6. Conclusion

Biological sex is extraordinarily complex and plastic in nature. Sexual phenotypes are as varied as the diverse sexual strategies that have evolved in nature over millions of years. In Biology, we have simplified this complexity by assigning categories to facilitate the study of sexual reproduction, but this simplification needs to be revised in light of the many new discoveries in the field of sexual differentiation that are often deemed to be “exceptions”, but that in reality make up a persistent and significant percentage of individuals of any one species, that represent the inescapable reality that biological complexity leads to variation, and that this variation is crucial for evolution to act. There is no single trait that can be used to unambiguously assign sex in all individuals of any species. For example, since not all individuals make gametes and some make both types, adding the categories of neither and both to the traditional sperm and egg is necessary to encompass all gametic variation even if those percentages are expected to be relatively small. Consideration of the significant role that phenotypic plasticity in response to the social and abiotic environment plays into the morphology and function of the gametes, gonads, and genitalia is critical to understand that these traits are not binary, but they have a continuous distribution. Such consideration does not require abandoning a more traditional understanding of sex in nature, but it does require expanding it to capture the nuance of biological reality. While many individuals are likely to have concordant phenotypes in their gametes, chromosomes, gonads, genital ducts and genitalia, some clearly do not. They are not “exceptions that prove the rule”, but rather full individuals with reproductive phenotypes that arise over and over and that represent important natural variation that deserves full attention and study.

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