DIVERSITY AND CLASSIFICATION 3

"... look at the animals, this is what we seem to know about them but the knowledge is not final, and any clear eye and sharp intelligence may see something we have never seen."
John Steinbeck
1939

SYNOPSIS OF BASIC LABORATORY ACTIVITIES

- ☐ Classify imaginary living organisms using a dichotomous (2-forked) key.
- ☐ Arrange imaginary living organisms and their fossil ancestors in a phylogenetic "tree" that reflects evolutionary relationships.
- ☐ Observe representative organisms from the five kingdoms' major phyla and become familiary with their distinguishing characteristics.
- ☐ Extract living organisms from soil and observe the structural diversity. Set this investigation up before beginning others (See H. Fig. 3-3).

Text Reference: Chapter 3 — Work in pairs or individually.

INTRODUCTION

One of the most striking aspects of life is its extreme diversity. Everywhere we look we see a bewildering array of different organisms, yet the fossil record indicates that approximately 99% of all organisms that have ever existed are now extinct. Even so, biologists believe there are some 10 million species of organisms alive today. Of these, they estimate only about 15% have been described.

To make sense out of this bewildering array, humans attempt to categorize all the organisms into meaningful groups based on evolutionary relationships--in other words, kinships.

Taxonomy is a field of study in biology that attempts classifying all living things into groups and subgroups based on these natural relationships. The result then, is a system that is useful, in part because it reflects the evolution of organisms, and in part because it reduces the millions of kinds of living organisms into a lesser number of groups with which we can deal, and finally, because it provides us with a system of naming organisms. The taxonomic groups are arranged hierarchically (groups within groups) and are named from largest taxon to smallest.

Kingdom
Phylum or Division
Class
Order
Family
Genus
Species

(An easy way to remember these group titles is by a mnemonic device such as "Kindly Professors and Doctors Cannot Often Fail Good Students".)

If you were to classify people in the world on the basis of where they live, you would probably begin by dividing the world population into groups, based on continents. Continents would be the biggest lumps and then you would continue to further subdivide to countries, states, counties, etc., until you reached an individual's specific address.

We do the same thing in biology with organisms when we classify them in a hierarchical system based on natural relationships or more precisely how much DNA they have in common instead of what land they have in common. For instance, consider the following.

Continent - North America	Kingdom - Animalia
Country - United States	Superphylum - Vertebrata
State - California	Phylum - Chordata
County - Monterey	Class - Mammalia
City - Pacific Grove	Order - Primata
Street - Lighthouse Avenue	Family - Hominidae
Number - 176	Genus - Homo
Specific address - 176 Lighthouse Avenue	Species - sapiens
	Specific organism - Homo sapiens

Note that each level in the hierarchies is contained within and is partly determined by all levels above it. To the informed geographer, the name Pacific Grove automatically conveys all the hierarchies above because they have been learned. In the same way, to an informed biologist the term, Primata, conveys certain information and the hierarchical categories above because they have been learned. It is also possible to identify and classify unknown organisms by descending the hierarchial categories in the form of a biological key.

INVESTIGATIONS

If you were given a mixed bag of diverse fruits (parts of living organisms) such as lemons, peaches, limes, bananas, grapefruit, and nectarines, you could probably organize them very quickly into piles based on structural similarities and differences even if you had not done Laboratory 1.

A Today you are being presented with a mixed gaggle of organisms in the mythical phylum, Nawga, to further classify based on structural similarities and differences. You will not be given an opportunity to smell, hear, feel, or taste nawgas or to observe their behavior or internal anatomy. If you were, your task would be simpler than with only visual clues because some nawgas smell very badly, while others have a noxious taste, and of course they do not all exhibit identical behaviors.

You could be even more sure of your nawga classification if you could do comparative chemistry on molecules such as certain proteins.

Modern taxonomists have many aids to sorting and classifying organisms--computers are another. You have only your eyes and a dichotomous key. "Two choice" keys to the identification of organisms with their either/or, yes/no decisions lend themselves to computer programs. If you have access to a computer, you may want to develop a program from the key below that would speed up the classification of your 15 nawgas.

- If not, begin by cutting your page of living nawgas apart--keeping their numbers and bodies associated. Then take each one and follow the options presented in the Nawga Key. Proceed down the key to the numbers indicated and continue making choices until all choices end. (You may begin to see natural relationships that will offer short cuts--if not, go it one step at a time.)

- Record the number and genus and species name for each nawga on the answer sheet. (#1)

KEY TO THE GENUS AND SPECIES OF NAWGAS OF THE SOUTH PACIFIC

Living nawgas were recently discovered on an island in the South Pacific by Dr. John Smith, a paleobiologist who was excavating fossil nawgas.

Nawgas are characterized by:

A flexible, one-piece carapace made of chitin and polymers of esters that extends over the head

Two external nares (nostrils) penetrating the carapace

Three pairs of jointed legs

These characteristics taken together differentiate nawgas from all other organisms and place them in their own separate phylum, Nawga. The phylum name was chosen because these strange creatures molt twice a year producing pelts of nawgahyde. Because the pelts become available by molts instead of by killing the organisms, they are extremely valuable to humans. Nawgas range 1-1.5 meters in length.

[1] a. The organism has well-developed eyes, no tail; the second pair of legs is rudimentary-----go to [2].

b. The organism is without eyes, usually a tail that may be segmented and has flattened leg segments, most often the first 2 pairs----go to [5].

[2] a. The antennae are at least 30 centimeters long; the setae are restricted to the head and tail regions-----go to [3].

b. The antennae are reduced to no more than 20 centimeters; the third pair of legs have 4 segments-----go to [4].

[3] a. The antennae are slightly bifurcated at distal ends; no perforations near margins of carapace-----Genus, Fatopteris
One species, noholensis

b. The antennae are deeply bifurcated--Genus, Forbantensis
Two species:
curves antennae, curla
straight antennae, straighta

[4] a. Antennae have proboscis like projections-----Genus, Elephantiasis
One species, grasshopperi
Two subspecies

b. Eyes lack striations, setae continuous along carapace margin-----Genus, Blanki
Two species:
larger nawga, brushes
smaller nawga, petiti

[5] a. Antennae with distal, setae tufts, tail longer than 30 centimeters, or if shorter, segmented-----go to [6].

b. Antennae tapering to points; setae restricted to tail region-----go to [7].

[6] a. Tail long and unsegmented; black coloration solid and in bands-----Genus, Bandus
Two species:
straight tail and antennae, pacifica
curved tail and antennae, fattus

b. Elongated snout, reduced segments in legs; segmented tail-----Genus, Sluggi
Two species:
tail in 2 segments, carapace margin unnotched, sluggi
tail in 3 segments, carapace margin notched, segmenti
Three sub-species

7 a. Tail absent, nares very reduced-----Genus, Nonosi
One species, Smithi

b. Tail thickened and prominent-----Genus, Thickus
One species, slickus

Genus names are capitalized and underlined or italicized. Species names are usually not capitalized but are also underlined or italicized.

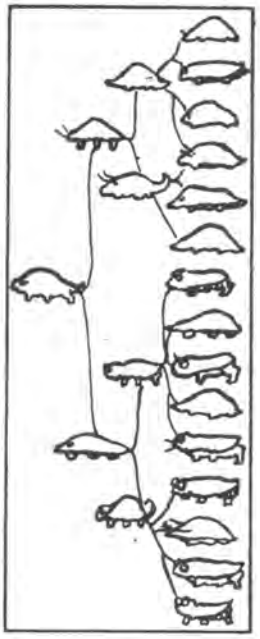


Figure 3-1. Construct the evolutionary history of the nawgas in a phylogenetic tree. Organisms on the right margin of the paper are contemporary nawgas. The others are their ancient ancestors.

B ● Now cut apart your fossil nawgas and try to construct a phylogenetic tree (the possible evolutionary history of your organisms). You will need 3 pieces of 8 1/2 x 11" paper taped together at the 11" margins. This 11 x 25 1/2" rectangle can now accommodate all your nawgas, past and present, if you position the living nawgas down the long right margin at right angles to that margin. Fig. 3-1

● The fossil nawgas were found in different levels of rock from different geological periods. Knowing the period will aid in constructing your evolutionary tree--but your best information will still be structural. Refer to the geological time scale in your text.

● When you have your evolutionary tree finally arranged, paste the nawgas in place and draw connecting lines to indicate the relationships. In a sense what you are doing is making a family tree--with all the living first cousins, etc., and their possible parents, grandparents, great-grandparents, etc.

In your nawga tree, however, you are not dealing with one species but a whole phylum, and you are not dealing with several hundred years but epochs of time.

C ● Displayed in the laboratory are representatives of real organisms arranged by kingdom and phylum. You should become familiar with the characteristics that differentiate the 5 kingdoms and the major phyla. Refer to your text. See Fig. 3-2.

● On the basis of what you now know, in what kingdom would you place the phylum, Nawga? (#2)

● Present day nawgas differ from their ancestors and each other. In other words, nawgas have changed (evolved) over time. Is it chance that nawgas in different environments, living different life styles have differences? Some nawgas live deep in caves emerging. Others are nocturnal, jungle dwellers. Indicate on your answer sheet which you think are night dwellers and which are cave dwellers. Be sure to underline the binomial (genus and species) and not to capitalize the species. (#3) (The rare case of capitalizing Smithi occurred to honor the discoverer of a new phylum, not because it is derived from a proper name. Nonosi Smithi was the first living nawga found.)

● Could you predict which species have unpleasant odors and what, if any, the function might be? (#4)

● Could you offer an explanation for some having a noxious taste and indicate what species they might be? (#5)

FIVE KINGDOM CLASSIFICATION SYSTEM

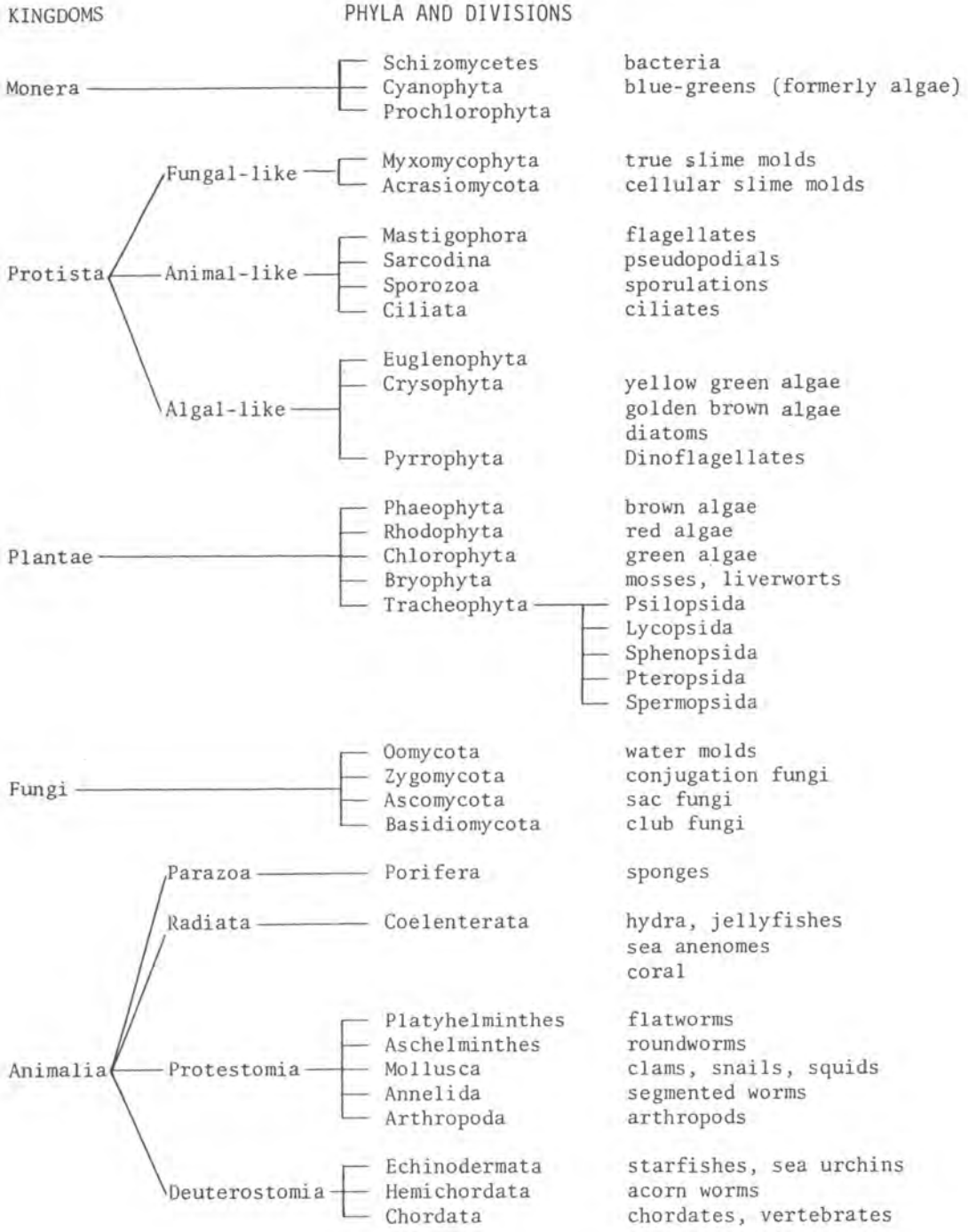


Figure 3-2

D● Before leaving the laboratory observe the "critters" extracted from moist soil, damp leaves, and other duff with a stereoscopic microscope. Place the organisms in a dish with a white background for viewing. Try a black background also. Could you place some of the organisms in the correct kingdoms or phyla? Note the diversity.

The method for extracting soil specimens is to drive them with the heat of a light bulb out through the bottom of a large funnel into a small beaker.

After two hours there should be a large assortment of organisms in the beaker in the 1-3 millimeter range. If not, shake the funnel several times.

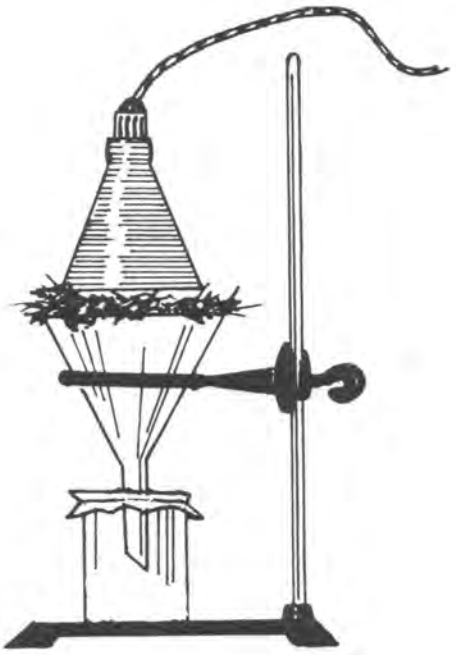
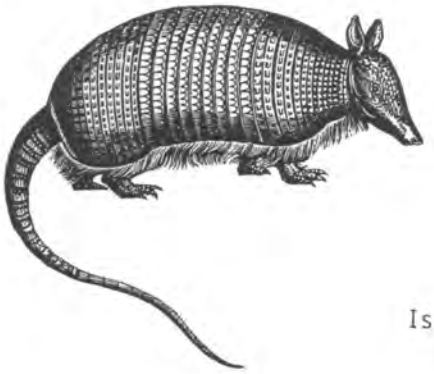


Figure 3-3. Method for extracting organisms from the soil. Cover the beaker with foil secured with a rubber band. Push funnel through foil.

OBJECTIVES

Upon completion of this laboratory, you should:

- ☐ Be able to use a simple dichotomous key to classify a group of organisms.
- ☐ Understand the construction of a phylogenetic tree reflecting possible evolutionary histories.
- ☐ List the five kingdoms and their distinguishing characteristics.
- ☐ Be familiar with the major phyla in the five kingdoms.
- ☐ Know the definitions of words new to you in the exercise.
- ☐ Be impressed by the number and diversity of organisms in a small amount of soil.



Is this a nawga?
If not what phylum?

Name_____

Section_____

Date_____

LABORATORY REPORT 3

#1

1._____	6._____	11._____
2._____	7._____	12._____
3._____	8._____	13._____
4._____	9._____	14._____
5._____	10._____	15._____

#2_____

CAVE DWELLERS	NIGHT DWELLERS
#3_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

#4 Indicate by numbers only_____

Possible function_____

#5 Indicate by number only_____

Possible function_____

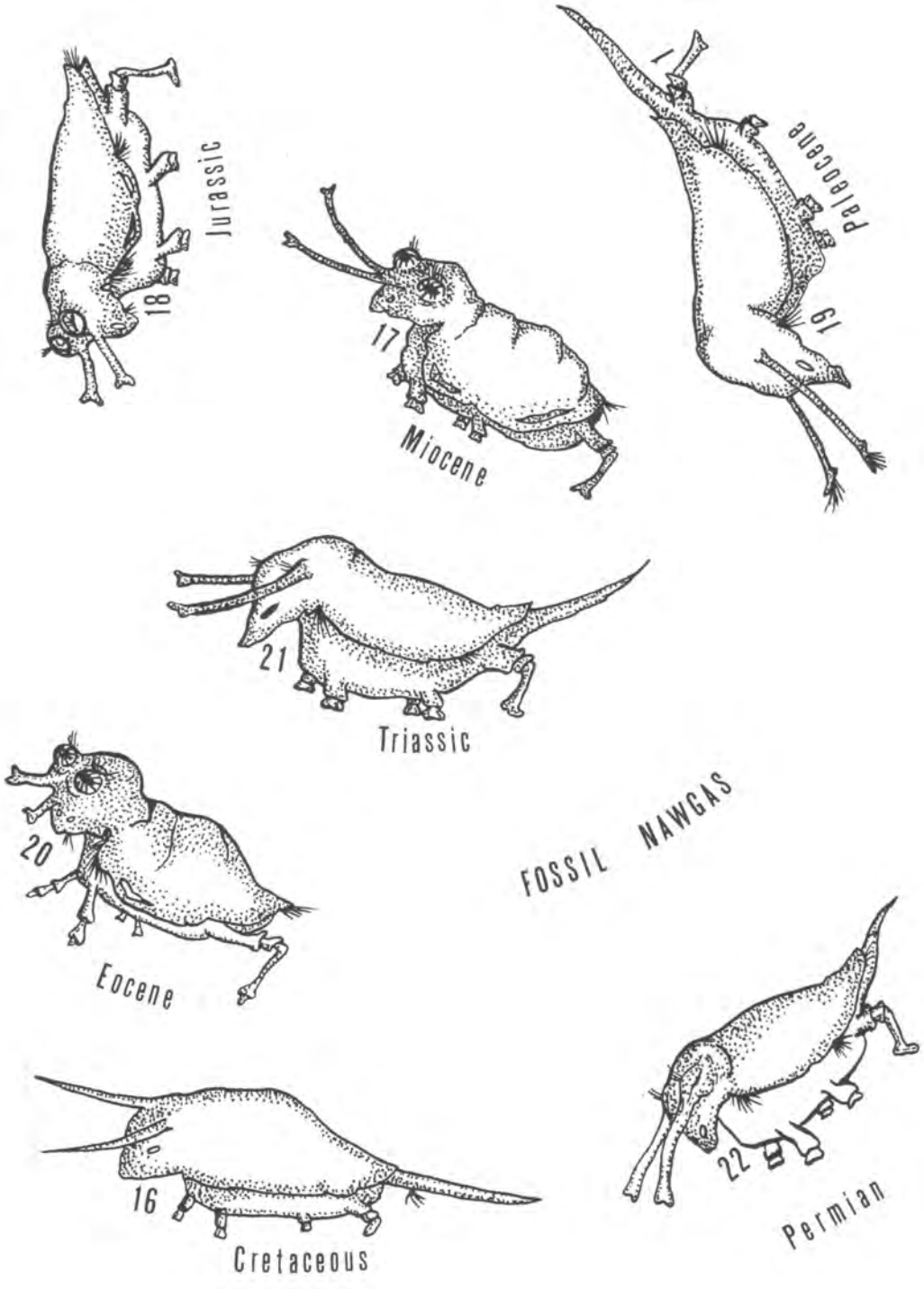
TURN IN YOUR PHYLOGENETIC TREE WITH THIS ANSWER SHEET. BE SURE YOUR NAME IS ON ALL PAPERS.

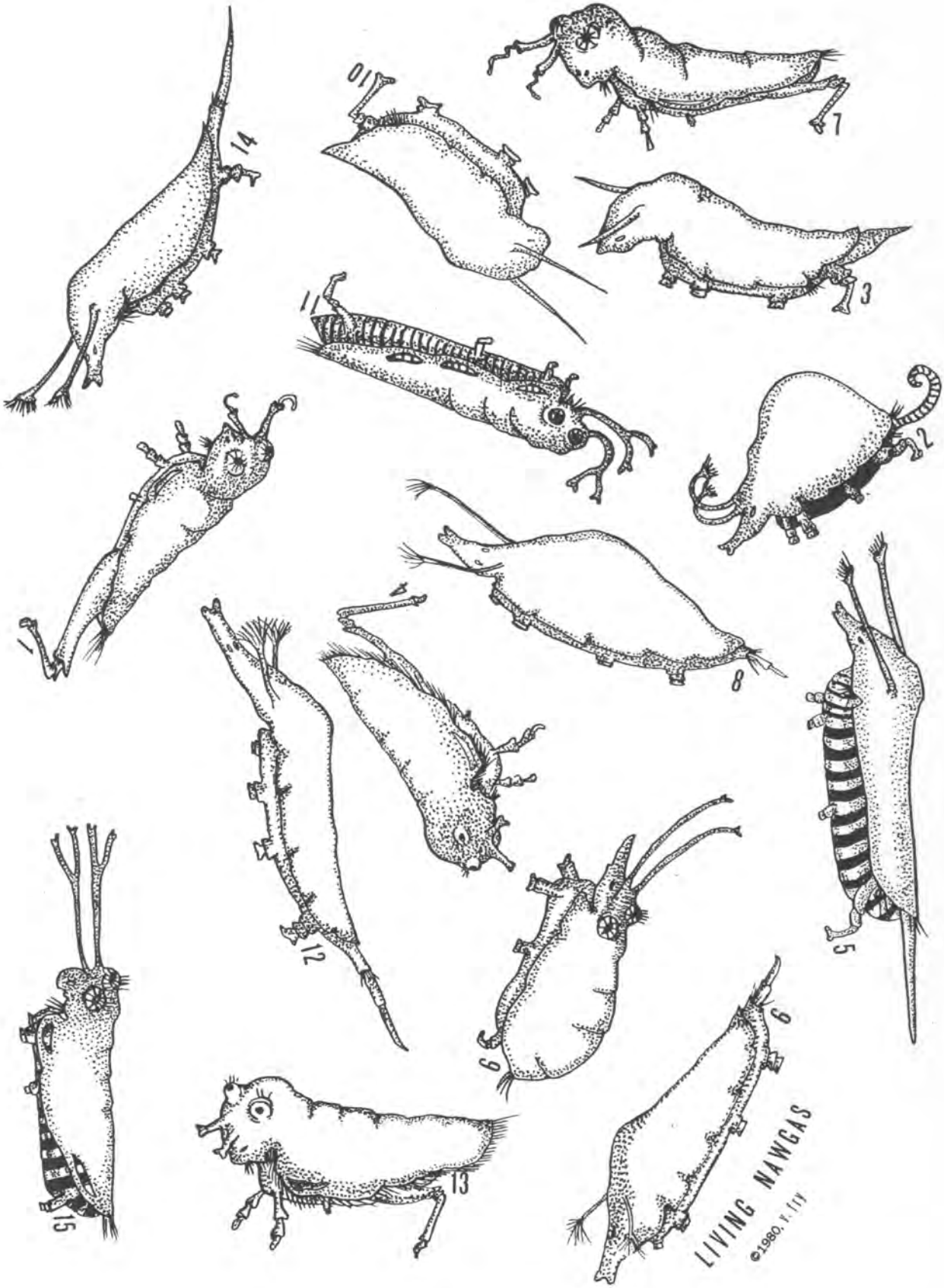
THE KINGDOMS AND MAJOR PHYLA SHOULD BE STUDIED WHENEVER TIME IS AVAILABLE FOR THE NEXT SEVERAL WEEKS.

Nawga Phylogeny and Cladistics

Some helpful hints on characters to use in your analysis… these are not all that you may wish to use, but they will get you thinking and observing the morphological features of the nawgas in ways that are useful for developing a cladogram. Some of these characters will be pleisiomorphic (primitive), some apomorphic (unique derived) , some synapomorphic (shared derived), and some will be a apomorphic or synapomorphic depending on the location in your cladogram. You may not need to use all of these particular characters to construct your cladogram.

- presence/absence of eye spots
- presence/absence of eyes
- presence/absence of eye striations
- presence/absence of carapace
- presence/absence of jointed appendages
- presence/absence of well-developed tail
- presence/absence of segmented tail
- two-segmented tail/three-segmented tail
- presence/absence of notches in carapace
- presence/absence of perforations in carapace
- two perforations in carapace/three perforations in carapace
- presence/absences of coloration
- presence/absence of banding
- normal 2nd pairr of legs/reduced 2nd pair of legs
- blunt antennae/sharp-tipped antennae
- presence/absence of setae tufts on antennae
- longer antennae/shorter antennae
- presence/absence of bifurcations on antennae
- presence/absence of tail
- presence of carapace perforations/loss of carapace perforations
- normal 3rd pair of legs/enlarged 3rd pair of legs
- others……


FOSSIL NAWGAS
Jurassic
18
Miocene
17
Palaeocene
19
Triassic
21
Eocene
20
Cretaceous
16
Permian
22


LIVING NAWGAS
©1980. T. ITY

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- presence/absence of tail
- presence of carapace perforations/loss of carapace perforations
- normal 3rd pair of legs/enlarged 3rd pair of legs
- others……