Are There Two Sexes? Yes and No, But Mostly No (and Gender is Something Else Anyway—More or Less)

Abstract

This paper brings a species-inclusive, biologically grounded lens to the question, are there two and only two sexes? Insofar as the terms associated with sex are used to pick out taxa where reproduction is typically achieved through the fusion of two gametes of different sizes, the answer is yes. Insofar as the terms associated with sex are used to pick out morphs within a species, the answer is often no, though the question is an empircal one and must be addressed species by species. Within our own species, where we have species-typical primary and secondary sex characteristics that usually align with gametic differences, there are many naturally occuring developmental differences that do not so align. Gender, though often confused with sex, is something else altogether, being a socio-cultural kind rather than a biological one. However, because the social roles and norms associated with a particular gender are frequently assigned on the basis of a sex ascription, gender is often experienced as inextricably entwined with sex. Moreover, in cultural animals, gender and sex traits are generally the result of the interactions between biological and social causes. I conclude that the idea that there are two and only two sexes in our own species is simply false, as is the idea that gender can be reduced to secondary sex characteristics.

1. Introduction

The use of sex terms is a contentious matter. The point of this paper is to clear up the various ambiguities and confusions around these uses in as brief a manner as possible. I offer a kind of opinionated review, as I aim to report the more or less settled biological facts and point out the unsettling (for some) and unsettled ones. I also aim to bring a diverse array of literatures addressing the nature of sex (and gender) categories into conversation. As the goal of this article is clarification and reframing and its intended audience is broad, I avoid presupposing prior technical knowledge of the area. The scope is also broad—a politically aware, species-inclusive account of sex categories (and their relation to gender)—so inevitably the treatment of many examples is cursory. There is much more to be said about everything and this article will have succeeded if it helps others to find better ways of saying them that are sensitive to what is at stake when we talk about biological sex categories.

Two clarifications must be made before continuing, one delineating the subject matter and the other more methodological and metaphysical in nature. First, this paper is about the classification of organisms on the basis of reproductive role, not the *activity* of sex. Of course, the activity is related to the type of organisms engaging in it but, as we shall see below, there are activities that have been described as sex (e.g., lateral gene transfer) that are not associated with sex types and, indeed, sexual organisms that do not have distinct sex morphs (isogamous organisms and hermaphroditic organisms). Moreover, it should not surprise readers to learn that a considerable amount of sexual activity is not reproductive.

The second clarification addresses what I mean by "category" or related terms like "concept," "type," or "sense," etc. in what follows. Perhaps there is a correct final answer as to the linguistic or metaphysical character of each of these terms and their application to the stuff of life. Currently, however, there is no consensus within the philosophy of biology on the matter. The futility of trying to tease out some correct final position on the metaphysics (and semantics) of biological kinds, categories, or types is exemplified by the species problem. Peter Godfrey-Smith offers a rather nice assessment of the limited applicability of various ontological grouping concepts to taxonomic practices in biology noting that "species are aspects of the world's organization that can be thought about in…different ways" (109). His point is that the interpretations of categorical language and ontological frameworks offered by philosophers are useful but limited, each highlighting different aspects of biological reality and amenable to different models and research questions. I take this point to be true of biological classification in general, including sex categories. If we are worried about getting our accounts of "the world's organization" right, then we need to take direction from the complex character of life and not impose *a priori* metaphysical theories that constrain what can be discovered. So, my use of these terms is not philosophically precise but reflects ordinary usage, identifying two ways that sex categories are used in biology and related sciences that provide different answers to the question, Are there two sexes?

The organization of the paper is as follows. First, I address the sense in which, yes, there are two sexes. In brief, anisogamous species have two sexes—female and male—determined by comparative gamete size. Here we find explicit definitions that offer necessary and sufficient conditions for being female and for being male. We will find this to be an important aspect of biological categorization, but one that does little work in determining whether *within a particular species*, like *Homo sapiens*, there are only two sexes. Second, I address the sense in which, no, there are not only two sexes—understood as two distinct morphs (roughly, body types) that perfectly correlate with gamete size and can adequately categorize all individuals within a species. This is where we must look to the character and distribution of traits that are variously correlated (more or less)[1] with differences in gamete size, like gonads and so-called primary and secondary sex characteristics. These are species specific, or, which is much the same thing, particular to some other level of taxonomic categorization, like order, family, or genus. We find here cluster concepts with various different operationalizations, depending on the matter at hand, that generally defy neat binary classification capturing all members of a species. It is important to acknowledge that how exactly we define the sexes within a particular species is significantly a matter of choice (as we decide, for instance, how to classify an individual that produces no gametes but is otherwise indistinguishable from female conspecifics). Nonetheless, no biologically robust (i.e., non ad hoc) way of specifying sexes is likely to give us only two without simply leaving out some members of a species, though we must look at each species to determine the facts of the matter. Certainly, within the species *Homo sapiens* it is not the case that the whole population neatly falls into two sex categories. To say as much simply denies not only the manifest diversity of our kind, but also the settled facts in biology, history, and anthropology. This is widely recognized among many philosophers

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[1] Throughout the article, "correlated" used without modification means connected but not necessarily so or without exception. Similarly, "typical" is used to signify usual and paradigmatic but not necessary or exceptionless.

of biology, who will find little novel in the main ideas in this article, though I hope the framing and approach offer some novel insights that usefully contrast with some similar projects (such as Dupré 1986, 2017; Franklin-Hall 2021; Griffiths 2021; Richardson 2021; Roughgarden 2005; Watkins and DiMarco 2025).

Given that how we define the sexes within any species is, to some extent, a matter of choice, defining sex within our species should be guided by good ethics as well as good (i.e., fact-based) biology. While some might demur that we should keep values out of our sciences, given that this is impossible (at least, in this case) we should work hard to let *good* values inform our science. Here, I understand good values, roughly, as those that generally support freedom and flourishing and don't impose parochial perspectives or bigoted expectations on people. Importantly, the question of gender, which is a social rather than biological kind (more or less), is in some senses a quite distinct issue, though in other senses it is intimately related. The extent and manner in which gender is something else will be discussed in the final substantive section of the paper.

It needs to be acknowledged from the beginning that we are not used to talking about these things frankly and that, in some (perhaps many) instances, our language fails us. Supposedly value-free scientific or descriptive sex terms in English, are often replete with complex, sometimes harmful, meanings. This is because the gender ideologies of traditions rooted in Europe have often been extremely bigoted against people who don't conform to fairly narrow gender norms (whatever these are at any given time and place). So, for instance, in contemporary English discourse outside a biological context, the term "hermaphrodite" is sometimes a slur and its use may be both shocking and painful to some readers (for which I apologize). Similarly, the term "eunuch," though widely treated as a descriptive term, is also a term of abuse. Concomitantly, "castration" is so stigmatized in this culture (despite it being a common life saving treatment for some cancers) that it is frequently used as a metaphor for being rendered powerless. The sexism (which I take to in include cis-sexism) of this use is manifest, as "castration" is also associated with a man becoming womanly. In contemporary medical contexts, "castration" is often called "orchiectomy" (though this can refer to the removal of only one testicle) or the more general "gonadectomy," presumably to avoid the harmful affects of this kind of stigma for the relevant patient groups.

What is striking about this is that it is an acknowledged reality that humans vary considerably in their sex morphology and this has often been a part of their public gender expression. For millenia intersex people and eunuchs have been recognized as part of the sexual diversity of our communities, even as they have had quite varied experiences in them—sometimes celebrated, sometimes vilified. This is not to mention the many different ways in which various cultures in Europe and beyond have understood normative sexual relationships and the untold numbers of people in human history who have transitioned, changing their gender identity from that assigned to them at birth to something else. In what follows, clarity is treated as the chief virtue and I can only apologize to those who bear the emotional burden for this. No frank discussion of sex is ever wholly a "safe space."

2. Yes, there are two sexes (but only if you are operating at a highly idealized, abstract level)

The sense in which there are two sexes is a taxonomic one. Species are classified into one of two kinds—sexual and asexual. The distinction is about reproduction. Asexual organisms, in effect, reproduce by making clones of themselves. Because of this, the genetic material of the offspring is more or less identical to the genetic material of the parent (with some wiggle room to accommodate mutation, lateral gene transfer and occassional polypoidy—more on this below).[2] Sexual organisms reproduce by mixing genetic material from more than one parent to produce offspring that resemble the parents but are not genetically identical to any of them. Special reproductive cells—gametes—allow the genetic material of each parent to mix, producing a new, distinct individual.[3]

One complication is that a number of organisms engage in both sexual and asexual reproduction, though, typically, if we are speaking taxonomically, the term "asexual" appears to be reserved only for those species that *cannot* engage in sexual reproduction. This is further complicated by lateral gene transfer—the various ways in which genes from a quite different species (even from a member of a different domain) can be incorporated into an organism and inherited by its descendants. Because, from an evolutionary perspective, sexual reproduction allows gene flow through a population, some theorists have suggested we should consider lateral gene transfer a type of sex in the sense of the activity (Narra and Ochman 2006), though this has no bearing on our question, which is about types of organism.

Another important difference is that asexual species are typically haploid, meaning that they have one set of chromosomes, while sexual organisms are usually diploid, meaning that, with the exception of the gametes, cells in the organism typically have two complete sets of chromosomes. Basically, any given sperm or ovum has only one set of chromosomes, so offspring from diploid organisms usually get one set of chromosomes from each parent. During the production of gametes the pairs of chromosomes inherited from the reproducer's parents are "recombined," meaning the genes from their parents get mixed together, producing new distinctive chromosomes, a single set of which, typically, goes into each gamete. There are, however, members of some sexual species that only have one set of chromosomes (such as males in ant and wasp species [Wilgenburg, Driessen, and Beukeboom 2006]) or many more than just two sets (again, see polyploidy below).

In theory, the evolutionary benefits of sexual reproduction are at the population level. By mixing genes in somewhat and variously isolated subpopulations generation after generation, sex creates a diversity of traits in a population of organisms, which both makes it robust against environmental contingencies and perhaps more evolveable as novel phenotypes emerge from

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[2] Even this is an oversimplification and there are various species that exemplify the diversity of asexual reproductive strategies (e.g., Rinkevich, Shaish, Douek and Ben-Shlomo 2016). Thanks to Elis Jones for drawing my attention to this.

[3] I treat much of the basic description of biology in this section and the next as general biological knowledge and so don't refer to particular sources for these claims, as they are generally available through introductory textbooks, online educational sources, and encyclopedias.

various novel genetic combinations (Smith 1978). (This is one of the reasons why its tempting to think of lateral gene transfer as a type of sexual activity.)

Among sexual organisms there is a further distinction between isogamous and anisogamous organisms. Isogamous organisms are those where the gametes are (roughly) equal in size and form. Anisogamous organisms are those where the gametes are not equal in size and form. Even though isogamous organisms don't have sexes as defined by gamete size, they do have mating types, "gametes [that] come in a number of self-incompatible, genetically determined variants" (Krumbeck, Constable, and Rogers 2020, 2). While some species have only two mating types, others have many more. It is tempting to refer to mating types as sexes; after all they are types relevant to sexual reproduction. However, as anisogamy has been overwhelmingly favored in multicellular organisms, reserving the terminology of sex, "male" and "female," for anisogamous organisms promises to support useful cross taxa comparisons of this method of reproduction. As it is generally thought that anisogamous organisms evolved from isogamous organisms (Smith 1978, 39), it is perhaps most natural to treat the sexes as a special case of gamete dimorphic mating types.

This is where the idea that there are two and only two sexes comes in. In brief, big gametes—eggs or ova—are female and small gametes—sperm—are male. Comparative gamete size is necessary and sufficient for this classification. The size difference comes with an important functional difference. The small gametes typically only contribute nuclear DNA (that just means DNA in the nucleus of the cell), whereas the female gametes contribute nuclear DNA and the rest of the cell (that is, all of the organelles that actually make it possible for the fertilized gamete to replicate and the organism to grow). This includes organelles with their own DNA (e.g., mitochondria and chloroplasts). This is the sense in which there are two sexes within anisogamous species; for sexual reproduction to occur, a small gamete—male—needs to combine with a big one—female, usually.

It is worth noting that if we just focus on the distinct size difference rather than the form/functional difference then taxonomy may be complicated by the wide range of gamete size that can be found within certain species. One species of fruitfly (*Drosophila pseudoobscura*) has three distinct sizes of sperm, so there are four different types of gamete based on size. There are several complications here. First, male fruit flies typically have all three types of sperm (Roughgarden 2005, 25). So, if sex is not about classifying the gametes themselves but is about classifying the bodies that house them, then we will have two sexes—one that has large gametes and one that has a range of gametes of different sizes. Other organisms, however, appear to have members that consistently produce morphologically distinctive sperm. For instance, Melanzona guppies (*Poecilia parae*) have five types that each produce different types of sperm (at least, on average), which are genetically determined and inherited (Hurtado-Gonzales and Uy 2008, 1191) and one egg-producing type. This means, *if* producing a distinct type of gamete is what counts as being a sex, there are six sexes in Melanzona guppies.

Of course, one might complain that it is the functional role and form that is the crucial difference; one gamete, the egg, brings the machinery of the whole cell while the other just brings some nulcear DNA (usually). It may also be objected that the sex distinction is not directly about gamete size per se, but about the bodies that house the gametes. After all, a considerable amount of sex classification for both practical and scientific purposes happens without directly observing any gametes at all. Just so, but we will find that, within a given species, there are often a variety of different bodies associated with the production of ova or sperm. This is the case with Melanzona guppies where the different types of sperm are associated with bodies that differ in their size, coloration, mating strategies, gonad morphologies, and genes (Hurtado-Gonzales and Uy 2008). And, indeed, there are some bodies within sexual species that produce both types of gamete and others (including our own) that don't produce or house gametes at all. (See Table 1 to summarize these possibilities.)

	Produces large gametes	Does not produce large gametes
Produces small gametes	?	Male
Does not produce small gametes	Female	?

Table 1 summarizes the various possible gamete producing capacities for individual members of sexual species. Reproduction in sexual species requires the combination of a small and a large gamete but a member of any given sexual species may produce just large gametes, just small gametes, both types of gamete, or no gametes. What these non-males/non-females are called often depends on their taxon and whether they are species-typical or atypical in their phenotype.

Ultimately, the sense in which there are two sexes is highly idealized and generic. It is focused on understanding how sexual reproduction works in the most general possible terms and so picks out the key thing about reproduction in anisogamous species—a small gamete with just one copy of nuclear DNA (usually) combines with a large gamete that has nuclear DNA plus other essential features of the cell. Importantly, for our purposes, this fundamental distinction for anisogamous species does *not* neatly divide the *members* of these species into two distinct kinds—male and female. Indeed, how many sexes there are within any given species or even whether a strict division into sex types makes good sense or something closer to a spectrum is in order is not merely contingent on the evolutionary history of the species itself but also contingent on the development of its members. For this far more complex and pertinent task, all the strict dichotomy based on gamete size does is tell you, when you find a sexual species, with a variety of different morphs which (if any) morph (or morphs) to identify as male and which as female. Scientists then build up a more detailed description of species-typical sex differences by seeing which other traits tend to cluster around individuals that produce large or small gametes (and those individuals who produce no gametes at all). These will provide descriptions of species-typical sex morphs that make is possible to classify other members of the species when direct observation of the gametes is impossible or undesirable.[4] Both within and beyond the species-typical sex morphs there is often considerable diversity and where exactly we cut the joints between "male" or "female" and other will, inevitably, be a question of judgement that goes beyond the evident facts. So, for instance, if scientists choose to identify common species-typical morphs of a sexual species that exclusively reproduce

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[4] How the description of the sex morphs for any given species developed is of considerable historical interest. For instance, it would be worth knowing for any given species whether the final species description was the product of simply averaging traits for each type of gamete producer (or non-producer) or choosing exemplars based on theoretical commitments.

asexually or don’t reproduce or don’t produce gametes as “female” (as can be the case with worker ants [Caste Terminology n.d.]) this may be driven more by an ideological commitment to the idea that there must be two sexes that exhaustively capture all species-typical members of the species rather than the biological facts.

It is also worth noting that this method of distinguishing sexes will give rise to some surprizes—that is, if we have acquired the habits of projecting human (and more generally, mammalomorphic) species-typical features onto sexual organisms generally, which is consistent with the dominant gender ideology of our time. For instance, one “surprizing” fact is that male seahorses gestate (Stölting and Wilson 2007). In these species, female seahorses produce the large gametes, males fertilize them with their small ones, and then the females deposit the embryos inside the “brood pouch” of the males. Some refer to the substantial period of time for which the males house the developing embryos as “incubation,” thus using a term commonly associated with birds and reptiles (etc.) sitting on eggs. However, given that the brood is entirely within their father’s body and seahorses appear to develop what can be described as a placenta through which their broods access “respiratory gas and waste exchange, osmoregulation, nutrient supplementation, and immunological protection” (Dudly et al. 2022, 88), “incubation” is, arguably, misleading. Whichever term is ultimately preferred is a matter of choice, but it cannot be pretended that this choice is “given by nature,” “purely scientific,” or “apolitical.”

3. No, there are not only two sexes (for almost all intents and purposes)

3.1 Primary and secondary sex characteristics

Most of the time when we are talking about sexes and trying to identify and class organisms by sex we are talking about morphs within species. Within any given sexual species, there will be a set of specific morphological and physiological traits statistically associated with producing gametes of each type (or not producing gametes at all). These traits often cluster together due to various genes and internal or externally driven developmental mechanisms, producing morphs can often easily be assigned “male” or “female,” but sometimes can’t. These traits are divided into “primary” and “secondary” sex characteristics. Primary sex characteristics are typically thought to be those traits directly involved in producing gametes and getting them where they need to go for species-typical successful sexual reproduction. Gonads (and their equivalents in plants) produce gametes and getting them where they need to go roughly corresponds to genitalia in animals and the stamen and pistil in flowering plants. Unsurprizingly, given that gonads are the mechanism that produces gametes, having male gonads (in humans, testes) is more or less co-extensive with producing small gametes (sperm) and having female gonads (in humans, ovaries) is more or less co-extensive with producing big gametes (ova). There are exceptions, as with individuals who experience hypogonadism, who may not produce any gametes, despite having gonads that are more or less identifiable as one kind or another. There is considerably more developmental leeway and thus more diversity of outcomes when it comes to other primary sex characteristics (which is perhaps why in some disciplines [e.g., genetics] a rather narrower definition of primary sex characteristics is preferred, limiting it to gonads and the gametes they produce[5]).

Secondary sex characteristics are far more amorphous and roughly correspond to any morphological, physiological, and behavioral traits that are significantly correlated with gamete size and/or primary sex characteristics. Secondary sex characteristics may be termed "sex-linked" to recognize the looseness of their association with gonads. They vary by taxon considerably, so, for instance, lactating is a sex-linked trait in mammals but not birds. Within taxa there can again be remarkable diversity. While lactation is considered a secondary sex characteristic typical of females, in some species of fruitbat it appears that males often lactate too and may nurse their young (Kunz and Hosken 2008, 83). Of course, in our own species, males, both transgender and cisgender, can lactate under certain circumstances (Cohen 2017). For humans, lactation is associated with having breasts at sexual maturity, even when one is not lactating. However, there is considerable diversity in breast size and no neat and absolute division between male and female, as some adult males have larger breasts than some adult females. There is what we might call a moderate sexual dimorphism (as opposed to absolute dimorphism, following Blackless and colleagues [2000]) for this trait, as breast size is significantly but imperfectly correlated with primary sex characteristics and gamete size in the population.

Certainly, it is possible that in some parts of the world, surgical (or other) interventions will have made breast size more dimorphic than it would be without those interventions. Doubtless the motivations for these interventions are diverse, but I would hazard to guess that often they are chosen to make people's bodies align more with what they take to be normal or normative for the sex that they identify with—though what exactly these norms are varies from culture to culture. Whether we are talking about men (cis and trans) getting breast reductions or women (cis and trans) getting breast enhancements, medical interventions are standardly used to make bodies conform to sex dimophic gender norms. To the extent that it happens, this will produce a population that is more morphologically dimorphic along this measure. Other secondary sex characteristics within humans include things like height, hip-to-waist ratio, body fat distribution, voice tone and depth, and hairiness. Obviously, secondary sex characteristics are species specific, with other organisms having entirely different sets of sex-typical traits, though there are a number of scientific research programs that appear to project contemporary dimorphic gender ideology onto other species (see Roughgarden's critique [2005; 2007]). This has, for instance, been a complaint made against sexual selection, since Darwin first proposed it (Hubbard 1990, 93).

The thing to notice here is that, whether you determine male and female by gamete size or other primary sex characteristics (leaving out those who are sufficiently anomalous to make categorization challenging), and however you measure a given secondary sex trait, there will be considerable overlap in the curves showing the trait's distribution for each sex. This is something we actually all know from common experience. For example, we can see this with the sex-linked trait of height. On average, human males are taller than human females, though

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[5] I thank Joe Bielawski for pointing out this disciplinary difference.

some females are taller than some males. This is no less true of other secondary sex characteristics. How dimorphic any given trait is and how its distribution for one sex overlaps with the distribution for another is an empirical question. Whether one excludes from one's data set those individuals who have had surgical (or other) interventions to enhance, lessen, or remove a trait is a decision. There is no biological fact of the matter that determines who to count. Only the goals of our descriptive or explanatory projects can give us direction here.

Secondary sex characteristics also include some behavioral traits. Many animals have specific behaviours, especially around reproduction, that are clearly linked to having certain primary or secondary sex characteristics. A standard example is lordosis in rats—a curving of the back indicating reproductive receptivity that is typical in estrous females but not particularly uncommon in males and anestrous females (Hernández et al., 2024). However, for animals that are cultural, whose behaviour is significantly informed through social learning that is particular to their community, we may well find sex-linked behaviours that have no biological basis beyond the capacities that ground social learning and the identification of morphological and physiological traits. It is particularly bizarre to expect that, for animals like humans, whose ordinary development includes significant enculturation, that some essential behavioral sex differences can be uncovered. This has not stopped scientists from spending a significant amount of time and effort looking for them—a set of research programs loosely collected under the moniker "brain organization theory" as well as related studies in evolutionary psychology. Rebecca Jordan-Young (2011), for one, has expertly analysed and assessed this research showing it to be systematically and profoundly flawed both in its theorectical assumptions and practice (see also Buller 2005; Griffiths 2008; Meynell 2012).

We will return to this topic in our discussion of gender. For now, is worth noting that, if we are talking about secondary sex characteristics, their relation to primary sex characteristics and gamete size is variable and contingent rather than absolute and deterministic. This is not news. When we identify someone as androgynous—there being ambiguity as to whether they are male or female—we are not typically talking about primary sex characteristics at all (as these tend to be hidden in "polite society"), but are instead referring to their having secondary sex characteristics that are in between typical male and female morphs or a mixture of traits that are typical of both sex morphs. The terms "linked" and "typical" are purposefully loosey goosey. That's because there are all kinds of exceptions to any trait that is dubbed sex or species-typical or sex-linked. In part, due to the contingencies of development (more on this below) and in part due to the way sexual reproduction mixes things up generation after generation, the members of a sexual species are diverse. As natural selection can *only* work on populations that have variations in them, this is an evolutionary *feature*, not a bug.

3.2 Sex(?) Chromosomes, the development of primary and secondary sex characteristics, and diversity

One might wonder how the so-called "sex chromosomes" work into all of this. We must start by recognizing that not all sexual organisms have "sex" chromosomes. Due, perhaps, to our anthropocentric biases, there appears to be a tendency to assume that the genes producing differences related to sex in humans are shared widely across taxa. This is not, in fact, the case. Certainly, all mammalian *species* have X chromosomes and most of them have Y chromosomes that are involved in developmental pathways that typically produce primary and influence secondary sex characteristics. (It is important to note that humans and the members of other mammalian species come in more than just two chromosomal types—XX and XY—though we will leave the details until later.) Birds and a variety of other animals have different sex chromosomes, the W and Z. While, in mammals, having two X chromosomes is associated with producing large gametes and the XY combination is associated with small ones, in birds it is the doubling of the Z chromosome that typically gives rise to male animals with the ZW combination typically giving rise to females. Many sexual species do not have sex chromosomes either because their members typically produce both types of gametes or because sex is determined by some other means, like a chemical signal, the ambient heat surrounding the fertilized egg, or even how many sets of chromosomes an individual has. Historically, of course, chromosomes are a latecomer to sexual classification, as chromosomes were only discovered at the end of the 19th century and the link between X and Y chromosomes and sex was only identified around the turn of the 20th century (Richardson 2013, 23ff.).

Some species are hermaphroditic meaning that there is only one morph (at least so far as sex is concerned) and it contains the gametes and associated sex organs of both sexes. It is important to distinguish this meaning from the use of the term that has been applied to certain humans. This latter use identifies a developmental variance found within the species (sometimes called "gynandromorphism" when applied to nonhumans [Fusco and Minelli 2023]) not a species-typical morph. Though it may seem natural to assume simultaneous hermaphroditism, where an organism produces both male and female gametes at the same time (as is common in flowering plants and snails), there is also what is called "serial hermaphroditism" in animals and often "dichogamy" in plants (Stout 1928). This is where the organism changes from producing one type of gamete to another, though the extent to which this is associated with a change in primary or secondary sex characterisitcs varies across species. In flowering plants it may just mean that the stamen and pistil ripen (and so release their gametes) at different times, but in some animals there is a significant morophological and physiological change (see Griffiths' discussion of the Eastern Blue Groper [*Achoerodus viridis*] [2021]). So far as the gametes are concerned, however, it's the same thing.

Here is one of the obvious places where a decision rather than the biological facts determine how we describe things. It makes just as much sense with serial hermaphroditism to classify organisms as one hermaphroditic sex as two sexes. This is perhaps easiest to see when we notice that the sex of serially hermaphroditic organisms is entirely developmentally contingent. Sex in these species is thus like maturity—a life stage—rather than something that renders the organism throughout its life one sex or another (though unlike life stages, some species can switch back and forth) (Todd, et al. 2016). I suspect that how exactly biologists navigate identifying sex for serially hermaphroditic organisms probably has as much to do with the history of their subdisciplines as anything else (though, so far as I can tell, this work is yet to be done). However, one principled way of deciding the matter might be based on the extent to which a phenotypic change accompanies the change in gamete production, which takes us back to primary and secondary sex characteristics. Likely, how serially hermaphroditic individuals are actually classified in the lab or the field, as male, female, in some transitional state, or what have you, is often not based on gamete size (as gametes are rarely easy to directly observe) but instead on primary and secondary sex characteristics. Although the importance of development and life stage for determining sex are particularly obvious for serially hermaphroditic organisms, this is no less true for any other sexual organism—a consideration that has led Paul Griffiths to suggest that we should treat all sex morphs as life stages (Griffiths 2021). Of course, every physiological, morphological, or behavioural trait of a multicellular organism depends not only on their genetic starting point but on the contingencies of development, to which we now turn.

Biologists have a way of talking about the contingencies of development; they call them "norms of reaction." Basically, this just picks out the range of possible outcomes of the development of an organism from a given starting point. The classic experiment here is to take a group of genetically identical sapplings (clones) and plant them in different environments, perhaps at different altitudes on the same mountain, to see how the different developmental resources available in those places affect the growth of the plants (see, e.g., Clausen and Heisey 1958, 123-56). The idea here is that the differences in outcome cannot be genetically driven—genes can't be the difference makers—because the plants are all genetically identical. Of course, this is a bit misleading as some of the differences will depend on different genes being expressed or being expressed at different times thus the outcome (and, indeed, every developmental outcome in all life on our planet) is *really* a product of genotype, phenotype, and environment interactions.

For sexual species, we often want to know about the possible range of outcomes (and, often, their frequency) for a whole species, population, or morph (i.e., body type) within a species. For the serially hermaphroditic organisms mentioned above, the norm of reaction from the fetal state of a typical individual will include both male and female morphs. For non-hermaphroditic species, however, the primary and secondary sex characteristics develop, in some cases, after some kind of trigger or the initiation of a scaffolded process, be it something in the environment or the expression of a gene, such as the SRY gene (usually found on the Y chromosome), which plays a significant role—along with other genes—in the development of the morphology of most humans who are identified as male at birth (and most, though not all, other mammals [Terao et al. 2022]). In other cases, there is a kind of default development that happens unless some causal factor initiates or scaffolds a different developmental pathway, which is how typical female development in mammals is sometimes described, despite significant flaws in this analysis (Richardson 2013, 127-46). Norms of reaction remind us that there will always be a *range* of possible outcomes from any given starting point.

It is important to note that norms of reaction are empirical and not normative. If there is an observed developmental outcome in a member of a species, population, or morphological type, then it is part of the norm of reaction for the species, population, or morph. It would be nonsensical to claim otherwise. Of course, some outcomes are common and others are unusual, given the starting point. Within our own species, we can take height as an example. There are relatively few people who are 7 foot tall and there is likely to be a complex set of genetic and developmental factors that explain why a given person is 7 foot tall. Their height could have been otherwise for any particular 7 foot individual if they had matured in a different environmental context. The statistical "abnormality" of this unusual outcome has no normative content until it is put into a particular social context where difficulties buying clothes and the call of professional basketball might make this trait a good or a bad thing.

So, when we come back to thinking about primary and secondary sex characteristics it is unsurprising that from any given genetic starting point for the fertilized egg there are a range of different possible outcomes. Certainly, some are more common than others—so much so that they might be considered species-typical. So, for instance, height between 5 foot and just over 6 foot is species-typical for humans (though this is not true of all human subpopulations); being over 7 foot tall is not typical. For any given species, we can say a similar thing about any given set of primary and secondary sex characteristics and how they tend to clump around having certain gonads that produce gametes of a certain size.

With a firm appreciation of developmental contingency in hand, we are in a better place to consider the significance of the range of possible genetic and chromosomal starting points. Again, this varies significantly across taxa. In some sexual organisms, extra sets of chromosomes can be added either during reproduction or in regular cell growth so that, rather than two (diploid) sets of chromosomes, the organism has three or more. This *polyploidy* is quite common in plants (Comai 2005). In some organisms, including humans, one can often get a extra copy of one of the chromosomes, ending up with three (or more) rather than two—thus trisomy 21, the chromosomal cause of Down syndrome in humans. Whether and which extra chromosomes make an organism unviable (effectively killing it in an embryonic state) can only be addressed species by species (or sometimes at a higher taxonomic level like genus or family). In animals, often an extra chromosome is developmentally deleterious, leading to various health challenges, as is common with trisomy 21. However, the seriousness and extent of these developmental outcomes vary significantly as is, again, exemplified by people with trisomy 21 (for an interesting example see Pradhan, Dalal, Khan, Agrawal 2006).

3.3 Intersex syndromes (with a distinctively anthropocentric bias)

It is, then, unsurprising that although most living humans have either XX or XY chromosomes, not all do. While missing one of the "sex" chromosomes, 45X (Turner Syndome) or having an extra, 47XXY (Klinefelter Syndrome), 47XXX, and 47XYY are relatively common, there are rare cases where folks have two or three extra. As noted, having any extra chromosome is rarely a good thing for health and typical functioning, though, again, for 45X, 47XXY, 47XXX, and 47XYY individuals, there are a wide range of outcomes and for some their chromosomal anomaly does not end up being clinically significant (O'Connor 2008) and may go undiagnosed. The point is, from each of these genetic starting points, there is a range of developmental outcomes. We typically call those with XX chromosomes female and XY chrosomes male, though certainly not always. Moreover, it's worth noting that this only became an option after the biological role of chromosomes was discovered; so, prior to the 20th century, we could only use primary sex characteristics to identify sex. We still primarily use this old-fashioned method, except in places that have normalized genetic screening. (As for other species, it's worth noting that if sex is not significantly influenced by genes or chromosomes because sex is determined by some environmental factor, then primary and secondary sex characteristics will be the only way of identifying sex, absent specific knowledge of the developmental history of the organism.)

Most of these chromosomal differences are considered “disorders” of sexual development and certainly some of them have serious deleterious health effects. Many of them would be considered intersex syndromes. Again, here we are presented with a messy complicated biological reality and how we classify it is largely a matter of decision. Before addressing the classificatory question, however, its worth considering that there are many more intersex conditions (though how many will depend on how we classify them [Witchel 2018; Fausto-Sterling 2000b, 52). Here, we will just consider two relatively common cases that exemplify the developmental contingency of primary and secondary sex characteristics for those who develop from XX or XY embryos.

The first is androgen insensitivity syndrome (AIS). This is where an individual who is XY is insensitive to the androgens produced by their gonads and so develops primary and secondary sex characteristics that are typical of XX individuals. People with *Partial* AIS visually appear to be intersex insofar as they have anomalous genitalia at birth that may be considered more or less paradigmatically male or female and, even if they are tending toward a more typically male presentation as a child, they may develop breasts at puberty. People with *Complete* AIS are not typically identified as intersex until puberty or adulthood when it is found that, despite their having typical secondary and external primary sex characteristics of females, they have undescended testes, not ovaries, and sometimes other anomalous internal sex organs (Gottleib and Trifiro 2017 [1999]; Fausto-Sterling 2000b, 52, 64).

Congenital adrenal hyperplasia (CAH) is a condition affecting both XX and XY individuals. Caused by a recessive gene, CAH is a serious endocrinological disorder where the adrenal glands don’t produce particular hormones. The details are complicated but the hormonal imbalance produced can lead to various serious health conditions, some of them life-threatening. In XX individuals, CAH can lead to the over production of androgens leading to the presentation of primary and secondary sex characteristics that tend towards those typical of XY individuals. As with, AIS, CAH comes in degrees and many cases are not be identified until later in life or not at all, though in this case it is the *mild* case that often escapes notice (Hannah-Shmouni, *et al*. 2017; Fausto-Sterling 2000b, 52-8).

Clearly, these differences in sexual development (and there are many others), whether chromosomally driven or not, produce morphs that are neither standardly male nor standardly female (however we define these). How *exactly* we classify the range of sexual morphs is a question of choice. In 1993, Anne Fausto-Sterling suggested that there were five human sexes—male, female, merm (intersex but with predominantly male features), ferm (intersex but with predominantly female features) and herm (intersex with neither dominant male nor dominant female features). However, only a few years later she suggested that “sex and gender are best conceptualized as points in a multidimensional space” (2000a, 22) (a suggestion brilliantly realized by van Anders [2015]).

Some might be tempted to take a gamete-centric hard line and assert that gamete size is necessary and sufficient for identifying sex within the human species. This would suggest that only those who have both ovarian and testicular tissue could be intersex, which is rare. However, it would also have the result that the reaction norms for human males and females would significantly if not entirely overlap, as, for example, morphologies typical of individuals with AIS (or relevantly similar syndromes) would be part of the reaction norm for males. It would also simply not align with how we ordinarily identify sex, which is on the basis of primary and secondary sex characteristics. It is, after all, not easy to get access to gametes with, say, a newborn child. Reliance on primary sex characteristics in medical and intimate sexual contexts is how we currently do identify and historically have identified people by sex. Even beyond the medical sciences, there are various research programs, most obviously in archaeology and anthropology, that ascribe sexes to human remains despite it being impossible to use gametes to do so (see e.g., Rösing et al., 2017). Ultimately, it is difficult to see what would be gained by revising the concept of sex to conform to a gamete-centric hard line.

3.4 Decisions and clinical interventions determining sex and their cultural context

Whether someone who is, say, nonstandardly male—due to having hypospadias (a condition where the urethral opening is not at the tip of the penis but somewhere along the underside of the shaft)—is intersex or not is a matter of decision (Lee et al. 2016, 159). There is no obvious biological fact to determine the matter and where a biologist or clinician falls in their judgement will depend on their training and the severity of the condition, i.e., how anomalous the penis is when compared to some stipulated (though not entirely arbitrary) norm and whether the condition is associated with other serious medical problems, like a difficulty urinating. Interestingly, those who defend a traditional dimorphic sex ideology tend to define this group very narrowly, rendering intersex people rare through their definition. The idea seems to be that if intersex conditions are sufficiently rare we can ignore them (like people who are 7 foot tall).

Often, decisions about whether someone is intersex (and what to do about it if they are) are decisions made about infants. Infants, obviously, have a huge range of possible developmental outcomes that will be significantly affected by environment, physical interventions on their bodies, and—especially for biologically cultural animals like humans—their cultural milieu. Whether a difference in sexual development is retained as something that is accepted or even celebrated or whether it is treated as tragedy to be corrected and covered up—a mark of shame for the individual and their family—is a question of cultural norms. In North American society, this second attitude has been dominant and has led to dangerous surgeries being performed on infants who subsequently often experience long-term medical intervention and surveillance throughout their childhood, puberty and into adulthood (Fausto-Sterling 2000b, 86-91; Jordan-Young 2010, 235-55; Mulkey, Streed and Chubak, 2021). Recently, there has been a push to move away from surgical interventions prior to a child's expressing some gender identity or being able assent or consent to surgery, though this is controversial (Lee, Mazur and Houk 2023).

Fausto-Sterling explains the decision-making process by medical teams that seems to inform and justify these interventions (2001, 45-61) and Stephanie Kapusta offers a useful analysis of its conceptual underpinnings (2017). The first step is to discover whether the child is "*really*"—male or female (Fausto-Sterling 2000b, 50); Kapusta describes this as the "precisification" of genital sex through various standardized measures (2017, esp. section 3). The second step is to create what Kapusta calls a determinate "sex of rearing" (2017, esp. section 4) through various medical interventions to change the child so that they meet the accepted standards of what male and female should be. The sex-specific goals of such interventions include things like giving the child the capacity to direct urine while standing up (Fausto-Sterling 2000b, 57), a penis that can "achieve penetrative intercourse" (Lee 2016, 169), and fertility in a manner typical of the chosen sex (Fausto-Sterling 2000b, 57). In this way, medical practice effectively imposes "determinate sex predicates" on children (Kapusta 2017), identifying intersex infants only to surgically eliminate them.

Even without critically examining the standards for *successful* surgeries, there is some extremely peculiar reasoning going on here. If a medical team determines that an infant is, say, male then whatever their external genitalia is, it is part of the range of naturally occurring male morphology. So, it's difficult to see how their own reasoning can justify these often dangerous surgical interventions. If clinicians are confident in their claim that a child with anomalous genitalia is male, why not just educate their parents, and indeed, the general public, about the range of genital morphology for males—the many different ways, morphologoically and physiologically, of being a human male. This natural diversity appears to be assumed by their own reasoning. Of course, another option is to allow that the child is "*really*" intersex. The medical intervention is then designed to transition the child from being intersex to male or female. This, in effect, imposes a gender affirming surgery (and, potentially, a lifetime of medical surveillance and care) on infants who have not yet expressed any gendered behavior, let alone developed their own gender identity. The shift away from the term "intersex" to the more explicitly normative "disorders of sexual development" or its bowdlerized cousin "differences of sexual development" functions to elide this reality and justify "corrective" surgery through semantic sleight of hand.

That such interventions have been done without properly informing parents (Fausto-Sterling 2000b, 63-6), which means without informed proxy consent, is chilling. It is yet more disturbing when one considers the fact that the need for such interventions—some of which leave permanent scars and seriously negatively affect adult sexual function (Fausto-Sterling 2000b, 78-95; Jordan-Young 2010, 235-46)—is imposed by a culturally specific gender ideology that demands, against the evidence, that there are only two human sexes. When it comes to intersex conditions, the medical establishment has put itself in the position of correcting natural diversity (or, for the religiously minded, God's work) by imposing morphological sex dimorphism on the population in their care. As Catherine Clune-Taylor (2019) has argued, this elimination of sex diversity appears to be squarely focussed on eliminating from our cultural consciousness the reality of folks having non-standard sex and gender identities. It is sex dimorphic ideology as standard medical practice.

This ideological commitment to sex dimorphism in places like North America is very odd given that the diversity of sex morphology and gender expression has long been widely understood throughout the history of European and European settler societies. After all, the term "hermaphrodite" is ancient—there's even a myth, recounted by the Roman poet Ovid, to go along with it (see, e.g., Ovid c. 8/1922, Book IV)—and Jewish law refers to more than two sexes and has some rules about who is supposed to do what (though here we start moving toward gender roles) (Fausto-Sterling 2000b, 33, 41; Strassfield 2022). The Pardoner from Chaucer's medieval best seller, *The Canterbury Tales* (1400/1987), uses "he" as a pronoun, but is described as "a geldyng or a mare" (I. 691)—i.e., a eunuch or a female, which, however we take it, is certainly gender nonconforming. And so on.

There are plenty of societies that recognize more than two sexes beyond the European tradition, though here again sex is often mixed up with gender and sexuality. How these bodies and identities are understood varies from culture to culture and modern or colonial categories often fail to adequately represent this. For instance, "berdache," as a colonial term, problematically lumps multiple culturally specific Indigenous gender identities together (Roscoe 1996), but to address post-colonial realities, people indigenous to North America have adopted "two-spirit" as a catch all for the many different ways these societies include those who didn't and don't fit sex or gender binaries (Davies-Cole and Robinson 2022). So, biologically, anthropologically, and historically we know there are more than two sexes within our species and this is only if we restrict our gaze to intersex conditions. When we consider the ways in which sexual diversity has been created and sometimes diminished through various conscious interventions, the two sex model becomes yet more suspect.

However we choose to classify the human population in terms of sex, at the end of the day it is clear that there are not just two sexes, if we mean by that two distinct and exclusive morphs correlated with gamete size, that exhaustively describe the members of our species. Forcing everyone to be one or the other on the grounds, not of their preference, but a decision based on an ideological commitment to sex dimorphism is simply scientifically and morally indefensible. The fact that most people morphologically and physiologically conform to one or other typical morph (more or less) is irrelevant. It would be ludicrous, biologically speaking, and ethically wrong, to force a person with size 14 feet to wear size 11 shoes on the basis that size 11 feet are more common in the population. Similarly, it is ludicrous to surgically modify a person who is intersex to fit a male or female sex category because intersex people are uncommon in the population. In both cases it amounts to a denial of a manifest biological reality—a refusal to address the real diversity in the population. Certainly, within a society that has a strong dimorphic gender ideology (like most societies in the European tradition), it will often be desirable, if not necessary, to identify with one sex or another for one's personal safety, but this choice of identification and the concomitant social roles is a question of gender, not genitals, chromosomes, gonads, or gametes. Gender is (in part) a public display of a socially meaningful identity, whereas genitals are typically covered up (though not in all societies), even if we understand that the public display of a certain gender is often assumed to be correlated with having certain genitals.

Before moving on to gender, it is worth spending some time with those sex differences that are imposed through surgical (or other medical) interventions. It is important to remember that many human bodies (and this will be true of other sexual organisms too) do not produce or house gametes. My mother had her ovaries removed in her 50s and, like my spade cat, from that time on had neither gonads nor gametes. This seems to have had relatively little impact on other primary or secondary sex characteristics for my mother and no impact on her identity, though other women have other experiences, and certainly my cat's behaviour and morphology would have been considerably different if she had kept hers.

Human males also sometimes have their gonads removed—and concomitantly stop producing gametes. Thanks to modern medicine, this sometimes happens as a medical intervention for treating prostate or testicular cancer. Although there are often significant morphological and physiological changes, producing traits that are more typical of human females—secondary sex characteristics such as reduced body hair, loss of muscle mass, increased body fat, or growth in breasts—there appears to be a reluctance to think of these changes in terms of sexual diversity, at least, in contemporary societies in the European tradition (Wassersug, McKenna and Lieberman 2012). This is, presumably, because there is considerable stigma around the loss of one's testicles for people who identify as men in this society. This is not merely encapsulated in various sayings and slang around "having balls," but in the fact that "eunuch" is typically a term of derision and is often used as a slur. But this brings us, again, to gender, so perhaps it is time to address it.

What I hope is obvious from this section is the sheer diversity of expressions of sex and that where we draw the line about who counts as what sex, even in the most biologically basic contexts, will sometimes be a question of judgement. Ignoring the diversity and complex, contingent multifactorial reality of sexed bodies is likely to be miseleading in biological research. In biomedical research it not only risks harming science but harming patients. This has led some to call for the elimination of sex as a category (Watkins and DiMarco 2025) and others to call for a contextual approach to sex in biomedical research that "recognizes the pluralism and context-specificity of operationalizations of 'sex' across experimental laboratory research" (Richardson 2021, 1; see also Clancy et al., 2024).

4. Sex is Not Gender (Though They Are Related and, in Some Cases, Impossible to Tease Apart)

The terms "sex" and "gender" are sometimes used interchangeably. There can be good and bad reasons for this, but ultimately, after pointing out quite how bad the bad reasons are, I will argue that the good reasons have better solutions. So, I will defend a clear theoretical distinction between sex and gender that often fails in practical applications where they cannot be disentangled. In such cases, a new term is in order. My position is not new but is simply taken from Sari van Anders' work on sexual configurations theory (2015). Briefly, gender is cultural, while sex is biological. When I say "biological" I'm referring to primary and secondary sex characteristics, discussed above. As for "cultural," I mean socially learned practices that are culturally and historically contingent; they vary across time and space within the same species and not for any obvious biological reasons, such as different foraging practices due to differences in available food. So, gender picks out a set of culturally specific social roles and rules that members of a species who are identified as being a particular sex are expected to follow because of that sex ascription. Wearing a skirt is a classic example of gender. In contemporary North America this is gendered as feminine garb. However, from Scotland to Samoa, traditional masculine dress includes articles of clothing that are, descriptively, skirts, although the term “skirt” is often rejected, presumably because it is associated with femininity in an external dominant culture. The typical developmental path for gender is that, on the basis of primary sex characteristics, a newborn (and sometimes a fetus) is assigned a sex and, from then on, they are expected to enact the gender norms associated with that sex in their cultural context, self-impose them, and impose them on others when able (Bussey and Bandura 1999, 694-701).

Some of the bad reasons for using “gender” and “sex” interchangeably are manifestly bad. The word “sex” is sometimes viewed as dirty or rude and so “gender” is preferred as a more polite way of referring to the same thing. If you have taken your cat to the vet and been given a form that asks about your cat’s gender you have encountered this. Whether the motivations are puritanical, purile, or concerns about causing offence, such scruples are clearly foolish, unscientific, and indefensible if they have any life beyond the vet’s paperwork. “Gender” reveal parties, which are typically announcements referring to genitals revealed by ultrasound images, seem to follow a similar logic (Jack 2020, 84).

Other bad reasons take us back to our discussion of secondary sex characteristics, which, if you remember, can include some behaviors. As noted above, there are some large research programs associated with brain organization theory and evolutionary psychology that seek to show that various sex-linked behaviours are genetically programmed. This means, in effect, that brain organization theory and evolutionary psychology seek to show that many, if not most, supposedly gendered behaviours are actually secondary sex characteristics, albeit perhaps with a cultural veneer on top that makes the data somewhat noisy. This means that there are few (if any) true gender traits; it’s all *really* sex. That’s why we can use “sex” and “gender” interchangeably. While a thoroughgoing criticism of these research programs is entirely in order, it would take us too far afield. Happily, many critics have ably done this work already (Buller 2005; Meynell 2012; Jordan-Young 2011; Rippon 2019).

The good reasons for the confusion arise because social and biological causes and effects are often difficult to tease apart, particularly when we are talking about real people in the real world. Because they often encode a form of life, gender norms, narratives, and expectations become entangled with a person’s own projects, understandings of their body, and self-conception. This means, from our own embodied perspectives, it may be impossible to say which experiences and attitudes are reflections or expressions of our sexed body or our gendered mind. Indeed, it is not even clear that the distinction makes much sense in this individual, experiential context (van Anders 2015, 1181). In addition to this, gendered activity—both the behaviors of and toward a given developing individual—can affect traits that might reasonably be considered biological. Sari van Andres has a tidy solution for this. She introduces a third category, “gender/sex,” which applies to those cases where the biological and cultural are so intertwined that they cannot properly be distinguished. So, we have three ways of classifying the members of a biologically cultural sexual species: Sex categories; gender categories; and gender/sex categories (van Anders 2015, Table 2).

4.1 Eunuchs, castrati, and hijra

As noted, complexities and contingencies of gender/sex (and indeed gender and sex as well) are often difficult to grasp when applied to our own person. Similarly, there may be a tendency for us to mistake those norms and differences that are common in our own particular cultural and historical context as given, fixed, and universal and so presume that they are in some sense biologically given. This is why reflection on eunuchs as a "third sex" with a distinct gender role is particularly instructive. Of course, in contemporary societies in the European tradition, few people identify as eunuchs (with some exceptions [Wassersug, McKenna and Lieberman 2012]), despite the relative prevalence of orchiectomies in these societies. So, in this case we have a distinct sex morph with no corresponding gender identity, despite the fact that in other societies this particular sex morph has been associated with various distinct gender identities.

Although other societies have had eunuch gender identities (e.g., Byzantium [Ringrose 2003]), I will focus, for the sake of brevity, on the eunuchs of Imperial China, the castrati of modern Europe, and the hijra of India. For two of these genders, the primary sex characteristics associated with them were considered necessary conditions due to their biological implications—in the first case, the impossibility of reproduction and in the second, the development of a distinctive, strong soprano singing voice. In ancient and medieval China, eunuchs had a distinct role as a kind of servant class in the imperial court and, intermitently, other high ranking households as well as the military and civil service. The status, number, and political influence of eunuchs varied significantly over time as did the source of eunuchs—some of whom were foreigners and others who were Chinese. Though some were castrated as a punishment, for others, chosing a eunuch identity was a path to economic security and a certain degree of political status and influence that was relatively easy when compared with the notoriously competitive bureaucrat education system (Tsai 1996, 1-9). During some periods, particularly when the emperor was suspicious of the bureaucrat class, the number and power of eunuchs grew (Tsai 1996)—as is exemplified by the story of Zheng He, the great Muslim explorer who, from 1405-1433, led a Chinese fleet around the Indian Ocean to Africa (Dreyer 2007).

There was not only a distinct social role for Chinese eunuchs but also a normative gender identity, albeit an unflattering one. They were thought to be ruthless and treacherous and were often assumed to have many of the character flaws associated with women (Tsai 1996, 11-12). Doubtless, many eunuchs lived up to this stereotype, internalizing the characteristics that they were told they had and treated as if they had. However, despite the fact that the Chinese at the time would have understood these to be essential traits, effectively, just behavioural secondary sex characteristics of eunuchs, I doubt that many contemporary Europeans or North Americans would agree. After all, that would mean that men who have life saving orchiectomies to treat their cancer would ungo the same change in personality. What, from the Ming Chinese perspective, would have been experienced and understood as gender/sex or even sex traits, most people in North American society now would simply consider culturally contingent gender norms.

This is not to say that there aren't real biological changes for people who undergo orchiectomies, though what exactly these are vary considerably and how any given individual experiences them will have a good deal to do with their own understanding of what their bodily changes mean (Wassersug, McKenna and Lieberman 2012). Most obviously, anyone who undergoes a complete orchiectomy, has no gonads and, concomitantly, no gametes. (Those who would make sex entirely dependent on gamete size should take note.) However, because of the role of the testes in producing hormones they often have other physiological differences from cis-men without orchiectomies, such as the growth of breasts (Wassersug, McKenna and Lieberman 2012, 257). There is a developmental component here also, as males who have orchiectomies prior to puberty may develop distinctive voices and growth patterns. Not only do they not typically grow facial hair but they also tend to have limbs that are rather longer, larger chests (associated with greater lung capacity), and higher voices than is typical for cis-men who do not experience orchiectomies (Skuse 2021, 17-8).

These high, strong voices are what led to the domination of castrati in Italian church singing and opera in the 16th, 17th, and 18th centuries (Rosselli 1988). Here again there is a distinct social role—being a soprano or alto non-woman professional singer—and, as with the eunuchs of Ming China, the role is ascribed on the basis of primary sex characteristics, albeit with the intention to produce the desired secondary sex characteristic—a high, strong voice—that was essential to the social role. For both Chinese eunuchs and European castrati a gender identity drove a surgical intervention, producing distinctive primary and secondary sex characteristics which made access to a certain social role and way of life possible for the people who underwent it. Is the castrati's voice a gender difference or a sex difference? Well, it's both—it's a gender/sex trait.

Some social roles that are associated with orchiectomies do not actually require them. Consider the hijra, who are now legally recognized in India as a members of a third gender (Boisvert 2020, 92). Although the ritual of *nirvāṇ*, in which not only a complete orchiectomy but also a penectomy is performed, is often an important step for hijra, their identity as hijra does not require it. Indeed, unlike the Chinese eunuch or European castrato, they become hijra prior to this intervention through an entirely distinct ritual (Boisvert 2020, 94-8). What is instructive for us is how clear it becomes through consideration of these examples that gender is entirely distinct from sex, while being intimately related to it. After all, all three of these gender identities fail to map onto contemporary North American gender identities associated with the same surgical intervention—orchiectomy—which, for some women, intersex folks, and gender diverse people, is an essential part of gender affirming medical care and, for some cis men, is a cancer treatment.

Again, this diversity of the meaning and experience of orchiectomy is striking because orchiectomy removes that which some want to take as definitive of dimorphic biological sex (gametes and gonads) and changes primary sex characteristics (though some cis men choose to have prosthetic testicular implants to retain this [Haymon, Michael and Coward 2020]) and secondary sex characteristics (though some cis men choose to undergo other medical interventions—for instance, hormone replacement—to lessen these [Fritz and Rienert 2024]). So, the sex morphology definitive of eunuchs in a variety of cultures historically, is not associated with with any contemporary gender identity in North America (again, with some exceptions).

5. Conclusion

So, are there two and only two sexes? Yes and no, but mostly no. Yes, insofar as “sexual” as a type of organism is defined in terms of sexual reproduction and anisogamous organisms are identified as those that reproduce by joining large gametes with small ones. No, once we start looking at particular taxa where species vary from having one hermaphroditic sex to multiple different sex morphs with their own distinct developmentally contingent varieties. Even within our own species, where we have species-typical primary and secondary sex characteristics that typically align with gametic differences, there are many naturally occuring developmental differences that do not so align and cultural and sugical interventions that sometimes make bodies align more with the morphology that is normative for the sex they were assigned at birth and sometimes don’t. These interventions are informed by culturally contingent gender norms. Gender is not sex, though because the social roles and norms associated with a particular gender are imposed, typically, on the basis of a sex ascription, gender is frequently experienced as inextricably entwined with sex. Moreover, in cultural animals, the traits that we see are frequently the result of the interactions between biological and social causes; thus the usefulness of coining a third term, gender/sex. One thing is clear, the idea that there are two and only two sexes in our own species and that gender can be reduced to secondary sex characteristics is clearly false. In the face of this reality, our moral and political obligations are obvious—working toward a world where all people, regardless of their physiology, morphology, or gender identity, can flourish.

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