PH.D. PROGRAM IN BIOLOGY - THE CITY UNIVERSITY OF NEW YORK
FIRST EXAMINATION - ECOLOGY, EVOLTUTTIONARY BIOLOGY AND BEHAVIOR
FALL 1988

Session I. Short factual questions. Answer 10 of the following 16 questions. One paragraph should be sufficient to answer each. Be sure to define and explain.

1. What is a synapomorphy?
2. What is meant by the term punctuated equilibrium?
3. What is altruism? ... what is reciprocal altruism?
4. What is parsimony ?
5. What are sibling species?
6. What is adaptive radiation?
7. What is the founder effect?
8. Explain r- and K-selection.
9. What is a fixed action pattern?
10. What is an outqroup?
11. What is an isolating mechanism?
12. What is a pheromone?
13. What is an innate releasing mechanism—
14. What is meant by eutrophication?
15. Distinguish between the fundamental and realized niche.
16. Why are the lengths of food chains limited?

PH.D. PROGRAM IN BIOLOGY - THE CITY UNIVERSITY OF NEW YORK FIRST EXAMINATION ECOLOGY, EVOLUTIONARY BIOLOGY AND BEHAVIOR FALL 1988

Session II. Longer factual essays. Answer two questions. -

1. Explain what would be required to show that coevolution has occurred between two or more organisms.

2. Discuss the significant differences among the concepts of sympatric, allopatric, parapatric and reductive (hybridization) speciation, giving examples to illustrate your ideas. 1

3. A biological community often is considered to represent the culmination of thousands of years of species interactions resulting in a finely-tuned, stable assemblage of taxa. Such equilibrium communities can be modelled by Lotka-Volterra and other equilibrium models, which lead to predictions regarding community structure, niche relationships etc. Is this a reasonable view of natural communities? Explain, citing field and laboratory studies where appropriate.

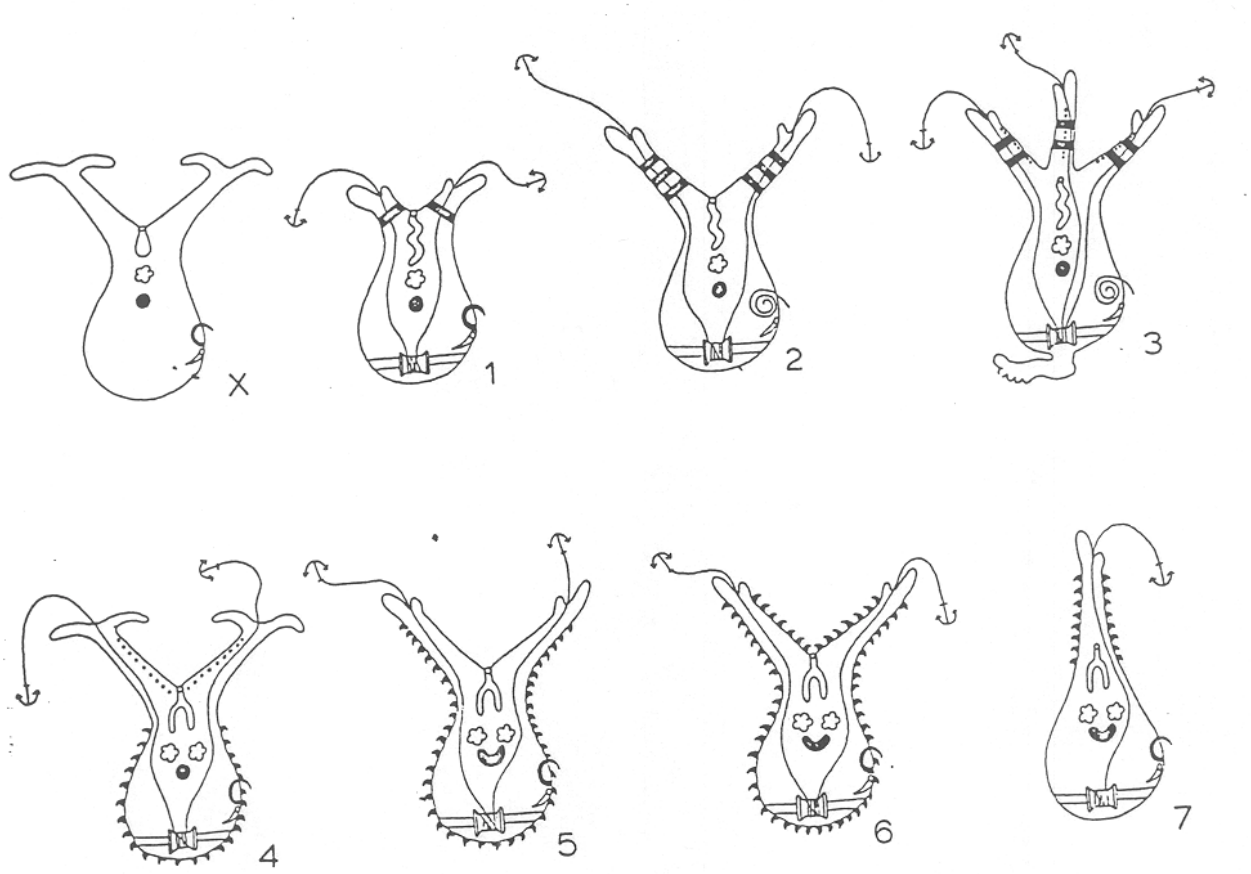
4. Define monogamy and polygyny. Discuss the physiological and ecological factors which are thought to underly the evolution of these two types of mating systems. Give specific examples.

5. Discuss the potential contributions and limitations of the practice of using developmental data to address macroevolutionary problems.

PH.D. PROGRAM IN BT.OLC-GY - THE CITY UNIVERSITY OF NEW YORK FIRST EXAMINATION - ECOLOGY, EVOLUTIONARY BIOLOGY AND BEHAVIOR
FALL 1988

Session III. Data analysis. Answer one question

1. With reference to the organisms shown below, how would you classify these organisms, assuming that organism X represents the outgroup of organisms 1-7? Why do you think that your proposed classification is superior to alternate ones?



Session III Con't.

2. In a recent paper by Ri chardson and Verbeek (1986) based on research in British Columbia, crows were shown to feed extensively on clams (*Venerupis* spp.) which the birds dig from the intertidal beach. Figures 1-4 and Table 1 (next page) show some of the data. Discuss these data within the framework of optimality models or optimal diet theory.

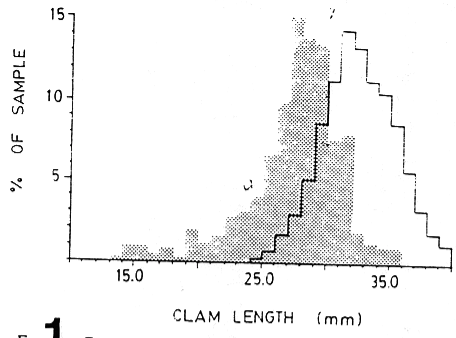


FIG. 1. Comparison of the size frequency distributions of 3265 clams eaten by crows on Mitlenatch Island (open histogram) and 514 extracted from the beach but then rejected (shaded histogram).

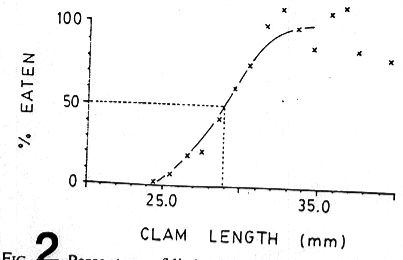


FIG. 2. Percentage of littleneck clams between 10.0 and 42.0 mm long which were eaten when encountered by foraging crows.

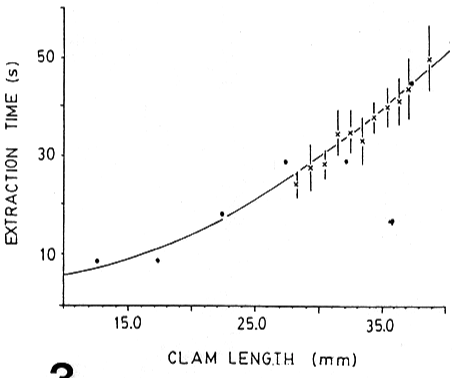


FIG. 3. Mean time required (±SE) for crows to extract the meat from broken clam shells while feeding on the beach (×) and at the feeding tables (○), as a function of clam length.

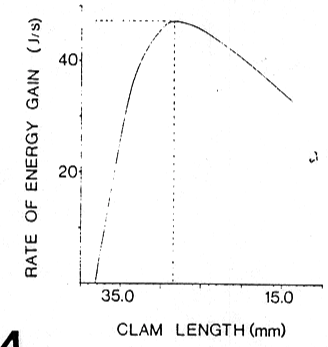


FIG. 4. Mean rate of net energy gain per capture, as a function of diet breadth expressed as the length of the smallest clams included in the diet. The dotted line indicates the maximum rate of energy intake (47.0 J/s) obtained by feeding on clams larger than 28.5 mm. Note reversed abscissa scale.

TABLE 1. Summary of the mean times (±1 SE) and energy costs of activities performed by crows on Mitlenatch Island in finding and eating littleneck clams.

Activity	*N*	Time (s)	Energy (J)†
Searching (TS_v)	186	34.6 ± 4.09	485 (4 × BMR)
Flight to first drop	80	4.2 ± 0.64	134 (9 × BMR)
Between drops*	95	5.5 ± 0.55	43 (2 × BMR)
Second drop*	96	2.0 ± 0.24	70 (9 × BMR)
Extraction (E_i)	$E_i = 0.13$ (clam length)$^{1.58}$		(2 × BMR)
Return flight	100	3.6 ± 0.27	115 (9 × BMR)

* Energy costs based on 1.71 drops per clam.
† Figures in parentheses show the scalar value of BMR (basal metabolic rate) used to calculate energy costs.

Session III Con't.

3. Using the data presented in the following table, (a) construct a phylogenetic tree showing the relationships among the seven species; (b) explain the reasoning used in constructing your phylogeny; and (c) discuss the limitations of using these kinds of data in phylogenetic reconstruction.

DISTANCE VALUES AMONG PRIMATES DETERMINED FROM DNA-DNA HYBRIDIZATION

	Human	Pigmy Chimpanzee	Common Chimpanzee	Gorilla	Orangutan	White-handed Gibbon
Pigmy Chimpanzee	1.9					
Common Chimpanzee	1.8	0.7				
Gorilla	2.4	2.3	2.1			
Orangutan	3.6	3.7	3.7	3.8		
White-handed Gibbon	5.2	5.6	5.1	5.4	5.1	
Cercopithecid Monkeys	7.7	8.0	7.7	7.5	7.6	7.4

These data were originally published by Sibley and Ahlquist (1984) and have been cited in Futuyma (Futuyma, D., 1986. Evolutionary Biology, 2nd edit., Sinauer). Each value is the average delta T_{50} H for a number of comparisons among individual organsisms. Delta T_{50} H is the depression in the temperature (degrees C) required to achieve 50 percent dissociation of hybrid DNA duplexes, relative to the temperature required to achieve this for native (single- species) DNA. Most of the DNA in these tests were single-copy. Sibley and Ahlquist present standard errors (ranging from 0.05 to 0.2) for these mean values. The variance is ascribed to experimental error.

PH.D. FROGRAM IN BIOLOGY - THE CITY UNIVERISITY OF. NEW YORK FIRST EXAMINATION - ECOLOGY, EVOLUTIONARY BIOLOGY AND BEHAVIOR
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Research proposal.
Choose one of the following topic areas for your research and carefully develop each of the following in your proposal:
a) What are the critical questions you are asking?
b) What field and/or lab methodologies would you use to examine the questions? What are your assumptions in using these techniques?
c) What sort of data do you anticipate collecting?
d) How would you organize and analyze the data?

1. Design a study to test the hypothesis that predation alters resource utilization.

2. Identify and describe a mimicry system and design an experiment to determine what selective-forces (components) maintain the mimicry system.

3. Design a study to test dispersal versus vicariance explanations, of the distributional history of a group of plants or animals.

4. There exist a taxon within which much morphological diversity exists between family, genera and species. Cladistic analysis suggests that this diversity could have been generated by heterochronic changes in growth patterns, independent of the adaptive value of this diversity. A species accepted to be the most primitive of extant forms is easy to maintain and breed in captivity. Design a research program to evaluate the supposed importance of growth phenomena in the evolution of the taxon.