and post-graduate teaching in child health and the diseases of childhood, will be a center of research and will be at the disposal of local public health and education authorities of the region for advice and consultation in the conduct of their child welfare and school medical services.

DISCUSSION

CHROMOSOME NUMBERS IN MAMMALS AND MAN

HAVING had occasion recently to survey the chromosome numbers in Marsupials and placental mammals, a group in which many new and accurate counts have been made in recent years, it seems worth while pointing out some of the relationships which emerge. In Marsupials the most common diploid number is 22, although certain genera have 12 or 14. On the other hand, the armadillo (Edentata) has 60, which is also the usual number in Ungulates so far as known, the horse, cattle, yak, goat and sheep all having this number. In domestic pigs and in peccaries the known numbers are respectively 38 and 30. In Carnivora the numbers range from 34 in the fox to 78 in the dog. This suggests the possibility that in dogs doubling has taken place through crossing under domestication. In Rodentia the numbers are variable, 40 and 42 being frequent numbers in mice and rats, while the squirrels appear to range from 28 to 62, and even higher numbers have been counted in certain genera of rodents. The single species of bats whose chromosome number has been determined has 48. This number is found in all the Primates hitherto studied, that is the Rhesus monkey, chimpanzee and man, with the exception of a brown Cebus monkey having 54.

Although many counts remain to be made, certain tendencies are already clear. The placental mammals have numbers which are generally more than double those found in the marsupials, the ungulates having generally higher numbers than the primates. The evolutionary tendency has clearly been to an increase in chromosome numbers. In plants such increases in numbers have frequently been through allo- or autopolyploidy, and this can be confirmed by a study of the nucleoli.[1] It is still uncertain in how far the number of nucleoli in animals can be used as an index of the number of sets of chromosomes.

It was formerly assumed that polyploidy in animals would upset the sex chromosome mechanism, although I predicted[1a] that, in dioecious plants such as Salix, chromosome doubling would be followed by a process of readjustment of the sex chromosomes, so that the sex balance would be maintained. The more careful papers on mammal cytology have all described an unequal XY pair, or rarely an XO condition which, however, can hardly be regarded as certainly authenticated in any case. In dioecious plants, where the conditions are essentially similar to those in most animals, it turns out that doubling of the chromosomes does not necessarily have the effect predicted. For example, tetraploid forms of *Melandrium album,* produced by heat treatment, had in the male $2n = 44 + XXYY$ and in the female $2n = 44 + XXXX$.[2] When these 4n males and females were crossed together, the plants (with $44 + XXXY$) were not intersexes but pure males, apparently owing to a strong dominant factor for maleness in the Y-chromosome. Even $4n \times 2n$ gave triploid males and females with $2n = 33 + XXX$ (♀), and $2n = 33 + XXY$ (♂), respectively. Blakeslee[3] independently showed that in dioecious Melandrium when the chromosomes are doubled the species ultimately settles down to a balanced tetraploid condition with equal numbers of male (XXXY) and female (XXXX) individuals. Similarly, tetraploidy was induced in *Carica papaya* by the use of colchicine.[4] Of the 4n plants so obtained, 9 were ♀, 4 ♂, 1 ☿. As might be expected, the sex balance differs from one species to another.

Chromosome doubling in the higher mammals is therefore by no means ruled out, and it is possible that the 48 chromosomes of the primates and man may be a secondary tetraploid number. This might help to explain the relatively frequent occurrence of intersex conditions in man. Various critical studies of the sex chromosomes in man, *e.g.,* by Painter (1923) and Koller (1937),[5] indicate that the X and Y bear satellites and therefore probably produce the nucleoli. A study of the nucleoli in human spermatogenesis should furnish evidence on the possible presence of more than one pair of nucleoli, but as the number 48 is evidently an ancient one, it is probable that in man (as in some varieties of rice) the mutational loss of a pair of nucleolus-producing loci will have occurred long since, leaving only one pair.

That chromosome evolution is going on in man is indicated by the fact (Koller, 1937) that a man descended in the second generation from a cross between a Scotswoman and a Frenchman was heterozygous for an inversion in a chromosome segment. The study of meiosis in racial hybrids may therefore disclose chro-

[1] See Gates, *Bot. Review,* 8: 337–409, 1942.
[1a] Polyploidy and sex chromosomes. *Nature,* 117: 234. 1926.

[2] M. Westergaard, *Dansk. Bot. Arkiv.,* 10: 1–131, 1940.
[3] Effect of induced polyploidy in plants, *Amer. Nat.,* 75: 117–135. 1941.
[4] J. D. J. Hofmeyr and H. van Elden, *S. Afr. Jour. of Sci.,* 38: 181–185, 1942.
[5] T. S. Painter, *Jour. Exp. Zool.,* 37: 291–336, 1923; P. C. Koller, *Proc. Roy. Soc. Edinb.,* 57: 194–214, 1937.

matin rearrangements, and possibly also (as in Drosophila) the order of their occurrence, as an aid in the study of racial relationships.

If mammals, like plants, retain for long periods their extra nucleoli arising through polyploidy or any other form of duplication of the nucleolus-producing chromosomes, then the nucleoli should prove a valuable aid in tracing phylogenies in this group of animals. It is now well known that in insects polyploidy in the fat bodies and other organs is a general feature of the ontogeny. From the work of Jacobi, Wermel and others, in which the nuclei of the liver and other organs fall into a geometric series of volumes, it is evident that something of a similar kind, perhaps polyteny, may take place in human ontogeny. Polyploidy in animals may thus prove to be much more wide-spread than we have been accustomed to suppose.

R. Ruggles Gates

Marine Biological Laboratory,
Woods Hole, Mass.

LONGEVITY OF FOWL SPERMATOZOA IN FROZEN CONDITION[1]

Preservation of life in monocellular organisms by storage at low temperatures offers many possibilities in biological studies requiring long-time storage. As cited by Luyet,[2] Brehme reported that cholera vibriones survived continuous freezing for 57 days at $-1°$ C to $-16°$ C and Prucha and Brannan, also cited by Luyet, isolated *Bacillus typhorus* from ice cream kept for 20 months at $-20°$ C. Jahnel[3] reports that some human spermatozoa resumed motility after having been held at $-79°$ C for 40 days and Shettles[4] reports the resumption of motility of human sperm after 70 days' storage at $-79°$ C.

A technique for preserving chicken spermatozoa by storage at low temperatures has been described by Shaffner, Henderson and Card.[5] Results from experiments using slight modifications of the original technique indicate that time is not an important factor in the retention of motility within the first year, when fowl semen is held constantly at the temperature of solid CO_2. Spermatozoa have been maintained at a temperature of dry ice ($-79°$ C) for 14 months. Little if any difference could be noted in the percentage of cells that regained motility between samples thawed immediately after freezing or those thawed after 14 months storage.

Unmated hens producing infertile eggs were inseminated with semen that had been frozen at $-79°$ C and thawed an hour later. Of 48 eggs produced by these hens after insemination 12 were fertile. However, in no case did the resulting embryonic development proceed for more than 10 to 15 hours, as determined macroscopically.

C. S. Shaffner

Poultry Department,
Purdue University

[1] Journal paper No. 20, Purdue University Agricultural Experiment Station.

[2] B. J. Luyet, Life and Death at Low Temperature, *Biodynamico*, Normandy, Missouri, 1941.

[3] F. Jahnel, *Klin. Wchnschr.*, 17: 1273, 1938.

[4] L. B. Shettles, *Am. Jour. Physiology*, 128: 408, 1940.

[5] C. S. Shaffner, E. W. Henderson and C. G. Card, *Poultry Science*, 20: 259, 1941.

THE ERADICATION OF NUT GRASS

Four years ago E. V. Smith and E. L. Mayton[1] reported that they were able to control nut grass by "plowing or disking at intervals of three weeks or less during two consecutive growing seasons." As the writer's[2] laboratory experiments have shown that nut grass is killed by 1 N chlorate or 2 N thiocyanate solutions, it seemed worth while to see if the chemical method would not offer a cheaper and quicker way of control of nut grass than that suggested by Smith and Mayton.

The experiments were performed during the spring and summer of 1940 on plots which contained 250–500 plants of nut grass per square meter. One liter of solution was applied per square meter. The chlorate ion was applied in the form of sodium chlorate, the thiocyanate ion in form of calcium thiocyanate. The author is very much obliged to the American Cyanamide and Chemical Corporation, New York, for the supply of the calcium salt. The results compiled in Table I show clearly that the result of the field experiments were less satisfactory than those of the laboratory experiments. One fifth to one fourth of the plants were still surviving after 20 days. Though some of them were very weak and died within 10 more days, still about one tenth of the weeds survived and were able to repopulate the field. Also a repeated application of the herbicide would not kill them.

TABLE I

Substance	Normality	No. of experiments	Percentage of plants surviving at 20th day	at 30th day
ClO_3^-	2	3	26	12
CNS^-	2	2	15	10
CNS^-	1.5	2	15	..
CNS^-	0.7	2	40	22

The reason for this incomplete control was the same as for the failure of simple tillage as a method of eradication of nut grass: the bulbs, which are the most resistant part of the plant, are relatively deep below the surface and can not all be reached by the weed killer if its solution is applied to the surface only. In May and July, 1940, further experiments in neighboring plots were, therefore, conducted in this

[1] *Jour. Am. Soc. Agron.*, 30: 18, 1938.

[2] *Rev. agr., ind. y com.*, Puerto Rico, 33: 180, 1941.