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Chromosomal Studies on Four Species of Aphodiinae Beetles (Scarabaeidae : Coleoptera)

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Abstract

Karyological investigations were carried out on adult male individuals of four species of Scarabaeidae beetles viz. Aphodius moestus F, A. pictusturum Her., A. pusillus pusillus Herbst and A. regi Peitt. A. moestus F, A. pusillus pusillus Herbst and A. regi Peitt. Possess 2n = 20 : 9 + Xyp sex chromosome mechanism while A. pictusturum Her. Exhibit 2n = 18 : 8 + Xyp Sex mechanism. Mitosis and meiosis have been described and discussed.

Keywords: Coleoptera, Scarabaeidae, Aphodiinae, Karyotype, Autosome, Sex Chromosome Mechanism.

Introduction

Species in the subfamily Aphodiinae are usually referred to as small dung beetles because most (though not all) feed on feces. These small beetles are usually brown, black or gray; the elytra are with or without markings. The Aphodiinae are more or less oblong convex species of small size with concealed labarum and mandibles. They are often found abundantly in dung (Madle, 1934; Schmidt, 1935). Aphodius is in great need of revision. Worldwide, the Aphodiinae contains 12 tribes, approximately 280 genera and 3,200 species, with approximately 210 species in the United States (Gordon, 1983). As presently understood, the New World fauna contains 9 tribes, 128 genera and 816 species. Thirteen fossil taxa have been described for the New World (Krell 2000, 2006). The classification proposed by Horn (1887) is still largely followed today. Some Aphodius are attracted to light while others are not. The adults of many species are surface dung feeders. Other species (detritivores) feed on organic material in the soil or on fungi (Ritcher, 1966). Present cytological investigation, the chromosome of four species belonging to one genera were under taken. Cytological details of four species have been rechecked.

Material and Methods

Adult male individuals of four species belonging to four genera Aphodius moestus F, A. pictusturum Her., A. pusillus pusillus Herbst and A. regi Peitt. constitute the material for present investigation. All the beetles were collected under the mercury vapour lamps during April to August 2006- 2007 from Ratlam, Indore and Dewas (Madhya Pradesh). Chromosome preparations were made following Yadav and Lyapunova (1983).

Results and Discussion

Aphodius Moestus Fabricius

The Spermatogonial metaphase revealed the diploid number of 20 chromosomes (fig.01). The karyotype is composed of nine pairs of autosomes, X and y sex chromosomes (fig. 02). Autosome pairs 1-5 and 9 were metacentric whereas remaining pairs 6-8 were submetacentric, the X and y chromosomes were acrocentric.

Metaphase I plate showed nine rod shaped autosomal bivalents and the sex pseudo bivalent Xyp (fig.09). The reductional first meiotic division result in the formation of metaphase II plate (Fig. 10).

The male chromosomal formula is 9AA+ Xyp.

Aphodius Pictustrum Har.

The diploid number of 20 chromosomes was revealed by spermatogonial metaphase (Fig. 03). The karyotype is composed of nine pairs of autosomes and X and y sex chromosomes (Fig. 04). Autosome pairs 1-4 and 8 were metacentric, pairs 5 and 6 were submetacentric and pair 7 was acrocentric. The X chromosomes was metacentric, y chromosomes was the smallest dot like chromosome.

Metaphase I possesses nine dumb-bells shaped autosomal bivalents and the sex bivalent Xyp. (Fig. 11). As a result of the first meiotic

division being reductional two types of Metaphase II plates were formed with X chromosome in addition to nine autosomes (Fig. 12).
The male chromosomal formula is 8AA+Xyp.

Aphodius pusillus pusillus Herbt.

The spermatogonial metaphase depicted the diploid number of 20 chromosomes (Fig. 05). The karyotype is composed of nine pairs of autosomes and X and y sex chromosomes (Fig. 06). Pairs 1, 2 and 9 along with X chromosome were metacentric pairs 3 and 8 were acrocentric, autosome pairs 4-7 were submetacentric whereas y is a dot like chromosome.

Metaphase I possessed nine autosomal bivalents usually rods or dumb-bells shape were formed. The sex bivalent resembles a parachute (Fig. 13).

As a result of the first meiotic division being reductional two types of Metaphase II plates were formed one with X and other with y chromosome in addition to nine autosomes. (Fig. 14)
The male chromosomal formula is 9AA+Xyp

Aphodius Regi Peitt.

The diploid number of 20 chromosomes was revealed by spermatogonial metaphase (Fig. 07). The karyotype is composed of nine pairs of autosomes and X and y chromosomes (Fig. 08). Autosome pairs 4, 5, 7 and 8 were metacentric, pairs 2 and 3 were submetacentric, pair 1 and 6 were acrocentric, The X and y chromosome was metacentric. When arranged according to size the autosomes show a gradual decrease. The chromatids appear closely applied to one another throughout their lengths. Metaphase I posses nine rod shaped autosomal bivalents and sex bivalents (Fig. 15)

As a result of the first meiotic division being reductional two types of metaphase II plates were formed (Fig. 16).
The male chromosomal formula is 9AA + Xyp

All the species under present investigations also possess the modal karyotype. Much variation was found in the form and size of chromosomes unlike other Aphodius beetles. Although 2n =20:9+Xyp polyphagan modal number is predominant in family Scarabaeidae (Yadav and Pillai, 1979) yet it depict certain numerical variations. A perusal of the literature on the karyology data of Aphodius species has some tendency to develop very long heterochromatic segments on some of their chromosomes. Aphodiinae is known on cytological grounds by known 39 species (Angus, 2009; Dange, 1991; Mate and Angus, 2005; Smith, 1953, 1960; Virkki, 1951, 1954, 1960; Wilson and Angus, 2004, 2005, 2006; Yadav, 1973; Yadav and Dange, 1988, 1989; Yadav et al., 1989) in which 35 species posses 2n=20 “model number”. Three species posses 2n=18 chromosome number (Angus, 2009; Kirade, 2011) and only one species A. moesiltusa F. exhibited 2n=22 chromosome number (Yadav, 1973; Yadav and Pillai, 1979). The exception is A. moestus F., for which Yadav (1973) record a diploid number of 22, with a meiotic formula of 10 bivalents plus Xyp. However later Yadav et al. (1993) record a diploid number of 20, nine bivalents plus Xyp for this species, and expressed surprise. Present investigation of above four species the total chromosome length was found to be maximum in Aphodius moestus F (77.04µ) and minimum in A. pusillus pusillus Herbst (49.81µ). All chromosomes show a gradual decrease in size. The size of X chromosome smallest in A. pusillus pusillus Herbst (2.16µ) and largest in A. pictusturum Her. (6.09µ). A. pictusturum Her. has the largest y (4.99µ) whereas y was smallest in A. pusillus pusillus Herbst (1.35µ).

Comparative studies of the karyotypes of Staphylinidae spp. are presented in table 1.

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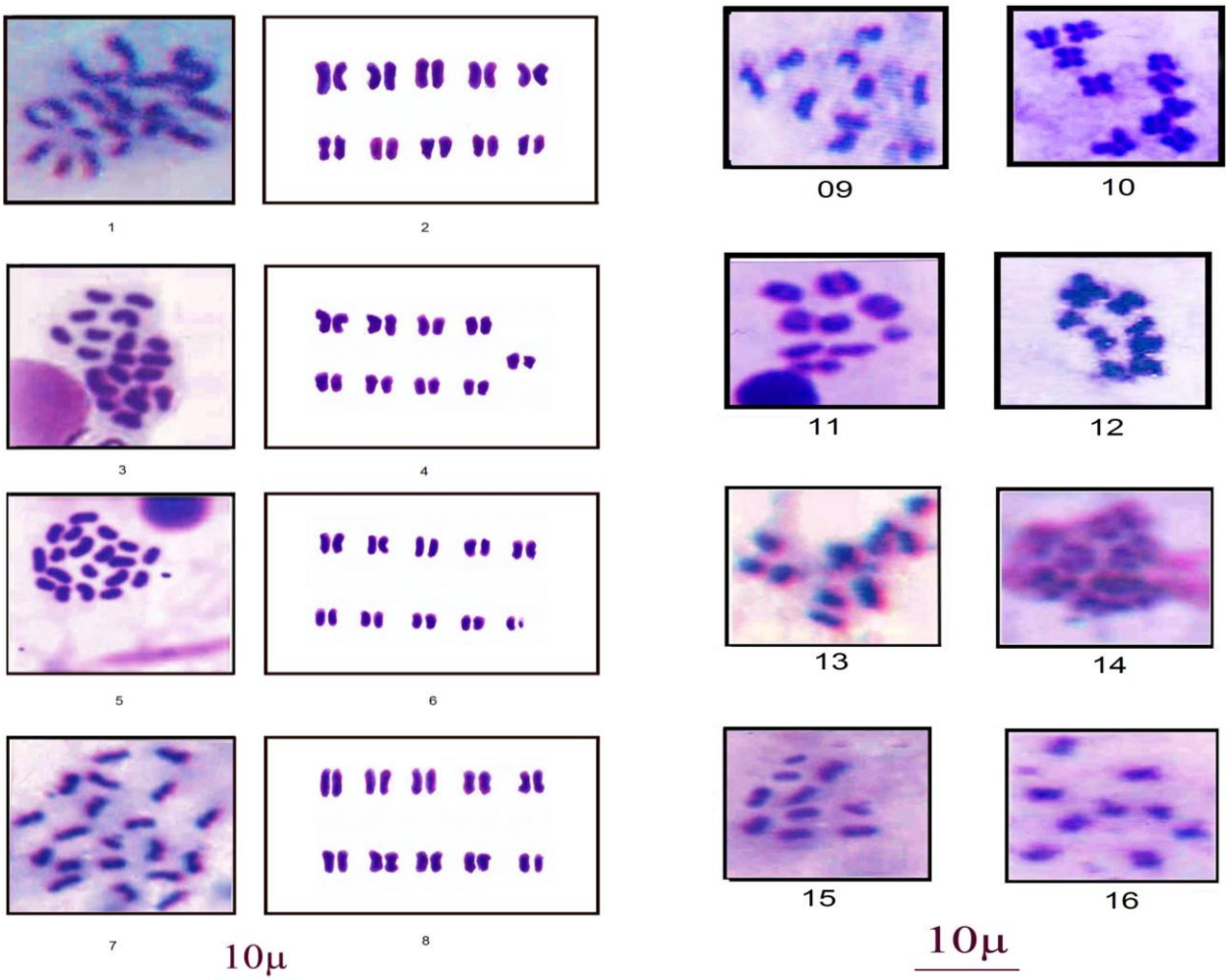
Fig.1 Spermatogonial metaphase of Aphodius moestus F
Fig.2 Karyotype of the same
Fig.3 Spermatogonial metaphase of A. pictusturum Her.
Fig.4 Karyotype of the same
Fig.5 Spermatogonial metaphase of A. pusillus pusillus Herbst
Fig.6 Karyotype of the same
Fig.7 Spermatogonial metaphase of A. regi Peitt.
Fig.8 Karyotype of the same
Fig.9 Aphodius moestus F (Metaphase I)
Fig.10 A. moestus F (Metaphase II)
Fig.11 A. pictusturum Her. (Metaphase I)
Fig.12 A. pictusturum Her. (Metaphase II)
Fig.13 A. pusillus pusillus Herbst (Metaphase I)
Fig.14 A. pusillus pusillus Herbst (Metaphase II)
Fig.15 A. regi Peitt .(Metaphase I)
Fig.16 A. regi Peitt. (Metaphase II)
For detail see text.

Table 1 : Karyotype analysis of four species of *Aphodius spp.*

Sr. No.	Species	Chromosome pairs in percentage length											Length in µ		
		1	2	3	4	5	6	7	8	9	X	Y	TCL	X	Y
1	*Aphodius moestus* F	21.74	21.27	19.12	18.19	15.52	15.52	15.16	13.80	13.75	6.77	5.96	77.04	3.39	2.98
2	*A. pictusturum* Her.	16.79	16.37	13.80	13.07	12.90	12.72	12.14	12.11	-	12.10	9.98	55.78	6.09	4.99
3	*A. pusillus pusillus* Herbst	12.96	12.88	12.59	10.68	10.58	10.38	9.98	9.80	9.77	4.31	2.70	49.81	2.16	1.35
4	*A. regi* Peitt	17.39	15.81	15.60	14.31	13.87	13.87	13.58	13.09	11.59	5.71	5.11	64.56	2.86	2.56

TCL = Total chromosome length.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