

Hornbills live in pairs and invest enormously in their nest, walling in the female with her eggs first and then walling in the chicks with a thick mud wall to keep out predators. Despite their social fidelity, both males and females engage in extra-pair copulations.



With the advent of DNA typing (DNA fingerprinting and genotyping) many species believed to be mating for life were shown to have substantial rates of extra-pair paternity.

Social pair-bonding does always reflect the mating choices of individuals in the pair.

Minisatellite repeat units are characterized by an approximate 16 bp core sequence in humans and other animals. (A) A core minisatellite repeat, a type of high repetitive DNA sequence, is present at three loci. (B) The number of minisatellite repeats at these loci are shown for one individual (the mother) who is heterozygous at each of the three loci. Locus 1 genotype: 5, 2; locus 2 genotype: 7, 3; and locus 3 genotype: 8,

1. (C)Representation of an autoradiograph showing restriction fragment profiles of four individuals at these three loci. At each locus in the child's profile, one allele is shared with the mother and the other is shared with the father, as would be expected when maternity and paternity have been correctly identified. Note that the unrelated individual shares only a small number of bands with the individuals from this family.

Practice question: Many bird species are socially monogamous. Does this mean that they reproduce exclusively with their mate?

No, many socially monogamous birds also reproduce with other individuals.



A group of chimpanzees from the Kasekala community in Gombe, Tanzania. A subordinate male greets the dominant male and engages in very brief sexual contact (penis to hind parts of dominant male)



Social excitation and piloerection (hair on ends) in the dominant male.



Unhabituated savannah chimpanzees in Issa Valley, Tanzania, quick mating captured by the camera trap.



Savannah chimpanzees in Issa Valley, Tanzania, 5 years later, fully habituated and not afraid of human observers anymore.





Non-human animals cannot be interviewed (down side) and cannot give deceiving information (up side)



A group of nests high up in the canopy of a West African Rain Forest.



Placing the pull line by slingshot over tree limbs near the nest.



Ascending on a static single rope (these ropes can hold a pick up truck weighing 2 metric tons), if they are undamaged and not gnawed on by a squirrel.....



view from a fresh chimpanzee nest in Taï National Park, Côte d'Ivoire, West Africa.





Pascal approaching a nest



Descending is very pleasant, especially after a nest yielded many hair samples.



Primatological field work: Many hours alone, without food or sex, while taking precise notes on pages socializing, feeding and mating.....



Hair retrieved from nest used as source of DNA for non-invasive genotyping. the top heir was plucked by a broken branch in the nest, so it has much better DNA in all the follicular cells.

Fecal samples are now used, as these contain much more high quality DNA from the animals gut epithelium, and also their pathogens (viruses, parasites, microbiome).



Nuclear and cytoplasmic genomes

The latter are molecules of choice because of the ease of extraction and lack of recombination

However, they represent less than 0.001 per mille of the nuclear genome



DNA sequence of mitochondrial DNA of the alpha chimpanzee male Fitz. Manual sequencing unsing four tubes per reaction and radioactive S35.



Nature paper with results on extra-group paternity was instantly picked up by media around the world...."chimpanzee females are sluts".....to some, "chimpanzee females have their own agenda" to others.

NYT write up

SCIENCE SCIENCE WATCH

Sex and the Female Chimp

By NATALIE ANGIER MAY 27, 1997

O.K., so maybe nobody ever accused female chimpanzees of being the virtuous Penelopes of the forest. They've long been known to mate promiscously, as have their male counterparity; after all, the genus name for chimpanzees, Pan, derives from the Greek god famed for his lechery. Nevertheless, it was assumed that the formales restricted their dalliances to the neighborhood, and that the offspring they bore were the progeny of a male living in their social group.

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	Instruction Further marking in fermale chargerouses PraceL (approx, Ca, David & Christophe Boesch <i>Instra 649</i> , 258–259 (1971) the Instra 649, 258–259 (1974) the Instra 640, 258–259 (1974) the Instra 640, 258–259 (1974). The Instra concluded that 7 as of 13 chipping new streld p mails red load in the methods work (applied and in MPA) patiently origing quartified and automation functions show that the includence of any gao galaritity is much lawer by the includence of any gao galaritity is much lawer originatile locas in-automation (and the Instra 640) and allows (1984) and 94 or 43 and dubata (1974) areas inaccaratily grandingki. Housile sources of error in the first subsy include law chargen in the any galaritity is much lawer (and the scale). The scale of any strength of the fair, and any charge law strength in the scale of any strength lawer (and the scale). The scale of any strength or any example, chargen barries the scale of any strength corresponds to the scale of any strength probably corresponds to the instructure of a strength and the scale of any strength and the scale of any strength probably corresponds to the instructure of the Instructure 1. Values, L. Harven kit, Instel 14. Dan Mol Commission and any strength mice, Len Mol Mol Commission and any strength mice, Len Mol Mol Commission and any strength mice, Len Mol Mol Commission and any strength mice, Len Mol Commission and any strength mice, Len Mol Mol Commission and any strength mice, Len Mol Commission and any strength mice, Len Mol Commission and any strength mice, Len Mol Commission and any strength mice, Len Mol Mol Mol Commission and any strength mice and any strength mice, Len Mol Commission and any strength mice, Len Mol Mol Commission and any strength mice and any strength mice and any strength mice and any strength mice and any strength mice and any strength mice and any strength mice and any strength mice and any strength mice and any strength mice and any strength mice and any strength mice and any strength mice and any strength

Retraction 4 years later as it became clear that our results did not hold up. Errors in the genotyping caused us to exclude males that had actually sired the offspring.

Write up in the NYT.....

ENCE	
A Fr	esh Look at the Straying Ways of the Female Chimp
	Consider it a serious case of chimp change.
	They are not about to win any awards for being chaste homebodies, but female chimpanzees, it seems, are satisfied with chasing after the bodies back home-

"Females h	ave their own Agenda"
	The Oxford Dictionary of American Quotations (2 ed.) Effects by high Reveals and Magnet New Per times - Deter Streing Park Per times - Deter Streing Park
	Pascal Sagneux # 1. Finite Inter their own agende. Manuer diagrams of the Son agende. In the son agender of the Son agender

My quote about female and their own agendas is still standing and I am sure not less true!



Many biologists are making very important discoveries about basic biology using short-lived, easy to grow in the lab "model species" Practice question: Name three non-human animal species frequently used as "model" organisms in laboratories. Mouse, fruit fly, worm.



bright plumage in male monogamous birds: more extra-pair paternity

and also more parasite burden.



Late Nobel Laureate Sidney Brenner, who discovered how DNA is read and translated into proteins has long been arguing that humans make their own best model organisms!

DUR, 68, 2						
Table 1. Percer	tage of in	dividuals rep	orting extrapain	copulations in hum	an populatio	ons
Population	Male	Female	(years)	Period	N	Source
France*	6.9	5.0	18-24	Lifetime	20055	Spira et al. 1992
U.K.*	33.7	51.7	35-49	Last 5 years	18876	Wellings et al. 1994
U.K.*	20.8	15.2	35-44	Last 12 months	11161	Johnson et al. 2001
U.S.A.†	41.0	27.2	18-29	Last 12 months	3111	Laumann et al. 1994
Australia*	20.0	13.0	18-24	Lifetime	416	This study

Asked about extra-pair mating, many humans admit having cheated, females sometimes more so than males.

Acceptance for such behavior varies strongly between societies: compare France with the UK.

	naman populations		
Population	% Extrapair paternity	N	Source
Michigan, U.S.A.	1.4	1417	Schacht & Gershowitz 1963
Detroit U.S.A	10.1	523	Potthoff & Whittinghill 1965
Oakford, California, U.S.A.	0.03	6960	Peritz & Rust 1972
Hawaii	2.3	1748	Ashton 1980
France	2.8	89	Le Roux et al. 1992
Switzerland	0.7	1607	Sasse et al. 1994
West Middlesex, U.K.	5.9	2596	Edwards 1957
Sykes family, U.K.	1.3	269	Sykes & Irven 2000
U.K. Nuevo León Mexico	11.9	204	Cords Elerer et al. 1991
South America, Yanamamo Indians	10.0	132	Chagnon 1979

The measured levels of extra-pair paternity range between 1 and 10 %, with most societies having rather low levels.



More recent genetic methods confirm that levels of extra-pair paternity are relatively low, but the are never 0!

Practice question: One often hears that ~10% of children are not the children of the man they are told is their father. What is the range of measured non-paternity rates in different societies?

Non-paternity rates range from less than 1% to over 10%.



How a simple little protein (a non peptide -> small protein consisting of nine amino acid blocks, each encoded by a different 3 DNA letter code) contributes to the pleasure of breast feeding a child, pair-bonding, organs, and pro-sociality and trust. Oxytocin can also increase prejudice against out group members "mama bear hormone" not all warm and fuzzy!!!



OXT and AVP are two closely related nonapeptides that exert their action on central and peripheral targets. (A)OXT and AVP are synthesized in the PVN and the SON of the hypothalamus. The peptidergic neurons in these nuclei project axons to the posterior pituitary, from where the peptides are released into the circulation. They act as hormones on peripheral targets, having well-documented actions (uterine contraction and vasoconstriction, for instance). In addition, dendrites of neurons in the PVN and the SON release the peptides directly into the brain, where they act as neurotransmitters or neuromodulators, regulating complex social cognition and behaviors. (B) OXT and AVP differ in only two aminoacids: this schematic drawing shows that, whereas the aminoacid sequence of OXT (top) includes an isoleucine at the third and a leucine at the eighth position, that of AVP (bottom) includes a phenylalanine and an arginine in the corresponding positions. Both peptides contain a cyclic six aminoacid ring, because of the disulfide bond formed by two cysteine residues.

Practice question: Which class of biomolecule does the hormone oxytocin belongs.

Proteins, (it is a small peptide = short protein and is encoded by a gene)



OXTReceptors and AVPReceptors are G-protein coupled receptor expressed in key structures of the brain. Their genes present characteristic polymorphisms associated with differences in human social (and pathological) behaviors. (A) In the human brain, OXTR is expressed in the basolateral amygdala, the anterior and ventromedial hypothalamus, the olfactory nucleus, the diagonal band of Broca, the septal nuclei and the anterior cingulate (left). Its gene (right) is located on chromosome 3p25.3 (approximate position indicated by red vertical line). It contains four exons and three introns, which include several known SNPs. (B) AVPR1A is expressed in the septal nuclei, the thalamus and the basal amygdaloid nucleus (left); the gene encoding this receptor (right) is located on chromosome 12q14 (approximate position indicated by red vertical line). As in the case for OXTR, it contains an intron before the exon that encodes the seventh transmembrane domain. The schematic includes the SNPs (in the case of OXTR) and SSRs (in the case of AVPR) that are reviewed in this article.

Practice question: How can two individuals with the same levels of oxytocin be affected very differently?

Their brains might be expressing very different levels of receptors for this hormone.



Autoradiograms illustrating the distribution of oxytocin receptors (a,b) and vasopressin receptors (c,d) in the monogamous prairie vole (a,c) and nonmonogamous meadow vole (b,d). Note the species differences in oxytocin receptors in the NAcc and the vasopressin receptors in the VP. PFC, prefrontal cortex; CP, caudate putamen; NAcc, nucleus accumbens; LS, lateral septum; VP, ventral pallidum.



(a) Schematic of the structure of the vasopressin receptor gene avpr1a in voles and AVPR1A in primates. The black bars represent the transcribed region of the gene. The hatched bars represent the microsatellite (simple sequence repeat) sequences in the 5' flanking region of the gene as discussed in the text. Numbers above the microsatellites indicate the relative position upstream of the transcription start site. (b) Autoradiograms illustrating the differences in vasopressin receptor binding in prairie voles with either short (top row) or long (bottom row) versions of the microsatellite in the avpr1a gene. Note the strain differences in the olfactory bulb (OB), lateral septum (LS) and the hypothalamus (HYP).



Traditional human cultures have mating norms that allow for different levels of female promiscuity.

Practice question: Name three traditional societies where wife sharing can be common.

Himba in southern Africa, Yanomamo in South America, Inuit in the arctic.



Zeal and Ardor Bristol, UK 2018

Concerts, parties, any social event can form an instant hook up arena, but also allow much more long-term pairs to form. Practice question: What is the technical term for hook-up culture, where males and females have multiple sex partners? Polygynandry



Tested mate choice by female fruit flies in the lab and was able to show that female discriminated against inbred males.

Kleptogamy?



When John Maynard Smith tried to establish "kleptogamy" as a term for stealing mating opportunities, he soon came to realize that "sneaky fucking" was already totally established and gave up.

Practice question: What behavior was the term kleptogamy supposed to stand for?

"sneaky fucking".



Jules Arsène Garnier (1847-1889) Le Droit du Seigneur Men of status, political as in Kings and other rulers or spiritual/religious as in shamans and priests have used their status to gain privileged access to young fertile women. This needed not even be sneaky, but clearly is kleptogamy.



Marriage tend to be major social affairs, highly publicized, subject to strong cultural norms, involving display of status and wealth, exchange of goods or money (dowry or bride price) and anchoring a couple in a complex mesh of social relationships, debts, gratitude etc.

Cheat and you face not just your partner, but an entire clan behind him or her....



Men with bigger testes make more sperm. Testes size in men, just as in other male mammals strongly correlates with the male hormone testosterone. Practice question: Which anatomical measurement correlates strongly with sperm numbers in ejaculates in men? Testis volume.



Relationship between reproductive biology and paternal investment. (A) Caregiving vs. testes volume residuals after testes volume was regressed against height. The dotted line indicates the score (72) at which mothers and fathers are equally responsible for their child's daily care. Scores below 72 imply that the mother does more than the father and scores above 72 imply the opposite. (B) Caregiving vs. plasma testosterone levels. (C) Plasma testosterone levels vs. testes volume residuals (regressed against height). Relationship between brain function, paternal behavior, and reproductive biology. (A) Main effect of the contrast Own Child–Adult for all emotions combined, Bonferroni-corrected P < 0.001, uncorrected P < $1.04 \times 10-8$. (B) Plot of caregiving vs. β -contrast values Own Child–Adult from functionally derived VTA ROI. The dotted red line indicates the score (72) at which mothers and fathers are equally responsible for their child's daily care. (C) Plot of β -contrast values Own Child–Adult from VTA ROI vs. residual testes volume (regressed against height and testosterone). This points to different male approaches to reproduction, more or less paternal.

Practice question: what body part measure correlated inversely with paternal care in the study of fathers using non-invasive imaging technology.



Three Genetic Genealogical Approaches that Allow Calculation of Past Extra-Pair Paternity (EPP) Rates in Human Populations. (

A) In the 'genealogical pair' method, the EPP rate is estimated directly from mismatches in Y chromosomal genotypes between pairs of individuals that based on genealogical evidence share a common paternal ancestor (N = number of genealogically related pairs analysed). First developed by Strassmann et al., this method was later extended by Larmuseau et al. to take into account the occurrence of multiple non-paternity events within one genealogy.

(B) In the 'surname' method, the EPP rate is estimated indirectly from mismatches in Y chromosomal genotypes across individuals that share the same surname. For this method to work, surnames must be patrilineally inherited and each surname must have only one single origin. EPP rates are estimated based on the proportion of individuals whose Y chromosome maps outside (red) the monophyletic surname cluster (broken line) in a median-joining phylogenetic network, taking into account the historical age of the surname, the rate of surname adoption (caused, e.g., by adopting a stepfather's name), and occasional matrilineal surname transmission (size of circles = incidence of particular genotype, N = number of surnames analysed).
(C) In the 'admixture' method, the EPP rate is estimated from the change in the distribution of Y chromosomal genotypes (pie charts) in a historical migrant population (right) and a resident population (left) before (top) and after (bottom) n generations of

admixture. High EPP would result in the disappearance of any differences in genotype frequencies between both sets of individuals. Residents and historical migrants are distinguished on the basis of authentic surnames typical for each region. Genotype frequencies before admixture are for the resident population estimated from a part of the population where no immigration took place, whereas for the historical migrants it is that of the present-day source population.



Neck rings in the Padaung as an example of a cultural custom that got coopted for punishment of female adultery.



Modern western societies, especially in Europe and the Americas seem to experience higher levels of mate poaching than in East Asia.



Historical Evolution of Human Extra- Pair Paternity (EPP) Rates. EPP rates in Western high-income societies have risen significantly (P = 0.0001) from 0.8% in historical EPP studies (which measured the mean EPP rate per child over the last 400 years to 2.5% for children born between approximately 1945 and 1962, but then significantly declined again (P = 0.002) to 1.2% following the introduction of the birth control pill (ca 1965). Data are based on Anderson and Voracek, subsetted to data from high-income Western societies, with the addition of some recently published studies and the exclusion of very small studies or studies deriving from paternity testing labs (which both show a strong upward bias) (supplemental information online for details; N = number of studies, n = total number of children investigated, bars show means plus 95% confidence intervals).

Practice question: Has the use of oral contraceptives ("the pill") let to increased rates of extra-pair paternities in western high income societies? No, extra pair paternities were much higher before the introduction of oral contraceptives.



Heterosexual sex most often carries a risk of unintended pregnancies. Homosexual sex does not, but protected sex is extremely important for preventing STIs, especially in gay men. More on that soon. Different countries have different prevalent modes of contraception. Not shown is easy access to morning after pills for women.



For-profit companies that offer sperm from screened donors are essentially getting paid to cuckold the father in heterosexual couples. For female same sex couples they offer a novel opportunity for pregnancy without any contact with men.

Practice question: How is paying for donor sperm like paying for kleptogamy? If an infertile male pays for the donor sperm, he is essentially paying to be cuckolded.





Sperm donors are often recruited among college students, they are screened for certain diseases and their ancestry is tested by characterizing a large set of markers.

Summary

$\widehat{\mathcal{P}}$

Social partners need not be exclusive reproductive partners.

Genetic techniques allow to measure the extent of non-paternity.

Genetic techniques are subject to errors!

Humans represent a very useful model species. They can be asked!

Non-maternity was never an issue (until very recently). Paternity assurance mechanisms are deployed by males and the societies they dominate.

Males try to control, but "Females have their own agenda"

Human social and sexual bonding is strongly influenced by biology (hormones and their receptors) and by culture (norms and life experience).

Individual humans show much variation in mating/bonding and parenting behavior.