metacentric chromosomes, only 2 pairs of small acrocentrics and about 40 microchromosomes. The karyotype of *A. Naccarii* consists of 75 pairs meta- and submetacentric, 6 pairs of acrocentric and about 76 microchromosomes. Although the number of chromosomes is the same, the karyotypes of *H. huso* and *A. sturio* are different and easily distinguishable by the presence in *H. huso* of a pair of large acrocentric which is lacking in *A. sturio*. *A. Naccarii* appears to be a polyploid, and by considering the morphology of the larger chromosomes, its karyotype differs from those of both *H. huso* and *A. sturio*.

The karyotypes of the above species of Acipenseridae are characterized by a high chromosomes number and by a large number of microchromosomes, similar to that found by OHNO et al.[3] for *S. platorhynchus*; this condition seems to be valid for the whole family of these Chondrostei. OHNO[3] also puts the question whether the high chromosome number of sturgeons is due to poliploidy; our results show that the number $2n$ = about 116 is widely distributed and perhaps it is not a polyploid condition; probably polyploid species, such as *A. Naccarii*, with about 240 chromosomes do exist.

The Russian authors[2,4] seem not to have noticed the microchromosomes; by considering only the larger meta- and submetacentric chromosomes, the karyotypes they describe are similar to those reported here. Therefore we believe that also *A. stellatus*, *A. nudiventris* and *A. ruthenus* have a fundamental chromosome number of about 120 similar to *H. huso*, *A. sturio* and *S. platorhynchus*; while *A. güldenstädti* has a complement of about 240 chromosomes like *A. Naccarii*, and both might be polyploids.

Many species of Acipenseridae produce easily interspecific and intergeneric hybrids[1,2]; the taxonomy of these species should be revised. The cytogenetic approach could provide a contribution to these problems. A working hypothesis to be tested is that *H. huso*, *A. stellatus*, *A. ruthenus* and *A. nudiventris*, which produce fertile hybrids and also have similar karyotypes characterized by the presence of 3 acrocentrics chromosomes, may be strictly related species or even the same species. Since *A. güldenstädti* and *A. Naccarii* might both be polyploid, the comparison of their karyotypes could thraw light on their reciprocal taxonomical relationship. *H. huso* and *A. güldenstädti* produce unfertile hybrids[2]. There is at present no available evidence on the derivation of *A. güldenstädti* and *A. Naccarii* as polyploid species; the morphology of the larger chromosomes of *A. Naccarii* differs from that of *H. huso* and *A. sturio*.

Résumé. On présente l'étude caryologique des trois espèces d'Esturgeons des eaux italiennes. L'espèce *Huso huso* a un nombre diploide d'environ 116, dont 34 couples de chromosomes métacentriques et submétacentriques, 3 couples de chromosomes acrocentriques, et environ 38 microchromosomes. L'espèce *Acipenser sturio* est caracterisée par environ 116 chromosomes, dont 35 couples métacentriques et submétacentriques, 2 couples de petits acrocentriques, et 40 microchromosomes. L'espèce *Acipenser Naccarii* est caracterisée par 240 chromosomes environ, soit, 75 couples de chromosomes métacentriques et submétacentriques, 6 couples d'acrocentriques et environ 78 microchromosomes. Les données caryologiques sont confrontées avec la systématique des Acipenseridae.

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Oceanian Type Black Rats (*Rattus rattus*) with a Subtelocentric M_2 Chromosome and C-Type Transferrin Obtained from North America

Oceanian type black rats with 38 chromosomes have been found widely in the world, namely in Oceania, South America, Europe, North America, Central Asia, Southwest Asia and Africa. The idiogram of these rats differs markedly from that of the Asian type with 42 chromosomes, by having 2 large metacentric pairs. According to YOSIDA et al.[1-3], the larger metacentric pair (M_1) have originated in the Robertsonian fusion of acrocentric pairs No. 4 and 7 and the other smaller one (M_2) in that of the acrocentric pairs No. 11 and 12 in the Asian type black rat. Sizes of 2 arms of the M_2 chromosome in these rats are usually similar. However, a subtelocentric M_2 chromosome, which is remarkable by having a shorter arm, was found in the black rats obtained from North America. In this paper the idiogram of these rats will be reported with special interest in the origin of the subtelocentric M_2 chromosome. In addition, electrophoretic analysis of their sera was carried out, indicating Oceanian type transferrin in those rats and also suggesting the homogeneous nature of the breeding colony.

The black rats (*Rattus rattus*) used in the present study were kindly supplied from Dr. REX MARSH and Mr. RAY RECORD in the Department of Animal Physiology, University of California at Davis, when we visited there in August, 1973. According to Dr. MARSH's correspondence 3 pairs of black rats were collected in San Lorenzo, California in 1970, by Mr. VAL DUTSON of Public Health in Berkeley, and since then they have been bred in an outdoor population cage. 10 rats (5 females and 5 males), randomly caught from the breeding colony, were given to us to send to Japan.

Chromosomes of these rats were observed in short-term cultured cells from their tail tips following the procedure described in the previous papers[4]. Chromosome preparations were made by conventional air drying technique and stained with Giemsa solution. To observe the banding patterns of chromosomes, SDS technique[3] was applied. In cutting the tail tip, a small blood sample, approximately 0.5 ml, was obtained for electrophoretic

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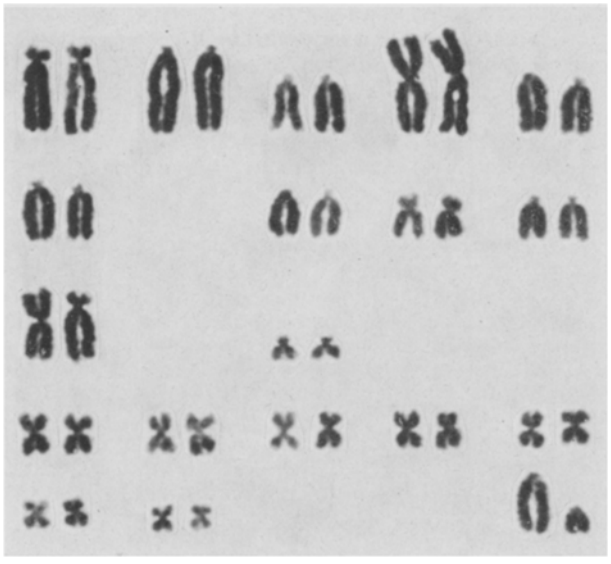

Fig. 1. Idiogram of a black rat with metacentric and subtelocentric M_2 chromosome pair (left in 3rd row) obtained from Davis' colony.

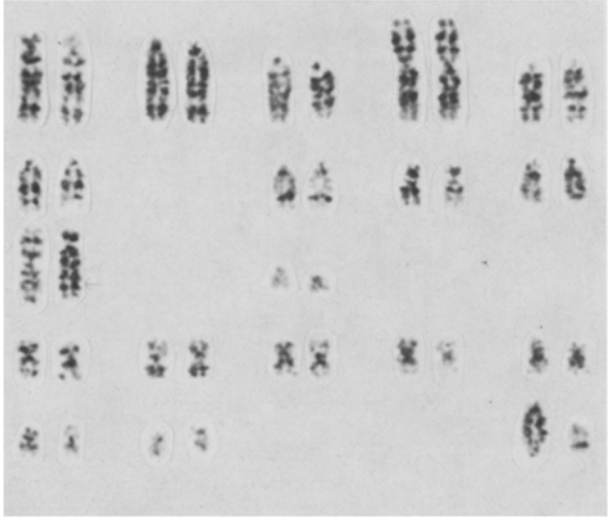

Fig. 2. G-banding pattern analysis of a karyotype in the black rat with metacentric and subtelocentric M_2 pair (left in 3rd row).

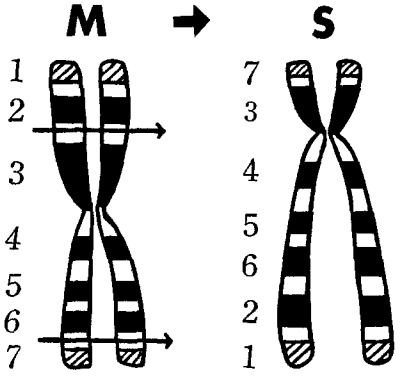

Fig. 3. Schematic representation of banding patterns in metacentric and subtelocentric M_2 chromosomes. Breakage occurs at 2 points (indicated by arrows) of the metacentric chromosome (M), one between bands 2 and 3 and the other one between bands 6 and 7; pericentric inversion occurs, and then the subtelocentric chromosome (S) is developed.

analysis of transferrin types, which was performed by the combined method of acrinol pretreatment and thin layer acrylamide gel electrophoresis[5].

All 10 black rats obtained from the Davis' colony were characterized by the Oceanian type with 38 chromosomes, except one with 37 chromosomes. All of them had 2 large biarmed autosome pairs (M_1 and M_2). Among them the larger one (M_1) was the same metacentric pair as those found in the other Oceanian type black rats. By the G-banding pattern analysis of the chromosomes, the origin of the biarmed autosome was confirmed to be originated from the Robertsonian fusion of pairs No. 4 and 7 in the Asian type black rat. On the other hand, the smaller one (M_2) in 5 rats was a similar metacentric homomorphic pair to those found in the other Oceanian type black rats. They were also confirmed to be derived from Robertsonian fusion of pairs No. 11 and 12. The remaining 5 rats were remarkable by having a metacentric and a subtelocentric heteromorphic M_2 pair. The morphology of the subtelocentric M_2 chromosome was similar among the 5 rats examined. Size of the metacentric M_2 chromosome and that of the subtelocentric M_2 were almost the same (Figure 1). This suggests that the subtelocentric M_2 was derived from pericentric inversion of the metacentric one. The comparison of G-banding patterns between metacentric and subtelocentric M_2 chromosomes strongly suggested that the latter was derived from the pericentric inversion of the former (Figure 2). As already demonstrated by us using G-band technique[3], short arm of the M_2 chromosome has 3 bands, 1 palely stained and 2 heavily stained bands (1 to 3) and the long arm has 3 heavily stained and 1 weakly stained bands (4 to 7). Inversion of the M_2 chromosome could have occurred by breakage at 2 points; one between the bands 2 and 3, and the other between the bands 6 and 7 (Figure 3).

Interestingly, 1 rat among 10 had 37 chromosomes with a single *X*-chromosome. External features of this rat, however, are those of the normal female. Details of this study are reported in an other paper[6].

Acrylamide gel electrophoretic analysis of the sera obtained from the 10 rats equally exhibited C type transferrin band which was common in the Oceanian type rats collected from Southwest Asia and Oceania[7]. Typical electrophoretic pattern was demonstrated in Figure 4. This result probably proves that the breeding colony has been strictly prevented from outcross.

According to Yosida et al.[2], the original karyotype of the black rat is an Asian type with 42 chromosomes. They[8,9] also suggested that the first Robertsonian fusion between pairs No. 11 and 12 had occurred in Southwest Asia developing the Ceylon type black rats with 40 chromosomes. The second Robertsonian fusion in the Ceylon type had arisen in the Southwest Asia developing Oceanian type black rats with 38 chromosomes. The latter had migrated first to Europe through Central Asia and from Europe to the new continent, North and South America with the movement of European people.

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Oceanian type black rats in Hawaii have been reported by YOSIDA and TSUCHIYA[10]. DAVIS and BAKER[11] have also reported Oceanian type idiogram in all black rats collected in Texas, Washington, Puerto Rico and Mexico. The M_2 pair of those rats was typically metacentric. The subtelocentric M_2 observed in the present material has never been reported in any locality of the world. As described above, the subtelocentric has been derived from the pericentric inversion of the metacentric M_2 chromosome. Such inversion seems to have occurred considerably more recently in California (San Lorenzo?) after the rats migrated there. All 5 rats with the subtelocentric M_2 showed heterozygous pair consisting of subtelocentric and metacentric. Have the rats with the subtelocentric M_2 pair become lethal? To solve this problem we are now breeding these rats in our laboratory, and the result of this study will be reported later[12].

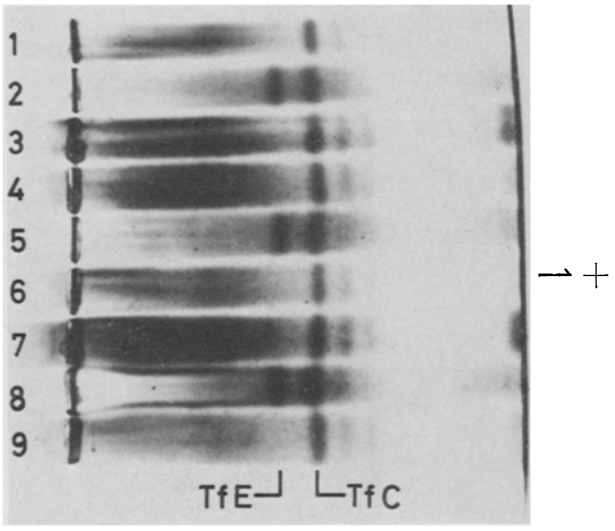

Fig. 4. Demonstration of C type serum transferrin by thin layer acrylamide gel electrophoresis combine with acrinol pretreatment[7]. Sample Nos. 2, 5, 8: Standard samples, TfC E. Sample Nos. 1, 3, 4, 6, 7, 9: Sera of Oceanian type *Rattus rattus* obtained from California.

Résumé. Dix rats (*Rattus rattus*) d'une colonie californienne ont été examinés. Cinq sont de type océanique. Les cinq autres ont 1 paire M_2 hétéromorphe, formée d'un métacentrique et d'un sub-métacentrique, ce qui implique une inversion péricentrique. Les transferrines sont du type océanique.

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G-Band Patterns, Chromosomal Homologies, and Evolutionary Relationships Among Wild Sheep, Goats, and Aoudads (Mammalia, Artiodactyla)

The tribe Caprini (family Bovidae) contains 5 genera[1,2], among which the wild sheep (*Ovis*) and goats (*Capra*) are most closely related[3]. The aoudad (*Ammotragus*) of North Africa shares affinities with both, especially the latter[2,3]. *Ammotragus*, together with the primitive caprine, *Hemitragus*, also shares behavioral and morphological characters with the tribe Rupicaprini, from which caprines probably evolved[3,4], and GEIST[3] postulated that *Ammotragus* resembles the form ancestral to *Ovis*, and is itself derived from rupicaprine ancestors. *Capra* presumably represents a separate evolutionary lineage derived from ancestral caprine stock. The divergence of sheep and goat lineages probably occurred no later than the early Pleistocene[3,5], contrary to PAYNE's[6] hypothesis that *Ovis* and *Capra* were derived from a single interbreeding caprovine stock in late Paleolithic time.

Chromosome analyses of these 3 genera demonstrated a common fundamental number ($NF = 60$). All goats, both domestic (*Capra hircus*) and wild (*C. ibex*, *C. falconeri*) have $2n = 60$, and karyotypes comprised entirely of acrocentric autosomes, a pattern consistent with the primitive bovid chromosome complement proposed by WURSTER and BENIRSCHKE[7]. *Ammotragus lervia* has a karyotype similar to $2n = 58$ *Ovis*[8]. Within *Ovis*, diploid numbers vary; the karyotypes observed in *O. vignei* ($2n = 58$), *O. ammon* ($2n = 56$), and in *O. musimon*, *O. orientalis*, *O. canadensis* and *O. dalli* ($2n = 54$) were postulated to be derived from a series of centric fusions resulting in 1, 2, or 3 pairs of biarmed autosomes[9].

A Giemsa-banding technique[10] was first utilized by us to evaluate chromosomal homologies of the biarmed autosomes of wild sheep[11]. More recently, these G-band

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