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A matter of time: Bateman's principles and mating success as count and duration in contemporary Finland

Linus Andersson, Marika Jalovaara, Jan Saarela, Caroline Uggla

Abstract

Bateman's principles continue to influence the understanding of human reproductive behaviour despite enduring criticism. However, few rigorous studies on Bateman's principles in contemporary industrialized populations exist, and previous studies are hampered by small sample size and exclusion of non-marital unions. Here we address these shortcomings by assessing mating success and reproductive success using population-wide Finnish register data of marital and non-marital co-habitations and children born. These unique data allow us to compare different operationalizations of mating success, namely, co-residential unions and cumulated union duration; and to examine variability across social strata. Our data support Bateman's first and second principles but the association between mating success and reproductive success is less clear. The number of unions is somewhat more positively associated with reproductive success for men than women, and the mating success–reproductive success association turns negative when adjusting for union duration. Having had more mates is associated with lower reproductive success than having had one union. More unions are positively associated with higher reproductive success only for men in the lowest income quartile. We conclude that union duration, controlling number of unions, is associated with higher male reproductive success and should be incorporated as an important dimension of mating success.

Keywords: serial monogamy, evolutionary demography, sexual selection; Bateman gradient

Introduction

Bateman's 1948 study of fruit fly mating concluded that variability in reproductive success (RS) was greater among males and that the difference was driven by the variance in the number of mates. The study was later crystallized into three principles: (1) males show greater variance in RS than females, (2) males show greater variance in mating success, and (3) the association between mating success and RS is stronger for males than for females[1]. These principles were incorporated into parental investment theory[2] and epitomized as the Darwin–Bateman paradigm, which has been hugely influential (see e.g. Borgerhoff Mulder, 2020 for a review[3]). The purported stronger link between mating success and RS for males has been pivotal in advancing the view of distinct sex differences in both non-human animals and humans, and has guided assumptions of sex roles in choosiness and competition for mates[4].

Bateman's study has withstood both critiques of methodology and theoretical advancements in sexual selection[5,6]. The latter has led to a re-evaluation of the role of anisogamy, and its role in the presumption of fitness pay-offs to coy females and competitive males. Conversely, females may benefit from mating with multiple males[7,8] and should not invariably favour parenting over mating effort, just because costs of gestation and lactation have already been paid[8,9]. Other factors, such as the adult sex ratio, can alter pay-offs to mating versus parenting efforts to males and females alike (for a review, see Schacht and Uggla, *in press*[10]). There is also evidence of variability in the Bateman gradient across taxa. Among cooperative breeders, the Bateman gradient has been found to be stronger among females[11]. Other studies have shown that there may be a strong gradient among both sexes, even accounting for the number of breeding years[12].

The Bateman principles in humans

Variance in both mating success and RS tend to be higher among human males than females[1] and several studies have found support for Bateman's third principle, that there is a stronger relationship between mating success and RS, in humans. Empirical analyses of Finland in the 18th and 19th centuries[13–15] have shown that multiple mates benefited men's RS, but not women's. Thus, what we currently know about the Bateman gradient in humans is to a large extent based on historical data from contexts in which women were not able to initiate divorce and where re-partnering was frequently the result of the death of a spouse. There is a lack of studies that test the Bateman principles in contemporary low fertility societies[3]. Studies based on data from the 20th century include one from the contemporary US[16], and one from Sweden[17], both of which demonstrated a stronger association between mating success and RS for men than women.

The existing literature from contemporary industrialized populations[16,17] is based on survey material with documented limitations, including sample attrition and measurement error in male fertility[18,19]. Moreover, most previous studies operationalized mating success as the number of marital partners. In societies in which a substantial share of mating occurs in non-marital co-habiting unions, this is a conceptual problem and an empirical shortcoming. In most contemporary industrialized populations, serial monogamy is to a great extent driven by non-marital unions[20]. Consequently, estimates of Bateman's second and third principles may be severely distorted owing to under-estimation of mating success by (co-habiting) unions. Furthermore, while non-marital unions represent an important family form, cultural and institutional settings promote conjugal fertility. Operationalizing mating success as marital unions partially conditions mating success on RS (childbearing within marital unions). This problematizes the interpretation of Bateman's third principle. In this study, we circumvent this issue by employing data that capture all co-habiting unions, whether marital or not.

Several studies on humans counter the notion that women do not benefit from multiple mates and that men should opt for a strategy that favours more partners to achieve higher fitness[21–23]. Among the Mpimbwe of Tanzania, women who have multiple marriages have higher RS, whereas the opposite is the case for men[24]. In her review, Scelza[23] notes the many ways in which females can and do seek out multiple mates. Humans are a species characterized by high parental investment, long childhood, variability in mating systems, and facultative paternal care. Thus, to empirically test the Bateman gradient, its components need to be operationalized in a way that is appropriate with regard to both the population's socio-cultural context and respect for the life history of the human species. Here, we follow Borgerhoff Mulder and Ross[25], who argue for increased detail on the components of mating success on which sexual selection may operate in humans. Below, we describe this aim and our focus on union duration during which an individual has a mate.

Mating success as the number of unions and union duration

Human mating success is traditionally measured as the individual's number of mates. Recent work proposes that in addition to quantity, the time duration that one is with a mate also can be considered mating success. This has led to interest in mating success measures that capture the exposure time to a mate[25,26]. In species with long-term pair-bonding and intensive parental care, the trade-off between mate quantity (additional births from other mates) and duration in union (continued investment in common offspring) may be essential. Leaving a current mate for the prospect of finding a new mate is undertaken at the risk of lower cumulated mate exposure. Consequently, the fitness benefits each partner receives from staying an additional year with their current partner have to be greater than any benefits accrued from acquiring a new partner. However, analyses of union duration as a predictor of RS are rare. A notable exception is the Mpimbwe of Tanzania where years with a marital partner, not the number of partners, predict RS more strongly for males than for females. This supports the existence of sex-specific returns to partner behaviour and extends the scope of Bateman's third principle[25]. In this study, we carry out a similar examination in a different socio-cultural context, namely present-day Finland.

Bateman's principles under social stratification

Under high mate competition, it can be costly to leave a current mate in search of a new one. When the likelihood of failure is high, one who attempts to switch mates – and who succeeds – may vary based on phenotype[27]. Individuals who possess traits attractive to potential partners may be more inclined to take such a gamble. One trait that is desired by men and women alike is resource access. Notwithstanding cross-cultural variation, overall mate choice data suggest a female preference for men of equal or higher status, while men do not show such preferences to the same extent[28,29]. Consequently, men with low socio-economic status are more likely to be childless[30] and are disadvantaged in the partner market[31]. However, in our population of contemporary Finns, such disadvantages are found among women with low socio-economic status, who have shorter union durations and higher rates of childlessness[31,32].

We currently know little about whether the correlation between mating success and RS is heterogeneous with respect to social status. Jokela et al.[16] find a stronger (marital) Bateman-gradient among black men than white men in the US, and suggest that this reflects underlying group differences in socio-economic status and adult sex ratios. In this study, we test whether Bateman's principles hold across our entire population, or whether they vary across different quartiles based on income for men and women.

Study population

Finland provides a useful context to study Bateman's principles in contemporary low-fertility societies. It has a high degree of serial monogamy, divorce, non-marital co-habitation, and non-marital childbearing[33]. No-fault divorce is practiced, and relatively high separation rates make childbearing with multiple mates common. Female labour market participation is high, and childrearing is shared between mother and fathers to a great extent, although mothers take most of the parental leave[34]. These demographic behaviours and gender relations are typically associated with Nordic countries but have been spreading across most industrialized countries for decades[35]. An examination of the Bateman principles in contemporary Finland – a socio-cultural context with a high degree of paternal investment and where both sexes are free to switch mates – would help broaden our understanding of sexual selection in humans.

Aims and contribution

To the best of our knowledge, this is the first comprehensive test of Bateman's principles in a contemporary low-fertility population. Our study makes at least four important contributions. First, we capture both non-marital and marital co-residential unions, producing a more accurate measure of mating success. While marriage is a precondition for reproduction in some societies in which the Bateman gradient has been explored, this is not the case in many contemporary industrialized, low-fertility societies. Second, deploying national registers of the entire population, we avoid issues with statistical power, sample attrition, and under-reporting of male fertility or children from previous unions. Third, we compare mating success operationalized as the cumulated number of unions and as cumulated union duration. In doing so, we build on previous work that has unpacked mating success with duration data from a natural fertility population[25]. Fourth, we are able to test whether any association between mating success and RS varies across social strata. This is important, as social status is an important trait in mate selection and is associated with differential outcomes on the mating market and childbearing[31].

Methods

Data

We use Finnish register data on Finnish-born individuals born between 1969 and 1972, alive in 2018 and who had resided in Finland since the year of their 18th birthday (in total 219,086 people). We focus on the population who remained residents in Finland in order to prevent under-estimation of births and unions that might have occurred abroad. Data on non-marital co-habitation in the total population exist since 1987, the longest-running population-wide record in the world. Marriage data are also available for this period. Therefore, we can analyse non-marital and marital co-habitation and childbearing histories during the ages of 18–46 years of the 1969–1972 birth cohorts.

Mating success

We measure the cumulated number of unions by the age of 46 years from each unique union, that is, with the same partner. A non-marital co-habiting union is defined by Statistics Finland for co-residence; this definition considers a person to live in a co-habiting union if they are domiciled for more than 90 days with an opposite-sex individual who is not a sibling or parent, with an age difference below 20 years, and the couple's status is not married. The approach has been assessed in previous research in Finland[36,37] and elsewhere[38]. To measure the cumulated union duration, we add the total number of years a person has spent in any union. Union duration is collapsed into 5-year categories to fit a non-linear model of duration effects in a regression framework. A union that is first non-marital and thereafter turns into a marriage is counted as a single marital union. Union duration is measured from the first to the last dates of observation. In appendix Table A5, to underscore the necessity of measuring non-marital unions, we demonstrate that marriage-only measurement under-estimates the share of those ever in one union and greatly under-estimates the share of those ever in two or more unions.

Reproductive success

RS is measured as the cumulated number of children ever born to a parent by the age of 46 years. Male and female fertility is identified using this parent–child linkage. Paternity is acknowledged for a spouse and by consent among the non-married. Contested or non-confirmed paternity is investigated vigorously by social services, and registers are updated accordingly. Only about 2% of births lack a father-link in the records. Appendix Figure A1 analyses how much (male) fertility is under-estimated due to our cut-off point being the age of 46 years. For the 1963 cohorts, which we can follow up to the age of 55 years, less than 1.5% of all births for males by the age of 55 years occur after the age of 46 years.

Social status

Our main measure of an individual's social status is income rank, which is based on earnings, capital income, and social transfers that are conditioned on earnings. We use the maximum value of income in the calendar year at the ages of 44, 45, and 46 years. This approach prevents under-estimation driven by temporary declines or breaks in employment. We create rank centiles of the entire working-age population. Because centile units become too small to analyse, they are collapsed into quartiles.

Analytical strategy

To analyse Bateman's first principle – whether men have higher variance than women in RS – we calculate 'the opportunity for selection', *I*, separately for men and women, as

$$I = \sigma_y^2/\bar{y}^2$$

where y is the number of children born to a parent by the age of 46 years, σ_y^2 its variance, and $\bar{y}^2$ its squared mean[21,40]. To analyse Bateman's second principle – whether men have higher variance than women in mating success – we calculate 'the opportunity for sexual selection', I_S, separately for men and women, as

$$I_S = \sigma_u^2/\bar{u}^2,$$

where u is operationalized as the cumulated number of unions by the age of 46 years and, alternatively, as the cumulated union duration by the age of 46 years; σ_u^2 its variance; and $\bar{u}^2$ its squared mean. As we use univariate parameters of the full population and not a sample of the population, we simply contrast I for men and women, and I_s for men and women, respectively, without test statistics. This exercise is repeated across social status categories. Thereafter, to analyse Bateman's third principle – whether mating success is more positively associated with RS for men than women – we accommodate the count distribution of y and estimate Poisson regressions, with the predicted mean of the associated Poisson distribution given by

$$E(y|x) = \exp(\alpha + \beta' x),$$

where x refers to regressor variables, α the intercept, and β parameters to be estimated. The regressor variables of interest are the interaction between sex and mating success, adjusted for birth cohort. Regressions are estimated separately for each operationalization of mating success as the incidence rate. We also estimate the association between the cumulated number of unions net of cumulated union duration, and *vice versa* and RS. To assess the effect of additional unions on RS for men and women, mating success is estimated on an ordinal scale, holding one union as the baseline level for the cumulated number of unions. The range of 10–14 years in a union is the baseline level when modelling cumulated union duration. We report average marginal effects (AMEs), which can be interpreted as the differences in the mean number of children compared to the baseline level.

To examine heterogeneity in the Bateman gradient across social strata, we include an interaction of sex, mating success, and income quartile (lowest 1st quartile and highest 4th quartile earners). Lastly, to facilitate comparison with previous research that tests Bateman's third principle, we also estimate the linear slope for the association between mating success and RS, for men and women separately.

Results

Bateman's first and second principles

In the total population, the opportunity for selection (variation in RS, *I*) is 1.56 for men and 1.37 for women (Table A4 in the appendix). For both sexes, *I* is largest in the lower-income quartiles. The opportunity for sexual selection (variation in mating success, $I_{S,}$) as defined by the cumulated number of unions, is 0.8 for men and 0.74 for women. When defined as the cumulated union duration, I_S is 18.12 for men and 14.99 for women. In the lowest income quartile, women have a higher variance in RS than men. In the first and second income quartiles, men show higher variance in mating success, while women have higher variance in the third and fourth income quartiles. Thus, at the population level, we find some support for Bateman's first two principles, but this is not consistent across social strata. Heterogeneity across social strata is also visible when *I* and I_S are calculated across the full continuum of income rank (appendix Figures A4 and A5).

Bateman's third principle

Figure 1, Panel A shows the AME of mating success, measured as the *cumulated number of unions*, on the number of children by the age of 46 years, adjusted for birth cohort. The number of children born decreases with more unions compared to one union, for both men and women. The negative effect is stronger for women than for men. Women who have had five or more unions have 0.26 fewer children than women who have had one union, compared to 0.12 for men. Intuitively, the association between never-partnering (0 unions) and the number of children is strongly negative, but do not differ across the sexes (AME = -1.81 for men and -1.82 for women who have never partnered compared to individuals who have had one union). The linear models for each sex present a positive slope for the cumulated number of unions on the number of children, which is slightly stronger for men than women (β is 0.157 and 0.061, respectively).

Panel B in Figure 1 shows *cumulated union duration* as mating success. Union duration positively predicts the number of children, and more strongly so for men. Men who had accumulated 24+ years in unions by the age of 46 years had 1.09 more children than those who had accumulated 10–14 years by the age of 46 years. For women, the corresponding difference is 0.92 more children. This sex difference of 0.17 children is substantial given a population mean of 1.78 children. The linear slope, estimated from the yearly cumulated duration in unions, is in line with Bateman's third principle: additional years of union duration predict higher RS for men than women.

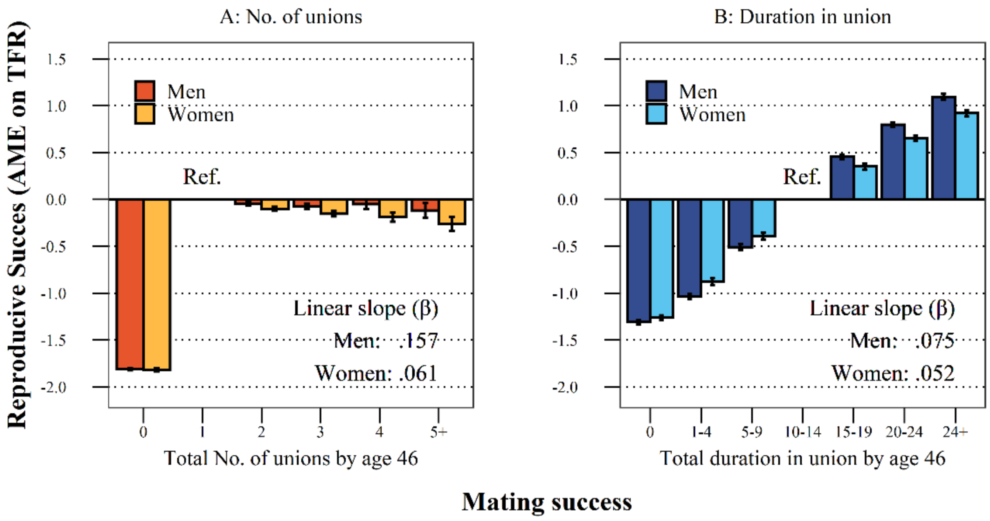

Figure 1. Panel A: The Y-axis indicates the average marginal effect of mating success, as union number by the age of 46 years (baseline = 1 union), on reproductive success (the number of children) by the age of 46 years, by sex. Regression coefficient for continuous estimate of union duration (Panel B).

Panel A in Figure 2 reiterates the analysis of Panel A in Figure 1 when controlling for cumulated union duration. The negative association between the number of unions and RS is attenuated when controlling for duration. The linear slope becomes negative for both sexes (-0.042 for men, -0.041 for women). Panel B in Figure 2 reiterates the analysis of Panel B in Figure 1 when controlling for the cumulated number of unions. Effect sizes and direction remain essentially the same.

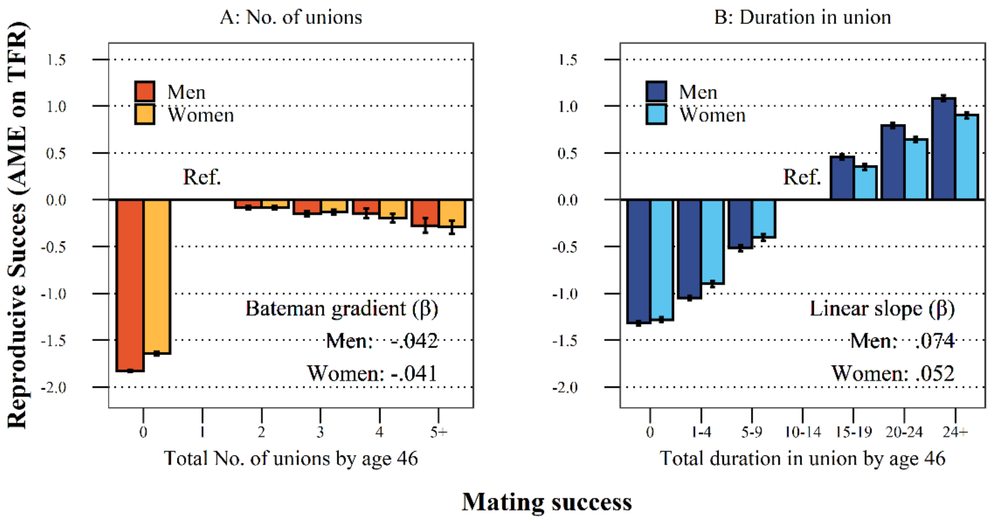

Figure 2. Panel A: The Y-axis indicates the average marginal effect of mating success, as union number by the age of 46 years (baseline = 1 union), on reproductive success (the number of children) by the age of 46 years, by sex, adjusted for union duration. Regression coefficient for continuous estimate of number of unions, adjusted for union duration. Panel B: The Y-axis indicates the average marginal effect of mating success, as union duration by the age of 46 years (baseline = 10–14 years), on reproductive success (the number of children) by the age of 46 years, by sex, adjusted for number of unions. Regression coefficient for continuous estimate of union duration, adjusted for number of unions.

Bateman's third principle across social strata

In Figure 3, Panels A1–A4 show the AMEs of the cumulated number of unions on RS (completed fertility) by income quartile, adjusted for birth cohort. The 1st quartile comprises the lowest earners for each sex, and the 4th quartile the highest earners. The negative association between a higher number of unions and RS is stronger in higher-income quartiles. Men in the lowest income quartile are the only group for which mating success, in terms of number of unions, has a sizeable positive association with RS. For these men, for example, having had five or more unions by the age of 46 years is associated with almost 0.5 more children, while for women, the effect is zero. Conversely, in the highest income quartile, having had five or more unions is associated with about 0.5 fewer children for both sexes. Similar patterns are found for the linear estimates.

The marked differences across income quartiles are less strong when mating success is measured as cumulated union duration (Panels B1–B4 in Figure 3). For longer union durations, men have higher RS than women in all income quartiles, relative to the baseline level. The linear slope is also steeper for men than women, but the sex differences are smaller in higher-income quartiles than in lower ones.

Figure 4A shows the results of AME of the number of unions adjusted for union duration. As in Figure 2, the linear slope turns negative when cumulated union duration is controlled (Panels A1–A4 in Figure 4). The exception, again, is men in the lowest income quartile, for whom there is a slight positive association between the number of unions and number of children (RS). Panels B1–B4 in Figure 4 show that the positive association between cumulated union duration and RS remains after controlling for the number of unions, as does the Bateman gradient in the linear estimates.

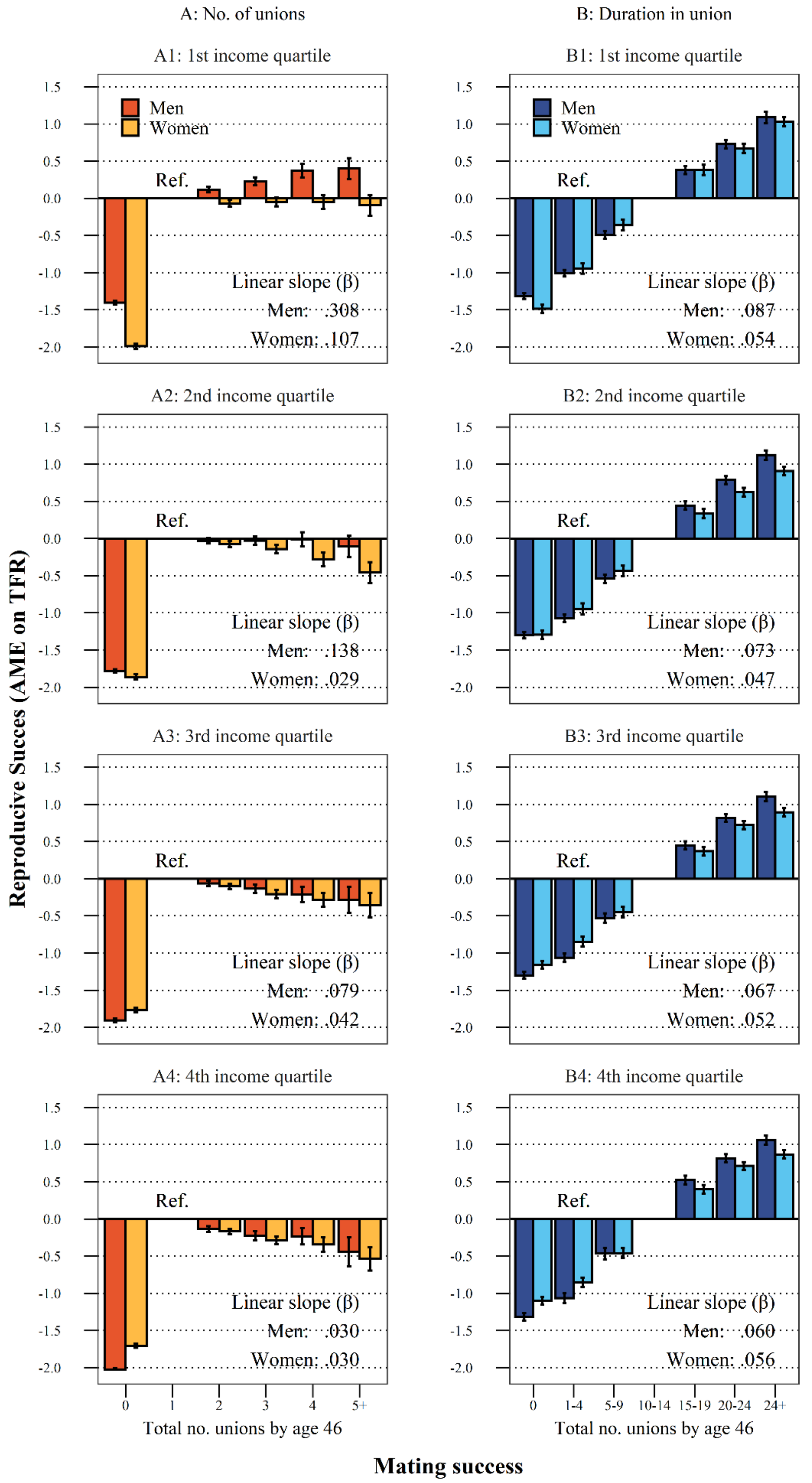

Figure 3. Panel A: The Y-axis indicates the average marginal effect of mating success, as union number by the age of 46 years (baseline = 1 union), on reproductive success (number of children) by the age of 46 years, by income quartile and sex. Regression coefficient for continuous estimate of number of unions. Panel B: The Y-axis indicates the average marginal effect of mating success, as union duration by the age of 46 years (baseline = 10–14 years), on reproductive success (number of children) by the age of 46 years, by income and sex. Regression coefficient for continuous estimate of union duration.

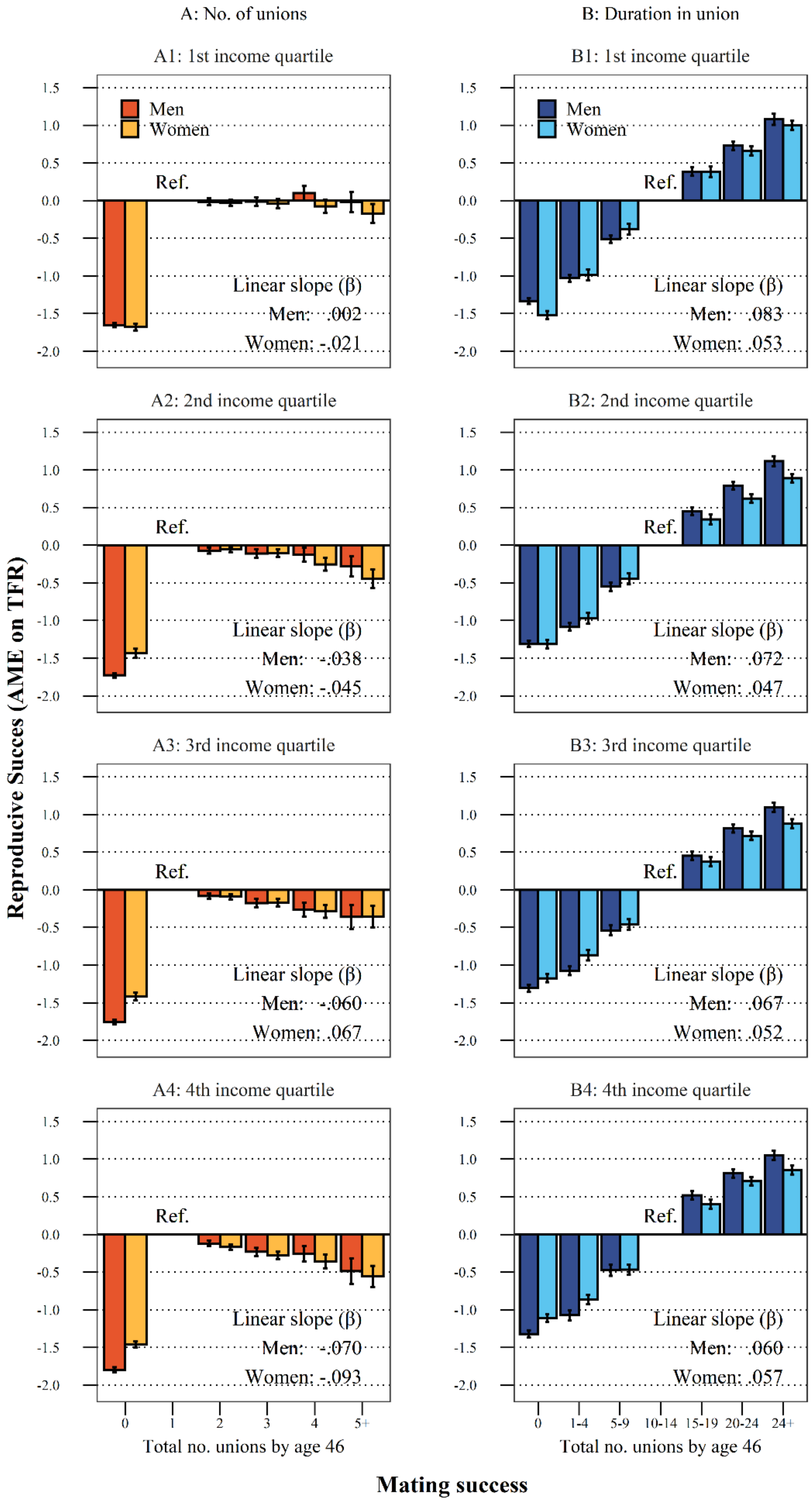

Figure 4. Panel A: The Y-axis indicates the average marginal effect of mating success, as union number by the age of 46 years (baseline = 1 union), on reproductive success (number of children) by the age of 46 years, by income quartile and sex, adjusted for union duration. Regression coefficient for continuous estimate of number of unions, adjusted for union duration. Panel B: The Y-axis indicates the average marginal effect of mating success, as union duration by the age of 46 years (baseline = 10–14 years), on reproductive success (number of children) by the age of 46 years, by income and sex, adjusted for number of unions. Regression coefficient for continuous estimate of union duration, adjusted for number of unions.

Additional specifications

As discussed, most previous work in the literature relies on marital partners only when operationalizing mating success[16]. For comparability with these studies, we analyse the third Bateman principle using only marital unions and duration in marriages. The findings are congruent with the Bateman gradient, but not conclusively so (see Figure A2 in the appendix). Our models include individuals who have never had a union as well as individuals with no children. In appendix Figure A3, we analyse the linear estimate of the third Bateman principle, first excluding never-partnered, and second excluding childless individuals. The results do not support the existence of the Bateman gradient, again except for men in the lowest income quartile. This group shows a positive association between mating success – defined as the number and the duration of unions – and RS, which is stronger than for women.

Discussion

This is the first study to assess Bateman's principles in a contemporary low-fertility population using population-wide data and to include non-marital relationships as co-habiting. Building on recent efforts that expand the concept of mating success[3,26], we incorporate union duration in addition to the number of unions. Our data support Bateman's first principle – that there is on average higher variance in the RS of men than of women. The results also indicate that Bateman's second principle applies to contemporary Finland: men have on average higher variance in mating success, both as measured by the cumulated number of unions and by cumulated union duration.

Bateman's third principle is not universally supported in our data, but rather, depends on the operationalization of mating success, and on social status. The association between the number of unions and RS is somewhat more positive for men but turns negative for both men and women when controlling cumulated union duration. Thus, in contrast to previous studies, we show that higher mating success (measured as the number of unions) is associated with lower RS compared to individuals who had only one union by the age of 46 years. In models that do not control for union duration, the positive relationship between mating success and RS for men is driven by differential entry into a union. Among the ever-partnered, who constitute 92% of the total population, there is no positive effect of additional unions.

Thus, these data lend little support for the argument that seeking more mates would increase the number of children more for men than women. However, importantly, in line with Borgerhoff Mulder and Ross' examination[25] of the Mpimbwe, we show support for sex-differences in returns to mating effort when mating success is operationalized as years of duration in a union. Union duration longer than the baseline value of 10–14 years is positively associated with RS, and more so for men when controlling the number of unions. This finding also holds across social strata. In other words, regardless of whether men are among the highest or lowest income earners, they incur fitness benefits from longer exposure to a mate through pair-bonding.

However, a key finding in our analysis is that men in the lowest social strata seem to be the only group who consistently benefit from serial monogamy in terms of RS. Only for men in the lowest income quartile does the number of unions consistently predict higher RS. This is noteworthy, because it indicates heterogeneity in the pay-offs to mating strategies even in the relatively egalitarian, low inequality population of Finland. Sex differences in childcare provision in Finland tend to be more traditional among low-income groups, in which women have the main childcare responsibilities[34]. While it is difficult to disentangle the causes and effects in these socio-cultural conditions, it is possible that these sex roles diminish the pay-offs to mate retainment among low-status men, and increase the relative gains to mate effort strategies. In societies in which transient unions and divorce are ubiquitous, low-status men face poor prospects not only for attaining, but also for retaining, a mate. Further explorations into sex-specific trade-offs in mate attainment across social strata would be a fruitful area for future research.

It is difficult to ascertain whether the difference between our findings relates to methodology and data quality, or socio-cultural differences. The question of whether or not to measure mating success through marriage only of course depends on whether childbearing is confined to marriage in the population under study. It is likely a valid strategy for 19th-century Finnish society[13], but not so for contemporary white and black ethnic groups in the US, where the former group has exceptionally high rates of co-habitation[16]. Furthermore, we acknowledge that our measures of mating success do not cover partners who have never resided together. However, in societies like Finland, the vast share of childbearing takes place in co-residential unions[41]. This study, like previous evidence, does not engage with causal pathways. However, by avoiding conditioning unions on marital status, we at least circumvent built-in reverse causality of mating success on childbearing. Future work may factor in the age of partners and age at childbirth as measures of mating success[25].

Our data suggest that the relationship between mating and reproduction does not follow the predictions of the Bateman gradient in modern day Finland, and question the rigidity of standard sex roles in human mating strategies. One possible explanation is that in industrialized contemporary countries, and Nordic countries in particular, cultural norms dictate an active paternal role in childrearing, and childrearing investments per child are high. This makes pair-bond and partner quality critical, and may lead both men and women to be choosy in their choice of partner, and focus on mate retainment once in a union. At the same time, high female labour market participation and well-developed social and family policies make women less dependent on a male provider. Therefore, sex roles in mating associated with 'typical' male or female strategies may be less beneficial in such a setting than others. In contemporary Finland, men who are able to retain a partner increase RS through longer exposure to reproductive partners. Future assessments from a range of contexts that incorporate union duration alongside more standard operationalizations of mating success may be critical to improve our understanding of sexual selection across human societies.

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APPENDIX: A matter of time: Bateman's principles and mating success as count and duration in contemporary Finland

Table A1. Final Parity by total number of unions at age 46 years, men and women

		0 unions		**1 union**		**2 unions**		**3 unions**		**4 unions**		**5+ unions**	
	parity	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*
Men	0	12453	96	10654	19	4998	18	1852	19	526	18	211	20
	1	401	3	8443	15	5512	20	2242	23	728	25	287	27
	2	131	1	21987	39	9592	35	3213	32	903	30	287	27
	3	39	0	11043	19	4936	18	1598	16	473	16	164	15
	4		0	2860	5	1708	6	681	7	221	7	66	6
	5+		0	1963	3	820	3	350	4	115	4	52	5
Women	0	5849	86	8010	14	4304	15	1782	17	627	19	257	21
	1	639	9	7774	14	5343	19	2190	21	718	22	298	24
	2	216	3	23297	41	10736	37	3501	33	978	30	326	27
	3	82	1	12337	22	5615	20	1955	19	617	19	204	17
	4		0	3416	6	1887	7	730	7	232	7	82	7
	5+		0	2121	4	877	3	353	3	123	4	54	4

Table A2. Final Parity by union duration at age 46 years, men and women

		0		1–4 years		5–9 years		10–14 years		15–19 years		20–24 years		24+ years	
	parity	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*		*%*
Men	0	12453	96	3751	76	3657	48	3364	29	3400	15	3185	9	884	5
	1	401	3	867	17	2098	27	2953	25	4502	20	5061	14	1731	11
	2	131	1	253	5	1434	19	3724	32	8773	40	15151	43	6647	41
	3	39	0	66	1	363	5	1242	11	3912	18	8323	23	4308	26
	4		0		0	97	1	333	3	1030	5	2497	7	1560	10
	5+		0		0	42	1	135	1	495	2	1389	4	1232	8
Women	0	5849	86	2114	62	2483	40	2455	25	2805	16	3189	10	1934	6
	1	639	9	801	23	1739	28	2521	26	3479	20	4526	14	3257	11
	2	216	3	337	10	1267	20	3138	32	6991	40	14557	44	12548	41
	3	82	1	106	3	507	8	1127	12	3040	17	7859	24	8089	27
	4		0	37	1	152	2	356	4	901	5	2166	7	2735	9
	5+		0	23	1	68	1	159	2	399	2	1004	3	1875	6

Table A3. Descriptive statistics of control variables

	Men (N=122849)	Women (N=120782)	Total (N=243631)
Birth cohort			
1969	29495 (26.4%)	28386 (26.4%)	57881 (26.4%)
1970	28317 (25.4%)	27517 (25.6%)	55834 (25.5%)
1971	27129 (24.3%)	26597 (24.7%)	53726 (24.5%)
1973	26583 (23.8%)	25062 (23.3%)	51645 (23.6%)
Income quartile			
1st	28768 (25.8%)	26014 (24.2%)	54782 (25.0%)
2nd	26872 (24.1%)	27940 (26.0%)	54812 (25.0%)
3rd	27254 (24.4%)	27469 (25.5%)	54723 (25.0%)
4th	28630 (25.7%)	26139 (24.3%)	54769 (25.0%)
Number of children born			
Mean	1.7	1.9	1.8
Median	2.0	2.0	2.0
SD	1.4	1.4	1.4
Q1, Q3	0.0, 2.0	1.0, 3.0	1.0, 3.0
Number of unions			
Mean	1.4	1.5	1.5
Median	1.0	1.0	1.0
SD	1.0	1.0	1.0
Q1, Q3	1.0, 2.0	1.0, 2.0	1.0, 2.0
Union duration			
Mean	16.2	18.8	17.5
Median	19.0	21.0	20.0
SD	8.5	8.1	8.4
Q1, Q3	11.0, 23.0	15.0, 25.0	13.0, 24.0

Table A4. Bateman's first and second principles: Opportunity for selection and opportunity for sexual selection. Men and women, by income quartiles.

		Opportunity for selection (I)	*Opportunity for sexual selection (I_s)*	
Sex	Income quartile	No. of children	Union count	Union duration
Men	All	1,56	0,80	18,13
Women	All	1,39	0,75	14,99
Men	1st	1,85	1,12	25,60
Women	1st	2,02	0,93	19,86
Men	2nd	1,60	0,81	16,87
Women	2nd	1,26	0,72	13,22
Men	3rd	1,42	0,68	13,27
Women	3rd	1,11	0,68	13,43
Men	4th	1,20	0,59	9,74
Women	4th	1,05	0,65	13,10

Table A5. Number of unions by age 46 as calculated from information on unique marriages compared to information on unique cohabitations and marriages. Men and women born 1969-1972.

Union measure (No. Of. unions)	Men	Women
Marriage		
(0)	33.8% (37750)	27.8% (29873)
(1)	58.1% (64784)	62.7% (67405)
(2)	7.5% (8339)	8.7% (9373)
(3+)	0.6% (651)	0.8% (911)
Cohabitation & marriage		
(0)	11.7% (13039)	6.3% (6818)
(1)	51.1% (56950)	53.0% (56955)
(2)	24.7% (27566)	26.7% (28762)
(3)	8.9% (9936)	9.8% (10511)
(4)	2.7% (2966)	3.1% (3295)
(5+)	1.0% (1067)	1.1% (1221)

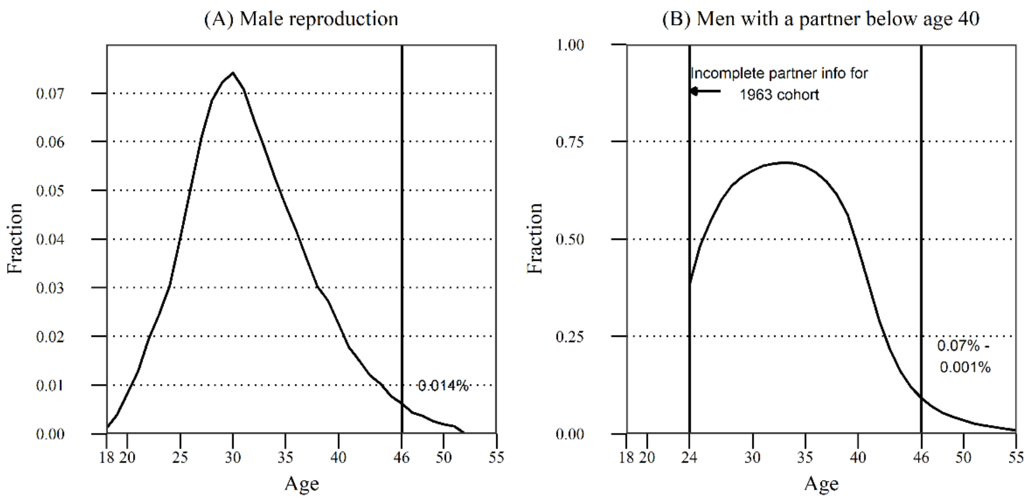

Figure A1. Panel (A): Fraction of reproductive success, across ages up to 55 years for the 1963 cohort. The vertical line indicates the age cut-off of 46 years used for the younger cohorts in this study. Panel (B): Share of men in a union with a (female) partner who is aged 40 years or below, across ages up to 55 years, for the 1963 cohort. The left-side vertical line indicate earliest available information on co-habitation. The right-side vertical line indicates the age cut-off of 46 years used for the younger cohorts in this study.

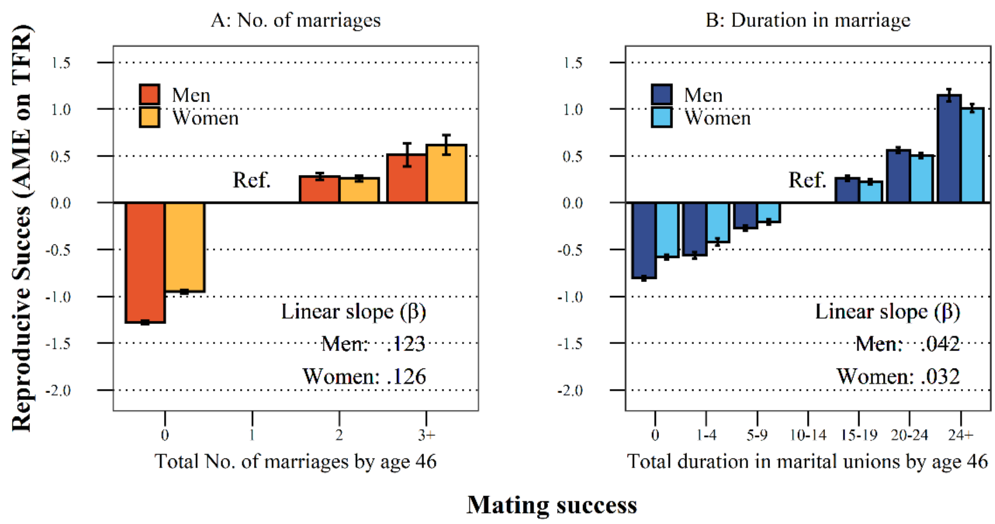

Figure A2. Panel A: The Y-axis indicates the average marginal effect of mating success, as the number of marital unions by the age of 46 years (baseline = 1 union), on reproductive success by the age of 46 years, by sex. Regression coefficient for continuous estimate of number of marriages. Panel B: The Y-axis indicates the average marginal effect of mating success, as marital duration by the age of 46 years (baseline = 10–14 years), on reproductive success by the age of 46 years, by sex. Regression coefficient for continuous estimate of marital duration.

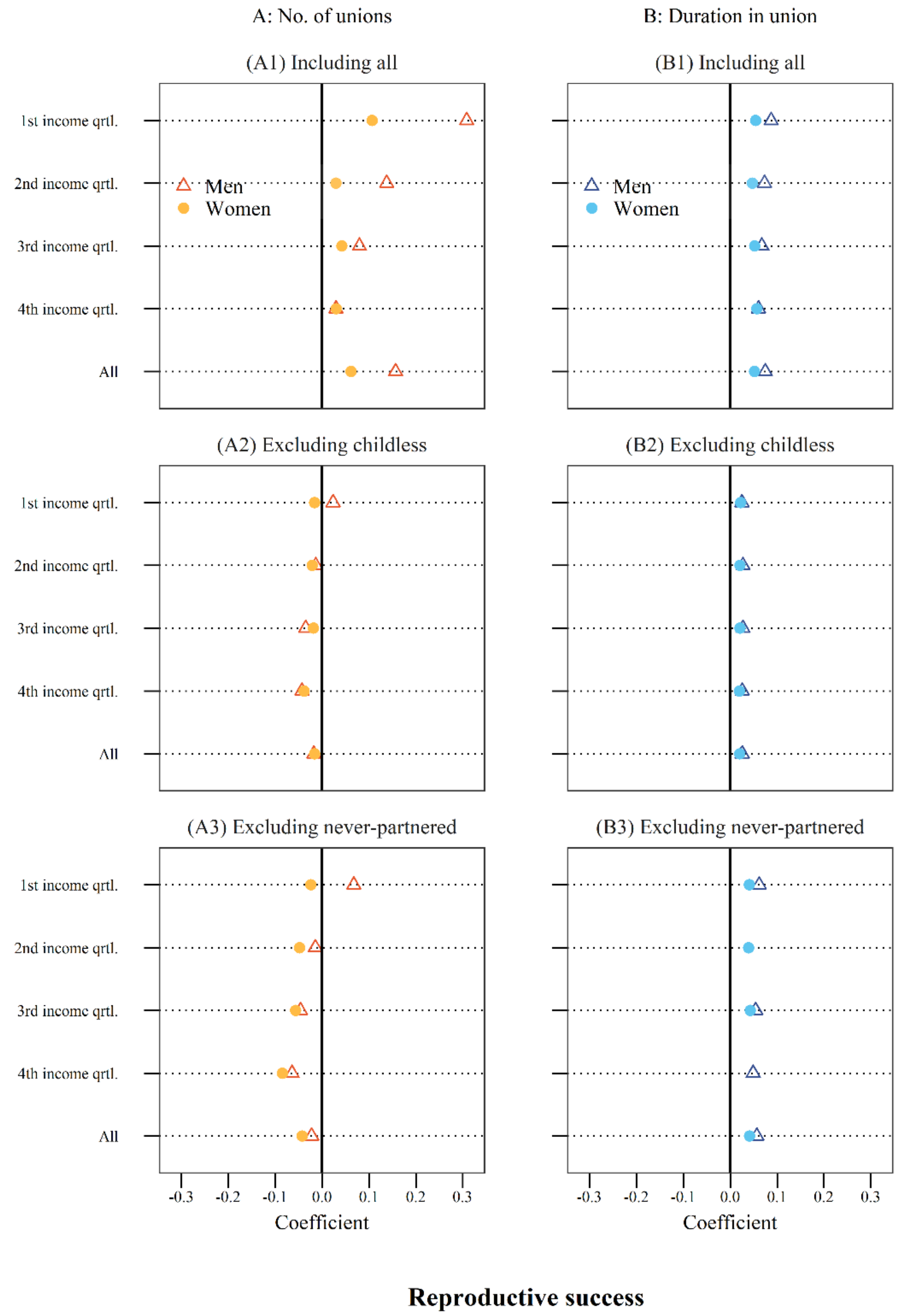

Figure A3. Regression coefficient for continuous estimate of number of unions on reproductive success for the full population (Panel A1) for those with at least one child (Panel A2) and for those with at least one union (Panel A3). Regression coefficient for continuous estimate of union duration on reproductive success for the full population (Panel B1) for those with at least one child (Panel B2) and for those with at least one union (Panel B3).

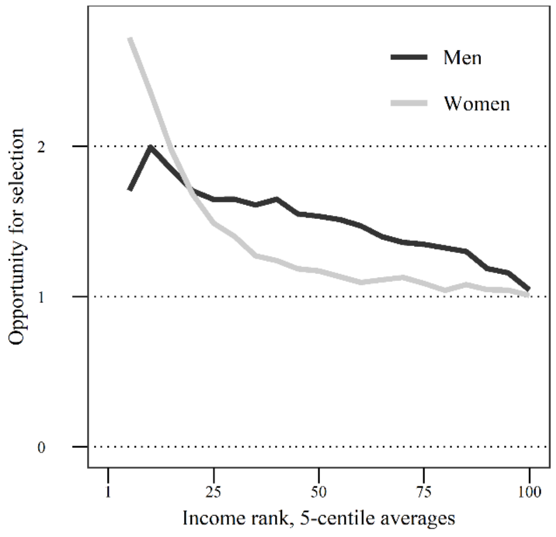

Figure A4. Opportunity for selection across income rank (centiles bins of 5). Men and women

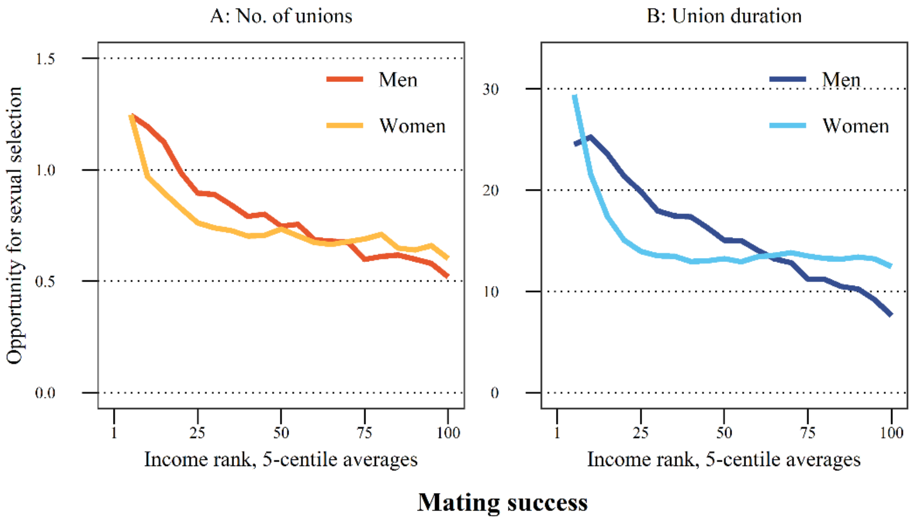

Figure A5. Opportunity for sexual selection across income rank (centiles bins of 5). Men and women