D II (Hons) Zoology Paper III rd Group-B

Topic – Sex Determination (contd) Lecture – 18

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SEX-DETERMINATION (Contd.)

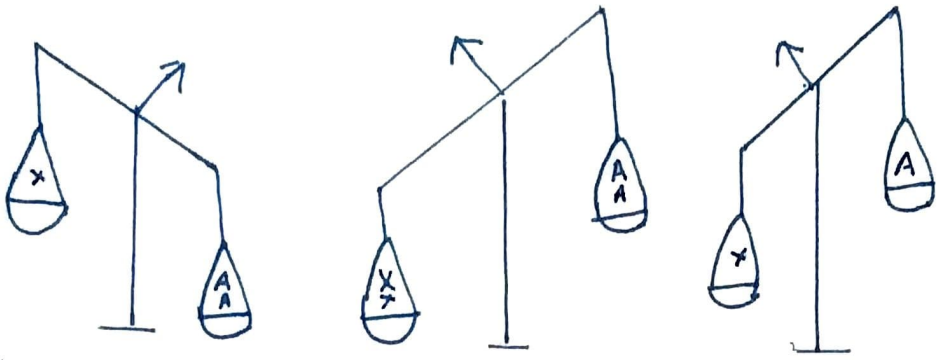
GENIC BALANCE THEORY.

The sex chromosomes and autosomes are mere vehicles of genes. In Drosophila, the X-chromosome carries more genes that incline the development towards femaleness and autosomes possess genes which incline the development towards maleness. Therefore, the deciding factor is the ratio between the number of X-chromosomes to autosomes.

S. No.	Sex	No. of X-chromosomes	Set of autosomes	Sex index ratio X/A
1.	Super female	XXX	AA	1.5 Super female.
2.	Normal Male → Tetraploid	XXXX	AAAA	1.0
	Triploid	XXX	AAA	1.0
	Diploid	XX	AA	1.0
3.	Intersex	XX	AAA	.66
		XXX	AAAA	.75
4.	Normal Male	X	AA	.50
5.	Super male	X	AAA	.33

Showing ratio of X & A chromosomes responsible for Sex determination in Drosophila.

For a normal male the ratio between X-chromosome & autosome is .5 and for female 1.00. The ratio increases in Superfemales and decreases in Super males.



Diagramatic representation for genic balance theory of Sex-determination

X- Contain female determining genes.

A- contain male determining genes.

Although the ratio of x-chromosome and autosomes is operative in Drosophila but it is not a universal mechanism. Coswing has shown that in Platypoecilus the Sex determining factor is the ratio of autosomes to y-chromosome.

Single Gene Effect.

In some organisms like Neurospora, chlamydomonas, yeast, Asparagus, Drosophila, maize and several fishes, Single gene is responsible for expression of Sex.

1. Monofactorial Sex determination in Asparagus:—

In Asparagus the Sex is determined by a single pair of gene. The maleness is dominant over femaleness and male plant are ordinarily heterozygous.

2. Monofactorial Sex determination in Maize:—

In maize the gene for tassel seed (male inflores-cence in tassel-ts) converts the male inflorescence into seed bearing inflorescence. The gene for silkless (sk) causes the absence of silk (female inflorescence). Therefore, a plant SK/sk is found to be male plant and a plant ts/ts a female Plant. By using These genes it is possible to convert maize from a monocious to dioecious form.

3. Monofactorial Sex determination in Drosophila:—

In Drosophila transformer gene (tra) when Present in homozygous condition (tra/tra) converts a female into a

Sterile male, but has no effect on normal male. The XX female with tra/tra genotype is a sterile male while XY male with tra/tra genes is a normal male.

Cytoplasmic Sex Determination

In bacteria, the sexuality is controlled by cytoplasmic factors or F- factor or fertility factor. Lederberg & Tatum (1947) found that the male or donar cells Posses a fertility factor & are designated as F^+ cells while the female or receipient cells are F^-. During conjugation the F factor may be transferred to receipient cells converting them into F^+ or donar cells.

Quantitative or Ratio Theory of Sex Determination

C. B. Bridge worked out Ratio Theory of sex determination in Drosophila.

Intersex in Drosophila & Ratio Theory of Sex determination

Bridge's hypothesis was supported by Studies of flies arising after abnormal distribution of chromosomes on account of Non-disjunction.

① Nondisjunction of x-chromosome:— Due to abnormal meiosis during oogenesis both the x-chromosomes fail to separate & move to one pole of meiotic spindle. The few eggs are formed with single autosomal genome but with 2 x-chromosomes i.e (AXX) and others with single autosomal genome but no sex chromosome (A). When such abnormal egg are fertilized with normal sperm the following results are obtained.

AAXXY — Female.
AAXXX — Super female
AAX — Sterile male
AAY — Non viable

Results of fertilization of abnormal female gametes with normal male gametes.

(2) Nondisjunction of complete set of chromosomes :—

The ratio theory was further supported by another instance of abnormal meiosis where along with X-chromosome autosomes also fail to separate and move to same pole of the spindle. So, these abnormal eggs possess AAXX. When such diploid eggs are fertilized with normal sperms the following combinations are produced.

AAAXXX — Female.
AAAXXY — Intersex.

(3) Triploid Intersexes and Balance Theory :—

The triploid flies with (3A x 3X) are much like the normal diploid females both in appearance as well as in fertility. On mating to diploid males their progeny consist of following type.

1. AAAXXX - Triploid females.
2. AAXX — Diploid females.
3. AAXXY — Diploid females.
4. AAAXX — Intersexes.
5. AAAXXY — Intersexes.
6. AAXY — Normal males.
7. AAXXX — Super females.
8. AAAXY — Super males.

(2) Gynandromorphs in Drosophila & Ratio Theory :—

In Drosophila, sometimes flies are found in which a part of the body show male characters and other parts show female characters. Such flies are known as gynandromorphs. These are formed due to misdivision of chromosome and starts as female with 2A + 2X chromosome. one of the X-chromosome is lost during cell division, as a result one daughter cell possess 2A + 2X chromosome and other 2A + X chromosome. If this happens during first 2 zygotic division 2 blastomeres with unequal No. of X-chromosomes are formed. The blastomere with 2A + 2X chromo. develop into female half which the blastomere with 2A + X chrom. develop into male.

Hormone & Sex Determination :- Hormones also play vital role in Sex change in higher vertebrates and in some invertebrates. Crew observed in chicks that a hen which laid fertile eggs accidentally lost its ovary & stopped laying eggs and developed male comb, male plumage & became a cock. There are several examples of hormonal effect & control of sex differentiation.

1. Free Martinism :- Lillie and others found that where twins of opposite sex (one male & other female) are born, the male is normal but female is sterile with many male characters. Such sterile females are known as free Martin. The formation of free martins is the effect of hormones on the male sex on the female. In cattle the foetal membrane of twins are fused in such a way that they have a common blood circulation. The female hormone is produced late in the development & guides its development towards female side but since twins have a common blood circulation blood passes from the body of one twin to the other. The male hormone produced earlier than the female hormone, it enters the body of female twin and before the female hormone orders the development of female characters it is already differentiated in the guidance of male hormone. As a result the developing female is sterile.

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