SUMMARY

1. In the present manuscript, detailed results of cytogenetical investigations on five species of the genus *Anopheles* and a species each of the genera *Culex*, *Arasimara* and *Mansonie* have been lucidly presented. A complete list of all these species along with their taxonomic status is given below:

1. *Anopheles* (*Anopheles*) *lindesarni*
2. *Anopheles* (*Culicic) *sundaeque*
3. *Anopheles* (*Culicic) *annulare*
4. *Anopheles* (*Culicic) *splendidus*
5. *Anopheles* (*Culicic) *amonits*
6. *Culex* (*Lutzia*) *raptor*
7. *Arasimara* (*Arakeraa*) *subalbatus*
8. *Mansonie* (*Mansoniiodea*) *annulifera*

The *Anopheles* species were investigated for their salivary gland chromosomes, whereas the remaining species were worked out for their detailed mitosis and meiosis.

2. In all the five anopheline species mentioned above, the salivary gland chromosome banding pattern has been described in detail, and a chromosome map for each of them is also produced. The normal banding pattern of each
species is further compared with that of the other species in their respective subgenera which are closely related on morphological and taxonomical grounds. As a result, the evolutionary and phylogenetic relationships between them have been drawn. For this purpose the present species are compared with the following allied species:

<table>
<thead>
<tr>
<th>Present species</th>
<th>Species compared</th>
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<tbody>
<tr>
<td>1. <em>A. lindesavi</em></td>
<td><em>A. nigerrius</em> and</td>
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<td></td>
<td><em>A. barbirostris</em></td>
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<tr>
<td>2. <em>A. sundaicus</em></td>
<td><em>A. subpictus</em> and</td>
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<td></td>
<td><em>A. rambia</em></td>
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<tr>
<td>3. <em>A. annularia</em></td>
<td><em>A. staphenai</em></td>
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<tr>
<td>4. <em>A. splendidus</em></td>
<td><em>A. staphenai</em></td>
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<tr>
<td>5. <em>A. aconitus</em></td>
<td><em>A. fluviatilis</em></td>
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3. Apart from the banding pattern comparisons, a striking phenomenon of chromosomal polymorphism (especially inversion polymorphism) has been studied in *A. lindesavi*, *A. sundaicus* and *A. annularia*. An attempt has also been made to describe the evolutionary and adaptive significance of these inversions in the concerned species.

4. For salivary gland chromosome preparations salivary glands of the well fed fourth instar larvae were found most suitable. The salivary gland chromosomes of all the
five species of the genus *Anopheles* are well developed, spread easily and have a weak chromocentre. In the salivary gland cell the diploid number of six chromosomes is represented by three long synapsed elements of varying lengths. They comprise a short X-chromosome and two longer autosomes (2 and 3). The autosome 2 in all the four species of the subgenus *Collis* has arms of unequal length and chromosome 3 is with arms of equal lengths, but in *A. lindesayi* (belonging to subgenus *Anopheles*) the autosome 2 is metacentric and has equal arm lengths, whereas chromosome 3 has unequal arms because of its submetacentric nature. All the three chromosomes are recognised by the shape and banding pattern of the free and centromeric ends and some diagnostic bands and puffs in the remaining zones of the arms.

5. The X-chromosome in each species shows its unique banding pattern and can be used to differentiate them easily.

6. *A. lindesayi* is an alpine species whose adults and larvae were collected from Kausali (Himachal Pradesh) at a height of 6,000 ft. It shows more banding pattern homologies with *A. nigerrimus* than with *A. barbirostris*. However, the X-chromosomes of all the three species do not show sufficient comparable areas. A high rate of
Chromosomal polymorphism is observed in the natural populations of *A. lindesayi*. In all, 16 aberrations were isolated, out of which 13 were inversions, 2 deletions and one translocation. Among the 13 inversions, one was pericentric, while the remaining 12 were paracentric and heterozygous. The X-chromosome and chromosome arm 3R were found more susceptible to aberrations. In addition to their evolutionary significance, these aberrations are presumed to be related with the adaptation of the species to the colder environment.

7. *A. sundaeicus* is a species of the coastal areas of India and for the present purpose of research it was collected from brackish water pockets around the Chilika lake (Orissa). It is found more closely related to *A. subnigricans*, morphologically as well as cytologically. Except for a slight difference, in the banding pattern of the X-chromosome, all the autosomal arms are represented alike in the two species. The two species differ because of one homozygous inversion in the X-chromosome and two in 2R. When compared with *A. gambias*, *sundaeicus* shows a close relationship due to the large scale similarities in the banding pattern and two heterozygous inversions on 2R of both the species. The present population of *sundaeicus* shows a high rate of chromosomal polymorphism.
This is attributed to its adaptation for brackish water habitat and also seems to be responsible for its evolution from *A. subnictus*.

8. *A. annularis* was collected from the villages in the hill tracts near Chandigarh (India). With regard to its banding pattern similarities, it has close relationship with *A. stephensi*. Almost the whole of the arm 3L is represented alike in the two species. *A. annularis* exists as a winter variety and a summer variety. The present results show a moderate amount of inversion polymorphism in the winter variety only in which there was one heterozygous paracentric inversion in 2H, three in 3H and one in 3L.

9. *A. splendidus* was collected along with *A. annularis* and its banding pattern was found quite similar to that of *A. stephensi* with which it also resembles morphologically. Similarities are more in chromosomes 2H and 3L, whereas 2L and 3R show sufficient divergence.

10. *A. aconitus* was procured from the rice field areas of Mandya, Karnataka (South India). When compared with *A. fluviatilis*, it shows the least homologies in the X-chromosome and close correspondence of bands.
in 2\(a\) and 2\(l\). The banding pattern of 3\(a\) and 3\(l\) is found to be unaltered and from the studies carried out so far, it seems free from the natural chromosomal polymorphism.

11. While carrying out comparisons in the presently worked out species viz., *A. lindesayi*, *A. sundarius*, *A. annularis*, *A. splendidus* and *A. scoticus*, it has been seen that species which are morphologically similar have close correspondence of bands and also the banding pattern is subgeneric in an overall arrangement except that some regions are species specific. The X-chromosome is more conservative than the autosomal arms in which 2\(a\) and 3\(l\) have undergone least changes in the course of evolution. On the other hand, the percentage of comparable bands is lesser in 2\(l\) and 3\(a\) which have probably contributed towards the diversification of species.

12. In summation, it may be added that in nature different species and species populations are separated by one or more isolating mechanisms, which often include a combination of several ethological, ecological, geographical and reproductive barriers, out of which the last two are of prime importance as they have a marked impact on altering the gene arrangements and forming different populations as independent genetic systems.
13. In the three non-anopheline species details of spermatogonial mitosis and meiosis are described. These studies have revealed the usual presence of six chromosomes at the gonial metaphase. A brief account of the chromosomal aberrations in various stages is also included in the present thesis.

14. In all the three species, three pairs of metacentric chromosomes are seen at the spermatogonial metaphase. The homologues of each pair lie close to each other in *Ar. subalbatus* and *M. annulifera* and show sematic pairing, whereas in *C. raptor* the members of each homologous pair lie scattered which may be due to the colchicine treatment given to the pupae in the initial stages.

15. Although the general picture of the metaphase karyotype is the same as has been studied earlier in the species of the subfamily Culicinae, yet minor differences are there in the ratio of size between chromosome pairs I and II, II and III and III and I. On the basis of metrical analysis and position of the centromere, the karyotype in *C. raptor* is *Litris*-type, whereas it is *Finiens*-type in *Ar. subalbatus* and *M. annulifera*.
16. The process of meiosis proceeds with usual changes of the chromosomes except that the leptotene and zygotene stages are absent in all the three species.

17. The first visible meiotic stage in all the species is the pachytene which forms a bouquet orientation in *M. amphilifera*. A phenomenon of prometaphase stretch has also been observed in *C. raptor* and *Ae. subalbatus*.

18. Chromosomal aberrations in the karyotype of natural populations of *C. raptor*, *Ae. subalbatus* and *M. amphilifera* have been observed. In *C. raptor*, aberrations like chromatid separation, secondary constrictions, satellite bodies, monosomy, trisomy and triploidy have been commonly seen, whereas in *Ae. subalbatus* along with secondary constrictions and satellite bodies, heterochromatinization, deletions,acentric fragments and anaphase bridges have also been observed. In *M. amphilifera* aberrations like excessive chromosome breakage were seen at diakinesis and metaphase-II, while dicentric bridge and acentric fragments were noticed at anaphase-I and II respectively.

19. Although the presence of sex chromosomes in the species outside the genus *Anopheles* is controversial
yet on the basis of existing data the possibility of the smallest pair being the sex pair has been suggested. Regarding evolution of the karyotype, there are different interpretations available. This has been discussed in some detail and the origin of mosquitoes from the species of the family Tipulidae (2n=8) or from the genus Corathra (2n=8) of the family Culicidae has been indicated.

20. The cytogenetic studies on the oriental fauna of the family Culicidae are still in initial stages because the oriental element shows great diversity in the prevalence of species and species populations in view of the marked differences in the ecology of the various areas of the country.