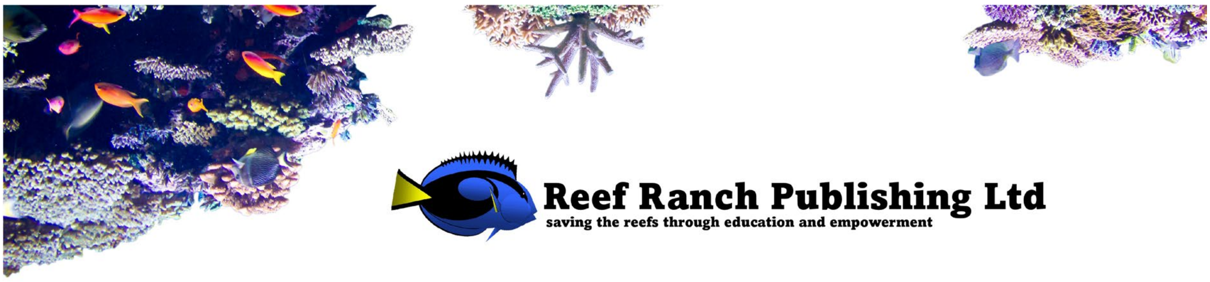


Coral Phenotypic Plasticity

Chris Aslett

"Descent with modification" is central to Darwin's theories which postulate all life originates from less complex progenitors. Nominal frequencies of genetic mutation occurring during procreation, bestow ecological impediments or advantages, which are consolidated in successive generations due to intraspecific transcendence; those acclimated to their environment prevail at the expense of the maladjusted (Alzoahairy 2009).

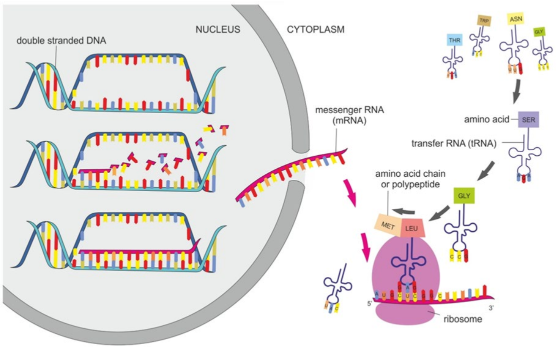
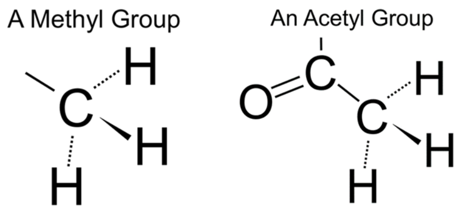


Fig 1 mRNA transcription, translocation to the cytoplasm and ribosomal translation.

Individuals within a populace retain non-identical heritable traits whilst competing for limited resources in an ever-changing environment. Qualities conferring procreation competence (fecundity) and survivorship are preferentially transmitted at elevated frequencies which are reinforced in successive generations (Gregory 2009).



Phenotype is influenced by genotype and refers to discernible characteristics such as colouration, growth form and how the coral interacts with its environment.

Epigenetics modifies the expression of the transcriptome. Genomic DNA is organised into nucleosomes by wrapping it around histone protein octamers. H1 histone addition forms a chromatosome whilst successive coiling and folding create chromosome chromatids (Annunziato 2008).

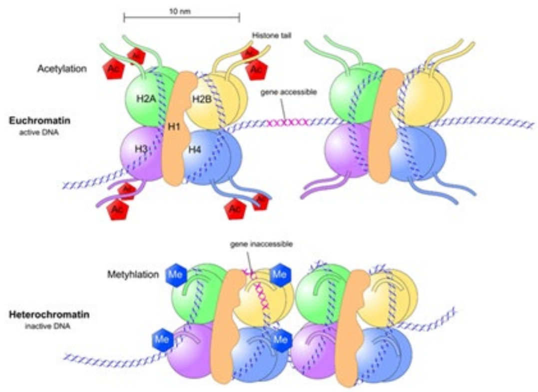


Fig 2 Epigenetic histone tail acetylation versus methylation.

An organism's transcriptome consists of actively expressed genes that are transcribed in the nucleus into messenger (m) RNA. Translocation to the cytoplasm permits ribosomal translation into a polypeptide that is folded into a protein (Fig 1).

Fig 3 *Pocillopora damicornis.*

Methylated histone tail/DNA complexes shield the gene from the transcription machinery, whereas tail acetylation unlocks the gene and facilitates unwinding and accessibility (Fig 2). Epigenetic modifications alter genomic expression, not the genetic code, and thus expedite rapid adaptation that cannot occur through transgenerational Darwinian evolution. The discovery that these modifications are heritable is truly ground-breaking and partly explains why clonal populations of corals can appear very different. Coral colouration is subject to epigenetic manipulation (Gittins *et al.* 2015).

Housekeeping genes are protected by steadfast gene methylation, whereas easy-to-modify methylation regulates environmental adaptation (Dimond & Roberts 2016).

Fig 4 *Montipora capitata.*

Phenotypic plasticity refers to alterations in appearance and function as a response to the environment. It operates independently of epigenetics and is poorly understood. All aspects of phenotype including behaviour, morphology and physiology are changed. Variation extends to all "living" things including the viruses of bacteria (bacteriophage) because all organisms have a genetic code to which phenotypic plasticity appears inextricably linked which may be the consequence of multiple switchable homologues (Liu *et al.* 2018). Science had recognised anomalous adaptations in the late 19th century which were largely ignored in favour of the paradigm and dogma of natural selection (Baldwin 1896).

Phenotypic plasticity may act continuously or spontaneously culminating in conspicuous diversity. Continuous adaptability must be extricated from genetic polymorphisms which rely upon multiple alleles. Changes are not exclusively induced by the environment and are not always advantageous, yet plasticity plays a crucial role in evolution and the development of "alternative" phenotypes and "specialisations" (West-Eberhard 2003). Furthermore, plasticity may be regulated conditionally or randomly (stochastically; Sommer 2020). For instance, bacterial phenotypic heterogeneity manifests in different cells (Ackermann 2015). How do scientists acquire empirical evidence of its existence and establish phenotypic inertia (canalisation) while identifying "environmentally responsive and developmentally plastic traits" (Sommer 2020).

Acclimation occurs within a generation and appears to confer resilience to established and current stressors (Million *et al.* 2022). Conventional fitness attributes offer resilience to heat, irradiance, acidification, wave action, hypoxia and eutrophy. Scientists hope such adaptations will facilitate rapid acclimation to climate change.

10 clonotypes of nursery-raised ramets (propagules) of endangered *Acropora cervicornis*, were outplanted in situ in nine locations in the Florida Keys. The most plastic individuals exhibited greater survival, adaptation, and vigour regardless of genotype (Million *et al.* 2022).

The epigenetic and plastic responses to ocean acidification in hardy *Montipora capitata* and comparatively delicate *Pocillopora damicornis* were laboratory assayed. The former adapted in the absence of epigenetic modification, whereas *P. damicornis* underperformed despite considerable methylation (Fig 3 & 4; Putnam *et al.* 2016). This research highlights unrecognised and uncharacterised mechanisms.

The photosynthetic sea fan *Antillogorgia bipinnata* (Octocorallia: Gorgoniidae) exhibits extensive growth form plasticity when exposed to variations in light, temperature, salinity, and pressure (Calixto-Botía & Sánchez 2017).

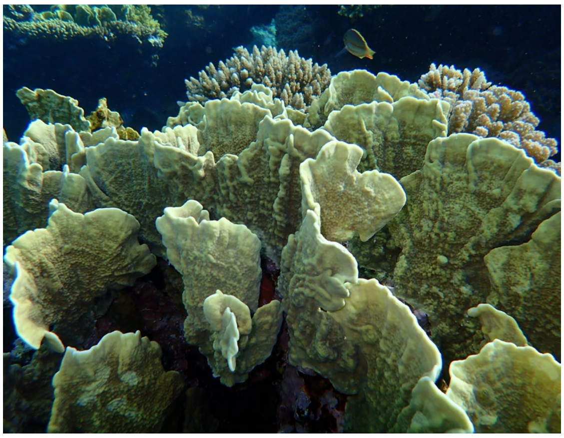


Fig 5 Vertical sheets of blade fire coral (*Millepora platyphylla*) the Red Sea, Egypt.

Clones of the fire coral *Millepora platyphylla* (Hydroidolina: Milleporidae) grow in three distinct forms: vertical sheet-like, encrusting, and massive. The former is more vulnerable to surf zone hydraulic buffeting. This example of phenotypic plasticity contrasts with other observations because sheet-like growth predominated on upper reef slopes making colonies susceptible to fragmentation, whereas massive and encrusting were adopted elsewhere (Dubé *et al.* 2017). What is first perceived as a contradiction may provide an ecological advantage by disseminating clonal populations.

Phenotypic plasticity raises more questions than it answers until science can develop analytical approaches.

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