

## CYTOTAXONOMICAL STUDIES IN FAMILY EUCALANIDAE (COPEPODA)

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### ABSTRACT

Eight species of copepods belonging to the genera *Eucalanus* and *Rhincalanus*, Eucalanidae, Calanoida, have been investigated cytologically. All the species revealed a diploid number of 20 and haploid number of 10 chromosomes during the mitotic and meiotic metaphases respectively. The other details of the karyotypes, however, were quite apart from one another. The results of the studies have been utilised in discussing cytotaxonomic relationship on the intra and inter-generic level and to trace the possible path of evolution of the karyotype.

### INTRODUCTION

In view of the importance of copepods in the marine ecosystem cytotaxonomical studies were initiated on these species from the Indian waters (Goswami and Goswami, 1972, 1973, 1974 and 1978). The present communication gives an account on karyotypes of 8 species belonging to the family Eucalanidae.

### MATERIAL AND METHODS

In tropical waters, family Eucalanidae is represented taxonomically by two genera, viz. *Eucalanus* and *Rhincalanus*. Eight species belonging to these two genera, namely *Eucalanus mucronatus* Giesbrecht, *E. elongatus* (Dana), *E. crassus* Giesbrecht, *E. subcrassus* Giesbrecht, *E. attenuatus* (Dana), *E. monachus* Giesbrecht, *Rhincalanus nasutus* Giesbrecht and *R. cornutus* Dana had been studied for the karyotypic details. Zooplankton samples were collected from 10 stations in Bay of Bengal using an Indian Ocean Standard Net (IOSN) from 200 - 0 m depth on board R. V. *Gaveshani* during its VII cruise (Fig. 1). The species were sorted out and the temporary squash preparation were made after staining the male gonads in Acetic orcein. The other details of methodology were the same as described earlier (Goswami and Goswami, 1974).

### RESULTS

#### *Eucalanus mucronatus*

This species was found to have a diploid number of 20 ( $2n$ ) and haploid number of 10 ( $n$ ) chromosomes during the gonial and meiotic metaphases respectively (Plate I, Figs. 1 & 2). The karyotype comprised of 4 submetacentric, 3 metacentric and 3 acrocentric chromosomes. The shape of the acrocentric chromosomes was like conical rods and that of the metacentric as dumb-bell. At times, the two sister-chromatids of a chromosome could clearly be seen apart. The average total length of

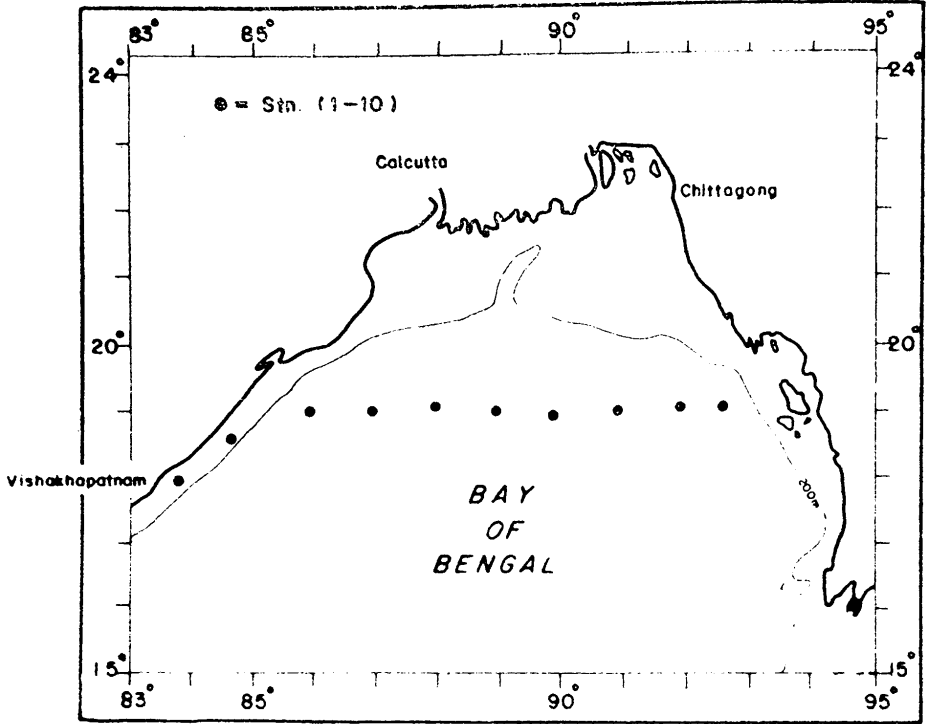


Fig. 1. Position of the sampling stations.

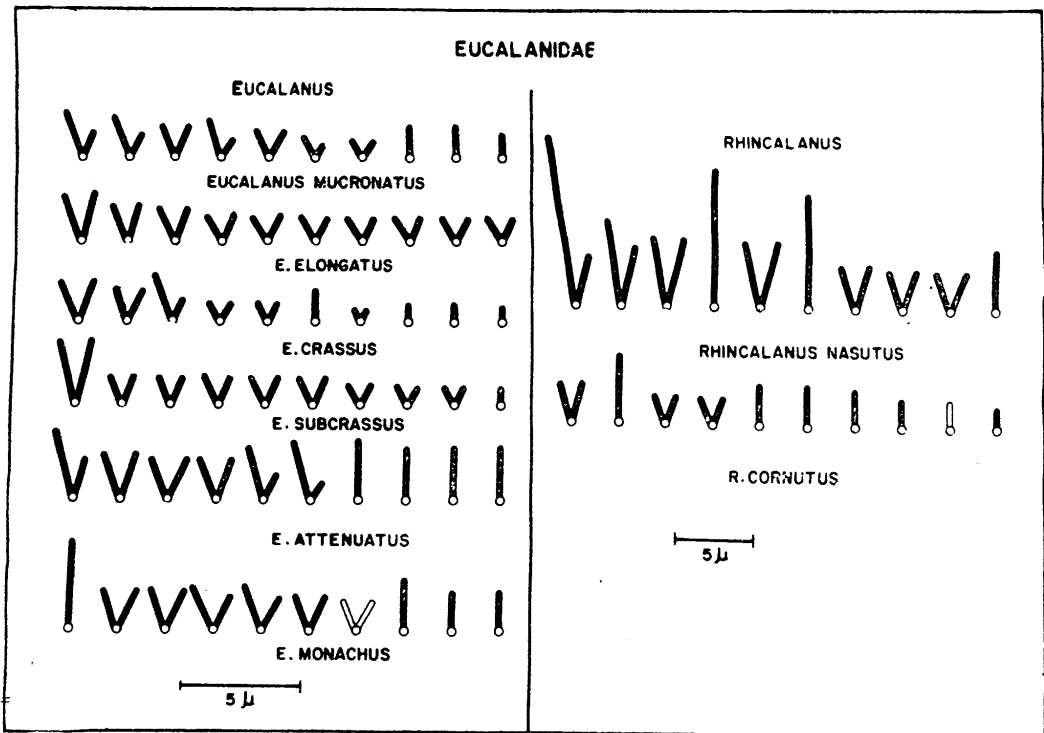


Fig. 2. Idiograms of the karyotypes of the species studied.

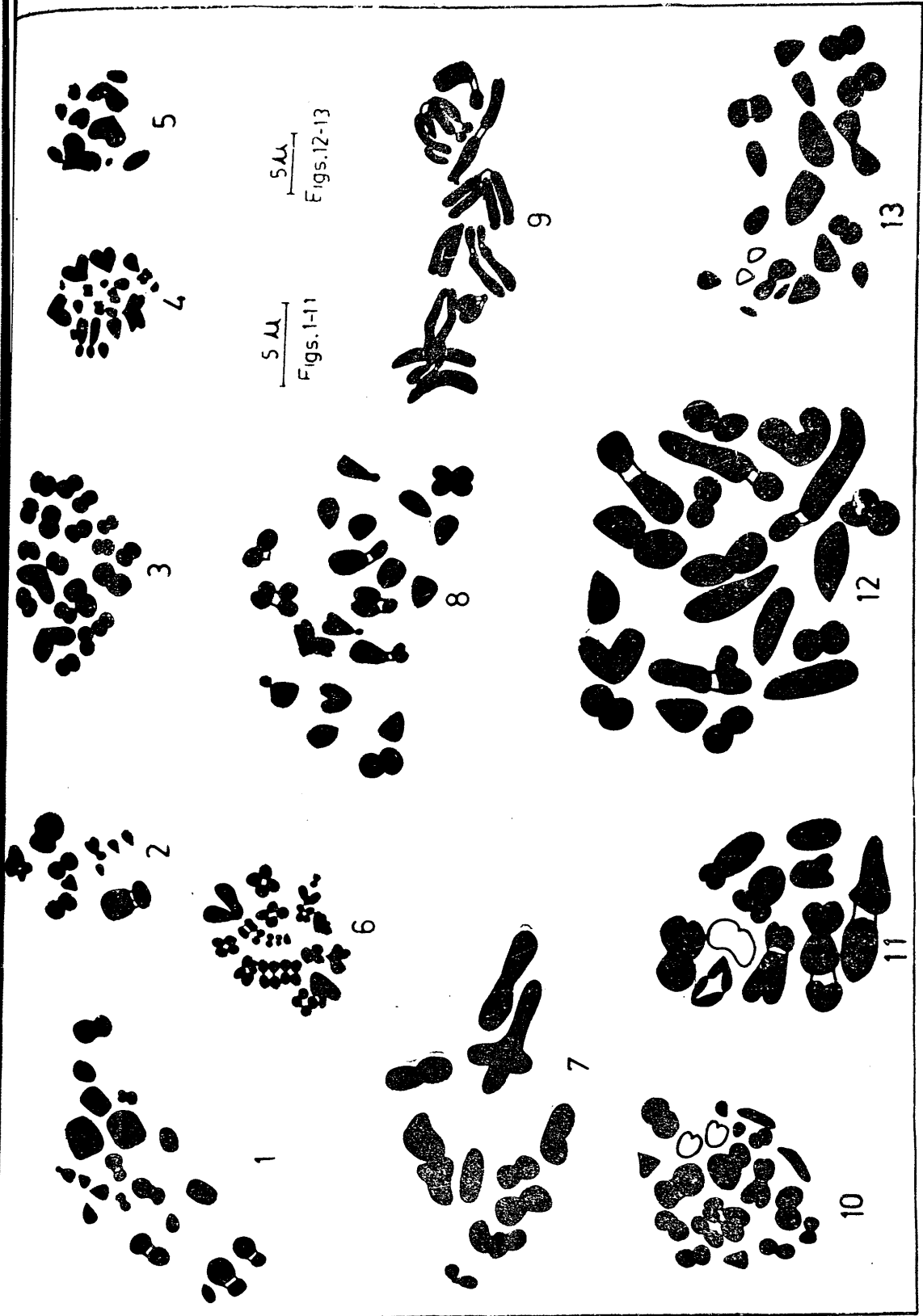


Plate I. Figs. 1 & 2. Spermatogonial metaphase II (*E. mucronatus*). Fig. 3. Spermatogonial metaphase II (*E. mucronatus*). Figs. 4 & 5. Spermatogonial metaphase II (*E. elongatus*). Figs. 6 & 7. Spermatogonial metaphase I (*E. crassus*). Figs. 8 & 9. Spermatogonial metaphase I (*E. suberassus*). Figs. 10 & 11. Spermatogonial metaphase I (*R. cornutus*). Figs. 12 & 13. Spermatogonial metaphase I (*R. nasutus*).

Table I. Karyotype formula and average total length of the homologous pairs (given in microns) in the species investigated.

Species	Karyotype formula	Individual chromosomal pairs and position of the centromere									
		*1	2	3	4	5	6	7	8	9	10
<i>E. elongatus</i>	10M	4.45 (M)	2.50 (M)	2.16 (M)	1.43 (M)	1.25 (M)	1.25 (M)	1.25 (M)	1.52 (M)	1.25 (M)	1.25 (M)
<i>E. subcrassus</i>	9M+1A	4.65 (M)	1.80 (M)	1.80 (M)	1.80 (M)	1.80 (M)	1.80 (M)	1.25 (M)	1.0 (M)	1.0 (M)	0.72 (A)
<i>E. crassus</i>	5M+1S·M+4A	2.86 (M)	2.26 (M)	2.26 (S.M)	0.90 (M)	0.90 (M)	0.90 (A)	0.80 (A)	0.55 (M)	0.55 (A)	0.55 (A)
<i>E. monachus</i>	4M+2S·M+4A	3.40 (A)	2.80 (M)	2.80 (M)	2.80 (S.M)	2.80 (S.M)	2.78 (M)	1.80 (M)	1.80 (A)	1.44 (A)	1.44 (A)
<i>E. attenuatus</i>	3M+3S·M+4A	4.28 (S.M)	3.22 (M)	2.86 (M)	2.86 (M)	2.86 (S.M)	2.86 (S.M)	2.14 (A)	1.80 (A)	1.80 (A)	1.80 (A)
<i>E. mucronatus</i>	3M+4S M+3A	2.86 (S.M)	2.50 (S.M)	2.50 (M)	2.30 (S.M)	1.80 (M)	1.75 (S.M)	1.44 (M)	1.43 (A)	1.43 (A)	1.25 (A)
<i>Rhincalanus nasutus</i>	5M+2S·M+3A	12.5 (S.M)	8.22 (S.M)	8.12 (M)	8.12 (A)	7.30 (M)	6.25 (A)	5.0 (M)	4.28 (M)	4.28 (M)	3.22 (A)
<i>R. cornutus</i>	3M+7A	4.28 (M)	3.80 (A)	3.20 (M)	2.86 (M)	2.14 (A)	2.14 (A)	1.80 (A)	1.25 (A)	1.25 (A)	1.08 (A)

\* The pairs have been numbered in a declining order of size.

Abbreviations used ; M – Metacentric S. M – Sub metacentric A – Acrocentric

the homologous pairs varied, and were between 1.25 – 2.86  $\mu$  (Table I). The differences in length were associated with the difference in size of the chromosomes. There was no distinction of the sex chromosomes. Metaphase orientation of the chromosomes was random irrespective of the size differences. Meiosis was chiasmatic, anaphase I reductional and anaphase II equational.

*Eucalanus elongatus*, *E. crassus*, *E. subcrassus*, *E. attenuatus* and *E. monachus*

All these species resembled *E. mucronatus* in having a diploid number of 20 and haploid number of 10 chromosomes encountered during mitotic and meiotic metaphase I stages respectively (Plate 1, Figs. 3 to 11). Karyotype of *E. elongatus* had all the pairs metacentric and of *E. subcrassus* nine pairs metacentric and only one acrocentric. Rest of the species had various combinations of submetacentric, metacentric and acrocentric chromosomal pairs. Karyotype formula of all the species are included in Table I. The average total length of the homologous chromosomes varied between 1.25 to 4.45  $\mu$  in *E. elongatus*; 0.55–2.86  $\mu$  in *E. crassus*; 0.72–4.65  $\mu$  in *E. subcrassus*; 1.80–4.28  $\mu$  in *E. attenuatus* and 1.44–3.40  $\mu$  in *E. monachus*. Details of mitosis and meiosis in all the species were the same as in *E. mucronatus*. In *E. monachus* the sex-chromosomes showed differential staining behaviour.

Genus : *Rhincalanus* Dana, *Rhincalanus nasutus* and *R. cornutus*

Both the species had a diploid number of 20 chromosomes Plate I, Figs. 12 & 13). The karyotypes consisted of 2 submetacentric, 5 metacentric, and 3 acrocentric

pairs in *R. nasutus* and 3 metacentric and 7 acrocentric in *R. cornutus*. The average total length of the homologous pairs varied between 3.22–12.5  $\mu$  in the former and 1.08–4.28  $\mu$  in the latter species (Table I). The metaphase orientation was at random. Sex chromosomal pair in *R. cornutus* was lightly stained.

#### DISCUSSION

Cytogenetically, all the species belonging to the genus *Eucalanus* presently studied, had a diploid number of 10 chromosomes. Gonial metaphase orientation of chromosomes was random, irrespective of the size differences. Metacentric and sub-metacentric chromosomes were of common occurrence in all the karyotypes. Meiosis I was chiasmatic and reductional and meiosis II was equational. However, the karyotypes differed amongst themselves in minute details like the total average lengths of the homologous pairs, the size of the chromosomes and the karyotype formula. The chromosomal similarities and dissimilarities support the inclusion of all these forms of copepods in the same genus *Eucalanus* as separate species.

In the second genus *Rhincalanus* also, both the species described here possessed a diploid number of 20 and haploid number of 10 chromosomes and similar mechanisms of mitosis as in the genus *Eucalanus*. These similarities in chromosomal behaviour showed the intrageneric closeness between *R. nasutus* and *R. cornutus* and the intergeneric relationship between *Eucalanus* and *Rhincalanus*. On the other hand, differences encountered in the details of the diploid complements of *R. nasutus* and *R. cornutus*, further justify the present systematic position of the two forms as separate species under the same generic name.

#### *Chromosome number*

Most of the Calanoid copepods had been reported to have a haploid number of 16 or 17 chromosomes (Harding, 1950 & 1963). However, the present and earlier findings of the present workers did not agree with this. Earlier, Goswami and Goswami (1973, 1974 and 1978) reported 6(*n*) modal chromosome number in the genus *Acartia*, 10(*n*) in the genus *Labidocera*, 6(*n*) in the genus *Tortanus* and 3(*n*) in *Centropages furcatus* and *Temora turbinata*. Six species of genus *Eucalanus* and two species of genus *Rhincalanus* included in the present paper showed 10 as the haploid chromosome number. Thereby, a modal number of 10 (*n*) chromosomes had been suggested for both these genera. Goswami and Goswami (1974) had reported the same modal number for the genus *Labidocera*. Further studies on more species of Calanoid copepods might throw some light upon the intergeneric relationship of these three genera belonging to the different families but possessing similar modal number of chromosomes.

#### *Evolution of the karyotype*

White (1954) while reviewing the meagre available data on copepod chromosomes made generalization that the calanoid copepods show great differences in the chromosome number even amongst the closely related species. Following this, Lazzaretto-Colombera (1976) on finding a great uniformity of chromosome number in ten species of genus *Tisbe* (Harpacticoida) commented that the pattern of evolution

in the suborder Harpacticoida was quite different from that of Calanoida. However, from the earlier and present information collected by the present workers on the copepod chromosomes it might be suggested that the generalizations made by the above said workers were not applicable to all the calanoid copepods. Even in the genera *Eucalanus* and *Rhincalanus* included here, the constancy of haploid number had been noticed.

In such cases the path of evolution had probably been through chromosomal rearrangements rather than a change in the chromosome number. In genera *Eucalanus* and *Rhincalanus*, the chromosomal changes seemed to have included the centromeric portion. Since metacentric chromosomes were of common occurrence in order copepoda, the karyotypes with submetacentric chromosomes had probably been of rather recent origin. In genus *Eucalanus*, one possible line of evolution could be from *E. elongatus* (all metacentrics and in genus *Rhincalanus* from *R. nasutus* (with larger metacentrics).

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