TRISOMIC AND HAPLOID EMBYROS OF THE CHICK (GALLUS DOMESTICUS)

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Summary. Two chromosomally aberrant chicken embryos (16 to 18 hr of incubation) were found. One was trisomic for a large submetacentric chromosome, number 2 of the chicken karyotype. The second was a haploid whose cells contained thirty-nine chromosomes. The probable modes of origin and usefulness of the findings are briefly discussed.

Although the genetics and embryology of the domestic fowl have been rather extensively studied, reports dealing with the chromosomal constitution of members of the species are rather few. Presumably, this is attributable, in large part, to the fact that their karyotype contains a large number of very small elements that do not lend themselves easily to such analyses. More recently developed techniques such as those described by Owen (1965), Shoffner, Krishan, Haiden, Bammi & Otis (1967) and Fechheimer & Jaffe (1966) do make possible the identification of members of eight pairs of chromosomes and accurate counts of the smaller elements in some especially well prepared cells.

Only a few aberrations have been reported, including one triploid adult (Ohno, Kittrel, Christian, Stenius & Witt, 1963), a triploid–diploid mosaic embryo (Bloom & Buss, 1966) and a trisomic chicken–coturnix hybrid embryo (Shoffner et al., 1967). This brief communication reports two additional aberrations of early chick embryos.

In conjunction with another experiment, 275 eggs from a stock (AG-1) selected for rapid growth rate (Jaap, 1963) were set. After 16 hr in an incubator at 101°F, the eggs were injected with 0.05 ml of 0.1% colcemide and returned to the incubator for 2 hr. In the laboratory, the eggs were opened into a petri dish and the germinal discs removed with a scalpel and fine forceps. Each germinal disc was placed in a 3-ml centrifuge tube containing 1 ml of Hanks’s balanced salt solution, and a cell suspension was prepared by repeatedly aspirating and discharging the disc in solution, with a finely drawn pipette. Hypotonic treatment and fixation of the cells and preparation of the slides for microscopic examination were accomplished by the method previously described (Fechheimer & Jaffe, 1966).

Each slide, containing cells from only one embryo, was scanned for the presence of cells in metaphase which were examined to ascertain the number of ‘Z’ chromosomes present. Of the 260 embryos from which preparations were made, 242 contained sufficiently good metaphase cells for the identification of
the sex chromosomes. Two of these embryos were seen to contain aberrant karyotypes and analysis was subsequently made of all the cells in which the chromosomes were clear and well spread.

All seven analysable cells from one embryo contained an extra, large, sub-metacentric element indistinguishable from chromosome number 2. A sample karyotype is shown in Pl. 1, Fig. 1 where it can be noted that there is an apparent trisomy of number 2. In some additional cells, where lack of clarity of the preparation precluded complete analysis, a count of the larger elements was made. In every case it was indicated that a trisomic state existed. While it is impossible to ascertain that the embryo was not mosaic, consisting of trisomic and normal cells, the presence of trisomy in all cells where it was possible to make an assessment makes mosaicism less probable. Should the trisomic state have arisen by non-disjunction of a mitosis during cleavage, one would expect to see at least two-, and more probably three-cell lines, i.e. a normal, a trisomic and a monosomic line. If non-disjunction had occurred at the first cleavage division, trisomy and monosomy would result giving rise to two-cell lines. On the other hand, a non-disjunctional event at one of the two meiotic divisions in either parent would be expected to yield a disomic gamete. When the disomic gamete joined, at syngamy, with a normal gamete, trisomy of the fertilized ovum would be the outcome. Because only trisomic cells were observed, it is hypothesized that meiotic non-disjunction was involved. It is not possible to ascertain which parent contributed the aberrant gamete.

The second chromosomally aberrant embryo was a haploid, a sample karyotype of which is shown in Pl. 1, Fig. 2. Twelve metaphase cells of this embryo were studied, each containing only one representative of each pair of major chromosomes. The sex chromosome of each was a 'Z'. From the clearest of the cells, when it was possible to make an accurate count of all elements, it was determined that thirty-nine chromosomes were present. No evidence of mosaicism was detected, all cells encountered being of the same type. The simplest explanation of the origin of this haploid is that the ovum, having completed both meiotic divisions, was induced to undergo cleavage and subsequent development without having completed fertilization. This explanation, i.e. haploid parthenogenesis, is the one that has been most frequently invoked to explain the occurrence of haploid mammalian embryos (Beatty, 1957). Other possible explanations appear much less likely to be valid but cannot be discounted as possibilities.

Although diploid parthenogenesis has been reported in the chicken and occurs not infrequently in some lines of turkeys, this is the first observed case of a haploid parthenote in an avian species. Should it be possible to increase the incidence of this type of development by selection, it could be a valuable tool for certain types of genetic studies. By the same token, a knowledge that trisomics do occur in avian species is very worthwhile. With the wealth of accumulated information on the ontogeny and genetics of the chick, and the relative ease with which the embryos can be handled and treated, it would seem that Gallus may be the genus of choice for studying the aetiology of cytological aberrations so frequently being reported in man, lower mammals and vertebrates in general.
Fig. 1. Karyotype of female (ZW) embryonic cell trisomic for chromosome number 2.
Fig. 2. Karyotype of haploid embryonic cell with 'Z' sex chromosome.
Trisomic and haploid chick embryos

REFERENCES


