KARYOLOGY OF GENERA CALANOPIA & PONTELLINA WITH A NOTE ON CYTOTAXONOMICAL & EVOLUTIONARY RELATIONSHIP IN FAMILY PONTELLIDAE

USHA GOSWAMI & S.C. GOSWAMI
National Institute of Oceanography, Dona Paula, Goa - 403 004.

ABSTRACT

Karyological studies were made on four species of copepods viz.: Calanopia aurivilli, C. elliptica, C. minor and Pontellina plumata. The diploid and haploid number of chromosomes encountered during the mitotic and meiotic divisions were 22 and 11 respectively. The karyotype formulae comprised of 7 sM + 13M + 2A (♂) & 8 sM + 12M + 2A (♀) in C. aurivilli, 5 sM + 14M + 3A (♂) in C. elliptica, 1 sM + 19M + 2A (♂) & 20M + 2A (♀) in P. plumata. The average total length of the chromosomal pairs varied between 0.52 — 1.88 μm in C. aurivilli, 0.35 — 1.28 μm in C. elliptica, 0.52 — 2.20 μm in C. minor and 0.31 — 1.63 μm in P. plumata. In all the species the sex-mechanism was of the XY-XX type with male as the heterogametic sex and distinguishable X and Y chromosomes. On the basis of chromosomal and morphological data available the cytotaxonomical and evolutionary relationship in the family Pontellidae is derived. It showed that the genera Labidocera, Pontella, Pontellopis on one hand and Calanopia and Pontellina on the other are more closely allied. The former three genera are of recent origin and Labidocera minuta is the connecting link.

Key-words: Karyology, Pontellidae, Calanopia, Pontellina.

INTRODUCTION

Copepods belonging to the family Pontellidae were selected for studying cytogenetical aspects of evolutionary processes in the sea. The animals inhabit the surface layers of neritic and oceanic realms and are widely distributed in the tropical to the warm temperate latitudes. The availability of these forms is closely associated with various hydrographic features. The karyological investigation on five genera of common occurrence from different waters was planned. Three of the genera from the Indian waters have been described earlier (Goswami & Goswami, 1974, 1978, 1979 & 1984). The present communication deals with the remaining two genera. The data collectively have been utilized in tracing cytotaxonomical and evolutionary relationships in the family at various taxonomic levels.

MATERIAL AND METHODS

Copepod species viz: Calanopia aurivilli (Cleve); Calanopia elliptica (Dana); Calanopia minor A. Scott and Pontellina plumata (Dana) were sorted from the zooplankton samples collected on board RV Gaveshani during April, 1984 from the Laccadive Sea. The material after filtration was fixed in acetic alcohol (1:3) and preserved in 70% alcohol. Temporary squash preparations were made after staining in aceto-orcein. The studies were carried out on male, female and during their cleavage stages.
RESULTS

Karyotypic details (Figs. 1 & 2).

The diploid number of 22 chromosomes was observed in C. aurivilli, C. minor, C. elliptica and P. plumata during the spermatogonial/oogonial/cleavage divisions. The haploid number encountered during metaphase I and II was 11 in all the species. The diploid complements comprised of submetacentric, metacentric and acrocentric chromosomes. The arm ratios ranged between 1.82 – 2.50 in submetacentric and 1.00 – 1.15 in the metacentric chromosomes. The acrocentrics were conical rods, without any visible small arm. The average total length of the chromosomal pairs varied between 0.52 – 1.88 µm in C. aurivilli, 0.35 – 1.28 µm in C. elliptica, 0.52 – 2.20 µm in C. minor and 0.31 – 1.63 µm in P. plumata (Table I). The karyotype formulae comprised of 7 submetacentrics, 13 metacentrics & 2 acrocentrics in males and 8 submetacentrics, 12 metacentrics & 2 acrocentrics in females of C. aurivilli, 5 submetacentrics, 14 metacentrics & 3 acrocentrics in males of C. elliptica, 1 submetacentric, 19 metacentrics & 2 acrocentrics in females of C. minor; 19 metacentrics & 3 acrocentric in males and 20 metacentrics & 2 acrocentric in females of P. plumata. The same number of different type of chromosomes were represented in the male and female producing embryos noticed during cleavage divisions.

Fig. 1. Calanopia aurivilli (Cleve) (a–i), a–d mitotic metaphase, oogonial, spermatogonial, cleavage with XX and cleavage with XY chromosomes. e Metaphase — I (♀), f — Metaphase — II (♀), g — Metaphase — I (♂); h & i — Metaphase — II (♂) showing X & Y chromosomes. j, Calanopia elliptica (Dana), Spermatogonial metaphase, Calanopia minor, A. Scott (k–o), k–m, mitotic metaphase, oogonial, cleavage with XY, cleavage with XX chromosomes. n, o Metaphase — I, II (female). Pontellina plumata (Dana) (p–s), p, q Mitotic metaphase, spermatogonial oogonial, r, s — Metaphase — II, female, male, t–w — Sex chromosomes of C. aurivilli, C. elliptica, C. minor & P. plumata respectively.
Table I. Arm ratio (L/S), Average total length (μm) and the chromosome type of various homologous pairs in the species investigated.

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<td>(Y) 0.87 (Y)</td>
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* absence of distinct arms
** Centromere at the end

Abbreviations used: sM = Submetacentric, M = Metacentric A = Acrocentric
Sex-chromosomes (Fig. 1, t-w, Table I).

The sex-mechanism in all the species presently studied was of the XY-XX type with male as the heterogametic sex. The X and Y chromosomes were distinguishable and formed an unequal and unhomologous pair. In C. aurivilli, C. elliptica, C. minor & P. plumata, the sex-chromosomes X & Y were respectively submetacentric & metacentric; submetacentric and acrocentric; metacentric and submetacentric and metacentric and acrocentric. As given in Table I, the X chromosome is the largest complement in all the species. Whereas Y chromosome is 18th in position in declining order of size in C. aurivilli, and P. plumata and 12th in C. elliptica and C. minor. In C. minor the X chromosome was lightly stained and Y chromosome was darkly stained.

DISCUSSION

Cytotaxonomical relationship in family Pontellidae:

On intergeneric level: Kasturirangan (1963) described taxonomically five general of family Pontellidae viz.: Labidocera, Pontella, Pontellopsis, Calanopia & Pontellina. Amongst these genera, dorsal cuticular eye lenses are present in Labidocera, Pontella & Pontellopsis but absent in Calanopia and Pontella (Silas and Pillai, 1973). Goswami and Goswami in earlier (1974, 1978, 1979, 1984) and in present studies described twenty species cytologically belonging to these five genera. The general course of mitosis and meiosis and the chromosome types are the same. These morphological and cytological similarities show their kinship on the intergeneric level and cytotaxonomically, justify their placement under the same family.
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The details of the karyotypes and the sex-mechanism are however, more similar amongst the genera Labidocera, Pontella & Pontellopsis on one hand and the genera Calanopia & Pontellina on the other. For example, in the former group, fifteen out of the sixteen species cytologically studied, showed 10 as the modal number of chromosomes and no distinction of X & Y chromosomes. Whereas, in the latter group, all the four species described possess 11 as the modal number of chromosomes and a distinct X & Y chromosome. Thus, cytotaxonomically, also, the closer relationship amongst genera Labidocera, Pontella, Pontellopsis and genera Calanopia and Pontellina is ascertained.

Intrageneric and interspecific level: Majority of the species studied in family Pontellidae belonged to genus Labidocera & Calanopia. The interspecific cytotaxonomic relationship in genus Labidocera has been derived earlier (Goswami and Goswami, 1974, 1978, 1979 & 1984). In genus Calanopia all the three species taxonomically represented in the Indian waters have been studied, e.g. C. aurivilli, C. minor and C. elliptica. They show a diploid number of 22 and a haploid number of 11 chromosomes. The karyotypes are dominated by metacentric chromosomes. The form of the various chromosome types are similar. The sex-mechanism is of the XY-XX type, with distinguishable X & Y chromosomes and male as the heterogametic sex. Taxonomically, also all the three species possess the generic characters. Hence, on the basis of the presence of similarities on the cytological and taxonomical level, the close relationship of all the species is justified on the intrageneric and interspecific level. On the intraspecific level, however, the number of the submetacentric, metacentric & acrocentric chromosomes and the shape & size of the sex-chromosomes varies. Thus, the individuality of each species is further ascertained, cytotoxonomically. Silas & Pillai (1973) in view of the morphological similarities assigned C. minor and C. aurivilli to one group Aurivilli and included C. elliptica in a separate group Elliptica though under the same genus Calanopia. Cytologically, however, no such close resemblance is noticed between C. minor and C. aurivilli. In fact C. minor is the only species amongst the three which show a differential staining behaviour of sex-chromosomes.

Evolutionary relationship within the family Pontellidae:

The general trend of chromosome evolution in various groups of copepods is towards reduction of the chromosome number. The species with smaller chromosome number, dominance of metacentrics in the karyotypes and lesser variations in the size-range of chromosomes, are more specialized (Harding, 1950 and Colombera & Colombera, 1977). During the present investigations, fifteen out of sixteen species of the genera Labidocera, Pontella & Pontellopsis showed 20 (2n) and 10 (n) chromosome number. Only Labidocera minuta showed 22 (2n) and 11 = (n) like four species belonging to the genera Calanopia and Pontellina. Keeping in view the course of chromosome evolution in copepods, the genera Labidocera, Pontella and Pontellopsis seem to
be of rather recent origin. Taxonomically also, the presence of the dorsal cuticular eye lenses in these genera is a more specialized character (Kasturirangan, 1963). Pillai (1984) considered Labidocera as an advanced form. The species _L. minuta_ having similarities with both _Labidocera_ and _Calanopia_, _Pontellina_ may be like a connecting link between the more ancestral and the recent genera.

Amongst the genera _Labidocera_, _Pontella_ and _Pontellopsis_, the maximum number of species studied cytologically, belong to genus _Labidocera_. The karyotypes of all the species in various genera of Pontellidae are dominated by the occurrence of metacentric chromosomes, _L. acuta_, _L. detruncata_, _L. pavo_ & _L. kroyeri_ in particular have all the 20 chromosomes as metacentrics. Along with the presence of the smaller 2n number in the family, these four species can be placed on higher level of the evolutionary tree. _L. acuta_, with the minimum size-range of 0.84–0.86 μm seems to be a cytologically specialized form.

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