f18 Asexual and sexual organisms < an alternation of generations >

> Without testosterone, humans would always revert to the default sex, which is female. The Book of Genesis is therefore exactly wrong. It isn't women who are made out of men. It is men who are made out of women. —Andrew Sullivan.[1]
>
> That the platypus has five X and five Y chromosomes is 'the weirdest thing.' — Ewan Birney.[2]

Many simple organisms have generations that reproduce alternately asexually and sexually. For many, asexual reproduction is retained as a "survival strategy." In higher organisms, genes that control embryological development have been co-opted to play a role in the regeneration of body parts and, subsequently, allowed the evolution of paratomy (asexual fission that clones the original). Alexandria Bely and Gregory Wray found this to be so for naidid worms, which in their middle grow a second head (for their existing tail) and tail (for their existing head) and then cleave between these.[3] Such agametic reproduction is an evolved feature exhibited by most worms, *Hyrda* that bud, and pink-tipped sea anemones that creep at their base to tear themselves into two. Agametic reproduction has not evolved in vertebrates, although some (the gecko) can regenerate as much as a whole tail.

Since the common definition of a species assumes interbreeding, it does not apply to asexual organisms per se. But asexual organisms that are sufficiently different genetically can be reasonably thought of as different species. How do such arise?

Groups or kinds of asexual organisms exist because given a variety of ecological niches, only those individuals whose genotypes produce well-adapted phenotypes survive in significant numbers. Speciation is the result of some variants being successful within certain bounds and others within other bounds. The species initially appear as peaks in the spread of the population's graphed diversity. In between the bounds that spell success, populations can dwindle and disappear.[4]

Speciation of asexual organisms is blurred by the fact that gene exchange does occur. This is especially so among microorganisms. The hybrids can be successful in perpetuating themselves.

Today, only about one in a thousand (that is ~2000 of ~2 million studied species) are totally asexual. Of these, 360 are the microscopic bdelloid (meaning leechlike—although they eat algae) rotifers. These are all females that, without the befit of identified male sexual partners, produce eggs from which daughter clones hatch. A sample of four of their species studied by Olivia P. Judson and Benjamin B. Normark in 2000 have gene sequences which indicate that bdelloids have diversified from a common ancestor.[5] The implied antiquity is supported by like bdelloids known from 40 million year old amber. As for macro-organisms, the crustacean *Darwinula stevensoni*, Isabelle Schön and Koen Martens have found in 2003, is the record holder for having reproduced without sex for at least 20 million years. Signifying exceptionally good DNA repair, the genetic distance between individuals of this asexual species is only about a quarter of that between members of a closely related sexual species.[6] Such ancient asexual lineages are not the rule, and so exceptions keenly bear on the perennial question: What goes wrong without sex?

The determination of sex, described in genetic terms, can be startling. In the case of humans, for its first thirty-five days in the womb, the natural development of the fetus is that of a female (which makes Simone de Beauvoir's observation that "To be a woman [*sic*], if not a defect, is at least a peculiarity"[7] questionable, as indicated). The gene, *SRY*, [8] that can determine the progression to male lies on the Y-chromosome. Absent from individuals with a XX chromosome pair, the natural development (which includes, to avoid up-regulation of X-borne genes, random X-chromosome silencing) of the fetus is to a fertile female adult (a mosaic of two cell populations).[9] An XY fetus would also continue as a female (although evidence reported by Carina Dennis in 2004 is that before sex hormones come into play the brain in males has begun to develop differently) [10] but on about the thirty-sixth day a single amino acid at a critical location on the Y chromosome is activated for the

fetus to develop as an outwardly physical boy. Testosterone (average levels in a deciliter of blood plasma are 40 to 60 nanograms in a woman and 300 to 1,000 nanograms in a man) is massively delivered in the womb to masculinize the male body and brain (with the instinctual knowledge of how to respond to later testosterone surges). Then some already developing female structures regress and the natural development is to a fertile male. Again at puberty, testosterone is massively delivered by the male body (announced by breaking soprano/basso voice, sprouting facial hair, adolescent pimples, and masculinizing form). Defective for some XY individuals, the to-male switch on the Y chromosome lacks a methyl group (of one carbon atom and three hydrogen atoms) and does not activate. In these instances, ongoing development is to an adult infertile female (be it unfair, debarred since 1968 from Olympic competition).

Three possible mechanisms for maintenance in populations of allele(s) on the X chromosome and/or on autosomes (non-sexual chromosomes), that predispose homosexuality (non-reproductive behavior) in individuals are: overdominance (male homozygotes may suffer but male heterozygotes have higher success in attracting females and/or their sperm may have some competitive advantage), sexually antagonistic selection (male loss of fitness by 'feminization' counterbalanced by a fitness advantage when expressed in females), and kin altruism.[11]

Sexual reproduction is an effective means for mutations to spread in a gene pool. The shuffling of genetic material is a primary consequence of meiosis (which includes chromatid crossing-over processes). This can speed evolutionary change channeled by natural selection.

As long ago as 1930, R. A. Fisher in *The Genetical Theory of Natural Selection* ("Natural selection is a mechanism for generating an exceedingly high degree of improbability.")[13] made the case that evolutionary potential of a population is proportional to its level of genetic variation. As that is mainly generated by sexual recombination between genetically different individuals, the fastest track can be via hybridization. For example, fungi that survive outside of their home range on hostile hosts, mainly by asexual cloning, have a low diversity.[12] However, Clive Brazier in 2000 has described two strains of fungal species, separately ineffectual to a host's evolved resistance, that hybridize to form a species (the leaf rust hybrid *Melampsora medusae* x *M. occidentalis*) that can *suddenly* overwhelm the relatively slower selected for resistance of a host species (the poplar tree *Populus deltoides*).[14]

Sexual reproduction (***Figure f18.1***) may persist once evolved merely because the alternative is blocked (Dollo's Law). In *Life Evolving* by Christian de Duve,[15] relevant themes, to quote Eörs Szathmáry, are: "The fact that there are no asexual gymnosperms [***Footnote f18.1***] is possibly due to the condition that the egg delivers the mitochondrion and the pollen provides the plastids, The lack of parthenogenesis in mammals may be partly explained by the existence of genomic imprinting."[16]

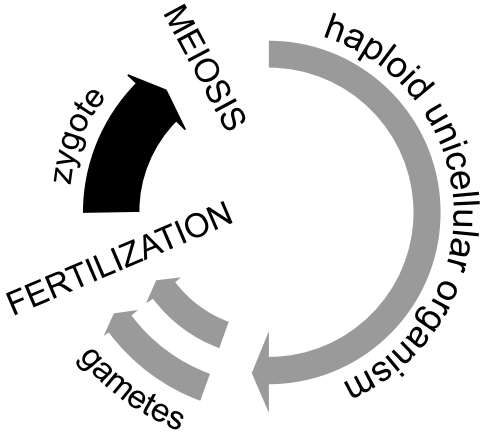

Figure f18.1

Schematic representation of the cyclical life history of *Chlamydodomonas*, which according to William Tinsley Keeton (1933-1980) is likely to be representative of the first sexually reproducing unicellular organisms (as the zygote is the only diploid stage).[17]

Footnote f18.1 "One of the academic achievements made by Japanese scientists in the nineteenth century was the discovery of gymnosperm sperm. In 1896 Hirase Sakugoro, an illustrator in the botanical laboratory of the University of Tokyo who later became a research associate, observed the swimming of ginkgo sperm, and published his paper on this discovery in the *Botanical Magazine* (Tokyo)."

—His Majesty The Emperor of Japan.[18]