

## NEOTENY

Neoteny is a condition in which larval characters are more or less completely retained throughout life and hence sexually mature animals possess larval characters. The term Neoteny is coined by KOLLMANN. According to him, it is essentially a process of retardation of metamorphosis of larvae into adults and the retention of larval characters. Neoteny is a special case of Paedomorphosis. The paedomorphosis is the retention of ancestral juvenile characters in the late developmental stage. In this regard, Neoteny is the alternative name of Neoteny. The Neotenic larva also called as the permanent. The persistence of larval or even embryonic characters into adult life is probably a much common phenomenon than is generally realized. De Beer (1951) regards it as an evolutionary process, in which adult characters are pushed back to earlier developmental stage. This phenomenon has been observed in both Urodela and Anura. In Urodels, this phenomenon is of common occurrence and very conspicuous.

The modern classification of Urodela is mainly dependent upon their neotenic characters and near about all genera and species of this order are neotenic. The Urodels are so to say "young but old" or "old but young."

The size of neotenic larva and adults are quite different. De Filippi (1861) reported 40 such sexually mature gill larvae of 5.5 cm in size in one locality of Lombardy. A classical example of the neoteny is met within a larva of *Amblystoma* (*Amblyostoma*) under certain circumstances. The larval condition is also known as Axolotl. The so called Axolotl was variously named as Siredon axolotl, Siredon mexicans, Siredon pisciformis etc. According to Cambridge Natural History, the term Axolotl applies to the permanent larval forms of the Mexican representative the genus *Amblystoma*. This view was supported by Dumeril (1876). According to several Zoologist, the Axolotl larva may or may not undergoes metamorphosis. Marie van Chauvin, Koelliker and many others have done a extensive works and

pointed out that several anurans and Urodels are known to become sexually mature in pre-adult stage and retain larval characters.

At the present time, neoteny is considered as secondary, relatively recent, changes that have occurred independently in several different taxonomic groups. On this basis KOLLWANN classified neoteny into two categories: →

▷ PARTIAL NEOTENY: → Partial neoteny involves the retardation of metamorphosis, beyond the normal period. Retardation of metamorphosis may be due to temporary changes in ecological conditions or due to sudden physiological abnormality. Hibernating of the tadpoles of *Pelobates fuscus*, *Hyla arborea*, *Bufo vulgaris*, *Rana temporaria* and many others furnish the typical example of partial neoteny. In *Alytes* the brood usually complete their development within autumn. But the larvae which hatched later in the months of July or August usually hibernate and retain their larval features up to the next autumn. In *Rana esculenta* most of the tadpoles remain in the larval stage for one or two years after which they metamorphose. In the partial neoteny, there is a simple retardation of metamorphosis and the larvae do not attain sexual maturity.

TOTAL NEOTENY: - In this category, the animal retains larval characters but become sexually mature. The retaining larval characters are external gills, tailfin, ill developed eyes, ill developed fins on the back and very weak limb. Animals exhibiting total neoteny normally do not metamorphose and remain as sexually mature larvae. The phenomenon of total neoteny can be illustrated by many Urodels like *Necturus*, *Amphiuma*, *Triton*, *Amphystomus*, *Siren*, *Poekilos* etc.

Intermediate stages between partial and total neoteny are also recorded where the larvae become sexually functional and may metamorphose into the

adults with the advent of favourable conditions. e.g. Axolotl larva. The phenomenon of neoteny has been extensively studied in case of *Ambystoma*. The axolotl larva of *Ambystoma* possess 3 pair of bushy external gills, four pair of gill slits, flat long tail. The axolotl larva becomes sexually mature at the age of 6 months.

The cryptobranchoids have semi larval characters at the adult stage. Gill slits are totally absent. Only one ostium or open passage present near the first gill clefts and this gives the water passage in the mouth by which the buccal respiration occurs.

Besides the above mentioned examples Proteles, *Necturus* and other show more or less neoteny in their life span.

### FACTORS FOR NEOTENY

The significance and cause of neoteny in Amphibians have been extensively studied by many zoologists. The following two factors are considered responsible for this unusual phenomenon.

#### 1) External or Extrinsic factor

Extrinsic factors influencing neoteny are abundance of food, surrounding media, temperature etc.

Gradow (1903) considered the cause of retention of larval features in axolotl is the abundance of food and other favourable conditions required in aquatic life. Weismann explained neoteny as case of reversion. His assumption that all the amphibia were originally gill breathing, aquatic and limbless animals and that the larva reflects the ancestral phylogenetic stage is not tenable. Shufeldt holds that deep water and coldness exhibit thyroxine secretion which retards metamorphosis. A/c to Marie von Chaunin physical factors somehow or other retards metamorphosis. The forced and prolonged use of larval gills and tail cause their further development while the growth of limbs and related structure for land life remained retarded if the

animals are reared in water holes so that they could not change from aquatic to terrestrial life. Further, axolotls could be forced to metamorphose when they are slowly accustomed to terrestrial life.

Huxley (1929) showed that larvae exposed to temp. range above 5°C could metamorphose quickly, while exposure to below 5°C failed to metamorphose. In both cases the level of thyroxine concentration was the same.

In spite of all these examples, there is no direct proof of the role of external factors. It is believed that typical neotenic and overgrown specimens frequently occur side by side with metamorphosed adult specimens. So, it can be said that some internal and physiological factors also influence the process of neoteny.

### INTERNAL OR INTRINSIC FACTOR

There are many internal or physiological factors which control the neoteny. Zondeck and Leiter (1923) established <sup>that</sup> the calcium delays metamorphosis in axolotls. Injection of thyroxine or implantation of iodine crystals beneath the skin induce metamorphosis. Cressner (1928) also advanced that insulin hormone inhibits metamorphosis. According to Etkin (1968) level of Prolactin acts as an inhibitor in the overall control of metamorphosis. So remains high all this time. In the light of modern genetics it may be suggested that the structural gene responsible for synthesis of thyroxine are "switched off" by some operator gene whereas the gene responsible for prolactin formation are "switched on". Now, the hypothalamus becomes sensitive to the low conc<sup>n</sup> of thyroxine and secrete thyrotrophic-releasing factor which stimulate secretion of thyroid-stimulating hormone (TSH) which inturn ~~inc~~ increase the secretion of thyroxine. As the level of thyroxine increases, the level of Prolactin suddenly falls. Studies have shown that the thyroxine secreting alveoli of the thyroid glands in neotenic larvae remain in underdeveloped conditions. Even fully developed thyroid glands sometimes fail to secrete adequate amount of

Thyroxine and under such circumstances transplantation of a few more thyroid glands induce metamorphosis.

According to Etkin (1968) the spacing of events during metamorphosis depend on thyroxin-concentration, while the sequence of events is inherent in the larval tissues.

In amphibians development the tadpole larva undergoes progressive metamorphosis, and transforms in adults.

### Genetics of neoteny

The thyroid hormone bind to nuclear receptors that are ~~in~~ in contact with DNA. The hormone helps to change the transcription of genes that also influence to develop the larval characteristics to one, these gradually change into juvenile and adult characteristics. A single gene hypothesis is applicable to control the axolotl's life cycle.

### Significance of neoteny

Weissmann (1875) regarded as a case of atavism which is a phenomenon of reversal to ancestral character. This implies that all amphibians were originally gill breathing aquatic creatures which is not true. External gills of Urodels are now considered to be secondary specialization. Also other larval features of neotenic larva do not represent atavism but are character secondarily acquired for aquatic life.

Noble (1954) pointed out that the retention of larval characters is no way connected with the phylogeny of the amphibians. The great heterogeneity of ~~the~~ perennibranchiate forms which are all neotenic forms 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 neotenic individuals.