

THE GENETIC SIGNIFICANCE OF INTRA-UTERINE SEX RATIOS AND DEGENERATING FETUSES IN THE CAT

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URING the past year the work was undertaken of examining the uteri of pregnant cats, with the hope of throwing some light on several questions which are of interest from the genetic point of view. Through the courtesy of the Society for the Prevention of Cruelty to Animals in New York City it was possible to do this. The routine procedure was as follows: as the dead cats were removed from the gas tank in which they were asphyxiated, any females which showed evidences of pregnancy were put aside. These were then dissected, and records taken of the coat color of the mother, the number of fetuses, and sex of those present in each horn of the uterus, as well as the coat color whenever the embryo was sufficiently developed to show definite color pattern. The occurrence of any structural abnormality was noted, but these were found to be extremely rare. A few polydactylous animals were found. In each case where this occurred, some of the fetuses also exhibited the abnormality. One female was discovered to have a cystic ovary on the left side. The left tube of the uterus contained a degenerating fetus. This case has not been considered pathological, however, in the calculation of the data, since we have no knowledge of the influence of

such an ovary on the surrounding tissues. Another case, that of a female in which a teratoma-like structure was found, is considered in detail in a later paragraph.

Doncaster¹ suggested that the occurrence of tortoiseshell males in cats and their usual sterility, might be due to hormone action somewhat similar to that apparently involved in the production of free-martins in cattle.² 148 pregnant cats were examined with a total of 653 embryos. Inspection of the uteri showed no sign of anastomosis of the circulatory systems supplying the fetuses in any case. This body of negative evidence makes the correctness of Doncaster's hypothesis seem extremely doubtful.

Of the 653 embryos, sex was determined in 613. The ratio was found to be 122.10 ± 8.30 . This is very much higher than that usually found in mammals when it is determined at birth. It is interesting, however, to compare this figure with that found by Jewell³ in fetal cattle of 123.21. These data are analogous, both being based entirely on embryos during intra-uterine development. Comparison of this fetal ratio with existing sex ratios in cattle shows a wide variation. Wilckens⁴ has given the ratio at or near the time of birth as 107.3. Pearl and Parshley⁵ give the ratio

¹ DONCASTER, L. The Tortoiseshell Tomcat—A Suggestion. *J. of Genetics*, Vol. IX. 1920.

² LILLIE, F. R. The Free-Martin; a Study of the Action of Sex Hormones in the Fetal Life of Cattle. *J. Exp. Zool.* XXIII. 1921.

³ JEWELL, F. M. Sex Ratios in Fetal Cattle. *Biol. Bull.* XLX. 1921.

⁴ WILCKENS, M. Untersuchungen über das Geschlechtsverhältnis und die Ursachen der Geschlechtsbildung bei Haustieren. *Biol. Centrabl. Bd.* VI. 1887.

⁵ PEARL, R. and H. M. PARSHLEY. Data on Sex Determination in Cattle. *Biol. Bull.* XXIV. 1913.

as 113.3, and from more recent data Pearl⁶ found the ratio to be 100.12. This last figure coincides more nearly with data collected by Gowen, giving a ratio of 101.58. King⁷ found the sex ratio of rats at birth to be 104.6. Little has calculated the ratio in mice to be 103.1, while Weldon's material⁸ gives a ratio of 104.1. The ratio in man was found to be 105 by Pearl and Salaman.⁹ Unfortunately, there is no published data on the sex ratio at birth of cats, so that a comparison with the fetal ratio is impossible. We are therefore unable to tell whether there is a differential intra-uterine mortality between the sexes or not.

White coat color in cats has been recognized for some time past as a probable Mendelian dominant representing an extreme form of spotting. Little¹⁰ has found a possibly similar case in mice. Here a factor with somewhat the same function behaves as a lethal when present in the duplex condition. To attempt to test this hypothesis for cats, the litters of white, or nearly white cats have been compared with those of non-white females. The cats classified as "nearly white" showed at most an area of color not larger than ten per cent of the entire coat. Since white, or nearly white cats, are not common, the chance of obtaining pregnant females was not great. Twenty-five were, however, obtained in the course of the experiment, with a total of 102 fetuses. The mean litter size of white females was 4.08 ± 0.13 , while that of non-whites was 4.48 ± 0.07 . The difference is 0.39 ± 0.15 , which is 2.71 times its probable error. This, of course, is not a significant difference and can only be regarded as an indication of a possible diminution in the size of white

litters which might have become apparent in the event of larger numbers. If this is due, as in the case of the mice, to the degeneration of the fetuses in utero, a larger number of degenerating fetuses should be found in the uteri of white females than in non-white. The records of degenerating embryos found have been kept, and show that out of 102 fetuses of white females, 11, or 10.78 ± 2.07 per cent were degenerating. In the non-white females, out of 551 fetuses, 25, or 4.54 ± 0.60 per cent were degenerating. The difference is 6.25 ± 2.16 , which is 2.89 times the probable error. The figures for the non-white fetuses include one litter composed of four degenerating fetuses in utero, while attached to the ventral body wall was a teratoma-like structure inclosing a fetus which had apparently fully developed, and showed at that time the skeletal structure and hair formation of a full-term embryo. This case has been considered abnormal and pathological, and a recalculation of the number of degenerating embryos in non-white litters has been made on this basis. With this correction, there are 21 degenerating out of 547 fetuses, the percentage being 3.84 ± 0.58 . The difference between whites and non-whites then becomes 6.845 ± 2.149 , which is 3.2 times the probable error, which may be considered as a significant difference, although the percentages are so small that it is difficult to be sure of the significance of such a difference. Thus, the conclusion is probably warranted that a significantly greater number of degenerating fetuses are found in white than in non-white female cats.

From the nature of the material used it was impossible to know the sire of any litter, but, as has been stated before, the proportion of white cats

- ⁶ PEARL, R. The Control of the Sex-Ratio. *Maine Agric. Exp. Sta. Bull.* No. 261. Part 3. 1917.
⁷ KING, H. D. and J. M. STOTENBURG, (1915). On the Normal Sex Ratio and the Size of the Litter in the Albino Rat. *Anal. Rec.* IX.
⁸ WELDON, W. F. R. Mice Breeding Experiments. Records of Matings. *Biometrika* XI. 1916.
⁹ PEARL, R. and R. N. SALAMAN. The Relative Time of Fertilization of the Ovum and the Sex Ratio Amongst Jews. *Maine Agric. Exp. Sta. papers from the Biological Laboratory*, No. 48, Vol. II. 1913.
¹⁰ LITTLE, C. C. Note on the Occurrence of a Probable Sex-linked Lethal Factor in Mammals. *Am. Nat.* LIV, 1920.

is relatively small. Since this is true, the probability is that in the majority of cases the sires were non-white. It therefore becomes likely that in some white female cats at least a lethal action of some sort is operative when the

factor for white is present even in the simplex condition.

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The Manners and Morals of Wild Animals

THE MINDS AND MANNERS OF WILD ANIMALS. By William Hornaday, Director of the New York Zoological Park. Pp. 200. \$3.00. Charles Scribners and Sons, New York. 1922.

William Hornaday, Director of the New York Zoological Park, writes of the manners and morals of wild animals with the authority bred by long and familiar acquaintance with his subject, and familiarity, in his case, far from breeding contempt, has engendered sincere admiration. "Some animals," he says, "have more intelligence than some men and some have better morals." To deny the thinking power of animals "in the face of the facts is to deny the evidence of one's senses." "The wild animal must think or die" is his contention upheld by many convincing records.

Wild animals, like men, says Mr. Hornaday, vary individually in ability, temperament, and morals. "The persistence of the mental and moral parallel between men and wild animals is a source of constant surprise."

The chimpanzee stands at the head of a list compiled to show the comparative intelligence of certain conspicuous wild animals. "The high class dog is the animal that mentally is in closest touch with the human mind, the feelings and impulses of man, and it is the only one that can read a man's feelings from his eye and facial expression."

The power of speech which is generally considered to be an attribute trenchantly dividing man from the so-called "lower animals," is, according to Mr. Hornaday, merely the result of man's attainment of a position in which life is not dependent upon caution.

Wild animals are silent or have only a few simple vocal expressions, because silence is the price of life. Only the silent species have survived the age-long struggle for existence. Wild jungle fowl, the ancestors of our domestic chicken, move silently through silent forests where any sound might betray their presence to a score of patiently waiting, tirelessly watching, chronically hungry enemies, but our barnyard fowl, strutting and cackling secure in the protection of man, have developed a highly useful vocabulary of resonant language calls and cries which are quite intelligible to the attentive human listener. The absence of vocal language in wild animals is largely compensated by a remarkable development of sign language which, as is well known, is also the medium of communication among many savage tribes of the human race. Spoken words are not the only indices of real mental processes.

Mr. Hornaday describes in detail the mental and moral traits of apes, bears, elephants, ruminants, rodents, serpents, spiders, etc. and gives numerous anecdotes illustrative of their abilities, virtues and failings, with occasional (sometimes somewhat caustic) commentaries on parallel phases of human civilization.

A chapter on the rights of wild animals speaks in no uncertain terms of the duties of man with respect to his fellow-citizens of the world, asserting that the killing of harmless animals solely for sport and without utilizing them when killed is murder.

The liberal use of side-heads detracts from the literary character of the book, although it may be justified by the

greater ease with which attention is called to the individual subjects under discussion by this means. Still we cannot but have a lingering regret that the demand of present-day readers does not require the artistic touch which beautifies the works of Walton and Gilbert White. The book, however, is entertaining to a high degree and its greatest attraction, perhaps, is the spirit of sympathetic understand-

ing which is the outcome of the writer's close association with his subject. If such a spirit were more common among men, an era of good will toward animals might bring about more peace upon earth, for the fear of man, the most terrible of all enemies, keeps alive in animals the passion of hate which is the seed of war. There is reason in the old motto, "Live and let live."

A. C. C.

The Dependent Organism

ORGANIC DEPENDENCE AND DISEASE: THEIR ORIGIN AND SIGNIFICANCE. By John M. Clarke, D.Sc. L.L.D. New York State Paleontologist. 113 pages. Yale University Press, New Haven, 1921.

The author's thesis is that dependency of one organism on another, including mutualism beneficial to both parties, is a perturbation of normal living which spells inevitably increasing degeneracy for the dependent organism. Normal living is defined as "full activity of an unimpaired physiology, inclusive of the function of locomotion or mobility." The author's point of view may be gathered from selections from his conclusions. "If dependence has affected and sealed the fate of one great division of the Kingdom of Life, so that it is and must remain subsidiary to the larger purposes of nature, dependence also has entered upon, probably the major part of the other, the animal world." "It is thus emphatically true in Nature's program, that physical salvation is of the few, and is the reward

only of righteous living." "For dependent races of life, there has been no rescue or return."

The thesis seems to approach perilously close to a truism. If progress is defined in terms of mobility, it is hardly likely that specialization in a form of dependency which involves fixation will lead to progress. Dependency which does not involve loss of mobility is apparently not looked upon as unrighteous and is not discussed. The whole animal kingdom is, of course, dependent on the plant kingdom having an unimpaired physiology with respect to the synthesis of organic compounds which involve storage of energy.

The greater part of the book is taken up with a discussion of the cases of symbiosis and parasitism among invertebrates which are revealed by the paleontological record. The sequences of increasing specialization and dependency illustrated by numerous photographs are of great interest apart from the ethical conclusions drawn from them.

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