A USE OF CHROMOSOME NUMBERS IN THE STUDY OF TAXONOMY OF THE LEPIDOPTERA AND NOTES ON THE INTERNAL REPRODUCTIVE ANATOMY

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The following report deals with the chromosome numbers observed in the germ cells of 16 species of Papilionidæ which are found in Japan. Further data are presented concerning the testicular form and color, and the stages of the life cycle at which meiotic divisions have been seen to have taken place. These data are correlated with the known morphological relationships of these species, and this relationship is more clearly defined.

Testicular form is classified into three major types: separate, gourd-shaped, and conjugated. In the larvæ of all species the testes are clearly separated, each testis being made up of four follicles. In certain groups this condition changes during development to a point where they become slightly adherent, having the appearance of a gourd or dumb-bell, or becoming completely conjugated and spherical. In these types the single testis has eight follicles. Table I presents the data concerning the distribution of these types during the various stages of development for the groups under discussion. These suggest a phylogenetic sequence wherein the separate condition appears most primitive, and the conjugated condition that of the derived forms. The latter form is found in most of the butterflies.

Table 1. Testis form during development in the Japanese Papilionidæ.

GENUS	LARVA	PRE-PUPA	PUPA	IMAGO
Parnassius	separate	separate	separate	separate
Luedorfia				
japonica	separate	separate	separate	separate or slightly adherent
puziloi	separate	conjugated	conjugated	conjugated
Graphium	separate	separate	gourd	gourd
Byasa	separate	conjugated	conjugated	conjugated
Papilio	separate	conjugated	conjugated	conjugated

In addition to the different shapes of testes that were found, coloration of their epithelial sheath was found to vary. Three distinct classes were found: yellow, pale blue, and red. The primitive genera (*Parnassius, Luehdorfia, Graphium*) have yellow or pale blue testes, while the derived ones (*Byasa, Papilio*) have them red-colored. These data, with the following on meiosis, are presented in Table 2.

Table 2. Chromosome Number and Imaginal Testicular Form and Color for Sixteen Species of Japanese Papilionidæ.

SPECIES	CHROMOSOME NUMBER	TESTES FORM	TESTES COLOR
Parnassius eversmanni	62 (I)	separate	yellow
P. glacialis		separate	yellow
P. stubbendorfii		separate	yellow
Luedorfia japonica	31 (I, II)	separate or adherent	pale blue
L. puziloi	30 (I, II)	conjugated	pale blue
Graphium doson	30 (I, II)	gourd	yellow
G. sarpedon	20 (I, II)	gourd	yellow
Byasa alcinous	30 (I, II)	conjugated	red
Papilio macilentus		conjugated	red
P. machaon	31 (I)	conjugated	red
P. xuthus	30 (I)	conjugated	red
P. protenor	30 (I)	conjugated	red
P. memnon	30 (I, II)	conjugated	red
P. helenus	30 (I)	conjugated	red
P. bianor	30 (I, II)	conjugated	red
P. maackii	30 (I, II)	conjugated	red

Meiosis is observed in a few butterflies only in the pre-pupal and early pupal stages. This was found to hold true for all the species of *Parnassius, Luehdorfia, Graphium, Byasa,* and *Papilio macilentus.* In all the other members of the family considered here, spermatogenesis was not only found in these stages, but also in the imagos. However, in the imaginal testes, most meiosis was aberrant and led to the formation of apyrene spermatozoa.

The chromosomes of all of the species are dot-like, and the following haploid numbers were found: 20, 30, 31, and 62. The roman numerals given after the numbers for each species in Table I refer to the stage of spermatogenesis in which the determinations were made.

A correlation is found between morphology and chromosome numbers, with the most primitive species exhibiting the highest number of 62. The numbers 31, 30, and 20 occur in the progressively more specialized, or derived, forms.

Graphium sarpedon with 20 and *G. doson* with 30 chromosomes are closely related, and it can be observed that differences in chromosome numbers here appear to be associated with chromosomal fusion. In *G. doson,* with the 30 chromosomes, 20 are small and 10 large dots; whereas in *G. sarpedon* there are 20 dots, all of which are large. The most probable explanation is that the lower numbers have been derived by fusion of the 20 small chromosomes into 10 larger ones.

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