Mahasagar–Bulletin of the National Institute of Oceanography, **18**(3), 1985, 433–438.

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, Pontellopsis* 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.

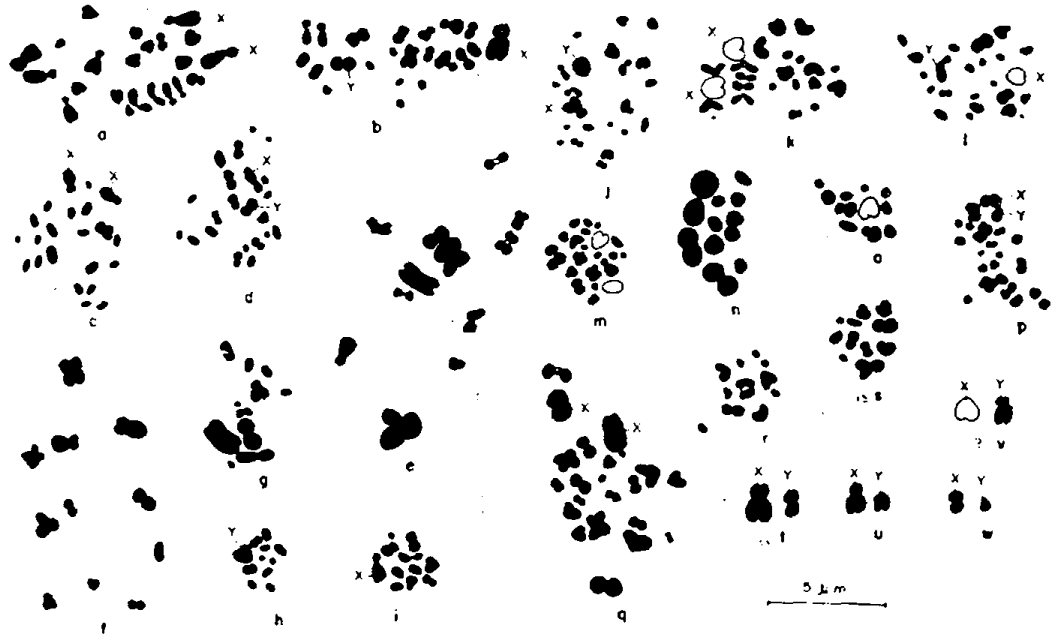

Fig. 1. *Calanopia aurivilli* (Cleve) (a–i), a–d mitotic metaphase, oogonial, spermatogonial, cleavage with XX and cleavage with XY chromosomes. e Metaphase — I (♀), f — Metaphase — II (♀), g — Metaphase — I (♂); h & i — Metaphase — II (♂) showing X & Y chromosomes. j, *Calanopia elliptica* (Dana), Spermatogonial 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 oogoniali, 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.

	Calanopia aurivilli			*C. elliptica*			*C. minor*			*Pontellina plumata*		
	Arm ratio	Total length	Chromosome type	Arm ratio	Total length	Chromosome type	Arm ratio	Total length	Chromosome type	Arm ratio	Total length	Chromosome type
1	2.37 (X)	1.88 (X)	sM	1.75 (X)	1.28 (X)	sM	1.00 (X)	2.20	M	1.00	1.63X	M
	1.00 (Y)	1.04 (Y)	M	(Y)	0.87 (Y)	A	2.50 (Y)	1.22	sM	—	0.70 (Y)	A
2	1.00	1.85	M	1.00	1.25	M	1.00	1.86	M	1.00	1.63	M
3	1.00	1.85	M	1.00	1.25	M	1.00	1.62	M	1.00	1.63	M
4	2.12	1.74	sM	1.00	1.05	M	1.00	1.62	M	1.00	1.22	M
5	1.15	1.74	M	1.82	0.99	sM	1.00	1.62	M	1.00	1.22	M
6	1.00	1.51	M	2.10	0.90	sM	1.00	1.51	M	1.00	1.22	M
7	2.19	1.39	sM	1.00	0.70	M	1.00	1.16	M	1.00	1.22	M
8	1.84	1.39	sM	1.00	0.70	M	1.00	1.16	M	1.00	0.82	M
9	1.00	1.34	M	* —	0.35	M	1.00	0.58	M	1.00	0.71	M
10	1.12	0.90	M	—	0.35	M	1.00	0.58	M	1.00	0.61	M
11	**	0.52	A	⟷	0.35	A	⟶	0.52	A	⟶	0.31	A

* absence of distinct arms

** Centromere at the end

Abbreviations used : sM = Submetacentric, M = Metacentric A = Acrocentric

Fig. 2. Karyograms of the species investigated (males).

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.

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, cytotaxonomically. 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*. Infact *C. minor* is the only epecies 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 advance 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.

ACKNOWLEDGEMENTS

The authors are thankful to Dr. V.V.R. Varadachari, the Director and Dr. T.S.S. Rao, the Head, B.O.D. for facilities and encouragement.

REFERENCES

Colombera, D. and L.I. Colombera, 1977. Chromosome evolution in some marine invertebrates P. 487–528. In: Battaglia, B. and Beardmore, J.A. (Edtd,) *Marine Organisms Genetics, Ecology and Evolution*, Nato conference series, Series IV. Marine Sciences. Volume 2. Plenum Press. New York, London.

Harding, J.P. 1950. Cytology, genetics & classification. *Nature*, **166**: 769–771.

Goswami, U. and S.C. Goswami, 1974. Cytotaxonomical studies on some calanoid copepods. *Nucleus*, **17**: 109–113.

Goswami, U. and S.C. Goswami, 1978. A note on the karyotype of some calanoid copepods. *Mahasagar–Bulletin of the National Institute of Oceanography*. **11**: 111–113.

Goswami, U. and S.C. Goswami, 1979. Karyology of genus *Labidocera* Lubbock from the Laccadive Sea (Lakshadweep). *Indian Journal of Marine Sciences*., **8**: 259–262.

Goswami, U. and S.C. Goswami, 1984. A note on chromosomes of *Pontellopsis herdmani* and *Pontella princeps* (Copepoda) from the Laccadive Sea. *Mahasagar–Bulletin of the National Institute of Oceanography*, **17**: 129–132.

Kasturirangan, L.R. 1963. *A key for the identification of the more common planktonic copepods of Indian coastal waters.* Council of Scientific & Industrial Research, New Delhi.

Silas, E.G. and P.P. Pillai, 1973. The calanoid copepod Pontellidae from the Indian Ocean. *Journal of Marine Biological Association of India*. **15** (2): 771–858.