THE CHROMOSOMES OF TWO SPECIES OF EDIBLE CRABS
(Brachyura, Decapoda, Crustacea)[1]

With Two Textfigures

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Approximately forty species belonging to the decapod Crustacea have been reported so far on their karyotypes (Niiyama '59, '62). It has been shown that the karyotypes are variable, the chromosome numbers ranging in n from 41 to 188, and that male heterogamety occurs with varying types of sex determining mechanisms such as X-O, XY, XX-Y and no identifiable sex-chromosome. The situation requires that chromosomal data be collected in a large scale in order to discuss the mechanism and the process of the evolution of this order.

The present study deals with the chromosomes of two species of common edible crabs belonging to the Brachyura of the decapod Crustacea: *Chionoecetes opilio* O. FABRICIUS and *Erimacrus isenbeckii* (BRANDT).

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Materials and Methods

Chionoecetes opilio O. FABRICIUS and *Erimacrus isenbeckii* (BRANDT) are well-known as tasty edible crabs in Japan. The former species, known as "Zuwai" in Japanese, has a wide distribution from the western Japan Sea to the northern Pacific. It is a member of the Family Majidae, Oxyrhyncha, Branchygnata, Brachyura, Reptantia in the Order of Decapoda. The latter species, having the Japanese name "Kegani" or "Ôkurigani", is widely distributed from the coast of Hokkaido to the northern Pacific. It is a species of the Family Atelecyclidae, Brachyrhyncha. Both belong to the same Tribe, Brachygnata. The specimens which provided material for this study were collected by fisherman at Mori, Uchiura Bay, Hokkaido, in Feburary, 1963.

The testes were pulled out under the carapace and fixed immediately after

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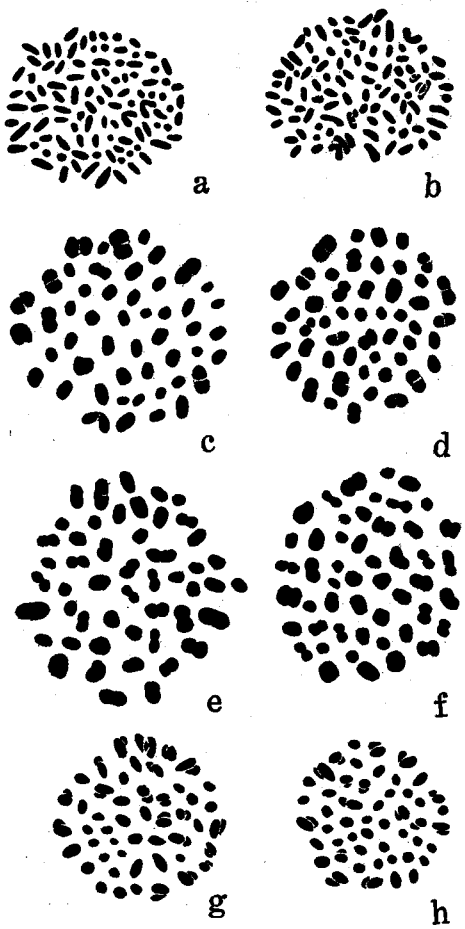
capture with Niiyama weak Flemming's solution. Sections were cut 10 micra in thickness by the routine paraffin technique. They were stained with Heidenhain's iron-haematoxylin.

Results

1) *Chionoecetes opilio* O. FABRICIUS

Spermatogonium: The spermatogonial cells were found constituting the inner thick wall of seminal tubules, surrounding many mature spermatozoa in a central space. Dividing figures are found rather frequently among resting cells in the cyst. Textfigure 1, a and b, are representatives of chromosomes of the spermatogonial division. The chromosomes constitute a circular equatorial plate, being well apart from one another. It is not difficult, therefore, to count the number of chromosomes. Based on the counting of several clear plates, the diploid number was determined to be 108. The spermatogonial complement was of a polymorphic nature: out of the 108 chromosomes, 4 were metacentric V-shaped elements, while the remaining ones were acrocentric in general appearance showing gradual decrease in size. The chromosome number, 108, was two more than that of *Macrocheira kaempferi* (Niiyama '39) which belongs to the same Family, Majidae. The diploid constitution, 4V+104R, was 12 less in V and 14 more in R than those of *Macrocheira kaempferi*.

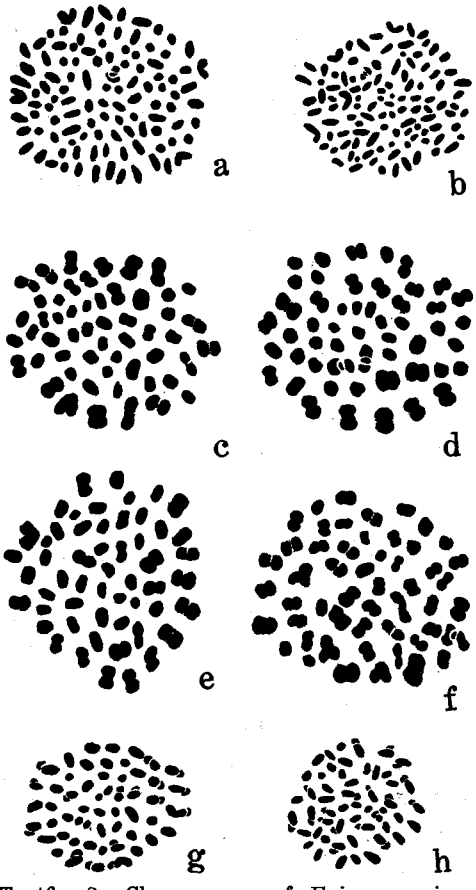


Textfig. 1. Chromosomes of *Chionoecetes opilio*: a-b, spermatogonial metaphases. c-f, primary spermatocyte metaphases. g-h, secondary spermatocyte metapphases. ×3700

Spermatocytes: Divisions of primary and secondary spermatocytes took place synchronously within a cyst. Many metaphase plates available for close observation of the haploid chromosomes were obtained in this species. Textfigure 1, c-f, are those

of primary spermatocytes at metaphase. Metaphase polar views showed consistently 54 bivalents, dumbbell and rectangular in shape, being in a beautiful circular arrangement. Some the larger bivalents exhibited a median transverse suture, as were commonly found in other decapod Crustacean bivalents (Niiyama '59, '62). At anaphase, all the bivalents separated simultaneously into two equal daughter halves.

Next to the primary spermatocytes in the course of division, the second division took place abundantly in every cyst. Equatorial plates at metaphase were about one half in diameter to those of the first division. There were 54 chromosomes in dyad nature in every metaphase plate of the second division (Textfig. 1, g-h). Two elements of metacentric nature and fifty-two acrocentrics were generally apparent. At anaphase, all the elements separated synchronously into two equal daughter halves. Through the two meiotic divisions, no special chromosome, characteristic to the sex chromosome in form or behaviour, could be observed at all.



Textfig. 2. Chromosomes of *Erimacrus isenbeckii*: a-b, spermatogonial metaphases. c-f, primary spermatocyte metaphases. g-h, secondary spermatocyte metaphases. ×3700

2) *Erimacrus isenbeckii* (BRANDT)

Spermatogonium: Due probably to the season of collection, almost all the testicular cysts were filled with mature spermatozoa. Within thin inner walls of the cyst, however, dividing figures of spermatogonial cells were found very rarely. Textfigure 2, a, is the ideal metaphase plate so far observed. The chromosomes distribute themselves well apart from one another without ambiguous presentation. Chromosome counts made of several metaphasic cells revealed that there were 100 chromosomes in every equatorial plate. The spermatogonial complex was polymorphic in nature: out of the 100 chromosomes two were metacentric in general appearance, being V-shaped, while the remaining 98 appeared to be acrocentric in general feature, varying from long rods to short dots. In Textfigure 2, b, are

shown spermatogonial chromosomes containing 2 metacentric V-shaped elements and 98 acrocentrics. This number is 24 less than that of *Telmessus cheiragonus* belonging to the same Family, Atelecyclidae. The chromosome garniture of the present species is 6 in metacentric chromosome and 18 in acrocentric ones less than those of the other species of the Family (Niiyama '42).

Spermatocytes: In a comparatively small portion of a testis, spermatocytes in process of meiotic division were observed. Division of the primary and secondary spermatocytes took place simultaneously. Textfigure 2, c-f, shows examples of primary spermatocytes at metaphase, each of which showed 50 bivalents. All the bivalents appeared as dumbbell- and rectangle-shaped ones, commonly occurring in Decapoda. Some larger bivalents exhibited in each a median transverse suture. At anaphase, all the bivalents separated into equal halves simultaneously.

Secondary spermatocytes at metaphase were rather abundant in some cysts. They were characterized by a smaller diameter than the primary spermatocytes. The individual chromosome exhibited a distinct dual nature scattering without any overlapping which rendered difficult the chromosome count. Textfigure 2, g-h, show examples of metaphase chromosomes. Chromosome counts revealed the occurrence of 50 chromosomes in every equatorial plate. Nothing particular was found in the mode of the present division: every dyad divided into two daughter elements equal in shape and size.

In the light of the above findings, the conclusion was made that the chromosome number of the present species was 100 in diploid and 50 in haploid, and that the complement was represented by 2V+98R. There were no chromosomes particular in form and behaviour in the course of the two meiotic divisions.

Discussion

Chionoecetes opilio and *Erimacrus isenbeckii* are members of the Tribe Brachygnata, Brachyura, Reptantia of the Order Decapoda. The former species, however, is a species of the Family Majidae, Oxyrhyncha, while the latter is a member of the Family Atelecyclidae, Brachyrhyncha. In the Brachyura, twenty-three species have been investigated chromosomally mostly by the present author. All the species were found to have more or less than 100 chromosomes with the exception of several species of the Family Grapsidae and one species of the Family Atelecyclidae (Niiyama '59). Six species of the Family Grapsidae, so far studied, were reported to have an X-Ymechanism having a larger number of chromosomes than 100. On this basis, therefore, this family may be a group slightly separated from the other families of the Brachyura. The Family Atelecyclidae is a unique

one, since the only hitherto cytologically investigated species, *Telmessus cheiragonous* has a large chromosome number, 124, furnishing no evidence for the special chromosome. The present species, *Erimacrus isenbeckii*, is a member of the same Family, and has 100 chromosomes involving no particular chromosome. In this situation it is probable that the Family Atelecyclidae may be a taxonomically indefinite group. *Chionoecetes opilio*, a member of the Family Majidae, is characterized by a regular number of chromosomes in Brachyura. In the two species considered here, no particular chromosome was demonstrated, as far as the observations have gone. Brachyura involved certain species belonging to the Family Grapsidae as well as to the Subfamily Portuninae in which clear-cut sex-chromosomes were detected (Niiyama '37, '38, '41).

Summary

The chromosome number of *Chionoecetes opilio*, a member of the Family Majidae, was found to be 108 in $2n$ and 54 in n. The diploid complement is formulated as 4V+104R.

The chromosome number of *Erimacrus isenbeckii* belonging to the Family Atelecyclidae was shown to be 100 in $2n$ and 50 in n. The diploid constitution is shown by 2V+98R.

Neither species has a chromosome, particular in shape and behaviour during meiotic phases characteristic to the sex-chromosome.

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