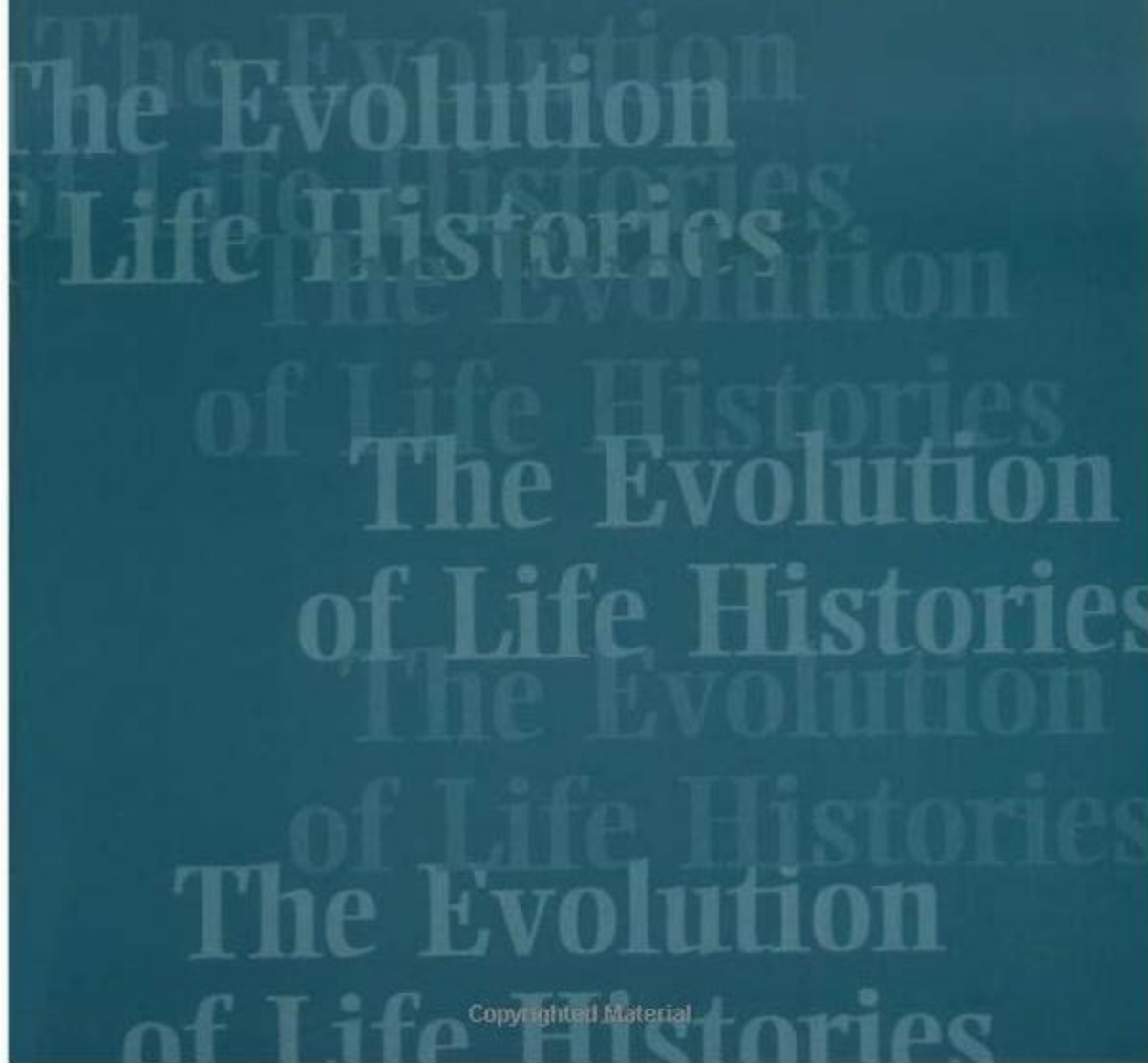


# The Evolution of Life Histories

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## PROLOGUE

### THE FOREST

In a forest just south of the Rhine, old and dense with oak and beech, a tree falls in an equinoctial storm. A beech seed germinates in the clearing left by the falling tree. It grows rapidly, escapes the

attention of slugs during its first summer, overtops the competing grasses and shrubs, and pushes its crown into the narrowing circle of sky overhead. As its branches near the canopy, it begins to



flower. It is 50 years old. Its growth then decelerates until, at more than 200 years of age, when it is two metres thick at breast height and fifty metres tall, further growth is no longer measurable. Every few years, it flowers heavily and sets abundant seed. Much is eaten by flocks of wintering bramblings. Some is scattered by winter storms. The seeds drop in various directions, more near the tree, a few at some distance. In the 154th year of its life, its pollen enters an ovule on a beech half a kilometre away whose seed survives to flower. In the 268th year of its life, a hornbeam falls about 80 metres away. One seed sprouts in the clearing and starts its climb to the canopy. Of the millions of seeds that the tree produces, only this one will survive to flower. It has produced two offspring that survived to reproduce, one through pollen, one through seed.

As the tree thickens with age, its grey bark wrinkles like the baggy skin of an elephant. It continues to flower and set seed in most years, but all the seeds and seedlings die, eaten by birds, rotted by fungi, nibbled by slugs, grazed by rabbits and deer. Overshadowed by younger competitors, ageing, it flowers less and fails to repair wounds and resist the fungi that have been evolving within it. For centuries it has been shedding its shaded lower branches, leaving a clear column 10 metres to the lowest limb, but now even its trunk and main branches are invaded by beetle larvae and mould. Woodpeckers visit it frequently. In its 316th year it falls in a storm. An oak seedling invades its space. Eighty metres away, its offspring begins to flower. Half a kilometre distant, the tree produced from its pollen is into its second century of reproduction.

### THE REEF

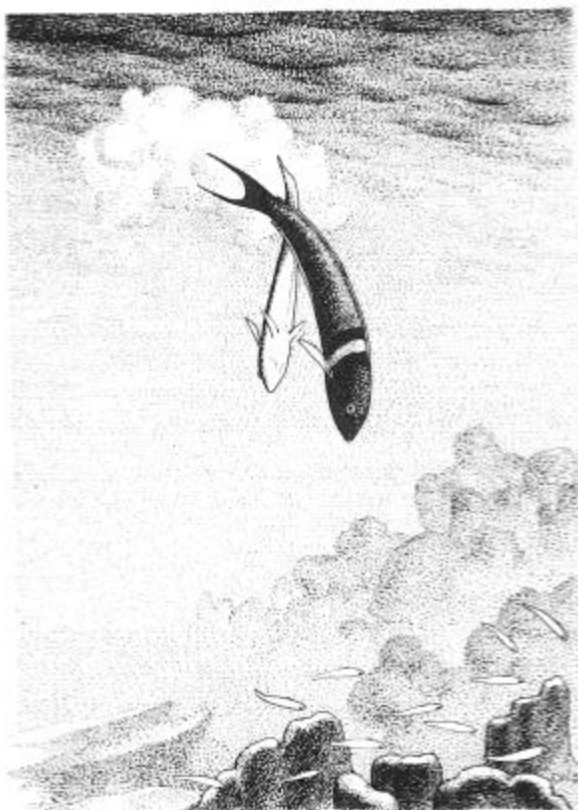
Every afternoon, the male blue-headed wrasse swims to the down-current edge of the patch reef. His harem of females, smaller, dull by comparison, move with him, holding position in the current pushing them out from the Panamanian shore. The male couples with each of the females in succession. A cloud of eggs and sperm drifts into deep water. Some fall on to the edge of the reef and are eaten by corals, hydroids, bryozoans, and polychaetes. The reef is a carpet of open mouths.

Before dawn, the surviving eggs reach their third cleavage, but small predators feast on the developing embryos. In deep water and turning in a huge eddy, the survivors hatch as larvae. Some are pursued and eaten by small fish. The others feed on tiny crustaceans as they are carried back towards the coast. A few, just a centimetre long, make it to shallow water. They reach the reef kilometres apart, separated by the vagaries of the sea. One arrives at a small reef on which a single male blue-headed wrasse lives with a harem of three females. The fingerling grows, feeding on plankton, picking small crustaceans and worms out of the coral, and reaches maturity as a female when it is one year old and ten centimetres long. It mates as a female until, when it is three years

old, it is the largest surviving female on the reef. One evening the male is eaten by a fish. Within 24 hours the female has acquired the blue head and swollen testes of a male. Its ovaries shrink. The next day it mates for the first time as a male.

Another larva settles on a reef too large to be defended by a single male. Instead of holding to territories, the wrasses forage freely across the face of the reef. The fingerling grows, feeds, and reaches maturity as a small, dull male when it is one year old and ten centimetres long. It looks like a female. Every evening it moves to the downstream side of the reef, and when a large blue-headed male begins to mate with a female, it darts in and releases its sperm into the spawn. Some fertilize eggs that survive to reproduce. Over the course of its life, the small, dull male manages to sneak into enough spawnings to produce about as many surviving offspring as do the few large blue-headed males on the reef, all of which spent their first several years as females.

On small reefs where territories can be defended and females can be guarded, few young fish mature as small, dull males. On large reefs where large males cannot control territories or harems, many young fish mature as small, dull males and never change sex. Ocean currents are capricious, and



there is no guarantee that a young fish will arrive on a reef of a certain type. None the less, they develop into the adult form that is appropriate

for the reef at which they arrive. There is some limited opportunity to change reefs after settling.

### THE PLUM

Pushed by a gust of wind, a plum falls to the ground and splits. Into a few drops of juice that enter the cleft, yeast cells topple from the plum's skin. Bacteria float in. The yeast and bacteria multiply. Within an hour, the first faint odours of ethanol waft out, and soon a female fruit fly lands. She walks back and forth along the cleft, pausing frequently to probe with her mouth parts, then lays nine eggs in an irregular row and departs. Many other females visit the plum.

The pearly eggs, driven into the flesh of the fruit by ovipositors, gleam in the light reflected from the ground. The two filaments with which each

egg breathes stick like arms into the air. A black ground beetle stumbles into the plum and probes along the cleft, eating every egg it touches. A day later, the remaining eggs begin to hatch. The larvae wander for a few hours over the rotting plum, following concentrations of bacteria and yeast. As they grow, they shed their tough skin and expand into the soft membranes beneath. More females visit the cleft. Large flies and beetles suck the fermenting brew. The population of larvae near the cleft grows dense, but the first-laid larvae move on. On the lower side of the fruit, a fungal mycelium invades, feeding on the juices,