Thesis
Year Fee for Exam

HUMAN MONSTROSITIES

THEIR ORIGIN AND TREATMENT

BY

MORRIS WITKIN

M.B., Ch.B., (Edin.)

H U M A N M O N S T R O S I T I E S

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HUMAN MONSTROSITIES: THEIR ORIGIN AND TREATMENT.

INTRODUCTION.

In the suburb of Clairwood, outside the coastal town of Durban, South Africa, lives a woman of middle age who created a great deal of interest and discussion through the birth of extraordinary twins. (Figs. 78, 81, 84)

On the 12th of November 1928 I was called to her bedside half an hour after the birth of the children. The reason for this summons was obvious, for the midwife was afraid to sever the cord of the second twin as there was "something very peculiar about it". On arrival I found the placenta in bed still attached to the second child. The first twin was normal in every respect, but I discovered that the second had a parasitic foetus (thoraco-pagus-parasiticus) attached to it. It also had a hernia-like protrusion of bowel in the umbilical region (hernia funiculi umbilicalis).

News soon spread not only through the village and the town but throughout the country, (for the press took it up), that this poor woman had given birth to "Siamese twins", and the mother was besieged by numerous callers all curious to see this "freak of nature".

The peculiarity of this malformation aroused my interest; particularly so, having performed two urgent operations: one for the umbilical hernia where there was strangulation of bowel soon after birth, and endangering the child's life, and the second operation for the removal of the parasite ("parasitectomy") which was drain-

ing the vitals of this child. In each case it made a splendid recovery.

The question which puzzled me was "how and why do these abnormalities occur?"

This thesis is a humble endeavour to answer this most difficult question.

Furthermore, I shall endeavour to point out that there exists a "growth-regulatory-mechanism" in the fertilised ovum. This mechanism is controlled under normal conditions by two opposing forces which operate at different times. These forces I describe as "growth inhibitory", and "growth-stimulatory", and are due to two subtle internal secretions in the ovum itself. The secretion causing the "inhibitory" phase I term "INHIBITIN," and the secretion causing the "stimulatory" phase as "STIMULIN".

The harnessing of INHIBITIN with its powerful growth-inhibitory properties might have far reaching effects in arresting growths in general, and might eventually lead to preventive and curative measures in malignant disease.

In preparing this paper I found that the literature in English dealing with human monstrosities is widely scattered and most unsatisfactory. We know of no English work comparable to those of GEOFFROY SAINT-HILAIRE, of FORSTER, and of AHLFELD, in which the entire subject is treated systematically, scientifically, and comprehensively.

In the following chapters I shall attempt to

explain the origin and treatment of human monstrosities, and shall approach the subject in the following order:-

1. History:
2. Embryology:
3. Teratology:
4. Teratology and Cancer:
5. Clinicology:
6. Obstetrical:
7. Surgery:
8. A case of "parasitectomy" (Clairwood Twin):
9. Morbid Heredity and Eugenics.
10. Summary.

A Glossary is appended as many of the terms used in Teratology are not often met with in ordinary medical literature.

An Index of authors quoted, an Index of clinical cases described, and a Bibliography, are also included. The latter is referred to by the bracketed figures in red.

CHAPTER I.

HISTORY.

HUMAN MONSTROSITIES: THEIR ORIGIN AND TREATMENT.

CHAPTER I.

HISTORY. (1, 2, 11.)

Human monstrosities have interested the world for centuries; particularly anatomists, embryologists, physicians, midwives, surgeons, and psychologists.

HIPPOCRATES, ARISTOTLE, and GALEN and many other ancient philosophers have described monsters, but in a ridiculous and extravagant manner.

In mythology we read of the Centaurs who were beings possessed of a human head, but the body and extremities of an animal.

We also meet with the Cyclops who were persons with but one enormous eye. There existed also men with pectoral eyes, and the Fauns whose lower extremities resembled those of a goat.

In the legends and folklore of every nation we meet with monsters possessed of one huge eye, two or more heads, or double bodies, etc.

ANCIENT EXPLANATION OF MONSTROSITIES.

Many incredible reports of monsters are found in medical literature from the time of GALEN to the sixteenth century, but without a fragment of scientific truth.

Until the nineteenth century, practically no progress was made in the scientific explanation of monstrous births. Particularly in the Middle Ages ignorance and superstition reigned supreme. They attributed such gross abnormalities to the influen-

ces of wrathful gods, devils, witches, and other supernatural elements in their religious worship. The semi-human creatures were invented or imagined, and cited as the results of bestiality and allied forms of sexual perversion prevalent in those times.

According to PARE there was born in 1493, as the result of illicit intercourse between a woman and a dog, a creature with its lower extremities the exact counterpart of its canine father, and its face and upper extremities resembling its mother.

Similar impossible monsters resulting from bestialities between human beings and animals especially the goat, ass, mare, and bull, are recorded. One early writer reports the mythical birth of a serpent by a woman.

In 1726, considerable notoriety was achieved by Mary Toft,(3) of Godalming, Surrey, England, by her spreading the news that she gave birth to rabbits! Even at this late period the credulity of the public was so great, that many believed the story. This woman was carefully watched, caught in her manoeuvres, and she then confessed that it was a fraud.

Modern research has proved conclusively that the results of connections between man and beast or between beasts of different species are always sterile; and we can wonder at the imaginative minds of our ancestors. Certain phenomena of nature, such as a comet, or an eclipse, were at one time held responsible for monstrous births. The moon was frequently considered as a causative agent, and the word "monster"

may have originated from the ancient word "mooncalf". Prominent among these theories was the belief that the maternal impressions are in some way registered and produce monsters from normal foetuses.

EARLY TERATOLOGY (2)

AMBROISE PARE in the sixteenth century evinced the first evidence of a step toward classification and definite reasoning in regard to the causation of monstrosities. His ideas were crude and some of his phenomena impossible; nevertheless, many of his facts and arguments are worthy of consideration.

PARE attributed the cause of anomalies-of-excess (monstra in excessu) e.g. conjoined twins, to an excessive quantity of semen, and anomalies-of-defect (monstra in defectu) e.g. dwarfism, to deficiency of the same fluid. He collected many instances of double terata from reliable sources, but has included in his collection accounts of some hideous and impossible creatures. He describes, for example, a creature with the head and trunk of a human being; wings, crest, and lower extremity of a bird, and with an extra eye in the knee! So credulous were people at this time that even a man of the stamp of PARE believed in the possibility.

SCIENTIFIC TERATOLOGY.

The seventeenth and eighteenth centuries witnessed the overthrow of many of these ideas. BLONDEL attacked them from a philosophical point of view, while a scientific attack was led by HALLER and VON

BAER. Early in the nineteenth century J. F. MECKEL proposed an embryological basis for teratology, vigorously denouncing ideas regarding the effects of witches, devils, and maternal impressions. As a result of MECKEL'S teaching the first experiments in teratology were performed by GEOFFROY SAINT-HILAIRE.

Since the work of SAINT-HILAIRE, hundreds of scientists have been attracted to the field of experimental teratology, and proofs of the astounding influence of external environment upon the growing embryo are ever increasing.

The earlier investigators laid much emphasis upon mechanical factors such as pressure, while more recent workers emphasise the chemical factors and what is most important of all, the time or developmental moment at which these factors are allowed to act, as we shall see later.

CHAPTER II.

EMBRYOLOGY.

CHAPTER II.

(3, 5.)

EMBRYOLOGY.

Embryology deals with the various changes which take place during the growth of an animal from the egg till birth. It furnishes the only reliable key for the interpretation of mal-developments.

I shall endeavour to trace the changes which occur in the fertilised ovum from the commencement of impregnation up to the stage there the abnormal development resulting in the birth of conjoined twins and other monstrosities is likely to originate.

GENERAL PRINCIPLES.

1. The sequence of events in embryology is:
   (a) From the simple towards the complex, and
   (b) From the general towards the special.
   This is known as the process of ONTOGENESIS.

2. The heterogeneity which is produced in the process of ontogenesis is of two kinds:
   (a) The cells grow unlike one another, and become histologically different;
   (b) The differences are visible in the arrangement of the cells into organs.
   This is known as the process of ORGANOGENESIS.

3. The rate of growth of the tissues composing the organs of the fully formed embryo varies considerably.

4. Each species has its own particular ontogenesis.

5. As a rule, the higher the animal is in the biological

series, the more complex is its ontogenesis.

6. According to the Law of Biogenesis, ontogenesis does not follow a simple and direct route, but reaches its goal by detours.

7. Ontogeny does not give a short recapitulation of evolutionary progress, and is not an epitomised phylogeny.

GERMINAL LIFE OF THE FUTURE INDIVIDUAL

The life of the ovum and spermatozoon destined to unite to form the oosperm, can be divided into two periods: (a) The ante-conceptional, and

(b) The intra- and post-conceptional.

These two periods constitute the germinal life of the future individual.

(a) THE ANTE-CONCEPTIONAL PERIOD.

This is a long period in which the spermatozoon and ovum are specialised cells of the future father and mother, and are exposed to the healthy or pathological influences which act upon them. The most noteworthy phenomenon in this epoch is the maturation of the ovum, as evidenced by: (a) the expulsion of polar bodies, and

(b) reduction of chromosomes.

A somewhat analogous process occurs in the sperm-cell.

We must note carefully that it is in this ante-conceptional period that peculiarities and

characteristics from the father or mother or both, are impressed on the germ. These hereditary tendencies exist potentially in the spermatozoon or ovum prior to impregnation. It is hardly conceivable that such hereditary characteristics could be conferred upon the substance of the reproductive cells at any other time.

I shall refer to this again when we study "Morbid heredity, and eugenics" (page 123).

(b) THE INTRA- AND POST-CONCEPTIONAL PERIOD.

This is a relatively very short period, during which time the mature spermatozoon unites with the mature ovum to form a single cell, the impregnated ovum, or oosperm.

During this short epoch, the cell thus produced becomes by a process of division and specialisation first a morula mass, then a blastocyst, and lastly a blastocyst with the amniotic sac and pro-embryon inside it.

The most noteworthy phenomena at this stage are:

(1) Impregnation:
(2) Segmentation of the ovum:
(3) Commencing embryo formation.

The most noteworthy structures at this period are:

(1) Trophoblast:
(2) Amniotic sac:
(3) Umbilical vesicle.

At this stage there is but a trace of the embryo, and is, as yet, of little importance.

We presume that three-and-a-half days after coitus impregnation of the ovum occurs, and germinal life begins.

We also presume that seven days later, germinal life ceases, and embryonic life begins.

We presume, also, that five weeks later embryonic life ceases, and neo-foetal life begins.

This division between the germinal, embryonic, and neo-foetal periods is only an arbitrary one.

In the seventh and eighth week of antenatal life, the facial regions become unmistakably a face, and the limbs lose their bud-like appearance, and become limb-like.

Thus, the end of the sixth week of intra-uterine life is fixed as the terminus of embryonic life, and the commencement of foetal life.

We shall only concern ourselves, for our subject matter, with the first two stages, namely the germinal and embryonic.

We have no knowledge of what takes place in the ovum from the time it is impregnated by the spermatozoon to the time when we see it, already a complex structure, at the estimated age of five or six days (Peters' early ovum). It then already consists of an extra-embryonic part, blastocyst, covered with trophoblast, and lined with a thin layer of mesoblast, which contains an amniotic sac, a pro-embryon, and other structures.

How the ovum with its segmentation nucleus becomes converted into this complicated blastocyst, we can only hazard an opinion from the study of mammalian ova other than those of the human subject.

We must recognise the fact that uniovular twinning,

though it may result in the birth of two separately and completely formed male or female twins, is not a normal physiological process. There are numerous pitfalls in such development, and may manifest themselves in conjoined twins, foetus papyraceus, epignathus, and a host of other monstrosities, as will be seen later when we study "Teratology".

It is clear, therefore, that before we can understand the development of conjoined twins, and other monstrosities, we must first of all study the embryology of uniovular twinning. Binovular twinning, as we shall see later, is not true twinning (p.[24]).

The only real clue as to the mode of twinning in the human female comes from a study of polyembronic development in the nine-banded armadillo[4] (Fig.1). For various reasons it is believed that the process of uniovular twinning in man is essentially the same as that of the armadillo. Polyembryony is a unique mode of twinning in which plural offspring are derived from a single fertilised egg.

Our studies of the development of the armadillo cover the whole range of stages from ovogenesis to birth; except the earliest cleavage stages of the normally developing ovum.

This particular animal has supplied much valuable data, that no other animal could have supplied, and as I shall be tracing its particular mode of development it is better to briefly describe its ecology and habits.

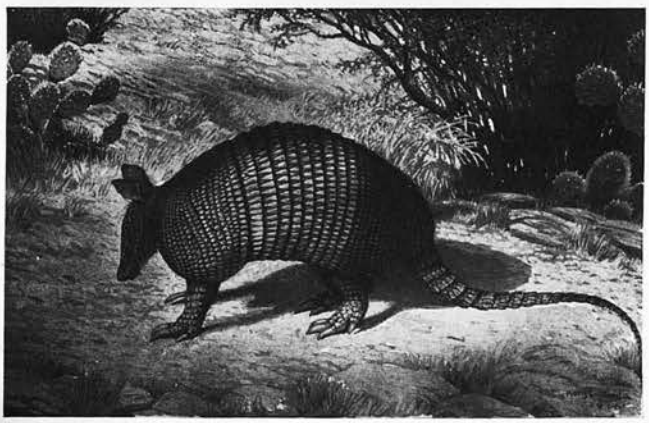


Fig 1. (after Newman)

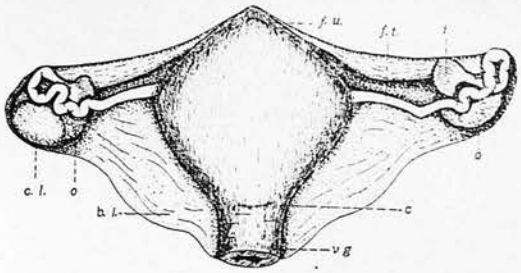


FIG. 2.—Uterus, ovaries, etc., of adult *Dasypus novemcinctus* (armadillo), showing simple squarish uterus with sharp fundus end (*f u*), cervix (*c*), Fallopian tube (*f t*), ovaries (*o*), only one of which, the left, has a corpus luteum (*c l*). (From Newman and Patterson.)

Fig. 2 (after Newman)

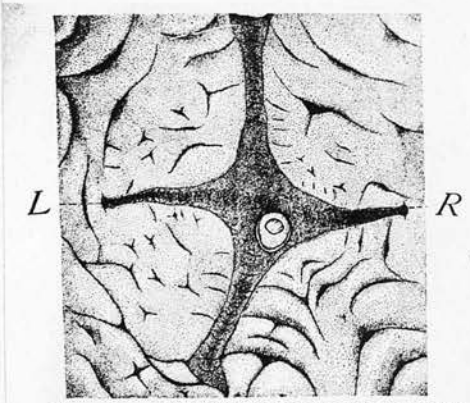


FIG. 3.—The small spherical body near the center of the cross-shaped area is an armadillo egg beginning to adhere to the uterine membranes in the fundus of the uterus. The wrinkled, lighter area surrounding the specialized attachment area is the general uterine mucous membrane. The lateral arms of the cross-shaped area are grooves communicating with the right and left oviducts or Fallopian tubes. (From Patterson.)

Fig. 3. (after Newman)

(4)

THE NINE-BANDED ARMADILLO.

(Dasypus novemcinctus Texanus)

The adult armadillo (Fig. 1) has a body length of eighteen inches. It possesses a long, sharp nose, and a tapering tail which is almost as long as the rest of its body. The head with its long ears resembles that of a mule. It has an armor, which consists of a carapace composed of a solid scapular shield anteriorly, a pelvic shield posteriorly, and a median banded region consisting of nine movable bands of armor. There is a cephalic shield on top of the head, and the tail is composed of rings of armor plate separated by armorless rings of soft skin. The legs are comparatively short, and the feet are armed with heavy claws adapted for burrowing. The armadillo is pre-eminently insectiverous. Insect-hunting is carried on at dawn and at night. It retires to its burrow during the day.

Mating takes place in October, and the period of gestation is between four and five months. The young are able to walk about within a few hours after birth.

THE FEMALE GENITALIA.

The uterus of the armadillo is simple and resembles that of the human female in a remarkable way (Fig. 2).

There is nothing suggestive of polyembryony about the ovaries and oviducts (Fig. 2). In every pregnant female there is an enormous corpus luteum in the particular ovary which has produced the fertilised ovum.

One of the most important discoveries in the armadillo

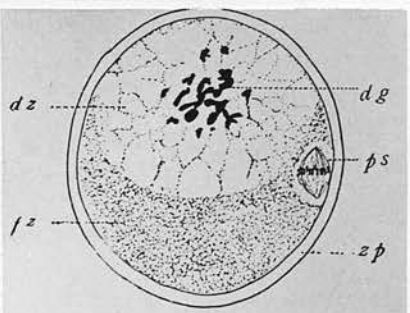


FIG. 6.—Maturating egg of the armadillo, showing total rearrangement of materials. The yolk (*d z*) with yolk granules (*d g*) occupies the animal pole, and the formative protoplasm (*f z*) occupies the opposite pole in the form of a cap. The nucleus (*p s*) is dividing to form the first polar body and lies tangentially to the periphery.

Fig 5 (after Newman)

investigation was that there is never more than one true corpus luteum in the ovaries of a pregnant female.

The number of corpora lutea is recognised by embryologists as a safe guide of the number of eggs involved in a pregnancy. We may feel confident in applying this test in cases such as those offered by human twins where the early embryonic history is unknown.

OVOGENESIS.

The process of ovogenesis in the armadillo is typical of mammals in general, and probably of the human female as well.

Each of the young ovocytes develops its own separate follicle. The ovocyte lies in the discus proligerus prior to maturation.

A pronounced cellular polarity exists in the full grown ovocyte (Fig. 4). The germinal vesicle is flattened against the zona pellucida at the animal pole. The deutoplasmic zone or yolk mass is a sphere of coarsely vacuolated material surrounded by a comparatively homogeneous zone of darkly staining protoplasm. The vegetative pole is most nearly in contact with the yolk mass.

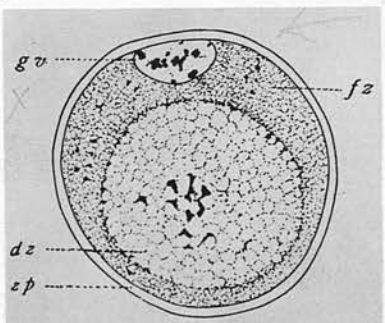


FIG. 4.—Full-grown ovocyte (unmaturated egg) of the armadillo, showing the mass of thin yolk in the center (*d z*) and the peripheral formative zone of protoplasm (*f z*), the nucleus or germinal vesicle (*g v*) at the animal pole, and the zona pelucida or egg shell (*z p*).

Fig 4. (after newman)

An extremely radical change in polarity and general organisation takes place during maturation. The formative zone of protoplasm moves to the vegetative pole, and forms a cap with a crescentic cross-section (Fig. 5). Opposite to that pole, and lying in contact with the zona pellucida, we now find the originally central yolk mass.

The germinal vesicle enters the stage of a first polar spindle, which lies tangentially to the periphery of the ovocyte. These phenomena pass through with extraordinary rapidity, for we have not been successful so far in finding out the transitional stages between that before the commencement of reorganisation (Fig.4) and that after its completion. (Fig. 5)

We thus find a complete reversal of polarity. The yolk mass now occupies the animal pole, and the formative protoplasm occupies the vegetative pole.

The physiological significance of the shift of the deutoplasm from the centre of the ovocyte to the periphery is the first step in the process of deutoplasmic extrusion. Apparently, this mass of degenerate yolk is of no value to the egg, and must be extruded before cleavage can take place. The process of extrusion is one of rupture of the vitelline membrane and abstriction of the yolk, followed by a subsequent rounding up of the formative materials to form an egg that is much smaller than the original ovocyte.

The egg completes its nuclear maturation prior to the complete abstriction of the yolk mass.

In the ovocyte of the first order there are thirty-two chromosomes, and after typical tetrad formation the number is reduced to sixteen in the first polar body, and to sixteen in the ovocyte of the second order. The second maturation division is equational, and produces a second polar body. In all probability this process goes on while the egg

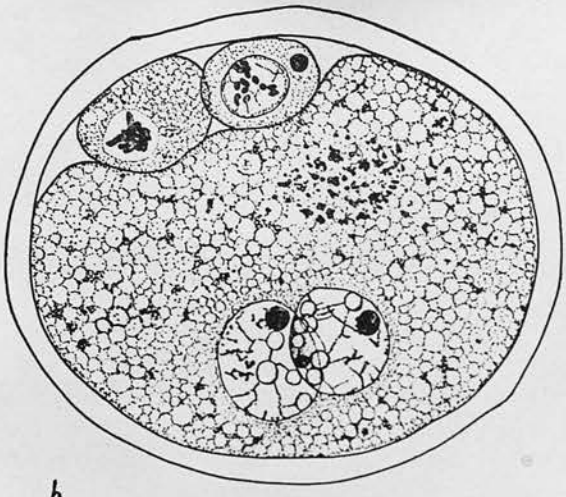


FIG. 6.—A fertilized armadillo egg with two polar bodies and the male and female pronuclei side by side.

(after Newman)

is in the tube just before impregnation.

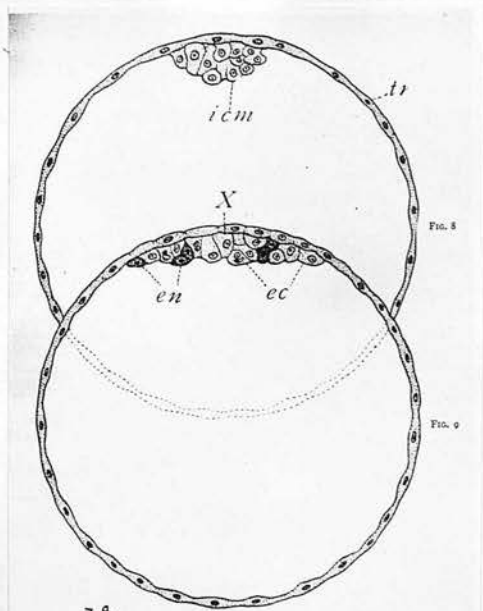
H. H. NEWMAN was fortunate enough to discover one fertilised egg in a part of the oviduct not far from the fimbriated end of the tube. This egg showed the male and female pronuclei lying close together in the formative protoplasm, and two polar bodies (Fig. 6). The deutoplasm had not yet been extruded.

We do not know with certainty what form of cleavage we have in the armadillo. NEWMAN predicts that when the cleavage is made known it will prove regular because, he argues, that the arrangements of embryos in pairs and the mirror-imaging effects that are so striking a feature of the quadruplets are much more in accord with a type of cleavage in which the blastomeres retain a regular and definite position than with one in which the cleavage cells shift about. There is nothing suggestive of polyembryony about any phase of the process. The eggs are ovulated singly, have small polar bodies, are fertilised by but one sperm, and in all probability begin cleavage in normal fashion.

EARLY EMBRYONIC DEVELOPMENT.

J. T. PATTERSON took up the study of the embryonic development, and discovered the late cleavage and early embryonic stages.

He never found more than one egg in the uterus or tubes of one female. From the fact that the eggs found in the Fallopian tubes, and all those found free



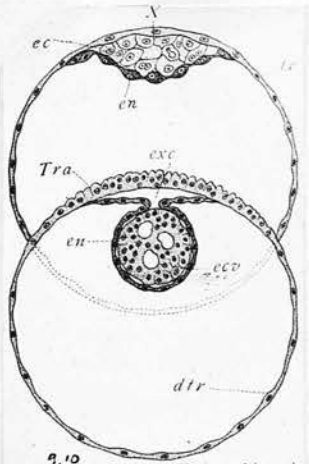
Figs. 7, 8.—Sectional view of two earliest embryos of the armadillo. The two are shown overlapping, to save space. (For description see text, stages I and II.) The trophoblast (*tr*) and inner-cell mass (*ic m*), ectoderm (*ec*), and endoderm (*en*) are shown. The point *X* is the apical pole of the egg. (Modified from Patterson.)

(after Newman)

in the uterus were in almost precisely the same embryonic stage, and from the additional fact that nearly every large female examined as late as three weeks after the earliest date mentioned had an egg in practically the same stage of development, he came to the important conclusion that there is a period of quiescence of about three weeks, during which time the egg either remains at a standstill, or else develops so slowly as to make no perceptile progress. This period most probably holds the clue to the physiological explanation of polyembryony. We shall consider this important point again when we discuss the underlying causes of twinning (p.34).

STAGE I. THE BLASTOCYST. (Fig. 7).

The youngest egg that has been found by PATTERSON has been in a rather late cleavage stage, in which the embryonic cells, eleven in number, form a knot, or inner-cell-mass (icm in Fig 7) attached to the inner surface of the large, hollow sphere of non-embryonic cells, the trophoblast (tr). The trophoblast has a purely nutritive function and serves later to attach the vesicle to the walls of the uterus. Six of the eleven cells seen in the earliest egg differ from the others in having larger nuclei, and are destined to form the embryonic ectoderm. The other five cells form the endoderm. At this stage there is not even the slightest indication of a prospective division into four embryos.



FIGS. 9, 10.—Two eggs of the armadillo, drawn as before, partly overlapping. The upper egg (stage III) shows the ectoderm (*ec*) rounding up into a ball and the endoderm (*en*) in the form of a continuous layer beneath the ectoderm. The apical pole is at X. The lower egg (stage IV) shows the ectoderm (*ec*) rolled into a ball and nearly surrounded with endoderm (*en*). Trophoblast has been thickened into Träger (*Tra*) at the upper pole and the remainder is called diplotrophoblast (*dtr*); extra-embryonic cavity (*exc*). (Modified from Patterson.)

(after Newman)

STAGE II. EARLY GASTRULATION (FIG 8).

At this stage we find the cells of the inner-cell-mass to have increased in number, and have formed themselves into a flat disc of one or two layers thick. The endoderm cells are distinguished from those of the ectoderm by being more deeply stained. They are already beginning to leave the part of the embryonic disc that is in contact with the trophoblast, and to migrate downward to a position beneath the ectodermal mass.

STAGE III. COMPLETED GASTRULATION (Fig. 9)

The cells of the endoderm have shifted from the trophoderm to form a complete layer of somewhat flattened deeply staining cells to lie in close proximity to the compact mass of ectoderm cells (ec in Fig.9) on the side away from the trophoblast.

Very little change occurs in the trophoblast during the first three stages. Eggs of about the stage shown in Fig.9 are found lightly attached to the uterine wall near the centre of the cruciform area shown in Fig. 3 .

STAGE IV. EMBRYONIC GERM-LAYER INVERSION (Fig. 10).

One would expect to find the ectoderm outside and the endoderm inside, but in the armadillo a form of inversion occurs which results in the ectoderm getting inside the endoderm. This remarkable phenomenon would appear to offer a highly favourable opportunity for this type of embryonic doubling.

Soon after completion of gastrulation the

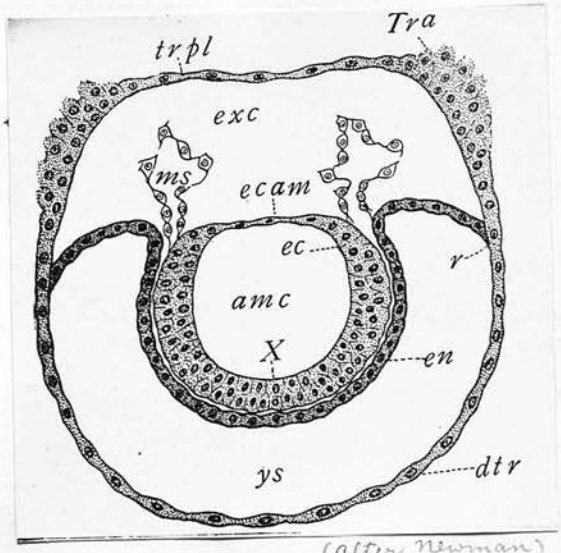
somewhat flattened mass of ectodermic cells begins to round up, and the process of rounding up is a form of invagination of the middle or apical portions, so that the free edges unite above, and the whole mass becomes essentially a hollow ball. The ball in Fig.10 appears to be only partially hollow, but the ectodermic mass is morphologically a vesicle with a central cavity, which is the primitive amniotic cavity.

In this process of germ-layer inversion, the ectoderm is the active agent, and the endoderm plays the merely passive role of maintaining its contact with the ectoderm. The result is that it comes almost completely to surround the ectodermic vesicle. The ectoderm becomes totally separated from contact with the trophoblast, and a cavity arises between the trophoblast and the embryonic tissues, which is the beginning of the extra-embryonic cavity (exc in Fig.10).

A process of rapid cell proliferation preparatory to invading the maternal tissues commences in that portion of the trophoblast which was adherent to the uterine mucosa. This specialised portion of the trophoblast becomes later the primitive placenta or trager, while the thin-walled part of the trophoblast is known as the diplotrophoblast (dtr in Fig.10).

STAGE V. PERIOD OF RAPID GROWTH: ESTABLISHMENT OF BILATERALITY (Fig. 11).

Up to now very little increase in the actual mass of tissue has taken place. The egg has merely



(after Newman)

Fig 11

Tra = trager :
ec = ectoderm: hollow vesicle
X = apical pole
r = junction of endoderm (en) and
apolar trophoblast (dtr.)
tr.pl. = Trophoblastic plate
ec.am = ectodermal layers of amnion.
am.c. = amniotic cavity
ms = mesoderm
exc = extra embryonic cavity
ys = yolk sac

(after Newman, modified from Patterson)

increased in size owing to the accumulation of fluid in the trophoblast cavity.

A period of rapid cellular proliferation and consequent tissue growth begins simultaneously with the development of the trager and its invasion of the uterine mucosa. At the stage shown in Fig.11 the maternal mucosa is deeply invaded by the trager. The increase in size of the vesicle shown in Fig.11 as compared with Fig.10 is due partly to the marked enlargement of the extra-embryonic cavity, and partly to the expansion of the cavity of the ectodermic vesicle, which is now a true amniotic cavity (amc in Fig.11)

The embryonic ectoderm is now a vesicular mass of cells with the anterior or apical end at X. The embryo is veritably a gastrula turned inside-out. The process is one of "germ layer inversion". The embryo, though inside out is clearly polarised and bilateral, but is still one embryo. In the mesoderm (ms) we see a further evidence of bilaterality which is proliferating at two bilateral points where the ectoderm and endoderm take leave.

STAGE VI. THE FIRST STEP IN TWINNING:THE PRIMARY EMBRYOS (Fig 12).

This is the stage which concerns us most in order to understand the origin of uniovular twinning in man which may either eventuate in the birth of separate male or female twins, or, if the development is arrested or other causes, as will be explained later, malformations and monstrosities such as my case of the

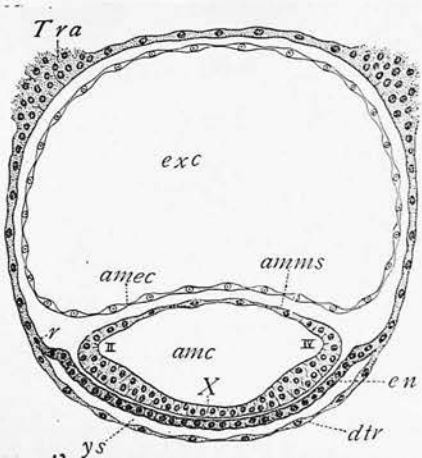


FIG. 12.—An armadillo embryo in the true twin stage. The thickened plates of ectoderm below the figures II and IV are the embryonic primordia of the twin embryos and are as yet undivided to form the quadruplet condition. Lettering same as in Fig. 11. (From Newman after Patterson.)

(after Newman)

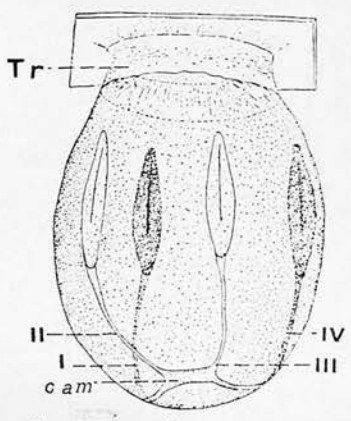


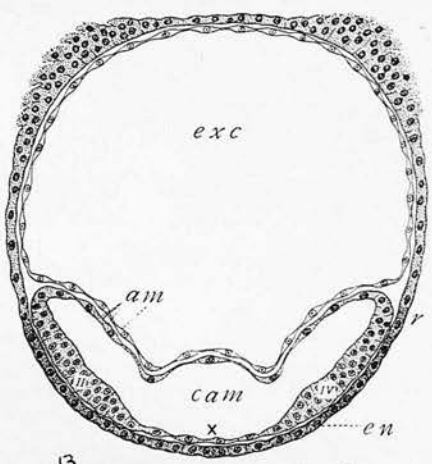
FIG. 25.—Armadillo egg showing four embryos in early primitive streak stages. (See stage VIII.) (From Patterson, but inverted in order to be comparable with the other stages.)

(after Newman)

Clairwood twin (Fig.7%) may result.

We have learnt that the ectodermic vesicle, which was originally situated near the animal pole of the egg, has progressively retreated from this pole and now lies with its apical part - head end - almost at the vegetative pole. The formerly voluminous trophoblastic cavity, has gradually diminished in volume (Stage V. and VI), until it is nearly a flattened cavity (ys in Fig.12) between the endoderm and the trophoblast. At this stage the free edges of the endoderm have fused with the trophoblast at r, and the diplotrophoblast has thinned out preparatory to a subsequent total disappearance as in stage VII. The retreat of the ectodermic vesicle from pole to pole, and the crowding out of the original trophoblast cavity appear to be due to the pressure of the rapidly enlarging extra-embryonic cavity (ex c in Fig.12), which is now lined internally with a complete vesicle of mesoderm (ms). That part of the mesoderm next to the ectodermal amnion completes the amnion proper. The embryonic mesoderm has not yet been formed.

The ectodermic vesicle is seen to be flattened against the endoderm, and two hollow evaginations are shown at right and left sides. These are the PRIMORDIA of the PRIMARY EMBRYOS (II. and IV). These outgrowths constitute twin embryonic areas with the apex or head end of each pointing towards the apex of the ectodermic vesicle (X), and with the posterior or growing end of each pointing the one towards the right, and the other



13

FIG. ■.—Armadillo egg showing two out of four embryos growing away from the common amnion (*c am*). The other two embryos (I and III) do not show in this plate. A view from the lower pole of the egg is seen in Fig. 15. (For description see stage VII.)

(after Newman)

towards the left side of the uterus

STAGE VII. THE ORIGIN OF QUADRUPLETS: SECONDARY EMBRYOS FORMED (Fig. 13).

It is at the stage shown in this figure that the second step in twinning occurs, but because it is a bilateral sectional view of the egg, fails to show the secondary embryos. The embryos II and IV in the Fig. are primary and lie respectively to the right and to the left of the egg, while a shorter secondary embryonic outgrowth appears to the left side of each primary embryo, so that the two secondary embryos lie with their axes pointed one towards the dorsal and the other towards the ventral side of the uterus. The embryo on the dorsal side is called III and is said to be the secondary embryo paired with primary embryo IV, while the ventral secondary embryo is called I, and is similarly related to the primary embryo II.

Fig. 16 is an armadillo egg showing four embryos in early primitive streak stages, and shows the retreat of the embryos from the common amnion toward the original pole of the egg.

I shall not follow up the development beyond this stage. We have traced the remarkable changes which take place from the early blastocyst to the early signs of twinning. With this knowledge we are now ready to proceed to the next chapter, and study the phenomena which occur in the formation of human monstrosities.

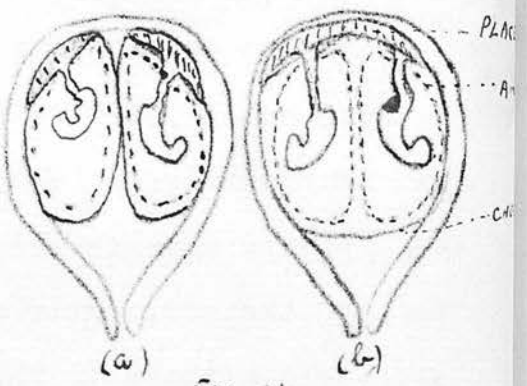


Fig 14.

Binovular Twins | Uniovular Twins

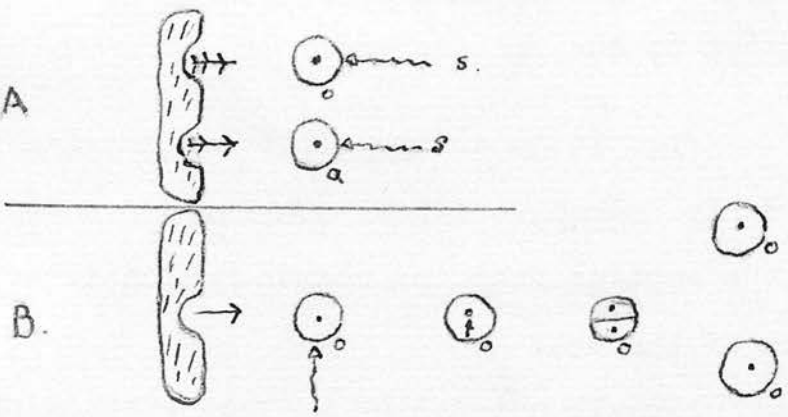


Fig 15.

A Diagram of production of Binovular twins. Two ova (o) dehisced. Simultaneously undergoing fertilisation by separate spermatozoa (♂)

B. Production of Uniovular twins. A single ovum (o) fertilised by a single spermatozoon (♂) undergoing later cleavage

CHAPTER III.

TERATOLOGY or THE PRODUCTION OF MALFORMATIONS

CHAPTER III.

PART I.

TERATOLOGY or THE PRODUCTION OF MALFORMATIONS. (6, 10)

INTRODUCTION.

Teratology is the science which deals with the causes and results of abnormal development. Embryology as we have seen, is concerned solely with normal development.

Teratology as a science embraces not only the major monstrosities such as the Siamese twins (Fig. 51), but also the minor malformations, and anomalies such as hemi-hypertrophy, polydactyly, (Fig. 40), giantism (Fig 43), spina-bifida (Fig. 33, 34), hare-lip (Fig. 30), etc.

In view of the fact that conjoined and parasitic twins result from a disturbed mechanism in the development of twins, it is necessary, in the first place, to study the formation of twins in general.

TYPES OF TWINNING IN MAN

We recognise two types of twinning in man:

(a) Uniovular, and

(b) Binovular.

(a) Uniovular twins (7) (Fig. 14 (b) 15 B.)

These twins have many synonyms. They are also known as "monozygotic", "duplicate", "homogeneous", "identical", and "monochorial" twins.

They are invariably of the same sex, being derived from a single fertilised ovum. They originate from two growing points on the embryonic cell mass. Generally there is one chorion, two amnions, and one large placenta. There is always a communication between the area of the placenta common to both.

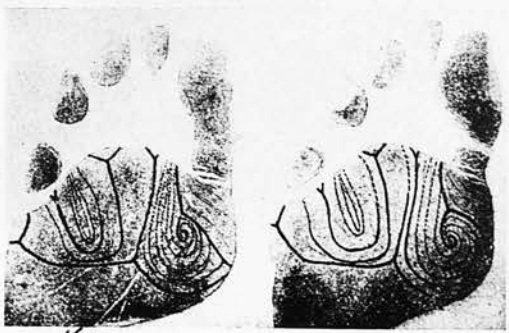


FIG. 16a.—Photograph (from Wilder) of the left sole-prints of a pair of duplicate twins. The heavy lines are lines of interpretation. Note the striking similarity amounting almost to identity.

(after Newman)

This intercommunication of circulations of the two foetuses may be very slight in some instances, but in others it is very pronounced, in which case there may be serious interference with the growth and development of either and result in an acardiacus (p.64).

These twins have a remarkable resemblance.. WILDER quotes a case of triplet sisters, obviously monochorial, so striking in their similarity, that even the mother could not identify them. On one occasion two of the sisters complained bitterly that they had not had their bath one morning, while the third gleefully announced that she had had three!

This striking similarity does not only apply to the external appearance and features, but also holds good in the study of their finger and sole-prints. Fig.16a is a reproduced photograph of the left sole-prints of a pair of uniovular twins, which shows the striking similarity.

(b) Binovular twins (4) (Fig. 14(a) 15A).

In two-egg twinning we get fraternal twins which may or may not be of the same sex, and are usually no more alike than are ordinary brothers and sisters. They originate from two ova, and develop normally. There are two placentae which do not communicate with each other. Thus, two-egg twinning is not true twinning at all. Twinning is twaining, or twoing. It is the division of one individual or one organ into two. Dichotomy is a synonym for twinning, for it means literally

a process of division into two parts.

THE DEVELOPMENT OF THE NORMAL INDIVIDUAL IS A FORM OF TWINNING.

Uniovular twinning, where a single ovum produces plural offspring, is a phenomenon that should be considered as only a phase of the much more general phenomenon of symmetrical division.

We are apt to forget that the development of the right and left homologous organs in a bilateral organism such as the human body, is essentially a twinning process, for it involves the division of a median unpaired primordium into two equivalent parts, one of which is the mirror image of the other. (vide hemi-hypertrophy p.69).

THE UNIOVULAR ORIGIN OF CONJOINED TWINS (8, 9).

Conjoined twins are the result of a peculiar and abnormal division of a single egg. We come to this conclusion for the following reasons:

(a) They are always of the same sex:

(b) They very frequently have transposition of the viscera (situs inversus viscerum).

(c) They are joined symmetrically with regard to each other, and homologous parts of the two systems are always united e.g. head to head, pelvis to pelvis, thorax to thorax (cf. Siamese twins Fig.57). This is known as the "Teratological Law": the union of like to like - "eadem ibidem".

SUMMARY.

1. Identical twins originate from one ovum.

2. Binovular twins originate from two ova.

3. Double monsters originate from one ovum.

4. Normal development is a form of twinning.

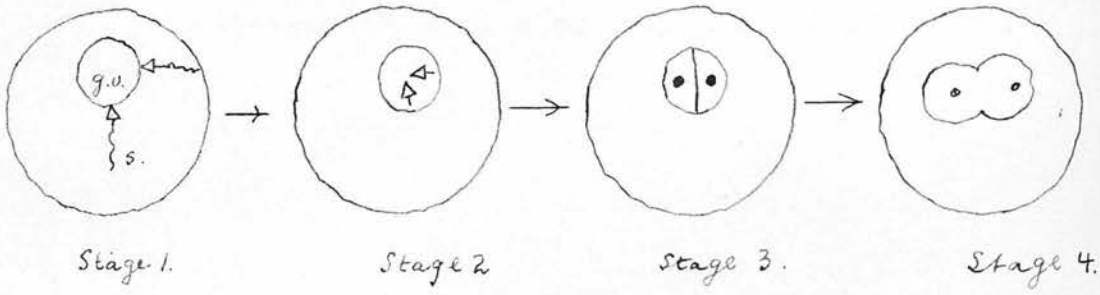


Fig 17. to explain DARESTE'S THEORY OF FUSION : S = Sperm
g.v. = germinal vesicle :

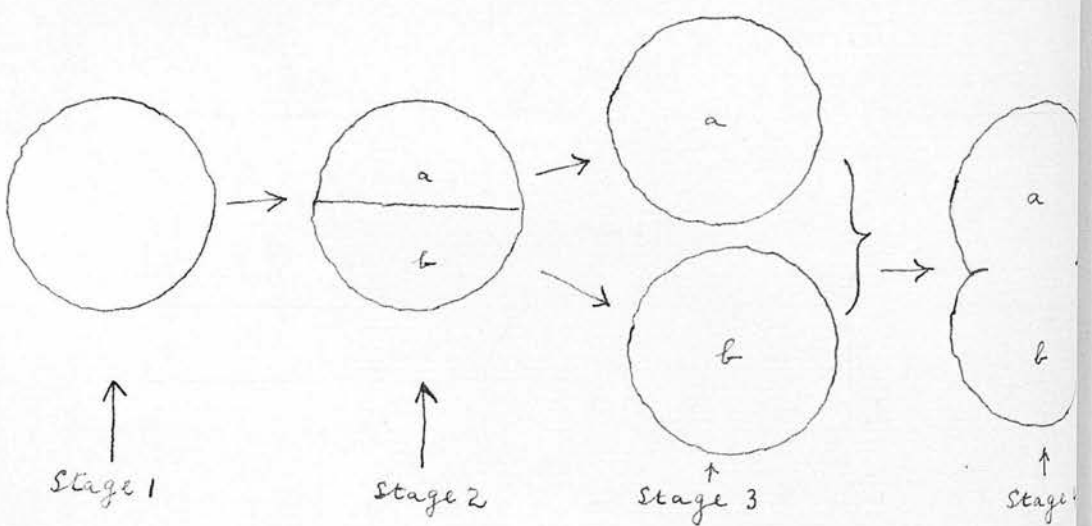


Fig. 17A to explain FISHER'S FISSION and FUSION THEORY.
stage 1 = young embryo : stage 2 + 3 complete fission
stage 4 = fusion of two embryos.

PART II.

(4.11)

THEORIES OF THE ORIGIN OF CONJOINED TWINS.

Numerous theories have been advanced from time to time to explain the origin of conjoined twins.

The following are the most important of these:

1. Fusion theory;
2. Fission and fusion theory;
3. Blastotomy theory;
4. Budding theory;
5. Fission of inner-cell-mass of early blastoderm theory.
6. Double gastrulation theory;
7. Radiation theory;
8. Superfluity theory;
9. Fission theory.

(12)

1. FUSION THEORY ("Verwachsungstheorie")

DARESTE believed double monsters to be produced by the fusion of two embryos on the same germinal vesicle, and believed that the existence of twins was determined prior to the commencement of incubation, and probably as the result of the entrance of more than one spermatozoon. Fig.17 is a diagrammatic representation of his theory.

(13)

2. FISSION AND FUSION THEORY

FISHER in 1866 postulated a theory that human double monsters are due to an early total fission of the embryo, followed by a subsequent fusion of the two parts. This implied that all united parts of double monsters are

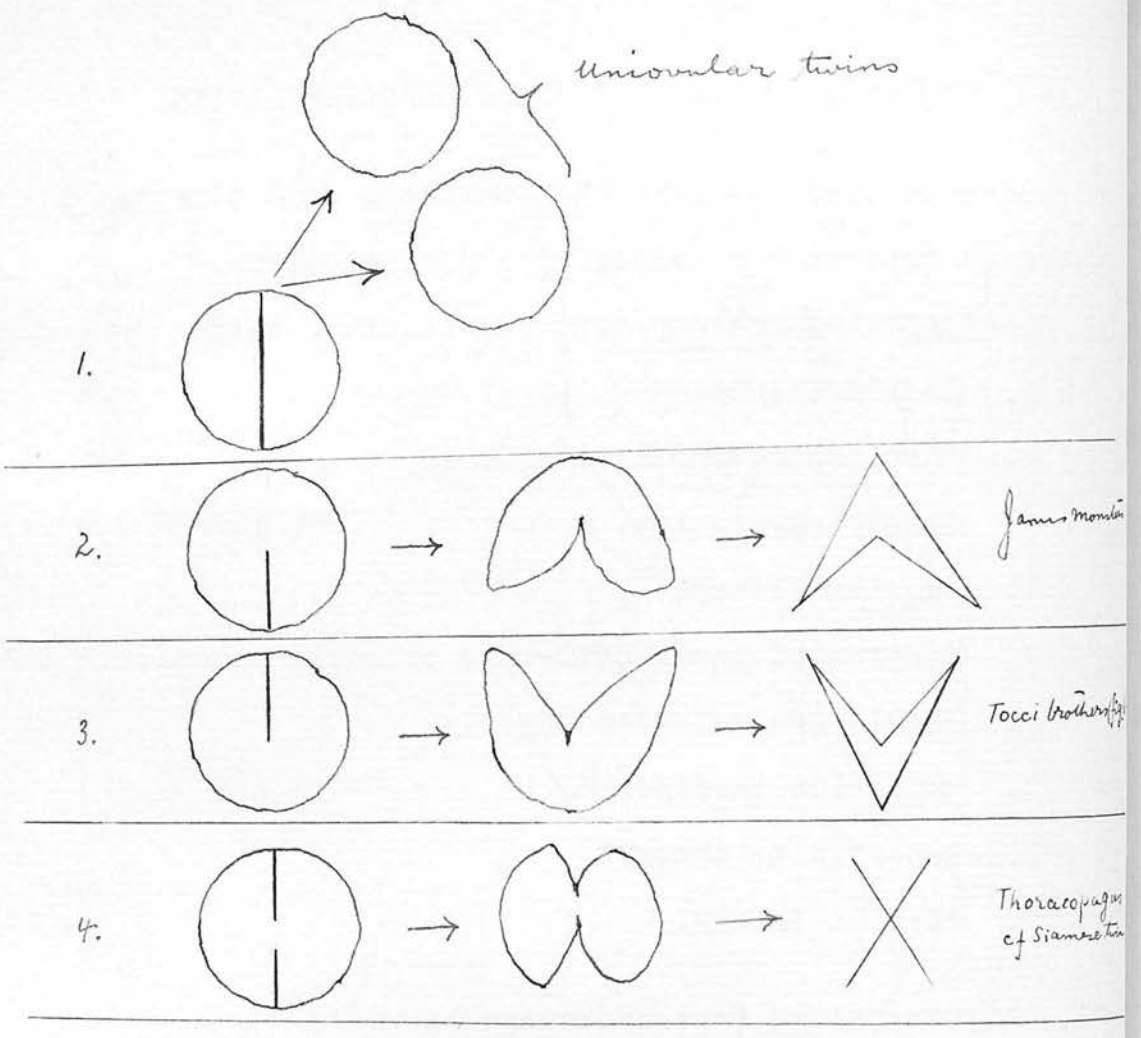


Fig. 178 1. Complete blastotomy leading to uniovular twins
2. Partial dichotomy " " Janus monsters
3 " " of anterior portion = Bicephalus etc
4. Incomplete dichotomy at centre = Thoracopagus.

Schematic representation of Wilder's Blastotomy Theory.

fusion products. Fig.17A is a diagrammatic explanation of FISHER'S theory.

3. BLASTOTOMY THEORY (14)

WILDER, in 1904, proposed the blastotomy theory of monstrous duplicities. His idea is that separate twins result from the complete separation of the blastomeres of the two-cell stage of the ovum, and that double monsters result from the incomplete separation of these blastomeres. The degree and position of the union between these twins are attributed to variations in the points of contact of the two cells. If they remain attached by the apical ends, we would have Janus monsters (see Fig.46), where the two heads are as fused together; if by the basal ends, we would have pygopagi (e.g. Fig.60), in which case the twins seem to be joined back to back; if by the ventral sides, thoracopagi, (e.g. Fig.77), where the junction is in front like in the Siamese twins (Fig.52).

WILDER later abandoned his theory in favour of the "Budding" theory. Fig.17B is an attempt at an explanation of the blastotomy theory.

4. BUDDING THEORY (4)

This theory was propounded by PATTERSON and STOCKARD. It holds that the original embryo retains its identity, but that, through its loss of dominance over the rest of the blastoderm, accessory or secondary buds arise which give rise to additional embryos. This theory turns out to be inadequate for its

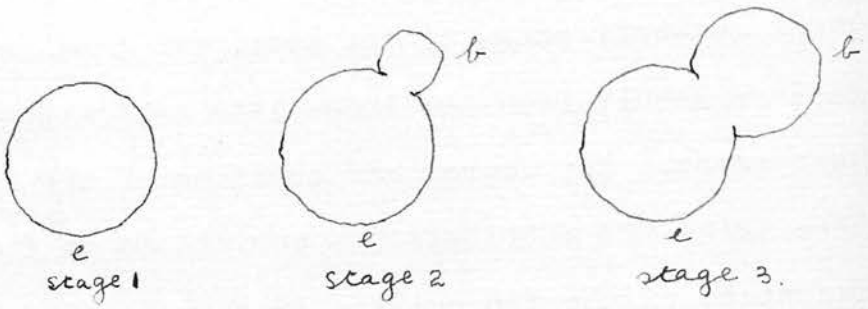


FIG. 17c. *e* is original embryo.

b is a bud which has grown bigger in stage 3.

Schematic representation of Patterson & Stockard's BUDDING THEORY.

adoption in the case of human uniovular twins, and especially is it inapplicable to that of conjoined twins.

The principals of this theory are shown diagrammatically in Fig. 17c.

(15)

5. FISSION OF AN EARLY BLASTODERM

STREETER proposed a theory of human twinning which is essentially a fission theory. He considers that the fission process takes place at the inner-cell-mass stage of the early blastoderm. This mass is believed to undergo subdivision into two embryonic primordia. If these primordia are equal in size, then the chance of development in an orderly manner would be equal, and eventually result in the birth of identical twins.

The chief objection to this theory is that it fails to account for the symmetry relations of duplicate twins, and for the fact that such twins frequently have a common amnion.

Double monsters always have a common amnion, and have strikingly symmetrical and intimate interrelations: conditions that could not be accounted for unless the embryonic axis was formed during the twinning process.

(16)

6. DOUBLE GASTRULATION THEORY

AREY collected together some sixty cases of human tubal twins about forty of which were uniovular. One of these was especially significant. It consisted of a single chorionic sac which contained twin embryos.

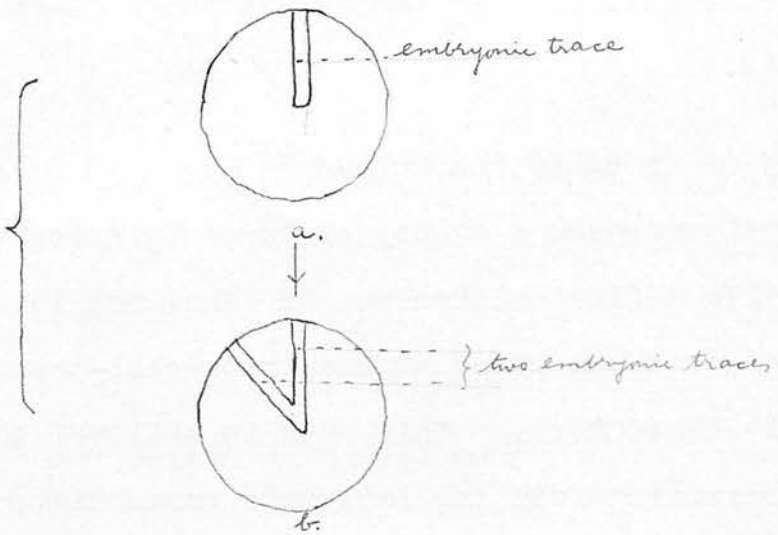


Fig 17 to explain RAUBER'S Radiation Theory.
a: one embryonic trace
b: two embryonic traces

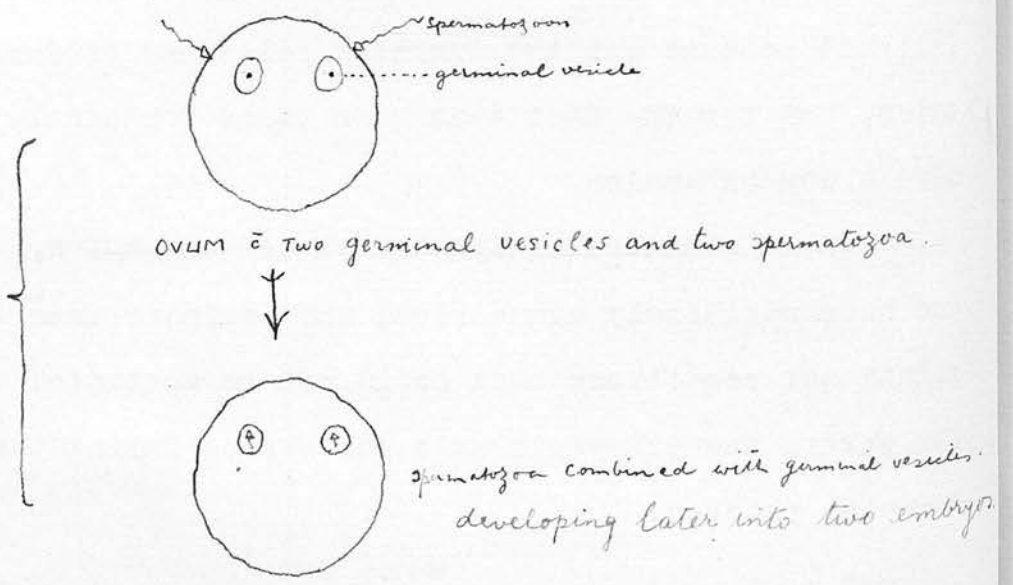


Fig 18 to explain Superfluity Theory.

There was a common yolk sac from which distinct yolk stalks arose near together, and passed to their respective umbilical cords. The mode of origin here is probably one of double gastrulation of a distinctly symmetrical kind.

(4.11.)

7. RADIATION THEORY

RAUBER introduced this theory which is based upon the fact that in the earliest stage the embryonic trace extends from the edge of the germinal ridge towards the zona pellucida as a radius. When a plural formation occurs he assumes that two or three of these embryonic traces appear instead of one, the development being designated as "pluri-radia". This theory is based largely on conditions obtaining in the lowest vertebrates, and we are not justified in applying it to the problems of the development of man.

Fig. 17 is a rough diagram to convey RAUBER'S meaning.

(11)

8. SUPERFLUITY THEORY

Under this heading may be grouped the theories of several investigators that see a cause for compound monsters in an excess of some of the elements of the original germ namely:

(a) Polyspermy, and

(b) Two germinal vesicles on a single yolk, each fertilised by a separate spermatozoon. This is conveyed in Fig. 18 . It has been proved conclusively that polyspermy is always fatal to the normal development of the ovum (vide page 38).

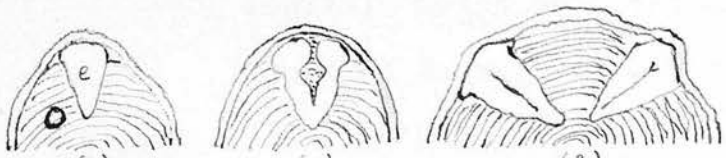
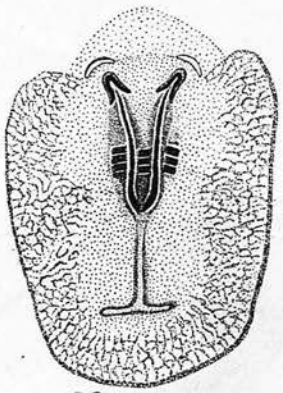


Fig. 19 o, Blastodermic vesicle; e, primitive germ.
z, Zona pellucida (Ahlfeld)
(1) Zona pellucida exerting pressure on embryo
(2) Embryo split incompletely
(3) Embryo split in two and separated.

Diagram to explain AHLFELD'S FISSION THEORY.



20.
FIG. 19.—A typical double-headed chick monster (anadidymus) resulting from the partial dichotomy of the anterior end of the originally single embryonic axis. (After Tannreuther.)

after Newman

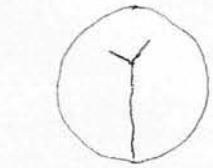
(17)

9. FISSION THEORY ("Spaltungstheorie")

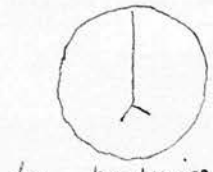
The theory of fission as presented by one of its most zealous supporters, AHLFELD, accounts for all forms of double monsters.

In consequence of unusual pressure from without, exerted by the enveloping zona pellucida upon the accumulated formative material of the embryo, the small undifferentiated embryonic cell-mass is cleft and displaced (Fig.19). This cleavage takes place prior to the appearance of the primitive streak. Where the pressure results in the complete equal separation, the halves lie parallel, and, at first, near its other, subsequently to be separated. Where the fission is incomplete, only the divided portions change position on the blastoderm. Should the cephalic rudiments remain united, the caudal extremities diverge (Fig.25); should, on the contrary, the latter remain connected, then the anterior extremities become separated (Fig.26).

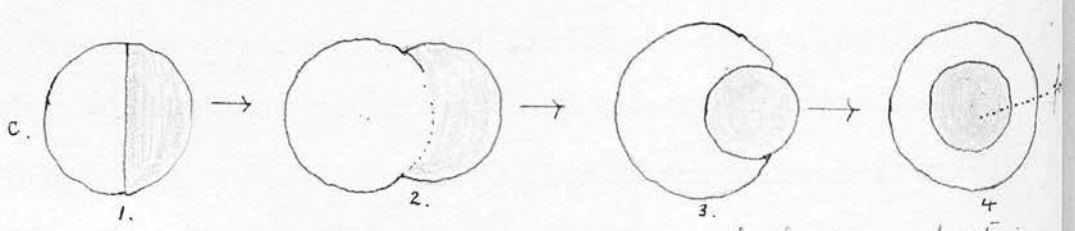
The early chick embryo of sixteen hours, which GERLACH actually observed bifurcate, suggest the changes probably taking place in mammalian ova (Fig.20). The first thing noted was a broadening of the anterior end of the primitive streak; then, a forked divergence which became more pronounced, and by the twenty-sixth hour reached a length of one-half of that of the undivided axis; from each anterior end of the diverging limbs a distinct head process extended.



a. anterior dichotomy.



b. posterior dichotomy.



Stages in the development of foetus in foetu showing fission (1); and complete inclusion (4).

Fig 21 Diagrammatic representation of the origin of Katadidyma anadydima and foetus in foetu

DISCUSSION

None of these theories are altogether satisfactory.

I do believe that fission plays the commonest role in double monstrosities of the type of "Mrs B." (Fig.72), Blanche Dumas (Fig.73), the Tocci brothers (Fig.64), and the like. In these cases the ovum most probably divides unequally, and these unequal parts develop depending on the inequality. Fig.21 is drawn to explain what I understand by this unequal fission and their results. If the unequal division takes place at the anterior end (*a* in Fig.21), a dicephalus results such as Ritta-Christine (Fig.62). If the unequal division is in the caudal end (*b* in Fig.21) Blanche Dumas (Fig.73) and "Mrs B." (Fig.72) result. Here the "law of teratogenesis" - "eadem ibidem" holds good.

This law fails us in the authentic cases of foetus in foetu (Fig.76), and epignathus (Fig.71). I would explain the origin of the latter monstrosities to be due to complete fission with subsequent partial or complete inclusion as I endeavour to show diagrammatically in Fig. 21(c)

SUMMARY AS TO MODES OF HUMAN ONE-EGG TWINNING

The three most probable modes of one-egg twinning in man are:

(1) Fission of the blastoderm:

(2) Double gastrulation:

(3) Fission of the embryonic axis.

I should add a fourth: namely, "Complete fission with partial inclusion (e.g. epignathus) or complete inclusion (foetus in foetu).

PART III.

(16)

CAUSES OF TWINNING.

AREY has shown that uniovular twins are far more common in the Fallopian tubes than in the uterus. The tubes are not a normal nidus for the placentation of the embryo, and there is reason to believe that even the makeshift placentation that does take place is greatly belated.

We thus have a " PERIOD OF QUIESCENCE " with consequent partial loss of axiate organisation, and a physiological isolation of two secondary apical points of gastrulation.

PERIOD OF QUIESCENCE

There are possibly three factors to account for this period of quiescence and retardation:

1. UNDERSTIMULATION OF THE EGG. This is due to some defect in the "development inhibitary mechanism" of the sperm. If the egg were retarded through insufficient stimulation on the part of the sperm, it would probably undergo belated fission, the consequences of which would depend upon the degree of retardation.
2. BELATED PLACENTATION. This is due to a failure of the corpus luteum to stimulate the uterine mucosa. This condition implies some physiological discoordination between the various intricately interdependent

factors responsible for implantation of the ovum.

3. A HEREDITARY CHARACTER DEPENDENT UPON A 'GENE'. (3)

This 'gene' would have to be regarded as an unfavourable "growth-retarding factor" that causes a temporary period of quiescence resulting in belated placentation and twinning.
According to this theory the cause of twinning is purely intrinsic, unaffected by environment, and could be readily transmitted through the sperm as through the ovum.

DISCUSSION

I should add a fourth factor which I believe is more satisfactory than the others. I believe that in the healthy fertilised ovum there exists a "GROWTH REGULITORY MECHANISM" which is controlled by two secretions: one inhibitory which I shall call "INHIBITIN", and the other is stimulatory, and call it "STIMULIN". Normally these are properly balanced, and normal growth takes place. Should, for reasons to be discussed later (page 67), "INHIBITIN" be in excess or the "STIMULIN" be deficient, a period of quiescence will result with consequent deaxiation and subsequent twinning.

SUMMARY

Twinning is due to a period of quiescence: due to

1. Faulty "development-inhibitory mechanism" of the sperm:
2. Belated placentation due to defective corpus luteum:
3. A hereditary growth-retarding factor:

4. Upset of the "growth regulatory mechanism" due to excess of "inhibitin" or deficient "stimulin".

PART IV.

EXPERIMENTAL TERATOLOGY.

43

PRINCIPAL FACTORS IN ARTIFICIAL MALFORMATIONS.

The experimental methods in teratology by a host of able scientists have helped to throw a great deal of light on the etiology of monstrous births. Moreover, I believe it has given us a much clearer conception of the causation of simple and malignant tumours with a clue as to its prevention and treatment. (vide page 67).

The possible causes influencing the production of monsters may be arranged in three groups:

1. Sexual: (Hereditary):
2. Mechanical:
3. Physiochemical:
4. Environmental.

1. SEXUAL ELEMENTS (HEREDITY).

(a) OVA. The ova of particular women may possess an especial inherent tendency towards anomalous development. This is indicated by the repeated delivery of malformations from one mother (e.g.Fig.3o).

(b) SPERMATOZOA. That the sperm has some influence in the production of monsters is rendered plausible by the experiments of BORDEEN who saw deformed ova result from fertilisation by the sperma of toads which had been exposed to x-ray, and those of ARLITT and WELLS (19) who proved that repeated small doses of alcohol given to white mice produced abnormal spermatozoids, and finally sterility.

Experimentally, the use of either stale ova or spermatozoa for fertilisation, is followed by retardation of development and subsequent abnormalities. In monospermic ova, a stale condition induces polyspermy which is always fatal to the normal development of such eggs.

Exclusive of environmental or genetic defects, normal human conception is dependent upon the union of the germ cells at a time when their physiological condition is optimum for development. Therefore, it is reasonable to assume that the actual meeting of spermatozoa and ovum is often delayed until the physiological equilibrium of one or both makes the normal development impossible.

Evidence permits of no escape from the fact that many variations, anomalies, and malformations such as hare-lip, are hereditary (e.g. Fig.[30]).

GUYER and SMITH produced rabbits with defective eyes by injecting the pregnant mother with the serum of fowls rendered immune by repeated injections of pulped rabbit's lenses, and the deformity was transmitted by male and female to subsequent generations.

2. MECHANICAL[20]

The influence of mechanical impressions early attracted the attention of the experimenter. The mechanical influence employed by investigators in modifying the development of the ovum have been:

a. Abnormal position,

b. Direct mechanical injury, and

c. Disturbed equilibrium.

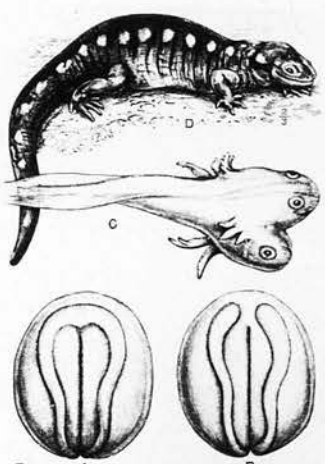


Fig. 22.—A, Normal egg of the American salamander, showing the medullary folds; B, an egg with abnormal medullary folds from which the double-headed embryo, C, was formed. (*Clark.*) D, The adult form of the salamander.

(after Bland-Sutton)

a. ABNORMAL POSITION

The long established fact that the germinal area corresponds with the lightest part of the egg, and consequently, when unrestrained always assumes a position on top, immediately beneath the shell, suggested the the elder GEOFFROY SAINT-HILAIRE an investigation of the effects of a change of position. The success of SAINT-HILAIRE in producing malformations by this method entitles him to the distinction of being the founder of experimental teratology.

The normal ovum of the chick, during the second half of incubation, lies with its axis parallel with the long diameter of the egg: the head at the broad end, and the tail towards the narrow end. Taking advantage of this relation, LIHARZIK placed eggs vertically, some with the broader end uppermost, others with it down. The effects of the augmented nutrition resulting from the increased blood supply, aided by gravity, were distinctly apparent in the unusual growth of that part which had been down, whether head or tail.

DARESTE, likewise, obtained similar results by incubating eggs in the vertical position.

b. DIRECT MECHANICAL INJURY

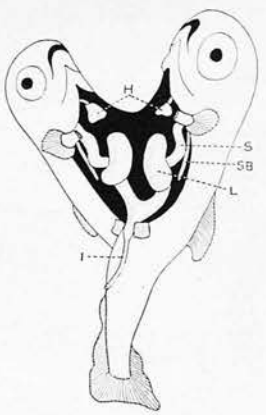
HERLITZKA (8), by constricting with a fine hair the blastula of a newt, produced a two-headed embryo.

STAHL and GASSER (11) succeeded in producing a partial inversion of the viscera by fixing the yolk with needles so that the germinal area lay beneath.

23

Fig. [redacted].—Twin salmon embryos from a hatchery, showing monstrous development with one common feature: the yolk-sac for each monstrous pair is single.

after Bland-Sutton



24.

Fig. [redacted].—A ventrolateral view of a trout double monster (anadidymus) showing *situs inversus viscerum*. The component on the reader's right is the true left-hand component and has the typical left-hand asymmetry of the species. The component on the reader's left (the right-hand component) has the reversed asymmetry of the viscera. Letters have the same significance as in Fig. 62. (From Swett.)

(after Newman)

c. DISTURBED EQUILIBRIUM

In another group of experiments, the disturbing influence was violent agitation. The early observations of VALENTIN on the unusual frequency of double monsters in fish ova which had been subjected to violent shaking, were followed by those of KNOCH who obtained similar results by keeping the water constantly disturbed.(Figs 23,24)

3. PHYSIOCHEMICAL (11)

Extensive experimentation in lower forms has contributed much data bearing on the teratological effects of slight variations in the optimum physio-chemical conditions under which development normally proceeds. Thus, by the addition of certain fatty acids, to the water in which, for example, sea urchins, or even fish, are reared, a wide series of monstrosities results. Similarly, by the addition to the water of magnesium chloride, lithium, and other salts, certain monstrous conditions, for example, cyclopia, can be produced.

4. ENVIRONMENTAL

The most favourable temperature for development of the chicken's egg is about 40 degrees C. Marked variations from this point either above or below, when long continued, are unfavourable for normal developmental processes. We are concerned here with two principal forces: (a) Thermic, and (b) Respiratory.

(a) THERMIC

By means of variations in temperature, DARESTE secured marked deviations in the form and development

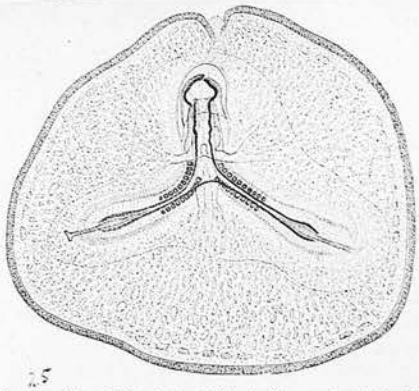


FIG. 25.—A typical two-tailed chick double monster (katadidymus) due to the partial fission of the posterior end of a single embryonic axis. (After Tannreuther.)

(after Newman)

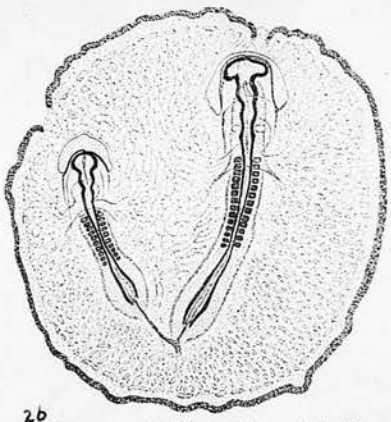


FIG. 26.—A rare type of chick duplicity, probably the result of a nearly complete longitudinal fission of an originally single embryonic axis. There are no evidences of plural gastrulation but, on the contrary, the posterior end of the axis is still single. (After Tannreuther.)

(after Newman)

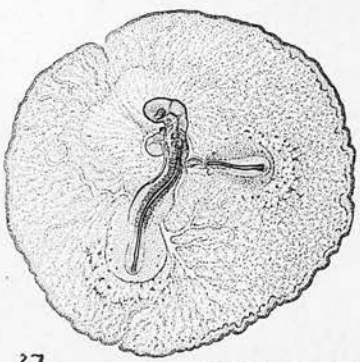


FIG. 27.—A very unusual type of chick twin embryo, doubtless a case that would lead to the autosite-parasite condition. The two embryos probably arose from two separate points of gastrulation, one of which was primary and the other secondary. The smaller, secondary, axis has evidently been partially inhibited by the larger, primary, axis, and was destined to be a mere parasite on the body of the latter. (Original.)

(after Newman)

of the germinal, and especially the vascular area. A continuous slight elevation of temperature retards growth, but accelerates development with the result that dwarf chicks are frequently produced.

(b) RESPIRATORY

Even more interesting have been the experiments by means of which the normal respiratory interchange of gases is affected. The effect of cutting off the access of oxygen by rendering the egg-shell impervious was studied long ago by REAUMUR, who found that in eggs in which the porosity of the shell had been destroyed, either by a complete coating of varnish, or by being submerged in water, development did not take place. Further, that an atmosphere saturated with moisture was, for similar reasons, unfavourable.

DISCUSSION

I believe that the conditions mentioned have an unfavourable influence on the "growth regulatory mechanism" which exists in the egg itself. An increase in temperature, for example, stimulates the "stimulin" of the egg, accelerates development, not permitting the normal steady growth, with the result that dwarf chicks are produced. Or, it may be, that this increase in temperature depresses the "inhibitin" with the same result.

SUMMARY

On reviewing the results of the foregoing attempts to produce malformations artificially, it becomes apparent that, disregarding direct mutilations, and bad heredity,

(a) Violent agitation,

(b) Variations in Physiochemical conditions,

(c) Variations in temperature, and

(d) Disturbance of normal respiratory interchange,

are all forces which, when acting on the early embryonic trace, are capable of producing profound alterations in the developmental processes not infrequently resulting in conspicuous malformations.

To this I should add that these forces cause a disturbance of the "growth regulatory mechanism" of the egg.

FIG. 28.—Infant with Spontaneous Amputation of Right Hand. Case No. 41.

(after Ballantyne)

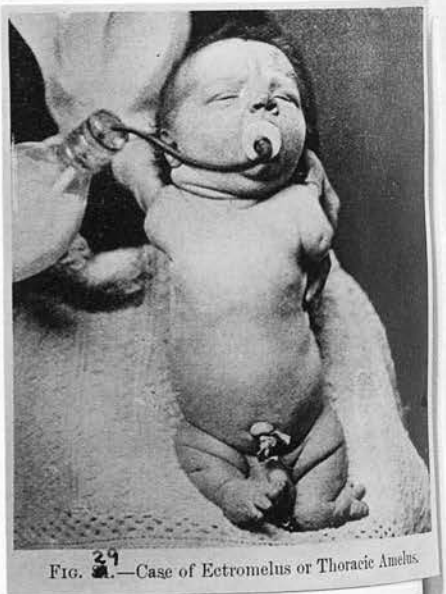


FIG. 29.—Case of Ectromelus or Thoracic Amelus.

(after Ballanty

PART V.

PRINCIPAL FACTORS IN HUMAN MALFORMATIONS. (3)

The experimental methods mentioned above have helped considerably to throw light on the mysteries of monstrous formations.

They point to two principal factors as the cause of human mal-developments, namely

a. environment, and

b. heredity.

a. ENVIRONMENT

Environmental factors which may lead to mal-developments may be listed under the headings:

a. Mechanical

b. Nutritional

c. Faulty implantation

d. Developmental arrest.

a. MECHANICAL FACTORS

J. W. BALLANTYNE of Edinburgh taught that amniotic bands play a leading part in adverse development. Such bands may span the amniotic cavity in various directions, thus permitting of adhesions, and ultimately producing developmental defects. (Fig 29) Occasionally these bands may become wrapped up about the legs or arms, or even about the neck, and in extreme cases, under these circumstances, may induce amputation (Fig.28). Amniotic bands are the result of imperfect vacuolisation of the originally solid primordium of the amniotic cavity.

According to MALL, it is the monster who produces amniotic adhesions, and not vice versa.

b. NUTRITIONAL

Under nutritional factors of teratogenesis may be listed:

a. Reduction in the normal oxygen supply,
b. Stringencies in the store of food, and
c. Vitamin deficiencies.

It is possible that the introduction into the system of the pregnant mother of alcohol, narcotics, lead, or other poisonous substances may result in mal-development.

Similarly, abortifacient drugs such as quinine, and even the toxins of imperfect and defective alimentation may, at certain critical periods of gestation, produce malformations.

c. FAULTY IMPLANTATION (20)

MALL holds the view that faulty implantation is a teratological factor, and is due to endometritis. He noted that early aborted terata were commonly associated with inflammation of the uterine mucosa frequently as a result of gonorrhoeal or syphilitic infection: such inflammation preventing the proper implantation of the egg.

CORNER disputes this point. He maintains that the fundamental factor in faulty implantation is nutritional, and physiochemical. CORNER'S studies of defective ova and the associated uterine mucosa in the pig, suggest that endometritis may have been overestimated as a prevalent factor in human teratogenesis. After examining the pregnant uteri of over five hundred

sows, he has shown that, in the pig, 10% of the ova never segment, 10% degenerate after becoming blastocysts, and that about 10% become abnormal during the subsequent course of pregnancy, leaving only about 70% to develop into normal, viable pigs. Since the uterine mucosa overlying these degenerate ova was both histologically and functionally normal, he concludes that, in the pig, delayed or faulty implantation can be eliminated as a causative factor of monstrosities.

d. DEVELOPMENTAL ARREST

The work of STOCKARD (21) has re-emphasized possibly the commonest factor of gross malformations, especially monstrous duplicities (monstra duplica), namely, the factor of developmental arrest at critical stages.

Working with the salt water minnow, (fundulus heteroclitus), he was able to produce at will practically any grade of duplicate monstrosities by simply interrupting development just before gastrulation, either

(1) by lowering the temperature, or

(2) by reducing the oxygen supply, and then, after a brief period, again starting development by return to normal temperature or oxygenative conditions.

The interpretation offered is to the effect that at certain critical stages in development, particularly in the beginning of gastrulation, normal development demands that a certain point in the blastoderm, e.g. the point of infolding in the formation of entoderm, and the production of the primitive streak, has developmental precedence over all other points. If

development be stopped by lowering of temperature, or by reducing the oxygen supply, other points in the blastoderm have the same advantage in the matter of developmental leadership when growth again starts with the return of favourable conditions. The opportunity is thus given to more than one point to develop two or more primitive streaks, and so various types and degrees of fission result (Fig.21).

Conditions in the hen's egg support this explanation. Normally, the egg is laid about the middle of gastrulation. Laying, generally, involves a lowering of temperature, and an interruption of development. At incubation, the temperature is again raised, and development resumed, resulting shortly in the formation of one primitive streak.

The occasional chick monsters are readily explicable on the assumption of a too early interruption of the gastrulation process giving the opportunity for the production of two or more primitive streaks. H. H. NEWMAN (4) believes that normal polyembryony in the armadillo (Fig.1) wherein four embryos always occur on the blastoderm, may be explained on the basis of the interruption of development at a critical period immediately preceding gastrulation due to a reduction in the optimum oxygen supply. This explanation does not appear to me to be adequate. It is hardly likely that the uterus of the armadillo when in the pregnant state would suddenly become impoverished in its store of oxygen. I believe that in normal development there is a specific retarding factor to be found in the ovum

itself - some subtle inhibitary factor probably in the nature of an internal secretion which has already been mentioned and described as "inhibitin".

Various human monstrosities, especially double monsters, are, no doubt, to a large extent, interpretable on the same basis of developmental arrest at the critical stage of gastrulation.

b. HEREDITY

This will be discussed under "Morbid Heredity and Eugenics" (p.123).

SUMMARY

The principal factors in human malformations are:

1. Amniotic bands and adhesions:
2. Faulty implantation of ovum due to endometritis:
3. Developmental arrest at critical stages of gastrulation due to disturbance of temperature, and oxygenation.
4. Heredity: Defective ova or spermatozoa.

PART VI. (3.6.11.)

CLASSIFICATION OF MONSTERS.

I shall not attempt at an exhaustive classification, but will group human monstrosities in a manner which I believe is most convenient from a clinical viewpoint.

Monsters can be divided into four big divisions:-

(A) Single monsters:

(B) Double monsters:

(C) Triple monsters:

(D) Unclassified monsters.

(A) SINGLE MONSTERS.

These come under three headings:

1. Monsters of defect (Monstra in defectu):
2. Monsters of excess (Monstra in excessu):
3. Monsters of default (Monstra per fabricam alienam).

1. MONSTERS OF DEFECT (MONSTRA IN DEFECTU)

Under this heading would come the following:

Cleft palate
Hare-lip
Hernia umbilicalis
Ectopia vesicae
Cyclops
Siren
Exencephalus
Anencephalus
Dwarfism (microsomia)

2. MONSTERS OF EXCESS (MONSTRA IN EXCESSU)

This variety would include the following:

Hemi-hypertrophy
Giantism (macrosomia)
Polydactyly
Macrodactyly.

3. MONSTERS OF DEFAULT (M. PER FABRICAM ALIENAM).

This includes those organs either wrongly formed or displaced. This would include also transposition of the viscera (situs inversus viscerum).

(B) DOUBLE MONSTERS (MONSTRA DUPLICA)

These come under three headings:

1. Terata Katadidyma:
2. Terata Anadidyma:
3. Terata Anakatadidyma.

1. TERATA KATADIDYMA

To this group belong the following types:

Diprosopus:
Bicephalus:
Ischiopagus:
Ischiopagus parasiticus:
Pygopagus:

These monsters are characterised by duplicity extending from above downwards. This class could be conveniently designated as type " Y " , as the doubling is above the waist.

2. TERATA ANADIDYMA

The most important types belonging to this group are:

Dipygus:
Syncephalus:
Craniopagus.

In this group we have the duplicity extending from below upwards. This could be called type " 人 " , as the doubling is below the waist.

3. TERATA ANAKATADIDYMA

The following are the principal types belonging to this group:

Thoracopagus:
Omphalopagus:
Omphalopagus parasiticus:
Thoracopagus parasiticus.

We have duplicity at both cephalic and caudal ends with union somewhere between, usually involving

the xiphoid region. In this type of monsters there is often situs inversus viscerum of the right twin. This is explained later (p.57).

This group could be designated as type " X " , seeing that the junction is about the centre of their bodies.

(C) TRIPLE MONSTERS

The commonest monstrosity of this class is the Tricephalus.

(D) UNCLASSIFIED MONSTERS

Under this heading I would include those monsters which do not fit in very well with any of the above groups. The principal ones are:

Foetus papyraceus:
Acardiacus:
Epignathus:
Polygnathus:
Foetus in foetu.

PART VII.

(A) SINGLE MONSTERS.

1. MONSTERS OF DEFECT (MONSTRA IN DEFECTU).

TERATOGENESIS.

We have noted that the normal embryo is formed essentially by the development and subsequent union of two symmetrical halves (vide p.25). These halves, at first lateral tracts, by a process of differentiation and proliferation form two sets of folds - dorsal and ventral.

The dorsal folds unite above the line of embryonic axis to form a dorsal tube, the neural canal.

The ventral folds join below to form the ventral body - wall. Normally the dorsal line of union is unbroken, while the ventral line of closure is interrupted by the oral, and umbilical primary openings, as well as by the secondary genito-urinary and anal orifices.

From these facts it is to be anticipated, that anomalies of defective union are of more frequent occurrence along the ventral than along the dorsal line of closure, a supposition corroborated by observation.

The immediate causes of the anomalies of this group, arising as the result of imperfect union, are very often mechanical, due to the obstruction offered to closure by the unusual presence of contiguous organs, on account of increased size, displacement, or abnormal attachments.

The action of abnormal amniotic bands, and the

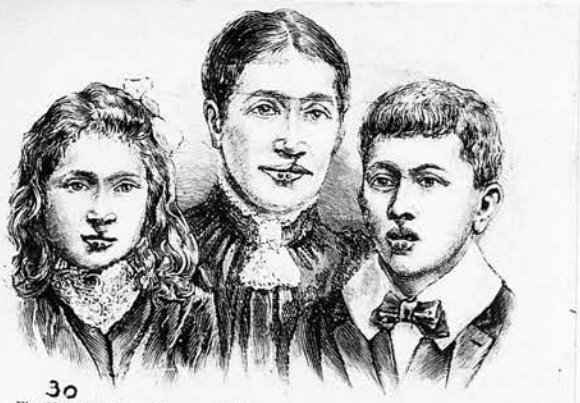


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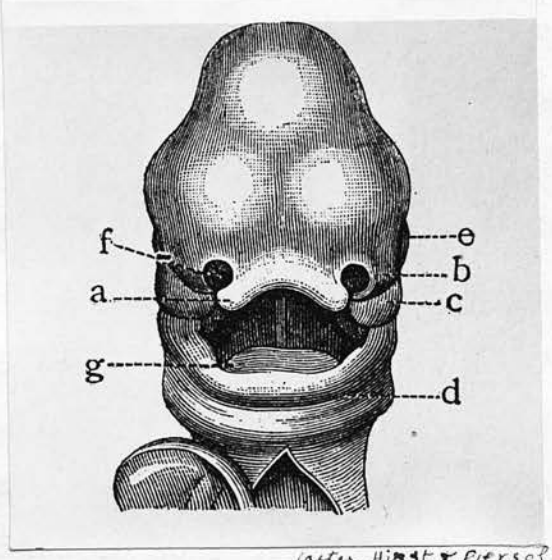
Fig. [illegible].—Mother and her two children with mandibular recesses. Each had double hare-lip. (*From a photograph.*)

(after Bland-Sutton)



(after Hirst & Piersol)

Fig 31. Head of a 35 day human foetus.

a. Intermaxillary process
b. Lateral nasal processes
c. Superior maxillary processes of first visceral arch
d Primary lower jaw
e Eye
f. Nasal pit and groove
g. Tongue.

adhesions of the overlying amnion to different parts of the embryo are, according to BALLANTYNE, most potent factors in the production of single monstrosities. The amnion is a membrane resembling peritoneum, and is subject to the effects of irritation, inflammation, and vascular changes that would cause cicatricial contraction and adhesion of different parts of the membrane to the embryo underneath. Bands lying within clefts which normally close at a later period may cause various abnormalities from incomplete closure at the proper time.

CLEFT PALATE: HARE-LIP

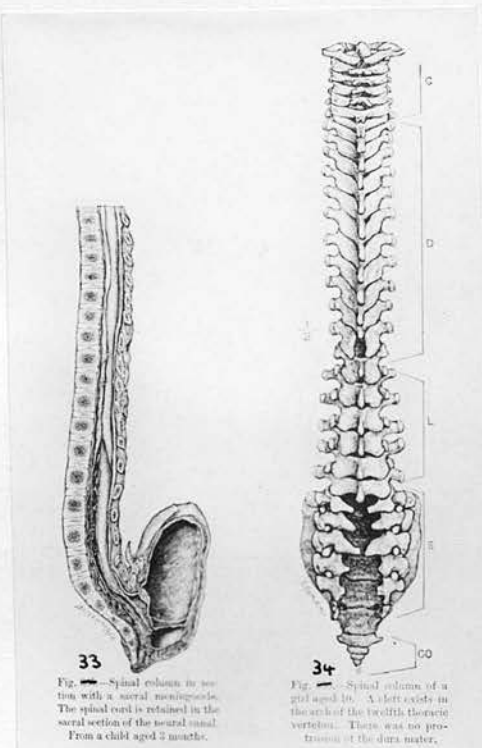
To understand the anomalies of the face e.g. cleft palate, and hare-lip, we must refer to Fig. 31 . It is obvious that should amniotic bands lodge or adhere to these clefts, anomalies will result at the time of closure. Such anomalies may be unilateral; when so they are more often seen on the left side. This is explained by the fact that the tendency of the embryo in the early stages is to lie on the left side, and so facilitates the formation of disturbing amniotic attachments on the side in question. These deformities may also occur on both sides.

In addition to the mechanical influence of the amnion, heredity must be accorded an important role in some, at least, of the defects of this group (e.g. Fig. 30).

Opposed to the mechanical influence of the amnion is the view that there is some deeply seated central cause profoundly influencing development.

FIG. 32.—Case of Unilateral Anophthalmus.

(after Ballantyne)



33

Fig. — Spinal column in section with a sacral meningocele. The spinal cord is retained in the sacral section of the neural canal. From a child aged 3 months.

34

Fig. — Spinal column of a girl aged 16. A cleft exists in the arch of the twelfth thoracic vertebra. There was no protrusion of the dura mater.

(after Bland-Sutton)

HERNIA UMBILICALIS: ECTOPIA VESICAE.

A similar condition prevails here. The amniotic bands lodge in these clefts, and they fail to close normally.

CYCLOPS (Fig. 35)

In many cases the twinning of parts may be inhibited due to an arrest of development so that a failure of certain parts to divide occurs and a single median structure appears e.g. siren, and cyclops. The paired eyes, for example, may fail to develop, and a single median cyclopic eye may result.

Fig 35
Cyclops.

Synopsia is an arrest of development because in the development of the eyes we have at first the material for a single eye which later is differentiated into two.

SIREN (Fig. 36).

Here also we have an arrest of development to account for this monstrosity. In this form the lower extremities are intimately fused. There is but a single femur, showing, perhaps, double formation at the lower extremity. The leg has only one bone and there is no trace of a foot, or, at most, but a single toe. The pelvis is defective in development, and the bones are twisted in a remarkable manner. The rectum, and lower end of the colon, the bladder and genital organs are usually absent.

Fig. 36
siren.
(after Hirst & Persaud)

EXENCEPHALUS: ANENCEPHALUS. (Fig.37)

Hydrocephalus is probably the sole etiological factor in the vast majority of these cases, but arrest of development, and amniotic adhesions play no small part in its causation.

In the case of the exencephalus, the hydrocephalus may have been external, and have ruptured the outer case of the brain, or prevented its development.

DWARFISM (MICROSOMIA)

A true dwarf is a person of unusually small stature, not as a result of any particular disease or deformity, but merely from growth having fallen much short of the usual standard. Microsomia is "monstrous smallness" of all the parts of the individual, whether it be an embryo, foetus, child, or adult. For the age reached, the size is much below the normal, growth having been arrested. The predisposing cause for this condition is, I believe, to be sought for in the impregnated ovum, and may be due to some internal inhibitary secretion referred to in this thesis as " inhibitin ".

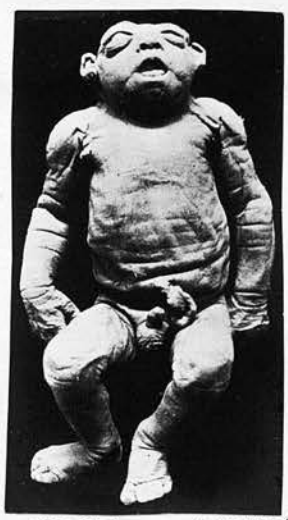
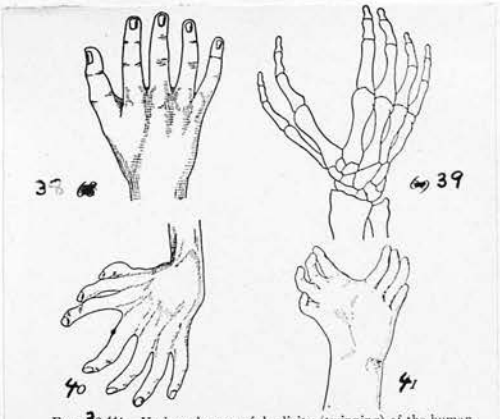


Fig 37 (Hirst + Pickrell)
Anencephalus



FIGS. 38–41.—Various degrees of duplicity (twinning) of the human hand. Fig. 38, a hand with a thumb like a little finger. Fig. 40, a hand with thumb represented by two fingers. Fig. 40, a hand with thumb represented by three fingers. Fig. 41, hand completely twinned with the thumb represented by four fingers which are mirror images of the fingers in the radial component. (After Bateson.)

(after Newman)

FIG. 42.—Case of Macrodactyly.

(after Ballantyne)

2. MONSTERS OF EXCESS (MONSTRA IN EXCESSU).

TERATOGENESIS.

In these monsters heredity plays the most important, if not the only, role. It is possible that amniotic bands and adhesions may be - contributary factors, but in all probability it is due to a "some-thing" in the fertilised ovum which leads to this abnormal growth.

BALLANTYNE (3) says "our knowledge of the teratogenesis of macrosomia and microsomia is a close neighbour to nothing".

HEMI-HYPERTROPHY (22)

No person is built exactly the same on both sides of his body, but the discrepancy is not sufficiently marked to attract attention. Occasionally individuals are seen, particularly in asylums, in which the asymmetry is striking. Usually these people are mentally defective.

Hemi-hypertrophy is regarded as a type of minimal twinning in man. It is defined as an overgrowth of one half or one side of the body, or of a part.

GIANTISM, POLYDACTYLY, & MACRODACTYLY. (22) (Figs 43, 40 & 42)

As already mentioned, heredity is the only explicable cause for these abnormalities in growth. I believe that it is due to some internal secretion in the ovum itself, which could be designated as " stimulin " as opposed to the other internal secretion " inhibitin " which leads to dwarfism (microsomia). I believe, further, that a secretion

Fig 43 (after Sutton)

similar to "stimulin" residing in the cells of the tissues involved, operates in malignant and other growth in post natal life. In other words, the cells of healthy tissue possess a "growth regulating mechanism" which is held in check by two forces "inhibitin" and "stimulin". Normally they are properly balanced but in malignant disease there exists either an excess of "stimulin" or a deficiency of "inhibitin", or both, thus leading to confusion of the "growth regulating mechanism". In the case of innocent tumours such as lipomata, fibromata, there is some deficiency of the "inhibitin" in the cells or there is an excess of "stimulin" in the tissues concerned, but not to a marked degree, with the result that the "growth-regulating mechanism" is not altogether upset. There is a tendency in some cases for the normal balance to become reestablished. Let us take the example of ordinary warts in children. They come, and also often go, spontaneously in a mysterious way. This is probably due to a temporary upset of the "growth mechanism" through an excess of "stimulin" which is later neutralised by additional "inhibitin" and so reestablish the balance.

If we could harness these two secretions, particularly the "inhibitin", we would be nearer to the solution of malignant disease.

(22, 44)

3. MONSTERS OF DEFAULT (M. PER FABRICAM ALIENAM).

TERATOGENESIS

This group of monstrosities shows no external manifestation of any abnormality, but we find complete or partial transposition of the organs of the body. This is known as situs inversus viscerum, or heterotaxis. The teratogenesis of this condition is thought to be as follows.

Normally, the embryo turns over on its left side very early in development, so that the dorsum lies toward the left of the ovum. In the cases of double embryos, if the twins lie far enough apart to enable both to take to the left sided position, there will be no transposition of the viscera of the right twin. This condition obtains in many homologous twins. When the two are united so that the right twin must lie with its back to the right, there will occur a transposition of the viscera in the right twin.

The anomaly is said to be twice as frequent in the male than in the female. The individuals affected are usually right-handed. There is no interference with nutrition or function by the abnormal arrangement of the parts.

This anomaly existed in Chang, the right twin of the Siamese twins (Fig. 51).

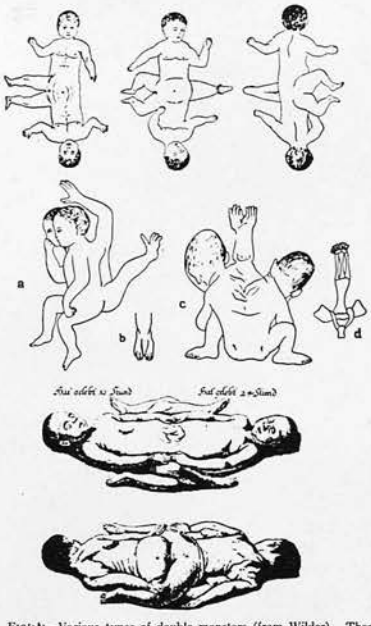


FIG. 44.—Various types of double monsters (from Wilder). These are all strongly conjoined and consist of less than two complete individuals. Note the inequality in size of the right-hand middle pair, the median, partially double arms and legs in several of the twins, and the symmetrical relations of the two individuals in all cases.

(after Newman)

(6)

(B) DOUBLE MONSTERS. (MONSTRA DUPLICA)

TERATOGENESIS.

The occurrence of monstra duplica can be explained largely by the action of physical forces external to the embryo. They arise most probably from incomplete fission of the original cell-mass (vide p.31). This fission occurs:

(1) from excessive amount of germinal material in the original embryonic area causing the cell-mass to project unduly above the surface of the ovum; or

(2) from constriction upon the embryo by the zona pellucida which may be unduly small, and gradually cuts into the embryonal mass, causing it to develop double, in whole or in part, according to the extent, direction and situation of the splitting (Fig.19).

If the fission has been complete, the two halves will lie parallel, and will slip down on the blastoderm away from each other, while the yolk granules from below are forced upward between the two embryos, and separate monozygotic twins result. If the fission has been incomplete, we have the formation of double monsters.

(6)

1. TERATA KATADIDYMA

DIPROSOPUS (Fig. 45)

This genus is distinguished by a body apparently single and a head more or less double as regards the face. It occurs in about 6% of double monsters.

Diprosopus tetrotus. (FLEMING.)

Fig 45
(after Hirst & Parrot)

BICEPHALUS (Fig. 62).

In cases where we have anterior dichotomy of the primordium, a two-headed individual is produced. In this instance, unlike the mechanism at work in the production of the cyclops, or siren, there is here an excess of division resulting in two bilateral structures becoming completely separated. In the case of bicephalus the individual develops two heads, while the remainder of the body is more or less normal.

ISCHIOPAGUS (e.g. Millie-Christine Fig. 60)

The distinctive features of this genus is the existence of two bodies, with the pelves united in such a way that the pubes of one joins the pubes of the other in the median line. The bodies are separate above the navel, thus allowing two abdomens, and two thoraces. The species is distinguished by the number of legs - two, three, or four. The union is by the innominate bones, a single pelvic cavity resulting.

ISCHIOPAGUS PARASITICUS (e.g. Jean Baptiste dos Santos Fig. 74)

Both sides of a double monster may be unequally developed, so that one portion appears as a parasite of the other. In ischiopagi, the head or head and trunk - of one twin may be wanting.

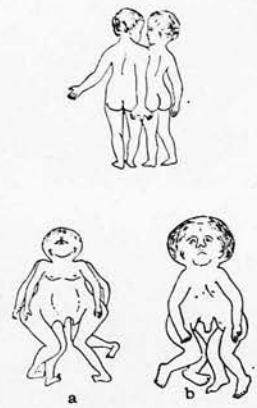


FIG. 46.—The upper figure shows Renault's twins (after Wilder), which approach the condition of the Siamese twins, where both individuals are complete or nearly so. The lower twins are typical Janus monsters: (*a*) a Cyclopian; (*b*) a case in which what appears to be a single broad face is really a double face in which the inner half of each component has been suppressed.

PYGOPAGUS (e.g. Helen & Judith Fig.58).

In this genus of the Katadidyma, the splitting from before backward has reached the maximum. The union is usually at the sacrum or coccyx. The vital organs in the typical and symmetric form are distinct, although the rectum and the external genitals are sometimes more or less fused. In females the vaginae are usually separate, but there is a common vulva. In males there is usually one scrotum containing four testes, and the penis is single. This form of monstrosity is extremely rare.

(11)

2. TERATA ANADIDYMA

DIPYGUS (e.g. "Mrs B." Fig.72)

According to the extent of the doubling, there will be room for a number of legs; and thus the species is distinguished as Dipygus tripus (e.g. Blanche Dumas Fig.73); and Dipygus tetrapus (e.g. Mrs. B. Fig72).

SYNCEPHALUS

In this genus the splitting has extended up to the head and often involves it, allowing the existence of two spinal columns and two sets of ribs. The duplicity often extends so far forward in the cranium that there are rudiments of a posterior face or often an ear. The thoraces are united by their ventral aspects. A complete sternum is developed on each side of the common thorax, half belonging to each twin. The gut is usually double below the duodenum; the

diaphragm is double.

CRANIOPAGUS (Fig.56)

In this genus the bodies are entirely distinct and there are two heads, which may be joined at any point along the median line, from the occiput to the face.

(2)

3. TERATA ANAKATADIDYMA

Here there is duplicity at both cephalic and caudal ends of the embryo, with union somewhere between, always involving the xiphoid region. The order is classified according to the extent of the duplicity and therefore according the amount of separation of the two halves.

THORACOPAGUS (Fig.77)

This genus is characterised by the junction of the two portions at the thorax. The genus is the most common of the equally developed double monsters.

THORACOPAGUS PARASITICUS

This type is very rare. Joannes Baptista Colloredo, Fig.68 is a famous example of this class.

OMPHALOPAGUS (Fig.51)

The line dividing the thoracopagi from the omphalopagi is not very definite. In the latter there is at least a connection between the tips of the xiphoids, and therefore a cartilaginous portion to the uniting band. This band usually contains peritoneum

and a portion of liver. The Siamese twins belong to this class.

(8)

OMPHALOPAGUS PARASITICUS (Fig. 78).

This form is not so rare as the parasitic form of thoracopagus. The Hindu lad Laloo, and my case of the Clairwood twin are examples.

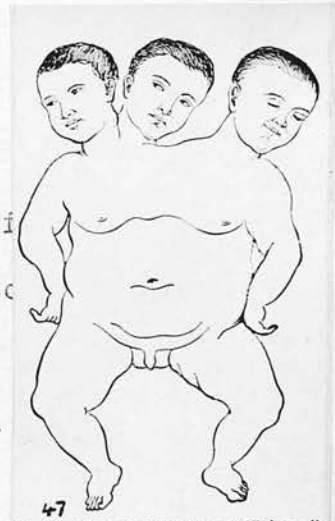
In these cases a second embryo becomes wedged in between the visceral arches or laminae of another, before they unite. Hence the development of the second is arrested. The parasite forms a conspicuous appendage on the body of the host. Anomalies of the viscera of the autosite adjacent to the attachment of the parasite are frequent; thus the liver may bear an unusually large number of lobes, or there may be two gall bladders.

(11)

C. TRIPLE MONSTERS

TERATOGENESIS

Triple monsters, like homologous twins, are always of the same sex, and are very similar in appearance and nature. Just as anterior dichotomy of the primordium may result in a bicephalic monster, so also, should the splitting of this area be double, a tricephalic monster may develop. Fig. 47A is a rough diagram to explain this double dichotomy.



47
Fig. 28. —Three-headed monster (Galvagni).

(after Gould & Pyle)

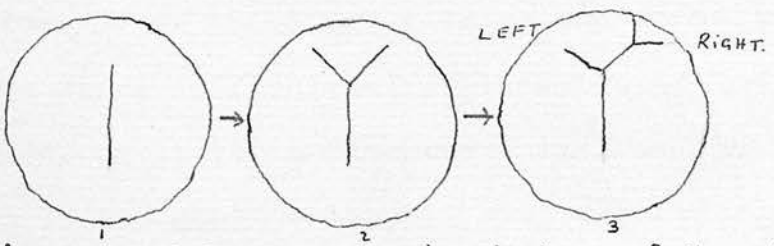


Fig 47A. 1: partial cleavage: 2: anterior dichotomy: 3 shows double dichotomy

(6)

(D) UNCLASSIFIED MONSTERS

There is a group of monsters which cannot be included under any of the above three divisions, and therefore deserve a division to themselves. The principal ones of this group are:

Foetus papyraceus,
Acardiacus,
Epignathus,
Polygnathus,
Foetus in foetu.

TERATOGENESIS

The teratogenesis of these monsters is extremely interesting, and can be reasoned as follows:

While the extensively cleaved embryonic cell masses may undergo uniform development, producing individuals capable of maintaining independent and almost separated existence like the celebrated Siamese twins (Fig.51), not infrequently the halves of the bifurcated area develop unequally, resulting in the predominance of the stronger part with a corresponding decline in the less fortunate member, whose circulation becomes more and more enfeebled, until from a perhaps former condition of equality, the weaker part is reduced to dependency upon the stronger to constitute a parasitic monster of which almost all forms occur.

Since these double monsters usually come under the observation in the later stages of their existence, the presence of an acardiac or shapeless parasite, at first glance seems difficult of explanation by the theory of fission, until it is remembered that at one time both parts of the cleft embryonic mass were of equal dignity,

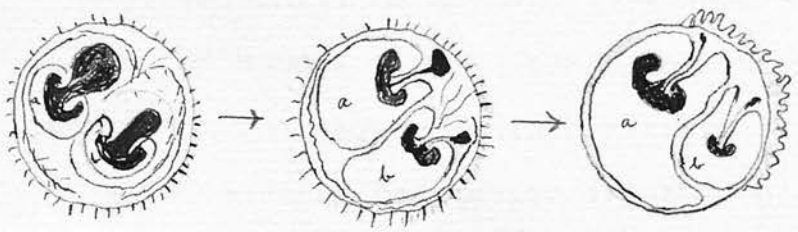


Fig 48 Schematic representation of development of Acanthiacens. (after Hektoen + Riesman)
For explanation see text

and that subsequent unequal development is accountable for the discrepancy later observed (Fig.48).

(a) FOETUS PAPYRACEUS. (11)

In the foetus papyraceus, as well as in the acardiacus, we find that up to about the twelfth day, the two embryos develop evenly. At that time the allantois buds out from the hind gut of each individual, and its vessels reach the placental portion of the chorion.

Sometimes the allantoic vessels and later the placental vessels anastomose too freely with those of the other twin. Then begins a contest of the two foetal hearts as to which shall dominate the circulation. One foetus, from its more favourable situation or other cause, overcomes the force of the other's heart in the anastomosing vessels, and thereby is caused a stasis in the arteries of the weaker foetus, progressing inward from the anastomosing allantoic arteries. Finally, the force of blood circulation is entirely overcome in the body of the weaker foetus, and it dies. The increasing growth of the surviving twin with its appendages gradually compresses the dead one, and finally squeezes it flat against the uterine wall, so that the foetus papyraceus results.

(b) ACARDIACUS (Fig.48). (6)

The acardiac monster arises in a similar way. The healthy embryos develop from one egg, as in ordinary cases of homologous twins. The allantoic stalk of one may reach the inner surface of the primary chorion

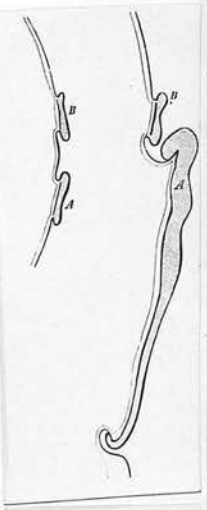
a few hours or so before that of the other. It becomes attached to the chorion there, and begins to develop its umbilical vessels before the second allantois reaches the placental site. Therefore the allantois of the second embryo finds no chorionic attachment, or only a limited one, and is compelled to attach itself to the allantois of the first. There results an anastomosis of the umbilical vessels, and the first foetus becomes dominant in the circulation. As the allantoic stalks become lengthened out into umbilical cords, the cord of the second may be attached to the placenta close to that of the first, or the two may be connected by a large vessel upon the placenta. The anastomosing arteries leading to the second will carry most of the blood directly from the circulatory system of the first, without going through the placenta. This is known as the "third circulation" . The venous current being slower, will not follow the line of least resistance so markedly. The second embryo, therefore, gets arterial blood, which is vitiated blood, from the first embryo's body. Also the blood pressure from the heart of the first forces the current backward through the arteries of the second. The embryonic heart of the latter thus atrophies.

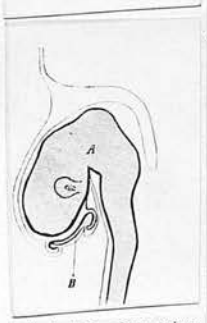
(c) EPIGNATHUS (Fig.7/): POLYGNATHUS (~~Fig.~~).

When the development of two closely approximated embryonic traces is very unequal in the early stages, a series of curious and obscure parasitic monsters is produced by a process of inclusion by the parts of the

more vigorous and rapidly growing foetus, the imprisoned foetus receiving its imperfect nutrition from its host.

Where the two embryonic traces lie with their cephalic ends near together in the course of development of the more active embryo, the weaker may be drawn within, and overgrown, or surrounded by the parts of the stronger, so that, finally, the only trace of the weaker foetus is found as a tumour attached to some part of the head of the more vigorous foetus, as the hard palate and known as the epignathus (Fig.49). If the foetus is attached to the lower jaw, it is known as polygnathus. It may be attached to other parts of the cranium.





The inclusion of one embryo within the cephalic fold of the other. (AHLFELD.)

Fig 49

(8)

(d) FOETUS IN FOETU (Fig. 76).

We noted that there is a time in development when the body cavity of the embryo is not closed (p.51) At this stage it is quite possible for one rudimentary embryo to become surrounded by the other and the larger twin. The rudimentary foetus undergoes its limited development within the walls of the autosite, and a foetus in foetu results. This form of inclusion is known as "enclavement".

When discussing the theories of the origin of conjoined twins (p.32) I pointed out that the Law of Teratogenesis "eadem ibidem" falls to the ground in cases of epignathus and polygnathus, and that the process is one of complete fission with subsequent partial inclusion.

CHAPTER IV.

TERATOLOGY AND CANCER.

CHAPTER IV.

TERATOLOGY AND CANCER.

The great similarity between monsters and cancer is to be found in their abnormal growth. In the one case it is ante-natal, in the other post-natal.

BALLANTYNE[3] of Edinburgh pointed out as far back as 1901 that "the human foetus is a MOST REMARKABLE TUMOUR about the FOURTH month, quadrupling its weight in a month". Further, he drew attention to the fact that this rapidity of growth is then SUDDENLY CHECKED, and differentiation of structure and functional activities take its place. He made the following important comment: "If we could discover THE CAUSE which CHECKS its growth, might we not be near the DISCOVERY HOW THE GROWTH OF A MALIGNANT TUMOUR MIGHT ALSO BE ARRESTED?".

I believe that this cause is to be searched for IN THE OVUM ITSELF.

We traced the development of the ovum under "Embryology", and noted its ontogenesis, and its organogenesis. A complicating and mysterious process goes on in the fertilised ovum about which we know practically nothing. I believe that in the ovum there exists, in addition to other vital mechanisms, a "GROWTH-REGULATING MECHANISM". This mechanism is influenced by two internal secretions present in the ovum; one of these is growth-inhibitary, and the other is growth-stimulatory. When these two secretions are

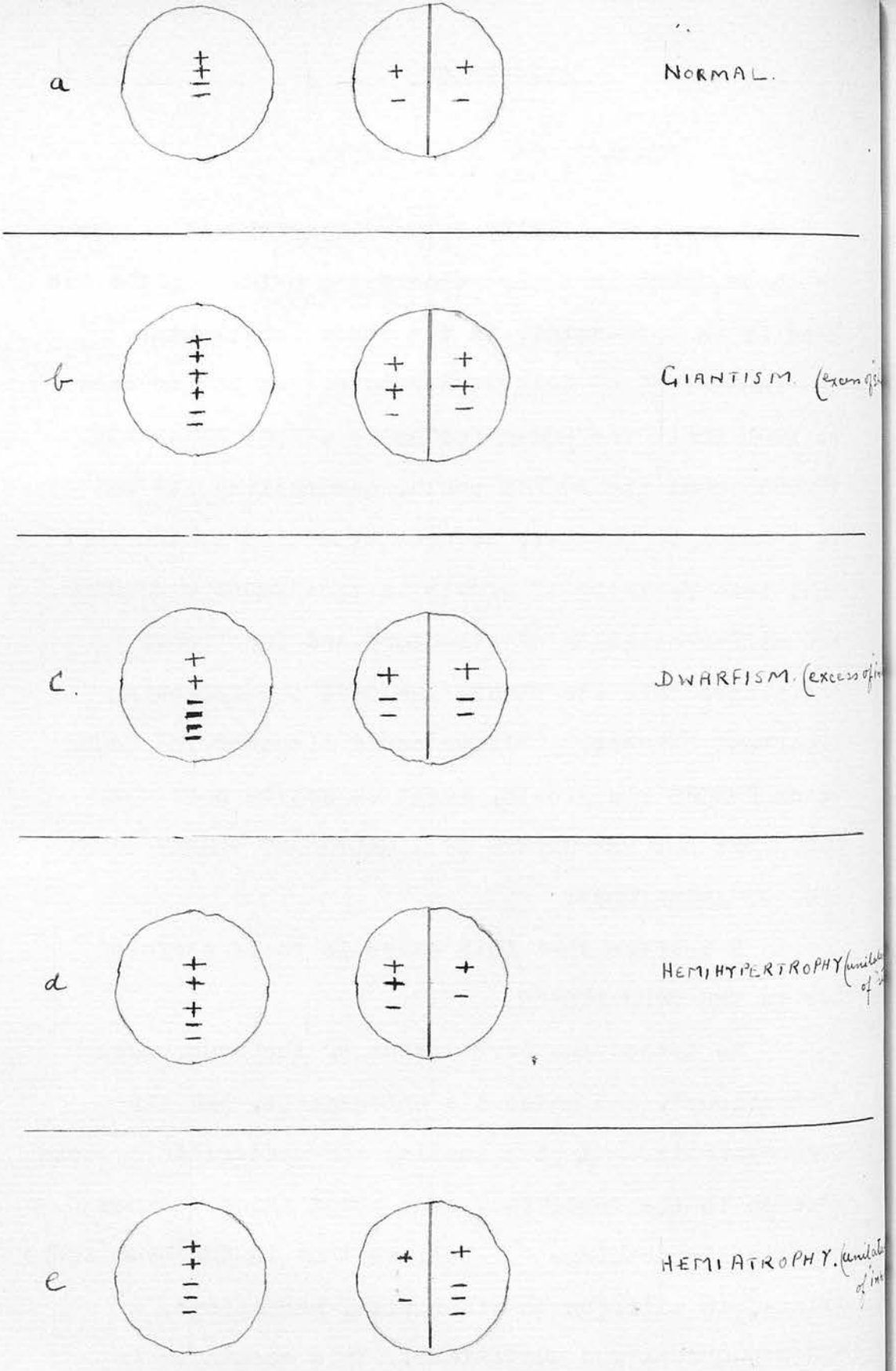


Fig. 50 + represents STIMULIN
− " INHIBITIN.

Author's DIAGRAMMATIC EXPLANATION OF GROWTH-REGULATING MECHANI
IN DEVELOPING OVUM.

properly balanced normal growth and development goes on. Should one be abnormally excessive, or the other diminished, the growth-mechanism is upset, and maldevelopment results.

This appeals to me as the most feasible explanation of such conditions as dwarfism (microsomia), giantism (macrosomia), hemi-hypertrophy (partial macrosomia), and hemi-atrophy (partial microsomia).

In microsomia either the inhibitary secretion of growth "INHIBITIN", is in excess, or else the growth-stimulatory secretion "STIMULIN" is deficient.

On the contrary, should the "STIMULIN" be in excess or the "INHIBITIN" deficient, giantism results.

This theory is explained in Fig. 50.

+ represents "stimulin", and - represents "inhibitin".

In this Fig. (a) is normal. Here we have a fertilised ovum with its growth-mechanism properly balanced by the stimulin" and "inhibitin". Symmetrical division takes place and normal growth develops.

In (b) the ovum has excess of "stimulin" + and a normal amount of "inhibitin" -. If equal cleavage takes place both sides of the ovum have an excess of"stimulin" and giantism results.

In (c) the ovum possesses excess of "inhibitin". If there is equal division, there is an excess of "inhibitin" with consequent dwarfism.

In (d) there is an excess of "stimulin" + . When the first cleavage into two blastomeres takes place there is a normal balance of "stimulin" and

"inhibitin" in one blastomere, but an excess of "stimulin" in the other, with the result that an individual with hemi-hypertrophy develops.

In (e) there is an excess of "inhibitin". One of the blastomeres as a result of the first cleavage happens to have a balanced amount of the two growth-regulating secretions but the second blastomere has an excess of "inhibitin" so that hemi-atrophy results.

Can we harness this "INHIBITIN"? Should we be successful it may prove the dawn of a new era in medicine.

We know that in the armadillo there is a "period of quiescence" of three weeks (p.17). At this stage of gestation the "inhibitin" is at its highest level.

1. What would be the effect of "inhibitin" on an embryo armadillo two months old? Would the "inhibitin" stop its development?

2. What would be the effect of "inhibitin" on the young embryo just about to pass through this "period of quiescence"? Would it prolong the"period of quiescence"?

3. What would be the effect of "stimulin" in similar cases?

Should we be successful in harnessing these two secretions "INHIBITIN" and "STIMULIN" it may prove the greatest victory of medical science.

It is possible that in post-natal life there exists a similar "growth-regulating mechanism" in the tissue cells. Should there be any marked and prolonged depletion of the "inhibitin" of the cells through some

constant irritant or other agent, the "stimulin" gets the ascendancy, and the "growth-regulating mechanism" is put out of gear with resultant malignant growth.

Should this "inhibitin" prove effective, it may stabilise the "growth-regulating mechanism" of the tissues involved, and not only check its growth, but may prove a specific and a powerful "decancerising" agent.

On the other hand, the ovular extract "stimulin" may prove a powerful therapeutic agent in most surgical and medical conditions of a non-cancerous nature.

CHAPTER V.

CLINICOLOGY.

CHAPTER V.

CLINICOLOGY.

In this Chapter I shall describe twenty cases of human monstrosities. Most of these were famous in their time, and exhibited all over the world.

I shall point out the salient features of their abnormalities, and refer also to their peculiar mental make-up.

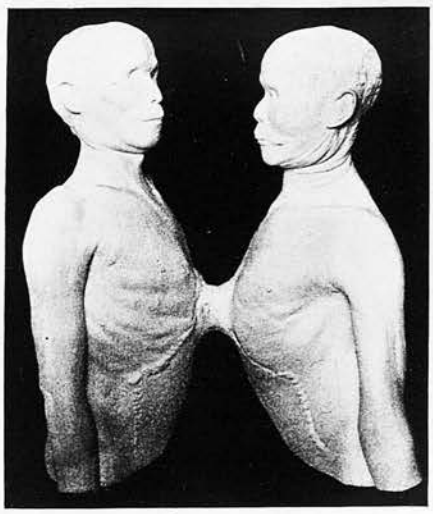
Most of them were short-lived for the simple reason that the illness or the death of the one meant illness or death to the other.

To face 72.

FIG. 51.—The Siamese Twins Chang—Eng at the age of 18. They were born without difficulty, and died in 1874, aged 63. Chang died first.

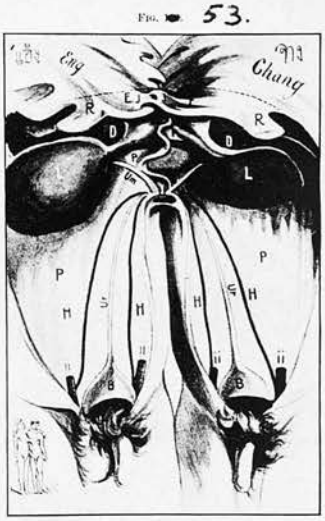
(after Bland Sutton)

FIG. 52.



Photograph of cast in the Mütter Museum of the College of Physicians.

FIG. 53.



Internal anatomy of the Siamese twins. (PANCOAST.)

U. Umbilicus. H, H. Hypogastric arteries. Ur, Ur. Urachi. Um, Um. Umbilical

(after Hirst + Pursol)

2. 8.11

THE SIAMESE TWINS: CHANG AND ENG BUNKER.

The best known of all double monsters were the Siamese twins (Fig. 51). They were exhibited all over the world, and had the additional benefit and advertisement of a much mooted discussion as to the advisability of their severance, in which opinions of the leading medical men in the world were advanced.

Eng and Chang were born in Siam about May, 1811. Their father was of Chinese extraction and had gone to Siam and there married a woman whose father was also a Chinaman. They were of dark colour and possessed Chinese features. The mother was about thirty-five years of age when they were born, and had delivered four children prior to Chang and Eng. She afterward had twins several times, having eventually fourteen children in all. The pregnancy was uneventful, although she averred that the head of one of the twins, and the feet of the other were born at the same time. The twins were feeble at birth, and Eng continued delicate, while Chang thrived.

The first scientific description of them was given by Professor J. C. Warren, who examined them in Boston, at the Harvard University, in 1829. At that time Eng was 5 feet 2 inches, and Chang 5 feet 1½ inches in height. They presented all the characteristics of Chinamen. Later in the same year they visited London. Their tour in France was forbidden on the grounds of the possibility of causing the production of monsters by maternal impressions

in pregnant women. After their European tour they returned to the United States and settled down as farmers in North Carolina, adopting the name of Bunker. When forty-four years of age they married two sisters, English women, twenty-six and twenty-eight years of age, respectively. Domestic infelicity soon compelled them to keep the wives at different houses, and they alternated weeks in visiting each wife. Chang had ten children, three boys and seven girls. Eng had twelve children, seven boys and five girls. Of Chang's children two, a boy and a girl, were deaf-mutes. Chang, it is necessary to mention, was somewhat deaf.

In 1869 they made another trip to Europe, ostensibly to consult the most celebrated surgeons of Great Britain and France on the advisability of being separated. It was stated that a feeling of antagonistic hatred after a quarrel prompted them to seek "surgical separation", but the real cause was most likely to replenish their depleted exchequer by renewed exhibition and advertisement.

The psychology of these twins is interesting. They showed affection and forbearance for each other until shortly before death. They bore each other's trials and petty maladies with the greatest sympathy, and in this manner rendered their lives far more agreeable than a causal observer would suppose possible.

The feasibility of the operation of separating them was discussed by many of the leading men in America and Europe with various reports and opinions

after examination. When in the fifties they had diseased and atheromatous arteries, and Chang, who was quite intemperate, had marked spinal curvature, and shortly afterward became hemiplegic. The outer legs and arms were stronger than the inner. The opposed chest surfaces were absolutely flat, the outer halves showing a compensatory fulness.

They were both partially blind in their two anterior eyes, possibly from looking outward and obliquely. The point of junction was about the sterno-xiphoid angle, a cartilaginous band extending from sternum to sternum. In 1869 Simpson of Edinburgh measured this band and made the distance on the superior aspect from sternum to sternum 4½ inches, though it is most likely that during the early period of exhibition it was not over three inches. Fig 52 shows very well the position of the joining band.

The twins died on January the 17th, 1874. A committee of surgeons from the College of Physicians of Philadelphia, went to North Carolina to perform the autopsy on the body. They made a long and most interesting report. The arteries were found to have undergone calcareous degeneration. There was an hepatic connection through the band, and also some interlacing diaphragmatic fibres therein. There was slight vascular ~~xxxitxxxxxx~~ intercommunication of the livers and independence of the two peritoneal cavities and the intestines. The band itself was chiefly a coalescence of the xiphoid cartilages, surrounded by areolar tissue and skin. (Fig. 53).

(2.11)

THE ORISSA SISTERS: RADICA-DODDICA.

These twins (Fig.54) were born in Orissa, India, in September 1889, and were exhibited in Europe in 1893 They resembled the Siamese twins in conformation, and were the result of the sixth pregnancy, the other five were quite normal. When exhibited they were four years old, and apparently in perfect health, except that they were united by a band 4 inches long and 2 inches wide from the ensiform cartilage to the umbilicus. When facing each other they could draw their chests three or four inches apart, and the band was so flexible that they could sit on either side of the body. Up to the date mentioned it was not known whether the connecting band contained viscera. I hardly think this is likely.

Fig. —Radica-Doddica, the "Orissa Sisters."
54.

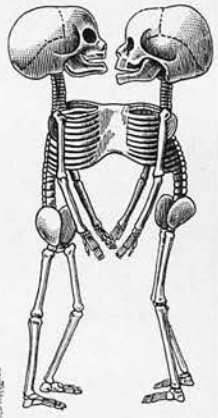


Fig. —Skeleton showing a mode of junctio of independent double monsters.
55.

(after Gould + Pyle)

(2)

CRANIOPAGUS.

Case 1.

At a foundling hospital in St Petersburg there were born two living girls, in good health, joined by the heads (Fig.56). They were so united that "the nose of one, if prolonged, would strike the ear of the other". They had perfect independent existences, but their vascular systems had evident connection. Through extra mobility of their necks they could lie in a straight line, one sleeping on the side and the other on the back. The literature on these twins is meagre. We do not know when they were born and how long they lived.

Case 2.

There is a report of two girls joined at their vertices, who survived their birth. With the exception of this junction they were well formed and independent in existence. There was no communication of the cranial cavities, but simply fusion of the cranial bones covered by superficial fascia and skin.

These cases would be amenable to surgical treatment.

56

Fig. [illegible].—Craniopagus (after Paré).

(3)

THE BIDDENDEN MAIDS. MARY AND ELIZA CHULKHURST.

These maids were born in Biddenden, Kent, in 1100. Their parents were fairly well-to-do people. They were supposed to be united at the hips and shoulders (Fig.57), and lived until 1134. At the death of one it was proposed to separate them, but the remaining sister refused saying "As we came together, we will also go together" and after about six hours she also expired.

We do not know of any case of this peculiar union. It may be that the maids had four separate arms, and were in the habit of going about with their contiguous arms round each other's necks, and thus gave the impression that these limbs were united.

Ballantyne of Edinburgh who made a special investigation of this case comes to the conclusion that "the date fixed for the birth of the Biddenden Maids is so remote as to throw doubt upon the reality of the occurrence".


ELIZA & MARY CHULKHURST.

A 34 Y IN 1100

BIDDENDEN

A SHORT AND CONCISE ACCOUNT OF

ELIZA AND MARY CHULKHURST.

Who were born joined together by the Hips and Shoulders.

IN THE YEAR OF OUR LORD 1100

At BIDDENDEN, in the County of KENT.

COMMONLY CALLED

THE BIDDENDEN MAIDS.

THE READER will observe by the Plate of them, that they lived together in the above state Thirty-four years, at the expiration of which time one of them was taken ill and in a short time died; the surviving one was advised to be separated from the body of her deceased Sister by dissection, but she absolutely refused the separation by saying these words, viz. "As we came together we will also go together," and in the space of about Six Hours after her Sister's decease she was taken ill and died also.

By their Will they bequeath to the Churchwardens of the Parish of Biddenden and their successors Churchwardens for ever, certain Pieces or Parcels of Land in the Parish of Biddenden, containing Twenty Acres, more or less, which now let at 40 Guineas per annum. There are annually made, in commemoration of these wonderful Phenomena of Nature, about 1,000 Rolls with their Impression printed on them, and given away to all strangers on Easter Sunday after Divine Service in the afternoon; also about 500 Quartern Loaves and Cheese in proportion, to all the poor Inhabitants of the said Parish.

Fig 57. (after Ballantyne)

(2.11)

THE HUNGARIAN SISTERS: HELEN AND JUDITH. (Fig 58)

Possibly the most famous example of pygopagus monsters were these sisters who were born in 1701 at Szony, in Hungary. Helen was born first to the navel; three hours later the feet were delivered, and the body of Judith followed in the reverse order. The desire for defaecation was synchronous, but micturition was separate, the latter leading to frequent disputes.

They were the objects of great curiosity, and were shown in most European countries. The ecclesiastical authorities stopped the exhibition of these twins, and they were placed in a convent at Presburg when nine years old. They died almost simultaneously in their twenty-second year. During their travels all over Europe they were examined by many prominent physiologists, psychologists, and naturalists.

They were joined back to back in the lumbar region, and all their parts separate except the anus between the right thigh of Helen and the left thigh of Judith. They possessed a single vulva. Helen was the larger, better looking, the more active, and the more intelligent. Judith at the age of six became hemiplegic, and afterward was rather delicate and depressed. They menstruated at sixteen and continued with regularity, although one began before the other. They had a mutual affection, and did all in their power to alleviate the circumstances of their sad position. Judith died of cerebral and pulmonary

affections, and Helen, who previously enjoyed good health, soon after her sister's indisposition suddenly sank into a state of collapse, and expired immediately after her sister. They had measles and smallpox simultaneously, but were affected in different degrees by the maladies. The emotions, inclinations, and appetites were not synchronous.

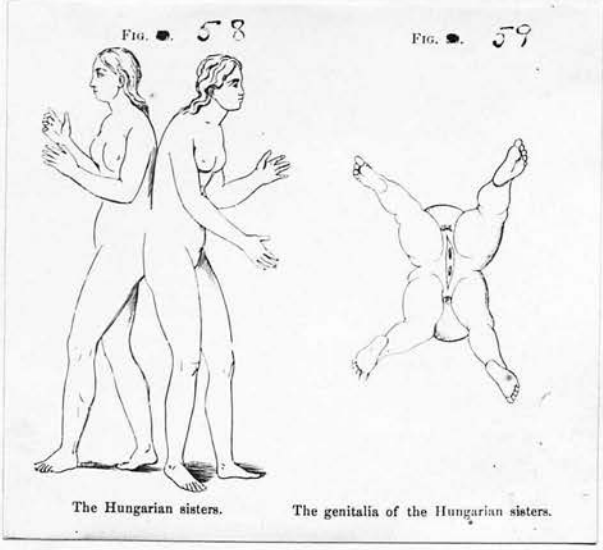


FIG. 58. The Hungarian sisters.

FIG. 59. The genitalia of the Hungarian sisters.

(after Gould + Pyle)

(2.11)

MILLIE-CHRISTINE: THE TWO-HEADED NIGHTINGALE. (Fig. 60)

These twins were born of slave parents in Columbus County, N.C., on July the 11th 1851, and had been extensively exhibited in Europe and the United States. The presentation was first by the stomach and afterward by the breech. These twins were united by the sacra by a cartilaginous or possibly osseous union.

Fig. 60.—Millie-Christine (Pancoast).

(after Gould & Pyle)

Physically, Millie was the weaker, but had the stronger will and the dominating spirit. Menstruation commenced at the age of thirteen, and was regular. Christine yielded instinctively to the other's movements, thus preserving the necessary harmony. They ate separately, had distinct thoughts, and carried on distinct conversations at the same time. One, in tranquil sleep, would be aroused by a call of nature of the other. Common sensibility was experienced near the location of union. They were intelligent and agreeable and of pleasant appearance, although slightly under size. They developed sweet voices and sang with great taste and skill a duet in a contralto and soprano voice. As they sang in public they soon acquired the name of the "Two-headed Nightingale". They could dance with two legs or four with equal animation. They walked, ran, and danced with apparent ease. Christine could bend over and lift Millie up by the bond of union.

RITTA-CHRISTINA. (Fig. 62)

The most celebrated case of Dicephalus tetrabrachius dipus was born in Sardinia on March the 23rd, 1829. The mother was thirty-two years of age, and this was her ninth confinement. The foetus presented by the heads, which were delivered one after the other without much difficulty. The heads, arms, and upper portion of each thorax, to a point a little below the mammae, were separate and normal (Fig. 62). Below this point they had a common trunk and single lower extremities. The right one, christened Ritta, was feeble and of a sad and melancholy countenance. The left, Christina, was vigorous and of a gay and happy disposition. They suckled at different times, and sensations in the upper extremities were distinct. They defaecated and micturated simultaneously, and had the indications and desire in common. The ventral surfaces were directed somewhat toward each other. If the right leg was pinched, only Ritta felt it, and Christina alone felt a pinch on the left; while at points near the median line, such as the abdomen, anus, and genitals, the sensations were common to both. The two heads cried and laughed, ate and slept, often at different times. Ritta caught a severe cold and died at the age of seven months. Christina died immediately after. At the postmortem the pericardium was found single, covering both hearts. The digestive organs were double and separate as far as the lower third of

the ileum, and the caecum was on the left side and single, in common with the lower bowel. The liver was fused, and the uterus was double. The vertebral columns, which were entirely separate above, were joined below by a rudimentary os innominatum. The sterna were fused.

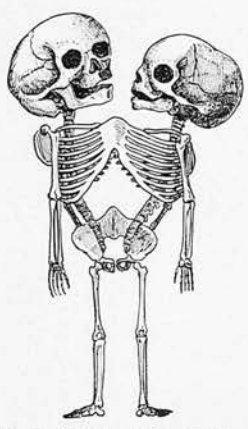


Fig. 46.—Skeleton of Ritta-Christina.

61

Fig. 47.—Ritta-Christina.

62

(after Gould & Pyle)

(2)

ROSA-JOSEPHA BLAZEK. ("THE BOHEMIAN TWINS")

These twins of the pygopagus type were born in Bohemia, on the 20th of January, 1878. (Fig.63).

The had a broad bony union in the lower part of the lumbar region, the pelvis being altogether fused. The had a common urethra and anus, but a double vagina, with an obvious septum.

They possessed independent sensibility, except where the pelvis joined them together.

Of the two, Rosa was the stronger. They had independent thoughts, and varied in their tastes for food and beverages. Thirst and hunger was not synchronous. They were exhibited all over the world.

Fig. 63.—Blazek sisters.

(after Gould + Pyle)

(2.11)

THE TOCCI BROTHERS. (Fig. 64).

This monster was born in 1877 in the province of Turin, Italy. Their mother was a healthy primipara. The labour lasted eight hours and was easy. The head of the right twin presented first in an occipito anterior position, the head of the left twin being delivered directly afterwards.

Dicephalus tetrabrachius (the Tocci boys).

Fig 64
(after Hirst + Piersol)

They each had a well formed head, perfect arms, and a perfect thorax to the sixth rib. They had a common abdomen, a single anus, two legs, two sacra, two vertebral columns, one penis, but three buttocks, the central one containing a rudimentary anus.

The right boy was christened Giovanni-Batista, and the left Giacomo. Each individual had power over the corresponding leg on his side, but not over the other one. Walking was therefore impossible. Their emotions and sensations were distinctly individual and independent. They were in good health at the age of five. I cannot trace their history beyond this age.

(2)

THE JONES TWINS. (Fig. 65)

These twins were born on June the 24th, 1889, in Tripton County, Indiana. Their spinal columns were in apposition at the lower end. The labour only lasted two hours, and was over before the arrival of the doctor. Lying on their mother's back, they could both nurse at the same time. Both sets of genitals and ani were on the same side of the line of union, but occupied normal positions with reference to the legs on either side. Their weight at birth was 12 lbs and their length 22 inches. Their mother was a medium sized woman of 19, and had one previous child then living at the age of two. Their father was a well built man 5 feet 10 inches in height. The twins differed in complexion and colour of the eyes and hair. They were publicly exhibited for some time, but on the 19th of February 1891 they died.

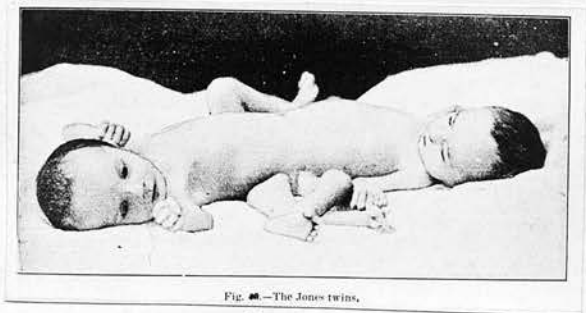


Fig. 65.—The Jones twins.

Fig. 65.

(after Gould + Pyle)

(8)

A BICEPHALIC MONSTER. (Fig. 66)

Sutton mentions a photograph sent to Sir James Paget in 1856 by William Budd of Bristol. This portrays a living child with supernumerary head, which had a mouth, nose, eyes, and a brain of its own. The eyelids were abortive, and as there was no orbital cavity, the eyes stood out in the form of naked globes on the forehead. When born the corneas of both heads were transparent, but through exposure became opaque. The brain of the supernumerary head was quite visible from without and was covered by a membrane which was beginning to slough. On the right side of the head was a rudimentary external ear. The nurse said that when the child sucked, some milk regurgitated through the supernumerary mouth. The great physiological interest in this case lies in the fact that every movement and every act of the natural face was simultaneously mimicked by the supernumerary face in a perfectly consensual manner. When the natural mouth sucked, the second mouth sucked. When the natural face cried, yawned, or sneezed, the second face did likewise, and the eyes of the two heads moved in unison. The fate of this child is not known.

66

Fig. 286.—A bicephalous infant. (*From a photo*

(after Bland-Sutton)

(2)

LAZARUS-JOANNES BAPTISTA COLLOREDO. (Fig. 68)

This monster was born in Genoa in 1617. He exhibited himself all over Europe. From his epigastrium hung an imperfectly developed twin that had only one leg, clubbed hands with only three fingers on each, a body, arms, and a well-formed head covered with hair, which in the normal position hung lowest.

There were signs of independent existence in the parasite, movements of respiration, etc but its eyes were closed, and although saliva constantly dribbled from its open mouth, nothing was ever ingested. It lived a purely vegetative existence. The genitals were imperfect. He was in Scotland in 1642, and was examined by the leading surgeons. He married and had several healthy, normal children.

67

Fig. —Parasitic monster (after Paré).

Fig. —Thoracopagus. Lazarus-Joannes Baptista Colloredo.

68

(after Gould + Pyle)

(2.11)

LOUISLE L.:"LA DAME A QUATRE JAMBES".

This woman was born in 1869, and had attached to her pelvis another rudimentary pelvis and two atrophied legs of a parasite, weighing 8 kilos (Fig 69).

The attachment was effected by means of a pedicle 33 cm in diameter, having a bony basis, and being fixed without a joint. The attachment almost obliterated the vulva, and the perineum was displaced far backward.

At the insertion of the parasite were two rudimentary mammae, one larger than the other. No genitalia were seen on the parasite and it exhibited no active movements, the joints of both were ankylosed.

The woman could locate sensations in the parasite except those of the feet. She married, and in the space of three years, had two well-formed daughters.

La dame à quatre jambes.

Fig 69
(after Hirst + Piersol)

(2-8-11)

LALOO. (Fig. 70)

Laloo was born in Oudh, India, about 1872, and was the second of four children.

The upper portion of a parasite was firmly attached to the lower right side of the sternum of the individual by a bony pedicle, and apparently contained intestines. The anus of the parasite was imperforate. A well-developed penis was found, but no testicles. There was a luxuriant growth of hair on the pubes. The penis of the parasite was said to show signs of erection at times, and urine passed through it without the knowledge of the boy.

Perspiration and elevation of temperature seemed to occur simultaneously in both. He was exhibited as a"brother and sister" joined; the managers of the museum shrewdly clothed the parasite in female attire. This was done to pander to the morbid curiosity of the curious. There is no doubt that the parasite was a male.

The Chinaman, A-Ke, was exactly similar to Laloo. He was exhibited in London in the early part of the nineteenth century.

70

Fig. 70.—Laloo, a Hindu, with a parasitic fœtus attached to his thorax.

(after Bland-Sutton)

(2.11.)

THE EPIGNATHUS.

Fig. 71 represents an epignathus. It is a peculiar type of parasitic monster, in which the parasite is united to the inferior maxillary bone of the autosite.

A mass projects from the mouth of the well-developed autosite, often containing or supporting easily recognisable parts of a foetal body, but more commonly composed of cysts, cavities, and intervening embryonal tissue of very low development. The covering of the tumour is fairly well developed skin, containing hair-bulbs and sweat glands, and covered in part by down. Sometimes the covering of the tumour within the mouth is mucous membrane continuous with that of the mouth. The contents of the cysts within the tumour is usually a thick fluid, and, in addition, brain substance, skin, epithelium, fat, hair, teeth, cartilage, and bones may be found.

The origin of the epignathus is described elsewhere (page 65).

Fig. 58.—Epignathus.

71

(after Gould & Pyle)

(2.11)

"MRS B." (Fig. 72)

"Mrs B." is perhaps the most perfect example of symmetrical dipygus yet described. She was born in 1868. She was described by Wells, who states that at twenty she was quite healthy.

The duplication in this case begins just above the waist, the spinal column dividing at the third lumbar vertebra; below this point everything is double. Micturition and defaecation occur at different times, but menstruation occurs simultaneously. She was married at nineteen, and became pregnant a year later on the left side, but abortion was induced at the fourth month on account of persistent nausea, and the expectation of impossible delivery.

She utilised her outside legs for walking.

FIG. 95.

Mrs. B. (WELLS.)

Fig 72
(after Hirst + Piersol)

(2.11)

BLANCHE DUMAS (Fig. 73)

This woman had a very broad pelvis, two imperfectly developed legs, and a supernumerary limb attached to the symphisis, without a joint, but with slight passive movement. There was a duplication of bowel, bladder, and genitals. Menstruation is said to have occurred from both genital passages at once. At the junction of the rudimentary limb with the body, in front, were two rudimentary mammary glands, each containing a nipple.

FIG. 94.

Blanche Dumas.

Fig 73
(after Gould & Pyle)

(2.11)

JEAN BATISTA DOS SANTOS ("THE HUMAN TRIPOD"). (Figs 74,75)

This man was the most celbrated of all the diphallic terata. He was born in Portugal in 1846. His parents were healthy, and had two other children who were normally developed. He was easily born after an uneventful pregnancy. He was well proportioned, of prepossessing features, and had two distinct penes, the left somewhat the larger. Both became erect at the same time, and both discharged semen. There were two scrotums, each with a testicle in it. Urine passed simultaneously through both penes.

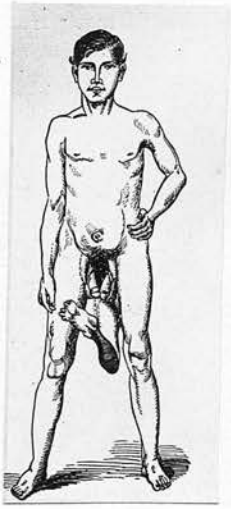
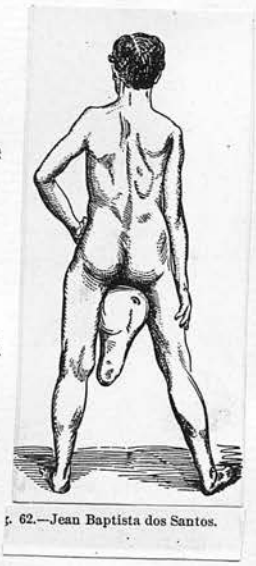


Fig 74

He had a medium pair of pelvic limbs fused together; hence he was called "The human tripod".

This fused limb was connected to the pubis by a short stem ½ inch long and as large as the little finger, consisting of separate bones and cartilages. There was a patella in the supernumerary limb on the anal aspect, and a joint freely movable. At adulthood the anus was three inches anterior to the coccyx. In the sitting or lying posture the supernumerary limb rested on the front of the inner surface of the lower third of his left thigh. He was in the habit of wearing this limb in a sling. The perineum proper was absent, the entire space between the anus and the posterior end of the scrotum being occupied by the pedicle. Santos' mental and physical functions were developed above normal, and he impressed everybody with his accomplishments.



. 62.—Jean Baptista dos Santos.

Fig 75
(after Gould & Pyle)

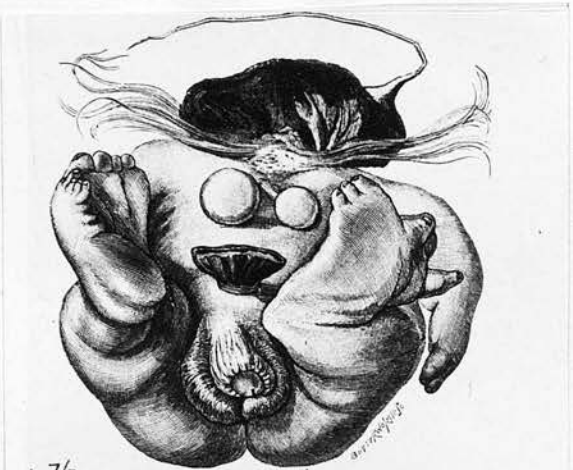
(2.4.11)

FOETUS IN FOETU.

In the abdominal inclusion of a foetus (foetus in foetu), the parasitic foetus may be fairly well formed, but never reaches full development (Fig.76).

It is contained in a sac either of connective tissue or of amniotic remnants, adherent to adjacent structures in the abdominal cavity. There may be a remnant of a cord. In one case the parasite, weighing one pound fourteen ounces, was contained in the abdominal wall (inclusio subcutanea).

Children with an included foetus commonly die at or shortly after birth. They are rarely long-lived, though one subject, a man, lived to the age of fifty. Usually the parasite excites peritonitis, and degenerates. This is an extremely rare condition.



76

Fig. 396.—Fœtus which was found enveloped in a cyst in the abdomen of a boy. When removed it was covered with sebum, and appeared as rosy and as healthy as if alive. (*Young*, 1808.)

(after Bland-Sutton)

CHAPTER VI.

OBSTETRICAL.

CHAPTER VI.

(23.24)

OBSTETRICAL

DOUBLE MONSTERS.

STATISTICS.

(a) Out of every 100 pregnancies, statistics show that 80 end in the birth of normal individuals;

7 are aborted as pathological ova;

12 are aborted as embryos or foetuses; showing various degrees of abnormality;

1 produces a monster at term.

(b) Out of 51 cases of double monsters:

19 were thoracopagus and omphalopagus;

3 were ischiopagus;

7 were dicephalus;

2 were syncephalus.

RESULT.

Curiously enough, double monsters are frequently expelled spontaneously without much difficulty, but when they do give rise to dystocia, dangerous and most complicated operations are often needed to effect delivery.

Double monsters have never been diagnosed before labour; at most twins have been suspected. Two bags of water exclude a double monster. As a rule, only after labour stops is the obstruction recognised to be due to joined foetuses, but inspection of the part delivered may give a hint as to the cause of the delay, for example hare-lip, or atresia ani.

(24. 28. 29.)

THORACOPAGUS, OMPHALOPAGUS, AND ISCHIOPAGUS. (Figs. 77, 51, 65).

These monsters generally present by the feet, and as the monster is born, the posterior head enters the pelvis first, and is followed by the anterior head.

If the heads present and are very small, the monster may be born with the upper head pressed in between the chin and chest of the lower head as it passes through the pelvis. If the heads are too large to allow of this method of delivery, the lower head having been born first, the two bodies are next born by a process of spontaneous evolution round the neck of the upper head which is resting on the brim of the pelvis, and which is born last.

BICEPHALIC MONSTERS. (Fig. 64)

These monsters also, as a rule, present by the feet, and are born in a way similar to that described above, as also they are when presenting by the head.

SYNCEPHALIC MONSTERS.

Unless the head of these monsters is very small, or the pelvis particularly large, they are delayed when the head enters the pelvis, be it first or last.

DIAGNOSIS

If the head presents, the diagnosis is not likely to be made until forceps delivery has failed, and the hand has been passed into the uterus to ascertain the cause of the delay, when the connecting bond between the two bodies will be identified.

(30.31-32-33.)

TREATMENT

Nature helps in the delivery of monsters by interrupting the pregnancy while the foetuses are still small, but cases are on record of united twins weighing 15 lbs and 17½ lbs, causing formidable dystocia.

In general, breach presentation is most favourable for all monstrosities, and if double, it is best if all four legs are accessible.

If the labour is progressing favourably, and the feet are presenting, the practitioner will do best to carry the body or bodies well forward over the symphisis pubis, by which means the posterior head may be encouraged to enter the pelvis first. If the heads are presenting and do not pass together, evolution may be assisted by pulling on the body or bodies.

Experience has shown that it is best to deliver the children whole, and not to amputate a head or a trunk which has been expelled. It may be necessary to amputate the delivered portion in order to gain access to the rest, or to render the balance of the mass movable, but such occasions are rare. Extremities should not be removed, as they do not interfere with our manipulations; further, they provide a grasp on the locked-in foetuses, and thirdly, their removal destroys their relations of one to the other, and aids complications in the diagnosis and treatment. If, however, labour be at all obstructed, the practitioner should at once resort to the operative measures which seem best suited to the particular case.

It is well to have some practical principle upon which to proceed in the treatment of such conditions and it may be summarised in this way

1. Under an anaesthetic, introduce the hand into the uterus, and make a thorough examination. In primiparae a deep episiotomy is advisable. Such an exploration must decide the presence of enlargement of a part of the foetus, a tumour of the uterus or of the foetus, a double monster, and, if the last, the location and extent of the area of fusion, the number of arms and legs, and the mobility of the child on the other.

2. If extraction seems to be possible with the help of perforation, either through the roof of the mouth or through the spine, decapitation, cleidotomy, or eventration, proceed at once.

3. If it is evident that this can only be accomplished after a prolonged effort and much mutilation of the maternal structures, and particularly if there is also a contracted pelvis, do a Caesarian section while the conditions are still favourable to the mother.

4. If compelled to do a Caesarian section after much previous handling, and there is suspicion of sepsis resulting, complete the operation with hysterectomy.

5. In no case should the malformed child receive consideration.

The following types of double monsters will be referred to seriatim:

Type 1. Thoracopagus:
" 2. Omphalopagus
" 3. Ischiopagus
" 4. Pygopagus
" 5. Craniopagus
" 6. Dicephalus
" 7. Syncephalus.

(35. 44)
TYPES 1 and 2. THORACOPAGUS (Fig.77) and OMPHALOPAGUS (Fig.51).

In the case of the Siamese twins one was delivered by the head, and the other by the breech. The connecting band may be so elastic as to allow version of the second twin after the delivery of the first. It is fortunate if the two children present by the breech. The posterior one should be delivered first, then the anterior child. If the bond of union is firmer, by unequal traction the head of the posterior foetus is to be drawn into the neck of the anterior and both delivered together. Exenteration should be done or the bond of union severed whenever necessary. If one child presenting by the head is delivered to the trunk and labour stops, the other may be turned by the breech and the two then delivered side by side. If two heads present and neither engages, version on both twins is performed. Failing these, decapitation, craniotomy, cleidotomy, and evisceration may have to be resorted to.

(34)
TYPES 3, 4 and 5. ISCHIOPAGUS (Fig.65), PYGOPAGUS (Fig.60) and CRANIOPAGUS (Fig.56).

These types seldom give trouble. The long sausage-shaped trunk slips through without any difficulty.

TYPE 6. DICEPHALUS. (Fig.64)

If the two heads present and engage, deliver the heads one after the other by forceps. If not engaged, version is performed, then exenteration and craniotomy in succession if necessary. If one head is delivered and the shoulders do not come, the delivered head may have to be amputated by which access is gained to the double trunk. The second head is lead into the pelvis, delivered, and then the double trunk reduced in size cleidotomy and exenteration. If the duplicity is caudal, all four extremities are to be delivered at one time and evisceration of the trunks performed, after which the extraction of the common shoulders and head is simple.

TYPE 7. SYNCEPHALUS (Fig.46a)

In this type the head may be crushed and the bodies eviscerated if necessary.

SINGLE MONSTERS.

Single monsters are more common than double, and are therefore of greater interest to the accoucheur, and, further, they produce dystocia more frequently because they more often develop to maturity, and also because enlargement of the parts is so often met with.

It is necessary here to describe the various possible forms of single foetal monstrosities. Most of them are incompatible with live birth, and may give rise to difficulty in labour.

It will only be necessary to give a few details about four of these, namely:

Hydrocephalus,
Anencephalus,
Acardiacus,
Extroverted viscera.

(36)

HYDROCEPHALUS

This is the commonest pathological enlargement of the foetus. In this condition the cerebral ventricles, particularly the lateral ventricles, are distended with an excess of cerebro-spinal fluid. The head may attain such colossal proportions that spontaneous delivery becomes impossible. Several pints of fluid have been drawn off such heads after perforation.

DIAGNOSIS

In either head or breech presentation there is arrest of the head at the brim of the pelvis. On examination the head will, in a head presentation, be found high up, right above the pelvic brim. It is

larger and rounder than usual. The fontanelles are large and bulging.

When the breech presents, the limbs and trunk are small and shrivelled, which makes any obstruction from the head all the more unexpected, and at once suggests the real state of affairs. The diagnosis may be confirmed by palpating the large rounded head above the symphisis.

PROGNOSIS

The great danger is rupture of the uterus. In 74 cases this accident occurred 16 times. The child is often dead, but in any case its life is of no consideration because, if it survives, it is almost inevitably doomed to hopeless idiocy.

TREATMENT

Forceps are not only useless, but actually dangerous, and should never be used prior to perforation. Perforation by some method is the only satisfactory treatment.

In head presentations a perforator, or an aspirating needle, or a pair of sharp scissors may be used. The head may then be extracted by forceps or a cranioclast.

In head-last cases perforate through the base of the occiput, or through the roof of the mouth. If the head is inaccessible, tap the spinal canal. Cut down on the lumbar spines, and insert an aspirating needle, or a stiff catheter into the vertebral column.

Endeavour to pass the cathether to the brain, as the foramen of Monro is not always patent, and otherwise it may not be possible to draw off the fluid.

30

ANENCEPHALUS (Fig. 37)

In this monster the vault of the skull is absent and the brain is undeveloped. The cervical and upper dorsal regions of the spine are rigid, and the arches of the vertebrae in these situations are often in addition incomplete (spina bifida).

The neck is rigid and the shoulders are frequently abnormally broad.

RESULT

These monsters may give rise to difficulty in labour by reason of their rigidity, and the undue breadth of their shoulders may be normal in size but are caught by the cervix which has been insufficiently dilated by the malformed head.

DIAGNOSIS

The commonest presentation is that of the face, when the bulging eyes and absence of any vault to the skull will attract attention. Transverse presentation are also common, or the monster may present by the base of the skull, in which case it can be recognised by the sella turcica, and the other cranial prominences.

TREATMENT

If the head is presenting and there is any delay, the best method of delivery, supposing that there is no

contraindication, is to turn, afterwards dividing the clavicles if necessary.

If turning is contra-indicated, the head can be seized with the cranioclast, and delivery thus effected, the clavicles being divided, or one or both arms amputated if necessary.

(31)

ACARDIACUS

Whatever form the acardiacus takes, whether it be acephalic (without a head), or acormic (with an undeveloped and a rudimentary body), or amorphic (without head, legs, or arms), obstruction to labour very seldom occurs. Rarely the acephalic form may become very swollen and oedematous, in which case labour may be obstructed.

TREATMENT

If necessary, the monster must be cut up piecemeal.

EXTROVERSION OF THE VISCERA

In these cases the outer abdominal wall is absent, and the small intestines and liver project into the amniotic cavity. In some instances the umbilical cord may be only two or three inches long.

The lie of the monster may be in the transverse diameter, with its viscera presenting, and the short cord may cause difficulty, and delay in delivery.

DIAGNOSIS

If the child is in the oblique lie, the exposed viscera will be felt. They have given rise to a mistaken diagnosis of placenta praevia.

TREATMENT

If the delay is due to the oblique lie of the child it should be turned or decapitated. If due to the shortness of the cord, the case must be treated accordingly.

It may be necessary to cut the cord, apply clamps to control the haemorrhage, and the child delivered as quickly as possible by forceps or traction on the breech, depending on the presentation.

CHAPTER VII.

THE SURGERY OF CONJOINED TWINS.

CHAPTER VII.

THE SURGERY OF CONJOINED TWINS.

To my knowledge, no work has, so far, been written on the surgery of conjoined twins.

While admitting that these cases are rare, they nevertheless exist, and merit the skill and sympathy of the surgeon.

When conjoined twins belong to poor parents, they usually fall into the hands of crafty individuals who exhibit them for gain. These unscrupulous showmen will not permit surgical intervention, even when it is practicable, for the obvious reason that such children are an added attraction and a valuable source of revenue in fairs and shows. These twins fare better when they are the offspring of wealthy or middle class parents.

PROGNOSIS OF CONJOINED TWINS.

The prognosis as to life of these twins is always a guarded one, for the illness or the death of one means the illness or the death of the other. It is for this reason that most of these twins die at an early age.

Referring to the death of the Siamese twins Chang-Eng (8) (Fig.51) Sutton writes that "one night they fell asleep. Near daybreak, January 17th, Eng called to one of his sons, who slept in the room above, to come down and waken Chang. The boy went to the side of Chang, and cried out, 'Uncle Chang is dead!' Eng at once said, 'Then I am going'. He died two hours

later. Eng probably died from syncope induced by terror". Had Eng lived an independent existence, his life would not have been affected by the death of his brother.

In the case of parasitic monsters, grouped under the heading thoracopagus parasiticus, such as the Chinaman A-Ke, the Hindu boy Laloo (Fig.70), Batista Colloredo (Fig.68), Karamet Hussain, and my case of the Clairwood twin (Figs.78,79), the danger ever to be feared is acute obstruction due to the strangulation of bowel in the isthmus. Sutton writing about Laloo describes how at the age of 18 he was suddenly seized with acute abdominal pain and vomiting. The showman asked Sutton to see him at midnight as there was a tense swelling in the band uniting him with his malformed brother. This was reduced and the symptoms of intestinal strangulation quickly disappeared. In my case of the Clairwood twin this is what actually happened soon after birth. The child was cyanosed, looked moribund, and I was compelled to operate the following morning, and reduced the hernia. The child made a rapid recovery. These two instances are sufficient to demonstrate that these unfortunate people are extremely liable to acute obstruction of the bowel.

THE SURGERY OF CONJOINED TWINS.

Although Sutton in his work on "Tumours" takes a gloomy view when he says that "the separation of conjoined twins is rarely practicable, and when carried out, even under favourable conditions, has

seldom been successful" is far more hopeful today. He writes in a happier strain in his illuminating article on "The Psychology of Conjoined Twins" (37). Referring to Kapur's clever operation, he comments as follows: "The leading facts of this case should serve as a stimulus to surgeons and encourage them to spare the autosite not only a dreadful life of bondage, but the disgust and ignominy of life in a travelling menagerie".

HISTORICAL

First operation (2, 11) - Under the Roman reign (A.D.945) two male children were brought from Armenia to Constantinople, well formed in all their extremities, but united by their abdomens. One of them took ill and died. The surgeons, in order to save the other, separated him from the corpse of his brother, but he died on the third day after the operation.

Second operation - In 1689, Dr Fatio (11) successfully separated two Swiss sisters who were united by their abdomens. He tied ligatures round the bond, which cut through in nine days, when the xiphoid cartilages were severed with a knife. Six months later the children were in good health.

Third operation (38) (2, 11) - By Dr Boehm, of Gunzenhausen, who was obstetrician, surgeon, and father of the twins - girls, of the xiphopagus type. Boehm performed the operation a few days after birth. An immediate cutting operation was done in the median

line, the umbilical vessels on both sides having first been tied. No other ligatures were applied. Three sutures were inserted in each wound, which were removed in three days. The union was mainly primary. One of the children, the feebler of the two, died on the fourth day. The other was nearly five years old when the case was reported.

Marie-Adèle. Separated by an operation.

Fig 77. (after Hirst + Pierson)

Fourth operation - Biaudet and Buginon, on October the 9th 1881, attempted to separate the conjoined sisters Marie-Adele (Fig.77), who were born on June the 26th, 1881 in Switzerland. Adele died in six hours, and Marie expired the following day. From the description it would appear that the operators did not have much experience in abdominal surgery.

Fifth operation - Chapot-Prevost, in May 1900, operated on the Brazilian twins Rosalina-Maria. The cavities of the pleura, pericardium, and peritoneum, communicated with the corresponding serous cavities in the opposite twin. Rosalina was saved. Chapot-Prevost closed the abdomen with skill and care. That part of the operation on Maria was done by assistants. She died on the sixth day. Chapot-Prevost deserves the highest praise for his success in saving Rosalina, considering the extensiveness of the operation.

Sixth operation - M. Doyen, in February 1902, separated the xiphopagus twins Radica-Doddica (Fig.54). Radica survived. The operation was done in twenty minutes. The band joining them contained a peritoneal

sac occupied by liver tissue. Doddica died suddenly seven days later. She had tuberculous peritonitis and a gangrenous appendix. Great prominence was given to Doyen's operation in the medical and the lay press.

(45, 46)

Seventh operation - D. D. Kapur. in 1927, separated the acephalic parasite (thoracopagus parasiticus) of Karamet Hussain. The autosite was one month old at the time of operation. He opened both abdomens, carefully dissected out the structures in the isthmus, ligated the arteries, cut through the nerves, dissected out the whole of the alimentary tract of the parasite, and transferred them complete into the abdomen of the host. Five months later the child was reported fit and well.

(47)

Eighth operation - In February 1929 I performed "parasitectomy" on the CLAIRWOOD TWIN which I shall describe more fully under a separate heading. My technique was somewhat different from that employed by Kapur, and, although the subject was a most unsuitable one, I am glad to say it made an excellent recovery.

It is worth while to speculate on the possible results of surgical intervention in the case of the xiphopagus twins Chang-Eng Bunker, better known as the Siamese twins (Fig.51) We must remember that aseptic surgery was not in vogue in their time. They were born in 1811 and died in 1874. Today, with our aseptic

technique, such an operation would probably have proved successful. It is possible that the large band of liver tissue joining the two livers (Fig.53) might have caused severe haemorrhage, but in view of the fact that a similar band of liver tissue existed in the case of Radica-Doddica (Fig.54), and the haemorrhage was controlled, the probability is that no difficulty would have been experienced in the case of Chang-Eng. There was no communication between their peritoneal cavities as in Radica-Doddica, and they were hale and hearty little gentlemen. Each twin had a normal set of organs, although there was a situs inversus viscerum in Eng, the right twin.

It is perfectly obvious that operative measures cannot be carried out in every case of conjoined twins. It would have been fatal, for example, to separate pygopagus twins such as Millie-Christine (Fig.60), as the union is far too extensive, and the shock of the operation would have been too great. Similarly, the Hungarian sisters, Helen and Judith (Fig.58) could not be parted as they had to share one anus and a single vulva.

INDICATIONS FOR OPERATION.

There are four indications for separating conjoined twins:-

1. Omphalopagus parasiticus;
2. Xiphopagus;
3. Thoracopagus;
4. Craniopagus.

1. OMPHALOPAGUS PARASITICUS

In this type of twins surgery is eminently successful as was shown by D. D. Kapur, and later by me.

The mortality in the hands of a skilled surgeon, should be practically nil. Laloo (fig.70), A-Ke, and Johannes Batista Colloredo (Fig.68, who belong to this class would have been, today, most suitable subjects for operation. The isthmus, in these cases, consists of peritoneum, arteries, veins, nerves and intestines. With a knowledge of the abnormal anatomy of these parts, the operation should be an unqualified success.

2. XIPHOPAGUS.

The Siamese twins (Fig.51) belong to this class. The pedicle between the twins consists usually of peritoneal pouches . Sometimes a large band of liver tissue connects the two livers (Fig.53). Although it would appear at first that cutting through this band would lead to uncontrollable haemorrhage, Doyen, apparently, experienced no difficulty in the case of Radica-Doddica (Fig.54).

3. THORACOPAGUS.

Rosalina-Maria-Marie-Adele (Fig.77) belongs to this class. Here the union is far more extensive, and hence there is a greater element of risk than in the first two groups. Chapot-Prevost found that the cavities of the pleura, pericardium, and peritoneum communicated with those of the opposite twin. In spite of this

extensive union Rosalina was saved. It is quite possible that had that part of the operation on Maria been performed by skilled surgeons instead of assistants, she also would have survived.

4. CRANIOPAGUS.

In cases of craniopagus where there is no communication of the cranial cavities as happened in Case 2. page76, surgical interference would be justifiable and successful.

COMMENTARY.

Surgery, today, is divided into specialities: ophthalmology, orthopaedics, etc., and practised by men possessing special skill and training in these subjects. This is as it should be, for ~~thr~~ it is to the patient's advantage. I feel convinced that it is essential for the surgeon who undertakes such a serious operation as the severance of conjoined twins to possess a sound knowledge of teratology, especially the anatomical anomalies met with in conjoined twins, and particularly of the structures most likely to be encountered in the band of union. Chapot-Prevost's operation on Rosalina-Maria (~~Mary~~) was marred by the want of skill and knowledge of his assistants.

The operators in the case of Marie-Adele do not appear to have had any experience in abdominal surgery, with fatal results.

I cannot conceive of a more delicate operation than the separation of conjoined twins. The saying "The abdomen is full of surprises" is nowhere so true

as in these united twins, and any misjudgment may easily prove disastrous. Y. J. Simpson of Edinburgh, in 1869, said "The variety, in double and other monstrosities is interminable, and truly the freaks and wonders of teratology are as odd as they are endless". We are dealing with faulty organogenesis, and I would urge that such operations be performed by two surgeons both versed in teratology, and possessing a knowledge of the abnormal anatomy of conjoined twins, especially of the structures, and their relations, most likely to be met with in the isthmus. Such a knowledge can be acquired by studying teratological specimens in a surgical museum, particularly specimens of conjoined twins of the type under consideration. They would teach us what we are most likely to find.

Before deciding to operate, it would be wise to administer an opaque meal and x-ray, and screen the abdomen thoroughly in the case of abdominal union. This will demonstrate the general lay out of the intestinal canal, and show up any communication of bowel between the twins should that exist. We have seen from the descriptions given above that, as a rule, no bowel communication exists between such twins as Chang-Eng (Fig) 51), and Radica-Doddica (page 75). But in the case of parasitic twins as in Laloo (Fig. 70), and A-Ke, the opaque meal and screening would be most helpful. It would show us where the bifurcation of bowel originates, whether in the host or in the parasite. I think that invariably the division originates in the belly of the autosite, and no intestines belonging

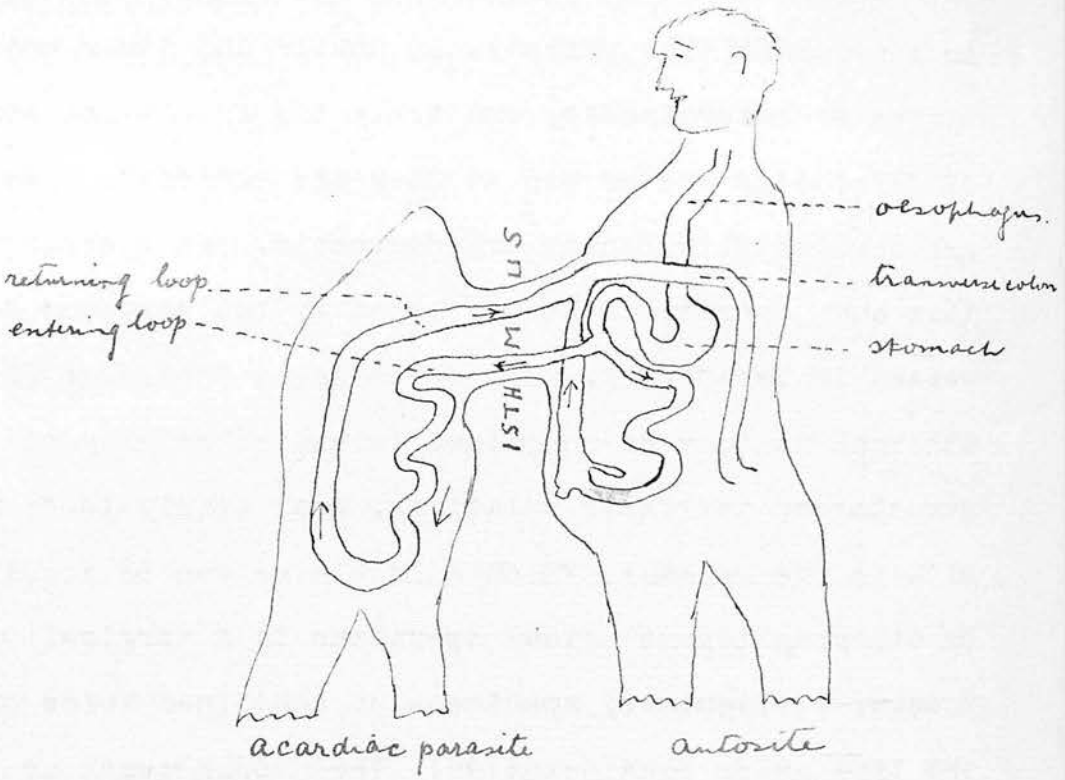


Fig 77A Rough sketch of alimentary system of parasite showing that the origin and termination is in the host's abdomen and that in the isthmus the intestines belong to parasite only an important point in "parasitectomy"

to the host are normally to be found in the abdomen of the parasite (Fig.77A). Should that occur at any time, acute symptoms of strangulation set in. This happened once to Laloo, and in my case of the Clairwood twin (Fig.78). Fig77A is an endeavour to explain diagrammatically what probably happens in the alimentary canal of the autosite. The bifurcation of bowel usually originates in the jejunum, traverses the isthmus as the "entering loop", continues as the intestinal tract of the parasite, and returns through the isthmus as the "returning loop", enters the abdomen of the host, and joins its large intestine. As a rule the alimentary system of the host is completely found in its own abdomen. The intestines of the parasite originate and terminate in the abdomen of the host. It is almost certain, therefore, that the intestines found in the isthmus belong to the parasite only. This fact is of the highest importance to the surgeon about to operate in these cases. That this is so can be verified by watching under the screen an opaque meal as it passes through the isthmus.

When operating, in order to leave a margin of safety, it is as well to include the first inch of intestines of the parasite, clamp, ligate, cut through, and transfer the stump into the abdomen of the host, and close the wound after inserting a small drainage tube which could be removed later. That portion of parasitic intestines atrophies, and gives no trouble.

While congratulating Kapur on his successful operation on Karamet Hussain (page110), I cannot help

thinking, in the light of these facts, that it was not necessary to dissect out the whole intestinal canal of the parasite, and transfer them in toto into the abdominal cavity of the host. Kapur admits that he experienced the greatest difficulty in getting the abdomen of the host to accommodate two alimentary canals. Fortunately he managed to squeeze them in, and to close the abdomen. The wound did not go septic, and the child made a splendid recovery.

I shall now report more fully on my case of the Clairwood twin, where I employed the technique advocated above.

CHAPTER VIII.

A CASE OF CONJOINED TWINS AND "PARASITECTOMY".

Fig 78
Conjoined twins at the age of 2 months

Fig 79
The same in prone position

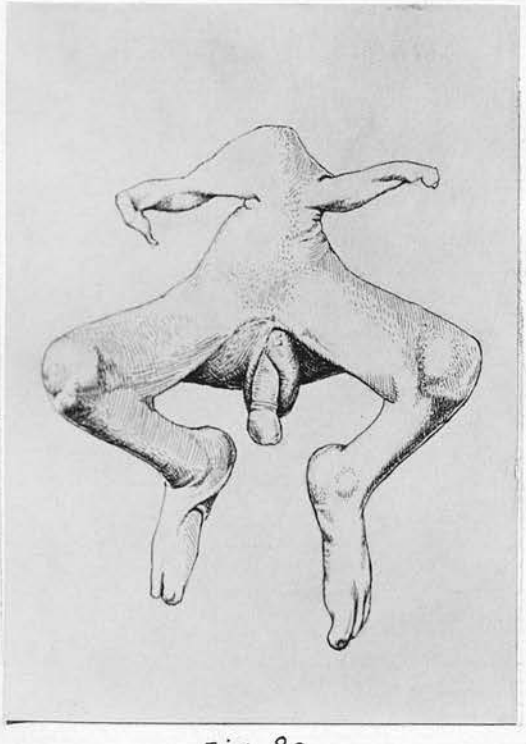


Fig 80
The parasite immediately after operation

Fig 81
The autosite at the age of 3½ months

AUTHOR'S CASE

CHAPTER VIII.

A CASE OF CONJOINED TWINS & "PARASITECTOMY." (47)

Rare as are conjoined twins, still rarer are cases in which one twin is normal and the other has a parasitic foetus attached. The case recorded below seems, therefore, worthy of recording. (Figs 78-81)

A multipara, aged 35, leaving near Durban, Natal, South Africa, gave birth to male twins on November 12th, 1928. The labour was, on the whole, easy. The first child, a head presentation, was normal in every respect, and weighed 7 lbs. The second child, a breech presentation, had a parasitic foetus attached to it. I was called half an hour after the delivery, as the midwife, finding an unusual bulging in the umbilical region of the second twin, was afraid to cut the cord. When I arrived I found the placenta in the bed, and after cutting the cord I noticed a hernia-like protrusion of the bowel in the umbilical area.

FAMILY HISTORY.

The father is 38 years of age, a factory employee of poor physique, below the average height and weight, and of intemperate habits. The mother is a healthy woman, and is of average height, weight, and physique. Three other children (two boys and a girl), aged respectively 7, 5 and 3, are normal in every respect. There is no history of miscarriages or of difficult labour.

THE AUTOSITE.

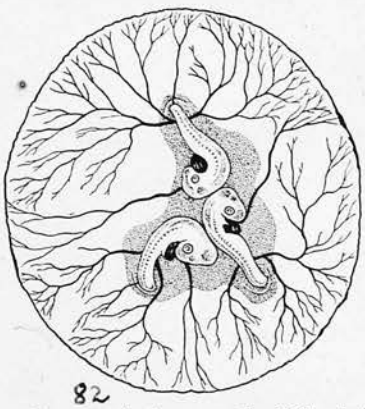
The autosite, a small baby weighing 5 lb. 8 oz.,

was poorly covered, had deficient muscle tone, loose skin, a Hippocratic facies, and a feeble cry. It was alert, cyanotic, especially about the feet, and had normal powers of suction and deglutition. The head was normal,, except that the cranial bones were unusually soft. The lungs, the upper and lower extremities, the abdomen, and the anal orifice were normally developed, and hearing, sight, and intelligence appeared to be normal. On the other hand, a bruit was heard in the heart, due, probably, to a patent foramen ovale, and the genito-urinary system was abnormal. The left testis was undescended, and micturition occurred at independent times from the penis of the autosite and from that of the parasite.

THE PARASITE. (Fig. 80)

The parasite was attached to the autosite by a pedicle the circumference of which was about that of half a crown. The pedicle was partly bony and partly muscular. The upper bony part was attached, slightly to the right, to the lower end of the autosite; the lower part of the pedicle was muscular, and joined to the upper part of the abdominal wall.

The chest of the parasite was undeveloped, and contained no heart or lungs. Its upper extremities were rudimentary; the right arm was longer than the left, and each hand had one rudimentary metacarpal, finger, and nail. The lower extremities were well developed and equal in size, but they were flexed to a right angle, and could not be straightened or bent



82

FIG. ●.—A fine example of identical triplet chick embryos derived from triple gastrulation of a single blastoderm. (After Dareste.)

any further. The ankles were stiff; each foot had five well-developed toes. There were no testes in the scrotum, but the penis was well formed, and the parasite passed water over the autosite. There was no umbilicus, and no anal orifice, though a distinct dimple marked the place of the latter. The parasite displayed no movement, but when its skin was pinched or pricked with a needle the autosite winced and uttered a feeble cry.

TERATOGENESIS.

We saw that the chief factor in the causation of defective development such as hare-lip, and umbilical hernia is to be found in the formation of amniotic adhesions in early embryonal life. These adhesions lead to the close approximation of the foetal body to the internal wall of the ovum at the future site of the placenta and prevent the complete closure of the centripetally growing walls.

The umbilical region is peculiarly liable to disturbances of development with the result of imperfect union, for it is the last portion of the anterior surface of the abdominal wall to close, and gapes widely up to a comparatively late date of development.

We have seen that whenever the embryonal area undergoes complete fission the resulting halves develop, under favourable conditions, into uniovular twins; so also when a secondary fission of one of the halves takes place, uniovular triplets result from such two-fold division of the original area (Fig.82). Such foetuses

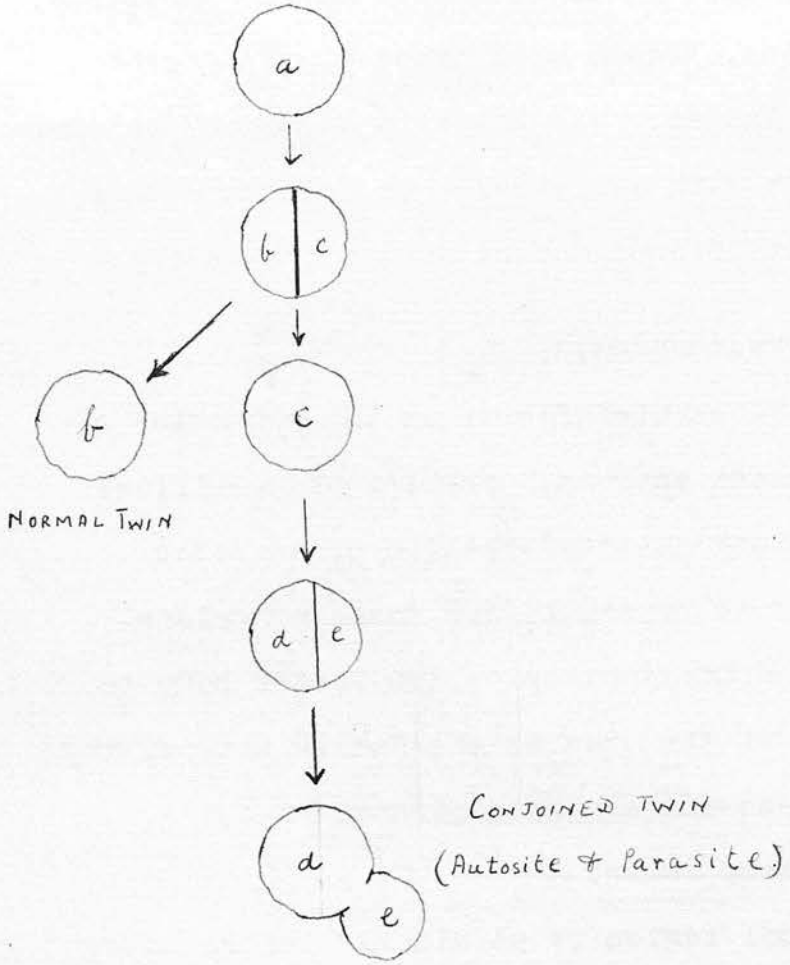


Fig. 83 Diagrammatic explanation of origin of the Clairwood twins. (For explanation see text.)

usually lie within a single chorion, enclosed by a separate or a common amniotic sac, the increased pressure arising from the unusual contents of the limited uterine cavity favouring absorption and disappearance of the amniotic partitions.

Instead, however, of the double cleavage resulting into triplets, very often those causes already indicated as affecting twins, namely developmental arrests, amniotic adhesions, etc., here still more often lead to the unequal development and the suppression of one or two foetuses, which then become acardiac, or amorphous parasites in connection with a single well-developed foetus.

In the case of the Clairwood twins the following, to my mind, is what has actually taken place. I shall endeavour to explain it diagrammatically in Fig. 83.

1. The fertilised ovum (a) divides into two equal parts (b) and (c).
2. (c) divides into two, (d) and (e) but incompletely.
3. The heart of (d) gets the ascendancy with subsequent atrophy of (e's) heart, leading to an acardiac foetus (vide p.64).
4. The acardiac embryo becomes drawn in towards the dominating embryo (d), with consequent development of conjoined twins one of which is parasitic.

We now possess a clearer knowledge of these particular Clairwood twins both as regards their external appearance as well as to their teratogenesis, and shall proceed to describe the operative measures which were adopted.

OPERATION FOR UMBILICAL HERNIA.

On November 13th, when the child was one day old, I found there was strangulated bowel in the hernial opening, and was acutely ill. I opened the abdomen, removed the hernial sac, returned the intestines to the abdomen, and closed the wound. The child made an uninterrupted recovery, the cyanosis disappearing almost at once and its general condition improving. Water-proof material was used to protect the wound from the parasite's urine. Healing took place by first intention, leaving a clean scar.

I considered that the child's condition did not justify an attempt to remove the parasite, and decided to wait a little before undertaking this operation. Later, however, when he was ten weeks old, I found him looking extremely ill, and was able to induce the father to allow me to remove the parasite at once.

REMOVAL OF PARASITE ("PARASITECTOMY"). (Fig. 80)

The operation was performed on February 6th under light chloroform anaesthesia. I made an incision round the pedicle, and on opening the abdomen I found that there was free communication between the abdominal cavities and between the bowels themselves. The peri-toneum of the autosite was continuous with that of the

parasite, but the latter's bowel had an independent mesentry attached to its posterior abdominal wall. The intestines of the parasite were very thin and narrow; they originated from the autosite's small intestine and ended in its lower bowel. The parasite had one small right kidney, but no liver or spleen. Large blood vessels and nerves passed from the autosite to the parasite. I ligated and cut the vessels passing into the parasite, and then decided to cut through the bowel of the parasite, taking care not to endanger the intestines of the host.

Fig 84
Mother of the Clairwood twins one month after operation.

Keeping as close to the parasite as possible, I clamped the bowel, removed it as one would an appendix, and returned the host's intestines into his abdomen. I closed the abdomen in the usual manner and brought the edges of the skin together by interrupted silk-worm-gut sutures.

The operation lasted fifteen minutes, and except for a little sloughing of the wound the child made an uneventful recovery. The parasite weighed 8 ounces.

The child was breast-fed at three-hourly intervals, and twelve hours after the operation he had a normal stool. The fact that thereafter the stools were of normal colour and consistency assured me that his intestines had not been damaged at the operation. He began to improve steadily and gained in weight, and a month after the operation he was still alive and doing well.

Fig.81 shows the child a month after the operation.

CHAPTER IX.

MORBID HEREDITY AND EUGENICS.

CHAPTER IX.

(3,39)

MORBID HEREDITY and EUGENICS.

A. MORBID HEREDITY.

THE PATHOLOGY OF THE EGG AND SPERM CELL

There is a Greek proverb which says "a bad crow lays a bad egg", and it represents the popular idea of morbid heredity.

Heredity in relation to morbid processes is believed to show itself in various ways. There exists in some families a special tendency for the members to be affected with certain maladies for which a hereditary character has been claimed: for example in epilepsy, and migraine. If we are to accept the evidences of after events, there is already in the ovum and spermatozoon the subtle and complex machinery of heredity. In the reproductive cell, perhaps in its nucleus, in its chromosomes, or in parts of it not yet differentiated by science, there is the mysterious something which determines that the child shall resemble his father or mother or his grandparents.

What is infinitely of greater importance than external physical resemblances is the heredity of mental characteristics and mental anomalies, as we see in children borne of mentally defective or "peculiar" parents. Such children grow up social misfits, and difficult to handle.

It is not always the disease itself that is transmitted, but a predisposition to it, a weakness

of the nervous system, in the case of epilepsy, which makes the individual prone to develop it. Some inherit a predisposition to gout, rheumatism, eczema, webbing of fingers or toes, supernumerary digits (Fig.40), colour blindness, diabetes insipidus, haemophilia, ichthyosis, and other diseases. Heredity is conspicuously active as a cause of these anomalies, as the perpetuation of certain deformities through several generations shows (e.g. Fig.30).

Some believe that cancer is hereditary (Fig.87). It is also believed that heart disease, bronchitis, nephritis, and certain eye diseases such as myopia, and cataract are transmitted hereditarily.

In all these transmitted conditions we have been dealing with the transference from the parents to the offspring of predispositions or tendencies. But it is a debatable point whether structural causes for these predispositions do not actually exist.

In the hereditarily transmitted disease haemophilia there is believed to exist a structural substratum, an error fundamentally in the tissue cells and not in the blood, which explains how this predisposition is brought about.

There are states intermediate between those in which no structural alteration is recognisable e.g. gout or cancer, and those in which definite and specific changes can be seen, as in syphilis. These connecting links lead us to ask the question whether in all hereditary maladies there may not be s subtle

substratum of tissue-defect which acts as the vehicle for the manifestation of the functional disorders which constitute the diseases. In the case of Bright's disease there may have existed a congenital narrowness of the renal arteries.

We have also a group of diseases of microbic origin. In tuberculosis there is a transmitted predisposition as a rule, although there are authentic cases in which tuberculosis has been transmitted by the mother to her offspring direct.

Variola, scarlatina, measles, malaria, and many other maladies (41) may be transmitted directly from mother to foetus. It is therefore possible that in these diseases there is an inherited predisposition to be attacked by them in postnatal life.

A hereditary factor exists among the teratological formations. The monstrosities and malformations of the embryo, may, like the diseases of the foetus, be transmitted hereditarily. Direct heredity is often prevented by the fact that so many monstrosities do not permit of postnatal life, but there are sufficient instances of it among the minor malformations, such as polydactyly, (Fig 40), hare-lip (Fig. 30), ocular anomalies, aural deformities, and herniae, to prove that it undoubtedly exists. Further, experimental teratogenesis has shown that malformations and monstrosities may be produced in the embryo by toxic, nutritional, mechanical, and other agents which produce disease in the adult, child, and foetus.

There is not, therefore, as great a difference as might at first be imagined between the heredity of diseases and the heredity of malformations. Each group has its limitations in certain directions, but there are many characteristics common to both. Finally, there is evidence of heredity in regard to morbid conditions which are generally supposed to arise in the germinal period of life. Germinal pathology thus falls under the laws of morbid heredity. Twin pregnancies, and large families (prolificacy) are often strictly hereditary. Take the case of the mother of the Siamese twins. This woman had a very large family, and also both her twins (p.72). The hydatid mole has been known to occur several times in the same patient. Sex anomalies runs in families. I am inclined to agree with BALLANTYNE that it is precisely in the early part of the germinal period that predispositions and tendencies to diseases and malformations are determined

TREATMENT OF ANTENATAL MORBID STATES

It has been shown that, even in families with most malformations and monstrosities, some members are born free from morbid states.

Morbid heredity is a break in the heredity of health and normal formation which may right itself in one, two or three generations provided environmental conditions are favourable. There is a constant tendency towards recovery and return to a healthy stock.

The practical conclusion as to prophylaxis is, therefore, to safeguard the specialised reproductive cells, namely the ova and spermatozoa, which are to become the infants of the next and of the succeeding generations, against morbid agencies of a toxic, microbic, or traumatic nature such as alcohol, tuberculosis, syphilis, and mental strain, so long as these reproductive cells are in the bodies of the prospective fathers and mothers of this generation.

It is perfectly obvious that if a man or a woman has a body poisoned with the septic products of small-pox, or infected with the toxins of the spirochaete pallida, or irrigated with fluids containing alcohol, morphia, lead, cocaine, etc or a brain subjected to extreme mental strain and mental shock (the gambler), his and her reproductive cells cannot escape the morbid influences thus brought to bear upon all the other tissues.

We know that certain poisons have a predisposition for certain tissues. We know the effect of lead on the nervous system. We know also the effect of syphilis on the arterial system. It is possible that others have a predilection for the reproductive system. It is quite feasible that these reproductive cells when so surrounded by malign influences grow into malformed embryos, diseased foetuses, and infants predisposed to various maladies. In other words, the chain of normal heredity is broken in them, and morbid heredity or degeneration supervenes.

There is evidence to show that the reproductive cells may join in general tissue recovery. The nervous system of the alcoholic may appear to be hopelessly enfeebled, and yet total abstinence may result in mental and physical recovery. It is quite possible, therefore, that the reproductive cells may reap the benefit as well.

Marriages of consanguinity should be avoided. Each individual should not postpone matrimony till late in life, or embark upon it too early. It is well for the person of unhealthy parentage not to marry one endowed with a bad family history, unless, at least, they are both making every possible endeavour to acquire health and strength, and so improve their germ-cells.

(39,40)

B. EUGENICS

The science of eugenics is the study of conditions of improving the human race; the art of eugenics is concerned with the application of the results of such study.

Eugenics recognises that with regard to racial welfare, heredity, and environment are interdependent, and that both are essential. Of the two, heredity is fundamental. The best environment cannot altogether change a defective heredity. The offspring of epileptic parents even under the most favourable environment would still develop an unstable nervous system. On the other hand, an unfavourable environment can vitiate

the full expression of the best heredity. Thus children of the healthiest stock, growing up under the worst environment would lose their heritage of health.

It is clear that perfect development needs the cooperation of a perfect heredity and a perfect environment.

Modern conception of heredity dates from the rediscovery of MENDEL'S work. GALTON defined eugenics as "the study of the agencies under social control that may improve or impair the racial qualities of future generations, either physically or mentally". He wished that eugenic ideals might "enter the national consciousness like a new religion".

Since the rediscovery of MENDEL'S laws of heredity in 1900, their general application in the case of man as regards mental and physical characters, has been amply confirmed.

The example of eye colour in man may serve as an illustration:

(1). Brown eyes are dominant over blue eyes.

(2). Pure bred (homozygous) brown-eyed parents will have only brown-eyed children.

(3). Hybrid (heterozygous) brown-eyed parents will have brown-eyed and blue-eyed children in the proportion of 3 : 1 .

The alternate unit characters of brown and blue eyes conduct themselves in heredity according to the Mendelian formulae.

Fig.86 is a pedigree chart illustrating the

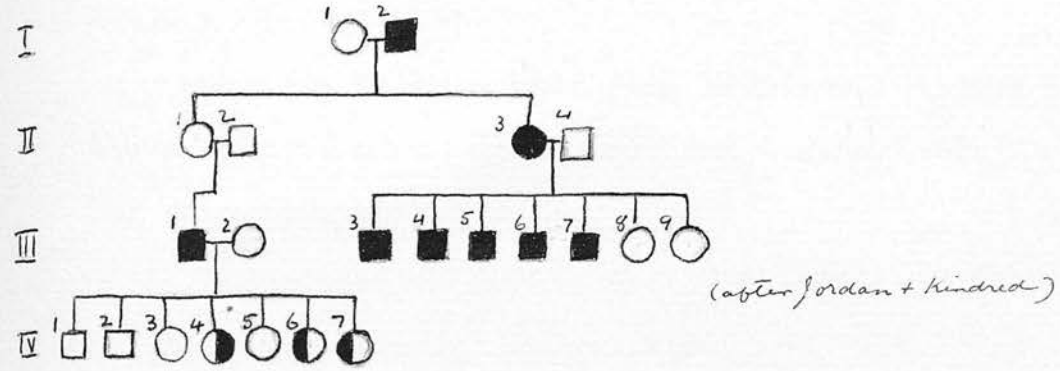


Fig.85 PEDIGREE CHART OF HEREDITARY HARELIP (SOLID BLACK SYMBOL) AND CLEFT-PALATE (HALF BLACK SYMBOL)
The type of defect is constant. I,2, simple fissure; II,3,bilateral fissure; III,1, palatine fissure; III,3-7,lip fissure;IV,4,harelip c cleft palateIV.6,7, palatine cleft s harelip

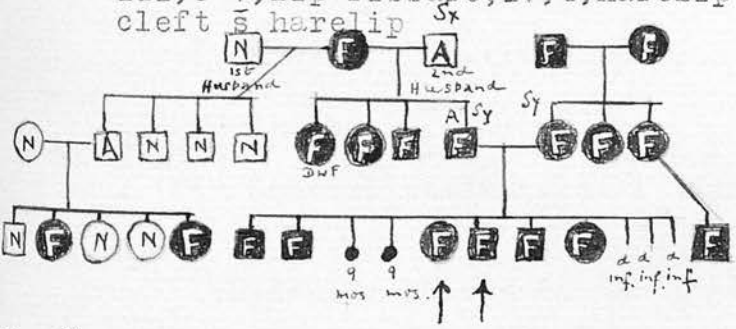


Fig.86 PEDIGREE CHART ILLUSTRATING INHERITANCE OF FEEBLE-MINDEDNESS (F). N, normal; A,alcoholic; Sx,sexoffender. Chart shows that in this family history offspring of matings among feeble-minded were all feeble-minded. Squares indicate males, circles females, solid characters affected individuals. (From C.B.Davenport, after Goddard, 1910; Heredity in Relation to Eugenics, Henry Holt & Co.)

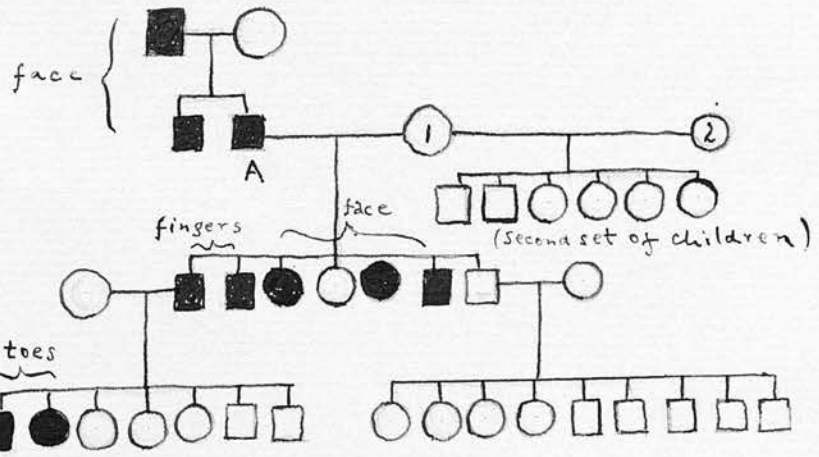


Fig.87. FOUR-GENERATION HISTORY OF CARCINOMA.
Nodules appeared on face, fingers and toes as shown.
(after Jordan + Kindred)

inheritance of feeble-mindedness (F).

Fig.85 is a pedigree chart of heredity in hare-lip and cleft palate.

Fig.87 is a pedigree chart of a four-generation history of carcinoma.

Numerous methods have been proposed for checking the supply of human defectives and degenerates. The principal ones are:

(a) Segregation during the reproductive period:

(b) Sterilisation by vasectomy and tubectomy:

(c) Restrictive marriage laws and customs:

(d) Eugenic education of the public and prospective marriage couples:

(e) System of matings, purporting to remove defective traits.

(f) General environmental improvement, etc.

Eugenics is one of the world's most pressing problems.

SUMMARY.

1. Human monstrosities are of great interest to the physician, surgeon, and obstretician.

2. Until the 19th century, malformations were attributed to the influences of wrathful gods, devils, witches, sex perversions, the moon, eclipses, comets, and "maternal impressions".

3. Scientific teratology only commenced in the 17th century.

4. Connections between animals of different species have been proved conclusively to be sterile.

5. Germinal life of embryo lasts about one week.

6. Embryonic life lasts about five weeks.

7. Foetal life lasts for the remainder of the ante-natal period.

8. Normal development is a form of twinning - "symmetrical division".

9. Uniovular twins originate from one ovum, and is not a normal physiological process.

10. Double monsters also originate from one ovum, and are due to partial fission of embryonic axis.

11. Binovular twinning is not true twinning.

12. The armadillo has supplied valuable data regarding early mammalian development.

13. The corpus luteum is a guide as to the number of ova involved in a pregnancy.

14. There is a period of quiescence of about three weeks in early development of the armadillo. This may explain its polyembryony, and may also explain uniovular twinning in man.

15. Twinning is due to a period of quiescence as a result of an upset in the growth regulating mechanism of the ovum.

16. In epignathus we have complete fission with partial inclusion.

17. In foetus in foetu we have complete fission with total inclusion.

18. Malformations can be produced experimentally in some animals by:
    (1) violent agitation,
    (2) variations in physiochemical conditions,
    (3) variations in temperature, and
    (4) disturbance of normal respiratory interchange.

19. The principal causes of human malformations are:
    (1) amniotic bands or adhesions,
    (2) faulty implantation of ovum due to endometritis,
    (3) developmental arrest at critical stages of gastrulation, and
    (4) heredity.

20. There is a growth regulating mechanism in the ovum.

21. This mechanism is controlled by two ovular secretions: "inhibitin" which inhibits growth, and "stimulin" which stimulates growth.

22. Normal tissues contain a similar mechanism with similar secretions.

23. In ante-natal life, inco-ordination between these two factors leads to mal-developments and monsters.

24. In post-natal life such inco-ordination results in simple or malignant growths.

25. "Inhibitin" may prove a powerful "de-cancerising" agent.

26. "Stimulin" may prove equally useful in most clinical conditions of a non-malignant nature requiring the speeding-up of tissue repair.

27. Surgery has a distinct field of usefulness in certain cases of double monsters namely, omphalopagus parasiticus, xiphopagus, thoracopagus and craniopagus.

28. Heredity is a potent factor in physical and mental peculiarities in the offspring.

29. There is a constant tendency towards recovery and return to a healthy stock.

30. Eugenics is "the study of the agencies under social control that may improve or impair the racial qualities of future generations, either physically, or mentally".

31. Mendel's laws of heredity have been found also applicable in man as regards mental and physical characters.

32. Several methods for checking the supply of human defectives have been proposed e.g. segregation, sterilisation, restrictive marriage laws, etc.

33. Eugenics is one of the world's most pressing problems.

GLOSSARY. (42)

Anadidymus	A monster foetus double above and joined below (" Y ")
Anlage	The embryonic area in which traces of any part first appear.
Blastocele	The cavity of a blastula
Blastocyst	Same as blastula
Blastoderm	The delicate membrane which lines the zona pellucida of the impregnated ovum. The blastoderm is formed by the cells (blastomeres) which result from the splitting up of the ovum after impregnation.
Blastomere	Any cell or cell mass of the blastoderm. One of the cells formed by segmentation of the fertilised ovum which constitute the morula.
Blastotomy	Destruction of a blastomere.
Blastula	Stage of development of embryo which follows cleavage when cells are arranged in a single layer to form hollow sphere.
Craniopagus	A twin monster united at the head.
Cyclops	A foetal monster with one median eye.
Dicephalus	A monster foetus with two heads.
Dichotomy	A process of division into two parts.
Diprosopus	A foetal monstervwith two faces.
Ecology	Science of organisms as affected by factors of environment. The study of environment and life history of organisms.
Ectoderm	The epiblast or outer layer of primitive embryo
Endoderm	The hypoblast or inner layer of the two layered embryo (blastoderm)
Entoderm	See endoderm.
Epignathus	A parasitic monster attached to the jaw of an autositic foetus.
Gastrula	Stage which follows the blastula, and in which embryo consists of two layers, the ectoderm and entoderm, and of two cavities, one between ectoderm and

and entoderm; the other the archenteron is within the endoderm.

Gene — A hereditary germinal factor which, either alone or in combination with other factors produces a single character.

Ischiopagus — A monster with two heads and with the bodies united at the hips.

Katadidymus — A twin monster fused into one in the lower parts.

Macrodactyly — Abnormal largeness of fingers and toes.

Macrosomia — Giantism

Mesoderm — The mesoblast or middle of the three layers of the primitive embryo and derived from the ectoderm and entoderm.

Microsomia — Dwarfism.

Morula — The segmented ovum in the mulberry stage, forming a solid mass of cells. These cells are known as blastomeres.

Omphalopagus — Twin monster fixed at umbilicus.

Ontogenesis — The evolution or developmental history of the individual organism.

Phylogeny — The evolution or ancestral history of a race or group of animals

Polygnathus — A double monster-foetus united at the jaws.

Primordium — Same as "anlage"

Pygopagus — A twin foetal monster joined at the buttocks.

Siren — A monster with fused legs and with no feet.

Syncephalus — A twin foetus with fused heads.

Terata — Monsters. Congenitally malformed foetuses.

Thoracopagus — A twin monster fused at the thorax.

Trager — Same as placenta.

Trophoblast — The epiblastic layers which line the chorionic villi in the foetal villi.

Zona pellucida — The innermost of the two lining membranes of the ovum.

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