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Karyological Investigations on Seven Species of Coccinellid Fauna of USSR (Polyphaga: Coleoptera)

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Abstract

The levels of exploitation of intraspecific genetic polymorphism of colour and chromosomal investigations of Coccinellidae distinctly differ from each other. The present account is the first report on the karyotypes of the Coccinellid fauna of USSR. The karyological preparations were made according to a modified air-drying technique. The idea of NF^a in insect chromosomes has been introduced for the first time. The basic data are: *Adalia bipunctata* L. $2n = 20$ (9 + Xyp); *Coccinella septumpunctata* L. $2n = 20$, $NF^a = 36$ (9 + Xyp); *C. quinquepunctata* L. $n = 10$ (9 + Xyp); *Harmonia axyridis* Pallas $2n = 16$, $N.F^a = 28$ (7 + Xyp); *Propylaea quatuordecimpunctata* L. $2n = 20$, $N.F^a = 36$ (9 + Xyp); *Aiolocaria hexaspilota* Hope (= *Ithone mirabilis* Motsch.) $2n = 20$, $N.F^a = 36$ (9 + Xyp); *Chilocorus renipustulatus* Scriba $2n = 20$, $N.F^a = 36$ (9 + neoXY). Of these *C. quinquepunctata* and *P. quatuordecimpunctata* are new additions. Intergeneric chromosome homology was observed. Analysis of distribution of the diploid number of chromosomes in 166 karyologically known species indicates that the group exhibits considerable karyological monomorphism. However, chromosomally polymorphic tribes are distinguishable within these limits.

Introduction

Notable intraspecific polymorphism of colour, peculiar to many species of Coccinellidae, long attracted the attention of zoologists and population geneticists (Dobzhansky 1924, 1937; Dobzhansky and Sivertzev-Dobzhansky 1927, Lus 1928, Zimmermann 1934, Zarapkin 1937, Timoffeeff-Ressovsky 1940, Timoffeeff-Ressovsky and Svirezhev 1965, Timoffeeff-Ressovsky et al. 1965, 1975; Komai 1956). It is known that the discovery of wide chromosomal polymorphism among Diptera and Mammalia has been closely connected with the advances in cytological technique: for giant chromosomes in the former and for ordinary somatic chromosomes in the latter. The question of correlation between phenotypic colour polymorphism and chromosomal polymorphism in Coccinellidae may be solved one way or the other firstly, with advancement in technique for analysing the chromosomes and secondly, with the accumulation of sufficient comparative karyological data. Basic chromosomal data of 164 species is on record to-date from

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Europe and America (STEVENS 1906, SMITH 1960), China (LI 1940), Japan (TAKENOUCHI 1976, T & Y 1937, YOSIDA 1944, 1948, 1949, 1951, 1952) and India (SHARMA et al. 1959, AGARWAL 1961, MANNA and LAHIRI 1972, DUA and KACKER 1975, KACKER 1973, 1976; YADAV and PILLAI 1979). The Coccinellid fauna of USSR had not been investigated karyologically before. The present communication deals with the number of chromosomes and karyotypic details in seven species from this fauna. The preparations were made according to a modified air-drying technique which allows precise determination of the centromeric position and chromosome morphology – a definite advantage over the old methods of section-cutting or squashing through which the previously recorded data were obtained.

Materials and Techniques

Adult male beetes belonging to *Adalia bipunctata* L., *Coccinella septumpunctata* L., *Propylaea quatuordecimpunctata* L., *Chilocorus reinipustulatus* Scriba (collected from Moscow), *Coccinella quinquepunctata* L. (collected from Ozhygovo 50 km SW Moscow), *Chilocorus renipustulatus* (collected from Kishinev, Moldavian SSR), *Harmonia axyridis* Pallas and *Aiolocaria hexaspilota Hope* (= *Ithone mirabilis* Motsch.) (collected from Marine Biological Station, Vostok near Nachodka, Primorsky District, Far East) constituted the materials for the present investigations. Karyological preparations were made according to YADAV and LYAPUNOVA (in press). Species were determined by the authors. Systematic arrangements of DYADECHKO (1954) and ZASLAVSKY (1965) have been followed.

Results

Coccinellini

Adalia bipunctata L. $2n = 20$

The present observations on the materials from Moscow support the earlier observations (STEVENS 1906, SMITH 1953, JOHN and LEWIS 1960). The sex chromosomes associated to form Xyp during the first meiotic division.

Coccinella septumpunctata L. $2n = 20$, $NF^a = 36$

This species was earlier investigated by Indian (SHARMA et al. 1959, AGARWAL 1961, MANNA and LAHIRI 1972) and British (JOHN and LEWIS 1960) cytogeneticists. AGARWAL (1961) described the morphology of the karyotype whereas all others dealt only with the chromosome number and sex-chromosome mechanisms. The present investigations on the material from Moscow confirm the numerical data. Substantial differences were noticed in the karyotypic details. Whereas AGARWAL (1961) reported 5 acrocentrics, two pairs of autosomes and the X-chromosome, all the autosomes, and the X-chromosome are biarmed in the present material. Morphology of the chromosomes is very clear. The karyotype is composed of one pair of metacentric (pair 6), seven pairs of submetacentric (pairs 1, 2, 4, 5, 7, 8, 9) and one pair of subtelocentric (pair 3) autosomes, X is submetacentric, next in size to the second pair of autosomes while y is spherical in shape and is the smallest element of the complement (Fig. 1 A). At metaphase I nine autosomal bivalents, mostly dumb-bells, and the sex parachute Xyp are observed (Fig. 2 A). The number and morphology of metaphase II chromosomes support the observations at spermatogonial metaphase.

Fig. 1. Spermatogonial metaphases and karyograms of 5 species of Coccinellidae.
A. *Coccinella septumpunctata*
B. *Harmonia axyridis*
C. *Propylaea quatuordecimpunctata*
D. *Aiolocaria hexaspilota* (= *Ithone mirabilis*)
E. *Chilocorus renipustulatus*

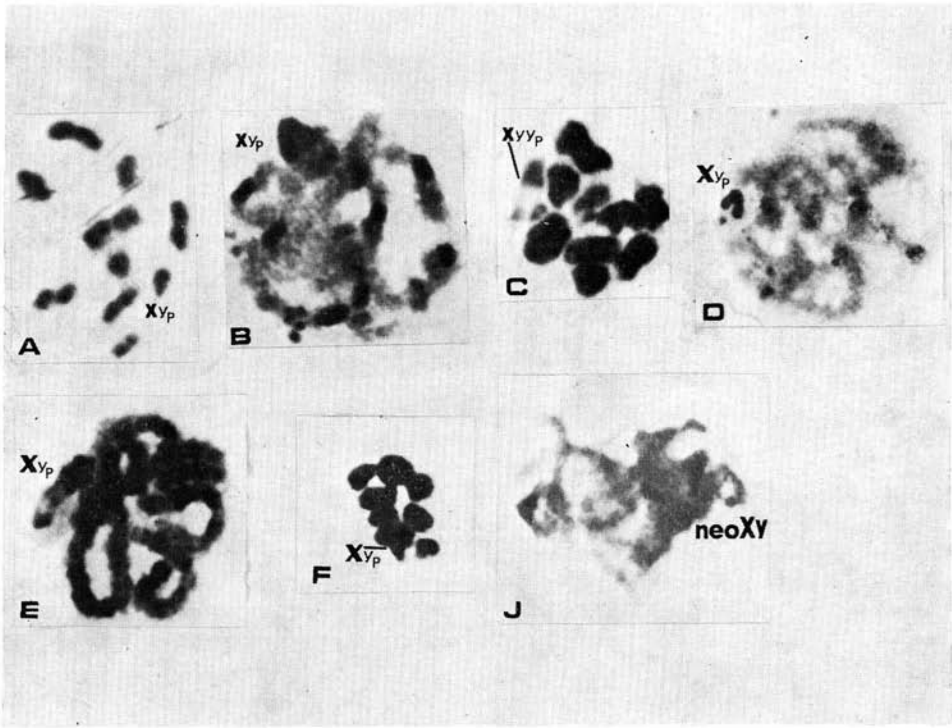

Fig. 2. Meiotic stages of Coccinellids.
A. Metaphase I of *Coccinella septumpunctata*
B. Pachytene of *C. quinquepunctata*
C. Metaphase I of *C. quinquepunctata* (Xyyp)
D. Pachytene of *Harmonia axyridis* (Xyp)
E. Pachytene of *Harmonia axyridis* (sowing terminal association of X and y in Xyp)
F. Metaphase I of *Harmonia axyridis*
J. Diplotene of *Chilocorus renipustulatus* (neo Xy)

Coccinella quinquepunctata L. $n = 10$

Only first meiotic stages were available in this hitherto uninvestigated species for study. The number of bivalents can be known from the centeromeric heterochromatic blocks in Pachytene (Figs. 2 B, C). At metaphase I nine autosomal bivalents and the Xyp are observed. Sometimes the sex parachute depicts Xyyp (Fig. 2 C). On account of condensation it is difficult to calculate the exact chiasma frequency. However, it is certainly more than the congeneric *septumpunctata*.

Harmonia axyridis Pallas $2n = 16$, $NF^a = 28$

The number of chromosomes and sex-chromosome mechanism were reported by Li (1940) and Yosida (1944) from China and Japan. Takenouchi (1976) recorded these same data in *H. axyridis spectabilis* from Japan. The present observations confirm the reports of Li (1940) and Takenouchi (1976) and add the account of morphology of the karyotype. The autosomes are metacentric (pairs 1, 6), submetacentric (pairs 2–5) and acrocentric (pair 7); X chromosome is a submetacentric of the size of pairs 5–6 whereas y is a small acrocentric (Fig. 1 B). The sex parachute Xyp is distinguishable during pachytene (Fig. 2 D). However, at times the euchromatic and heterochromatic nature of X and y chromosomes respectively and their terminal association is clearly seen (Fig. 2 E). There are eight autosomal bivalents which show heterochromatic blocks in near centromeric regions. The short arms of autosome pairs 3–5 are characterized by strong contraction. The number of elements at first and second metaphases confirm the observations at spermatogonial metaphase (Fig. 2 F).

Propylaea quatuordecimpunctata L. $2n = 20$, $NF^a = 36$

Karyotype of this hitherto unknown species is comprised of nine pairs of metacentric autosomes which differ only slightly in size and the position of the centromere, an equally large submetacentric X and a small spherical y chromosome (Fig. 1 C). The male chromosomal formula 9 + Xyp is depicted at metaphase I.

Synochini

Aiolocaria hexaspilota Hope (= *Ithone mirabilis* Motsch.) $2n = 20$, $NF^a = 36$

$2n = 17$ (8 + X) was reported by T & Y (1937) under the name *Aiolocaria mirabilis*. YOSIDA (1949, 1951), however, counted 20 chromosomes in the diploid complement of females. The present investigations confirm this number in males. All the autosomes and the X chromosome are biarmed: pairs 1, 2, 9 are metacentric, pairs 4–8 are submetacentric, pair 3 is either subtelocentric or metacentric with satellites on the short arm, X is a large metacentric, y is very small and spherical (Fig. 1 D). Nine autosomal bivalents and Xyp are observed during diakinesis and at metaphase I.

Chilocorini

Chilocorus renipustulatus Scriba $2n = 20$, $NF^a = 36$

SMITH (1965) recorded $2n = 20$ (9 + neoXY) from material from Finland. The same number and sex-chromosome mechanism is possessed by the beetles collected from Kishinev, 2,000 km S. of Finland (Fig. 1 E). Biarmed autosomes and X chromosome characterize the karyotype: pairs 1, 4, 5 are submetacentric, pair 2 ist metacentric and pair 3 is subtelocentric showing gradual decrease in size. Autosome pairs 6–9 are distinctly smaller in size and submetacentric in nature, X is a submetacentric of the size of 3–4 pairs of autosomes whereas y is acrocentric. The neoXY association of sex chromosomes was evident in diplotene (2J).

Discussion

The diploid number of chromosomes fluctuates from 10–26 in the 166 cytologically known species (Fig. 3). The family conforms to the polyphagous modal karyotype $2n = 20$ (9 + Xyp). However, clear distinctions are seen at the level of tribes. In Hyperaspini only one species has $2n = 20$, a few show $2n = 16$ whereas $2n = 14$ is the common number. Among Coccinellini $2n = 20$ is the prevailing number although two species possess a very low $2n = 10$. Epilachnini has two peaks at $2n = 18$ and 20, only one species possessing $2n = 14$. Comparatively wide variation is observed in Chilocorini in which 2 n varies from 14–26. The remaining tribes are scantily investigated and are thus insufficient for discussion.

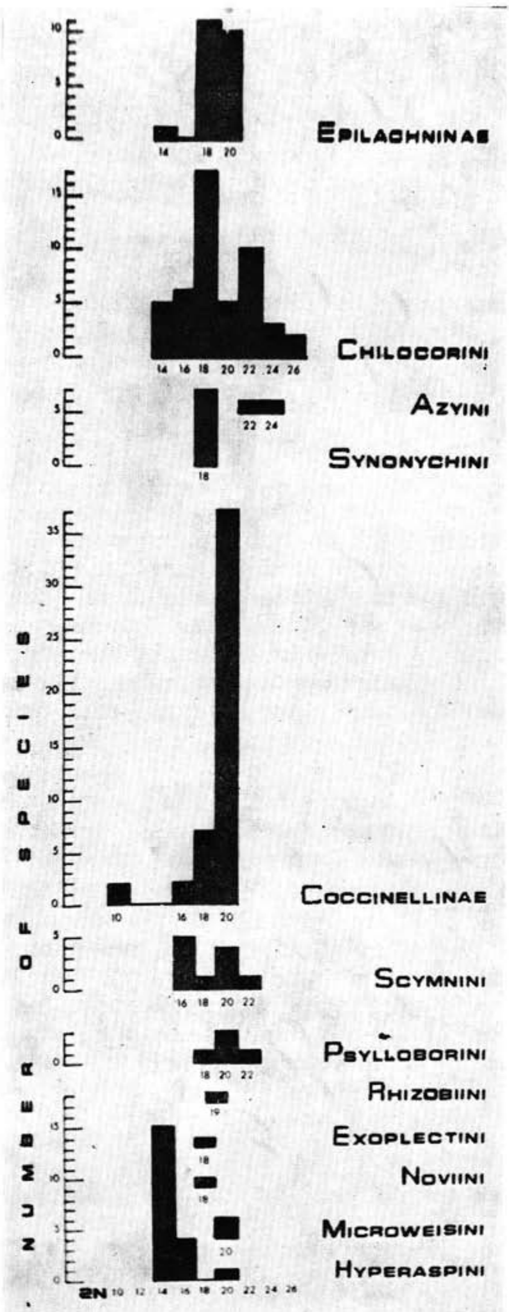

Fig. 3. Histogram showing distribution of diploid number of chromosomes in different subfamilies, tribes of Coccinellidae

Since all species under present investigations revealed the prevalence of biarmed chromosomes the changes in the number of chromosomes cannot be explained due to simple Robertsonian changes, though X–A fusions are prevalent in *Chilocorus* (SMITH and VIRKKI 1978). From a comparison of karyotypes of *Coccinella septumpuncta* from USSR (present report) and India (AGARWAL 1961) it appears probable that pericentric inversions might have been involved in the evolution of karyotype. Analysis of karyotypes suggests homology between first four pairs of autosomes in *Coccinella septumpunctata* and *Harmonia axyridis.* It seems that third pair of autosomes retains homology not only in these two species but also in *Aiolocaria hexaspilota* and *Chilocorus renipustulatus. Propylaea quatuordecimpunctata* differs substantially in the morphology of autosomes from all other 20 chromosome species. The X chromosome seems to have retained its homology in all the species, except *Chilocorus renipustulatus,* under present investigations. *C. renipustulatus* also differs from other species in the possession of a neoXy sex-chromosome mechanism.

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