SPECIAL ARTICLES

ON THE RELATIVE STERILITY OF THE ADOLESCENT ORGANISM

THE literature of adolescence is chiefly psychological. Anatomical and physiological studies on the adolescent organism are extremely sporadic and uncorrelated. A recent conference of "experts" served chiefly to emphasize our ignorance of the subject.

One of the prevailing notions concerning adolescence is that it is a very restricted period of time marked by sudden, almost explosive changes in bodily structure and function. The immature organism is represented as becoming all at once mature; the boy becomes a man, the girl a woman, almost as if by a change of clothing. The illusion is probably due to the popular as well as gynecological notion that the first menstruation, which certainly is a definitely demarcated event, is equivalent to the attainment of full maturity. It can, however, easily be shown that puberty and maturity are neither synonymous nor synchronous. The interval of time between the two in man, monkey and rat is about what one would expect with the application of Donaldson's law of equivalent ages: three years, one year and one month, respectively, for man, monkey and rat.

The Carnegie colony of rhesus monkeys has had fifteen females whose every menstrual cycle from the very first was observed. An excellent opportunity was thus afforded for studying the phenomena of adolescence, as affecting body growth, certain changes in the secondary sex characters and changes in the ovaries and genital tract. The sex skin becomes redder and redder and at the same time greatly swollen, almost to pathological proportions at times. Such swellings are extremely rare in mature animals. Furthermore, the menstrual cycles of the young females are extremely irregular in length and duration, and there is a very low incidence of ovulatory as compared with non-ovulatory cycles.

Now, these fifteen females averaged 3,350 grams in weight at the first menses. Most of them were mated soon after puberty, but not a single female conceived before attaining a weight of 4,370 grams. The average weight at first conception of nine of these females was 5,000 grams; hence it is apparent that many menstrual cycles passed between the first menses and the first conception, despite frequent matings in the interval. The interval may be estimated at about a year of time.

The same gradual unfolding of maturity holds true for such good breeders as the rat and the mouse. Slonaker's studies on spontaneous activities in the rat[1] show a gradual increase in the peak of the cyclic activity to the maximum which is maintained during the reproductive life of the individual. This "staircase" phenomenon of adolescence indicates a gradual though saltatory increase in the effect of the ovarian hormone. It is very likely that the first cycles of moderately high activity were unaccompanied by ovulation, though I know of no studies on the rat to bear this out.

With regard to the mouse we are somewhat more fortunate. That puberty and maturity are distinct phenomena separated by a considerable interval of time was established for the mouse by Mirskaia and Crew.[2] In a series of experiments pregnancy followed first matings in only 24 per cent. of cases, whereas the same mice were 80 to 90 per cent. fertile with later matings. Puberty is defined by these authors as the ability to elaborate functional gametes and to possess the physical ability and the desire to play the appropriate rôle in mating; maturity, on the other hand, is defined as the stage of maximum fertility ratio and the ability to produce viable offspring and to rear them.

In this definition, ovulation is included as one of the criteria of puberty. To my notion maturity, the end of adolescence, is marked by the first ovulation and the preparation of a receptive uterus capable of carrying the offspring to term; puberty is indicated by the first manifestations of gonadal activity and marks the beginning of adolescence. The threshold for the hormones causing the latter changes (sex color, menstruation, cyclic variations in spontaneous activity, cornification and opening of the vagina, according to various species are much lower than the changes culminating in ovulation and conception.

The onset of menstruation in girls is, of course, a momentous event. Nevertheless, though the mores of a given people may force "effective marriage" upon them at this moment, there is much indication that, by and large, nature herself prevents motherhood supervening during an important series of preparatory years.

The reader will naturally recall the case of India in this connection and the lurid picture of child mothers conjured up by Katherine Mayo in her notorious "Mother India." This propagandist would have us believe: "The Indian girl, in common practise, looks for motherhood nine months after reaching puberty, or anywhere between the ages of 14 and 8. The latter is extreme, though in some sections not exceptional, the former is well above the average."

In characteristic fashion, Mrs. Mayo fails to con-

[1] *Am. Jour. Physiol.*, 1904, on.

[2] Proc. Roy. Soc., Edinburgh, 1930.

tinue her quotation from the Appendix VII of the 1921 Indian Census, where we read that, though cohabitation begins with puberty, "in the majority of cases the first child is born the third year of effective marriage." Alden Clark[3] has pointed out, furthermore, that returns from maternity hospitals place the first parturition at 18.3 to 19.4 years. At the Madras Maternity Hospital only 10 out of 3,000 cases were under 15! Besides, we learn also from the 1921 census that only 399 out of 1,000 girls were married at 15, which would seem to indicate the average age at menarche is over 15 rather than under 13!

Among gynecologists Dr. Henry Vignes seems to be the only one to recognize the principle suggested in this paper. He says in his "Physiologie Gynécologique" (Paris, 1929), p. 55: "The onset of menstruation does not mean the capacity for conception; many girls who are just beginning to menstruate conceive with difficulty. Godin says that the age of maturity (nubilité), when the individual is capable of reproducing, is about five years after puberty." Dr. Vignes, moreover, kindly sent me a copy of the article "Nubilité" by Mondière in "Le Dictionnaire des Sciences Anthropologiques" (1890?). This gynecologist spent some years in Cochin-China, where he gathered certain data (first menses, first parturition, number of children, menopause, etc.) concerning 960 Annamite, 106 Chinese and 87 Cambodian women. He found that the first menstruation took place on the average at 16¼ years in the Annamites, at 16½ in the Chinese, at 16 10/12 in the Cambodians; the first parturition in these groups at 20½, 16 10/12 and 22½ years, respectively, despite their early marriages. He therefore concludes: "Maturity (nubilité) is often confused with puberty, which is a very different thing, for maturity signifies the faculty of normal reproduction."

This interval between the appearance of the first manifestations of sexual activity and the ability to conceive doubtless explains the Trobiand Islanders' ignorance and denial of physiological paternity and the corollary thereof, a matriarchal form of society, as set forth by Malinowsky in his "Sexual Life of Savages" (London and New York, 1929). Contact with white man has not yet made any headway in convincing the natives that sexual intercourse has any relation to procreation.

Malinowsky is, nevertheless, well-nigh baffled by the fact that despite the absolutely unrestrained and promiscuous sex life of the young Trobiander from childhood on, pregnancy among young unmarried girls is extremely rare—perhaps one per cent. "Can there be any physiological law," the author asks, "which makes conception less likely when women begin their sexual life young, lead it indefatigably, and mix their lovers freely?"

It seems highly reasonable that Malinowsky's predicament is explained by the facts presented in this paper, namely, that the first menstruation (*puberty*) marks merely an early manifestation of a train of events (*adolescence*) which only after three or four years on the average lead to ovulation and conception, the proof of *maturity*.

CARL G. HARTMAN
CARNEGIE INSTITUTION OF WASHINGTON,
BALTIMORE

[3] *Atlantic Monthly*, February, 1928.

THE ETIOLOGY OF EPIZOOTIC ENCEPHALOMYELITIS OF HORSES IN THE SAN JOAQUIN VALLEY, 1930[1]

EARLY in July, 1930, scattered cases of a peculiar disease of horses which involved the central nervous system began to attract the attention of the livestock owners in certain parts of the San Joaquin Valley. A gradually increasing number of cases was reported from most sections of this region throughout the month of August. With the onset of cool nights the disease disappeared. The peak of the epizootic was reached in the middle of September; no cases were reported after November. From the records of the tallow works and incomplete survey studies it has been estimated that a total of approximately 3,000 horses and mules succumbed to the malady or were sacrificed on account of its sequelae. Close to 6,000 equine animals developed recognizable symptoms. About 50 per cent. of these cases terminated fatally. On one ranch with 687 horses and mules 67 contracted encephalomyelitis and 32 died.

At first the malady was quite generally diagnosed by veterinary practitioners as equine botulism but the spread of the epizootic suggested an infectious disease with an incubation time of from 1 to 2 weeks. Observations revealed febrile reactions preceding the onset of the symptoms which were manifest in form of psychic and motoric disturbances. Signs of fatigue, somnolence, and occasionally excitability, were followed by incoordinated action of the limbs, disturbed equilibriums, grinding of the teeth, paresis and paralyses which varied and were largely dependent on the lesions produced in the innervation centers of the nerves in the brain and the spinal cord. Inability to swallow, paralysis of the lips and bladder, amaurosis, etc., were quite common. In the mild cases which were able to rise recovery was as a rule uneventful and without demonstrable sequelae, but about half were so severe that they terminated fatally in 3 to 8 days or became so obviously hopeless on ac-

[1] From the George Williams Hooper Foundation and the Division of Veterinary Science, College of Agriculture, University of California, San Francisco and Berkeley, California.