The evolution of reciprocity and exchange*

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Contents

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Introduction and summary

Most economists believe that money is primarily medium of exchange and that indirect exchange with money has developed from direct barter exchange. These doctrines are derived from the authoritative classics such as Aristotle [a] (Bk. V, Pt. 5) and Adam Smith [1776] (Bk. I, Ch. IV). But exchange system of the earliest human beings was not made from independent individuals, nor was barter exchange the first reciprocal trade.

Junichiro Itani and other primatologists proposed that the exchange economy of human beings was originated from food sharing among a group of adult chimpanzees, bonobos or capuchin monkeys. Furthermore it became clear that food sharing among adults evolved from food sharing with offspring, because any species that shares food among adults also shares food with offspring without exception.

Necessary condition for food sharing among unrelated adults may be the state where children can sometimes get food from unrelated adults if they pestered. In primates maternal behavior to breed infant has been extended to the adoption of unrelated infant. Furthermore chimpanzees, capuchin monkeys and human beings admit interspecies adoption and pet breeding. Behaviors which neither kin selection nor reciprocal altruism can explain has been evolved. Biologists who are interested in these phenomena argue that adoption of unrelated infant is evolutionarily maladaptive. Nevertheless, for the species in which child care is not merely innate and instinctive behavior but also it contains skills which will be improved if one experiences it more and more, and the child who is brought up with other child has more possibility to survive and reproduce than the child who grows as only child, adoption of unrelated infant must be adaptive and interspecies adoption can be adaptive, too. We can regard the adoption of unrelated infant as self-investment. The origin of fairness and

egalitarianism found in food sharing among unrelated adults seems to go back to the relation between adopted child and true child.

Hunting together in return for the shared food is another example of self-investment. Repayment for the food and training for oneself are consistent in this case. Also in the case where a female who have got food from a male copulates with him, the repayment is not contradict to her own interest because she may have his baby. In these cases reciprocity and self-interest does not contradict each other and there is no room for prisoner's dilemma.

One of the origins of reciprocal altruism in primates must be food sharing among adults where repayment for food itself accrue the benefit for the recipient of food but the recipient is not necessarily aware of the benefit. Strictly speaking this is not altruistic. In other cases where repayment contradicts self-interest of the recipient, without any mechanism of sanctions against rout-cutting or free-riding, that is, reducing the repayment or paying nothing for the food, reciprocal altruism cannot work smoothly and establish itself.

Food sharing in which we can observe the sprouting of reciprocal altruism yields fruits from self-investment. The gains such as skills of hunting and nursing belong to the recipient who has served to the donor of the food, but other gains do not belong exclusively to only one individual of those who have took part in hunting or nursing. Game of cooperative hunting and a baby as an outcome of mating are the examples of the latter. A baby always has half of the genes of both parents, but in the case of hunting for example, the problem how to divide the game within the participants remains. Those who did not get fair division are apt to become uncooperative and the gains of succeeding hunting tend to diminish. Those who try to keep the game to themselves or distribute it partially are apt to lose reputation and those who have good talent no longer want to take part in them.

Foods are often distributed from one individual to many others, so quasi-indirect reciprocity seems to have been evolved first in food sharing, and direct reciprocity between two individuals becomes a problem on the basis of quasi-indirect reciprocity. Direct reciprocity between two individuals seems to be evaluated tacitly by third party because outcome of the interaction cannot be concealed from any third party if one of the two does something unfair and the sufferer makes a noise. The third party that can judge the legitimacy of retaliation may repress vicious circle of revenge.

Third party can be expressed as spectator. The role of spectator in Smith [1759] is suggestive from this point of view. As for human beings impartial third party or impartial spectator in the breast utters voices of conscience. Impartial spectator in the breast must be key person for morality. Impartial spectator in one's breast and impartial spectator in another's breast is identical, so Impartial Spectator is unique and peerless, and has been called God, True Self or Inner Self, Truth Body (Dharma-kāya in Sanskrit) and so on (Hirayama [2009] Vol.1&2).

The contrast between the insiders tied by the networks of reciprocal cooperation and the outside enemies may be the main social structure of chimpanzees and capuchin monkeys. Their reciprocal behavior such as mutual grooming and food sharing takes place among the members of the same group. Between the male of a group and that of another group mutually altruistic interaction occurs seldom if ever in wild life because they are competing for females and resources.

We can regard the structure that distinguishes rigidly between the insiders and the outsiders of a group as an extension of mother-child bond. Recent study about oxytocin, best known for its role in uterine contraction at the time of the childbirth and lactation, verified that it also breed confidence among people. But further studies clarified that oxytocin promotes altruistic and self-sacrificing actions within the group, and defensive, but not offensive, aggression toward competing out-groups, and

reinforces human ethnocentrism.

Quasi-indirect, indirect and direct reciprocity is often attended with the sentiments that those who repay sufficiently are allies but those who do not are enemies, and one should retaliate against betrayers, because oxytocin acted at all times while food sharing begun between mother and child evolved to create the reciprocal interactions between unrelated adults. It is the intimate and physical contacts which chimpanzees and bonobos often do before food sharing, for example, hugging, kissing each other, and having sexual intercourse, that stimulate to secrete oxytocin, and oxytocin promote physical contacts, so positive feedback acts between them. As a result, the deepening of friendly atmosphere and the increase of oxytocin take place jointly. After these preliminary stage food sharing begins.

As long as we must suppose that almost the same mode of food sharing as observed among *Pans* today was once held among the common ancestors of them and human beings, and that exchange economy and money of the latter has been evolved from it, all of the doctrines which regard direct barter as the oldest form of exchange or reciprocity are false.

In the process of food sharing, repay for food is such services as participating in hunting and sexual intercourse. Service is means of payment that anyone including those who have nothing to pay other than one's own body can use. Human beings tend to encourage reciprocity with those who appear to be healthy because the apparent health is the signal for working capacity and fertility. In this context exchange of different goods and services during comparatively long term must be expected and calculated reciprocity is in question. Typical example of such interaction is division of labor between males and females. So we can suppose that the calculated reciprocity of hominins began to evolve along with the formation of comparatively stable pair bond after branching off from the common ancestor of humans and *Pans*. The reason

why marriage in human beings requires to be approved by the group the couple belongs to or third party such as a priest is that each member of the couple can refrain from myopic behavior with the help of authoritative monitoring. Owing to the institutionalized marriage they can overcome prisoner's dilemma and maintain reciprocity in the long run. In chimpanzees independent breeding by mother is usual but in human beings breeding by couple and many others is common. Cooperation in breeding by formation of pair bond and so on seems to have encouraged the development of spontaneous prosociality and calculated reciprocity.

Depending on service as universal means of payment, hominins evolved with the development of spontaneous, strategic and calculated reciprocity. Not only human relations but also those between humans and nature have been regarded as reciprocal. We humans have been served to nature in order to receive favors. The idea of reciprocity led us to the practices to refrain from excessive hunting-gathering and helped us to devise agriculture and cattle-breeding.

Notwithstanding that there exists service as universal means of payment for anyone including those who have nothing but their own body, how money could evolve as means of exchange and payment? This is the true question concerning the origin of money.

The origin and evolution of the monetary economy must be grasped as follows. Reciprocal exchange by hominins was primarily confined within the members of the same group or community. On the contrary monetary exchange first evolved between communities, and money gradually became used in the contexts of reciprocal relationships within the community, so the community was changed in quality as monetary exchange prevailed. It is the diffusion of paying money in exchange for services such as various labors and sexual practices that has been important for this transition.

Many species of primates form patrilineal or matrilineal groups. In case of matrilineal species males get away from the group where they were born to the group where they mate, whereas in case of patrilineal species females get away from the group where they were born to the group where they mate. Doing so they avoid incest. Intergroup migration of the individuals to avoid incest must be the starting point from which intercommunal transfer of various goods and services have developed, and we may regard that as the archetype of money.

Early human beings formed patrilineal communities in most cases, so females who leave the home community to marry into a family belonging another community and have babies played the role to overcome exclusiveness of each community and relax hostilities among communities. A distinctive feature of the role human females play is that they preserves the relationship to their home family after wedding and intermediate between the family they married into and the family they had been born, and between the communities both family belongs to respectively, by contrast with that of female chimpanzees and bonobos. Among human beings emigration of marring females from their home community into another community inevitably brought about intercommunal exchange of goods and services. In ancient China shell of cowries which resembles female genitalia were perforated and used as money, so Chinese characters concerning monetary economy often have a radical “貝” that is the pictograph of cowrie. The origin of the word “money” is Roman goddess Juno Moneta who seems to be deification of Sabine women who lead Romans and Sabines to reconciliation and unification according to the tradition. Moneta as a symbol of the intermediation between communities became the origin of the word “money”.

Neandertals, the closest subspecies to human beings seem to have no ability for long-distance exchange. On the other hand human beings emerged about 200 thousand years ago began long- distance exchange about 130 thousand years ago. Besides, beads

of perforated small snail (*Nassarius gibbosulus*) shells, the oldest personal ornaments emerged then and has excavated from inland areas remote from seashore. So at the beginning of long-distance exchange perforated shells used as personal ornaments were transported from production areas to distant places. A snail shell encloses and protects the living. It may symbolize the womb and perforating it figures coitus or delivery. The emergence of long-distance exchange was closely related to the invention of the personal ornament that symbolizes female, and to transport and to exchange shell beads symbolized the migration and marriage of females. Beads were transported in the same direction or the opposite direction to the migration of females and their transfer and exchange symbolized marriage. These symbolic meaning of the ornaments seems to have advanced the development of long-distance trade. Each bead was standardized in weight, size and quality, so beads possessed three functions of money, i. e. medium of exchange, unit of value and store of value.

The objects of long-distance exchange were carried through many communities without being consumed, and some goods or services or humans moved in the opposite direction to repay them, so they were used as medium of exchange. We can explain the evolution of money in long-distance exchange by the standard tool of economics even if the good that became money did not have symbolic meanings as stated above. Any durable good becomes less valuable marginally as the amount of the good accumulated becomes larger. So the opportunities to get more valuable goods and services in return for the durable good increases as the amount of the good accumulated becomes more and more. For example the community of important place for obsidian trade which exclusively intermediates many production areas and many consumption areas can get it cheaper and sell it at higher price, so the community can earn copious profits. In the stage where general medium of exchange did not developed, the profit mainly consists of stock obsidian. As the amount of obsidian increases, marginal value of it decreases,

so they can pay with obsidian for more valuable goods and services. In this way the community that has accumulated larger amount of durable good begins to use the good as medium of exchange and the usage of the good as money gradually spreads over the surrounding areas. The good which can be exchanged for various goods and services easily becomes more saleable because more communities and more individuals within each community tries to get the good as medium of exchange, and the good gets the position of money in its area of circulation.

Marx [1867] thought that one special commodity became money and that money was originally used as general medium of exchange but transformed into capital by repeated increases through circulation. In fact money preceded and produced commodities. Money was primarily the symbol of fertility and self-propagation, and became used secondarily as general medium of exchange.

1. Food sharing in primates

Junichiro Itani who succeeded Kinji Imanishi and led Japanese Primatology to the top level in the world proposed the unique hypothesis that human economy have evolved from food sharing which we can see in the society of chimpanzees. The examples of food sharing among chimpanzees are as follows. A boy stretches out his hand to his mother who eating papaya and gets one piece of it. Five chimpanzees kill a monkey, then share and eat the meat. A chimpanzee breaks a stem of sugar cane into two pieces, and gives one of them to another chimpanzee. Itani argued, “We cannot see such food sharing behavior in other primates. The emergence of the behavior certainly changes the economic mechanism of their society. The society of other primates is based fully on the ability of individuals to live alone, but it may not be wrong to insist that the society of chimpanzees represents the figure of a society that is almost supported by economy. We can easily imagine that their psychological ability

to share food is a necessary condition to establish division of labor."(Itani [2008] p.15, *my translation*)

Bonobos or pygmy chimpanzees are members of *Pan* as well as chimpanzees, and they also share food with the others who beg. Itani recognized this and argued, "Food sharing contains several important problems. First, valuable food moves from one individual to another. This is the phenomenon that we cannot see in the society of Japanese macaques. The consumption system of 'from a hand to a mouth' suffers a delay, through roundabout rout of transfer. The individuals who have not originally acquired the food consume it. If I say that this is the emergence of the circulation economy, one might think that I am exaggerating the phenomenon. Nevertheless it is true that human economy cannot be established without this basic principle." (Itani [2008] p.325, *my translation*)

Pan is the genus closest to human being (*Homo sapiens*) among extant creatures. Hominin[1] split off from their common ancestor about 7 million years ago (Kawai [2010]). Itani conjectured that our common ancestors were used to share food at that time in almost the same way as chimpanzees and bonobos do now, and that the division of labor and circulation economy of human beings has evolved from their food sharing. The hypothesis proposed by Itani has been supported roughly by various findings but we need corrections at some minor points.

Kuroda argues as follows. Children of dogs and birds are fed by their parent(s), females of the wolves who stay in the den get food brought by others or swallowed, vomited and given by them only in the breeding season, and birds gives food to their spouse who warms the eggs. These giving and receiving of food are seen among birds and mammals widely in the case of breeding, whereas food sharing by *Pans* and

[1] I mean 'hominin' as tribe *Hominini* and 'human being' as *Homo sapiens*, following the taxonomy which excludes genus *Pan* from tribe *Hominini* (Wood and Richmond [2000]).

human beings is different qualitatively from those of other animals and birds. Our food sharing is based on the property rights that are recognized by others of the same species and the food owned by one is distributed to others. The emergence of such mechanism of food sharing was a qualitative jump or revolution attained by our common ancestors. (Kuroda [1999] pp.152-5)

Such an interpretation on the evolutionary history seems to recommend us human beings to regard *Pans* as our comrade and the emergence of our common ancestors as a distinguishing incident. But nowadays it is recognized widely that tufted capuchins, the most intelligent among new world monkeys living in South America use instruments and share food as cleverly as *Pans* (De Waal [1997a], Brosnan & de Waal [2003], Takimoto et al. [2010]), and we can no longer regard us human beings and *Pans* as unique comrade which has advanced intelligence among primates.

Itani conceived as follows. Japanese macaques form a matrilineal society where females belong to the same group until they die and males move from the group where they were born and raised into the new group where they mate. Their society is unequal where the ranking of individuals who belong to the same group and sex is defined (Watanabe [1997]). On the contrary *Pans* form a patrilineal society where males belong to the same group until they die and females move from the group in which they were born and raised into the new group where they mate. In their society egalitarianism is developing through food sharing and other behaviors. Imagining further that the egalitarian nature has fully developed in the human society living by hunting and gathering, he insists, “The most important fact is that the way that mankind have walked is not the matrilineal rout which end up with the completion of inherent inequality where no room for the dominance of contingent equality as a new social norm remains” (Itani [2008] p.352). But tufted capuchins who developed food

sharing and equality just like *Pans* form a matrilineal society (Izawa [1994]). So we cannot judge whether egalitarianism evolves or not according to the types of the society whether it is patrilineal (non-matrilineal) or matrilineal.

Furthermore the accumulation of reports concerning various species of primates becomes so abundant that we can now reconstruct the process how food sharing evolved persuasively (Fig. 1).

All the species of the apes of *Hominoidea* (superfamily of apes and hominins) to which human beings also belong share food with their offspring. Food sharing among adults is observed in bonobo (*Pan panicus*), chimpanzee (*Pan troglodytes*), Sumatran orangutan (*Pongo abelli*), Bornean orangutan (*Pongo pigmaeus*), so all the species of *Pan* and *Pongo* share foods among adults. Within the three species of gibbon (*Hylobatidae*) only yellow-checked gibbon (*Nomascus gabriellae*) shares food among adults. Lar gibbons (*Hylobates lar*) and siamangs (*Symphalangus syndactylus*) do not. Two species of *Gorilla* do not share food among adults, too. As we see above, food sharing among adults in apes emerged not only once in a unique position of the phylogenetic tree, but several times at the different positions.

After *Hylobatidae* split off, *Pongo* differentiated itself from the rest. The latter was divided into *Gorilla* and the other that became the common ancestor of *Pan* and *Hominini*. It is impossible to judge whether our ancestor shared food among adults before *Pongo* split off and *Gorilla* became not to share, or *Pongo* as well as common ancestor of *Pan* and *Hominini* began to share food independently.

It is probable that *Gorillas* do not share food among adults because food sharing among adults seems incompatible with their social structure. As we see later food sharing is a relationship among equal individuals, but the gap between the sexes of *Gorillas* is large. A mature male encloses females and has strong authority over his wives and children. Just like the socialist revolutions that abolished the free trade and

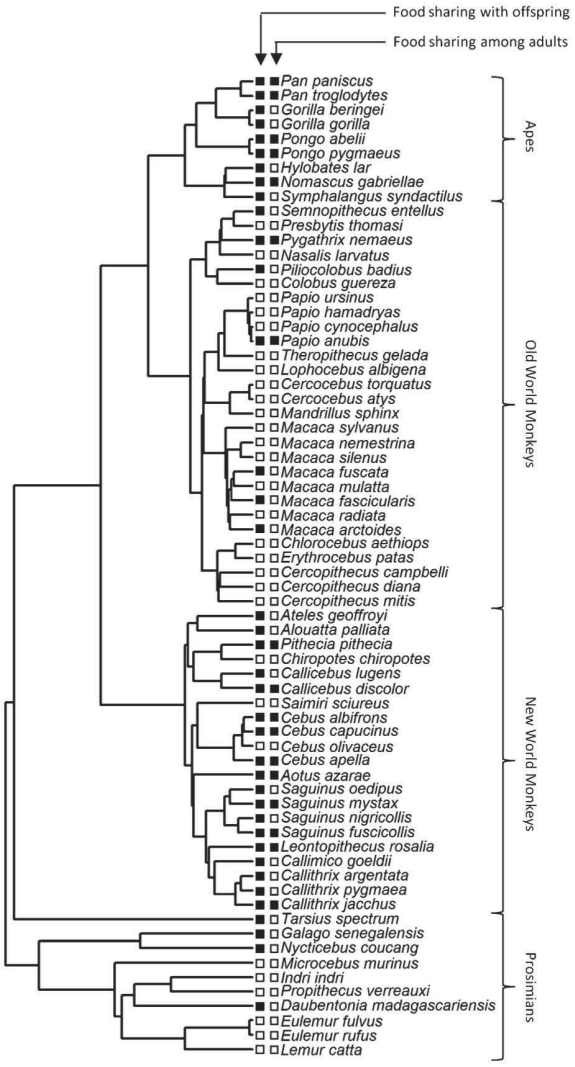

Fig. 1 Phylogenetic tree and food sharing in primates

The traits "food sharing with offspring" and "food sharing among adults" are marked as present (*black*) or absent (*white*).

(Sauce: Jaeggi & Van Schaik [2011] p.2130)

put their idea of planning economy into practice under the dictatorship of communist party, paternal revolution might have suppressed the food sharing among adults that had been widely practiced among common ancestor of *Gorillas* and us.

The doctrine that the gap between the sexes among early hominins was as large as *Gorillas* was influential until late years[2], so not a few researchers hypothesized that the society of mankind have evolved not from the society where plural males and plural females do promiscuity as *Pans* but from the society where one or a few males encloses wives as *Gorillas* do. Even within the Kyoto School, Furuichi [1999] and Nishida [2007] insist that our earliest society was similar to *Pan* society, whereas Yamagiwa [1994] and Enomoto [1998] insist that our society evolved from that resembles *Gorilla* society. However, the social structure of *Gorillas* have been suppressed food sharing among adults and *Gorillas* took different rout of evolution from that on which our ancestors walked to develop food sharing that we see now among *Pans* and *Pongos*.

2. From adoption of unrelated infant to food sharing among adults

According to Fig. 1 all the species that share food among adults also share it with offspring. Food sharing with offspring is the necessary condition for food sharing among adults, so we can conclude that the latter has evolved from the former (Jaeggi & Van Schaik [2011]).

Brown-mantled tamarin (*Saguinus fuscicollis*) shares food among adults, but it is restricted only among male relatives (Jaeggi & Van Schaik [2011] Table 1). Izawa reports about brown-mantled tamarin, " sometimes we can watch the behavior that a

[2] Recent researches suggest that the gap between the sexes among early hominins was small (Nakatsukasa [2010]).

female slides up to a male who has a grasshopper on her knees, looks fixedly to it and holds out a hand to it, and sometimes a male does in the same way to a female. Once I found a father doing in the same way to his child who had a grasshopper. But in these cases I have never observed anyone who had a grasshopper gave a cut of it to those who approached to him/her, nor anyone who approached tried to rob those who had a grasshopper of it, nor anyone who have it threatened those who approached to him/her and sent them away. In all cases the monkey who have a bag in his/her mouth disliked to be followed by a beggar persistently and ran around trying to escape." (Izawa [1985] *my translation*) From his report I imagine that it may be possible that a male who has a grasshopper is followed about by his brothers, surrounded by them, gives up and shares it with them.

By the way, it is suggestive that in the society of brown-mantled tamarin adults beg for food not only to other adults but also to his own child, in spite of the fact that food sharing among adults occurs very few. In adult chimpanzees and bonobos food sharing occurs only if someone begs to the individual who owns food, and no one gives food voluntarily even though he/she has not begged as human beings do. It is natural for children to pester adults for food, and such behavior may be diffusible among adults because children grow and become adults but they just does not stop pestering in these cases.

Consequently, necessary condition for food sharing among unrelated adults may be the state where children can sometimes get food from unrelated adults if they pestered. Above all, it must be possible for females to lactate and feed unrelated infant besides her own child.

Crab-eating macaques (*Macaca fascicularis*) do not share food among adults. According to the experiments by captive eleven females, 8 out of 11 females gave food to their own daughters and sisters and juvenile nonrelatives indifferently even

though they distinguish between kin and non-kin, remaining 3 females gave more food to the youngest living offspring than juvenile nonrelatives, but observation on their behavior does not necessarily support that they favor them because they are relatives (Schaub [1996]).

These conclusions of the experiments are proposed to falsify Hamilton's rule of kin selection (Hamilton [1964]). Hamilton's kin selection and Trivers' reciprocal altruism (Trivers [1971]) are the only two theories that can explain altruistic behavior as long as we know up to now. In order to explain altruistic behavior between unrelated individuals or far-off relatives, the only theory we can apply is Trivers'. So, in the case of food sharing among unrelated adults those who get food are often supposed to pay something to the original owner (Kuroda [1999] pp.223-36, Jaeggi & Van Schaik [2011]). However the fact that female crab-eating macaque gives food to her offspring and juvenile nonrelative indifferently cannot be explained by reciprocal altruism because it does not seem true that only juvenile nonrelative repays her favor and her offspring do not repay.

It is asserted that the distribution of food from female adults to juvenile nonrelatives occurs only within crab-eating macaques among the world of animals in http://en.wikipedia.org/wiki/Crab-eating_macaque, but female primates who adopt and breed unrelated infant are widely seen. "Naturalistic observations of infant adoption in group-living primates have been made in two main contexts. One situation involves mothers whose infant dies soon after birth and adopt another newborn. The second situation involves females with live offspring who adopt an additional newborn and raise it along with their biological offspring. The adopted infant has usually been abandoned by another parturient female or in some cases forcibly kidnapped from her." (Maestripieri [2001] p.97)

The number of wild chimpanzees bred by other than their own mother counts

less than twenty up to 2008. Most of them are children who lost their mother. Examining 13 of them shows that 10 children were bred by kin such as grandmother, sibling or aunt, and remaining three are adopted by unrelated females who were all young and had no child yet (Myowa [2010] p.40). Adolescent female chimpanzee who had not delivered a baby captured and carried one western tree hyrax, slept with it in her nest, and groomed it, but did not eat it at all (Hirata et al. [2001]). We can interpret that she was affectionate with a pet, and she was preparing to breed her own children by doing so.

It was observed an interspecies adoption of female capuchin monkeys (*Cebus libidinosus*), the most intelligent within the new world monkeys, who bred an infant marmoset, and the marmoset appeared to be socially integrated into the group of capuchin monkeys (Izar et al. [2006]). They are very similar to the chimpanzee who loved a hyrax and those human beings who make a pet of small animal. An adult capuchin monkey is ten times as heavy as a marmoset, so the expression that the capuchin monkeys bred and loved the infant marmoset as a small pet may be appropriate.

In primates maternal behavior to breed infant has been extended to the adoption of unrelated infant. Furthermore chimpanzees, capuchin monkeys and human beings who have excellent intelligence admit interspecies adoption or pet breeding. From these observations we can conclude that the behaviors which neither kin selection nor reciprocal altruism can explain have been evolved in accordance with the development of intelligence. According to Maestripieri, "primate mothers are sometimes prone to making evolutionarily maladaptive choices such as adopting an unrelated infant." (Maestripieri [2001] p.114). Izar et al. refer to it positively as follows, "Maestripieri [2001] proposed that adoption of an unrelated infant is an evolutionarily maladaptive consequence of mechanisms selected to promote mother–infant bonding." (Izar et al. [2006] p.693)

It is inconsistent to argue that the adoption of unrelated infant is evolutionarily maladaptive on the one hand and that food sharing among unrelated adults which developed from the adoption of unrelated infant is evolutionary adaptive because those who get food pay something and reciprocity holds on the other. After all there is no attempt by any disputant who supposes that adoption of unrelated infant is maladaptive to answer the question why evolutionary maladaptive behavior has not faded out but extended and refined in the process of evolution up to capuchin monkeys, *Pans* and human beings. It must be true that the adoption of unrelated infant has developed in some species of primates because it is adaptive for them, but there are few biologists who are interested in the adoption of unrelated infant and found the reason why it can be adaptive.

We must go back to the basic standpoint that an evolutionary adaptive behavior must contribute to one's own interest if neither kin selection nor reciprocal altruism can explain it. In biology something increase one's own interest if and only if it contributes to the prosperity of one's direct descendant by blood. So we must suppose that the adoption of unrelated infant tends to contribute to the prosperity of direct descendant if certain conditions hold.

The conditions that promote the adoption of unrelated infant may be as follows. For a female to adopt a child increases her own interest because the experience of breeding her adopted infant increases the possibility for her own descendants to survive and get reproductive power (Nakagawa [2007] p.198). And besides, the adopted child will help her to breed her own children, reduce her burden, and become foster parent if she died. These may be the merit for a female who has no baby yet and a mother who lost her own baby to adopt unrelated infant. Furthermore, if a female adopts an infant besides her own child and breeds them together, children will consider themselves as siblings. The bond between adopted infant and her own

children may be useful for her own children to survive and get more advantageous positions for reproduction in the group to which they belong.

These conditions holds for the species in which child care is not merely innate and instinctive behavior but also it contains skills which will be improved if one experiences it more and more, and the child who is brought up with other child has more possibility to survive and reproduce than the child who grows as only child. In the species that have such characteristics, adoption of unrelated infant must be adaptive and interspecies adoption can be adaptive, too.

Adopting unrelated infant is costly because his/her foster mother must give food to him/her. She can have more babies and breed them if she adopts no infant. If and only if the benefit of adopting unrelated infant exceeds the cost of it, the adoption is adaptive. The cost is derived from the burdens for a female who breed unrelated infant, but most of the benefit accrues later when she nurses her own children with better skills, the adopted child grows enough to fondle her own children, and so on. We can regard the adoption of unrelated infant as self-investment.

According to Matsuzawa, about a half of baby chimpanzees in Japan was raised artificially because their mothers could not nurse them well. The trouble was supposed to be an outcome of the fact that the number of chimpanzees within the group was fewer than that of wild chimpanzees and mothers could not have enough experience to see their friends of the group nurse babies, to come in contact with babies, so they were deprived of opportunities to learn how to have and nurse a baby. Accordingly he tried for pregnant chimpanzees to watch the video of lactation, to practice holding a stuffed toy of a baby chimpanzee, and to see the human who was embracing a baby gibbon. Then they could nurse their own babies after the childbirth. (Matsuzawa [2002] pp.33.ff.) This report suggests the fact that training to breed a child is very important for chimpanzees. And besides, we can often observe elder

brother or sister on the side of his/her mother taking care of their younger brother or sister. Above all, elder sister continues nursing after she becomes five years old. (Matsuzawa [2002] p.65) These findings suggest that the adoption of unrelated infant is adaptive for chimpanzees, as well as for capuchin monkeys and human beings.

Furthermore, the origin of fairness and egalitarianism in food sharing among unrelated adults seems to go back to the relation between adopted child and true child[3]. Those mothers who breed unrelated infant and her own child together treat them fairly to some extent without severe favoritism against Hamilton's rule of kin selection. We cannot deny that human beings tend to bully stepchild, but breeding stepchild per ce contradicts Hamilton's rule. Moreover fairly tales of stepchild bullying such as *Cinderella* contains morality criticizing it.

I suppose that in the family of *Gorillas* the power of husband is too strong for his wives to adopt infant whose father is neither their husband himself nor the patrilineal kin of him. This may be the reason why food sharing among adults does not take place among them.

3. Self-investment and pseudo-reciprocity in food sharing

We can reconstruct how food sharing among unrelated adults evolved from feeding by mother to child as above. By the way, there is considerably large difference between them. The former begins with the begging by those who approves the ownership of the food that the begged has. This condition holds in the case where the

[3] Long-tailed macaques=crab-eating macaques and cottontop tamarins (*Saguinus oedipus*) do not share food among adults (Fig.1 of this article) but they tend to avert inequality (Yamamoto & Takimoto [2012] Table 1). Cottontop tamarins form the group consisting of dominant pair, their children and immigrants from the outside. Dominant female frequently gives birth to non-identical twins and subordinate adults of the group help in rearing the children of the dominant pair. Crab-eating macaques and cottontop tamarins suggests that receiving nonkin individual as one of family members prompts emergence of the values such as impartiality and equality.

begged has superiority over the beggar, and vice versa. The ownership is established irrespective of the position the owner occupies in the group. On the other hand, in the case of feeding by mother to infant, their relationship is integral and in the most cases child does not recognize mother's ownership of the food when he/she begs it.

For example, crab-eating macaque females do not discriminate between their own child and nonkin in the case of food sharing, but adult females often rob her own offspring of food but they do not rob other juveniles. This means that mother does not esteem the ownership of her own child because of the integrity and close proximity between them, but she approves and esteems the ownership of other juveniles (Kummer & Cords [1991] p.533). Consequently feeding by mother to her own child and adopted child is not based on the ownership. On the contrary feeding to other juveniles and food sharing among adults is transference of food from its owner to the beggar based on the ownership of it.

Nevertheless, in the case of transferring food whose ownership is approved by both giver and beggar, relationship similar to mother-child bond may hold between them. When a young individual who is too large to be adopted but not matured yet begs a food to an adult female who has experience of breeding, she may give food as if adopting him/her. Then the young individual may regard the children of the giver as pseud-siblings and begin to take care of them with their mother. These allomothering is not only the repayment for the food but also dummy run for breeding his/her own child.

To participate in collaboration, for example, hunting together, in return for the food can be interpreted in the same way. A young man who longs for a talented hunter begs a piece of his game as asking to become his disciple, gets a piece as permission, and goes into training with him. Repayment for the food and training for oneself are consistent in this case, too.

In the case of human beings, *Pans* and capuchin monkeys, training to improve skills often takes the form of 'learning by doing' as Japanese artisans are recommended to steal advanced skills from the more experienced who works with him/her but does not intend to teach him/her. Among apes intention to teach has been observed seldom if ever (Yamagiwa [2012] pp.228.f.).

Ability to learn by imitation is based on mirror neurons (Lizzolatti & Craighero [2004], Lizzolatti & Sinigaglia [2006]). Mirror neurons are related to empathy, too (Preston & de Waal [2002], Keysers [2011]). The mirror-neuron system that regards self and others as identical[4] supports both food sharing and skill learning.

As above, in food sharing among unrelated adults begging a food often means applying for the admission into apprenticeship, so when the owner judges to give food or not he/she can consider whether the applicant is talented for hunting or nursing. As far as I know there is no researcher who found these meanings of food sharing. In the case of adoption, foster mother herself can get opportunity to learn nursing, and the adopted child may be willing to help her breeding up her own children because such experiences will be useful when he/she breeds his/her own children. I tried to interpret food sharing among unrelated adults as a natural extension of such adoption. Probably the oldest food sharing established among unrelated adults was the interaction in which the repayment for the given food also increased the benefit of the recipient of the food. In these cases reciprocity and self-interest does not contradict each other and there is no room for prisoner's dilemma. Namely, it is nonsense to distinguish between the free rider and the less talented individual who cannot cooperate well in hunting.

By the way, it is often observed in bonobos that a female who gets food from a

[4] I had been contending befor the discovery of mirror neurons that self and others *is* identical and that the problem of other minds does not exist (Hirayama [2009] Vol.1 & 2).

male copulates with him. In these cases the repayment is not contradict to her own interest because she may have his baby. If a male who can give food are apt to have good genes, then a female who get food from him and mate with him is seeking her own interest irrespective of whether she wants to have his baby or not.

Nursing child, participating in cooperative works and copulating in exchange for food may accrue benefit sooner or later for those who serves to the donor now. Those who serve to the donor in return for the shared food do not necessarily anticipate the benefit. Even human beings carry out such anticipations and calculations not frequently, so *Pans* and capuchin monkeys must do seldom if ever. Nevertheless, the behaviors that accrue the benefits exceeding the costs on an average has selected in the process of evolution.

Hence among those who take part in food sharing among adults, the normative awareness can prevail which orders those who get food to pay altruistically some costs for the donor. In the case of female bonobo who experiences fairly severe competition among sperms of not a few males, the copulation with a male who gives her a food reduces the opportunity to have a baby of other males, which means for her to pay opportunity cost. So the female who tempts a male whose child she does not hope to have so strongly in order to get his food may have awareness that copulation is the repayment for the food. It may not always be easy for her, him and the spectators to distinguish clearly whether she begs food as an excuse for making advances to him, or she tries to prostitute herself for his food.

As above one of the origins of reciprocal altruism in primates must be food sharing among adults where repayment for food itself accrue the benefit for the recipient of food but the recipient is not necessarily aware of the benefit. Strictly speaking this is not altruistic, so Connor [1986] calls it as pseudo-reciprocity. In other cases where repayment contradicts self-interest of the recipient, without any

mechanism of sanctions against rout-cutting or free-riding, that is, reducing the repayment or paying nothing for the food, reciprocity cannot work smoothly and establish itself. According to the experiments on chimpanzees reported in Yamamoto [2008], Yamamoto & Tanaka [2009a] [2010], the donated does not repay unless they are requested, but the donor has a mentality to punish those who do not respond to his/her request and try to cut corners or get free passage. So within chimpanzees the donated does not repay spontaneously from the feeling of the debt of gratitude as human does, but request or punishment of the donor stimulates the donated to repay and reciprocity can be accomplished more or less (Yamamoto & Tanaka [2009b], Yamamoto [2010a] [2010b] [2011]). Because some evidence for spontaneously altruistic behaviors has been reported in common marmosets and tufted capuchin monkeys but not in chimpanzees and bonobos, spontaneous and/or strategic other-rewarding behavior of human beings seems to have evolved after divergence from the common ancestor of humans and *Pans* (Yamamoto [2010b], Yamamoto & Tanaka [2010]).

4. Indirect reciprocity and Impartial Spectator

Food sharing in which we can observe reciprocal altruism at first glance yields fruits from self-investment in many cases. The gains such as skills of hunting and nursing belong to the recipient who has served to the donor of the food, but other gains do not belong exclusively to only one individual of those who have took part in hunting or nursing. Game of cooperative hunting and a baby as an outcome of mating are the examples of the latter. A baby always has half of the genes of both parents. By stretching this principle through obscuring female's childbearing estrus sign, bonobos and hominins has developed the non-reproductive relations of both heterosexual pair and homosexual pair. But in the case of hunting for example, the problem how to

divide the game within the participants remains. Those who did not get fair division are apt to become uncooperative and the gains of succeeding hunting tend to diminish. Those who try to keep the game to themselves or distribute it partially are apt to lose reputation and those who have good talent no longer want to take part in them.

Suketomo Hino, one of the most trusted courtiers of Japanese Emperor Go-Daigo (reign: 1318-1339) was ordered to find and mobilize those samurai warriors who would participate in a plot to overthrow Kamakura Shogunate. In order to know their real intention, Suketomo originated the Burei-ko (the banquet without etiquette) where ranks and orders of the participants were ignored, more than ten young and beautiful ladies wearing only see-through raw silk lingerie served with many kinds of

Fig.2 Burei-ko in *The Taiheiki*

(Sauce: Hasegawa [1994] p.33)

delicacies and excellent liquors, through which Go-Daigo got confidence and loyalty of samurai warriors and succeeded in overthrowing Kamakura Shogunate after many twists and turns (McCullough tr. [1979] pp.14.f., *my translation and summary from original Japanese text*).

But Go-Daigo lost his fame among samurai warriors when he granted rewards according to the merits of each participants. Go-Daigo was estimated as an impartial supervisor at Burei-ko banquet of food sharing, but in the distribution of the gain from the military operations he was unfair, and those who were treated unfavorably became his enemy from then on.

Indirect reciprocity is a sort of reciprocity in which those who know that A behaved altruistically to B raise their estimations of A and such indirect reputations brings A good fortune (Nowak & Sigmund [1998] [2005], Yoeli et al. [2013]). Orangutans, chimpanzees, 2～5-year-old human children and capuchin monkeys can form indirect reputation judgments (Herrman et al. [2013], Anderson et al. [2013a] [2013b])[5]. The situation where indirect reciprocity evolves may be the case in which cooperative actions such as hunting together bring about game, and its distribution becomes the important problem. It is fruit that is distributed among bonobos and they do not need cooperative action such as animal hunting to get it, so it seems that indirect reciprocity dose not develop among them.

Suppose that A got game of hunting in which A, B and C take part. C (B) must be interested in the distribution from A to B (C), comparing the distribution from A to himself/herself. Such comparison is easy because parts of the same game are distributed from the same individual A to B and C almost simultaneously. If A is not

[5] Among human beings indirect reciprocity contains selectively altruistic strategy of C in which C who observed A's altruistic behavior to B behaves altruistically to A and reputation of A by third parties to which A pays attention and by which A's behavior is controlled, but these contents of indirect reciprocity has not been observed among chimpanzees so far (Yamamoto [2011] p.100.f.).

partial to B(C), A must be trusted by C(B). This situation is similar to indirect reciprocity but both B and C are not third parties but interest parties concerning A's distribution. So we call it quasi-indirect reciprocity. I think that the origin of impartiality and egalitarianism is the triangular relationship among mother=A, real child=B and stepchild=C (the end of section 2 in this article). Structure of this relationship is the same as that of quasi-indirect reciprocity.

Among chimpanzees the donated does not repay unless the donor requests as mentioned above, whereas they behave altruistically without any expectation of repay if he/she was requested (Yamamoto, Hummle & Tanaka [2009] [2012], Yamamoto [2010a] [2010b]). Altruistic behavior of chimpanzees is contingent to the apparent request observable to the third parties, too. It has been evolved in the situation where the decision to respond or not to respond to the request affects the evaluation of the requested not only by the requesting but also by the third parties, so indirect reciprocity can work.

The nature of inequality aversion observed among chimpanzees and capuchin monkeys is ambiguous among bonobos and negative among orangutans (Yamamoto & Takimoto [2012] Table 1). The objects of bonobos' food sharing are fruits which they can get without any cooperation with other individual(s). Orangutans live more solitary lifestyle than chimpanzees, bonobos, human beings, gorillas and capuchin monkeys. These seem to be the reasons why social norm of impartiality and equality does not prevail among them. Cooperative behaviors of the group including unrelated members exposed to the eyes and ears of its members are the cradle of values such as impartiality and equality based on the situations of quasi-indirect reciprocity.

Direct reciprocity in which food is distributed from A to B and after a while B helps A in hunting or B permits A to copulate with is intellectually more complicated than quasi-indirect reciprocity. To evaluate such direct reciprocity between A and B

sufficiently, the equivalence of one thing (good or service) transferred from A to B on one occasion and another thing transferred from B to A on another occasion must be judged, so the ideas of just price and just interest rate are necessary for comparison. Intentional exchange of different thing and/or with time lag between two individuals is defined as "calculated reciprocity", whose evidence can be seen seldom if ever among chimpanzees (De Waal & Luttrell [1988]). Calculated reciprocity seems to be special to human beings, or among other animals it can be seen in extremely restricted sense if ever (Hammerstein [2003], Stevens & Hauser [2004], Yamamoto [2010b]).

Foods are often distributed from one individual to many others, so quasi-indirect reciprocity seems to have been evolved first in food sharing, and calculated reciprocity between two individuals becomes a problem on the basis of quasi-indirect reciprocity. Calculated reciprocity between two individuals seems to be evaluated tacitly by third party because outcome of the interaction cannot be concealed from any third party if one of the two does something unfair and the sufferer makes a noise.

After quasi-indirect reciprocity were established in the food sharing among three individuals A, B and C, in the situation where A and B interact directly and C becomes neutral third party who can supervise for them to esteem impartiality and equality, owing to C free riding and prisoner's dilemma can be avoided and calculated reciprocity between A and B seems to evolve. For example, in the hunting comrade A, B and C, the position of C in the case where A and B killed game cooperatively and A holds the corpse seems the archetype of neutral third party. In the case of cooperation more than two individuals A (who get game eventually) is minority, so others can form an alliance and put pressure on A to distribute the prey. Following this strategy C supports B to get some portion of the game from A and C himself/herself also can get a tiny share as brokerage. Both indirect reciprocity and calculated reciprocity are underdeveloped among chimpanzees because these reciprocities need triadic

interaction which chimpanzees are not good at (Tomonaga et al. [2004], Yamamoto [2011] p.100).

The third party that can judge the legitimacy of revenge may repress vicious circle of revenge. In Edo period Japan those who wished to revenge had to obtain permission of their lord. Forty Seven Ronin lost their lord and killed his enemy Kira Kozukenosuke without any permission. The Tokugawa shogunate ordered for them to perform seppuku (ritual suicide) because of committing the crime of murder.

Third party can be expressed as spectator. The role of spectator in Smith [1759] is suggestive from this point of view. As for human beings impartial third party or impartial spectator in the breast utters voices of conscience. Impartial spectator in the breast must be key person for morality. Impartial spectator in one's breast and impartial spectator in another's breast is identical, so Impartial Spectator is unique and peerless[6], and has been called God, True Self or Inner Self, Truth Body (Dharma-kāya in Sanskrit) and so on (Hirayama [2009] Vol.1&2).

Tit for tat strategy in dyadic relations and the reputation formed by spectators work as punishment against those who gat benefits from someone but repay insufficiently or not at all. Uncooperative member is apt to suffer from social ostracism, be regarded as a witch or a mortal enemy in severe cases. The contrast between the insiders tied by the networks of reciprocal cooperation and the outside enemies may be the main social structure of chimpanzees and capuchin monkeys except for bonobos. Their reciprocal behavior such as mutual grooming and food sharing takes place among the members of the same group. Between the male of a group and that of another group mutually altruistic interaction occurs seldom if ever in wild life because they are competing for females and resources. By the way, in case of bonobos their inter-group hostility is weak. Individuals belonging other groups groom mutually

[6] See note 4 of this article.

and also share and eat fruits together (Yamamoto [2011] p.104).

5. Group formation and oxytocin

We can regard the structure that distinguishes rigidly between the insiders and the outsiders of a group as an extension of mother-child bond where they share their life and death. Recent study about oxytocin, a nonapeptide hormone released from the posterior pituitary best known for its role in uterine contraction at the time of the childbirth and lactation (Lee et al. [2009]), verified that it also breed confidence among people (Kosfeld et al. [2005]). But further studies clarified that oxytocin promotes altruistic and self-sacrificing actions within the group, and defensive, but not offensive, aggression toward competing out-groups, and reinforces human ethnocentrism (De Dreu et al. [2010] [2011]).

Quasi-indirect, indirect and direct reciprocity is often attended with the sentiments that those who repay sufficiently are allies but those who do not are enemies, and one should retaliate against betrayers, because oxytocin has been acting in food sharing begun between mother and child and evolved to create the reciprocal interactions between unrelated adults. Oxytocin which primarily stimulates mother to see herself and her child as one and to defend the life of child must have expanded the situations to be released in the process of evolution, and supported to form the various group actions of chimpanzees, capuchin monkeys and human beings. For the food sharing among unrelated adults to take place, members of a group must reduce the psychological distance among them and promote mutual trust. De Waal describes what happened among captive chimpanzees when he gave them bound branches with leaves they like to eat as follows.

> Wild chimpanzees do not need to share the foliage that is all around them.

In captivity, however, branches with fresh leaves are idea1 to investigate sharing; they arouse quite a bit of excitement yet no excessive competition. When the chimpanzees see a caretaker arrive in the distance with two enormous bundles of blackberry, sweetgum, beech, and tulip tree branches, they burst out hooting. General pandemonium ensues, including a flurry of embracing and kissing. Friendly body contact increases one-hundred-fold, and status signals seventy-five-fold. Subordinates approach dominants, particularly the alpha male, to greet them with bows and pant-grunts. Paradoxically, the apes are confirming the hierarchy just before canceling it, to all intents and purposes.

I call this response a *celebration*. It marks the transition to a mode of interaction dominated by tolerance and reciprocity. Celebration serves to eliminate social tensions and thus pave the way for a relaxed feeding session. Nothing even remotely similar occurs in species that do not share. If macaques notice the arrival of attractive food, they immediately move into a competitive mode: high-ranking monkeys come forward, supplanting those of low rank. Chimpanzees do the exact opposite, throwing themselves into each other's arms with obvious delight. Within minutes each and every member of the colony has obtained some food. They do show competition, occasionally even fight, but it is their peacefulness and civility that is most striking: only 3 percent of interactions between adults involve any sign of aggression. (De Waal [1996] pp.151.f.)

Kuroda reported the responses of wild bonobos (pigmy chimpanzees) when he gave them sugarcane as follows.

Pigmy chimpanzees rush to stacked sugarcane, but they do not struggle for it. Young female screaming loudly joins in the cluster of members, excitement

causes coitus and females raise a loud voices, a youth who get sugarcane climbs to the tip of the branch in order not to be disturbed by anyone. I hear such a din caused by these behaviors but nothing more than these noises happens. They have sex frequently when they come to new place to get foods and eat. In the place loud voices are heard first, dominant male displays himself, meanwhile sexually excited individuals have sex, female couples rub their genitals together. Pigmy chimpanzees, as well as chimpanzees, expresses sexual excitement when they enter into new situations such as new place of getting food, or hear curious sound. Sexual behaviors in the place of getting food can be supposed to relax the tension about food and prevent the conflicts.

Two females grasp the same piece of sugarcane at the same time. At the moment I think they begin to scramble for it, they fall together looking at and embracing each other. The tip of pink genitals as large as a fist of young female fallen on her back and that of white genitals intumesced as large as a melon of middle aged female fallen over the younger are rubbed each other by sideways. Both of them hug and look at each other with several pieces of sugarcane in the hand. The upper female plants her feet firmly on the ground and the lower holds the upper in her feet. This continues about ten seconds, and the younger gets the sugarcane in question…

Those who come too late to get sugarcane directly approach to the individual who is at high rank and has many pieces of sugarcane in many cases. The owner secures with his/her legs or thighs but putting around the legs when he/she cannot hold and puts his/her hand on the piece if someone approaches to it. On the contrary those who have no sugarcane stare at the pieces of the owner, or watching the feeling of the owner he/she stretches out a hand slowly to the piece of sugarcane in owner's mouth or knee. The palm is closed and not always turned

> to the top, a little different from our pose of begging. The gesture is almost the same as to touch it quietly. Thus the beggar sometimes gets a whole trunk of sugarcane, or piece almost no better than leftover from owner's mouth. Sometimes the beggar picks up a scrap of sugarcane bark… But the owner seldom presents by him/herself, only permits tacitly for the beggar to take. (Kuroda [1999] pp.89-92, *my trauslation*)

It is the intimate and physical contacts which chimpanzees and bonobos often do before food sharing, for example, hugging, kissing each other, and having sexual intercourse, that stimulate to secrete oxytocin, and oxytocin promote physical contacts, so positive feedback acts between them. As a result, the deepening of friendly atmosphere and the increase of oxytocin take place jointly. After these preliminary stage food sharing begins.

Japanese macaques usually eat independently, but occasionally those who have repeated sexual intercourses several times eat together but independently, touching their bodies mutually and picking up wheat or small nuts (Kuroda [1999] p.241). Their behavior is different from food sharing, but this also is an example of relaxing conflicts about scarce resources by intimate contact of mutual bodies, and oxytocin acts here, too.

Burei-ko held in ordet to organize Go-Daigo's campaign where ranks and orders are ignored temporally and beautiful young ladies only with see-through lingerie served alcohol as if suckling infants, possessed perfectly the characters of sexual food sharing originated from food transfer from mother to child, and increased oxytocin secretion among the participants to strengthen the mutual confidence for the secret conference aiming to overthrow Kamakura Shogunate. Their conspiracy came out to Shogunate because Yorinao (Yorikazu) Toki told the plan to his wife after sleep who was the daughter of Rokuhara (Kyoto office of Shogunate) magistrate (McCullough tr.

[1979] pp.18.f.). Oxytocin was acting in this case, too. The story of Yorinao and his wife suggests that in the case of human beings, pair bond between a male who belongs to a group and a female who came from another group sometimes makes the working of oxytocin full of contradiction and complicated.

6. Service and money as universal means of payment

Food sharing among wild chimpanzees and capuchin monkeys occurs within a reproduction group of males and females. Their food sharing including some groups or members of different groups does not happen because it premises the mutual confidence increased by intimate contact. On the contrary, it is often supposed that the origin of human exchange was barter between the two groups or individuals A and B. If A wants some good or service of B and B wants that of A as well, then barter may takes place between them. Mutual wanting of the good or the service the other possesses within a dyad is expressed as "double coincidence" of wants (Jevons [1875] Ch.I) and in the cases where the double coincidence does not hold and direct barter is impossible, exchange can be managed by money as medium of exchange. Thus human exchange often supposed to have evolved gradually from direct barter to monetary exchange.

However as long as we must suppose that almost the same mode of food sharing as observed among *Pans* today was once held among the common ancestors of them and human beings and that exchange economy and money of human beings has been evolved from it, all of the doctrines which regard direct barter as the oldest form of exchange or reciprocity are false.

In the process of food sharing, repay for food is such services as participating in hunting and sexual intercourse. Services is means of payment that anyone including those who have nothing to pay other than one's own body can use, so food sharing of

primates teaches us that double coincidence of wants can always be realized easily. Among human beings as well as *Pans*, those who have nothing saleable except for labor and prostitution always support food sharing and its evolutionary forms such as redistribution economy and exchange economy from the base. Service is universal means of payment that have been continuously used from the age of the common ancestors of *Pans* and human beings.

In a Japanese fairy tale, Momotaro gives millet dumplings to dog, monkey and

Fig.3 Momotaro

(Sauce: Tomson tr. [1885] cover)

pheasant, and they agreed to help him in his conquest of ogres (Tomson tr. [1885]). Even today if I find that I have no money to pay for the food that I have already eaten in the restaurant, I must pay the bill by dish-washing or some other work. This example is not so different from the food sharing of chimpanzees. Chimpanzees can manage service economy fairly well (De Waal [1997b]). Among those who live in developed service economy, double coincidence of wants is not so difficult for money to evolve as medium of exchange. Human beings tend to encourage reciprocity with those who appear to be healthy because the apparent health is the signal for working capacity and fertility (Krupp et al. [2011]).

In this situation exchange of different goods and services during comparatively long term must be expected, and calculated reciprocity is in question. Typical example of such interaction is division of labor between males and females. So we can suppose that the calculated reciprocity of hominins began to evolve along with the formation of comparatively stable pair bond after branching off from the common ancestor of humans and *Pans*. The reason why marriage in human beings requires to be approved by the group the couple belongs to or third party such as a priest is that each member of the couple can refrain from myopic behavior with the help of authoritative monitoring. Owing to the institutionalized marriage they can overcome prisoner's dilemma and maintain reciprocity in the long run. In chimpanzees independent breeding by mother is usual but in human beings breeding by couple and many others is common. Cooperation in breeding by formation of pair bond and so on seems to have encouraged the development of spontaneous prosociality and calculated reciprocity (Hrdy [2005]). Burkart & Van Schaik [2010], Cronin et al. [2010] etc. suggest that spontaneous prosociality evolves with cooperative breeding.

Depending on service as universal means of payment, hominins evolved with the development of spontaneous, strategic and calculated reciprocity. Not only human

relations but also those between humans and nature have been regarded as reciprocal. We humans have been served nature in order to receive favors. The idea of reciprocity led us to the practices to refrain from excessive hunting-gathering and helped us to devise agriculture and cattle-breeding. According to Socrates, "earth of her own will gives lessons in justice and uprightness to all who can understand her meaning, since the nobler the service of devotion rendered, the ampler the riches of her recompense." (Xenophone V)

Notwithstanding that there exists service as universal means of payment for anyone including those who have nothing but their own body, how money could evolve as means of exchange and payment? This is the true question concerning the origin of money.

We must grasp the origin and evolution of the monetary economy as follows. Reciprocal exchange by hominins was primarily confined within the members of the same group or community. On the contrary monetary exchange first evolved between communities. But by and by money became used in the contexts of reciprocal relationships within the community, so the community was changed in quality as monetary exchange prevailed. It is the diffusion of paying money in exchange for services such as various labors and sexual practices that has been important for this transition. Such modification of community is often conceptualized as 'From Gemeinschaft to Gesellschaft' following F. Tönnies. Therefore we must investigate the evolution of early money based on the development of intercommunication between communities.

Many species of primates form patrilineal or matrilineal groups. In case of matrilineal species males get away from the group where they were born to the group where they mate, whereas in case of patrilineal species females get away from the group where they were born to the group where they mate. Doing so they avoid

incest. Intergroup migration of the individuals to avoid incest must be the starting point from which intercommunal transfer of various goods and services have developed, and we may regard that as the archetype of money.

Pans often form patrilineal groups, that is, females migrate from their birthplace to another group where they have babies, and capuchin monkeys seem to form matrilineal groups where adult males dwell in a strange mass. The progenitors of human beings has been forming patrilineal groups from the common ancestors of us and *Pans* to the emergence of *Homo sapiens*, because not only early hominins such as *Australopithecus africanus* and *Paranthropus robustus* but also Neandertals who were most closely related to human beings formed patrilineal (patrilocal) groups as well as chimpanzees and bonobos. Intergroup relationship of chimpanzees is severely oppositional, but in the case of bonobos females are dominant over males and females have sexual intercourse more often with males of another group than those of their own group when two groups encounter (Furuichi [2012] p.52).

Early human beings formed patrilineal communities in major cases, so females who leave the home community to marry into a family belonging another community and have babies there played the role to overcome exclusiveness of each community and relax hostilities among communities. This can be reasoned by analogy with the role of females in bonobos, and supported by many famous facts in history. Wang Zhaojun became adopted by Emperor Yuan of Western Han Dynasty as his daughter to marry into the royal family of Xiongnu. Yoritomo Minamoto founded Kamakura Shogunate owing to the support by Tokimasa Hojo Taira, father of his wife Masako Hojo Taira. Lady No, the daughter of Dosan Saito, Sengoku-daimyo ruling Mino, married Nobunaga Oda, the best military commander of Warring States Period Japan and supported him to gain power. Princess Kazu went down to Edo to marry 14th Shogun Iemochi Tokugawa in order to unite the Shogunate to the Imperial Court.

To compare our society with the matrilineal (matrilocal) society of capuchin monkeys where males leave the home group into another to mate, not males who take on the role to defend their group against enemies but only females seems to intermediate between their home group and mating group. So it must be difficult for matrilineal society to form a more complicated society by colligating different groups. Itani's insight that matrilineal society cannot become more complicated society like human beings (Itani [2008] p.352, quoted in p.11 of this article) can be revived in this context.

Chimpanzees cannot know their father clearly because their sexual relations are promisculous, but their mother can be identified without any ambiguity. Nevertheless they cannot understand mother-daughter relationship even though they know mother-son relationship (Parr & Waal [1999]). So the relation between daughters emigrated to other groups and their home group must be very few. This corresponds to the fact that the relationship between different groups of chimpanzees is hostile. Female bonobos does not preserve the relationship to the home group after emigration, too. A distinctive feature of the role human females play is that they preserves the relationship to their home family after wedding and intermediate between the family they married into and the family they had been born, and between the communities both family belongs to respectively, by contrast with that of female chimpanzees and bonobos.

The reasons why human females play such role may be as follows. Human beings have stable bond between husband and wife, so father of infant is identifiable in many cases. There exist relationships not only between mother-child but also between father-child. Moreover, the longer is the average life span prolonged, the more important becomes the relationship between grandparents and grandchild whom their daughter gave birth to in the family she had married into. The life span of human

beings became much longer than Neandertals (Caspari and Lee [2004]), so the relationship between grandparents and grandchild may be the basis for the structural feature unique to the society of human beings except any other subspecies of *Homo*[7].

When *Homo sapiens* emerged, it can be supposed that the decrease of population caused by cooling diminished the opportunity for females to marry into other communities, so that the frequency of consanguineous marriage within the community increased. Coefficient of blood relationship between children by consanguineous marriage and their grandparents seemed to become so high that grandparents are willing to take care of their grandchildren. In the case where whole brother and sister get married, the coefficient between their child and their parents is equal to that between themselves and their parents. Therefore grandparents began to participate in nursing their grandchildren because of the high rate of consanguineous marriage. According to my hypothesis this custom became applied to the case of nonconsanguineous marriage and the support by grandparents to grandchildren from a daughter married into another family also prevailed (Hirayama [2013]). Irrespective of the validity of this hypothesis, parents became interested in their married daughter and her children, so they began to support them even if she had married into another family. This relationship between parents and their married daughter as well as her children or between brother and married sister as well as her children was the basis of intercommunal relationship unique to human beings.

Once parents or brother of the bride became interested in her and her children even after her marriage, it probably became custom for the bridegroom or his family to pay the bride price too. Especially if a spinster has candidates of bridegroom, the

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[7] According to the recent researches some of contemporary human beings has genes derived from Neandertals and Denisovans (Reich [2010], Green [2010]). Common ancestor of Neandertals and Denisovans split off from the common ancestor of them and human beings, so human beings, Neandertals and Denisovans seem to be subspecies belonging to the unnamed same species.

quality and quantity of bride price may be the deciding factor in competition among candidates.

As we saw above, among human beings emigration of marring females from their home community into another community inevitably brought about intercommunal exchange of gifts and returns. In the primitive societies that seem to preserve the archaic form of exchange economy unique to human beings fairly well, "it is not individuals but collectivities that impose obligations of exchange and contract upon each other. The contracting parties are legal entities: clans, tribes, and families who confront and oppose one another either in groups who meet face to face in one spot, or through their chiefs, or in both these ways at once." (Mauss [1923-4] tr. by Halls [1990] p.5)

Indirect exchange with money can be interpreted as exchange of gifts and returns. Namely, offering something one owns for sale is gift, money received in return for it is a deed of credit to receive real return, goods and services bought in return for money are real return. In Japan gift catalog and gift certificates are popular as returns for the gifts received in ceremonial occasions. Those who received the catalog or the certificates can order the most favorite thing(s) in the catalog or in the assigned stores. Money is something like gift catalog or gift certificates because those who received money can order various goods and services.

Marx [1867] thought that one special commodity became money but Mauss [1923-4] argues that monetary economy evolved from gift economy. If it is true that those gifts which aimed mainly to get a certain amount of money as return present were distinguished from other gifts and became commodities, money preceded and produced commodities.

7. From food sharing to money

In Kula Ring, a ceremonial exchange system prevailing among a wide area including Trobriand Islands, shell armbands (*mwali*) which symbolize females are traded in a counterclockwise direction and shell-disc necklaces (*soulava*) which symbolize males are traded in a clockwise direction, and both treasures circulate endlessly (Malinowski [1922]).

A voyager's partner of Kula exchange is mutually fixed and they are compared to a son and his mother, Kula exchange itself is a metaphor for wedding between two

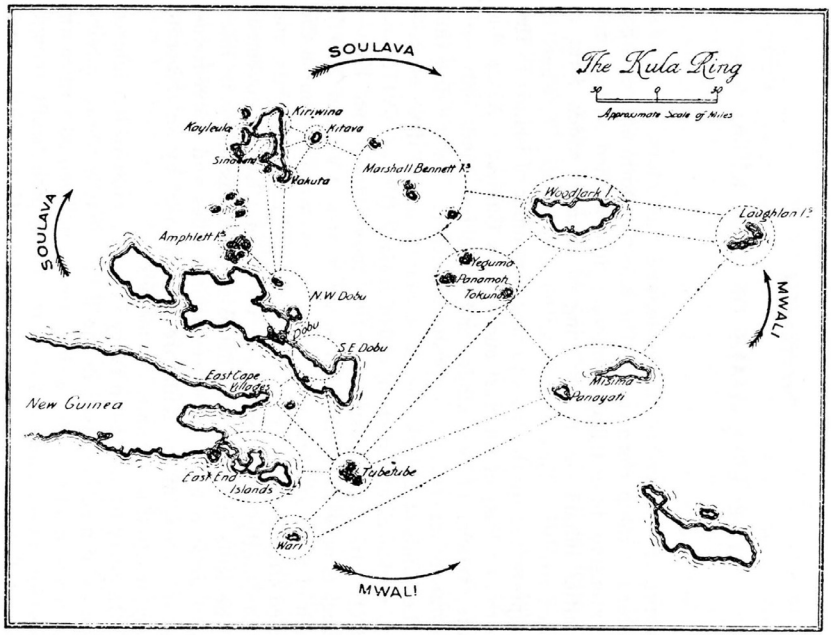

Fig.4 The Kula Ring

(Sauce: Malinowski [1922] p.82, Map V)

kinds of treasures, and "the symbolic relationship between the voyager and the partner with whom he exchanges these objects recapitulates the feeding relationship, including its sexual overtones, between a young boy and his mother" (Spiro [1982] p.83). Among chimpanzees when a mother weans her son she has intercourse with him to compensate for delactation. According to Oedipus complex proposed by Freud, a boy of human beings also desires to commit incest with his own mother in phallic stage (about 3～6 years old), so feeding from mother to her son on that stage often has shade of incestuous meaning, and Kula exchange contains such symbolic meaning. So Kula exchange illustrate eloquently that food sharing among unrelated adults in primates developed as a metamorphosis of feeding from mother to children, and exchange economy between communities in human beings emerged as an extension of food sharing.

Society of Trobriand Islands is matrilineal which ignores blood relationship of the paternal line but it adopts patrilocal residence, so a female emigrates from her home community to marry. A circulating armband symbolizes migration of a female with her marriage and an armband cannot keep staying in the same community for a long time because it symbolizes a girl who must leave her home to marry.

Moreover in Trobriand Islands a female marry into her husband's family and their children grow up there, but a male must move into his mother's brother's community when he reaches the age of puberty or marries and lives there until he dies. This custom is named as viri-avunculocal residence (Keesing [1975] pp.68.ff., Sudo [1989] p.12). A shell-disc necklace symbolizes a male who moves from his father's residence into his mother's brother's community when he has grown up. A shell-disc necklace and a shell armband circulating in the opposite direction to each other symbolize a male and a female who leave their home to marry.

In Kula Ring shell-disc necklaces that symbolize males are as important as shell

armbands that symbolize females because of viri-avunculocal residence that forces not only females but also males to leave their home. In contrast to Kula system, among the communities where patrilocal residence is accompanied by patrilineal or non-matrilineal relationship, only those treasures that symbolize females seem to circulate. It must be difficult for goods or services used as repay for the treasures to have symbolic meaning comparable to that of the treasures. Therefore in patrilineal (non-matrilineal) and patrilocal society those treasures that symbolizes females and circulates among communities must be exchangeable for various goods and services.

In ancient China shell of cowries which resembles female genitalia were perforated and used as money, so Chinese characters concerning monetary economy often have a radical "貝" that is the pictograph of cowrie. "寶 treasure", "貨 treasure coin", "資 capital", "財 good", "貸 lend","貯 save","賣 sell", "買 buy", "販 sell", "貿 trade", "賃 sell or buy on credit", "賃 wage", "負 debt", "債 loan", "責 claim", "質 pawn", "賠 pay for", "貢 tribute", "賢 profuse", "貪 covet" and "貧 poverty" are the examples.

We can find another good example in the legends of ancient Rome. The origin of the word "money" is Roman goddess Juno Moneta in whose temple money was coined. Matronalia, the festival cerebrating this goddess on March 1, was held as anniversary of traditional peace between Romans and Sabines. The war occurred by Romans' rape of Sabine women was ended by the mediation by Sabine women who had married Romans and had children. Roman king Romlus and Sabine king Titus Tatius ruled jointly over the Romans and Sabines. Tatius dwelt where the temple of Moneta was located later. According to these traditions Moneta seems to be deification of Sabine women who lead Romans and Sabines to reconciliation and unification. Moneta as a symbol of the intermediation between communities became the origin of the word "money".

It is possible for the same kind of treasures that symbolize females to circulate

in either of two directions. This is nothing but that A gives B money and B return A the same kind of money later. From the norm that the quondam gift must be returned with bonus seems to have evolved the loan agreement that a debt must be paid back with prescribed interest until designated day.

Aristotle thought that charging positive interest for money was immoral because money is not productive. I think he forgot that money symbolizes females. Money is not productive if it is horded, but it can be productive when it leaves the owner to serve its borrower just the same as a daughter leaves her parents to marry her husband and have babies. Money as a symbol of female is often related to the desire for fertility and prosperity, buried with dead body and offered to deities and Buddhas, so it justifies apparently anti-Aristotelian thought that loaned money is so productive that it can yield surplus and some portion of it should be paid for the lender.

To say the truth Aristotle's doctrine about interest (Aristotle [b] Bk. one, Pt. X) falls into self-contradiction, so it is logically false. According to him the lender (owner) of an orchard which will not suffer senile deterioration and whose price will be fixed eternally can get interest (rent) from its borrower (tenant) justly because the orchard yields fruits every year and the interest is nothing but a portion of the fruits. However, to buy an orchard in exchange for borrowed money is virtually the same as to borrow the orchard from the lender of money, because the orchard is a mortgage that guarantees the principal for the lender of money. Not to pay any interest but to repay only the principal (money or a mortgage) at maturity for the borrower of money is precisely equivalent to borrow the orchard and to get all of its fruits without paying any rent to the owner of the orchard. Therefore money used to buy an orchard is as productive as the orchard itself.

Conclusion: Long-distance exchange and money

According to de Waal food sharing of primates occurs among unrelated adults if food in question fulfills the following characteristics:

(1) Highly valued, concentrated, but prone to decay.
(2) Too much for a single individual to consume.
(3) Unpredictably available.
(4) Procured through skills and strengths that make certain classes of individuals dependent on others for access.
(5) Most effectively procured through collaboration.
(De Waal [1996] pp.144.f., (5) does not holds among bonobos as seen in sec. 4 of this article.)

(1) and (2) means that there is little benefit to retain leftovers and little cost to share with others for owners, so food sharing contributes to consume such foods efficiently and evenly. On the contrary goods often used as money are comparatively preservable, so they can be conserved for a long time, sent to remote places, and accumulated so large amount that it cannot be consumed entirely by the owner and the members of the community he/she belongs. From the beginning of the intercommunal exchange accumulable goods have been selected to transport. Moreover such goods can be passed from community A_1 to A_2, from A_2 to A_3, ……, from A_{n-1} to A_n successively and transported to far distant place. A good needed by everyone can prevail widely from producing center via such chains of exchanges.

Neandertals, the closest subspecies to human beings seem to have no ability for such long-distance exchange because their stone implements have been excavated

only from production area and its neighborhood. On the other hand human beings emerged about 200 thousand years ago and began long-distance exchange about 130 thousand years ago when Riss glaciation ended, the climate became warmer and they also invented fishing and their population began to increase (McBreaty & Brooks [2000] pp.515, 532, Kawai [2007] p.101). Besides, beads of perforated small snail (*Nassarius gibbosulus*) shells, the oldest personal ornaments emerged then and has excavated from inland areas remote from seashore (Vanhaeren et al. [2006], Kawai [2007] pp.92-4). So at the beginning of long-distance exchange perforated shells used as personal ornaments were transported from production areas to distant places. Each bead was standardized in weight, size and quality, so beads possessed three functions of money, i. e. medium of exchange, unit of value and store of value.

A snail shell encloses and protects the living. It may symbolize the womb and perforating it figures coitus or delivery. Perforated beads were made from ostrich eggshell too (McBreaty & Brooks [2000] p.522, fig.9). These materials of self adornment support the interpretation that they symbolizes the uteri, coitus and childbirth. Eggshell is shell of egg in English. So the emergence of long-distance exchange was closely related to the invention of the personal ornaments that symbolizes females, and it must be better to say that to transport and to exchange shell beads symbolized the migration and marriage of females than to say that they were transported "for symbolic use" (Vanhaeren et al. [2006] p.1785). Beads were transported in the same direction or the opposite direction to the migration of females and their transfer and exchange symbolized marriage, too. These symbolic meaning of the ornaments seems to have advanced the development of long-distance trade. Cowries transported from the tropical or subtropical regions to Central Plane of China (中原) and shell armbands (*mwali*) circulating in the Western Pacific are the direct descendants of shell beads born more than 100 thousand years ago.

The objects of long-distance exchange, for example, ores, stone instruments and personal ornaments were carried through many communities without being consumed, and some goods or services or humans moved in the opposite direction to repay them, so they were used as medium of exchange until they were received in the hands of ultimate owner. But they were so durable that the owner who used them habitually at first might part with them and get necessary goods or services, and that they might be inherited or transferred. So the ultimate owner of them was indefinite until they disappeared and the proverb "Money goes around and around." can be applied to the object of the oldest long-distance exchange. If the objects symbolized females, it seems that those who kept them for a long time were condemned and they were urged to exchange them for other goods and services or to lend them in the same way as Kula Ring.

We can explain the evolution of money in long-distance exchange by the standard tool of economics even if the good that became money did not have such symbolic meanings. Chimpanzees save those tokens that are exchangeable for food (Sousa & Matsuzawa [2001]). So it must have been quite easy for human beings who did not know money yet to save and accumulate durable goods exchangeable for foods and other useful things. Any durable good becomes less valuable marginally as the amount of the good accumulated becomes larger[8]. So the opportunities to get more valuable goods and services in return for the durable good increases as the amount of the good accumulated becomes more and more. For example the community of important place for obsidian trade which exclusively intermediates many production areas and many consumption areas can get it cheaper and sell it at higher price, so the community can

[8] In Hirayama [2008] I devised the notion of marginal power of the good to support population which means the increase of population caused by marginal increase of the good in question. This notion premises the model based on the objective function that aims to maximize the population of a community.

earn copious profits. In the stage where general medium of exchange did not developed, the profit mainly consists of stock obsidian. As the amount of accumulated obsidian increases, marginal value of it for the community decreases, so they get more opportunities to pay with obsidian for more valuable goods and services. In this way the community that has accumulated larger amount of durable good begins to use the good as medium of exchange and the usage of the good as money gradually spreads over the surrounding areas. The good which can be exchanged for various goods and services easily becomes more saleable because more communities and more individuals within each community tries to get the good as medium of exchange, and the good gets the position of money in its area of circulation.

The dynamics concerning the evolution of money sketched roughly as above is different from that which begins with barter economy consisting atomistic individuals. Among others Menger [1892] is excellent and I adopt the notion of "salableness" from it. But mine is different from Menger's theory in the point that it is based on the asymmetric relationship between communities with more durable good and those with less because the latter are located in the lower reaches. See Hirayama [2008] for a more detailed research.

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