lobes of three such animals has failed to reveal the slightest evidence of either Ammon's horn sclerosis or any more obvious pathology. Although aberrant behavior is infrequently reported because of the distaste it arouses in animal owners who, as a consequence, have their pets castrated, it is probably more common than we are accustomed to believe (*1*). In all this the male cat does not appear to differ from other species of domesticated animals which can be trained to mate with artificial vaginae for sperm collection.

Every variety of abnormal behavior which has been used as a criterion of hypersexuality in male cats has been encountered, with one exception, during the past 5 years of observation of animals without brain damage. The exception is mounting activity toward alien species which I have not observed. Upon this I cannot comment except to observe that such activity may be less specifically related to the sex drive than the visual agnosia which forms part of the temporal lobe syndrome. The patterns of spontaneously occurring abnormal behavior include (i) the tenacious clinging to female partners by males during copulation when attempts at separation are made—so that both animals can be suspended in mid-air, (ii) indiscriminate mounting by males of other males, (iii) tandem and multiple mounting behavior, (iv) neck grips, mounting, and attempts at copulation with kittens of under 900 grams, and (v) masturbatory activity, mounting, and ejaculation upon inanimate objects. This latter phenomenon occurs spontaneously in freely running animals as well as in those subjected to training procedures within the laboratory. Although such phenomena as multiple mounting behavior seem at first to be very bizarre, the expression of identical patterns of behavior in animals which have not been subjected to operative interference suggests the need for caution in the interpretation of results. The observations that are presented here show clearly that many of the manifestations of so-called "hypersexuality" can either occur spontaneously or be produced as a conditioning effect by simple manipulation of the environmental situation.

It would be wrong to infer from the foregoing that the rhinencephalon is not of great importance in the regulation of sexual behavior in the cat and other species; the evidence in the rhesus monkey is overwhelmingly against this. But the spontaneous occurrence of such behavior in male cats without brain damage implies a need for quantitative studies combined with control procedures aimed at excluding the possible effects of training. Only such measurements will enable the precise role of the temporal lobe in the sexual activity of this species to be evaluated (*8*).

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References and Notes

1. H. Kluver and P. C. Bucy, *Am. J. Physiol.* **119**, 352 (1937); *J. Psychol.* **5**, 33 (1938); *A.M.A. Arch. Neurol. Psychiat.* **42**, 979 (1939).
2. J. H. Masserman *et al.*, *Am. J. Psychiat.* **115**, 14 (1958).
3. L. Schreiner and A. Kling, *J. Neurophysiol.* **16**, 643 (1953); *A.M.A. Arch. Neurol. Psychiat.* **72**, 180 (1954).
4. ———, *Am. J. Physiol.* **185**, 486 (1956); C. D. Clemente, *Clin. Research* 7, (1959); J. D. Green, C. D. Clemente, J. de Groot, *J. Comp. Neurol.* **108**, 505 (1957).
5. R. P. Michael, *Behaviour*, in press.
6. R. E. Whalen, personal communication.
7. L. R. Aronson, *J. Comp. and Physiol. Psychol.* **42**, 226 (1949).
8. Investigation carried out during tenure of M.R.C. fellowship in clinical research.

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Spontaneous Occurrence of Chromosome Abnormality in Cats

Abstract. A syndrome in male cats analogous to chromatin-positive Klinefelter's syndrome in human males has been demonstrated. The physical characteristics which suggested an abnormality of chromosome number in cats were "calico" or "tortoise-shell" coat colors in a male. Buccal mucosal smears were found to have "female-type" patterns in two out of 12 such male cats screened, and these two were found to have a diploid chromosome number of 39 rather than the normal 38. Testicular biopsy performed on one revealed an abnormal pattern; no gonadal tissue was found in the other cat with an abnormal chromosome number. These findings indicate that the cat, in addition to the mouse, is available for experimental study of chromosome number abnormalities.

Geneticists have been puzzled by the mechanisms involved in the rare male cat with both black and orange colored patches in its coat (*1*). Under the hypothesis that control of these two coat colors is related to allelic genes on the X sex chromosome (*2*), both should occur simultaneously only in individuals with two X chromosomes, such as normal females. The reports of males with both black and orange colors have cast doubt upon the hypothesis. However, the observation that a majority of reported "tortoise-shell" or "calico" males are sterile (*3*) suggests that some unusual mechanism is operating.

The possibility that the male calico cat might represent a chromosome abnormality comparable to chromatin-positive Klinefelter's syndrome in human males was suggested. Chromatin-positive Klinefelter's syndrome includes a sex-chromatin pattern of "female" rather than "male" type, at least one additional chromosome determined by tissue culture techniques (this is considered to be an X chromosome to give a sex-chromosome complement of XXY), and abnormality of the testicular tubules with failure of spermatogenesis and clinical sterility. If male tortoise-shell and calico cats are feline analogs of human "Klinefelter's" and thereby have two X and one Y chromosomes, the explanation of the presence of both colors in their coats would be simple. The spontaneous presence of such an abnormality has additional interest in that it would permit laboratory study of basic mechanisms involved in an order other than the Rodentia and encourage search for similar anomalies in other species.

Male cats with combinations of three coat colors were examined for the criteria used in the diagnosis of human chromatin-positive Klinefelter's syndrome. Of 12 animals located, only one had typical black and orange patches. The 12 were screened by examining the nuclear chromatin patterns in buccal mucosal cells stained with aceto-orcein. Ten showed the normal male pattern consistent with control male cats tested, but two had the female type, chromatin-positive smears. These two, one being the typically marked calico cat, were examined further.

The one of the two cats with chromatin-positive cells but without the true orange and black spotting had a normal male phallus and a normal scrotum containing descended testes, one of which was removed by excision biopsy. The exposed testis was smaller than normal, measuring 10 by 15 mm, and was firmer than usual. Aceto-orcein squash preparation of fresh biopsy material previously treated with 0.17-percent NaCl solution for 10 min revealed cells in meiotic division, but no spermatids or spermatozoa were seen. This lack of normal spermatogenesis was confirmed by observation of tissue sections stained with hematoxylin and eosin.

The second cat, typically marked, also had a normal male phallus but the scrotum was undeveloped and no testes could be palpated in it or in the inguinal canals. Exploratory laparotomy was done, and no gonadal tissue or internal reproductive system structure could be

identified. The surgery was done by an experienced veterinarian (*4*), who stated that he had never seen an animal without at least vestigial organs. White blood cells from the two chromatin-positive cats were established in tissue culture (*5*) by a modification of the method published by Mellman *et al.* (*6*). Growth was obtained in culture from the first cat, but technical problems limited the number of countable cells to three. These showed 39 chromosomes rather than the normal number of 38 reported by various workers (*7*) and confirmed by our procedures with blood from normal cats. Better preparations were obtained from the second cat, the typical calico, and the chromosome number in nine cells was also 39. Further work is being done to establish which chromosomes are involved in the abnormality, and we are preparing idiograms for chromosomes in tissue culture from normal and abnormal cats (*8*). It should be emphasized that this chromosome abnormality would not be limited to the male with calico markings. The rare coat color merely served as a convenient primary screening device.

We feel that this demonstration of a spontaneously occurring chromosome abnormality in which the chromosome number is $2n + 1$ is an encouragement to seek associations of sex-linked characteristics with such chromosome abnormalities in mammals more suitable than the cat to experimental laboratory study of factors involved in the etiology of such disorders. Russell and his associates (*9*) demonstrated the occurrence of fertile XO ($2n - 1$) females in a population of laboratory mice. This may or may not be proved etiologically analogous to gonadal dysgenesis in human females, an abnormality in which the sex chromosomes are XO ($2n - 1$). Thus both a decreased and an increased number has now been found in mammals other than humans. The similarity with respect to testicular development between the effect of an extra X chromosome in humans and these cats in which the additional chromosome is presumed to be an X chromosome is also of marked interest in its implication that specific genetic mechanisms may be located on the analogous chromosomes in two differing species. Finally, the utility of the buccal mucosal smear technique in screening individuals for this chromosomal abnormality appears to be valid in cats as well as humans (*10*).

Note added in proof: Since this report was submitted, L. B. Russell has published a review of the genetics of mammalian sex chromosomes as studied in mice at the Oak Ridge National Laboratory, Oak Ridge, Tenn. [*Science* **133**, 1795 (1961)]. She cites the finding of an XXY male mouse, apparently sterile, among 6368 animals observed. The apparent sterility of this mouse extends to three the number of species in which abnormality of gametogenesis is associated with an additional X chromosome in the male.

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References and Notes

1. R. C. Bamber and E. C. Herdman, *J. Genet.* **26**, 115 (1932); T. Komai and T. Ishihara, *J. Heredity* **47**, 287 (1956).
2. L. M. Sprague and C. Stormont, *J. Heredity* **47**, 237 (1956).
3. R. C. Bamber and E. C. Herdman, *J. Genet.* **24**, 355 (1931).
4. R. P. Whitaker, D.V.M., Lakewood Center, Washington, kindly did the surgery.
5. Cultures from blood were started in February 1961. Skin cultures were started at the same time but lost to fungus contamination in spite of thorough preparation of skin for surgery.
6. W. J. Mellman, P. S. Moorhead, P. C. Nowell, D. M. Batipps, A.M.A. *J. Diseases Children* **100**, 614 (1960); P. S. Moorhead, P. C. Nowell, W. J. Mellman, D. M. Batipps, D. A. Hungerford, *Exptl. Cell Research* **20**, 613 (1960).
7. S. Makino, *An Atlas of the Chromosome Numbers in Animals* (Iowa State College Press, Ames, ed. 2, 1951).
8. The rarity of true tortoise-shell or calico male cats requires that evidence on this problem be accumulated by workers in various geographic areas.
9. W. L. Russell, L. B. Russell, J. S. Gower, *Proc. Natl. Acad. Sci. U.S.* **45**, 554 (1959); W. J. Welshons and L. B. Russell, *ibid.* **45**, 560 (1959); L. B. Russell and C. L. Saylors, *Science* **131**, 1321 (1960).
10. Financial support has been provided for this study by the Washington Association for Retarded Children Guilds and the Washington Association for Retarded Children.

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Simian Malaria in the Philippines

Abstract. The first field study of simian malaria in the Philippines found that malaria occurred in 8.6 percent of the animals tested. Although based on a very limited study, this report suggests that the simian reservoir of malaria is probably of limited significance for the human population in the Philippines.

The first field study of simian malaria in the Philippines has been conducted in view of the recent report of malaria transmission between lower monkeys and humans (*1*) and because of the possible significance of this finding on current methods for eradicating malaria.

In the western Pacific region, simian malaria has been reported in Taiwan, Borneo, Java, Sumatra, Malaya, and Indochina (*2*). There are no published accounts of related studies having been made in the Philippines, but *Plasmodium inui* has been isolated from Philippine monkeys sent to the United States and England (*3*).

In a preliminary blood survey within the Philippines, 16 positives (8.6 percent) were found among 186 *Macaca irus* (*M. cynomolgus*). From the northern provinces of Cagayan, Nueva Vizcaya, and Bulacan, the sample (24 animals) was negative. From the southern province of Palawan and the island of Mindanao, 16 positives were found in 162 animals.

The infected animals did not appear to be seriously ill. The parasites contained pigment during the trophozoite stage. No enlargement of red cells or Schuffner's stippling was found. The close morphological resemblance to *Plasmodium malariae* suggests the identification of *P. inui*. Halberstadter and Prowazek (*4*) first described this species in *Macaca irus* and *M. nemestrina* from the island of Borneo, which lies adjacent to the southern boundary of the Philippine archipelago. Since the flora and fauna of the southern islands are similar in many respects to neighboring Borneo, the presence of *Plasmodium inui* in both areas is not an unexpected finding.

For the past several years, the distribution of the Philippine human population has been undergoing a major shift away from the overpopulated coasts and valleys toward newly opened public lands which characteristically lie in hilly uplands bordering forested mountain ranges. Many variables contribute to the high potential for the transmission of malaria along these population frontiers, not the least of which are the many open, sunlit upland streams that constitute a highly favorable breeding habitat for the common Philippine vector, *Anopheles minimus flavirostris*.

It is an associated factor that monkeys are present in large numbers in the forests which lie adjacent to the advancing edge of new settlements. As a general pattern, it is often necessary for the new settler to spend some time within the forest in order to clear and burn his land before he can plant the usual upland crops of rice or corn. Careful assessment of the many epidemiological variables which apply at this geographical location indicates that the human malaria reservoir accounts for the source of *all* infections which have been investigated up to the present time. While the present report is based