A Cytotaxonomic Study of the Chrysopidae (Neuroptera)

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(With 12 Text-figures)

Since many evolutionary transformations have had their origin in the chromosomes, the differences in the chromosome number and shape which distinguish one species from its relatives may throw new light on the problems of taxonomy. In recent years, cytotaxonomy has made notable advances, and it is becoming more and more useful in an analysis of the morphological interrelations of related species.

In the present paper the author wishes to deal with the distinguishing cytological characters, including the chromosome number occurring in the Chrysopidae. He hopes thus to contribute to knowledge of taxonomical and phylogenetical relationships among the members of this family of the Neuroptera, because there are some controversies in the classification of this insect family.

Before going further, the author wishes to acknowledge here his very great indebtedness to his professor, Dr. Sajiro Makino, who suggested the problem of this study and directed it with continuous kind encouragement. The author's cordial thanks are due to Dr. Y. Yanagimoto through whose friendly assistance some important materials were obtained, for his critical advice.

Observations

The Chrysopidae is a family of the Neuroptera in which the cytological studies have rather actively extended to many species. Naville et de Beaumont (1932, 1933, 1936), Klingstedt (1933), Brückner (1935), and some others have reported on the chromosomes of thirteen European species. The present author has dealt with the chromosomes of tweleve Japanese species. They are listed in Table 1, with Figures 1-12. In the following, the author wishes to exclude from the discussion Brückner's information (1935) on the chromosomes of *Chrysopa vulgaris*, since the reported evidence seems to be somewhat dubious from present-day standards.

In the Chrysopidae so far cytologically sampled, four different karyotypes are presented: they are, 1) $2n=12r$, 2) $2n=10=2V's+8r's$, 3) $2n=12=2V's+10r's$, and 4) $2n=14r's$.[1] Among them, the first type is predominant in occur-

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1) r denotes the rod-shaped chromosomes, and V indicates the V-shaped ones.

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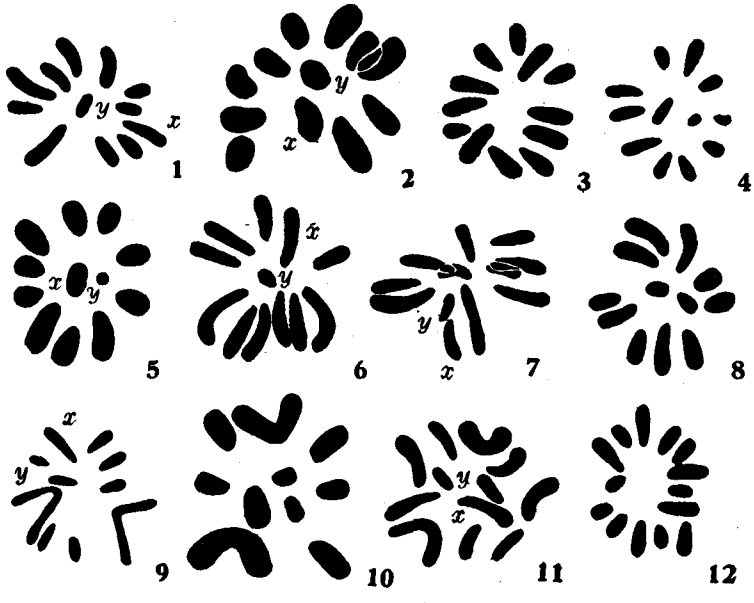
rence through this family The karyotype of the second type can be introduced from that of the first type by subjecting to Robertson's law (1916) which involves the formation of multiples through the fusion of two rods, so-called centric fusion. Four species possessing this type are known; They are *Chrysopa septempunctata* (Naville et de Beaumont 1932, 1933), *Ch. sept. cognata* (Kichijo 1935), *Ch. rysopa* sp. (Naville et de Beaumont 1933), *Ch. rysopa* sp. (*Ch. ciliata* ?) (Hirai 1956). Formerly, *Chrysopa septempunctata* was treated as *Cintameva septempunctata*, but it has been placed in the genus *Chrysopa* by recent taxonomists. The third type is known to occur in *Chrysopa alba* (Naville et de Beaumont 1933) and *Ch. japonica* (Kichijo 1934). These two were formerly described as species of *Chrysotropia*, but recently Killington (1935) and Kuwayama (1945) have included them in the genus *Chrysopa*. The karyotype of the fourth type was found to occur in



Figs. 1-12. Diploid chromosomes of the Chrysopidae. 1-8. Type I. $2n=12r$. (Type-*Chrysopa*). 1, *Chrysopa japana, spg.* 2, *Ch. intima, spg.* 3, *Ch. matsumurae, oog.* 4, *Ch. yamamurae, oog.* 5, *Ch. cognatella, spg.* 6, *Ch. kurisakiana, spg.* 7, *Ch saspporensis, spg.* 8, *Chrysopa* sp. ♀ *som.* 9-10. Type II. $2n=10=2V+8r$, (Type-*Cintameva*). 9, *Cintameva* (*Chrysopa*) *septempunctata, spg.* 10, *Cintameva* sp. (*Cintameva* (*chrysopa*) ciliata ?), oog. 11. Type III. $2n=12=2V+10r$. (Type-*Chrysotropia*), *Chrysotropia* (*Chrysopa*) *japonica, spg.* 12. Type IV. $2n=14=14r$. (Type-*Nineta*), *Nineta* (*Chrysopa*) *vitatta, oog.*

spg.=spermatogonium, *oog.*=oogonium, ♀ *som.*=egg follicle cell, x=X-chromosome, y=Y-chromosome.

Chrysopa (*Nineta*) *flava* (Naville et de Beaumont 1936) and *Ch.* (*Nineta*) *vittata* (this author). Recently, Kuwayama (1954) synonymized *Nineta* with *Chrysopa*. It is noticeable that the fourth type is represented by a quite unique karyotype, $2n$, $14=14r$'s.

Discussion

The taxonomists agree in the view that the Chrysopidae is to be considered a close ally to the families, Hemerobidae and Osmylidae. So far as the cytological characters are concerned, however, there is no evidence favoring or supporting the above view.

In the Chrysopidae, there occur certain cytological characters in relation to

Table 1

Species	$2n$	n	Authors
Type I (*Chrysopa*-type)			
Chrysopa aspersa (*Ch. prasina*)	12 *s*, *o*	6♂ (I)	Naville et de Beaumont '33, '36
Ch. carnea		7(I)	Klingstedt '33
Ch. cognatella	12 *s*, *m*	6(I, II)	Kichijo '43
Ch. flavifrons	12 *o*		Nhville et de Beaumont '36
Ch. formosa	12 *s*	6(I)	〃 '36
Ch. intima	12 *s*	6(I) 6(II)	Kichijo '34, Hirai '55
Ch. japana	12 *s*, *m*	6(I)	〃 〃
Ch. kurisakiana	12 *s*, *o*	6(I)	〃 〃
Ch. matsumurae	12 *o*		Hirai '56
Ch. parabola		6(I, II)	Kichijo '34
Ch. perla	12 *s*, *o*	6(I, II)	Naville et de Beaumont '32, '33
Ch. sapporensis	12 *s*	6(I)	Kichijo '34
Ch. venosa		6(I)	Naville et de Beaumont '36
Ch. ventralis	12 *o*		〃 '36
Ch. vividana		6(I)	〃 '36
Ch. vulgaris	12 *s*, *o*, *m*	6(I)	〃 '33
Ch. yamamurae	12 *o*		Hirai '56
Type II (*Cintameva*-type)			
Ch. septempunctata	10 *s*	5(II)	Naville et de Beaumont '32, '33
Ch. sept. cognata	10 *s*, *o*	5(I, II)	Kichijo '35
Ch. sp.	10 *s*	5(I)	Naville et de Beaumont '33
Ch. sp. (*Ch. ciliata*?)	10 *o*, *m*		Hirai '56
Type III (*Nineta*-type)			
Ch. (*Nineta*) *flava*	14 *s*	7(I)	Naville et de Beaumont '36
Ch. (*Nineta*) *vittata*	14 *m*		Hirai '56
Type IV (*Chrysotropia*-type)			
Ch. (*Chrysotropia*) *alba*	12 *s*, *o*	6(I)	Naville et de Beaumont '33, '36
Ch. (*Chrysotropia*) *japonica*	12 *s*	6(I)	Kichijo '34

s, spermatogonium. *o*, oogonium. I, first spermatocyte. II, second spermatocyte.

taxonomy. The chromosomes of most species of this family are characterized by $2n=12$, all of which are rod-shaped. This type seems to constitute the basic chromosome number of this family, since it is distributed predominantly through many species. Further, there are three additional types different in character; they are $2n=10$ (2V's+8*r*'s), $2n=12$ (2V's+10*r*'s), and $2n=14$ (14*r*'s). The second type (2V's+8*r*'s) is known to occur in *Chrysopa septempunctata* (Naville et de Beaumont 1932, 1933), and *Chrysopa* sp. (Naville et de Beaumont 1933). Further more, *Ch, septempunctata forma cognata* and *Chrysopa* sp. (*Ch. ciliata* ?) are chracterized by this type. It is probable from their karyological similarity that the above two unidentified species of *Chrysopa* here concerned will be found to be close allies to *Ch. septempunctata* The latter was formerly treated as *Cintameva* which was an independent genus different from *Chrysopa*, but lately synonymized into *Chrysopa* by recent entomologists The particular chromosome formula occurring in these forms suggests that they are taxonomically distinguishable from the first group. The third type (2V's+10*r*'s) is represented by *Chrysopa* (*Chrysotropia*) *alba* (Naville et de Beaumont 1933, 1936) and *Chrysopa* (*Chrysotropia*) *japonica*. These have segmentatum anales longer than those of *Chrysopa*; they were formerly treated as *Chrysotropia*, but recently Killington (1935) synonymized them into *Chrysopa* with the agreement of Kuwayama (1954). In the light of information on cytological characters now available, however, the establishment of the genus *Chrysotropia* is most possible. The fourth type (14*r*'s) is represented by *Chrysopa* (*Nineta*) *flava* (Naville et de Beaumont 1936) and *Chrysopa vitatta*. Both species were formerly placed in the genus *Nineta*, due to the structural peculiarity of the external sexual organs. Recently, *Nineta* was synonymized into *Chrysopa* by Killington (1935) and Kuwayama (1954). Based on the karyological character specific to these two forms, it seems better to distinguish the genus *Nineta* from *Chrysopa*.

In fact, it is interesting to see that the cytological characters bear a considerable significance in relation to taxonomy in the Chrysopidae. From the cytological point of view, it is quite natural to establish such particular genera, as *Cintameva, Chrysotropia* and *Nineta*, without syonymizing them into *Chrysopa*.

Some taxonomists divide the genus *Chrysopa* into *alba*-group, *punctata*-group and X-group, according to the presence and number of dot marks on the head. Cytologically, however, there is detectable no appreciable difference to distinguish the above three groups.

Summary

The present paper describes the chromosomes of twenty five species of the Chrysopidae. Though there is a considerable variation in the chromosome number in the species thus far studied, the chromosome number proves a useful tool in elucidating systematic relationships among the genera. So far as the karyological characters are concerned, it seems most reasonable that the following genera,

Cintameva, Chrysotropia, and *Nineta* should be distinguished from *Chrysopa,* though recent entomologists synonymize the former genera into the latter.

It is the author's great honor to dedicate this piece of work to Professor Tohru Uchida in celebration of his 60th birthday.

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