A game-theoretic/genetic view on female exploitation

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In evolution, how did the two sexes evolve? Some fungi are observed, in which there are gametes, but they are not specialized and any gamete can merge with any other. Geneticists propose that sex selective gametes(egg and sperm), which are observed in most of the species today, evolved from similar cells. Millions of years ago, when there were no sex-selective gametes, some individuals chose to increase the size and nutrition provided by their gametes, in order to increase the chance of survival of its progeny. When these cells prospered, some others in the population decided to cheat. They figured that they could get away with producing *smaller* gametes, as long as they ensured that their gamete fused with one of the larger cells. To ensure this, they developed higher mobility by providing the gametes with a tail. These individuals also had an advantage since they could produce a larger number of gametes(since each gamete now needs lesser resources), and hence ensure that their genes reach the next generations. The individuals with intermediate size died out, since they enjoyed none of the advantages of these two cells. The larger cell evolved into egg, and the smaller tailed cell into a sperm. Hence male and female sexes evolved. The male cell apparently is a good for nothing slacker, taking advantage of the generosity of the female. Exploitation of the female begins here.

Now, let us come to the present, and consider the individuals of a species in which the sex selection procedure is properly evolved. Once the child is conceived, it must be taken care of. Both the male and female have a vested interest in the survival of the child, since their genes propagate in this way. Hence ideally, they should both help in raising it. However, the female has made a bigger "investment" in the child, since she has produced the egg, which requires larger resources to make. Hence the male might be tempted to run away, leaving the female with the baby in her hand to take care of. She will *have* to take care of the baby, since she has a lot to lose if the baby does not survive. The female cannot run away, as if she does, the male would simply do the same, as he would rather go about impregnating more females with his relatively cheap sperm than spending his valuable resources on raising a single child.
To prevent this kind of cheating by a male, a female may choose to ask for an *"engagement period"* before marriage, during which she would keep an eye on the male and not allow him to copulate. The logic is that if the male is willing to spend a month for her, he would be more likely to take care of the child later too. Let us mathematically analyze the different strategies that can be employed by males and females in order to maximize their gains. First, let us allot some scores to the various factors in the game:

+15 : Score for successful birth and full growth of progeny. Positive because the individual's genes are propagated
-20 : Penalty for taking care of the child. It is negative because resources are needed to raise the child. This can be shared between the two parents.
-3 : Penalty for the engagement period. It is negative, since some time is wasted in this.
Let us also define certain "strategies" which can be adopted by a male or a female. Note that these are not conscious strategies, but inherent behaviour, which is determined by the genes. The individual with the successful behaviour survives, and his genes are passed on to the next generation.
Possible strategies for the male are
Faithful: These males agree to an engagement period, and also take care of the child after conception.
Casanova: These males do not agree to the engagement period, nor do they take care of the child.
Possible strategies for the female are
Coy: She asks for an engagement period.
Fast: She does not ask for an engagement period.

The payoff matrix now looks like this:

	Coy	**Fast**
Faithful	Male: +15 – 10 – 3 = +2 Female: +15 – 10 – 3 = +2	Male: +15 – 10 = +5 Female: +15 – 10 = +5
Casanova	Male: 0 Female: 0	Male: +15 Female: +15 – 20 = -5

When all males of a population are faithful and all females coy, they share the work, but waste some time in the engagement period. Hence they both get a score of +2 and live happily ever after. Ah, but there is a catch . Now suppose that just one fast female arises in the population. She does not want an engagement period, hence does not get the -3 for that. Since all males are faithful, they still raise the children, so the -20 is shared. Hence the average payoff for a fast female is +5, instead of the +3 which a coy female gets. Since she is more successful, the number of fast females in the population rises, and after a few generations, all females in the population are fast. So all males are faithful and all females are fast. They both get a payoff of +5, and live happily. But not yet. Suppose now that a casanova male rises in the population. All females are fast and do not ask for an engagement period. So he copulates, but leaves as soon as the baby is born. He gets +15, but does not pay any penalty. The fact that the poor female is left high and dry is of no consequence to the genes of the male. So in a population of fast females, a casanova is immensely successful, as he gets a +15 compared to the +5 of the faithful. Hence after a couple of generations, the population consists of casanovas and fast females. The poor female now gets an average payoff of -5. Now if a coy female arises, she asks for an engagement

period, to which none of the male agree. She hence gets an average payoff of 0, which may seem low, but is still better than the -5 which a fast female would get. Hence coy females prosper, and in a few generations, the population has coy females and casanova males. The cycle is completed when we observe that a faithful male(+2) does better than a casanova(0) in presence of a large coy population. Hence the population comes again to be dominated by faithfuls and coys. By the above discussion, it may seem that the population keeps oscillating between the different combinations of male and female strategies. In reality, however, an equilibrium condition is achieved.
At equilibrium, no individual can be better off by switching to the rival strategy, because if he could, he would, and then that would be the equilibrium. Let us then calculate the equilibrium.
At equilibrium,
Fraction of males who are faithful = r
Fraction of males who are casanova = 1-r
Fraction of females who are coy = q
Fraction of females who are fast = 1-q

Expected payoff for a faithful = Expected payoff for a casanova
$2q + 5(1 - q) = 0q + 15(1 - q)$
$q = 10/12 = 83\%$

Expected payoff for a coy = Expected payoff for a fast
$2r + 0(1 - r) = 5r + (-5)(1 - r)$
$r = 5/8 = 62.5\%$

Hence at equilibrium population, there are 83% coy females, 17% fast females and 62.5% faithful males, 37.5% casanova males.
Now lets look at what the average payoffs are for males and females.

Male = $2q + 5(1 - q) = 15(1 - q) = 5/2 = 2.5$
Female = $2r = 5r - 5(1 - r) = 5/4 = 1.25$

Hence at equilibrium, fast and coy females have equal payoff, and faithful and casanova males have equal payoff. However there is a built-in asymmetry in the system, in the fact that the average female payoff is less, and significantly less, than the average male payoff.

I shall not be tempted to draw any moral or ethical conclusion from this discussion. In fact, I never even mentioned human beings in the whole discussion. All I would say however, that as human beings, we have the ability to defy what nature tells us to do. Hence even if nature deals an unfair hand to women, we can defy nature, and rectify its mistake. And in fact we must defy nature in this regard, otherwise we are no better than animals, the blind servants of nature and Darwinian evolution.