Theory of sexes by Geodakian as it is advanced by Iskrin

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Abstract

In 1960s V.Geodakian proposed a theory that explains sexes as a mechanism for evolutionary adaptation of the species to changing environmental conditions. In 2001 V.Iskrin refined and augmented the concepts of Geodakian and gave a new and interesting explanation to several phenomena which involve sex, and sex ratio, including the war-years phenomena. He also introduced a new concept of the "catastrophic sex ratio." This note is an attempt to digest technical aspects of the new ideas by Iskrin.

1. Introduction

In several publications which date back to 1960s cyberneticist Vigen Geodakian puts forward a theory that explains sexes. (See his site geodakian.com; an easy-to-read article "Why two sexes" by Geodakian is web-available in English, see arxiv.org/abs/cs.NE/0408006) According to the theory, the sexual mechanism of reproduction provides evolutionary advantages for the species that employs it. The 2001 book "Dialektika polov" by Vladimir Iskrin presents Geodakian’s concepts substantially refined and augmented. Iskrin also publishes an article "Catastrophic sex ratio" devoted to his new concepts in the subject. (Both the book, in Russian, and the article, in English, can be found in iskrin.narod.ru.)

In this note I discuss the contributions made by Iskrin to the theory of sexes. This is not a review of either the book or the article. I omit many interesting observations in history, psychology, philosophy, and even politics, made by Iskrin who views his writings in general as a philosophy. The present note is an attempt to digest the mere technical aspects of Iskrin’s ideas. The note has not been authorized nor approved by either of the two authors and I do not guarantee that my interpretation fully agrees with the originals. In case of any doubt an interested reader is referred to the sources indicated above.
2. Life expectancy and size

While agreeing with Geodakian on that the sexual reproduction is evolutionary more advantageous than the asexual one, Iskrin also pinpoints a specific reason for the emergence of the sexes. The reason is basic, it exists across different species. Namely, we, the complex multi-cellular organisms, better be sexual because we live long. Long, that is, by comparison with the simple organisms. Longer the life expectancy of a species’ members, more evolutionary pressure is exerted on the species to become sexual.

It can be added that being multi-cellular our large size as compared with the size of simple organisms also contributes to the pressure. Indeed, the number of microbes of a particular species thriving under appropriate conditions (temperature, availability of nutrients, etc) in a small pool of water might be comparable with the entire human population.

For single-cell or other simple organisms, the life duration is the time elapsed from the moment of setting the new organism’s genetic makeup to the moment when the organism is able to divide or otherwise reproduce and to set a genetic makeup of its offsprings. The life duration is understood in a usual way for complex multi-cellular creatures: it is the time from the birth to the death.

Here is the argument. The life expectancy of individuals in a species divided by their number is inversely proportional to the species’ renewal rate. (The renewal rate is the rate at which new organisms substitute the old ones. It is the number of new organisms produced per unit of time, if the population size remains stationary. The ratio of the renewal rate of a microbe species over that of humans might easily be greater than ten orders of magnitude.) On one hand, for an asexual species to survive, its renewal rate has to be high enough for the species’ genotype to be able to track and adapt to the environmental change. The tracking occurs by the way of a simple random search whereby the species uses the Darwinian survival-of-the-fittest selection superimposed on the random mutations. And those mutations occur with the rate proportional to the renewal rate. On the other hand, the sexual reproduction mechanism compensates the species’ slowness, if any, in renewal. That is, the sexual species relies not only on the simple random search via mutations at renewals for tracking the environmental change, but also and primarily on the sexual selection. The mechanism of sexual selection is more complex than the basic random search. Its description constitutes the Geodakian’s base theory of sexes, and I skip here the explanation, see, e.g., arxiv.org/abs/cs.NE/0408006.

A species of living long and large-sized individuals if the sexual reproduction is not employed is more likely to become extinct than one that does employ it. This holds assuming that all the other conditions between the two cases are the same and that the environment changes fast.

It may be added that while the longer life and larger size of complex organisms puts the species at a disadvantage as the mechanism of evolutionary adaptation of the species to changing environment is concerned, the complexity itself offers many advantages. The complexity is an evolutionary result of accumulating mechanisms that serve to withstand a possibly larger variety of environments. A complex creature withstands the environmental change better than a simple creature as long as the changed condition is within the band of acceptable conditions. For a complex creature such band is wider than for a simple
creature. This is a "resourceful" method: for different conditions the creature offers different mechanisms. The body complexity and size are utilized to host these different mechanisms.

Occasionally, the nature offers what seems like counter-examples: populations of long-living large-sized multi-cellular organisms, which none-the-less are asexual. According to Iskrin these examples do not contradict the rule. Such populations were lucky enough to enter exceptionally stable and comfortable environments. Another way of saying this is that the genotype of such species has accumulated and presently holds all the mechanisms and features that are necessary to prosper in the current environment and in its possible variations. The sexual reproduction mechanism of such populations has since become redundant, and it has weakened and/or disappeared. These populations usually include only females and in the absence of males they reproduce parthenogenetically.

A particular attention is paid to the life duration of an individual as an operating factor in the mechanism of sexual reproduction. This distinguishes the treatment of the problem by Iskrin from that by Geodakian. The life duration is involved in various ways in all the proposed new mechanisms and theory refinements.

3. Sex ratio

For example, Iskrin considers the sex ratio \( SR \), a much studied statistics for the humans and other sexual species. This is the number of the living males divided by the number of the living females. The statistics is usually reported as being multiplied by 100. For instance, a typical reported sex ratio at birth for humans is \( SR = 105 \) which means that among the newborns on average there are 105 boys for 100 girls. The life duration enters the consideration of the statistics by segregating the \( SR \) according to the individuals’ age so that to each age interval its own \( SR \) corresponds. If the granularity of the segregation is made very fine, then, at least ideally, the \( SR \) can be thought of as a continuous function of the continuous time-like age parameter \( t \), let us denote this function \( SR(t) \).

In agreement with the base theory of sexes, in any age group \( t \), the chance of a death for a male is greater than that for a female. (This is usually confirmed by statistics, but Iskrin also notes distortions of this rule in certain human subpopulations in the former USSR.) Therefore \( SR(t) \) monotonically decreases with \( t: SR(t_1) > SR(t_2) \) if \( t_1 < t_2 \).

The aging begins at \( t = 0 \), the moment of conception. The sex of an embryo is set at conception, so the values of \( SR(t) \) make sense for \( 0 \leq t \leq t_b \), where \( t_b \) is the time elapsed from conception to birth. (Among many implied idealizations of the model, \( t_b \) is assumed to be the same for all the individuals in a population.) For humans, various estimates give values from \( SR(0)=120 \) to \( SR(0)=180 \). \( SR(t) \) gradually reduces to 0 for large enough \( t \), because women live longer than men do, on average.

4. Parity age

It is proposed to view the sex ratio profile, especially its rate of descent, \( \frac{d}{dt}SR(t) \), as a measure of the harshness of the environmental conditions and/or of the speed of their change. The parity age \( t_p \) is introduced. By definition, at \( t = t_p \) the profile crosses the value of 100.
Thus at the parity age the number of living males is equal to the number of living females. Because of the monotonicity and continuity of the profile, and because of its starting value $SR(0)$ being greater than 100 and ending value $SR(\text{large } t)$ being close to 0, parameter $t_p$ is well-defined. Assuming tacitly that the entire profile of the functions $SR()$ is determined by this single parameter, the $t_p$ now measures the harshness or the speed of change of the environment: smaller the $t_p$ faster the descent of $SR(t)$ and harsher or changing faster the environment is toward the population.

5. Quality of an individual

Along the footsteps of Geodakian, Iskrin considers quality, quantity, and assortment (that is, variety or diversity) as the main operating parameters in the sexual mode of reproduction. He then concentrates on the parameter of quality of an individual ($Q$). The $Q$ measures the degree of adaptability of the individual to the current conditions offered by the environment, the degree of the ability to adjust to and be comfortable in the environment.

By contrast with the unambiguous definition of the parameter $SR$ as above, the given definition of the parameter $Q$ is vague. It is open to different interpretations let alone that no method of assigning a concrete numeric value to $Q$ is proposed by Iskrin (or by Geodakian, for that matter).

It seems to me that there may be at least three different directions of making the definition of $Q$ more precise:

I) "genetic" $Q = Q^g(t) = \text{const}$, the $Q$ stays unchanged over the lifetime of the individual because it is determined entirely by the genome;

II) "aging" $Q = Q^a(t)$ which monotonically decreases over time, as the individual ages while exhausting the living resource used to withstand the environment;

III) "wisdom" $Q = Q^w(t)$ which monotonically increases over time, as the individual matures while learning how to better adapt to the environment.

These three directions for defining the $Q$, differ primarily in the behavior of $Q = Q(t)$ with respect to the age parameter $t$. The parameter is the "speciality domain" for Iskrin. By contrast, for the "lump" version of the $Q$ in Geodakian’s treatment, without segregating according to $t$, the question of these distinctions does not arise.

Perhaps, a better model would be some combination of the three: $Q(t) = f[Q^g(t), Q^a(t), Q^w(t)]$ where function $f$ is not necessarily linear. However, as the subject is further discussed in the book, it appears that Iskrin adopts the simplest it-is-all-in-the-genes definition so that $Q(t)$ remains constant throughout the life of an individul.

So $Q$ is not well-defined. But if it were defined well, one could operate with the $Q$ measure in the same manner as with the $SR$ measure. Namely, a statistically averaged $Q$ could be considered and the average could be segregated by the age. Furthermore, the average could be segregated by the sex. The average quality of males $Q_m(t)$ could be compared with that of females $Q_f(t)$ at different ages $t$. Iskrin is doing just that in his book, ignoring the fact that the $Q$ is underdefined.
6. Parity in quality

As mentioned above, Geodakian does not segregate anything according to the life duration, in particular, he does not segregate the $Q$. He makes a "lump" statement to the effect that the average quality of a male is lower than that of a female.

But Iskrin does segregate. According to him, the average quality of a living individual in the population, $Q(t)$, increases with $t$. This is so, because lower $Q$ individuals remove themselves from the averaging sooner than the higher $Q$ individuals. Note that the increase would take place if the quality is "genetic" $Q = Q^g(t)$. The latter is apparently the assumption by Iskrin. And the average "wisdom" quality would also increase but not necessarily the average "aging" quality.

Furthermore, the average $Q_m(t)$ increases faster, than the average $Q_f(t)$. This is so, because the weaker sex (those are the males, see arxiv.org/abs/cs.NE/0408006) depletes its lower $Q$ members at a faster rate than the stronger sex.

At $t = 0$ (conception), $Q_m(t) < Q_f(t)$. This is in agreement with Geodakian. But as the lower $Q$ individuals die out for $t > 0$ the ratio $Q_m(t)/Q_f(t)$ monotonically increases while inequality $Q_m(t) < Q_f(t)$ still holds. For a sufficiently large $t > t_p$ the inequality between $Q_m(t)$ and $Q_f(t)$ reverses sense and becomes $Q_m(t) > Q_f(t)$. Here $t_p$ is the age of parity in the average quality between the sexes: $Q_m(t_p) = Q_f(t_p)$.

Note that the age of parity in quality needs not be the same as the age of parity in numbers of members of the two sexes, discussed in Section 4 above. A sort of a "proof" is suggested that for humans these two ages better be the same or differing only slightly. Iskrin’s "proof" appeals to an argument of the economy of "material." The argument is that the evolution benefits a population that avoids an unnecessary waste of its members.

Iskrin assumes that the mating occurs in pairs of the same age on average and of the same quality on average and therefore if the numbers were not equal there would be a waste. However, Iskrin also suggests elsewhere in the book, that, on average, there is, perhaps, a small systematic discrepancy in quality between a pair of mating individuals, namely, an increase from the female to the male. Furthermore, there exists a similar systematic discrepancy in the ages between a pair, also an increase from the female to the male. Because of these discrepancies, a small discrepancy may exist, he concedes, between the two parity ages.

If the argument above seems vague to a reader-mathematician, so it does to me. That is why I enclose "proof" in quotes. Perhaps, the theory can be mathematically completed in such a way that the equality or small discrepancy between the two parity ages would indeed follow from the definitions as a simple theorem.

Among the statistically observed phenomena that confirm the changing relation between $Q_m(t)$ and $Q_f(t)$ is the one that says that, on average, a teenage boy-driver is more prone to an automobile accident than a teenage girl-driver, whereas for senior drivers the relation is reverse.

Iskrin also cites statistics which indicates that in the 1950s, in the after-the-WWII USSR, the humans’ $t_p$ was smaller than 20 years and then, as the conditions improved, the $t_p$ gradually increased to reach in 1980s almost 30 years, the value, he thinks, the $t_p$ should be equal to in a comfortable social environment. In pre-civilization environments, he believes,
7. Which sex is more responsible for forming the sex ratio

The base sex theory of Geodakian states that faster the environment is changing, larger the target $SR$ is being set by a sexual population so that more new males are being produced in proportion to the number of the new females. But where in the species is the mechanism of adjusting the $SR$ located and how specifically does it operate? Which sex in the population is more responsible for forming the $SR$?

Iskrin furthers the theory by attempting to answer these questions. Implications of his answers can be verified statistically. In my opinion, the answers allow one to explain convincingly certain existing statistical and natural phenomena. These will be discussed below.

Iskrin argues that in a sexual species the heterogametic sex is primarily responsible for forming the $SR$. (The heterogametic sex is the one that supplies two sorts of gamets, X and Y. The opposite sex is homogametic, it produces only one sort or gamets, X.) Among the mammals, particularly, for the humans, the heterogametic sex is the males.

By Iskrin, each individual man controls the $SR$ in his progeny by setting the pre-conception $SR$ in his sperm. Therefore, the controlling parameter is the ratio of the number of Y spermies over the number of X spermies. Iskrin stops short of saying that this value is, in fact, equal to the mathematical expectation of the sex ratio at conception $SR(0)$ (for the individual father, not the average over the population). There might exist some hormonal and other biological "filters" in the woman’s body which change the pre-conception sex ratio.

The existence of such filters is strongly suggested by the existence of some family trees where only girls were born in each generation and where this property was inherited through the mother. However, the apparent strength of the filters for such rare families is not a rule for all humans. On average, the effect of such filters on the deviation of $SR(0)$ from its parity value $SR(0) = 100$ is much weaker than the effect of the initial setting which is formed exclusively in the man’s body.

Continuing this discourse mainly for the case of humans, Iskrin next proposes that the man, his body, and especially, his sex organs is sort of a "sensor" in the mechanism of controlling the man’s individual expected $SR$. He makes an interesting observation about the natural built-in sensitivity and protection of the sex organs in the body. Man’s sex organs are very sensitive and yet they are not well protected, being positioned outside of the protective body bulk. Such positioning of the man’s sex organs is obviously against the private interest of the individual man, but it is expedient for the population as a whole. It allows the male’s sex organs to perform better their sensory function, for instance, to sense the outside temperature. The safety of the male’s sex organs is sacrificed for the same cause the life itself of an individual male, if he is of a lower quality, unfit, is sacrificed. This cause is speeding up the adaptation of the species to the changing environment.

The proposed parameter which controls the $SR$, namely the pre-conception $SR$ in the man’s sperm, fits well with statistically observed phenomena and this fit will be discussed below. But before that, I should explain an item in Iskrin’s theory which is completely new, as compared with Geodakian’s theory.
8. Iskrin’s ”catastrophic sex ratio”

A population of an initially sexual species may become parthenogenetic (all-female) if it finds itself in an exceptionally comfortable and stable environment. In such an environment the population sets a target ”comfortable sex ratio” $SR = 0$.

Iskrin also considers a diametrically opposite scenario. In it a sexual population encounters conditions which are interpreted by its members as exceptionally bad and unstable. In such a state, the population ”feels” threatened with what is perceived as an imminent extinction, a catastrophe. In this emergency state a special target $SR$ is set. Paradoxically, as a number, this ”catastrophic sex ratio” is the same as the ”comfortable sex ratio” $SR = 0$.

This paradox is illustrated with a metaphor. The population is compared with a canoe rider. The sexual mechanism of reproduction is compared with the steering paddle. If the flow is laminar and very steady the rider may not even need to use the paddle. On the other hand, if an extremely turbulent flow overturns the canoe the rider would not need to use the paddle either.

Iskrin cites several examples that involve the catastrophic $SR$, including examples of sexual plants. Some plants change their sex in response to their worsening conditions. When the conditions become mildly bad, female plants may become males. This exemplifies the mechanism of increasing the $SR$. When the conditions become very bad, male plants may become females. This exemplifies the mechanism of setting the catastrophic $SR$. The gardeners, farmers or other plant care takers systematically ”condition” the plants (cut brunches, flowers, etc.) to achieve desired plant properties, for instance, the ability to produce tasty fruits. Such ”conditioning” is interpreted by the plants as none else but mutilation, abuse. It awakens the evolutionary developed response of the sex change, which is a defence of the species.

Also, a research paper is cited which observes an unusually low $SR(t_b)$, less than 40, in the families where the father’s occupation, such as a geologist, a high-altitude scientist, makes him to stay up in the mountains for long periods of time. The low $SR(t_b)$ has nothing to do with the air, water, difference in heights and other such physical factors conjectured as the cause by the author of the paper. Instead, Iskrin sees in this case a clear involvement of the catastrophic $SR$ phenomenon. More specifically, it is the result of a prolonged abstinence.

For many millions of years of our animal prehistory the primary reason for male’s extended abstinence was the absence of females. The no-female situation threatens the species with the extinction. The animalistic assessment of this fact remains genetically imprinted in the man’s body, who decreases the pre-conception $SR$ in his sperm when being abstinent. The mere tens of thousands of years of our existence as Homo sapiens have not washed out the mechanism which can be triggered by the appropriate conditions in us just as well as in the mice. This explanation implies an obvious and tangible recommendation for fathers who wish a son as well as the one for those who wish a daughter.
9. Why the firstborns are often boys

Speaking only about humans, to any person an index value \( i \) corresponds, \( i = 1, 2, 3, ..., \) such that this person is the \( i \)th born child of his/her father. The \( SR \) statistics can be segregated by this index. \( SR[1] \) becomes the sex ratio of first-born children, \( SR[2] \) the ratio of the second-born children, etc. (I denote the segregation by order index \( i \) with the square brackets, \( SR[i] \), and that differs from the notation for the age segregation; the latter is denoted using parentheses, \( SR(t) \).)

The reported average \( SR[1] \) is usually noticeably larger than 100. The subsequent values of \( SR \) are monotonically decreasing: \( SR[1] > SR[2] > SR[3] > ... \). Iskrin explains the phenomenon by the mentioned in Sec.6 increase of average \( Q(t) \) with \( t \). The male’s own sensed quality sets the pre-conception \( SR \): a lower \( Q \) male sets \( SR \) higher, and a higher \( Q \) male sets it lower. But the lower \( Q \) males also have a higher chance to remove themselves from the process of reproduction and that is why the \( SR[i] \) decreases with \( i \). \( SR[1] \) is higher than 100 because an average young father has low \( Q \).

This phenomenon is compatible with the ”genetic” \( Q \) model and even more so with the ”wisdom” \( Q \) model, but it might not be compatible with the ”aging” \( Q \) model.

10. War years phenomena

The most familiar war-years phenomenon which involves \( SR \) is the increase of \( SR(t_b) \) in a nation which participates in a war. While a typical peace-time value is \( SR(t_b) = 105 \), during a war it usually increases a couple of points and sometimes it might become as high as \( SR(t_b) = 109 \). Such statistically significant increases persist across different nations and different wars.

In arxiv.org/abs/cs.NE/0408006 Geodakian attributes this increase to a general tendency of the \( SR \) increase under various hardships. Elsewhere he suggests a more specific mechanism of the increase as being attributable to a reduction of the number of men available for reproduction.

However, Iskrin proposes a different specific mechanism which might be responsible for the phenomenon. The phenomenon is caused by a redistribution of \( Q \). A military draftee, man, must pass a medical commission to become a military serviceman. The commission filters out physically unfit individuals. The physical fitness strongly correlates with the quality \( Q \), hence during a war the population of reproductive age men is being split into the two subsets: those who go fight, they are, on average, higher \( Q \) men; and those who stay behind, they are, on average, lower \( Q \) men. The fighting men have substantially smaller opportunity to become fathers than those who stay home. The non-fighting lower-\( Q \) men generate progeny of a higher \( SR \) than the \( SR \) would have been among all the men capable of reproduction.

A less known war-year phenomenon is a significant decrease of the \( SR(t_b) \) in a subpopulation which becomes subject to an extreme hardship, in particular, to starvation. An example of the phenomenon is the 1941-44 blockade by the German troops of the city of Leningrad (presently known as St.Petersburg) in Russia.
The war with Germany started in the mid-1941, and the German troops fully surrounded the city of Leningrad by the late fall of 1941. During 1941 a war-year increase of $SR(t_b)$ was observed in Leningrad. It has reached 106. However, in 1942 the value of $SR(t_b)$ sharply decreased to 101 and then again increased to 105 in 1943 and kept increasing in 1944 to reach 109 in 1945.

It is known that the living conditions in the city, especially, the food shortages steadily worsened since the beginning of the war reaching their worst in the winter of 1941-42. Beginning with the spring of 1942 the conditions, mainly the food availability, began to slowly improve for those who had survived thus far. The living condition history matches the history of the $SR(t_b)$ statistics, so that the 1942 minimum in $SR(t_b)$ matches the worst food situation in the city with a several months lag.

Iskrin thinks that a malnutrition of mothers during pregnancy reduces the parity age $t_p$. The Leningrad blockade starvation sent the $t_p$ value to below the $t_b$ value for those who were born in Leningrad in 1942. In other words, the male-fetuses were dying at an especially high rate as compared with the female-fetuses. This mother-induced filter was decreasing $SR(t_b)$ while it was acting in superposition with the father-induced setting for $SR(0)$. The latter was pushed higher during the years of the war. The ambivalent war-years profile of $SR(t_b)$ in Leningrad was the result.

During the WWI and the few years after, the Russian cities of Moscow and Petrograd (another old name for St.Petersburg) exhibited similarly ambivalent profiles of $SR(t_b)$ (high, low, high again, low again) with lows for years 1919-20 and then 1924-25. The lack of food was the main hardship during those "low" years. The analogous statistics available for the years of WWI in the West (Germany, France, England) show a unimodal increase-decrease profile of $SR(t_b)$ with no ambivalence.

11. Conclusion

In my view, Iskrins’ theory is interesting for a researcher in the area in two respects:
I. It allows one to set experiments and make predictions with testable outcomes.
II. It opens new directions for a mathematical modeling.