The Discovery of Chromosome Trisomy 22: A Novel Chromosomal Feature of Siamang (*Symphalangus syndactylus*)

Sitthisak Jantarat¹, Alongkoad Tanomtong^{2,*}, Praween Supanuam²,
Sarawut Kaewsri³ and Worapon Aengwanich⁴

¹ Biology Program, Department of Science, Faculty of Science and Technology, Prince of Songkhla University (Pattanee), Muang, Pattanee 94000, Thailand

² Genetics Program, Department of Biology, Faculty of Science, Khon Kaen University, Muang, Khon Kaen 40002, Thailand

³ Program in Applied Biology, Department of Science, Faculty of Science, Buriram Rajabhat University, Muang, Buriram 31000, Thailand

⁴ Stress and Oxidative Stress Unit, Faculty of Veterinary Medicine and Animal Science, Mahasarakham University, Muang, Mahasarakham 44000, Thailand

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Summary For this knowledge, the discovery of the chromosome trisomy 22 in siamang (*Symphalangus syndactylus*) is the first report. To our scheme, blood sample was collected from one female of Khao Kheow Open Zoo (KKOZ), Chonburi province, Thailand. Chromosomes were prepared by lymphocyte cells culture at 37°C for 72 h then stained by G banding technique. The result indicated that diploid ($2n$) of siamang was 51 (one irregular chromosome was found). The autosome consists of 47 metacentric and submetacentric, 2 telocentric chromosomes. The X chromosome was metacentric chromosome. The increasing of one metacentric chromosome 22 lead to the presence of the irregular chromosome and the changing of $2n=50$ to $2n=51$. The augmentation of chromosome 22 was found in all metaphase cells of the entire study. We suggested that the chromosome increasing is a consequence from the non-disjunction in meiosis cell division.

Key words Chromosome, Trisomy 22, Siamang (*Symphalangus syndactylus*).

Animals in family Hylobatidae (gibbons) are small apes that live on trees and not come down to the ground. Its arms and fingers look like a hook for holding branch. Its activities usually in daytime. It eats fruit, treetop, flower, leaf and insect and lives along with group like a family with one married couple. Gibbons are exist in all parts of Thailand. There are 4 species, white-handed gibbon (*Hylobates lar*), dark-handed gibbon (*Hylobates agilis*), pileated gibbon (*Hylobates pileatus*) and siamang (*Symphalangus syndactylus*) (Parr 2003).

The autosomal trisomies have been reported in 11 nonhuman primates from eight different species (McClure *et al.* 1969, McClure 1972, Turleau *et al.* 1972, Andrieu *et al.* 1979, Ruppenthal *et al.* 1983, Vigfusson *et al.* 1986, Ward *et al.* 1994, de Best *et al.* 1995, Moore *et al.* 1998, Best *et al.* 1999, Lear *et al.* 2001, Ruppenthal *et al.* 2004) (Table 1). There were many previous reports on cytogenetics of siamang including Bender and Chu (1963), Klinger (1963), Chiarelli (1972), Groves (1972), Couturier *et al.* (1982), Koehler (1995) and Muller *et al.* (2003). However, chromosome trisomy 22 in siamang has never been reported before. The chromosome trisomy 22 that we found is the novel chromosomal feature of siamang.

* Corresponding author, e-mail: tanomtong@hotmail.com

Table 1. Autosomal trisomies have been reported in 11 nonhuman primates from eight different species

Homology to human trisomy	Reference
Human trisomy 13	
Pig-tailed macaque (<i>Macaca nemestrina</i>) 43, XY, +16 and cells with other trisomies (variable karyotype)	Vigfusson <i>et al.</i> (1986)
Long-tailed macaque (<i>M. fascicularis</i>) 43, XY, +16	Ward <i>et al.</i> (1994)
Pig-tailed macaque (<i>M. nemestrina</i>) 43, XX, +16	Best <i>et al.</i> (1999)
Human trisomy 17	
Baboon (<i>Papio hamadryas</i>) 43, XX, +16	Moore <i>et al.</i> (1998)
Human trisomy 18	
Pig-tailed macaque (<i>M. nemestrina</i>) number one 43, XX, +18	Ruppenthal <i>et al.</i> (1983)
Pig-tailed macaque (<i>M. nemestrina</i>) number two 43, XX, +18	Ruppenthal <i>et al.</i> (1983)
Pig-tailed macaque (<i>M. nemestrina</i>) number three 42, XX/43, XX, +18 (mosaic karyotype)	Ruppenthal <i>et al.</i> (1983)
Rhesus monkey (<i>M. mulatta</i>) 43, XX, +18	de Best <i>et al.</i> (1995)
Bonobo (<i>Pan paniscus</i>) 49, XX, +17	Lear <i>et al.</i> (2001)
Human trisomy 21	
Chimpanzee (<i>P. troglodytes</i>) 49, XX, +22	McClure <i>et al.</i> (1969)
Lowland gorilla (<i>Gorilla gorilla</i>) 49, XY, +mar exact origin of marker was not confirmed	McClure (1972)
Orangutan (<i>Pongo pygmaeus</i>) 49, XX, +22	Andrie <i>et al.</i> (1979)

Materials and methods

Blood samples from the jugular vein were collected with aseptic technique from one female siamang which were kept in Khao Kheow Open Zoo (KKOZ), Chonburi province, Thailand and then applied for cytogenetic studies by lymphocyte culture of whole blood samples. The culture cells were treated with a colchicine-hypotonic-fixation-air-drying technique followed by G-banding with Giemsa's adapted from Rooney (2001) and Campiranon (2003). G-banding can provide an accuracy homologous chromosome of mammals. Twenty cells of each individual chromosome checks, karyotyping and idiogramming were accomplished by using a light microscope as previously described (Supanum *et al.* 2007).

Results and discussion

According to the scheme, G-banding technique indicated that female siamang has $2n=51$ instead of the normal $2n=50$ (one irregular chromosome which different from the previous reports) (Bender and Chu 1963, Klinger 1963, Chiarelli 1972, Groves 1972, Couturier *et al.* 1982, Koehler *et al.* 1995, Muller *et al.* 2003).

Our results demonstrated that the autosome of female siamang consists of 47 metacentric and submetacentric chromosomes, 2 telocentric chromosomes (Fig. 1). The results are differ from Bender and Chu (1963), Klinger (1963) and Chiarelli (1972) that reported the 46 metacentric and submetacentric chromosomes, 2 telocentric chromosomes of siamang. The difference is resulted from the addition of metacentric autosome chromosome 22 that lead to trisomic. Therefore, this study is the first report on trisomic chromosome of siamang. For the sex chromosome, the results indicated that the X chromosome of female siamang was metacentric chromosome which is in agreement with Bender and Chu (1963), Klinger (1963) and Chiarelli (1972).

The karyotyping of metaphase cells from G-banding technique make a confirmation that the irregular chromosome was metacentric autosome 22. Moreover, that addition of chromosome 22 was found in all metaphase cells for the entire research. It is a result of the chromosome non-disjunction (meiosis I or II) which is in agreement with those the addition of human chromosome 13,

Fig. 1. Metaphase chromosome (top) and karyotype (bottom) of female siamang (*Symphalangus syndactylus*) $2n=51$, by G-banding, chromosome trisomic 22 (arrows).

18, 21, X chromosome in male, X chromosome in female and Y chromosome in male and the irregular chromosome causes Patau's syndrome (47, +13), Edwards's syndrome (47, +18), Down's syndrome (47, +21), Klinefelter's syndrome (47, +XXY), XXX syndrome (47, +XXX) and XYY syndrome (47, +XYY) (Cumming 1988). The autosomal trisomies have been reported in 11 non-human primates from eight different species. Some of these animals have a marked similarity in phenotype to the homologous syndromes reported in humans. The chimpanzee, *Pan troglodytes* (McClure *et al.* 1969, McClure 1972) and an the orangutan, *Pongo pygmaeus* (Andrle *et al.* 1979) with trisomy 22 indicated both of some clinical and behavioral symptoms of human Down's syndrome. The great apes' chromosome 22 is homologous to human's chromosome 21 (Wienberg *et al.* 1992). The gorillas (*Gorilla gorilla*) which have the same chromosomal abnormality expressed both of normal morphological and behavioral characteristics (Turleau *et al.* 1972).

In this study, female siamang was born in Khao Kheow Open zoo (KKOZ) and separated feed from parents. Now it is 1 year old. For phenotype and behavior checking, it was similar to other siamang. We have no detail of its parents because of it was donated to the Zoo. Although we were not taken any action but we predicted that this siamang had abnormally oocyte results from unnatural synapsis of homologous chromosome in meiosis I. Then trivalent of Chromosome 22 was appeared and effected to chromosome separating in anaphase I. One chromosome piece was separated to one site while two chromosome pieces were separated to another site lead to normal and abnormal gamete, respectively.

Conclusion

In this study, siamang's chromosome number was $2n=51$ which consists of 47 metacentric and submetacentric chromosomes, 2 telocentric chromosomes. The X chromosome was metacentric chromosome. The increasing of one metacentric chromosome 22 lead to the presence of the irregular chromosome and the changing of $2n=50$ to $2n=51$. We suggested that the chromosome increasing is a consequence from the non-disjunction in meiosis cell division.

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