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Chromosomal Studies on Aphids Infesting Cereals from Himachal Pradesh, India

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ABSTRACT:
The present study investigated aphids' chromosomes infesting cereal crops from Mandi District, Himachal Pradesh. The chromosomes in aphids were holocentric and had equally distributed kinetic energy along the entire length. The aphids were collected from cereals belonging to Poaceae family. These aphid species *Metopolophiumdirhodum* (Walker, 1849), *Rhopalosiphummaidis* (Fitch, 1856) and *Sitobionbrevirostre* (Heikenheimo, 1978) were found infesting *Hordeumvulgare, Zea maize* and *Triticumaestivum* respectively. The diploid chromosome number in these species was2n=8 and 18. The idiograms were constructed based on relative length data.

Keywords:
Holocentric chromosomes, Aphid, Karyotypes, Relative length, Idiogram

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INTRODUCTION

Aphids are a group of polyphagous homopterans which infest wide variety of plants by feeding on phloem sap using their piercing and sucking mouth parts. These insects are predominantly a Northern temperate group, with remarkably a few species occurring in the tropics. Aphids cause considerable damage to horticultural and agricultural crops by sucking plant sap and also by the chemical action on the plant as well as by transmiting viral diseases of plants (Will & Vilcinskas 2015). The damages are related in one way or another to polymorphism of aphids. About 450 species of aphids have been reported to infest crop plants (Blackman & Eastop, 2000). The holocentric chromosomes of aphids have morphologically or physiologically undistinguished centromere and the kinetic activity is distributed along the entire chromatid (Hughes-Schrader & Schrader, 1961). These chromosomes can fragment at many points along their whole length to produce stable dissociated products because of their kinetic activity (Hughes-Schrader & Ris, 1941 and Blackman, 1987).

Cereals are the most important edible plant species belonging to monocot family Poaceae, also known as Gramineae, which usually have long, thin stalks. These are sources of carbohydrates, proteins, vitamin B, minerals and

trace elements. (Cereals & Cereal Products, 2009). Worldwide, wheat is the crop that occupies the most land. Approximately 40 % of the global population is fed by it, and it supplies 20% of the calories and protein needed for human nutrition (Asif et al., 2014). The whole grain is the healthier version. In addition it also contains fibre, polyphenols, vitamins, minerals. Barley, which is low in gluten and high in fibre, is typically found in cooler climates. In addition, it has proteins, minerals and vitamin B. Maize, also known as Queen of cereals, because every part of the plant, the grains, leaves, stalk, tassel, cob, has economic value, which is used in the production of food and non-food products (Saritha et al., 2020). Potassium is a major nutrient present in it, besides vitamin C, A, K and carotenoids (Shah et al. 2015). In India, 47% of maize production goes for poultry and 13%for livestock feed.

MATERIALS AND METHODS

The aphids were collected from crop fields of *Triticumaestivum*, *Hordeumvulgare* and *Zeamaize*from Mandi district (Latitude 31.5892° N, 76.9182° E and Altitude 1044 metres above sea level) of Himachal Pradesh. The infested leaves, grain heads, tassels and husk of the maize cob were used for aphid collection. The collection was done from April 2022 to August 2024**.**

For chromosomal preparations, young embryos dissected from the parthenogenetic females were used. Following 25 to 30 minutes at room temperature pretreatment in 0.7% trisodium citrate solution, the embryos were fixed for 15 to 20 minutes in 1:3 acetic acid-ethanol solution. After that, these embryos received three to five minutes of treatment with a 45% acetic acid solution. To ensure that the substance was disseminated evenly, a coverslip was placed on the slide containg the treated embryos (and thereafter pushed off the slide abruptly) after air drying and staining with 2% Giemsa, both the slides and coverslips were mounted using DPX.

The permanent slides were observed with a binocular microscope for well spread chromosomal plates and photomicro graphed. The chromosomal lengths were measured. The length of the complete complement for every species was determined. In order to prepare the idiograms, the relative lengths of the chromosomes were estimated from their actual lengths.

The keys of Blackman and Eastop (1984) were used to identiy the aphid species.

RESULTS

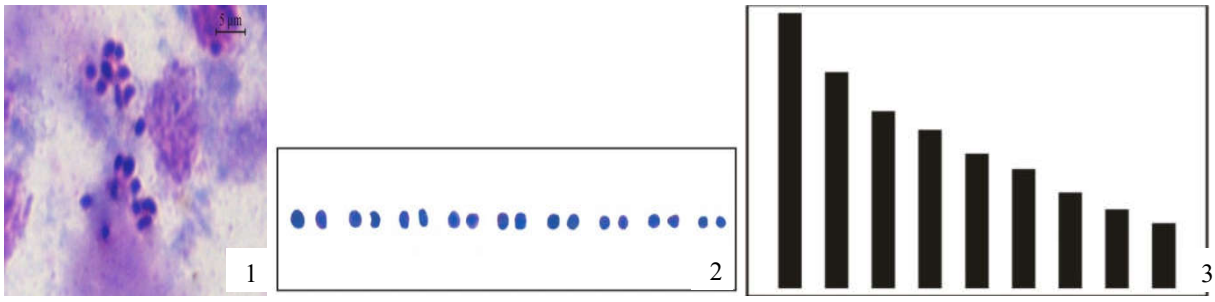
This study involves chromosomes of 3 aphid species *Metopolophiumdirhodum, Sitobionbrevirostre and Rhopalosiphummaidis,* infesting cereals from Mandi district of Himachal Pradesh. The numbers of chromosomes varied from eight to eighteen. The diploid chromosome number 2n=8was recorded in *Rhopalosiphummaidis* and 2n= 18 in *Metopolophiumdirhodum* and *Sitobionbrevirostre*.

Table 1: **Various lengths (actual chromosome length, relative length and total complement length as well as the diploid chromosomes number of aphid species obtained from diverse host plants.**

S. N.	Name of the Aphid species	Diploid chromosome no. (2n)	Host plant	AL(μm) ±S.E.		RL(μm) ±S.E.		TCL (μm) ±S.E.
				lowest	highest	lowest	highest	
1.	*Metopolophiumdirhodum* (Walker,1849)	18	*Hordeumvulgare*	0.45 ±0.03	2.14 ±0.14	2.33 ±0.13	11.08 ±0.44	19.32 ±0.98
2.	*Rhopalosiphummaidis*(Fitch, 1856)	8	*Zea maize*	1.19 ±0.10	2.13 ±1.00	8.91 ±0.33	16.01 ±0.43	13.3 ±0.94
3.	*Sitobionbrevirostre*(Heikenheimo, 1978)	18	*Triticumaestivum*	0.50 ±0.04	1.31 ±0.11	3.97±0.14	10.41 ±0.49	12.58 ±1.09

***Metopolophiumdirhodum* (Walker, 1849)**

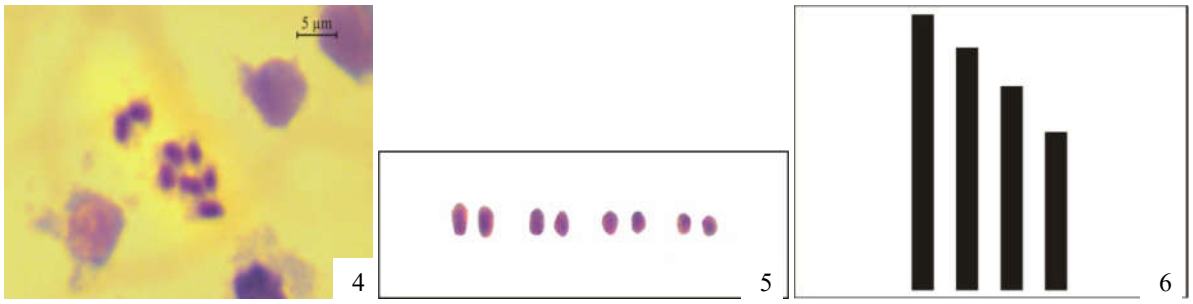
Metopolophiumdirhodum was collected from Barley (*Hordeumvulgare*) which is its secondary host. Both pterous and apterous aphids were yellowish green and body shape is slender and long. This species' diploid chromosome count was determined to be eighteen (2n=18) (Fig.1, 2). The shortest chromosome's length ranged from 0.45 µm ±0.03 S.E. while the longest chromosome's was 2.14 µm ±0.14 S.E. The calculated total complement length was 19.32 µm ±0.98 S.E. In terms of relative length, the shortest chromosome measured 2.33µm ±0.13 S.E., while the longest chromosome measured 11.08 µm ±0.44 S.E. The ideogram demonstrates a progressive reduction in chromosomal length (Fig.3).



Figures1-3: *Metopolophiumdirhodum* 1. Somatic chromosomes. 2. Karyotype. 3. Idiogram.

***Rhopalosiphummaidis* (Fitch, 1856)**

The *Rhopalosiphummaidis* was collected from the maize leaves, tassels and husk of the maize cob of the plant. This species' diploid chromosome count was determined to be eight (2n=8) (Fig.4,5). The shortest chromosome's length ranged from 1.19 µm ±0.10 S.E. while the longest chromosome's was 2.13 µm ±1.00 S.E. The calculated total complement length was 13.32 µm ±0.94 S.E. In terms of relative length, the shortest chromosome measured 8.91µm ±0.33 S.E., while the longest chromosome measured 16.01 µm ±0.43 S.E. The idiogram demonstrates a progressive reduction in chromosomal length (Fig.6).



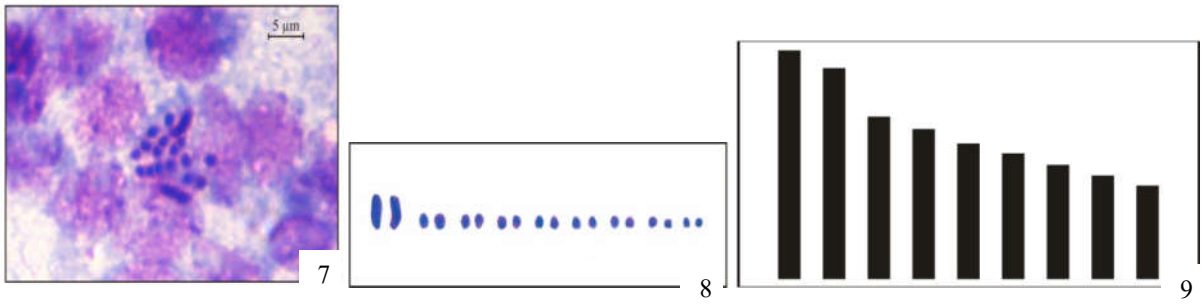
Figures 4-6:*Rhopalosiphummaidis* 4.Somatic chromosomes. 5. Karyotype. 6. Idiogram.

***Sitobionbrevirostre* (Heikenheimo, 1978)**

This species' light green aphids were found on leaves and grain heads of *Triticumaestivum*. The a late form has two sets of wings, which were transparent with black coloured veins and legs. The colour of the adult form was darker than the nymphs, which were lighter in colour.

This species' diploid chromosome count was determined to be eighteen (2n=18) (Fig.7, 8). The shortest chromosome's length ranged from 0.50

µm ±0.05 S.E. while the longest chromosome's was 1.31 µm ±0.11 S.E. The calculated total complement length was 12.58 µm ±1.10 S.E. In terms of relative length, the shortest chromosome measured 3.97µm ±0.15 S.E., while the longest chromosome measured 10.41 µm ±0.50 S.E. The idiogram shows that the first pair of chromosomes is longest and others decrease gradually (Fig.9).



Figures 7-9: ***Sitobionbrevirostre*** **7. Somatic chromosomes. 8. Karyotype. 9. Idiogram.**

DISCUSSION

In these species, the chromosome number ranged from 8 to 18. The genus *Metopolophium* comprises about 18 species, resembling closely to *Sitobion* and infesting Rosaceae and Gramineae. *Metopolophiumdirhodum*is also known as rose grain aphid as its primary host is rose and grasses, including Barley (*Hordeumvulgare*) is its secondary host. From India, 2 species out of a total 3 were found infesting Gramineae. Chromosomes of *Metopolophium alpinum* had been studied earlier by Kumari and Gautam, 2014, and *Metopolophiummalvae has* been reported by Sharma et al, 2024.

Rhopalosiphum has threeteen species found infesting prunes during winters and the plants of Graminaeae and Cyperaceae during the summer as secondary hosts. From India, it was reported by Raychaudhari et al. 1981 from the Silent valley, Kerala. Thediploid chromosome numbers (2n=8) in *Rhopalosiphummaidis* have been reported earlier by Brown and Blackman **(**1988), Dutta and Gautam (1993), Gautam and Dhatwalia (2003), Khagta and Gautam (2016), Sharma and Gautam (2019) worldwide. Karyotypic variation in *Rhopalosiphummaidis* with chromosome complement of 8 and 10 has been reported by Chattopadhay et al. (1982) and Brown and Blackman (1988). The genus *Sitobion* comprises about 75 species. Of these, 30 species were reported from Asia, and out of these, 6 were collected infesting the plants of Gramineae (Blackman and Eastop, 1984). Previous research has examined the chromosomes of many species within this genus (Robinson and Chen, 1969; Blackman, 1980; Chen & Zhang, 1985a, b; Hales et al. 1990; Dutta & Gautam, 1993 and Kumari & Gautam, 2014). In these diploid chromosome numbers varying from 11, 12, 16, 18 and 20 have been reported.

CONCULSION

The aphid species *Metopolophiumdirhodum, Sitobionbrevirostre and Rhopalosiphummaidis* were found infesting cereals, the staple food of most of the human population. The genus *Metopolophium* resembles closely *Sitobion* and both have a diploid chromosome number of 2n=12, so these can be distinguished on the basis of chromosome lengths.

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DECLARATION

The authors declare that there is no conflict of interest regarding the publication of this paper.

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