The role of hybridization in speciation biology essay

Charles Darwin had published, The origin of species by natural selection, using his lifes discoveries and analysis to define what a species is and how species originate follow through as a contentious debate especially in the study of evolutionary biology. The study of evolution helps us to understand what species are by loosely idealizing it as alien till one feeds on their hunger to gain knowledge about what has created the world and the extant and extinct varieties that have claimed it, including man.

Many different species are discussed and debated continuously, with each one being weighed by pros and cons which can also be seen as the strong point to either validate the concept or a short -fall to nullify it. The most accepted definition of current is Mayr’s biological species concept, according to Coyne & Orr (2004) who have accepted nine species concepts (Claridge et al, 1997). Mayrs’s biological species concept places the evolution of complete reproductive isolation as the focal point of the process and nature of speciation (Mayr, 2002), the biological species concept was the solid basis of which he based his belief in gene flow being absent in some species, a decreased fitness level to certain hybrids. It is believed that the emergent species would infrequently form from the process in question according to Mayr (2002).

Hybrid speciation implies that hybridization has had a principal role in the origin of a new species, hybrid species that have doubled their chromosome number (Mallet, 2007), the definition applies: 50% contributions from each derived species initially contain exactly one genome from each parent, although, in older polyploids, recombination and gene conversion may eventually lead to unequal contributions (Mallet, 2007). The factor which is

critical in hybrid speciation is due to being reproductively isolated with a decreased fitness-level; therefore these progeny formed are of transitional then it is more likely to be more weakly reproductively isolated. Speciation can also be influenced by hybridization by the factor of reinforcement, this means that obstacles in reference to mating because of unfit hybrids being chosen, even-though progeny from this relationship does not form from the courtship, the scenario is questionable as to whether reinforcement can be looked at as hybrid speciation. An example of this that can be discussed is the diploid or triploid frog Rana esculenta which is complete heterozygous for Rana lessonae and Rana ridibunda genomes (Mallet, 2007; Tunner&Nopp, 1979).

Poly-, Allopoly- and Homoploidy, is it all just about how you do ‘ It’?

Plants use the means of polyploid evolution; these species are reproductively isolated due to the process of mating with diploid mates which give rise to uneven ploidies of progeny like triploids. These progeny may be able to reproduce but these progeny would cease to exist due aneuploidy (Stebbins, 1971; Grant, 1981; Ramsey & Schemske, 2002) – polyploidy is a simple way of creating speciation. Bisexually polypoid speciation is highly prevalent in plants as compared to animals due to: plants usually have indeterminate growth and somatic chromosome doubling can lead to germline polyploidy, germline refers to the sex cells that an organism contains which is sperm, egg and pollen in plants. Plants are often perennial or temporarily clonal which allow multigenerational persistence of hybrid cells within which polyploid mutations occur; plants are more often hermaphrodites, in rare

polyploids self-fertilization allows a means of sexual reproduction (Mallet, 2007). Gene flow is weaker in plants as compared to animals with local populations which have unusual ploidy (Bullini, 1994; Otto&Whitton, 2000; Astaurov, 1969).

Speciation can occur by the process of duplication of chromosomes within a species or duplication of hybrids (Mallet, 2005) between an autopolyploidy and allopolyploidy, respectively. Allopolyploid speciation follows self-fertilization and gives rise to a tetraploid; this can be seen from studies on Primula kewensis which was a result of Primula verticillata and Primula floribunda which had cultivated diploid hybrids. Speculation had lead to the belief that fusion of unreduced gametes had caused this due to the failure in reduction divisions during meiosis. A triploid species, known to be sterile, may add to the production of tetraploids by progeny being back-crossing triploid gametes; this was used to produce the first bisexual self-sustaining animal in a laboratory which was a polypoid strain hybrid between silk moths: Bombyx mori and Bombyx mandarina (Astaurov. B. L, 1969; Mallet. J, 2005).

Homoploid hybrid speciation is well known to angiosperms, also known as flowering plants. Speciation occurs by mean of sympatry, a hybridization which requires gene flow. This is hybrids need to overcome challenges such as chromosome and gene incompatabilies with the lack of reproductive isolation, this often renders the process unlikely. There are approximately twenty plant species which are known for being a good example of homoploids however, this plant is hardly detected due to prevalence. Helianthus anomalus, Helianthus deserticola and Helianthis paradoxus are

the best documented desert sunflowers which come from hybrids between mesic-adapted Helianthus annuus and Helianthus petiolaris (Buerkle et al, 2000; Gross &Rieseberg, 2005; Mallet, 2007). Synthetic hybrid populations are re-created; being similar to those of wild species due to selection continuously favors combinations of compatible chromosomal rearrangements. In Helianthus recombinant genotypes and spatial separation have enabled the hybrids to flourish where their parents are absent (Mallet, 2005). In animals, bisexual polyploids are often excluded, the homoploid hybrids are less prominent in animals yet there is no given reason. The number in animals is growing rapidly (Dowling & Secor, 1997; Gross & Rieseberg, 2005). A recent example is the invasive sculpin, a hybrid fish derived from the Scheldt River (compare Cottus perifretum) and upper tributaries of the Rhine (compare Cottus rhenanum) (Mallet, 2007). Upper river tributaries of Europe have normal conditions of clear, cold waters, which make them oxygen-rich, for Sculpins. Earlier canal building became connected and these are a result of The Rhine and Scheldt rivers, but invasive sculpins appeared in the warmer water and muddier lower Rhine only in the past fifteen years. Morphologically the invasive sculpin is intermediate and its mitochondrial DNA, as well as nuclear single nucleotide polymorphisms and microsatellites, are characteristic of both Scheldt and Rhine forms (Mallet, 2007; Nolte et al., 2005). This provides evidence of adaptive hybrid origin hence communicating that hybrids are displaying positive selective pressure.

Hybrid speciation in the animal kingdom results thus far by data based on the respective genome. The disadvantages is that many homoploid hybrids

fail to be present in the parent, secondly a decreased level of being reproductively isolated, however, contributing to maintaining or expanding ecologically with latest forms (Mallet, 2007).

Importance of a future

Innumerable discussions and journals of speciation have stressed the importance of reproductive compatabilities and isolation that occur due to physical and geological barriers; from this essay one can see that polyploidy is more dominant in plants but found to be rare in animals. Furthermore, at the root of many animal and plant groups ancient polyploidy has been found. Genome duplications probably facilitated the evolution of complex organisms (although this is debated) (Mallet, 2007; Otto & Whitton, 2000), and we can infer that successful genome duplications were mostly allopolyploid, provided that limited plant community data are reliable (Grant, 1981; Brochman et al., 2004; Mallet, 2007). In my opinion, hybridization can be viewed as an effective catalyst for speciation to occur as it creates variation as in the case of the liger, apart from mutations, which according to the Molecular Clock hypothesis, occurs at a constant rate over time.

The process of natural selection includes the need for gene variety which can then be complemented with hybridization also, the compatibility of species more suitably in more noticeably growing groups; suggesting that enough suspected animal homoploid hybrid species exist. A need for in depth genomic analyses is required, it is already possible for hybrid species, like the Helianthus, which can be developed and made accessible via the laboratory or grown naturally, making it hard to find another speciation mode documented historically and can be used experimentally easily.

If hybrid species can adapt to survive, showing positive selection pressure, regardless of the challenges which are faced and to survive in competition with the parent organisms by completely new adaptations then will hybridization truly demonstrate the power of evolution through the years, starting a completely new train of thought which will spark more questions hence more research into this wide unknown.

The ability of hybrid species to invade hitherto unoccupied niches also means that hybridization can contribute to adaptive radiations such as African cichlid fish and Darwin’s finches (Mallet, 2007). Humans have come up with uses of genetically modified crops and other ways in which to manipulate the gene and species of not only plants but animals too, therefore it can be said that Homo sapiens are in fact the invaders of Earth, not hybridization of species.