

18. *Chromosome Numbers and Sex Chromosomes Newly Recorded in Seventy-Six Species of Coccinellid Beetles*

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(Comm. by Sajiro MAKINO, M. J. A., Feb. 12, 1976)

I had an opportunity to investigate the chromosomes of coccinellid beetles (Coccinellidae: Coleoptera) in the Forest Insect Laboratory, Sault Ste. Marie, Ontario, Canada, during a period from 1960 to 1961, while I was staying there as a Post Doctorate Fellow of the National Research Council, Canada, in collaboration with the late associate, Dr. S. G. Smith. These coccinellid beetles were collected extensively through the World by Dr. Smith. The squashed slides of their germ cells were kept in his laboratory. Seventy-six species supplied the material for the study of the chromosome numbers, the morphology and behavior of the sex-chromosomes in meiotic phases. When I left the Forest Insect Laboratory in Mid-June of 1962, Dr. Smith offered me the chromosome data to publish them elsewhere with drawings made by me. But there were considerable troubles to handle them by myself, and therefore, I placed all the data into the hands of Dr. Smith in order to be published in joint work with him. Unfortunately, Dr. Smith passed away last May. The situation led to publish them by my own name, though I do not have drawings and photomicrographs for printing. Thus, the present paper records the chromosome numbers and symbols of sex-determining mechanisms in the 76 species in the form of a list.

Referring to the literature (Agarwal 1960; Smith 1953, 1960), a total of 110 species of coccinellid beetles have so far been chromosomally studied. Most of them were studied with the classical testis-sectioning method, and therefore details of their chromosome morphology have remained rather insufficient for cytotaxonomic and cytogenetic considerations.

In the list, the sex-chromosome types are shown by symbols: Xy_p , NeoXY, XY, and Xy. The most widespread and characteristic type of sex-chromosomes in Coleoptera is represented by Xy_p , which indicates the association of a relatively large metacentric X with an extremely smaller metacentric Y. At the first metaphase it is remarkable by a unique parachute-like configuration. NeoXY is a compound or multiple type of the sex-chromosome complex in which the NeoX is made up

Table I. Chromosome numbers and sex chromosomes in 76 species of Coccinellidae

Species	Sex	Chromosome No.	
		2n	n
<i>Adalia bipunctata</i> L. (Wash.)	♂	20s	9AA + Xy _p
" " (Kipewa)	♂		9AA + Xy _p
<i>A. frigida melanopleura</i> Lec. (Oregon)	♂	20s	
<i>Anatis quindecimpunctata</i> Oliv.	♂	18s	8AA + NeoXY
<i>A. rathvoni</i> Lec. (Calif.)	♂		8AA + NeoXY
<i>A. mali auct</i> (Batcha Don W)	♂	18s	8AA + NeoXY
<i>Anisocalvia duodecium-maculata</i> Gebl	♂	20s	9AA + Xy _p
<i>A. quatuordecimguttata</i> L.	♂	20s	9AA + Xy _p
<i>Axion plagiatum</i> Ol. (Calif.)	♂	18s	8AA + NeoXY
<i>Azya luteipes</i> Muls. (Trinidad)	♂	24s	11AA + NeoXY
<i>A. trinitatis</i> Marsh. (Trinidad)	♂	22s	10AA + NeoXY
<i>Brachyacantha ursina</i> F. (Ottawa)	♂		7AA + NeoXY
" " (B. C's)	♂		7AA + NeoXY
<i>B. felina</i> F.	♂	16s	7AA + NeoXY
<i>Brumus suturalis</i> F. (Pakistan)	♂		8AA + NeoXY
<i>Chilocorus angolensis</i> Cr. (Kenya)	♂		8AA + NeoXY
<i>C. bipustulatus</i> L. (Calif.)	♂		10AA + NeoXY
" (France)	♂		10AA + NeoXY
" (Algiers)	♂		10AA + NeoXY
" (Israel)	♂		10AA + NeoXY
<i>C. circumdatus</i> (India)	♂		10AA + NeoXY
<i>C. discoideus</i> Cr. (Kenya)	♂		11AA + NeoXY
<i>C. hauseii</i> Wse (India)	♂		10AA + NeoXY
" (Israel)	♂		10AA + NeoXY
<i>C. kuwanae</i> Silv. (Japan)	♂		9AA + NeoXY
" (Calif.)	♂		9AA + NeoXY
<i>C. rubidus</i> Hope (Japan)	♂		8AA + NeoXY + ss
<i>C. n. sp.</i> (Kenya)	♂	18s	8AA + NeoXY
<i>Chnoodes</i> sp. (Trinidad)	♂		8AA + Xy _p
<i>Coccinella trifasciata</i> L.	♂		9AA + Xy _p
" " <i>juliana</i> Muls. (Calif.)	♂		9AA + Xy _p
" " <i>perplexa</i> Muls.	♂		9AA + Xy _p
<i>C. novemnotata</i> Hbst.	♂		9AA + Xy _p
<i>C. transversoguttata quinquenotata</i> Kby.	♂		9AA + Xy _p
<i>C. californica</i> Mann. (Calif.)	♂	20s	9AA + Xy _p
<i>C. septempunctata bruckii</i> Muls. (Japan)	♂		9AA + Xy _p
<i>Coleomegilla maculata legi</i> Timb.	♂		9AA + Xy _p
<i>Cryptognatha nodiceps</i> Marsh. (Trinidad)	♂		6AA + NeoXY
<i>C. simillima</i> Sicard (Trinidad)	♂		6AA + NeoXY
<i>Cryptolaemus montrouzieri</i> Muls. (France)	♂		10AA + Xy _p
" " (Calif.)	♂		10AA + Xy _p
<i>Curinus coeruleus</i> Muls. (Mexico)	♂		7AA + Xy _p
" " (Trinidad)	♂		7AA + Xy _p
<i>Cycloneda poliata</i> Csy. (Calif.)	♂		9AA + Xy _p
? <i>sanguinea</i> L. (Dominica)	♂		9AA + Xy _p
<i>Epilachna</i> sp. (Costa Rica)	♂		9AA + Xy _p
<i>E. v. nipponica</i> Lewis (Japan)	♂	20s	9AA + Xy _p
<i>Erochomus bisbinotatus</i> Gorb. (Trinidad)	♂	14s	6AA + NeoXY

Table I (Continued)

Species	Sex	Chromosome No.	
		$2n$	n
<i>E. flavipes</i> Thunb. (Kenya)	♂		8AA + NeoXY
<i>E. floralis</i> Mots. (Morocco)	♂	14s	6AA + NeoXY
<i>E. jamaicensis</i> Sicard (Jamaica)	♂	18s?	8AA + NeoXY?
<i>E. marginipennis childreni</i> Muls. (Fla.)	♂		8AA + NeoXY
" <i>fasciatus</i> Csy. (Calif.)	♂	20s	
" <i>californicus</i> Csy. (Calif.)	♂	16s	7AA + NeoXY
<i>E. metallicus</i> Korsch. (Calif.)	♂		8AA + NeoXY
<i>E. orbiculus</i> Weise (Brazil)	♂		8AA + NeoXY or 7AA + NeoXY (most likely)
<i>E. quadripustulatus</i> L. (Calif., Palpae)	♂	14s	6AA + NeoXY
" (Calif.)	♂	(14+s)s	6AA + NeoXY + s
<i>E. septentrionis</i> Weise (L. Waskesiu)	♂		8AA + NeoXY
" (Kenora)	♀	18o	
<i>Harmonia axyridis spectabilis</i> Fald. (Japan)	♂	16s	7AA + Xy _p
<i>Hippodamia sinuata</i> Muls. (Calif.)	♂	20s	9AA + Xy _p
<i>H. convergens</i> Guér. (Calif.)	♂		9AA + Xy _p
" (Mexico)	♂		9AA + Xy _p
<i>H. quinquestignata ambigua</i> Lec. (Calif.)	♂		9AA + Xy _p
" <i>punctata</i> Lec. (Calif.)	♂		9AA + Xy _p
<i>H. tredecimpunctata tibialis</i> Say	♂	20s	9AA + Xy _p
<i>Microweisea marginata</i> (Conquest, Sask.)	♂		9AA + NeoXY
<i>Mulsantina picta picta</i> (sp. 1)	♂		9AA + Xy _p
" <i>p. m.</i> (sp. 2)	♂	20s	9AA + Xy _p
<i>Mulsantina</i> sp. 3	♂	18s	8AA + XY
<i>Mulsantina hudsonica</i> (sp. 4)	♂	12s	5AA + Xy
<i>Mulsantina hudsonica</i> (sp. 4b)	♂	(12+ss)s	5AA + Xy + s
<i>Neomysia caseyi</i> Timb. (Calif.)	♂	20s	9AA + Xy _p
" <i>p. pullata</i> Say (Ind.)	♂	20s	9AA + Xy _p
" <i>p. randalli</i> Csy.	♂		9AA + Xy _p
<i>Neomysia</i> sp. (New York)	♂	20s	9AA + Xy _p
<i>Olla abdominalis</i> Say (Calif.)	♂	20s	9AA + Xy _p
<i>Orcus chalybeus</i> Boisd. (Calif.)	♂	18s	8AA + NeoXY
" " (Australia)	♂	18s	8AA + NeoXY
<i>Pharoscymnus</i> sp. (India)	♂		10AA + Xy _p
<i>Psyllobora taedata</i> Lec. (Calif.)	♂	18s	8AA + NeoXY
<i>Rhizobius ventralis</i> Er. (Calif.)	♂	18s	8AA + Xy _p
<i>Scymnus binaevatus</i> Muls. (Calif.)	♂		7AA + NeoXY
<i>S. marginicollis</i> Mann. (Calif.)	♂		7AA + NeoXY
<i>S. nubilis</i> Muls. (India)	♂		7AA + NeoXY
<i>Scymnus</i> sp. 1 (Calif.)	♂	16s	7AA + NeoXY
<i>Scymnus</i> sp. 2 (Calif.)	♂		8AA + Xy _p
Genus nr. <i>Scymnus</i> (Trinidad)	♂	20s	9AA + Xy _p

s: spermatogonium, o: oogonium, s: supernumerary chromosome

of an acrocentric X and an autosome through the mechanism of a centric fusion. Therefore, the NeoX exhibits a V-shape in general appearance, the longer arm of which corresponds, in size and shape, to the rod-shaped NeoY which is originally an autosome. In meiosis, the latter always connects end-to-end to the longer arm of the former. The XY refers to a complex in which the size difference between the X and Y is not remarkable. In contrast, the symbol, Xy, deals with a complex showing the association of a larger X with an extremely smaller Y.

I am grateful to the late Teacher Professor, Dr. S. G. Smith for providing the necessary laboratory facilities and the material. I am also thankful to Professor Emeritus, Dr. S. Makino, Hokkaido University, for improvement of the manuscript.

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