

Introduction: Darwinism denotes the type of evolutionary mechanism as organic changes. No doubt, it was largely favoured by many biologists (Wallace, Huxley, Haeckel, Mendel etc.) but was attacked by few scientists eg, Owen, Sedgwick etc. due to following objections (= shortcomings, drawbacks etc):

1. It did not distinguish between heritable (= germinal) and non-heritable (= somatic) variations. It stated that all the variations are heritable, however, the origin and transmission of variations are not explained.
2. It is unable to explain origin of new characters.
3. It did not explain actual process of inheritance.
4. It did not ^{give} any idea about useless variations. It stressed upon small fluctuating variations (principal factor for natural selection). Darwin explained that sports (> saltation variations) or mutations are infrequent and did not provide basis for selection.
5. Darwinism did not recognize intermediates forms (= connecting links).
6. It is unable to explain over specialization of certain structures. eg, Irish Elk has large size of horns. Enormously overgrown and over specialized dinosaurs became extinct, spiral tusk of Jefferson mammoth.
7. It did not explain neutral flowers and sterility of hybrids.
8. Degeneration of organs are not explained.
9. It is too much based on Lamarckism in use and disuse concept (Weismann). It also utilized giraffe.
10. It did not explain effect of use and disuse and presence of vestigial organs eg, ~~that would be the~~ advantages of feathers in a bird and when these were begin to diverge from their reptilian ancestor?
11. It could not explain whether the instinct ^{are} and acquired and modified through natural selection or not.
12. It is unable to explain survival of fittest.
13. It could not explain evolution of land plants from aquatic ones.
14. It believed in blending inheritance.
15. Darwin stated that the parts of body give off pangenes, which are collected in eggs and sperm. The pangenome is responsible for a particular character but the hypothesis of pangenome is untenable.
16. Darwin does not mimicry, though it is of elaborate use in Kalima butterfly.
17. Darwin dealt with quantitative approach of variation but the interspecific variations are qualitative.
18. It is unable to answer the following questions:
 - (a) Why has not the ostrich acquired power of flight?
 - (b) Why some animals have mental power more developed, whereas the development is advantageous or not?
19. How some species, when crossed produce sterile offsprings, whereas when varieties are crossed they produce fertile offsprings?
20. Artificial selection to improve races of domestic plants and animals can never lead to definite permanent specific variations.
21. It appears somewhat absurd that variations tend to infinitesimal degree of preservation.
22. Intraspecific struggle among bees are not explained.
23. Darwin believed that man could produce varieties in changed conditions, habitats and climates.

usually to formulate artificial selection ideas

24. Origin of adaptations and co-adaptations can't be explained by natural selection eg. electric organs of fishes

25. How some structures became rudimentary? Darwin explained that first whale ancestors were hand-capped by hind legs and that any decrease in size which would be enhanced by disuse will be advantageous. It was explained by Weismann in terms of panmixia hypothesis.

26. Special directions are attributed to the subsidiary sexual selection theory, which involves passivity on the part of male, active choice on part of female for more attractive and handsome males.

Later with more recent works, certain ideas were dropped or certain were added and substituted by Dobzhansky, Stebbins, Mayr, Carter, Romanes, Fischer, Sewal, Haldane, Goldschmidt, Wright, Kettlewell, Spencer etc. These scientists are called Neo-Darwinians and the concept is Neo-Darwinism (a Defence of Natural Selection).

Experimental ideas of Neo-Darwinism:

1. Industrial melanism in moth: It is the development of black colour (melanin pigment) by the moth living in the industrial areas to match their body to soot-covered background on the bark of trees. It has been reported in peppered moth (*Biston betularia* or light variety and *B. carbonaria* or dark variety), 70 other species of moths in Great Britain, 100 species of moths in United States etc. It has been discussed by Fisher,

Ford, Kettlewell, Bishop and others.

Researches on industrial melanism reflect the operation of directional natural selection and example of origin of adaptation. The development of dark melanic species of moths

in industrial regions of Western Europe furnishes the most striking example of evolutionary changes.

Before industrialization in Manchester, *B. betularia* was prevalent but *B. carbonaria* was absent in 1845.

In 1910, both the species shared equal proportion but today only *B. carbonaria* is present due to rapid industrialization.

It seems that both the species differ in single Mendelian gene of which dark variety is usually dominant. It is actually the mutant of lighter form caused by deposition of melanin. Cross breeding experiments indicate that the melanic genes follow the Mendelian inheritance. The change in gene, genotype and phenotype frequencies beautifully corresponds to the spreading of industries in Great Britain. Therefore, it may be concluded that nature favours black moths which suits the dark background.

2. Resistance of insects to pesticides: In agriculture, pest are controlled by spraying of pesticides like DDT (Dichloro-diphenyl-trichloroethane). However, DDT cannot bring about 100% deaths in any species of insects. Sassa (1947) first reported that ^{few} *Musca domestica* became resistant to DDT and then about 225 species of insects and other arthropods became resistant.

The resistance is a character controlled by genes and so they reproduce more and more resistant insects. Resistance is specific to one/a group/other pesticides but multiple resistance is also reported. The resistant populations were evolved as a selective advantage against insecticides.

3 Australian rabbits: resistance for virus in 1859: 24 wild rabbits (*Oryctolagus cuniculus*)

1. Resistance of mammals to chemicals: Warfarin (rodenticide) acts on blood as a coumatral and interferes with vitamin K. Warfarin resistant mutant rats were first observed in England. It was observed that resistant rats were replacing ordinary ones. Therefore, struggle has survived under an altered environment.

4. Resistance of bacteria to antibiotics: The effectiveness of Penicillin, Sulphonamide, Streptomycin, etc. is being reduced by the emergence of resistant strains of bacteria. Cavalli and McCaero (1952) proved that *Escherichia coli* develop resistance to Chloramphenicol 250 times as great as that tolerated by normal bacteria by exposure to increased concentration of drug. Lederberg (1952) used replica plating technique with an antibiotic free medium (inoculation plate) and explained that drug resistant mutations arise in bacteria either in presence or absence of drug. The crossing experiments prove that resistance has been inherited on Mendelian principles. It concludes that population can be made to respond adaptively.

5. Heavy metals resistance in plants: Bradshaw et al (1972) have studied that plants are able to grow on soils contaminated with Cu, Zn, Pb etc. Such varieties maintain themselves on soil with concentration of pollutants that are lethal or at least stressful for ordinary members of such species. The resistant and non-resistant varieties meticulously confined to their respective contaminated and uncontaminated soils.

6. ~~Australian rabbit resistance for virus in 1859: 24 wild rabbits (*Oryctolagus cuniculus*) was brought~~

from Europe to Victoria (Australia). In 1859, it was found that rabbits caused extensive damage to sheep grazing pastures and to wheat crop fields. In 1859, along with trapping, poisoning of water-holes, fumigation etc, a virus was inoculated to cause myxomatosis. By 1953, about 95% of rabbits in Australia had been eradicated. Then evolutionary changes occurred in both myxoma virus and rabbit. Fenner (1959) suggested that viruses undergo genetic changes to form less virulent strains of virus by which population of rabbits further increased.

7. Infectious diseases in men: Haldane suggested that some diseases (Tuberculosis, plague, phthisis etc) are agents of natural selection in men. During 16th and 17th centuries, tuberculosis spread with the growth of cities and created havoc throughout the industrial world. It has been established that minute droplets of sputum contain thousands of *Bacillus mycobacterium tuberculosis* which can survive in air for several hours. Even though sputum dried, the bacteria are infective. It was first seen in New York, Philadelphia and Boston in early 1800s, which lowered to 40 per 100,000 population by 1945. It seems that severity of infections has most likely been diminished by genetic selection and has been essentially independent of public health medication.

8. Sickle Cell Anaemia: HbS is responsible for sickle cell anaemia. Homozygous individuals die at an early stage. In heterozygous condition, RBCs containing HbS become sickle shaped and are unable to bind oxygen efficiently but kill parasite (say *Plasmodium*) effectively. Therefore, heterozygous individual becomes sickle-shaped Hb cope up with malarial infection much better than HbA.

These examples represent differential (directional) selection.

9. Differential mortality in babies: According to Kahn and Penrose, birth weights of newborns provide an example of a human character subjected to stabilizing selection. The optimum birth weight is 7.3 pounds. Newborns infants < 5.5 and > 10 pounds have the highest probability of mortality.
10. Differential mortality in sparrows: Bumpus brought 136 stunned English sparrows under the exposure of severe snow, rain and sleet storm into his laboratory at Brown University. Of these, 64 birds died and 72 revived. He measured the weight and length of body, wings, head and beak of all the dead and living birds and concluded that death was due to deviation in length and weight of sparrows.
11. Differential appearance of colour in moths: Ford raised pale wings as an abnormal character in Pan-
xia dominula (red checker moth) by artificial selection. These moths were true breeding for pale wings but they contained genes for normal wings. These moths were released in an area where none of this species existed. After 5 years, descendants produced a population of normal wings to show stabilizing selection.
12. Differential mortality of starlings: David Lack observed that optimum and modal number of eggs in the nest of starlings is 5. He reported that higher mortality occurs in the nests where there were > 5 fledglings. The mortality was probably due to poor nutrition when there was more fledglings. It seems that optimum number of nestlings was always maintained even though the reproductive activity was greater.

These examples represent stabilizing (= Normalising) selection.

13. Dispersive selection in butterfly: The males of Papilio dardanus (African swallowtail butterfly) have yellow and black wings with tails. They resemble the similar animals of US. The females do not have tails. This cue characterized by mimicry obtained by females only in different ways. They mimic distasteful species of butterfly and is associated with adaptive value of protection during the period when female is laying eggs.
14. Weldon's experiment on shore crab (Callinectes mearnsi): Weldon laid a large breakwater in the mouth of river Plymouth sound to slow down rate of water flow. It results in deposition of silt which causes death of crabs. He analysed that living crabs were provided with narrow carapace and the dead ones with broad carapace.
- It shows that changed environment produces minute changes and natural selection operates in changed environment to select narrow carapaced crabs with little deposition of silt.
15. Davenport's experiment on chicks: Davenport painted chicks with black, grey, white along with bars on some and allowed to wander freely in the field. He observed that most of the chicks except bars were captured and killed by hawks, kites, etc. It was probably due to colour of bars merges with the surroundings and nature selects animals with favourable characters.