

Mosquitoes of North and Central America and the West Indies, published by the Carnegie Institution of Washington, and in that connection observations of a somewhat similar character by several other authors are mentioned (see pages 126-129, Vol. I. of the Monograph).

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THE WORKS OF AMEGHINO

THE Minister of Public Works of the Province of Buenos Aires, Argentine Republic, is financing the publication of a complete edition of the scientific writings and correspondence of Florentino Ameghino (1854-1911) the distinguished South American paleontologist. The editorial work has been undertaken by Alfredo J. Torcelli, and Volumes I. and II. have been issued; though printed in 1913-14 they have just been received. Volume III. will be devoted to "The Antiquity of Man in La Plata," originally issued in two volumes in 1880-81.

The publication of such a work, stupendous as it is, will prove of inestimable value to those workers who entered the field after Ameghino had published his first papers, copies of which are rarely found in an ordinary scientific library. His writings number 179 essays and books written in Spanish, French and English; some of them large volumes. Ameghino was a voluminous writer and he seldom published short papers. While the number of papers is not large compared to some European writers; Hermann Schaaffhausen for instance, wrote 314 contributions along the lines of anthropology; yet in content they compare favorably with the productions of any one scientific writer of modern times.

The first volume is entitled "Vida y Obras del Sabio," an octavo of 391 pages, printed on a poor quality of paper, and containing a complete account of the life and activities of this noted South American scholar. There is likewise appended a description of the elaborate funeral ceremonies with which his native city mourned the loss of this eminent man.

The second volume with the title: "Primeros

Trabajos Científicos," is much larger, comprising 770 pages. One regrets the poor quality of the drawings; but it must be remembered that Ameghino's drawings, of which there were thousands, were made by his own hand, untrained to do such work, and under unfavorable conditions, working in the back room of his stationery shop in La Plata. The drawings originally poor and not well produced at first, are not all we would like, but are still of great value as an aid in interpreting Ameghino's ideas.

The third volume will comprise the XXIVth memoir, and since there are 154 memoirs to follow one can, with a little simple mathematics, compute the approximate size of the series. An interesting sidelight to Ameghino's restless mental activity is given in Memoir XXIII., with the title "Taquigrafia Ameghino," which appears to be an attempt on his part to reduce the Spanish language to shorthand; the characters having a marked resemblance to those used in some American shorthand systems. It is to be hoped that his shorthand system was successful. But of its use in the commercial world of Spanish-speaking peoples, I know nothing. How many living paleontologists have devised a system of such far-reaching importance to another world than their own?

Florentino Ameghino was a wonderful man, and I am sure we wish Alfredo J. Torcelli all the success in the world in his "honorable autant que difficile travail."

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SPECIAL ARTICLES

THE FREE-MARTIN AND ITS RECIPROCAL: OPOSSUM, MAN, DOG

IN 1917 the writer purchased a large fat opossum, presumably a male, but actually a sex-intergrade possessing the following characters: externally, normal penis, empty scrotum, small malformed pouch, head rather like that of a female; internally, reproductive organs distinctly of the female type, infantile

in development, consisting of vaginal canals, uteri, Fallopian tubes, and small round bodies in the situation of the ovaries. These bodies were sectioned and found to contain within a thin albuginea a mass of closely packed tubules of uniform size, devoid of all indication of sex cells, male or female.

This specimen is presented in further evidence of the hormone theory of sex differentiation, in the light of which it is interpreted. The explanation here offered was suggested by Lillie's beautiful demonstration of the cause of the free-martin in cattle,¹ wherein he showed beyond all doubt that the free-martin is a female sterilized by sex hormones from the male co-twin in all cases, and only in such cases, in which the fetal circulations anastomose and mutual blood transfusion occurs. One type of pseudo-hermaphroditism is thus adequately and simply explained and Steinbach's² assumption of an embryonic gonad containing both male and female interstitial cells as the origin of the antagonistic sex hormones in fetal life becomes superfluous.

The opossum briefly described above is interpreted as a reciprocal free-martin, a term I wish to employ for a sex-intergrade which is zygotically *male* but which in its ontogeny develops *female* characters. I venture to suggest that it has arisen by "inhibition and stimulation of normal embryonic rudiments"³ through the influence of female hormones from a female co-twin. It is believed, therefore, that the case constitutes an answer to the following significant statement by Lillie:

On the male side there is complete absence of information as to the effects of early embryonic castration and the possible effect of the presence of female hormones in the absence of male hormones.⁴

The writer acknowledges, of course, that he

is arguing from analogy; and he would himself interpose the further objection that such sex-intergrades are very rare, at least in adults of the opossum. And yet, when one opens a pregnant opossum uterus and observes that it is crowded to capacity with vesicles under great pressure and that the chorions are in mutual contact by large surfaces, he must wonder why anastomoses of the chorionic circulations do not more frequently occur. In this extreme crowding the marsupials are unique. It has occurred to the writer as highly probable that the shell membrane of marsupial eggs, far from being a useless vestige of Sauropsidan ancestry, serves to separate the vesicles until it is safe for them to come into immediate contact, if indeed they ever do. This point will be the subject of further investigation, as also the mechanism by which the male embryo is protected against the hormones of its mother and of its sister embryos. There being no placenta in the opossum, this organ is ruled out in this case.⁵

There is one condition, however, under which in the opossum fusion of the chorions is likely to occur, namely in twin eggs where two ova are included in the same egg envelopes. I have several such eggs in different stages of development.⁶ A comparable case has been described for the rat where fusion took place between the trophoblasts of two eggs that became included in the same decidua.⁷ Professor H. M. Evans, of the University of California, told the writer that among several hundred dog embryos of his collection he found one pair of very young twins within the same uterine swelling. The placenta were fused (v.i.). These points raise interesting questions as to the mechanism by which the ova are usually distributed singly in oviduct and uterus.

The sex-intergrade of the opossum here pre-

¹ F. R. Lillie, *Jour. Exp. Zool.*, 23, 1917, 391-452.

² E. Steinach, *Pflüger's Archiv*, 144, 1912, 71-108 (see especially page 86).

³ Lillie, *l. c.*, page 419.

⁴ Lillie, *l. c.*, page 415.

⁵ Cf. Lillie, *l. c.*, footnote, page 415.

⁶ See Carl G. Hartman, *Jour. of Morph.*, 32, 1919. One twin egg may be seen in each of the batches shown in Fig. 4, Pl. 9 and Fig. 2, Pl. 1.

⁷ V. Widakowich, *Zentralbl. f. Physiol.*, 24, 1910, 305.

sented furthermore corroborates in a striking manner the findings of Lillie (l.c.) and Chapin⁸ that the hormone influence makes itself felt in the earliest stages of sex differentiation. That this must be so is proved by the fact that this animal is born ten days after fertilization and five days after the primitive streak stage.

Again, since in the specimen the cortex of the gonad is seen to be entirely absent we have here a confirmation of Lillie's statement that the gonad of the zygotic male, not possessing the homolog of the cords of Pflüger, is capable of less transformation than the embryonic ovary.⁹ The absence of male sex cells in the specimen and the presence of healthy tubules (probably Sertoli cells only) is precisely in keeping with the theory of the influence of the female hormone in fetal life.

The assumption of certain embryologists that the embryo in the undifferentiated stage is a true hermaphrodite, is, therefore, no longer tenable.

More crucial evidence in favor of the view expressed above is, however, furnished by the following human case described by Eschricht.¹⁰ It concerns a sex-intergrade which in all essentials was an exact counterpart of the opossum described above: externally, penis and empty scrotum; internally, uterus, Fallopian tubes with fimbriæ, and atypical "ovaries." It was a reciprocal free-martin, who, because of other malformation, died a few minutes after birth. The significant facts, however, in this human case are: (1) that *the child was born co-twin to a normal female* who lived and (2) that *the placenta were fused* ("sehr genau verbunden"). Better proof could hardly be desired. I refrain from mentioning other human cases that must be interpreted as reciprocal free-martins, as, e. g., those cited by Simpson.¹¹

⁸ Catherine L. Chapin, *Jour. Exp. Zool.*, 23, 1917, 453-482.

⁹ Lillie, l. c., page 419.

¹⁰ Eschricht, *Müller's Archiv*, 1836, 139-144.

¹¹ Sir J. Y. Simpson, article "Hermaphroditism" in Todd's *Cyclopædia of Anat. and Physiol.*, 1836-39.

From the same article by Simpson it seems clear that the true free-martin also occurs in man. Such cases the author classifies with the free-martin of cattle, showing that he correctly interpreted them. This occurrence of both types in the same form (man) need constitute no great obstacle to the hormone theory, for it is quite conceivable that sometimes the male, sometimes the female co-twin gets the start in development, since the handicap need be very slight to prove ruinous to the laggard.

That the free-martin also occurs in rare instances in the dog, a multiparous animal, seems probable, since the "hermaphroditic dog" described by Home¹² in an apparently forgotten article is almost certainly a free-martin of the cattle type. In this connection the case of fused placenta of the dog embryos found by Dr. Evans and cited above is of more than passing interest.

Free-martins, reciprocal free-martins and intermediate conditions may, therefore, be expected to occur in all mammals. The principle of hormone influence in fetal life, first demonstrated by Lillie,¹³ constitutes the most important contribution to the subject as yet made. Twins and double monsters will have to be reclassified in the light of the theory¹⁴ and such monographs as those of Sauerbeck and of Hübner¹⁵ will have to be largely rewritten.

A more complete paper will be published later.

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THE NEBRASKA ACADEMY OF SCIENCES

THE Nebraska Academy of Sciences held its thirtieth annual meeting at Deane College, Crete, Nebraska, on April 30 and May 1. The plan is to meet in Lincoln every other

¹² Everard Home, *Phil. Trans. Roy. Soc.*, 1799, 162.

¹³ See F. R. Lillie, *SCIENCE*, N. S., 50, 1919, 183-184.

¹⁴ Cf. E. Steinach, *Archiv f. Entwicklungsmech.*, 42, 1916, 307-332.

¹⁵ *Ergebn. d. allg. Path.*, 15, 1911.