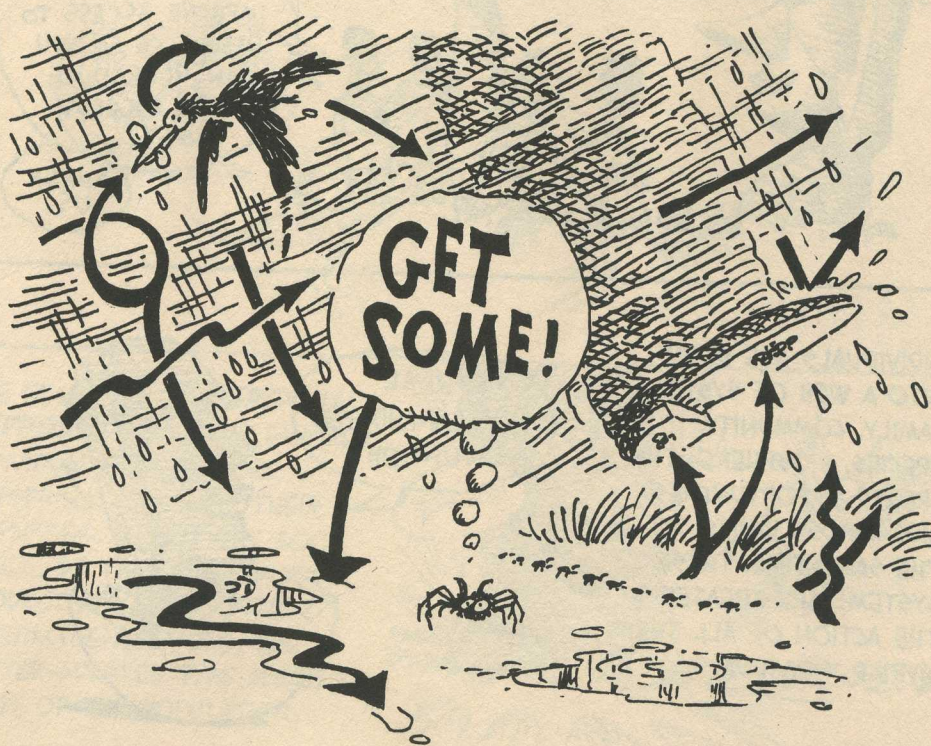


CHAPTER 3

EVOLVING SYSTEMS, STRUGGLING INDIVIDUALS

UNDER THE INFLUENCE OF LIFE, THE EARTH'S CHEMICAL CYCLES WERE CREATED, MODIFIED, AND MAINTAINED OVER THE EONS. COMPLEX WEBS OF ORGANISMS MOVE PRECIOUS TRACE ELEMENTS AROUND. SOME HAVE EVEN ARGUED THAT THE EARTH BEHAVES LIKE A GIANT LIVING THING, REGULATING CHEMICAL CYCLES TO ITS OWN ADVANTAGE.

AT LEAST, THAT'S HOW IT LOOKS FROM A DISTANCE, WHEN BIO-, GEO-, AND HYDROCHEMICAL CYCLES ARE VIEWED AS **SYSTEMS**. FROM THE STANDPOINT OF THE **INDIVIDUAL ORGANISM**, HOWEVER, THINGS LOOK A LITTLE DIFFERENT. BORN INTO THIS VAST FLUX OF CYCLING CHEMICAL RESOURCES, THE INDIVIDUAL HAS A SIMPLER, MORE SELFISH GOAL:

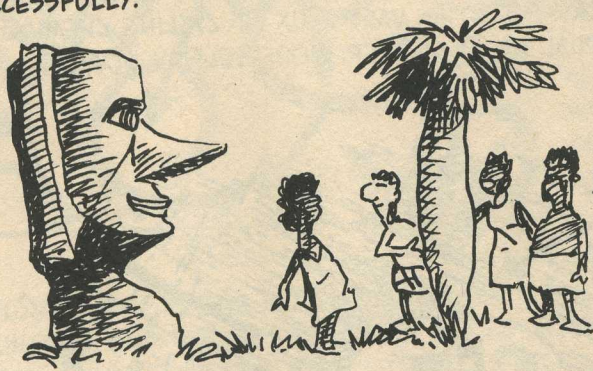


THE INDIVIDUAL ORGANISM STRIVES TO EAT AND AVOID BEING EATEN LONG ENOUGH TO REPRODUCE SUCCESSFULLY (I.E., SO THE OFFSPRING SURVIVE).

WELL, IT'S A START, ISN'T IT?



ALTHOUGH THE INDIVIDUAL IS PART OF THE SYSTEM, THE INDIVIDUAL'S NEEDS ARE NOT NECESSARILY THE SAME AS THE SYSTEM'S NEEDS. FOR EXAMPLE, AN EASTER ISLANDER NEEDED ONLY ONE TREE AT A TIME FOR FUEL OR BUILDING MATERIAL, WHILE THE SOCIAL SYSTEM NEEDED A FOREST TO RUN SUCCESSFULLY.

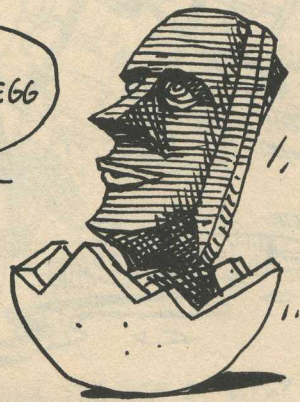


AGAIN: WE SET UP STATUES TO INCREASE CLAN PRESTIGE TO IMPROVE ACCESS TO RESOURCES SO YOU CAN REPRODUCE MORE SUCCESSFULLY.

THANK US.

INDIVIDUALS ARE BORN INTO A WEB OF SYSTEMS—FAMILY, COMMUNITY, SPECIES, BIOSPHERE—THAT CREATE OPPORTUNITIES AND IMPOSE LIMITS. AT THE SAME TIME, THESE SYSTEMS ARE CREATED BY THE ACTION OF ALL THEIR MYRIAD INDIVIDUALS.

A REAL CHICKEN-AND-EGG SITUATION!



IN THE INTERPLAY OF INDIVIDUAL AND SYSTEM,
EVOLUTION TAKES PLACE.

INDIVIDUALS COMPETE WITH EACH OTHER FOR RESOURCES. EVERY CREATURE TRIES TO SUSTAIN ITS OWN LIFE LONG ENOUGH TO REPRODUCE, AND IF THAT MEANS SOMEBODY ELSE GOES HUNGRY, TOO BAD!



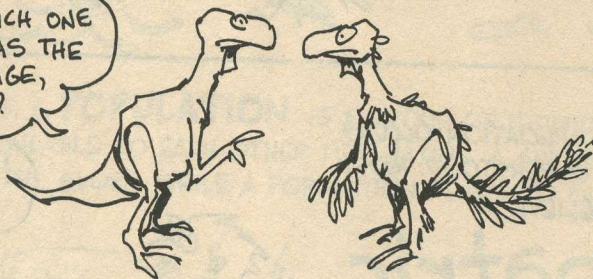
TIGER SALAMANDER
LARVA EATING ITS
COMPETITOR

THAT IS SO
ENVIABLE.

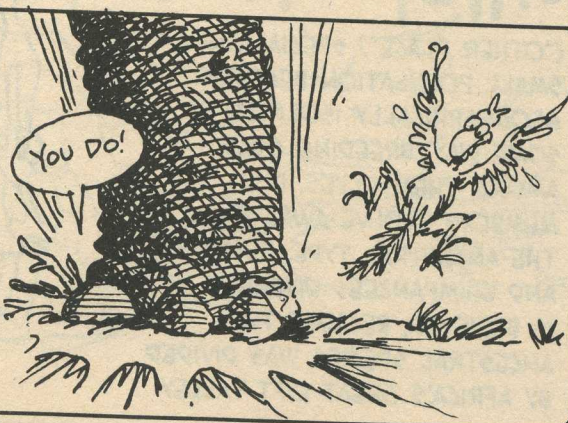
THIS DOESN'T MEAN THAT
CREATURES DON'T COOPERATE
ALSO! SOMETIMES COOPER-
ATING WITH OTHERS IS THE
MOST EFFECTIVE WAY TO
SURVIVE.

NOT ALL INDIVIDUALS ARE ALIKE: EACH ONE HAS A SLIGHTLY DIFFERENT COMBI-
NATION OF GENETIC TRAITS, AND SOME OF THESE COMBINATIONS GIVE THEIR
OWNERS A **SELECTIVE ADVANTAGE**: THE LUCKY ORGANISM IS BETTER ABLE TO
GET FOOD, EVADE PREDATORS, WITHSTAND HEAT AND COLD, REPRODUCE, ETC.

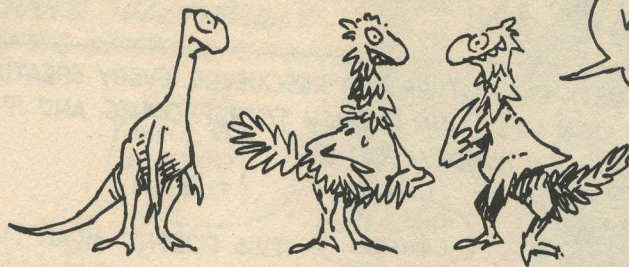
AND WHICH ONE
OF US HAS THE
ADVANTAGE,
COUSIN?



THE RESULT IS **DIFFERENTIAL REPRODUCTION**: THE FAVORED INDIVIDUALS BREED MORE OFFSPRING... SOME OF THEIR OFFSPRING INHERIT THE GOOD GENES, SO THEY BREED MORE PRODUCTIVELY TOO. AFTER SEVERAL GENERATIONS, THE BETTER-ADAPTED TYPE MAKES UP MOST OF THE POPULATION.



SOMETIMES THE DESCENDANTS WILL EVOLVE INTO AN ENTIRELY NEW SPECIES.



GOOD NEWS!
WE'RE EVOLVING
INTO CHICKENS!

WHAT IS A SPECIES? GENERALLY SPEAKING, A SPECIES CONSISTS OF ORGANISMS THAT CAN MATE WITH EACH OTHER... BUT THE DEFINITION IS SOMEWHAT FUZZY, BECAUSE SOME ORGANISMS CAN MATE ACROSS SPECIES, AND WHEN YOU START TALKING ABOUT ORGANISMS LIKE BACTERIA, OTHER CRITERIA MUST BE FOUND.



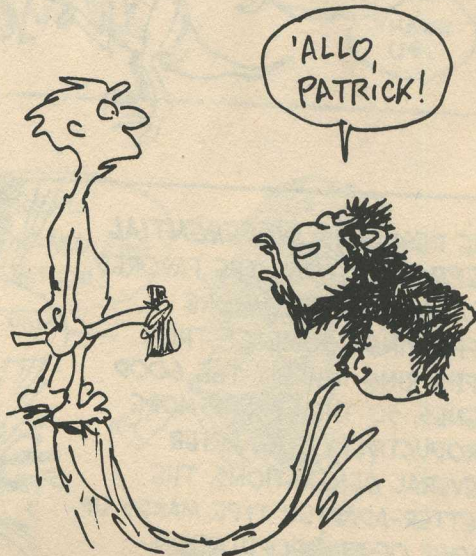
SORRY... BUT
YOU KNOW WHAT
THEY SAY ABOUT
"BIRDS OF A
FEATHER..."

NO
PROBLEM.

EXACTLY HOW SPECIATION OCCURS IS NOT WELL UNDERSTOOD. MOST BIOLOGISTS BELIEVE IN

allopatric

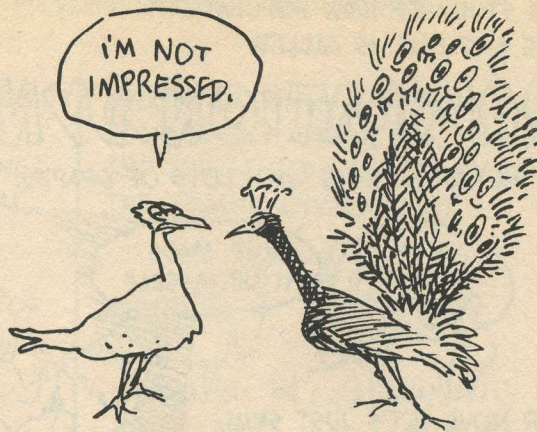
("OTHER PLACE") SPECIATION: A SMALL POPULATION BECOMES GEOGRAPHICALLY ISOLATED IN SOME WAY. BREEDING ONLY AMONG THEMSELVES, ITS MEMBERS EVOLVE AWAY FROM THE ANCESTRAL TYPE. HUMANS AND CHIMPANZEES DIVERGED, IT IS BELIEVED, BECAUSE THE ANCESTRAL SPECIES WAS DIVIDED BY AFRICA'S GREAT RIFT VALLEY.



'ALLO,
PATRICK!

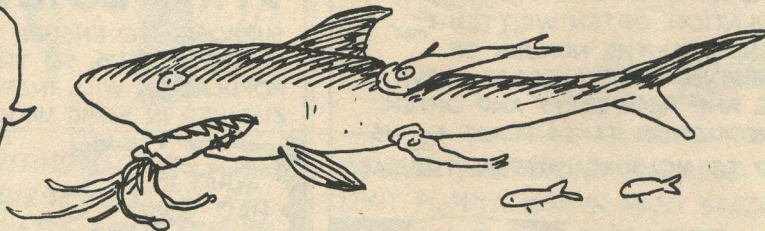
Sympatric

("SAME PLACE") SPECIATION CAN INVOLVE **SEASONAL** OR **HABITAT ISOLATION**—POTENTIAL MATES AREN'T IN THE SAME PLACE AT THE SAME TIME—OR **BEHAVIORAL ISOLATION**, FOR EXAMPLE, WHEN A COURTSHIP RITUAL DEVELOPS THAT APPEALS TO SOME BUT NOT TO ALL.



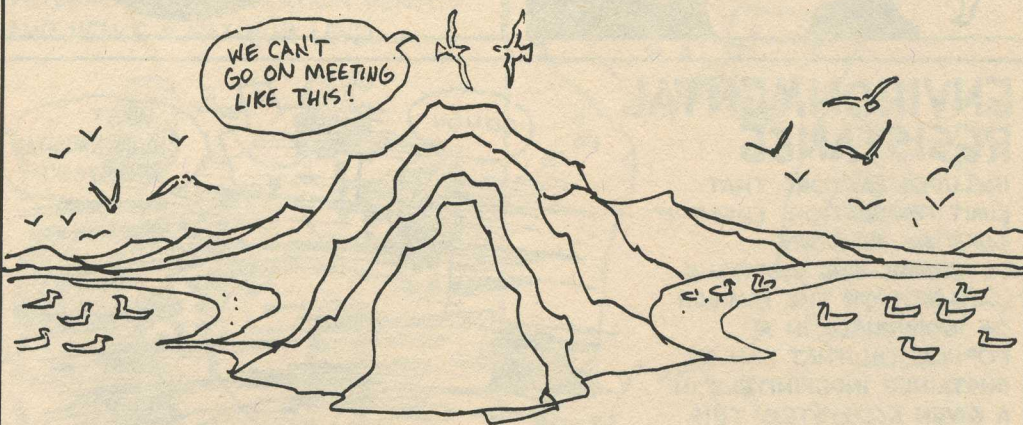
IN ONE WAY OR ANOTHER, THE WORLD IS DIVIDED INTO MILLIONS OF SPECIES.

NOBODY KNOWS EXACTLY HOW MANY!



WITHIN A SPECIES, A **POPULATION** IS A GROUP OF INDIVIDUALS THAT ARE ACTUALLY AVAILABLE TO EACH OTHER FOR MATING. A SPECIES MAY BE SPREAD ACROSS THE GLOBE, WHILE A POPULATION TENDS TO CLUSTER TOGETHER.*

WE CAN'T GO ON MEETING LIKE THIS!



*EXCEPTIONS, AS ALWAYS, EXIST!