Accessory Chromosomes in Apples

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Occurrence of accessory chromosomes is known in a large number of plants. These were shown to occur in *Sorghum*¹ (Darlington and Thomas 1941), maize (Randolph 1941), *Xanthium taxanum* (Berger *et al.* 1955), *Panicum coloratum* (Swaminathan 1956), *Crepis conyzaeifolia* (Frost and Östergren 1959), wheat (Moore 1961), *Poa alpina* (Müntzing 1966), and *Phleum nodosum* (Frost 1969). These were also reported in Himalayan hard woods (Mehra and Bawa 1968) and in *Pterotheca falconeri* (Mehra and Mann 1972). However a detailed study has been undertaken in a few species only (Frost 1969).

Apple, though an important fruit crop grown extensively in the Kulu Valley of India, is comparatively least worked out cytologically. Occurrence of accessory chromosomes in apples has not been reported so far. Therefore it was considered interesting to undertake the morpho-cytological studies in some of the important cultivated apple varieties of the Kulu Valley.

Material and methods

Plant material used for this study was grown in the Aramgarh orchard at a height of 5000 ft above sea level in the Kulu Valley. The apples are grown over there for many years under constant observation. Cytological data of apple varieties such as the number of accessory chromosomes present and their meiotic behaviour was studied.

The fixation for the meiotic studies was made in acetic alcohol (3 parts absolute alcohol and one part glacial acetic acid) and in Carnoy's fixative (100 parts absolute alcohol, 50 parts chloroform, 16 parts glacial acetic acid) the former fixative proved more useful in dissolving the refractive bodies contained in spore mother cell of the apple.

According to Einset *et al.* (1947), apples are poor cytological material, the chromosomes are small, meiotic stages are not easily located and preparations are rather difficult to interpret". The author, however, could accomplish staining with aceto-carmin containing traces of iron acetate, with good results.

Cytological studies were made on the spot, as well as in the University Botanical Laboratories at Chandigarh. The material which was kept in the fixative or preserved for more than 15 days in 50 percent alcohol become brittle whereas the fresh material tried on the spot proved to be the best.

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Results and disussion

A comparative study of morphological and cytological investigation were made in two cultivars of apple namely Ambri and Kulu Kenya (Table 1).

Meiosis was studied in these two cultivars. Ambri was found to be diploid

Fig. 1. Normal meiotic bivalents $n=17$ in apple cultivar Ambri.

Fig. 2. Pollen mother cell of apple cultivar Kulu Kenya at M1 showing 17II and 5 accessories. The accessory chromosomes are lying at the periphery.

with $n=17$ (Fig. 1). Regular separation of chromosomes was seen at the two poles which led to the formation of normal tetrads but 17 II+5 accessory of supernumerary or B chromosomes in a tree of Kulu Kenya apple in Kulu gardens were observed (Fig. 2). The same are absent in other trees of the same variety growing there under

similar conditions. This is the most interesting cytological investigation which is reported for the first time in fruit trees.

The accessory chromosomes were defined by White (1945) as "elements which are present in some individuals of the population but not in others". Müntzing (1961) observed that "these chromosomes represent more or less incidental addition to the normal chromosome complement".

They differ in size, number, and stainability and can be distinguished from the normal chromosomes. Among the angiospermous families they appear to be common in Gramineae. Accessory chromosomes were first observed in Homopteran insect *Metapodium* by Wilson (1905). Later studies by Darlington (1937), Håkansson (1945), Fernandes (1946), Ostergren (1947), Melander (1950), Baenziger (1962 a, b) have revealed the presence of these chromosomes in many insects and higher

Table 1. Cytomorphological characters of apple cultivars

Name of the cultivar	Ambri	Kulu Kenya
Parentage	Chance seedling in Kashmir Valley.	Chance seedling in Kulu Valley
Habit of the tree	Strong, slow growing, upright and round headed, comes in bearing after a long time, i.e. 10–15 years, look graceful, average bearer.	Very vigorous, upright spreading, round headed, heavy bearer.
Flowers	In clusters of 5–6 flowers; pedicel very thin, 2.00–2.5 cm long, densely hairy; corolla attractive pinkish, 4.8–5.0 cm in diameter; colour diffused in petal lines, apex obtuse to emarginate.	In cluster of 4.5; pedicel thick, 0.9–2.2 cm long, sparsely hairy; corolla light pink; colour diffused in petals, apex rounded.
Fruit	Medium, oblong; skin of shining red colour, red streaks on greenish-yellow back ground of the fruit; flesh unusually white, not juicy, some what tough, sweeter than other commercial varieties. It has long storage life than any other variety and can be kept till the next crop is ready.	Medium, roundish, slightly flattened; skin smooth, covered entirely, with attractive bright red stripes; flesh slightly yellowish, juicy, taste relishing. It can be used for preparing liquor.
Chromosome count	$n=17$	$n=17 + 5a$

plants. Recently Makino (1951) and White (1945) have added a number of plant and animal species possessing these chromosomes. According to the writer's knowledge, this is the first report of accessory chromosomes in apple. These varied in number and size in different mother cells of the same population therefore, represent true accessories. Further, the properties and behaviour exhibited by them during meiosis also point in the same direction.

At metaphase I they take a very light stain with aceto-carmin and are rather small in size. They have neither been observed to pair or divide longitudinally but they are usually orientated to the periphery of the cell. Their irregular distribution can be attributed to a weak centromere compared to the normal bivalent. Morphologically there exists no distinction between the individual possessing the accessory chromosomes and the trees without them. Hence, as first pointed out by Müntzing

they do not have an important role in the life process of the plant. Their mode of origin could not be studied precisely but it is possible that they might have arisen by fragmentation of the ordinary chromosomes as suggested by Bosemark (1954), Hutchinson and Bashaw (1963).

Summary

Cytological studies were conducted on two important cultivars of apple with a view to include in future breeding programme. The chromosome behaviour is normal, resulting in well filled pollen grains in the Ambritype. Accessory chromosomes with members of the normal 17 chromosome complement were noted in the variety Kulu Kenya. This appears to be the first report of its kind in temperate fruit trees. Morphologically there exists no distinction between the individual possessing the accessory chromosomes and the trees without them.

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