THE CHROMOSOMES OF THE EDIBLE CRAB, *PARALITHODES CAMTSCHATICA* (TILESIUS)[1]

BY

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(*With 3 Figures in Text*)

During the past few years the present author has been studying the chromosomes of various kinds of Crustacea, with the purpose of making clear the chromosome constitution of this group of animals, and if such exists to discover the sexual difference of chromosomes. The present paper deals with the chromosomes of *Paralithodes camtschatica*, a decapod Crustacea, in comparison with the results of the author's previous study on the crayfish, *Cambaroides japonicus* (NIIYAMA, '34), and those recently published by LEOPOLDSEDER ('34) and DELPINO ('34) on *Pandalus* and *Telphusa*, in which they have claimed the existence of the accessory chromosomes.

Paralithodes camtschatica (TILESIUS) on which the present study was based, is a well known edible crab widely distributed along the coasts of the north Pacific ocean. The material consists of the testes from several specimens captured by nets from the waters adjoining the Akkeshi Marine Biological Station, Hokkaïdo, in the middle part of May 1934. They were operated and fixed immediately after capture on board the fishing boats.

As the fixatives, weak CHAMPY's and weak FLEMMING's fluids, which were employed by the author in the study of chromosomes of the crayfish, were proved also to be very favourable for the present material. In addition to them, CHAMPY's fluid diluted with an equal volume of sea-water was used and gave satisfactory results. In these fixing fluids the chromosomes were preserved with sharply defined

1) Contribution No. 87 from the Zoological Institute, Faculty of Science, Hokkaido Imperial University, Sapporo.

outlines, quite well enough to research their morphological characters.[1]

All the figures were drawn with ABBE's drawing apparatus, using a Zeiss H.I. 90 obj. and a K20 × compensating oc., at the level of the desk on which the microscope was set.

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Observations

1. *The spermatogonium.* The spermatogonia are found constituting the inner walls of the seminal tubules, the central portions

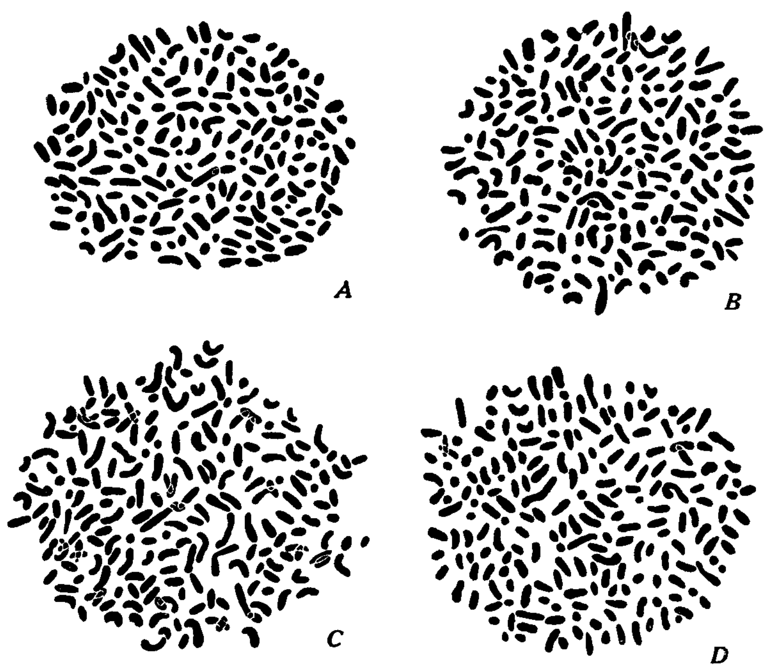

Fig. 1, *A–D*. Metaphase polar views of spermatogonia, 208 chromosomes in each. ×3000.

1) The technique was described in detail in the author's previous paper (NIIYAMA, '34).

of the latter being occupied by cells of various kinds in maturating stages. As occurred in the case of the crayfish, the spermatogonia do not undergo simultaneous division in a cyst, but dividing figures are encountered independently among the resting cells.

As seen in the polar view of the metaphase, the chromosomes arrange themselves well apart from one another, forming a fairly round equatorial plate. It is not so difficult, therefore, to count the number of chromosomes, in spite of their considerably large number. By careful counting of many clear plates, the diploid number was determined to be 208 (Fig. 1, *A–D*). This chromosome number seems to be larger than any hitherto known in any kind of animal, and is probably the same as in *Cambarus immunis* (?), on which FASTEN ('14) reported 104 chromosomes as the haploid number.

The chromosomes range in length from rod to dot, showing gradual diminution in size. The longer rod-shaped chromosomes are sometimes slightly curved and frequently found lying at the central region of the equatorial plate, as in the case of *Cambaroides japonicus*. On the whole, the chromosome constitution of the present species shows much resemblance to that of *Cambaroides japonicus*, but, more strictly, the longer chromosomes of the present crab are seen to be much more numerous when compared with the above-mentioned crayfish.

2. *The primary spermatocyte.* In the metaphase polar view, the tetrads take their appearance with distinct clearness, scattered evenly on the equatorial plate, as drawn in Fig. 2, *A–F*. In the present stage, therefore, the number of chromosomes can be counted with much ease and without fail. By counting many clear metaphase plates, it was ascertained that the primary spermatocyte contains 104 tetrads without exception. The tetrads vary in size, and when viewed from the pole, the majority of the larger ones exhibit a clear dumb-bell shape, showing a conspicuous transverse suture in each middle region. Because of this suture each tetrad seems to be composed of two equal halves. Concerning the similar structure of tetrads, the author has already discussed in his previous study on

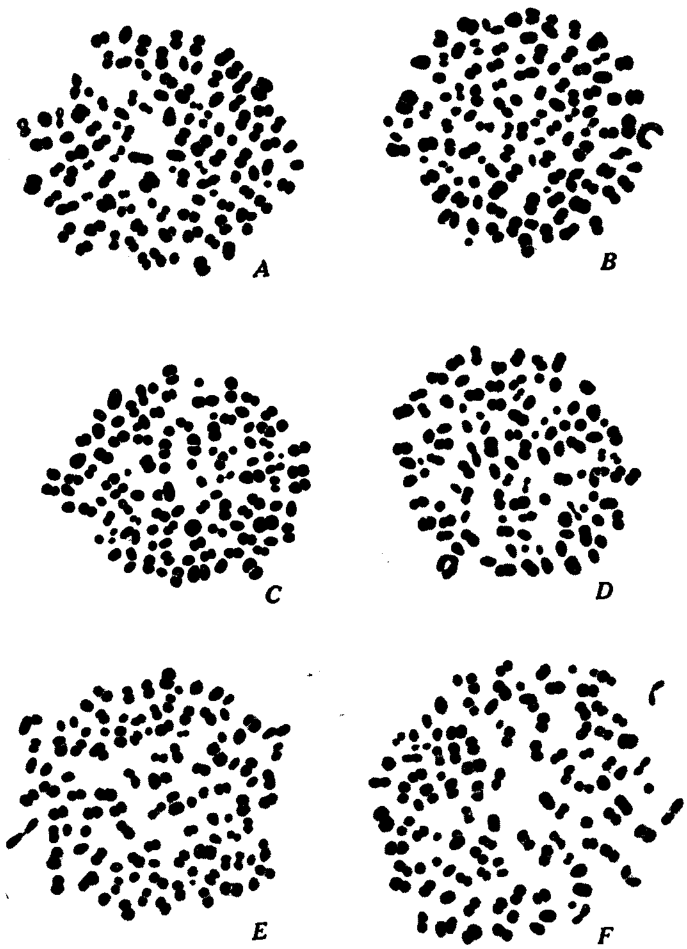

Fig. 2, *A–F*. Metaphase polar views of primary spermatocytes, 104 tetrads in each. ×3000.

the crayfish (NIIYAMA, '34). In the smaller tetrads, however, one can hardly demonstrate the actual presence of that middle suture. The range of the size variation of the tetrads seems to be more remarkable in *Paralithodes* than in *Cambaroides japonicus*, in which all tetrads apparently show nearly equal size (NIIYAMA, '34).

In the ensuing division, the tetrads are all separated equally into two sister components. In the favourably preserved condition, the separation of the sister chromosomes is quite synchronous in every tetrad. But sometimes, due probably to improper fixation, a few tetrads are observed to be displaced out of the spindle, as if they might be accessory chromosomes passing ahead of the others to the pole.

3. *The secondary spermatocyte.* The symmetrical distribution of chromosomes in the primary spermatocyte division gives rise to only one kind of secondary spermatocyte in respect to the chromosome garniture.

The metaphase equatorial plate of the secondary spermatocyte much resembles that of the primary spermatocyte, but is reduced in dimention as compared with the latter. The individual chromosomes exhibit a distinct dual nature and are scattered all over the equatorial plate without any overlapping with one another. In the equatorial plates examined, it is proved that the number of dyads is 104 without any exception (Fig. 3, *A–D*).

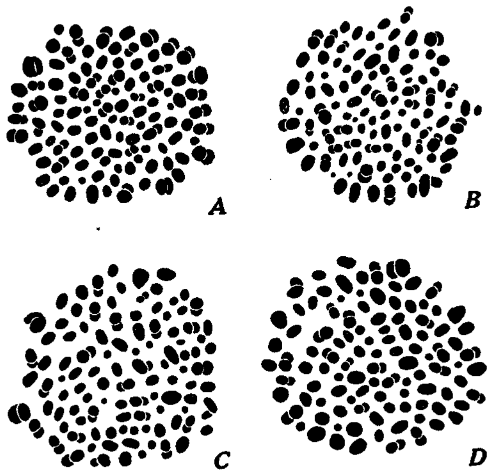

Fig. 3, *A–D*. Metaphase polar views of secondary spermatocytes, 104 dyads in each. ×3000.

Nothing particular is found in the mode of the secondary spermatocyte division; every dyad divides into two equal daughter monads. Occasionally, as in the case of the previous division, a few dyads are found displaced out of the spindle, owing probably to inadequate fixation.

Discussion

The problem of the heterochromosomes in hitherto studied species of the Crustacea has already been discussed in the author's previous paper (NIIYAMA, '34). In the present place, therefore, the newly published data concerning two species of the Decapoda will be taken under consideration.

It seems that LEOPOLDSEDER's conclusion ('34) on *Pandalus borealis* can be so summarized as follows: the primary spermatocyte contains 34 chromosomes. These chromosomes divide normally and thus the secondary spermatocyte also receives 34 chromosomes. In the equatorial plate of the secondary spermatocyte metaphase, however, 2 peculiar chromosomes, nearly equal in size and shape, are found isolated from the equatorial plate. Since these 2 isolated chromosomes pass undivided to one pole in the secondary division, there should be produced two types of sperms, the one containing 32 autosomes plus 2 peculiar chromosomes and the other only 32 autosomes. LEOPOLDSEDER adds that a similar condition of the heterotropic chromosomes has also been observed in some other species of Decapoda such as *Munida* and *Nephrops*. However, he could not extend his observation to the behavior of these chromosomes in question during the whole course of spermatogenesis. LEOPOLDSEDER failed, moreover, to determine the diploid chromosome number. As is obvious in his figures, the isolated chromosomes, accepted as heterochromosomes by him, exhibit a distinct dyad nature, assuming dumb-bell shape. Considered from all angles, the conditions indicate that these two seem to be ordinary dyads displaced by some mechanical causes, since, in fact, a quite similar case has frequently been encountered, as previously mentioned, in the present observation when the fixation was not adequate.

DELPINO ('34) investigated the spermatogenesis of *Telphusa fluviatilis* and concluded that there are 78 chromosomes in the spermatogonium and 39 tetrads in the primary spermatocyte, of which one exhibits a peculiar behavior and represents an X-group composed of two sex chromosomes. But the figures upon which the above mentioned conclusion was based, are by no means so absolutely clear as to induce such a decisive conclusion. Looking over DELPINO's descriptions and figures the present author hesitates to take the chromosome in question as the sex chromosome as DELPINO considered it to be. With all probability that chromosome should be accounted for also as a displaced autosome as suggested in the case of LEOPOLDSEDER ('34).

So far as the present observations show, in *Paralithodes camtschatica* there are discovered no kinds of chromosomes, so particular in form and in behavior as to be considered as sex chromosomes.

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