An Address ON STERILITY IN WOMAN.*

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In any study of sterility in the human race we should try to discover what is the trend: is sterility more common to-day than it was, say, fifty years ago? This must be a matter of sociological and national importance in some of its aspects as they are related to conditions of environment. Moreover, we must consider the effect of sterility on the health, character, and outlook of the individual woman, both in respect of her own personality and in relation to the circle in which she lives. We know, indeed, the influence of a happy family life on those immediately concerned, and we fully realize the importance of it to the nation at large. So it is that, properly considered, the question of sterility becomes a large and weighty issue.

In a remarkably short space of time, certainly not more than forty years in this country—indeed, it is only 130 years since Malthus's book on the limitation of population was first published—the control of childbirth has become common enough to vitiate statistics in regard to sterility, fertility, and fecundity, especially in relation to the upper classes. It would be impossible to-day to collect figures as accurate in regard to sterility and fecundity as those set out in the following table, which illustrates the fertility of women as estimated by Matthews Duncan from data given in the registers of Glasgow and Edinburgh in 1855.

TABLE I.—Influence of age on the fertility of married women. Showing the percentage bearing a child within two years of marriage. (4,500 marriages.)

Age when married.	Percentage bearing child within two years.
16	12.9
17	30.0
18	46.4
19	57.8
20-24	90.51
25-29	75.8
30-34	62.9
35-39	40.9
40-44	15.4
45-49	4.3

Matthews Duncan points out that these figures are not absolutely correct, for dead children are not reckoned in the records from which they were obtained. Still, he regards them as indicative of fecundity at different ages at that date. As a matter of interest my house-surgeon, Mr. Jeffcoat, obtained for me the figures shown in Table II, from the histories of more than 1,000 consecutive married women attending a gynaecological out-patient clinic.

TABLE II.—Fecundity in relation to the age of 1,000 consecutive married women attending a gynaecological out-patient clinic. Showing percentage bearing a child within two years of marriage.

Age when married.	Percentage bearing child within two years.
16	86.7
17	85.2
18	90.9
19	90.4
20-24	83.1
25-29	71.9
30-34	62.5
35-39	52.0
40-44	29.0
45-49	0

These figures show no resemblance to those of Matthews Duncan so far as the younger women—16 to 20 years of age—are concerned. The reason seems to be that the figures collected from an out-patient gynaecological clinic are concerned with a group of women who for the most

part are parous; indeed, 56 per cent. presented themselves for the relief of obstetric injuries. In this class of woman contraceptive measures do not appear to be widely practised, and if we wish to discover the influence of contraceptive measures we must study the Registrar-General's figures concerning the general birth rate.

According to the latest official statistics it appears that the birth rate per 1,000 of the population has fallen from 32.3 in the eighties, and 29.4 in the nineties of last century, to 16.3 in 1929, for England and Wales generally, and to 15.9 for London. The gap between the birth rate and the death rate is, it seems, being rapidly closed. In the last forty years, which is the period of birth control, the birth rate has dropped to one-half of the previous level. Moreover, in the Registrar-General's Decennial Supplement (1921), under the section on "Occupational Fertility," it is stated that in Class I—the highest grade—the fertility rate per 1,000 married males under 55 years of age is nearly half that of Class V (unskilled workers). Since the wives are included and births alone are taken into account, the term "fecundity rate" would be better than "fertility rate." No account has been, or could be, taken as to the exact influence of contraception, but it must be clear that this factor has been concerned in the upper classes, otherwise their low fecundity rate is inexplicable. Such a state of class sterility could not occur naturally.

According to Matthews Duncan the Glasgow and Edinburgh registers indicated that 15 per cent. of all marriages were sterile.

DEFINITION OF STERILITY.

The definition of the term "sterility" has never been satisfactorily determined. Matthews Duncan wrote: "Sterility is generally considered to imply the condition of a woman who, under ordinary favourable circumstances for reproduction, does not bring forth a living and viable child. But the term is used with many other meanings. . . ."

Quite recently, in a discussion at the Royal Society of Medicine,⁹ there was a difference of opinion on the matter. Some held that the term should indicate failure to conceive, while others maintained, as apparently did Matthews Duncan, that abortion should be included. For myself, I think it is more exact to hold to the original meaning of the word, which was jejune, empty, or barren; so it is from this point of view I shall review the subject, and therefore shall not discuss abortion. It is necessary to add that sterility may be primary or secondary—that is, after previous fecundity—and that it may be absolute or permanent, or temporary and curable.

CAUSES OF STERILITY.

In the first place it may be said that it is unscientific, and often inhumane, to subject a woman whose only complaint is sterility to what may be tiresome, if not painful, investigations, and perhaps to operations, until the condition of the husband has been established. It should be definitely understood that before anything is done to a woman the husband must be examined. In a considerable percentage of cases the male partner is found to be either impotent or temporarily or permanently sterile from absence or abnormality of the spermatozoa. According to Matthews Duncan, Gross placed the number of sterile husbands at 17 per cent., while modern writers¹⁰ have estimated the figure at 20 per cent. in unfruitful marriages.

Apart from active contraceptive measures, which some believe may lead to subsequent sterility, and which I shall not consider further, sterility in women is due to congenital or acquired lesions in the generative organs, or to some disordered physiological state, and somewhat rarely to toxicological factors.

Congenital Lesions.

These consist of (a) atresiae, which are often amenable to operative procedures; (b) malformations, which may or may not be remediable by surgical intervention; and (c) underdevelopment or absence of essential organs—the latter producing, of course, absolute and permanent sterility, whereas slight underdevelopment may be curable if treated soon after puberty.

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The recognition of the stenoses of congenital origin that may occur in the vagina and cervix is not difficult, and the treatment is well defined. The subsequent result in regard to conception depends chiefly on whether the uterus and tubes have been permanently damaged by the back-pressure of retained menstrual secretions. So also in regard to malformations: some of these, especially conical and hypertrophied cervixes, can readily be corrected by simple surgical procedures, and sterility may be relieved. Underdevelopment (hypoplasia) of the genitalia I shall consider later, for it is, strictly speaking, the result of disordered function.

Acquired Lesions.

On these some stress must be laid, for there is none, apart from those which are the result of eradicated procedures, that cannot in favourable circumstances be remedied. The lesions fall into three groups—*anatomical, neoplastic, and infective derangements*. They may act directly by preventing the spermatozoa from reaching the ovum, or indirectly by causing dyspareunia, and so by interfering with coitus.

1. Anatomical Derangements.

Retroversion of the Uterus.—Whatever other symptoms may be caused by backward displacements of the uterus, there can be no two opinions as to the frequency with which sterility is caused by retroversion. The usual explanation, and it seems a sound one, is that the spermatozoa are unable to reach the cervical canal, for the external os may so point forwards as to lie in close apposition to the anterior vaginal wall and be occluded by it. If the position of the uterus be corrected conception may follow almost immediately. Undoubtedly many women have become pregnant with the uterus in the retroverted position, and it is not unlikely that in a certain number of these there has subsequently been a retroverted gravid uterus, though in some the malposition may have been spontaneously rectified. The whole picture, however, lends support to the view that married women, in whom no other cause is found for sterility, should have the position of the uterus corrected by operation. In a number of cases of "puerperal retroversion" there is some streptococcal infection binding down the uterus, tubes, and ovaries, and frequently the tubes are occluded by adhesions only. This is one of the causes of so-called "one-child sterility." When these adhesions are separated and the uterus is fixed in the normal position with the tubes and ovaries suspended the patient is no longer sterile.

Prolapsed ovaries may be associated with retroversion of the uterus; but it is not at all uncommon to find a prolapsed and tender ovary without any other lesion, and this may cause severe dyspareunia, and, as a consequence, sterility. In a married woman such a condition always demands treatment.

Trauma, for the most part operative, may result in the disappearance of essential parts of the generative organs, or in their mutilation to so great an extent as to prevent conception. I have always been a strong advocate of conservative measures in operations on the female genitalia; and by this I mean that while all permanent lesions causing symptoms should be removed, or otherwise dealt with, the surgeon should be careful never to remove unnecessarily or to interfere with the function of healthy structures. That, of course, should be the guiding principle in all operative procedures, but in no other part of the body is it more important that there should be strict adherence thereto than in the genital organs of a woman, whose whole life may be clouded, and perhaps her mentality affected, by too drastic procedures.

Further, the danger of rendering a young woman sterile by an imperfect operation must be mentioned. In the performance of posterior colporrhaphy, for example, a "sump" should always be left in the natural position of the posterior fornix in which the semen can collect. A circular amputation of the cervix obliterating the fornices may cause sterility.

It is necessary to call attention also to the possible danger of *curettage* for sterility. There is no need for

this procedure, even though dilatation of the cervix be performed. On at least three occasions I have found occluded tubes after curettage had been performed, and it appeared probable that the occlusion had followed a slight streptococcal infection of the uterus after curettage; but, of course, one cannot be absolutely sure of this. Nevertheless, if there was pre-existing tubal occlusion, why was curettage performed?

Under this heading I must mention the danger of producing sterility in young women when x rays or radium are applied for menorrhagia. Valuable as radium is in certain cases, the greatest care is required in its use; so it is better to give small, and if necessary repeated, doses rather than large doses. There are, however, comparatively few cases in which this type of treatment is really indicated in young women.

2. Neoplasms.

Neoplasms of the body and cervix of the uterus may or may not cause sterility; much depends on the position of, and the secretions from, the tumour. The treatment of malignant tumours cannot be viewed from the standpoint of sterility, even in young women, but innocent new growths require careful consideration, fibromyomata especially. Usually fibromyomata require treatment, and their presence becomes known because of associated symptoms, such as haemorrhage, requiring relief. Nevertheless, in women under or in "the thirties" the surgical treatment applied must, when possible, take into consideration the practicability of preserving a functional organ. Innumerable cases are on record of subsequent conception in these circumstances. This statement applies equally to the removal of ovarian innocent tumours. I can recall patients from whom I have enucleated fairly large bilateral cysts or have excised endometriomata from the ovaries who have subsequently borne children.

3. Infections.

It is always dangerous to give figures which are based on numbers too small and are applied to conditions in regard to which associated factors are of a very variable nature. Still, it appears probable that about 40 per cent. of all cases of sterility in women are due to this cause. Fortunately we have enough clinical experience and pathological knowledge on which to establish our methods of relief in a certain percentage of these patients.

We know that the local lesions caused by the gonococcus are far more enduring and serious, so far as sterility is concerned, than those due to the streptococcus; and these are the two commonest organisms responsible for failure to conceive. The vagina of the adult, covered as it is with squamous epithelium, is rarely seriously enough infected to give rise to contraceptive discharges. The cervix, on the other hand, may be deeply infected by the gonococcus, which finds a harbour in the racemose glands, and, even though it may soon perish, such damage as it has caused is difficult to cure. There may be a copious semi-purulent discharge, and this may alter the normal acidity of the vaginal secretions, which should contain not more than 0.5 per cent. of lactic acid—and render it inhospitable to the spermatozoa. This perhaps is infrequent; still, the cervix may be a focus of infection which should always receive attention before conservative operations are performed on tubes occluded by inflammation, to which I shall now refer, just mentioning in passing that the endometrium usually escapes serious lesions, owing, probably, to the monthly regeneration that takes place.

Tubal Occlusion.

Occlusion of the Fallopian tubes is a causal lesion—long recognized in the more serious forms—of sterility. The condition has come into prominence in the last ten years owing to the recognition of the minor lesions of infection with obstruction by means of the so-called "patency test" of Rubin. It is well known that the tubes may be occluded, and the patient thereby rendered absolutely sterile, without physical signs or symptoms, or even a history indicative of the state of the tubes. This has been so in 35 per cent. of the cases of sterility without

apparent cause under my care in the Liverpool Royal Infirmary which have been submitted to the patency test during the last few years. There have been eighty-two in all of such cases. Hunner and Wharton¹⁰ state that in 30 to 45 per cent. of all cases of sterility the tubes are occluded. In these cases there has usually been appendicitis with pelvic invasion, or a mild gonorrhoeal infection; more rarely there has been puerperal or other streptococcal involvement. In all cases, therefore, in which the husband is found to be normal it is advisable to test the patency of the tubes before any other step is taken, unless some well-defined pathological condition is present which of itself necessitates laparotomy.

The method employed is comparatively simple, and there is really no necessity to use the expensive and rather complicated pieces of apparatus introduced at first. I became acquainted with this procedure when I was in America in 1921; but I have myself always pumped air slowly into the uterus with a rubber double-ball syringe and tube connected with a sphygmomanometer through the metal uterine catheter employed by Rubin. The air is filtered through wool plugs placed in the glass T-shaped manometric junction tube. It is important, of course, that there should be no leakage; consequently I test the apparatus prior to use on an artificial rubber uterus.

Experience enables one accurately to gauge the amount of air injected. Originally CO₂ was used instead of air, and no doubt this gas is more rapidly absorbed from the peritoneal cavity than is air. If an unnecessarily large quantity of air is pumped into the uterus and on through the tubes, for twenty-four hours there may be a certain amount of discomfort with pain in the neighbourhood of the right scapula, due to the downward displacement of the liver by the air which collects under the diaphragm and gives the diagnostic feature of patency of the tubes on x-ray examination of the abdomen. Radiographic observation, however, is often an unnecessary refinement, for anyone experienced in the method is usually able to tell by the way the manometric needle falls after reaching about 80 mm. Hg of pressure that the air is passing into the peritoneal cavity. Moreover, it can be heard whistling through the abdominal ostia of the tubes if a stethoscope is placed on either side of the hypogastrium. The uterine catheter, which is fitted with a rubber or metal obturator, is held firmly in the cervix gripped on either side by volsella forceps, otherwise the air will escape. If there is any doubt the cervix can be submerged in saline solution and any escape of air noted. I have never found this necessary. The free perforated end of the catheter should not extend more than 1½ inches into the cavity of the uterus. If the first test is not positive, a second test should be made shortly afterwards, for occasionally there is spasm of the isthmial portion of the tube which produces temporary occlusion.

In cases of doubt, and in those in which it is important to define the site of obstruction, it is advisable to test also with lipiodol, 6 to 8 c.cm. of which are injected with a syringe attached to the uterine catheter into the uterus. A subsequent x-ray examination gives a clear picture of the result. It may here be added that one of these methods of testing the patency of the tubes should always be practised about three weeks subsequently to conservative operations, such as salpingostomy, performed to relieve occluded tubes. We have in them a method of testing the perfection or otherwise of our operative procedures.

There is one other interesting point in regard to patency testing with air or CO₂, and it is this: somewhat rarely a woman previously sterile conceives after tubal inflation alone. Apparently in such circumstances there has been slight "glueing" or adhesion of the tubes, and this is broken down by air pressure. It is important to test the tubes, however, with a pressure not greater than 200 mm. Hg lest rupture from over-inflation be brought about. A few instances of collapse of the patient after inflation have been reported. I have not seen this accident.

When the abdominal ostia are patent the region of obstruction may be identified by an air inflation method I published in 1917.² After the peritoneal cavity has been opened the abdominal ostia are brought into view and the

nozzle of a syringe filled with air is passed into each in turn. A small quantity of air is *very slowly* expelled from the syringe into the lumina of the tubes, and it is noted whether it passes on into the uterus or is held up at the isthmus or in the interstitial portion. If air passes into the uterus, it can be heard "popping" through the cervix, or if the uterus be nipped between the finger and thumb the air can be felt gurgling out of the cavity. In exceptional cases coloured fluid may be injected and identified by the coloration of a vaginal swab.

Having used and described this method of transtubal inflation some years before Rubin introduced his method of transcervical insufflation, it seems that I must have had a mental air-pocket, otherwise it is difficult to understand why I did not also try transuterine inflation.

Operations for Tubal Occlusion.

Of the operations designed to restore functional integrity in regard to conception little need be said. The only procedures generally practised are freeing the tube when buried in adhesions, and salpingostomy. As already stated, the result of the operation should always be tested by insufflation subsequently. In my own cases of salpingostomy, not many it is true, I have been able to demonstrate by this means that patency has been restored in 62 per cent.; but this is by no means a guarantee that pregnancy will follow. The percentage of cases in which this desirable eventuality supervenes is small. Still conception, previously impossible, does sometimes follow, and the knowledge of the possibility has a beneficial effect on the mind of a woman who has given up hope.

It seems that tubes infected by the gonococcus, which damages the mucosa much more seriously than other organisms, except that of tuberculosis, may be made patent, yet are still inhospitable to the ovum on its descent to the uterus, or to the spermatozoa in their ascent to meet the ovum. Consequently, it is after operations performed for occlusion due to the streptococcus and *B. coli* that one expects to see, and in fact, I think, does most often see, subsequent conception.

The recent interest in occluded tubes has brought to light what may be described as congenital imperforation of the tubes, usually in the isthmus. Here one may find a tortuous cord that has no lumen. In such cases, and also when the tube is occluded in this region or at the cornu of the uterus as the result of infection, it is necessary to excise the affected portion and to implant the healthy ampulla in the uterus. I have also performed this operation successfully in the case of a tube attached to a uterine horn that was imperforate.

Sometimes, however, it is impossible to save either tube. It has therefore been suggested by Estes⁶ and Tuffier¹² that in some of these cases the ovary attached to its normal vascular supply, or a graft of the ovary, should be implanted in the uterus in such a manner as to allow the surface of the ovary to project into the cavity. I have performed such operations about ten times without immediate or remote harm to the patient, indeed with considerable improvement in her general condition. Tuffier,¹² on the other hand, has reported some accidents after these procedures. In some of my few cases it is too soon to give up hope, but, so far, in none has pregnancy ensued. This, I think, is about the limit to which we can hope to go in surgical conservation of the function of conception.

Physiological Dérangements.

I have repeatedly emphasized the fact that the individual metabolism of a woman is her reproductive metabolism, and that the whole group of ductless glands is concerned in its regulation, and may therefore be regarded as forming a genital system. So it comes about that during the period of individual growth before puberty the strain of menstruation and pregnancy is withheld. From this we can draw the very general and obvious conclusions:

- (1) Those chemical substances which are required by the growing girl are the same as those required by the foetus.
- (2) Menstruation is a process whereby the substances utilized by the foetus and in excess of the requirements

of the non-pregnant woman are excreted periodically. Menstruation is a constitutional disturbance as well as a local one, and doubtless some of the excretion occurs through the ordinary channels.

It is well known that a woman can conceive without having recently menstruated, and that menstruation may occur without the dehiscence of a ripe follicle, and, indeed, that the uterine periodic activity can be maintained by the ovarian interstitial cells alone.³ It is, however, quite obvious that conception cannot take place unless there be follicular ripening and rupture. The absence of ripe follicles in an ovary may be regarded as a state of hypoplasia which may require careful investigation, for it is due to failure of function in some part of the genital system.

In many of the lower animals—for example, the rabbit—rupture of the ripe follicle occurs only on the mechanical stimulation of coitus, and possibly during what is known as “doe-jumping,” when pseudo-pregnancy may follow.³ It may be noted that for sterility in cattle veterinary surgeons sometimes practise manual rupture of cystic corpora lutea. In women we have long recognized persistence of the follicle with cystic formation not only as a cause of sterility but also of menorrhagia, and this condition is extraordinarily difficult to treat from the point of view of sterility. It seems that sometimes the failure to rupture is due to a dense tunica albuginea, which prevents the ripening follicle from rotating to the surface, but there can be little doubt, I think, in view of the correlation of function between the follicular and corporal secretions, that there is often failure of some normal physiological process in these circumstances, for we know that before puberty follicles may ripen and undergo atresia or cystic formation. Further, we know that the pituitary and the thyroid are as closely related to genital functional integrity as are the ovaries themselves, and that in many cases of congenital or acquired genital hypoplasia the functional activity of the pituitary or thyroid is at fault. Thyroid and anterior lobe (pituitary) extracts may be administered in these circumstances, but it is always extremely difficult to know, if pregnancy supervenes, whether the result can be attributed to the treatment, since so many complex factors are concerned.

I shall not discuss those abnormal conditions in the endocrine system, such as cortical hyperplasia of the suprarenal, which produce masculinity in women, with amenorrhoea and sterility. This and other related questions concerning the “genital system of ductless glands” are dealt with in my book *The Sex Complex*, to which reference may be made for a further consideration of them. It is sufficient here to record that insufficiency of the secretions of the pituitary and thyroid leads to amenorrhoea and sterility. It will be noted that all constitutional disturbances which produce sterility also produce amenorrhoea, or scanty and infrequent menstruation, partly because enough of the chemical materials required by the foetus are not available, and this deficiency affects menstruation as well as conception.

Furthermore, experimental investigations have taught us that one of the chief chemical substances required is calcium,^{1 3 4 11} and that just as a hen deprived of calcareous material in its diet ceases to lay eggs, so in similar circumstances may a woman be sterile. This is not difficult to understand when we take into consideration the strain there may be on the calcium metabolism of the mother during pregnancy and also in lactation, when, as we can readily appreciate, menstruation is normally absent. Needless to say, there are many subsidiary articles of diet and vitamins—such as D, which is believed to control the calcium-phosphorus balance—that are necessary. I purposely omit consideration of vitamin E, for though insufficiency of this substance causes infertility in male animals, sterility is not so produced in females, but early abortion follows.^{7 8} But while some chemical substances seem essential, there can be no doubt that perfect health and a full mixed diet alone should be the standard at which every woman who wishes to conceive should aim. Much harm may follow “fads” in the matter of diet, and the mixed food of the ordinary citizen contains all that is necessary.

Occupational and Toxicological Factors.

There seem to be no actual figures that serve to show whether occupation *per se*—apart from age of marriage, environment, and so on—has a definite influence on fertility and fecundity. Still, we do know that in those industries in which chronic lead poisoning used to be common sterility was produced in men and, to a less extent, in women. So, also, chronic alcoholism may produce sterility, and therefore occupations in which women find an opportunity for drinking may show a reduced fecundity rate.

Psychical Factors.

Civilized woman, with her “educated” outlook on sex questions, can hardly be considered an ideal female mammal from the breeding point of view. This is not directly her own fault; circumstances of over-population and environmental disharmonies have led to the suppression of natural sexual manifestations, and have fostered abnormal variations in the exploitation of sexual desire. Such widespread deviations from the strict physiological path as now exist must in time have some effect on actual fertility and fecundity. It need hardly be said that the more natural men and women are in their manner of living and loving the greater will be their power of reproducing their species. In primitive man, no doubt, as with the rest of the mammals in the wild state, and with the birds, the coquetry of courtship was the immediate prelude to mating and almost inevitable conception. It is certain that love-making stimulates the sexual functions, so the ability of some men to arouse desire in, and to fertilize, a woman who is sterile with another partner may be the whole story of what we call “incompatibility” or “selective sterility.” No one can accurately foretell what will happen in the future; it is, indeed, difficult to say how much right or wrong there is in the growing assumption by Man of the prerogatives of Nature, and perhaps, after all, I should not tread on such slippery ground.

SUMMARY.

1. No woman should be subjected to unpleasant examinations or treatment for sterility *per se*, until her husband has been proved fertile. A considerable percentage of men are temporarily or permanently sterile.
2. Statistics concerning sterility in women generally are inevitably vitiated by the widespread adoption of contraceptive measures.
3. There is no evidence that women are more infertile now than they were fifty years ago.
4. Some congenital anomalies of the genital tract are amenable to treatment.
5. Of the acquired lesions causing sterility infections of the Fallopian tubes are the most prominent. Recent methods of investigation and of surgical treatment afford the hope that in some cases relief may be effected.
6. Conservation of function, when possible, should always be attempted in operations on the female genitalia.
7. Physiological derangements of the metabolism and the regulators thereof, and dietetic factors, are becoming well understood, and this may soon lead to improvements in treatment.
8. Psychical factors doubtless are responsible for both voluntary and involuntary sterility. The influence of these factors has not yet been fully investigated by scientific methods.
9. Good health, a natural mode of life, and a normal psychological outlook, in the absence of physical defects and lesions, are the concomitants of natural reproduction.

REFERENCES.

- ¹ Bell, W. Blair: *Proc. Roy. Soc. Med.*, 1907, i, 291.
 - ² Bell, W. Blair: *Disorders of Function*. Eden and Lockyer's *System of Gynaecology*, 1917, p. 409.
 - ³ Bell, W. Blair: *The Sex Complex*, London, second edition, 1920.
 - ⁴ Bell, W. Blair, and Hick, P.: *British Medical Journal*, 1909, i, 593.
 - ⁵ Bell, W. Blair, et al.: *Journ. Obstet. and Gynaecol. British Empire*, 1925, xxxii, 1.
 - ⁶ Estes, W. L.: *Surg., Gynecol. and Obstet.*, 1924, xxxviii, 324.
 - ⁷ Evans, H. M.: *Proc. Nat. Acad. Sci.*, 1925, xi, 373.
 - ⁸ Evans, H. M., and Burr, G. O.: *Ibid.*, 1925, xi, 334.
 - ⁹ Giles, A. E., Robinson, A., et al.: *British Medical Journal*, 1929, ii, 760.
 - ¹⁰ Hunner, G. L., and Wharton, L. R.: *Southern Med. Journ., U.S.A.*, 1924, xvii, 269.
 - ¹¹ Reynolds, E., and Macomber, D.: *Trans. Amer. Gynecol. Soc.*, 1921, xvi, 99.
 - ¹² Tuffier, T.: *Surg., Gynecol. and Obstet.*, 1924, xxxix, 401.
- Duncan, J. Matthews: *Sterility in Woman*, London, 1881.