

Neoteny

The term 'Neoteny' or Paedogenesis is defined as the phenomenon of the retention of larval characters in the sexually mature state. In this process the metamorphosis of larva is retarded and the larval characters are retained beyond the normal period. This phenomenon has been observed in amphibians, both in Urodels and Anura. In Urodels, this phenomenon is of common occurrence and very conspicuous.

It has been long observed that the larvae of Spotted Salamander, sometimes attain the size of 80 mm. while the majority metamorphose when they measure 60 mm larvae of Triton have been observed with fully developed sexual organs while still possessing functional gills.

De Filippi (1861) also reported occurrence of specimens which were sexually mature but still retained their gills. The discovery by Deumeril (1876) that the Mexican gill breathing axolotl would metamorphose into lung breathing terrestrial Ambystoma led to a series of observations and experiments by Campana (1896) and many others.

Types of Neoteny

There could be different degrees of neoteny. There may be slight, moderate or extensive retardation of development of adult features. Kollmann has distinguished two types of Neoteny.

① Partial Neoteny -

In this type there is a single retardation of metamorphosis beyond the normal period due to temporary changes in surroundings habitat or some physiological disorders. Example of partial neoteny are mostly found in animals like the tadpoles of Rana esculenta, Rana temporaria, Bufo vulgaris etc.

② Total Neoteny

In this category the animals retain larval characters but become sexually mature. The larval characters retained are external gills, tail, fin, ill-developed eye, ill-developed dorsal fin and weak limbs. Animals exhibiting total neoteny normally do not metamorphose and remain as sexually mature larvae. In some cases however such larvae may undergo metamorphosis under favourable conditions as the axolotl larva. Total neoteny is observed in Urodels only.

Causes of Neoteny

Workers like Chavin, Koelliker, Camerano and others, did extensive work in this regard. While some workers attribute it to some external factors, others have suggested that some internal factors are responsible.

① External factors

According to some workers it is the result of adaptation to the surroundings which make it advantageous for the animal to retain its larval features.

Presence of abundant food, and favourable conditions in aquatic habitat - may be the cause of this phenomenon (Gadow 1903)

Weisman's assumption that all the amphibians were originally gill breathing, aquatic and limber animals and that the larva reflects the ancestral phylogenetic stage is not tenable. Owing to the fact that the environment

Physical factors somehow or other retardated metamorphosis. Lack of food supply, rise in temperature and drying up of water bodies may be responsible for retardation of metamorphosis. 1

Researches on the role of external physical factors on metamorphosis do not provide any basis to conclude that they are the sole factors. It has been observed that typical neotenic and overgrown specimens frequently occur side by side with metamorphosed adult specimens. So, it is reasonable to say that some internal and physiological factors also come into play to control metamorphosis.

(B) Internal factors

It has been shown experimentally that a gilled axolotl may change into a form without gills. It has also been experimentally shown that injection of thyroid hormone (thyroxine) or implantation of iodine crystals beneath the skin induce metamorphosis.

On the basis of recent researches it has been revealed that metamorphosis is mainly influenced by the level of thyroxine and also the degree of responsiveness of the larval tissues to the hormone.

In this connection it has been established that prolactin plays an effective role in metamorphosis as its level is high in early stage prior to metamorphosis.

The genetic explanation advanced by Etkin and his co-workers (1968) is that formation of prolactin is increased by concerned genes, while the genes responsible for the synthesis of thyroxine are switched off by concerned operator genes in the early phase of larval life.

Now the hypothalamus becomes sensitive to the low concentration of thyroxine and secretes TRF (thyrotropin-releasing factor), which stimulates the anterior lobe of pituitary to produce TSH which in turn increases the rate of thyroid secretion.

The increase in the level of thyroxine brings about the initiation of metamorphosis. The increase in the level of thyroxine, results in decrease of prolactin.

Even fully developed thyroid glands sometimes fail to secrete adequate amount of thyroxine and under such circumstances transplantation of a few more thyroid gland induces metamorphosis.

Significance of Neoteny

Weissmann (1875) regarded neoteny as a case of atavism, which is a phenomenon of reversion to ancestral characters. This implies that all amphibians were originally gill breathing aquatic creatures which is not true. External gills of Urodeles are now regarded to be secondary specialization serving as additional respiratory organs. Also, other larval features of neoteny larvae do not represent atavism, but are characters secondarily acquired for aquatic life.

Noble (1954) pointed out that retention of larval characters is in no way connected with the phylogeny of the amphibians. The great heterogeneity of perennibranchiate forms which are all neoteny, prove this point. So, it may be concluded that the larval features are retained due to some intrinsic factors combined with environmental factors, and are advantageous for the neoteny individuals.