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Genetic Adaptation of Caenorhabditis elegans (Nematoda) to High Temperatures

Abstract. *When taken directly from a strain kept for several years at 18°C in the laboratory,* Caenorhabditis elegans *cannot reproduce indefinitely at temperatures higher than 22°C. By progressive and very slow increments of the breeding temperature, a strain fecund at 24.5°C was obtained.*

Caenorhabditis elegans is a species consisting almost entirely of hermaphroditic, self-fertilizing individuals (about one male out of 1000 hermaphrodites). Its fecundity is easy to measure when the nematodes are raised individually on a special agar medium (*1*). At 18°C, the strain Bergerac (*2*) studied shows an average fecundity of 141 offspring per hermaphrodite.

When an embryo grown at 18°C is transferred to growing conditions at 24.5°C, the embryo develops into a sterile adult whose morphology is apparently normal. When the growth conditions are changed from 18° to 23°C, the resulting adult has a very low fecundity. If the succeeding generations are kept at 23°C, fecundity decreases, and complete sterility is reached with the fifth or sixth generation. Thus there exists between normal (around 20°C) and immediately sterilizing (above 24°C) temperatures a range that leads to the extinction of the strain within a few generations.

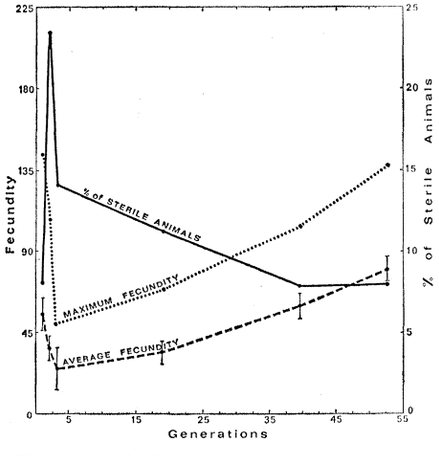

Fig. 1. Evolution of fecundity and sterility for successive generations of *C. elegans* after transfer from 18° to 22°C. Each point is the average of three experiments.

When the nematodes were transferred from 18° to 22°C, fecundity dropped during the first few generations to a minimum and then gradually increased (Fig. 1). Hence it appears that a strain perfectly adapted to 22°C has been obtained.

Attempts to obtain a new strain at 23°C depend upon the time of transfer of the nematodes from 22° to 23°C. Transfers made up to approximately the 90th generation yielded results already noted: fecundity decreased to zero over several generations. However, transfers made starting with the 95th generation showed fecundity that decreased to a minimum and rose afterward. Thus a strain, stable at 23°C, was obtained.

If animals that were stable at 23°C were transferred to 23.5°C, similar results were obtained: adaptation to the new temperature occurred if the transfer was made within or after the 252nd generation.

Further, by successive increments of 0.5°C, a permanently fertile strain was finally obtained at 24.5°C (Fig. 2). This strain is radically different from the initial strain grown at 18°C, which, when directly transferred to 24.5°C, becomes immediately and irreversibly sterile.

Cytological study of gametogenesis showed that sterility of the nematodes transferred to high temperature came from an abnormal oogenesis similar to that produced by thermal shocks (*3*). Hence, the adapted animals had undergone a change of ovarian physiology that permitted normal gametogenesis.

The gradual changes in fecundity and the apparently repetitive process at each stage of adaptation suggest that the corresponding genetic modifications occur in successive steps of small degree over the generations studied. Since *C. elegans* is self-fertilizing, selection in a highly heterozygous state presumably cannot be exploited to achieve a progressive adaptation. Comprehensive observations

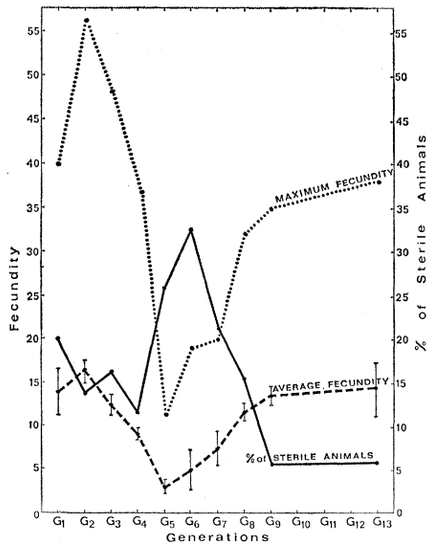

Fig. 2. Evolution of fecundity and sterility for successive generations of *C. elegans* after transfer from 24° to 24.5°C.

(*4*) support the assumption that adaptive transmissible cytoplasmic states are produced gradually and are responsible for the production of fertile high-temperature strains.

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Antibodies in Gastric Juice

Abstract. *The presence in gastric juice of specific antibody has been demonstrated. It is mainly an IgG antibody reacting with the cytoplasm of gastric cells; it has been detected in patients with atrophic gastritis, with or without pernicious anemia, whose serums contain antibodies to parietal-cell cytoplasm. Evidence is presented that associated circulating antibody to cytoplasm of thyroid acinar cell does not appear in the gastric juice.*

There is a growing body of evidence that, in man, immunoglobulins are normal components of various secretions, such as tears, saliva, colostrum