbouring hairs, hence the use of the phrase "more or less" in the above definition. Another way of defining a hair tract therefore is the following:—a hair tract on the surface of the body is a group of hairs all of which have a common centre of divergence. We shall see later that in some cases the hairs on the scalp, although having many different directions, all belong to one tract because they all have a common centre of divergence. Should adjacent hairs have markedly different directions, they must belong to different tracts. Such hairs if their directions be convergent, form a *line of convergence* or a "tuft," and if the directions be divergent, they form a *line of divergence* or a true parting, and hence lines of convergence or divergence always mark part of the boundaries between two tracts; but it is by no means essential that such boundaries shall always be thus indicated, for if the directions of the marginal hairs of the tracts be nearly parallel, the tracts merge imperceptibly the one into the other, but generally in such cases at some part of the boundary there is sufficient difference in the directions to cause the appearance of lines of convergence or divergence and thus to indicate the presence of two separate tracts.

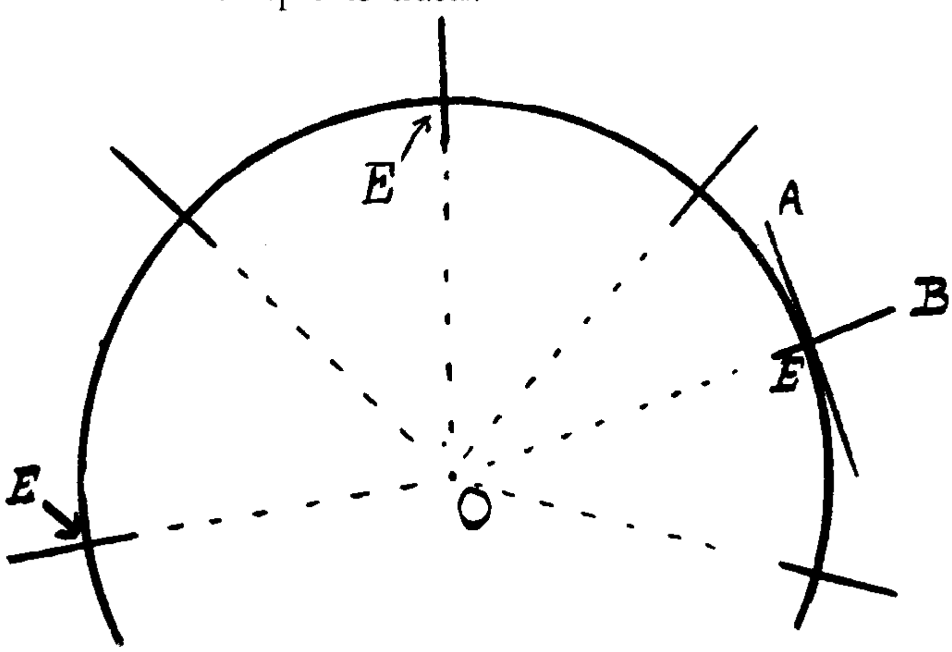

Figure 1. Illustrating the fact that when the centre of divergence of hairs coincides with the centre O of the spherical surface, the angles of emergence of the hairs are all equal to 90°.

Angle BEA is the angle of emergence of hair EB at point of emergence E.

Experience has proved that the best way to understand the different hair distributions found on the human head is first of all to consider the surface of the head as the surface of a sphere. If the centre of divergence of the hairs is at the centre of the sphere it is readily understood that all the hairs will emerge radially and their angles of emergence will all be 90° (Figure 1). Now consider the sphere to be converted into a shape roughly similar to that of the human calvarium, by demarking left and right sides, front and back, and by incising it so as to allow the sides and back to hang down vertically and the front to be raised horizontally. If we have allowed the centre of divergence to remain at the sphere centre, we would find the angles of emergence of the hairs over the persisting dome to be the same as before—all 90°—but the hairs over the sides and back would now have their angles of emergence reduced and their directions all caudad while the hairs on the top of the head would have frontad directions of emergence. All these direction changes would be gradual without a sign of lines of divergence or convergence, in fact all the scalp hair would belong to one tract (Figures 2 and 3). This hair distribution forms the author's Type I which type is characterised by the absence of true partings and whorls, the centre of divergence being at the centre of the cranial sphere in the median sagittal plane and the direction of emergence being radial (Plate I).

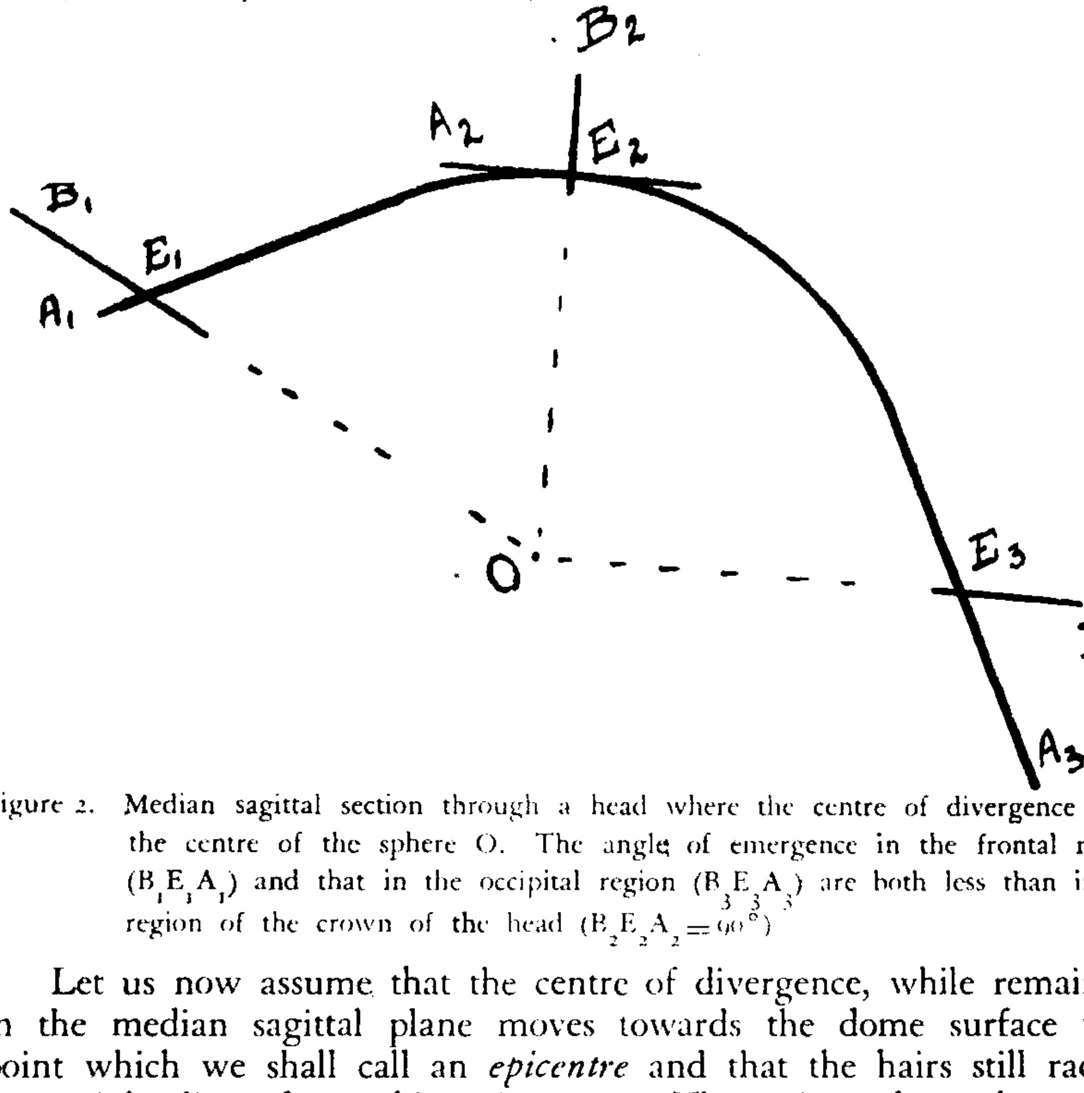

Figure 2. Median sagittal section through a head where the centre of divergence is at the centre of the sphere O. The angle of emergence in the frontal region ($B_1E_1A_1$) and that in the occipital region ($B_3E_3A_3$) are both less than in the region of the crown of the head ($B_2E_2A_2 = 90°$)

Let us now assume that the centre of divergence, while remaining in the median sagittal plane moves towards the dome surface to a point which we shall call an *epicentre* and that the hairs still radiate in straight lines from this epicentre. The point where the radius through the epicentre cuts the surface will then appear to be a region on the scalp from which the hairs diverge, and their angles of emergence will be less than 90°, diminishing as the distance of the point of emergence from the scalp surface decreases; the angles of emergence at the sides, back and top of the head will be less than before, and the hair in general will "lie down easier." (Figure 4). This distribution is easily recognised and is known as a *star* (*St*) and forms the author's Type II. (Plate 2). It is characterised by the centre of divergence at an epicentre; the absence of a true parting; and a star in the mid-line, the hairs being disposed around the centre of the star in concentric circles like the feathers on a shuttle-cock. Should the epicentre lie on a radius passing to the left or the right of the mid-line, we should get a star situated to the left (Figure 5) or right of the median sagittal plane as the case may be. In members of this type the hairs are to be imagined as radiating from the epicentre in *straight lines* along the surfaces of concentric cones whose apices are at the epicentre and whose common base centre marks the star on the head surface. The greater the diameter of the cone base, the

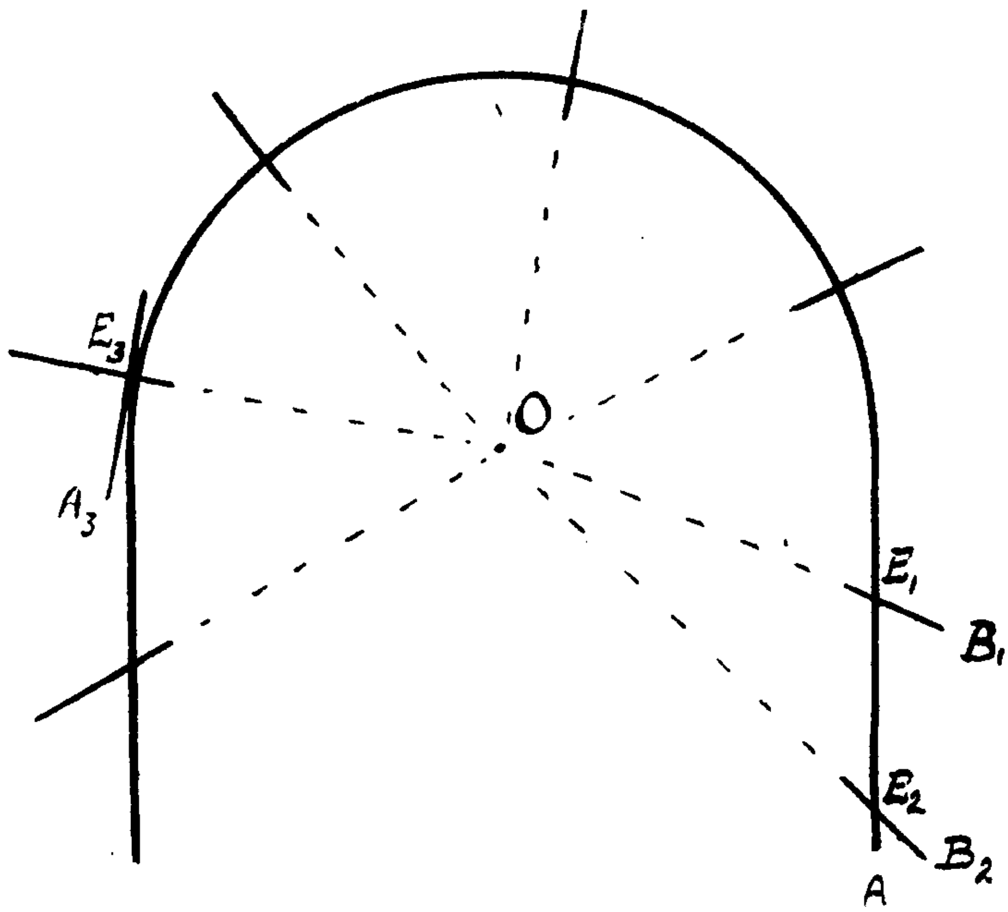

Figure 3. A coronal section through the centre of the same head as Figure 2 showing the smaller angles of emergence B_1E_1A and B_2E_2A over the parietal regions and the caudad direction of these hairs.

smaller will be the angle of emergence and thus the angle of emergence of any hair in any one tract will depend on two factors (*a*) the distance of the point of emergence from the centre of the star and (*b*) the distance of the epicentre from the cranial sphere centre in such a way that the smaller this distance is, the greater will be the emergence angle.

The most common method of divergence of hair is not in straight radii however, but in lines winding spirally around the epicentre radius and such examples constitute the author's Type III (Plate 3). In such a case the hairs appear to radiate like the curved arms of a multiple swastika from the point where the epicentre radius meets the surface; this formation is known as a "whorl" and its position described according to the position of its central point on the scalp. If the hairs radiate from the centre of the whorl in a clockwise direction, they constitute a clockwise whorl (denoted by '*Cl*') and if in the other direction an anti-clockwise one (denoted by '*A*'). Anti-clockwise is used in preference to counter-clockwise because in field records where abbreviations are always used '*Cl*' is very likely to be mistaken for 'Cc' counter-clockwise, especially in notes made in a hurry or under trying conditions.

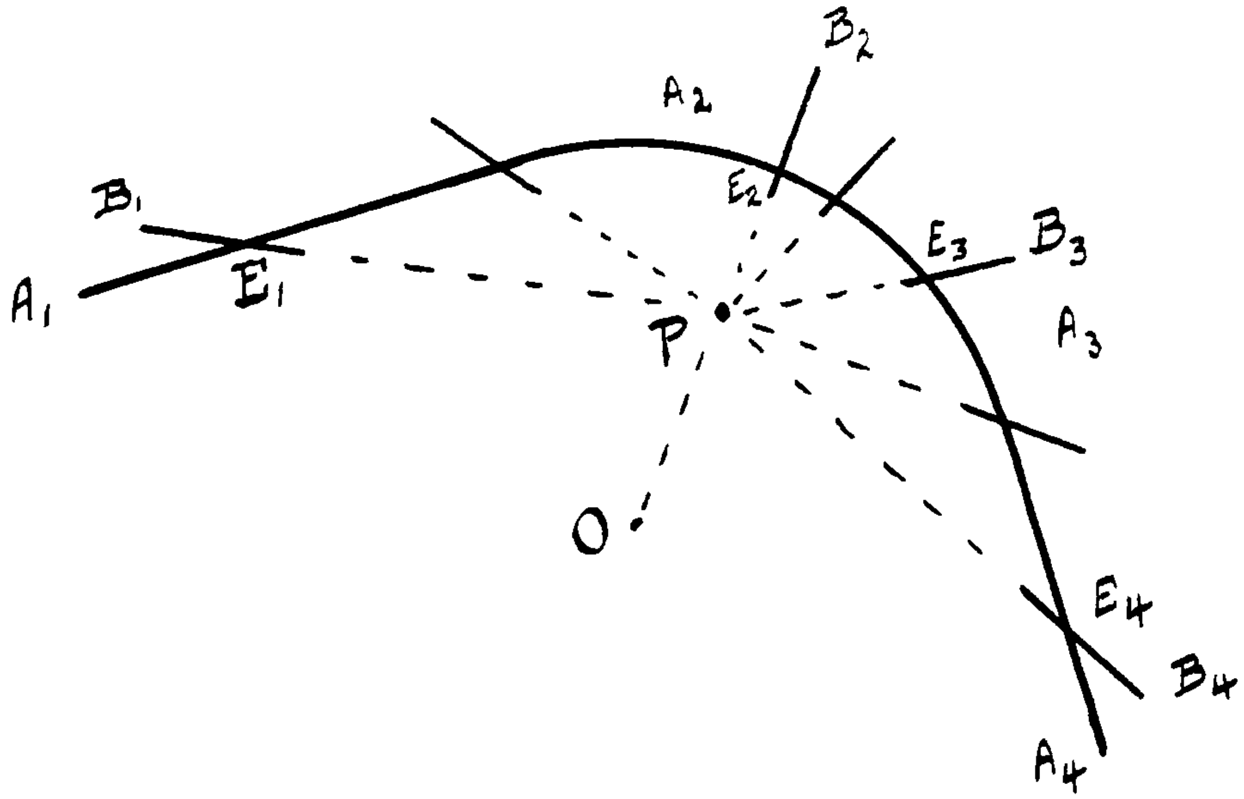

Figure 4. Median sagittal section of a head where the centre of divergence is at an epicentre P. The angles of emergence of hairs grow smaller as the distance between their points of emergence and the emergence of the epicentral radius OPE_2 increases.

If we assume that the spirals radiate as though they were on the surfaces of concentric cones we can understand how the whorling direction is most marked near its centre and as one passes centrifugally the directions become more and more parallel so that the directions of the hairs on the sides, back and top of the head are just the same in the other types. According as to whether the epicentre is in the mid-line or to the left or right, we get the whorl position located in those respective positions on the scalp. Thus the position of the centre of a whorl (or a star) on the head relative to the mid-line, depends on the angle between the epicentre radius and the median sagittal plane, and the best method of describing the position of such a whorl or star is in terms of that angle, which we shall call the ***lateral angle*** of the whorl (or of the star). Where the whorl (or star) is in the mid-line, the lateral angle is zero. This brings us to the consideration of the methods of denoting the position of a star or a whorl.

The usual method adopted by investigators is that of merely stating whether the star or whorl is on the left, on the right or in the mid-line. The author's Borneo and Canadian data were recorded according to this old system. In a previous article (Ride 1935) this method was criticised and reasons were given for abandoning it. Briefly they were these :—

(i) The descriptions left, centre and right are not strictly comparable because a whorl to be included in one or other of the lateral groups may fall in any plane outside the medial sagittal plane, but to be classified as central, it must fall in one particular plane; such a method is thus biased in favour of the lateral groups;

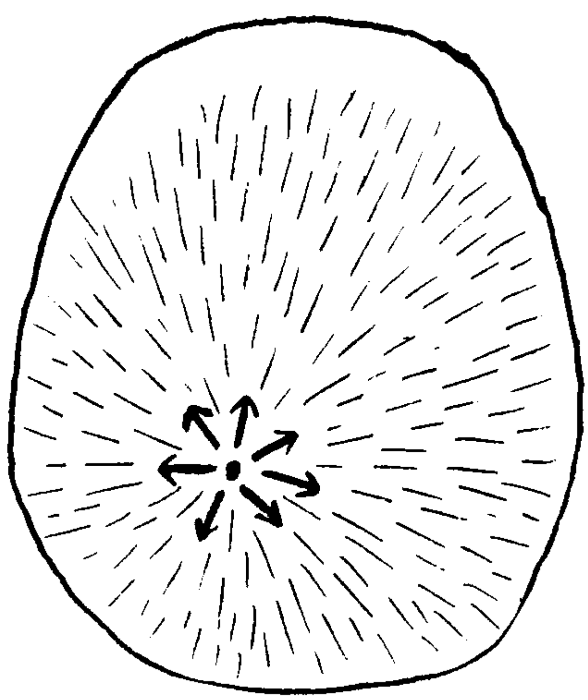

Figure 5. Distribution of hair over the head in a case where the centre of divergence is at an epicentre to the left of the median sagittal plane. This is an example of the Author's Type II, characterised by a star pattern and the absence of a true parting. The centre of the star corresponds with point E_2 of Figure 4.

(ii) there is no valid reason why one should make a whole group of whorls lying in the medial sagittal plane any more than for those lying in any other plane, nor is there any advantage to be obtained from so doing;

(iii) it is very difficult to decide what is the exact mid-line of the body and how to designate a whorl bordering on this region, and hence the accuracy of results is greatly dependent on personal factors which vary greatly during lengthy investigations. Repeatedly on expeditions one has noticed that early in the day, when one is fresh and more critical, whorls lying close to the mid-line are placed in one or other of the lateral

groups, while later in the day when critical faculties are dulled by fatigue, such types tend to be classified as central;

(iv) in heredity studies one is tempted to use such data on the assumption that the embryonic mid-line and the anatomical mid-line are coincident, and for this assumption there is no evidence;

(v) whorl positions form a continuous, and not a discrete series, and in classifying these positions a method should be chosen which employs the same standard of accuracy for each group.

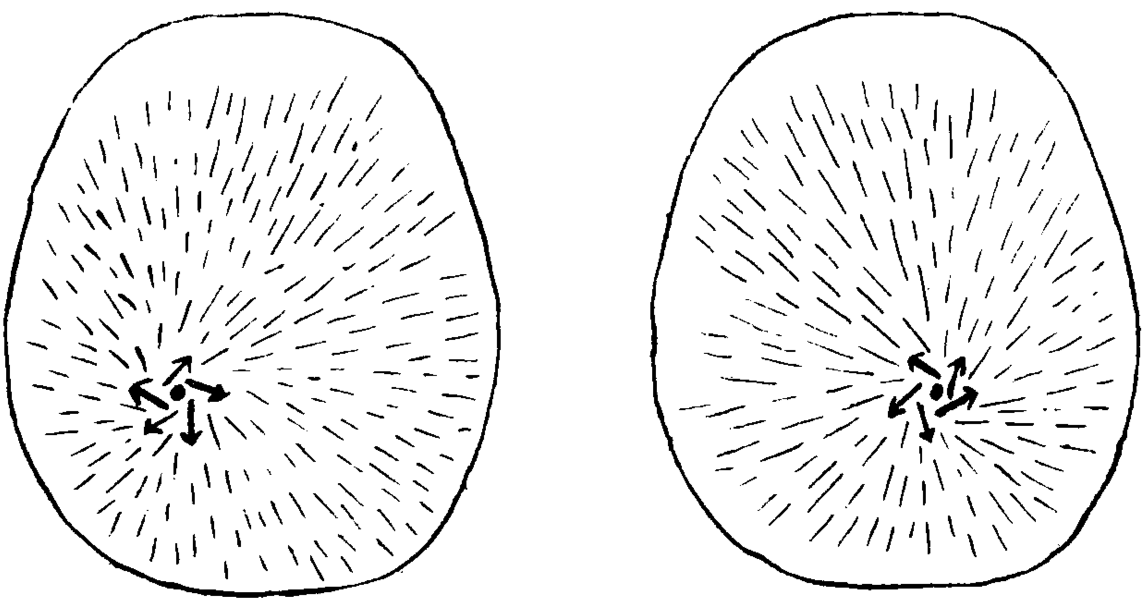

Figure 6. Examples of the Author's Type III characterised by patterns known as whorls, and the absence of true partings. On the left is a clock-wise whorl and on the right anti-clockwise.

To overcome these defects it was suggested that the position of a whorl should be denoted by the ratio of its distance from a fixed point on the left of the head to the distance between that point and the corresponding point on the right of the head, the ratio being expressed as a percentage. The points chosen were the upper margin of the tragus of each ear. The position of a point thus described is independent of head size or growth, and being quantitative, allows of statistical treatment whereby average positions can be ascertained for any series of positions. The Hong Kong data (see Tables VI, VII and VIII) were recorded using this new method. But using these same measurements the lateral angle of a whorl may be readily calculated as follows. If the contour of the head passing between the two tragi through the whorl be approximately a semi-circle then a figure such as Figure 7, may be assumed to represent this contour, *L* and *R* being the left and right tragi respectively, *O* the centre of the circle, the centre of divergence being at an epicentre *P*, the whorl at *W*, *OM* being the median sagittal plane. It will be seen that the lateral angle of the whorl is the angle *MOW*. According to the author's earlier method, the position of this whorl is fixed by the measurements along the circumference of the semi-circle of the lines *LMW* and *LMR*. Let the values of these lengths be x and y respectively. Then the position of *W* according to the author's method is $(\frac{x}{y} \times 100)$. But the angle *MOW* can be calculated from the following equation. $\dfrac{x - y/2}{\frac{y}{2}} = \dfrac{\text{angle } MOW}{90^\circ}$ that is, the value in degrees of the lateral angle $MOW = 90 \left(\dfrac{2x - y}{y}\right)$

If this value be positive, the position of the whorl is to the right of the mid-line, if negative, to the left. The data of Table VI were taken and the lateral angles estimated according to the above equation; the values are set out in Tables IX and X and they are discussed in the next section.

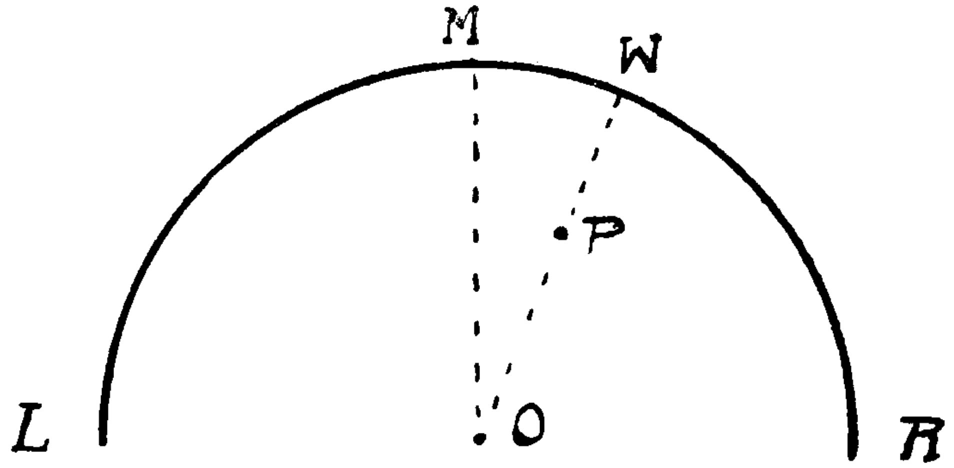

Figure 7. Diagrammatic coronal section through the head showing the method formerly used to express quantitatively the position of the centre of a whorl or star pattern. L = left tragus, R = right tragus, OM = median sagittal plane, P = epicentre, W = pattern centre, angle MOW = lateral angle of pattern centre.

Thus far in Types I, II and III all the hairs on the scalp have had a common centre of divergence and hence all form part of one and the same tract, the different hair directions being simply due to the direction of the different head surfaces. If the centre of divergence be not coincident with the centre of the cranial sphere, we may have more than one divergent centre. Type IV is composed of those patterns with two centres of divergence situated at different epicentres, the direction of emergence being along straight lines. This type is thus characterised by the presence of two stars on the surface of the head. (Figure 8). At present this is a purely hypothetical type for the author has not yet come across any case fitting into this category. Where the centre of divergence is double and the directions of emergence are along spirals and not along straight lines, we get two whorls and such cases comprise Type V which is relatively common (Plate 4). In this category is found a number of sub-types according as to whether the whorls are both clockwise, both anti-clockwise or whether one is clockwise and the other anti-clockwise (Figure 9). The most common of the sub-types is where there is a clockwise whorl to the left of an anti-clockwise one. If the whorls are far apart, the hairs belonging to the two different tracts where they meet have such small angles of emergence that the tracts merge imperceptibly into one, but where the whorls are close together the angles of emergence are too great to permit of this, and we find the hairs emerging in different directions forming a definite *tuft* (Plate 4a). A tuft is always formed between the converging hairs of two whorls situated close together. If the whorls are far apart the two hair streams converge so gradually that the tracts blend without tuft formation (Plate 4e).

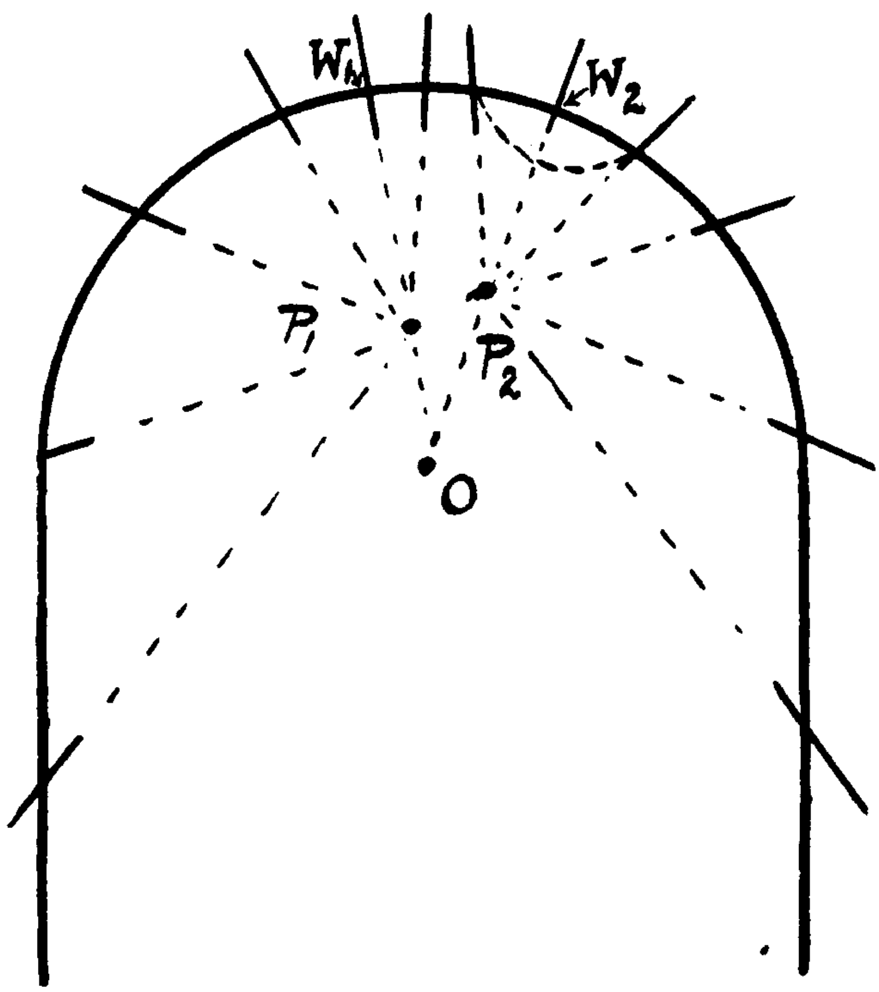

Figure 8. Diagrammatic coronal section through the centre O of the cranial sphere, showing hairs diverging from two epicentres P_1 and P_2. The hair pattern is an example of the Author's Type IV, a double star, the centre of one being situated at W_1, and that of the other at W_2.

Where the anti-clockwise is to the left of the clockwise whorl,— a much rarer condition,—we get a definite parting extending for some distance between them, again being more evident the closer the whorls are together. If the whorls are far apart, for the same reasons as given above the parting does not appear, the two tracts merging the one into the other imperceptibly. (Plate 4b).

There are a few interesting cases of double whorls that are very difficult to classify accurately, and care must be exercised if the true condition is to be recognised. The first of these is where the two whorls are almost coincident. In such cases the medial sides of the whorls have no room to appear, and the hairs on one side are clockwise in direction and on the other side are anti-clockwise.

Since the commonest double sub-type is *ClA*, the commonest of these limiting cases is where the hairs on the left. of the whorl are

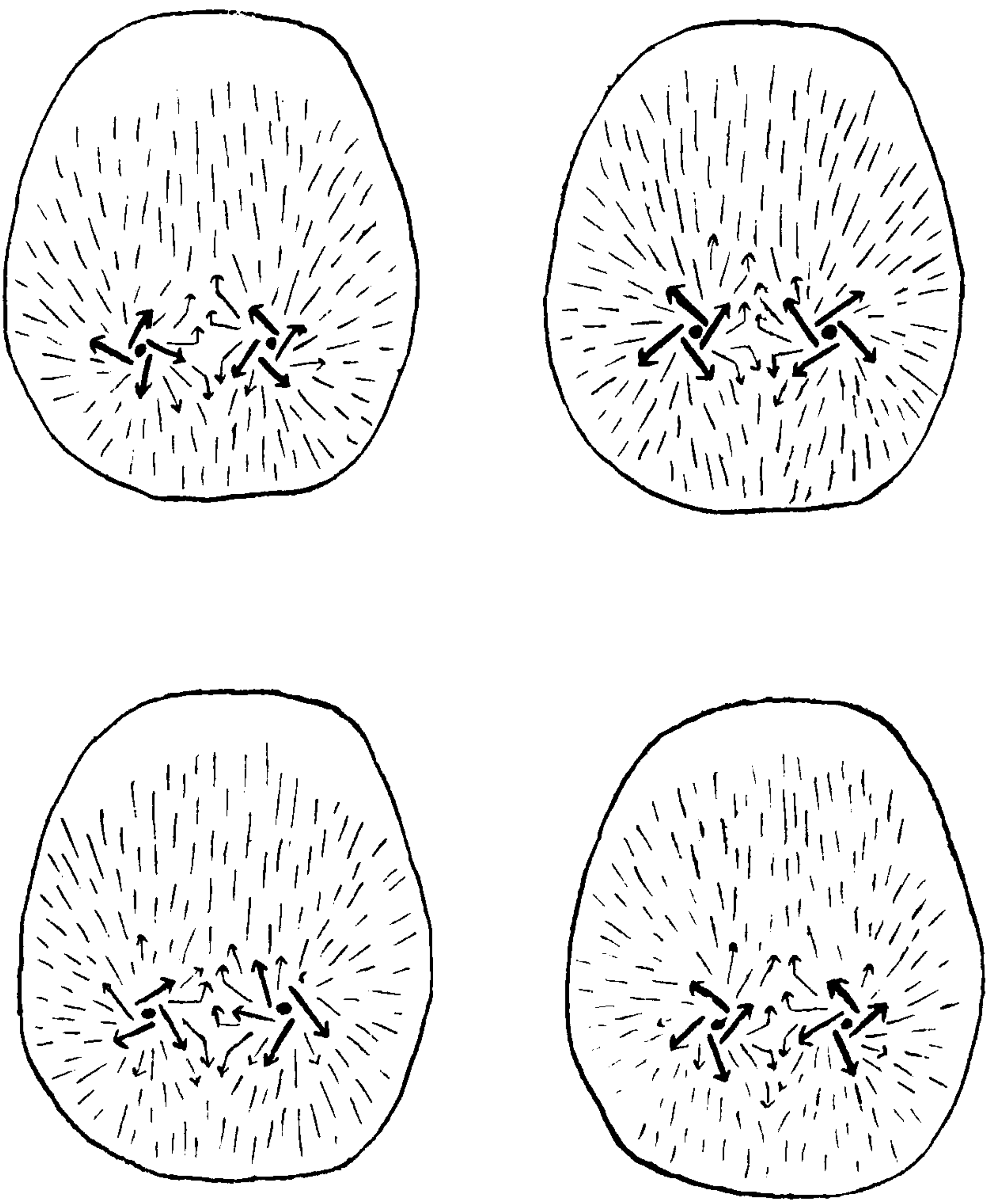

Figure 9. Examples of the Author's Type V, showing convergence of hairs with tuft formations between double whorls. Top left *ClA*, top right *ACl*, lower left *ClCl*, lower right *AA*.

clockwise and those on the right, anti-clockwise. Most of the author's cases are of this type, but if the sub-type be *ACl,* the limiting case shows the hairs on the left side to be anti-clockwise and those on the right clockwise. (Plates 4f and 4g).

Where these whorls have slightly different lateral angles, they are relatively easy to recognise, but if the lateral angles are equal, that is to say if the two whorls are in the same sagittal plane, the condition is harder to diagnose. In such cases the hairs cranial to the whorl radiate in one direction and those caudad in the opposite direction.

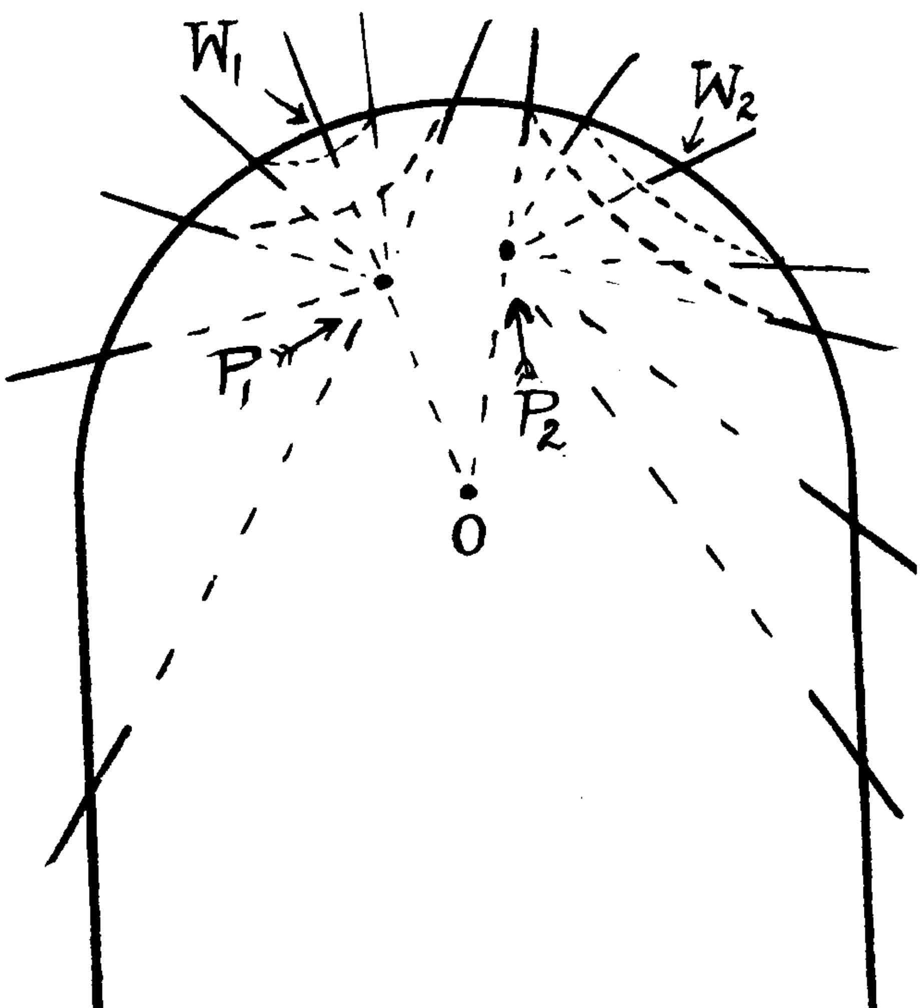

Figure 10. A type similar to that depicted in Figure 8 except that the common axis P_2 W_2 of the cones (along whose surfaces the hairs radiate to form the pattern around W_2) does not pass through the sphere centre O, but is set at an angle to the epicentral radius OP_2. This pattern belongs to the Author's type VI.

In the author's 1932 Borneo data there are two cases of this type, Nos. 1487 and 1923, and in Table III they are classed under double types. Easier types to recognise, but ones which do not fit into the four more common double sub-types, are those in which the lateral angles are equal, but one whorl is situated more caudally than the other. Two distinct whorls are present each in the same sagittal plane. In the above mentioned data we have three such cases, Nos. 1814 (a male) and Nos. 2107 and 2799 (both females). In each of these cases the anti-clockwise whorl was caudal to the other. As a general rule in double whorls, they are both at about the same caudal level, i.e., the radii through the whorls make equal angles with the longitudinal axis of the body, but in a number of cases, these angles are not equal. Extreme cases of this inequality are shown when there is one whorl over the occiput and another in the frontal region, of which types the author has noted a number of cases.

Where both whorls are of the clockwise (Plate 4c) or both of the anti-clockwise type (Plate 4d), we get characteristic hair distributions if the whorls are close together. In each case there is a tuft formed making an angle with the line joining the centres of the whorls, the direction of the tuft depending on whether the whorls are both clockwise or both anti-clockwise.

The next group, Type VI, consists of distributions which for a long time remained unexplained. The inheritance studies made it evident that they comprised an important group and demanded a classification. They may be described roughly as being intermediate between single and double whorls and are designated in the author's field books as the '*S*-type.' For reasons now about to be explained, the author is of the opinion that this is also a double type; one whorl being formed by the processes above described, but the other varying in this respect that the common axis of the cones of divergence does not coincide with its own epicentre radius (Plate 6). The axis of these cones does not emerge at right angles to the tangential plane at the point of emergence, and the head surface does not cut the cones in circles but in ellipses (Figure 10). Hairs belonging to the same cones therefore have different angles of emergence and a true whorl does not become evident. The hairs on the side of the ellipse furthest from the centre of this undeveloped whorl have such small angles of emergence that they merge imperceptibly into the tract belonging to the formed whorl, but those nearest have large enough angles of emergence to enable them to be distinguished from those belonging to the other tract and they thus form a parting along an *S*-shaped line starting from the centre of the normal whorl and gradually disappearing in the combined hair tracts.

Of Type VI there are eight possible sub-types whose existence can be explained according to (*a*) the types of the double whorls present and (*b*) the type of the one undeveloped. (Plate 5). The undeveloped whorl is denoted by *SCl* if it be clockwise, and by *SA* if it be anti-clockwise. The sub-types are set out in the following table :—

TABLE I.

Original Type		*ClA*	*ACl*	*ClCl*	*AA*
Sub-types Possible	....	Cl-SA	A-SCl	SCl-Cl	SA-A
		SCl-A	SA-Cl	Cl-SCl	A-SA

The members of this intermediate group are thus just as much double whorls as those of Type V and in heredity studies must be treated as such. In the data of Table I to V collected by the author, they have not been thus classified but are grouped amongst the single whorls. In order to rectify this error, a new investigation of Hong Kong Chinese was undertaken and the results are discussed in Section (d). This new frequency classification was thus made the basis of heredity studies and it is due to this together with the fact that an explanation of these intermediate cases is made possible that the writer believes the foregoing hypothesis to be reasonable and true.

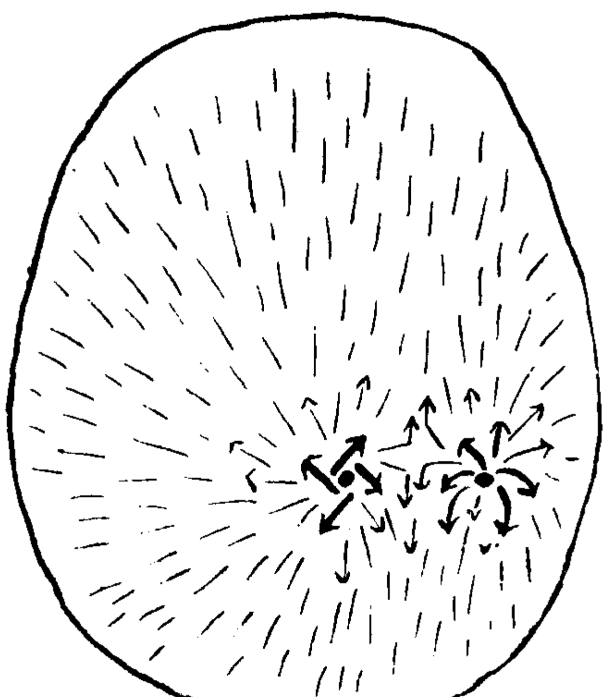

Figure 11. Multiple pattern, *Cl ACl* (Author's type VII) showing a clockwise whorl to the left and to the right a coincident double pattern, the left side being anti-clockwise and the right side clockwise.

Very rarely one comes across cases where there are three whorls present or even four. The application of the foregoing hypothesis will just as readily explain these peculiar yet interesting cases. They are all classed together in Type VII (Plate 6).

This type is really reserved for all those patterns which do not fit in to any previous type; triple and quadruple whorls occur too rarely to give them a separate grouping. Amongst this type are also included the various combinations of examples of the previous types

TABLE II.

TYPE	I.	II.			III.		IV.	V.	VI.	VII.
SUB-TYPE	Nil	Left	Cent.	Right.	Cl.	A.	Nil	ClA, ClCl, ACl, AA.	Cl-SA, A-SCl, SCl-Cl, SA-A, SCl-A, SA-Cl, Cl-SCl, A-SA.	Various multiple whorl types.
POSITION OF CENTRE OF DIVERGENCE	Centre of cranial sphere.	Epicentre			Epicentre		Two Epicentres	Two Epicentres	Two Epicentres	More than two epicentres.
LATERAL ANGLE	Nil	Negative	Zero	Positive	Negative, zero or positive.		Present	Present	Present	Present
DIRECTION OF HAIR AT POINT OF EMERGENCE	Along radii	Along straight lines on concentric cone surfaces. Epicentre at cone apex.			Clock wise. Spiral lines on concentric cone surfaces.	Anti-clock wise.	Same as Type II.	Same as Type III.	Same as Type V but one cone set at an angle to its epicentre radius.	Same as Type V
DETERMINING CHARACTERS	Absence of star or whorl. Angle of emergence of hairs over dome of head = 90°	Star.			Clock-wise whorl.	Anti-clock wise whorl.	Double Star.	Double whorl.	One whorl with an S-shaped parting emerging from it.	More than two whorls.

mentioned, for instance Figure 11 shows a pattern seen by the writer where there was a clockwise whorl slightly to the right of the mid-line, and further to the right coincident double whorls of the ACl type described on page .

It may be worth while summarising here all the foregoing types, as shown in Table II.

Hair Tracts and Partings.

Reference to earlier papers shows that the true significance of hair partings has not been recognised. For example a previous statement of the writer (Ride, 1932) concerning partings was criticised by Gray (1935), and my further experience leads me to acknowledge his criticism as correct. Misunderstandings are caused by not recognising that there are two types of partings, a morphological parting (which we have referred to above as a true parting) and an artificial parting. The latter is due to the way in which the hair falls or parts under external influences—generally gravity—*after* it has emerged from the skin; it is undoubtedly influenced by the direction and angles of emergence of the hairs and, especially in the case of thin hairs, can also be influenced by environmental factors such as brushing habits, pressure, etc. True partings on the other hand only appear when the adjacent hairs of two streams are running in markedly divergent directions; artificial partings can thus occur—and most frequently do so—in the absence of true partings. Where the latter exist, there is a very strong tendency for the artificial parting to co-exist but when we get the external forces acting against the direction of the emerging hairs we meet the difficulties which man overcomes with the various hair creams that are advertised as making the hair " lie down and part properly." Individuals belonging to the author's Types I, II and IV show no true partings. This has been verified time and time again on heads of the men of the Chinese coolie class who wear the hair very closely cropped and so convinced is the writer of the truth of this that the sign of a true parting is taken as evidence of an undeveloped second centre of emergence—double types.

A general description of hair tracts would not be complete unless it contained mention of the cause of hair patterns as a whole. Kidd (1920) writes:—

> " The critic might reasonably ask for experiments which will bear out the suggested views (on the evolution of hair patterns). But verification by calculated experiments is impossible, for, *ex hypothesi*, the variations or patterns which are described require long periods of time for their production. Such experiments being ruled out, the evidence in favour of hypothesis must be sought in some region of the hairy coat of mammals where whorls, featherings and crests can be observed in all stages of their formation."

This writer then makes his choice of a region and, as so often happens, the conclusions arrived at depend so much on the choice. He chose the side of the neck in the domestic horse and, on account of the manifold, various and constant movements and the remarkable muscular development of the horse's neck, arrived at the conclusion that "changes in the direction of the hair in the individual can be caused by muscular action." He assumed the normal direction to be caudad and concluded that the shearing action of the neck muscles produced the large variety of whorls, featherings and crests found in that region. But if muscular movement be so similar in all horses, as he affirms, why are the resultant hair direction changes so varied, or if neck movements in any one horse are so varied and manifold, why do we find one constant pattern in any one horse? And again, in the human scalp where movement is practically a minimum why do we find just as much pattern variation as in the neck of the horse? The factor which Kidd overlooked and which made his choice unfortunate is that the neck of the horse is a region of unequal growth. The neck grows most in the direction of the long axis of the body. The significance of this statement will be understood better if we consider a few important aspects of growth of the skin and its appendages.

The skin is composed of two main elements—a deep vascular connective tissue layer (the dermis) which forms the foundation for the epidermal layers which are four in number; the deepest of these, the stratum germinativum, is composed of a single layer of basal cells. The skin grows by multiplication of these basal cells, enough of them remaining basal in type and position to satisfy the new size required, the rest being pushed superficially as prickle cells. These later give rise to the cells of the stratum granulosum which are characterised by the formation of the keratin in the protoplasm. As these cells are pushed still more superficially by repeated basal cell divisions, a further change takes place whereby the keratin becomes converted into eleidin and the protoplasm undergoes dehydration. These cells form the stratum lucidum, and when they finally become lifeless, dry, horny scales, they form the stratum corneum, the outermost protective layer of the skin. Skin growth is thus accomplished and maintained by cell currents arising in the basal layer and passing towards the free surface.

The hairs project from the basal layer through to the surface and are developed in the first place about the third month of foetal life as solid cylindrical down growths from the deeper layers of the epidermis. By this time the growth currents of epidermal cells as they pass superficially have already been set up and it seems logical to conclude that these new developing cellular masses passing inwards against this current will not cut across it, but pass up it directly; in other words the direction of the future hair is already laid down by the direction of displacement of the growing cells of the epidermis. The down growth later becomes differentiated into the various layers of the hair and its follicle, and the hair grows by continuous mitotic division of the basal cells in the bulb which push the older cells superficially along the line of the follicle.

If the skin be covering a spherical surface, growth must be equal in all directions in order to maintain the spherical shape and hence each successive generation of prickle cells together with the hair cells must be pushed outwards radially and the angles of emergence of the hairs will be 90° (c.f., Type I above). But if growth be unequal so that the growing body becomes elongated in any one direction the covering cells of the skin as they form will have to be pushed away from the original growing centre to cover the elongation, and the lines along which the prickle cells are forced while still radiating from the growing centre, emerge from the skin at angles of less than 90° and these directions are those also followed by the hair cells. In fact hair direction is to be explained on exactly the same principles as the direction of nutrient arteries in the long bones of the limbs. If we consider the hair over the whole body being derived from a number of such growth centres, then we have the simplest and most reasonable explanation of hair directions, lines of convergence and divergence, etc., and other forces such as muscle action and use habits only affect the hair direction in so far as they can be shown to be responsible for the unequal growth of the region.

We can now understand why Kidd's choice was most unfortunate because hair direction in the neck of the horse is complicated by one of the most marked inequalities of growth in that animal. By the same reasoning the human occiput should be the simplest and most valuable region to study for there we have an area of the body surface still roughly spherical in form and uncomplicated by gross growth inequalities.

Having considered the part played by skin growth in hair direction we can now briefly discuss the question as to whether true hair directions can be altered by external forces. Obviously the line of action of a force to be so effective must be applied so as not to coincide with the original hair direction, and then its effect will depend on (*a*) its direction relative to the direction of the hair, (*b*) its magnitude, (c) the time during which it acts, (*d*) the stiffness of the hair and (*e*) the texture of the skin through which the hair passes. If any or all of these cause a change in the point of emergence of the hair—then the direction must be changed. The writer has no definite data on this point but the following observations are of interest. (*i*) Hair types are recognised easier in young children than in older children, or than in adults whose hair has been subjected to continual dressing. (*ii*) They are generally more easily recognised in men than in women though amongst one tribe in North Borneo where the men wear long hair tightly wound in a bun on the top of the head, the types were very hard to recognise in men as well. (*iii*) Whorls, especially if the angles of emergence of the hair are small, are never obliterated and they can generally be detected by relaxing the tension on the hair.

(*b*) *RACIAL DATA.*

The racial data available here in Hong Kong are set out in Table III.

TABLE III.

Population	Investigator	Number Investigated	SINGLE PATTERNS Cl	A	St.	Total	Double Patterns
North Germans	Bernstein Quoted by Cockayne	3528	74.23% ±.736	18.91% ±.659	—	93.14% ±.426	6.86% ±.426
American Whites	Landauer	1854	75.19% ±1.003	18.77% ±.907	—	93.96% ±.553	6.04% ±.553
North American Indians British Columbia	Ride	187	64.17% ±3.51	28.34% ±3.30	1.60% ±2.14	94.11% ±1.72	5.88% ±1.72
Australian Aborigines	Gray	41	60.98% ±7.618	29.27% ±7.106	—	90.24% ±4.634	9.76% ±4.634
Hong Kong Chinese	Ride	597	59.30% ±2.01	29.15% ±1.57	—	88.4 % ±1.31	11.56% ±1.31
British North Borneo Natives	Ride (1st Series)	649	59.17% ±1.93	29.12% ±1.78	—	88.29% ±1.26	11.71% ±1.26
—do—	Ride (hitherto unpublished)	1888	64.14% ±1.104	24.42% ±.989	.48% ±.158	89.04% ±.719	10.96% ±.719
Borneo Totals		2537	62.87% ±.959	25.62% ±.867	.36% ±.118	88.85% ±.625	11.15% ±.625

These figures show that certain characters are common to all races; they are (*a*) single patterns are roughly 8 or 9 times as frequent as double patterns (*b*) of the single patterns the clockwise whorl is by far and away the commonest; and (*c*) despite racial differences to be discussed now, the frequencies of the various types here listed are remarkably similar amongst the various peoples investigated.

Owing to the smallness of the numbers yet to hand one must omit the Australian Aborigines from any discussion of these figures, but it is certain that expeditions in Central Australia will very soon supply us with much more data.

Concerning the rest of the figures, the double whorl frequencies group the North American Indians with the Germans and Americans of Europeans descent (about 6%) whereas the Asiatic races studied have a double whorl frequency of about 11%. The differences are set out in Table IV.

TABLE IV.

Populations Compared.	Difference in frequency (%) of double whorls.
North American Indians and North Borneo Natives.	5.27% ± 1.835
North American Indians and Hong Kong Chinese.	5.68% ± 2.167
American Whites and North Borneo Natives	5.11% ± .834
American Whites and Hong Kong Chinese.	5.52% ± 1.422

These figures are not sufficient to warrant us to assert that a high double pattern frequency is characteristic of Mongolian races but they are sufficient to justify investigation amongst other Asiatic peoples. Most of the Hong Kong data were taken from short haired children whereas the North Borneo data include large numbers of long haired women and men, and the close agreement of the figures from those two peoples with such widely different hair dressing customs leads us to conclude this similarity of hair pattern frequencies is not due to such external causes. It can hardly be seriously argued that the differences between the Asiatics and the Europeans can be accounted for by variations in activity of the epicranial muscles and hence the most likely explanation of the difference is that it is a racial one which is sufficient evidence to warrant us considering that the hair pattern characters are hereditary.

Turning our attention now to the single whorls we find the Germans and American Whites in one group with approximately 75% *Cl* and 19% *A* types. While the North American Indians and the Asiatic peoples fall in the second group with 59-64% *Cl* and 25-29% *A* types.

A point of anthropological interest in these data is that if the high frequency of double whorls be a Mongolian character, these figures may be taken as evidence of Mongolian infiltration amongst the North Borneo Natives, and if infiltration in one direction results in such a change of frequency, it is difficult to understand why a similar infiltration among the North American Indians has not produced similar results. In the light of these figures it would be more reasonable to consider a high anti-clockwise frequency to be a character of Mongolian races and thus would the hair whorls show Mongolian infiltration both in East Indies tribes and North American Indians; and at the same time to look upon a high double pattern frequency as a character that has spread up to China from the Indies. While such an assumption is the only one which will explain the meagre results at present to hand, it also shows how necessary further figures from peoples in this part of the world are, before any such theory can be considered firmly established.

Double Patterns.

In Table V is set out the frequency of the different double patterns included in some of the racial data of Table III.

TABLE V.

Population	*ClA*	*ACl*	*ClCl*	*AA*	Totals
North American Indians	8	1	2	—	11
British North Borneo	244	20	5	4	273
Hong Kong Chinese	58	11	1	0	70
Australian Aborigines	1	2	1	—	4
Totals	311	34	9	4	358

Showing the frequencies of the various sub-types of double whorl patterns amongst the populations indicated.

These figures show how much more frequently in double patterns the clockwise whorl is found situated to the left than to the right of an anti-clockwise whorl, and in considering single patterns, it was similarly found that the anti-clockwise whorls tended to be placed further to the right than those of the clockwise type. In order to obtain a quantitative statement of this finding, the author's method of expressing the position of the whorl already described was put to the test by examining Chinese in Hong Kong and Cheung Chau (one of the neighbouring islands). Of the 597 individuals included in this study, 200 were from Hong Kong itself, chosen at random in the streets near the University and comprised mostly children and men with short hair so that errors in diagnosis were reduced to a minmum and the maximum of accurate results was assured. The other 397 observations were made on Cheung Chau Island during routine blood grouping investigations. Here again care was taken to use only those results which could be recorded with precision and accuracy. Of these 597, 528 were single patterns (354 *Cl* and 174 *A*) and 66 were double. The position of each whorl was measured according to the method mentioned earlier and the frequencies of occurrence of whorls in the various positions on the head are set out in Table VI.

From these data the mean position of each type of whorl the standard errors of the mean value, the standard deviations of the distributions and the co-efficients of variation of each frequency group were calculated and are found set out in Table VII.

TABLE VII.

Hair Pattern		Frequency	Standard Deviation	Value of Mean Position	Standard Error of Mean	Co-efficient of variation
Single	*Cl*	354	4.90	50.0396	± .265	9.9721
	A	174	5.40	51.5919	± .167	10.4668
Double	*Cl*	69	5.29	46.8260	± .637	11.2971
	A	69	5.00	52.0435	± .602	9.6073

Tabulation of data given in Table VI concerning occipital hair patterns of 597 Hong Kong Chinese.

The first thing to notice here is the relative mean positions of clockwise and anti-clockwise whorls. Where single whorls are concerned the mean position of the clockwise whorl is further to the left than the mean position of the anti-clockwise type, the difference in

TABLE VI.

Whorl Position	Single Pattern Frequencies		Double Pattern Frequencies	
	Cl	*A*	*Cl*	*A*
33	—	1	—	—
34	—	1	—	—
35	—	—	—	—
36	—	—	—	—
37	—	—	1	—
38	3	1	1	—
39	5	1	4	—
40	4	2	1	2
41	3	1	4	—
42	7	6	2	1
43	12	3	9	1
44	17	3	4	4
45	14	6	9	2
46	25	6	4	3
47	21	5	3	2
48	29	7	3	2
49	21	8	2	3
50	18	5	6	1
51	29	14	4	2
52	34	13	1	6
53	25	15	1	7
54	26	14	4	8
55	15	18	1	5
56	9	13	2	10
57	12	9	1	3
58	7	11	1	4
59	6	5	—	—
60	9	3	—	3
61	0	1	1	—
62	2	2	—	—
63	1	—	—	—
Totals	354	174	69	

Showing the frequencies of the various types of occipital hair whorls amongst 597 Hong Kong Chinese for each of the head positions from 33 to 63. *Cl* = clockwise; *A* = anti-clockwise.

the mean value being 1.55 ± .313 a difference which is significant, being 5 times its standard error. This substantiates the statement made in an earlier paper concerning the position of these types of whorl, and it is due to the new method of estimating the position of the whorl that this statement can now be verified.

We have already seen that this occurrence of anti-clockwise whorls further to the right than clockwise whorls is also exemplified in the double whorl data by the great preponderance of the *ClA* type. Such a conclusion can now be statistically verified for in all cases where there are two whorls, one being clockwise and the other anti-clockwise, the mean position of the former is 46.83 ± .637, and that of the latter 52.04 ± .602, giving a difference of 5.21 ± .877 which difference is again undoubtedly significant.

It can thus be taken as definitely established that there is some relation between the position of the whorl and its type, whereby an anti-clockwise whorl tends to be further to the right than one of the clockwise type.

The next question to consider is whether the presence of two whorls has any effect on their mean positions individually. In order to test this, the mean value of clockwise whorls when they occur alone was compared with the mean value of similar whorls occurring in association with an anti-clockwise whorl. The two means are 50.04 ± .265 and 46.83 ± .637 respectively, giving a difference of 3.21 ± .690 which again is significant. It would therefore appear that the mean position of clockwise whorls occurring alone is further to the right than that of such whorls associated with anti-clockwise whorls.

These differences are set in Table VIII.

TABLE VIII.

Means Compared	Difference	Remarks
Cl (single) with *A* (single)	1.55 ± .313	S
Cl (double) with *A* (double)	5.21 ± .877	S
Cl (single) with *Cl* (double)	3.21 ± .690	S
A (single) with *A* (double)	0.45 ± .625	N.S.

Table VII in which are set out the differences in mean position of various whorls, together with the standard error of these differences. S = significant; N.S. = not significant.

A similar test applied to anti-clockwise whorls shows a difference in means of 0.45 ± .625, a non-significant difference. Hence the mean position of anti-clockwise whorls is independent of the presence of other whorls, whereas that of clockwise whorls depends on the presence or absence of other whorls in such a way that when an anti-clockwise whorl is present, the clockwise whorl appears further to the left.

The results are set out in Tables IX and X :—

TABLE IX.

Hair Pattern		Frequency	Standard Deviation	Mean Lateral Angle	Standard Error of Mean
Single	Cl	354	9.42	+ 0.23°	± .501
	A	177	9.94	+ 4.24°	± .747
Double	Cl	69	9.98	− 6.09°	± 1.201
	A	69	9.69	+ 3.80°	± 1.166

Table IX in which are set out the mean lateral angles of whorls of 600 Hong Kong Chinese.

If these data are treated according to the lateral angle method described above, we get similar differences exemplified and this new method has these advantages that the significance of the results expressed in degrees is more readily understood and the actual working out of the mean values and deviations is simpler.

TABLE X.

Mean Lateral Angles Compared	Difference		Remarks
Cl (single) with *A* (single)	4.01°	± .899	Significant
Cl (double) with *A* (double)	9.89°	± 1.675	Significant
Cl (single) with *Cl* (double)	6.32°	± 1.302	Significant
A (single) with *A* (double)	0.44°	± 1.385	Not significant

Table X in which are set out the differences in mean lateral angle values of the various whorls of the data in Table IX.

(To be continued)

Review of Books.

"*A SHORT PRACTICE OF SURGERY,*" Third Edition. By Hamilton Bailey, F.R.C.S. and R. J. McNeill Love, M.S., F.R.C.S., Pages 996, Illustrations, 763 (88 coloured). Price 28s. net. Published by H.K. Lewis & Co., Ltd. 136, Gower Street, London, W.C.1.

Only little over a year ago, the previous edition (2nd edition) of this book was published, a review of which appeared in Caduceus Vol. 14, No. 1, February 1935. In six months' time, the 2nd edition was reprinted and now the 3rd edition. The popularity of this book and the effort of the authors in trying to bring this work more up to date, in pace with the rapid advance in modern Surgery, can be easily conceived.

One, after reading this book, cannot fail to note that the authors' arrangement of relegating the rare conditions in small types and emphasizing the important sections in large prints is a great help to the reader. In every section there are beautiful pictures or diagrams to illustrate the text; thus the subject is easily and directly explained. It consists of 951 pages with 763 illustrations of which 88 are coloured. One also realises that this book as its title implies, gives more teaching in clinical Surgery, in physical signs, diagnosis, and treatment. Generally speaking, the methods of treatment for various sections are most up to date—special mention may be made of the treatment of fractures of the lower limb, of burns and the use of Radium in different malignant lesions. It does not include any Embryology Surgical Anatomy, and only very little Surgical Pathology in the separate sections but on the other hand a short paragraph on descriptive operative surgery is often included in the treatment. This I think is an advantage to those who are doing clinical work particularly to senior students who may from time to time wish to make quick references during case taking. This book is in this way extremely helpful.

The reviewer regrets to find that very few corrections are made in preparing this volume since the 2nd edition was published. The general question of "Shock" has not been included. However, I must state that no other book of this kind has ever given me fuller information, clearer and easier reading than this small volume. "A Short Practice of Surgery."

T. K. L.

Acknowledgements

McGill Medical Undergraduate Journal. Vol. V. No. 4. May, 1936.

Post-Graduate Medical Journal. Vol. XII. No. 127-131. May-September, 1936.

Fukuoka Acta Medica. Vol. XXIX. Nos. 5-9. May-September, 1936.

Mitteilungen aus der Medizinischen Akademie Zu Kioto. Vol. 17 and Vol. 18. Nos. 1-3 and No. 1. May-July, 1936 and September, 1936.

The Nagoya Journal of Medical Science. Vol. 10. No. 1. May, 1936.

Taiwan Igakkai Zasshi. Vol. XXXV. Nos. 5 and 6. May and June, 1936.

The Middlesex Hospital Journal. Vol. XXXVI. Nos. 1 and 4. June and July, 1936.

The Hospital. Vol. XXXII. Nos. 6-9. June-September, 1936.

Annual Report of the Malarial Advisory Board. For the Year 1936.

Manchester University Medical School Gazette. Vol. XV. No. 4. May, 1936.

The Queen's Medical Magazine. Vol. XXXIII. Nos. 5 and 6. May and June, 1936.

The Journal of the Chosen Medical Association. Vol. 26. Nos. 4-8. April-August, 1936.

Archives of Medical Hydrology. Vol. XIV. No. 2. April, 1936.

Folia Medica Sinica. Vol. 1. Nos. 5-8. May-August, 1936.

The New Zealand Medical Journal. Vol. XXXV. Nos. 187 and 188. June and August, 1936.

Annual Report of the Institute for Medical Research. For the Year 1935.

Lingnan Science Journal. Vol. 15. No. 2. June, 1936.

Review Medico Chirurgicale de Jassy. Vol. 47. Nos. 1 and 2. 1936.

The Australian Journal of Expreimental Biology and Medical Science. Vol. X. Part 2. June, 1936.

The Broadway (Westminster Hosp., Gaz.). Vol. R6. No. 6. Spring 1936.

The North Wing. Summer 1936.

Bulletin of the New York Academy of Medicine. Vol. 12. Nos. 5-8. May-August, 1936.

Revista de la Facultad Medicina. Vol. IV. Nos. 1-4. July-October, 1936.

The Tohoku Journal of Experimental Medicine. Vol. 29. Nos. 1-3. July-August, 1936.

Laboratory Studies and Clinical Studies. 1935.

Medicina de Hoy. Vol. 1. Nos. 4-6. May-July, 1936.

Cambridge University Medical Society Magazine. Easter Term.

The Journal of the Cancer Research Committee of the University of Sydney. Vol. VII. Nos. 3 and 4. May, 1936.

St. Mary's Hospital Gazette. Vol. XLII. Nos. 4-6. May-July, 1936.

Chiba Igakkai Zasshi. Vol. XIV. Nos. 6-8. June-August, 1936.

Memorias de Instituto Oswaldo Cruz. Vol. 31. No. 2. 1936.

The Keijo Journal of Medicine. Vol. 7. No. 1. May, 1936.

The Bristol Medico Chirurgical Journal. Vol. LIII. No. 200. Summer 1936.

Unitas. Vol. XV. Nos. 2 and 3. August and Septembear, 1936.

The Brimingham Medical Review. Vol. XI. New Series. No. 2. June, 1936.

St. Thomas' Hospital Gazette. Vol. 35. No. 10. July, 1936.

Health and Empire. Vol. XI. No. 2. June, 1936.

The Japanese Journal of Experimental Medicine. Vol. 14. No. 3. June, 1936.

King's College Hospital Gazette. Vol. 15. No. 3. July, 1936.

The Leech. Vol. 7. No. 1. June, 1936.

Guy's Hospital Gazette. Vol. L. Nos. 1251-1253. July and August, 1936.

St. Bartholomew's Hospital Journal. Vol. XLIII. Nos. 10-12. July-September, 1936.

The National Quarantine Service Reports. Series VI. 1935-36.

Bulletin de L'Academie de Medicine de Roumanie. I-ere Annee. Tome I. No. 3. 1936.

The Journal of Bone & Joint Surgery. Vol. XVIII. No. 3. July, 1936.

Okayama Igakkai Zasshi. Vol. 48. Nos. 6-9. June-September, 1936.

Bulletin de la Societe Medico-Chirugicale de L'Indo-Chine. Vol. XIV. No. 6. June, 1936.

Arbeiten aus der Medizinischen Fakultæt Okayama. Vol. 5. No. 1. September, 1936.

Transactions of the College of Physicians of Philadelphia. Vol. 4. No. 1. Fourth Series 1936.