Simulations of Natural Selection

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Natural-selection simulation games have been used in a variety of ways in elementary schools (Klimas, 1969) and secondary schools (Kuhn, 1969). The present model includes color-matching by prey (crypsis), morphologic adaptation to habitat (beak length vs. prey size), flock vs. individual feeding success, and the concept of carrying capacity of the environment. This has been successfully used in a college and a secondary school and with modification could be used in elementary schools.

Concealing Coloration

The class is divided into two equal groups, each including a person who acts as recorder. The group is taken to a preselected habitat, which consists of two large lawns or weedy fields. Each group walks onto one of the lawns or fields. The students close their eyes while 100 red and 100 green toothpicks (cocktail or food-color-dyed) are scattered at random in each of the habitats. (This can be done before class.) The toothpicks represent insect prey. The students then open their eyes. Pretending to be birds, they collect as many of the toothpick prey as possible in a 30-second trial. (Size of plots and amount of time spent feeding can be varied, with interesting results.) They close their eyes again, and the recorder tallies and collects the toothpicks from each person. The trials are repeated until each group has collected most of the 200 toothpick prey. The red toothpicks are very obvious and are picked up rapidly, but eight or more trials may be required to find all of the green toothpicks. This agrees with and supports the findings of Kettlewell (1959) on the selective advantage of habitat-matching in moths.

The class is next taken to a brown dirt habitat, where 200 red and green toothpicks are distributed and the hunt for them is repeated. Both colors of prey (toothpicks) are easily seen here and are selected against by the birds (students); usually fewer than four trials are needed to collect most of the toothpicks.

Morphologic Adaptation

To show morphologic adaptation within a habitat, beak length in birds as seen in the Galápagos Islands finches (Lack, 1953) can be easily investigated. The two groups are taken to the grassy or weedy plots as before. Half of each group is provided with kitchen tongs or long forceps: these students are the long-beaked birds. The other half of each group is asked to pick up prey with only one hand: they are the short-beaked birds. Wooden matches are scattered over the two plots—long-stemmed matches on one plot and short-stemmed matches on the other. In either case the matches are to be picked up with the hand or tongs and transferred to the other hand, for holding. The data show the disadvantage of using tongs (long beaks) to pick up the short-stemmed matches (small prey) but not the long-stemmed matches (larger prey).

Feeding Efficiency

Flock vs. individual feeding efficiency can be studied by using 200 green matches on the grassy plots. Half the class "feeds" as individuals; the other half feeds as a flock or herd, each student remaining

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Fig. 1. Data sheet (abbreviated) used by a recorder.

Condition:	Bird no.	Trials and prey type 1		2		3		4		5		6		7	
Grass		*R*	*G*	*R*	*G*	*R*	*G*	*R*	*G*	*R*	*G*	*R*	*G*	*R*	*G*
	1	12	14	7	8	7	3	1	1	0	2	0	0		
	2	9	4	8	5	5	4	0	2	0	1	0	1		
	3	5	2	6	5	3	1	3	1	0	1	0	1		
	4	4	4	3	4	2	3	0	2	0	0	0	0		
	5	4	5	5	3	1	2	0	0	0	0	0	0		
	6	7	6	3	6	1	4	4	4	0	1	0	0		
	Sum	41	35	32	31	19	17	8	10	0	5	0	2		
	Cum f	41	35	73	66	92	83	100	98	—	98	—	100		

within 30 cm of his neighbor. The flock or herd usually will collect more food items, because of its greater efficiency in finding prey in a restricted locality, its cooperative strategy in hunting, and its social facilitation, as was noted by Etkin (1967) in both mammals and birds.

The effect of injury on feeding efficiency can be studied by using 100 red toothpicks on the green plot. In one group the students cover one eye with a hand, simulating an eye injury; in the other group the students simply place the unused hand on top of the head. The data usually show higher efficiency in the binocular birds than in the injured, monocular birds. The role of injury and illness in decreasing the chances of survival is well known for both individuals and groups of animals; for example, Washburn and DeVore (1961) noted this in baboon troops.

Carrying Capacity

Carrying capacity can be illustrated on two grassy plots of equal size. Scatter 200 toothpicks on each plot. Start with only six people (birds) to a plot. After each trial, while the number of prey items captured is being tallied, cast 26 new toothpicks onto the plot selected for prey growth. The birds on the other plot, which has no prey growth, are soon observed to "starve"; but the competition for prey becomes rigorous on the plot with prey growth. The model can be amplified and altered by changing the numbers of birds on each plot. Data can be suggested to the class for consideration. For example, a species of longspur, which is a tundra bird, requires three prey items every 15 minutes for eight hours every day, on average (Custer, 1971). According to Welty (1962) the European blackbird (a thrush) requires 7.3% of its body weight in food daily; for most birds the figure is 3% to 30%. Data from the Tasmanian sheep populations (Davidson, 1938; Caughley, 1970) can be used to illustrate growth to a fixed value that represents the carrying capacity of the range. Overpopulation and crashes can be illustrated by using data from the Kiabab Plateau population of mule deer, as presented by Caughley (1970).

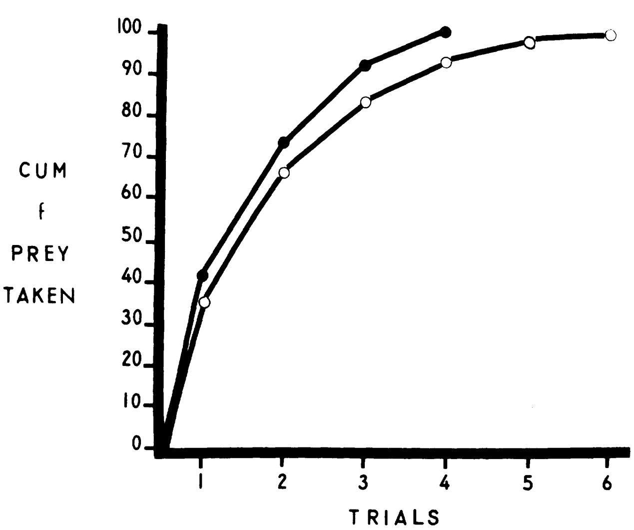

Fig. 2. Capture of red and green prey in a green grass habitat.

Instructional Use of Data

Fig. 1 is a data sheet (abbreviated) used by one of the recorders. The data can be cumulated and graphed after the recorder returns to the laboratory. A graph could show the cumulative number of prey removed from the habitat under a given condition of predation (fig. 2), or it could show the number of prey remaining in the habitat per trial. The first graph would show the number of prey removed under the two conditions; the latter would show the number of prey still to be removed from the habitat. The students can also tally the data for each individual and then rank the birds as to their efficiency in each habitat: Usually they will discover that a bird is more efficient in one habitat than in another. Data on sex can also be tallied: usually males will have collected more prey items than most of the females.

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ANCIENT ALGAE HOLD SECRETS

Fossil evidence that blue-green algae much like those that exist today existed as much as two billion years ago has been found on a knoll near Eveleth, Minn. Blue-green algae are among the world's most primitive organisms; they are not much more advanced than the most primitive bacteria. Yet the Eveleth samples appear to be very similar to the blue-green algae that help clog today's eutrophying ponds. They are among the world's earliest identifiable life forms, and the Minnesota fossils, says Preston Cloud, a biogeologist at the University of California at Santa Barbara, are the oldest demonstrable examples yet found.

He said the Minnesota fossils appear to be "slightly older—probably not more than a few million or tens of millions of years," than the famous Gunflint microfossils from the north shore of Lake Superior, the oldest that could up to now be confidently identified.

"But the real significance is not the age," said Cloud, whose research is supported by the National Science Foundation and the National Aeronautics and Space Administration. "They are not all that much older than the Gunflint fossils." In contrast with the Gunflint microfossils, the fact that they are readily separable from the rock deposits in which they occur permits a comparison with living organisms with a precision and detail not heretofore possible.

If, thanks to fine detail like that seen in these fossils from the Pokegama strata in Minnesota, evolutionary changes can be detected in blue-green algae, he suggests, then perhaps they can be used to identify the relative ages of strata in which they are found.

Older microfossils have been reported; they go back some 3.2 billion years or more. But Cloud feels that those are still open to scientific question; the Pokegama and Gunflint fossils, he said, are the oldest ones that can be called relics of early life with 100% certainty.

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