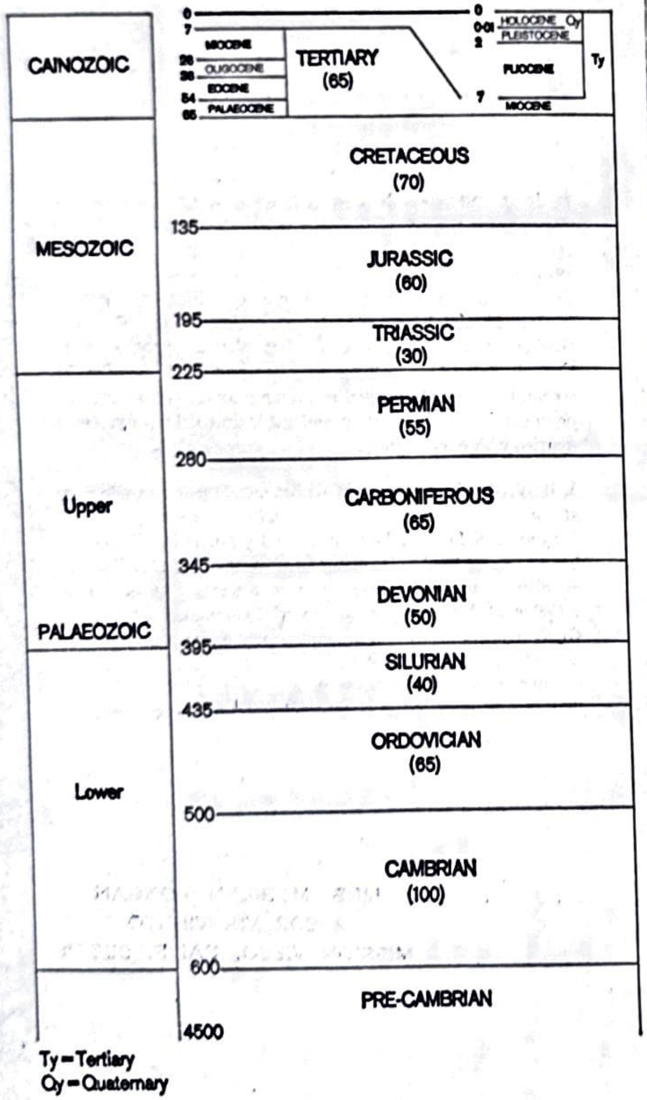


The geological time-scale in millions (10^6) of years.

The Penguin Dictionary of

GEOLOGY

D. G. A. WHITTEN

with

J. R. V. BROOKS

PENGUIN BOOKS

of a rock developed at the time of its formation. (Cf. ◇ *Secondary*.)

Prismatic body. ◇ *Sedimentary structures* (1).

Pro- (prefix). Before.

Prod marks. ◇ *Sedimentary structures* (3).

Proglacial lake. A lake formed directly adjacent to the 'snout' of a glacier. ◇ *Varves* are commonly found in such an environment.

Projection, crystallographic. A term used for any representation of a crystal. Purely 'pictorial' projections, such as the perspective or clinographic drawings which are commonly made, are of little use to a crystallographer, as he is unable to use them for measurements or calculations. The 'plan-and-elevation' projections are little better for these purposes. Since the crystallographer is mainly concerned with the angular relationships of the crystal faces, it is possible to dispense with a pictorial representation and use a purely geometrical projection. All such projections in common use involve the projection of normals to the crystal faces on to a sphere. This spherical projection can be reduced to a two-dimensional representation by the use of the same methods as are used in map projections for reducing the Earth's sphere to a flat map. The two main projections used are the stereographic and the gnomonic, which yield an 'angle-true' 'map' of the faces.

A. C. Bishop, *An Outline of Crystal Morphology*, 1967.

Propylitisation. The hydrothermal alteration of a fine-grained igneous rock (especially ◇ *andesite*) to a mass of ◇ *secondary* minerals such as ◇ *chlorite*, ◇ *epidote*, quartz, carbonates, and sub-◇ *micas* such as 'sericite'. (Cf. ◇ *Saussuritisation*; ◇ *Uralitisation*.)

Prospecting. ◇ *Geophysical prospecting.*

Proterozoic. ◇ *Precambrian.*

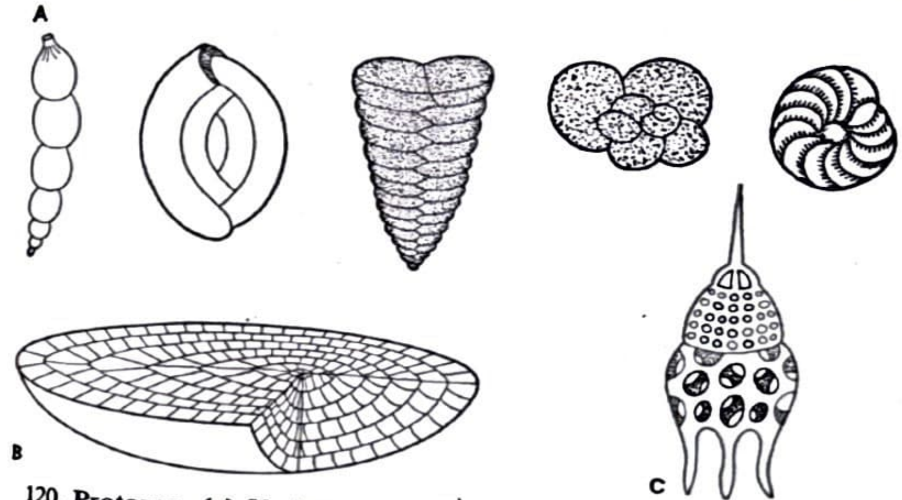
Proto- (prefix). First.

Protoclastic. A term used to describe the structure displayed by an igneous rock in which the early-formed crystals have been broken or deformed owing to movement of the still-liquid portion, either during intrusion or in a lava flow. The term has also been used to describe certain types of gneissose structure in which fragmentation of crystals was presumed to be due to the flow of liquid material. It seems possible that some gneisses to which this adjective has been applied are in fact showing early mylonitisation, and not the effects of liquid injection. (For augen structure, ◇ *Gneiss*; ◇ *Mylonite*.)

Protoconch. ◇ *Mollusca* (Gastropoda) and Figs. 100 and 106.

Protore. Material containing ◇ *ore minerals* in too low a concentration for economic working, but which may be a workable ◇ *ore* where ◇ *secondary enrichment*, especially ◇ *supergene* oxidation, has occurred.

Protozoa. A unicellular animal, which may or may not secrete a test or skeleton, ranging in size from 0·1 mm. to 8 cm. Modern protozoa are divided into a number of groups, but only two of these are



120. Protozoa. (A) Various types of Foraminfera; (B) A nummulitid (sectioned); (C) A radiolarian. (All greatly magnified.)

of geological importance – the Foraminifera and the Radiolaria (◇ Fig. 120):

FORAMINIFERA. The Foraminifera are mainly marine benthonic or planktonic forms, in which there is considerable morphological variation, the forms ranging from a single, non-chambered flask-shaped animal to the complex, chambered, form of the discoidal nummulites. The Foraminifera are subdivided into three groups, based on the character of the test, which may be of porcellaneous calcite, hyaline (clear) calcite, or arenaceous with a cement which is partly calcite. The test is usually perforated, allowing translocation of food particles from the external cytoplasm to the cytoplasm inside the test. The Foraminifera range from ◇ *Ordovician* to Recent, although some Cambrian forms may occur. They are important as zone fossils especially in the Tertiary, where they may be locally present in sufficient numbers to be major rock-building constituents.

a student guide to Orange County Fossils

BY

CAROL J. STADUM

CHAPMAN COLLEGE PRESS

ORANGE, CALIFORNIA 92666

MICROFOSSILS

Microfossils are not commonly collected but their abundance in marine sedimentary rocks merits some comment. Extremely small nannofossils (.002 millemeters in diameter) are the up-and-coming stratigraphic markers for marine sediments. Nannofossil species have varied greatly through geologic time and are an important tool for oil geologists. The trained geologist can quickly smear a fine veil of subterranean mud on a glass slide and microscopically examine it, identify the species present and determine the age of the sediment being drilled.

The microfossils most widely used by paleontologist are the one-celled marine animals called foraminifera or "foram" for short. Forams are considerably larger than nannofossils and can be detected by a sharp eye as pin-head size white globes. These calcareous chambered shells vary in shape from species to species and from cold to warm water. Thus they have been useful to geologists who wish to date a geologic formation and determine the ancient environment of the formation. The author found a good Miocene collection of these microfossils floating in puddles of water at a construction site near El Toro where grading equipment had ground up the Miocene sedimentary rocks, freeing the tiny fossils. You will need a magnifying glass or preferably a microscope to study the variety of forams you can collect.

The most intriquing microfossils are the plants and animals that have the ability to extract dissolved silica from sea water and form glassy protective shells. These shells contribute the greatest thickness (over 3,000 feet) of any fossil remains in the county. The glassy one-celled animals are called Radiolaria and their spherical spinose shells could be crystal decorations for a microscopic Christmas tree. The largest of these delicate fossils is .015 millemeters in diameter and barely visible if you have good eyes and a good imagination to match. The one-celled plants that secrete a siliceous supportive test or structure for their protoplasmic mass are called diatoms. Oil is formed by diatoms and other plankton, and some of the great

California oil fields produce from Miocene diatomites. Diatoms and Radiolaria are commonly preserved in sediments deposited in deep-seas whereas the calcareous shells of forams are preserved in shallower sea-muds.

There are hundreds of fossil pollen and spore species in county rocks. The laboratory techniques required to see their structures are so involved that the casual collector leaves these microfossils to palynologists (scientists who study pollen and spores). These professionals rely upon these fossils,.like forams, to identify the age and paleoenvironment of sedimentary rocks.

Photographs Plate I # 6 and Plate II # 7 are reversed.

LIFE THROUGH TIME

HAROLD L. LEVIN

Washington University

other angiosperms have evolved for seed dispersal.

Angiosperm pollen grains extracted from Jurassic rocks provide the earliest evidence for the existence of flowering plants. By Cretaceous time, angiosperms were conspicuously present. Forested areas included stands of magnolia, poplar, sassafras, birch, and willow (fig. 6.2). By the end of the Mesozoic Era, angiosperms clearly surpassed the nonflowering plants. Their diversity and range of adaptation has been truly incredible. Angiosperm trees, shrubs, vines, herbs, and grasses gave a modern aspect to the landscape and, either directly or indirectly, affected the evolution of insects, birds, and mammals.

SEA PLANTS

Life in the oceans, as on land, is dependent on plants. The record of marine plants extends far back into the Precambrian Era. As discussed earlier, those ancient plants included bacteria, blue-green algae, and green algae. Red and green algae capable of causing the precipitation of calcium carbonate have been noted in rocks as old as Ordovician. Brown algae, of which the living kelp is an example, have left uncertain imprints in Devonian rocks and may have existed much earlier.

Two phyla of marine plants are well known as fossils, and also of exceptional importance in food production in the sea. These are the Pyrrophyta, or dinoflagellates, and the Chrysophyta. The latter phylum includes diatoms and coccolithophorids. Species of these two phyla are components of the great phytoplankton pastures of the seas. On these and associated plants depend the oceans' zooplankton, from which in turn extend food chains to fish, whales, seabirds, and ultimately man, dining elegantly on lobster at Delmonico's. The phytoplankton began a rapid expansion during the Cretaceous. Earliest fossil coccolithophorids and diatoms are found in rocks of Jurassic age. Dinoflagellate evolution may have begun in Silurian time with a group of possible pyrrophytes called hystrichospherids.

Preservation of the outer coverings of coccolithophorids and diatoms is improved because of their mineral composi-

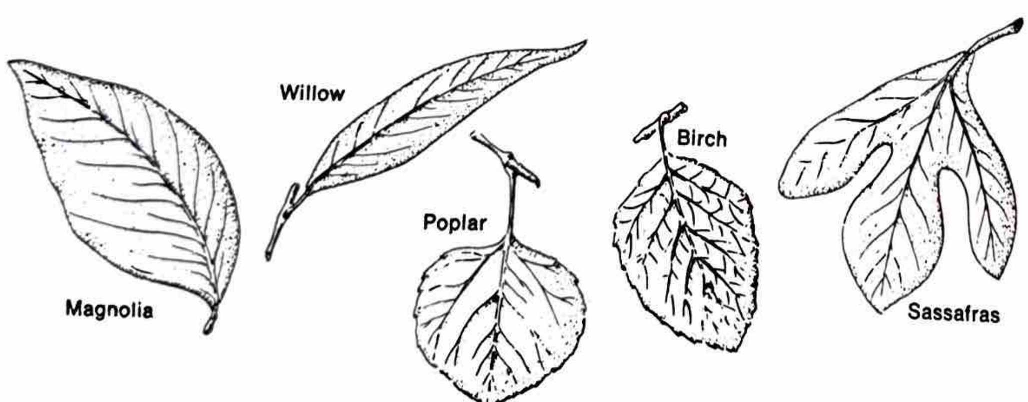
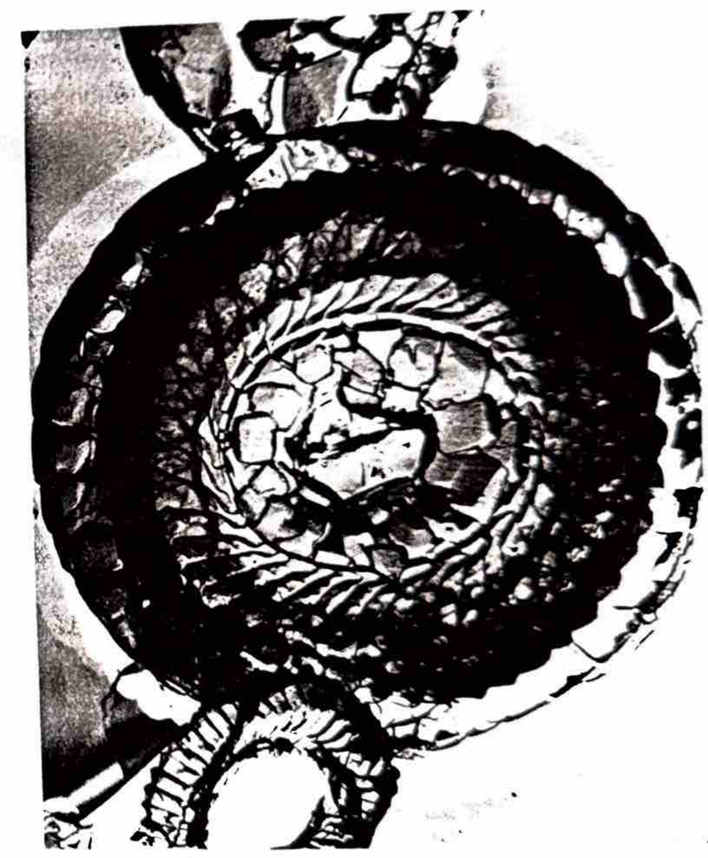


FIG. 6.2 *Leaves of angiosperms found fossilized in Cretaceous sediments.*

tion. Coccolithophorids build spherical coverings (coccospheres) of calcium carbonate plates (fig. 6.3). The plates are usually circular, elliptical, or pentagonal and are themselves composed of still smaller crystallites arranged in a uniform manner. Diatoms (fig. 6.4) secrete siliceous coverings which are formed like medicine capsules with two slightly overlap-



ping halves. The calcareous and siliceous oozes that blanket extensive areas of the ocean floors are composed largely of the remains of these two groups of phytoplankton. (The protozoan radiolaria and foraminifera also contribute to the for-

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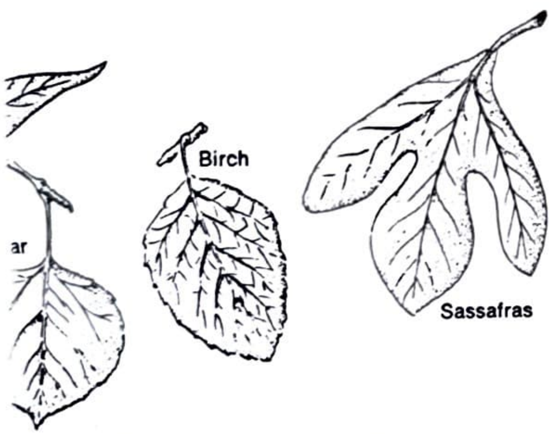

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Plants, whether they comprise myriads of microscopic phytoplankton of the oceans or vast fields of grain on our continents, sustain us all. Our reliance on plants is not confined to those presently living, for plants of bygone eras have provided us with coal and oil to fuel our factories and warm our homes. The very air we breathe contains its vital gift of

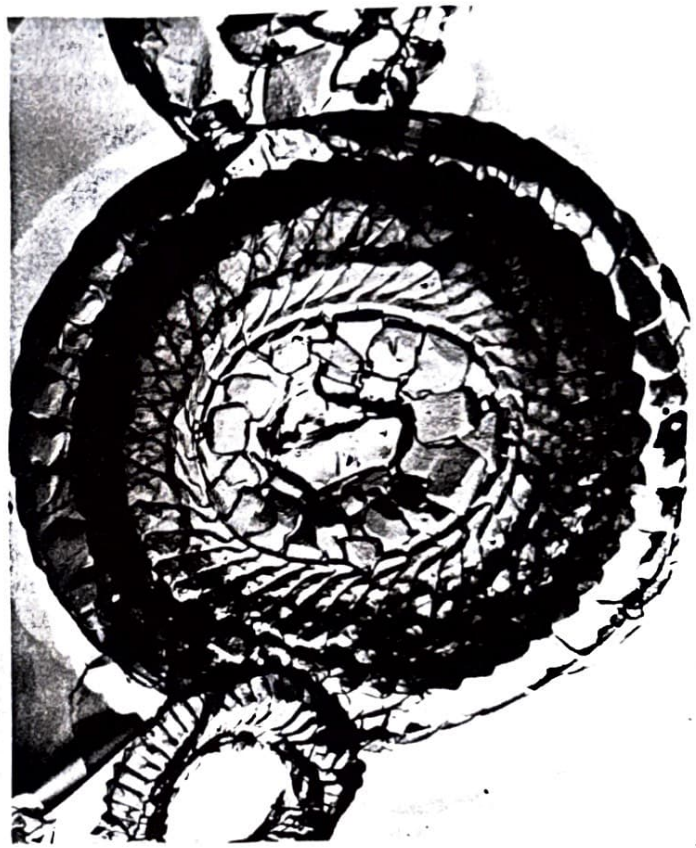

FIG. 6.3 *A coccolith, one of many platelike structures covering a coccosphere.*

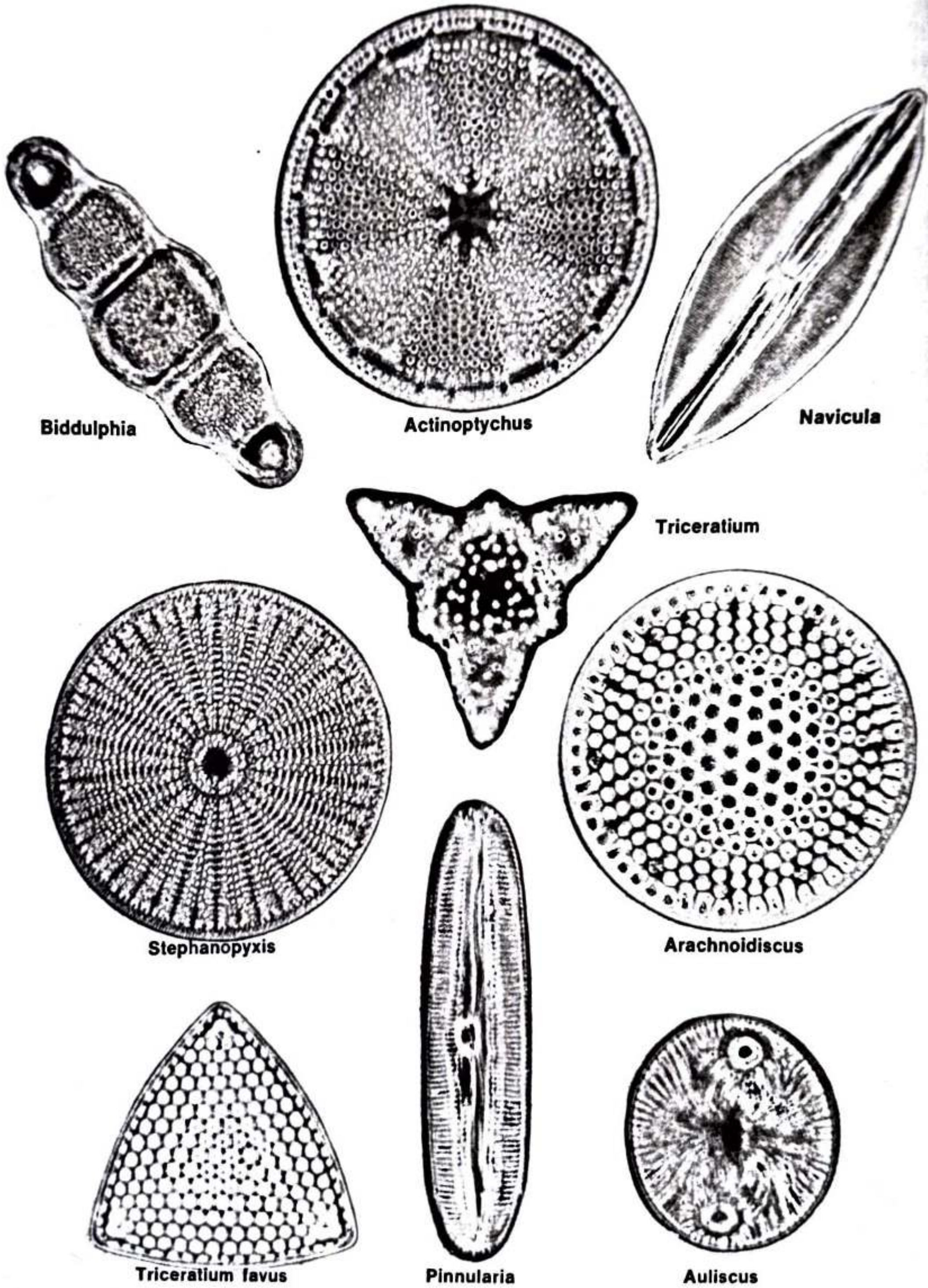

FIG. 6.4 *Diatoms.*

the surface of the open oceans as plankton. Their tests, upon death of the organism or when abandoned at times of reproduction, rain down onto the seafloor like

FIG. 7.3 *Foraminifers.*

ontinuous snowfall. Among the plankonic foraminifers, a common form is *Globigerina* (fig. 7.4). The extensive, imey, deep sea sediments known as glo-igerina ooze contain in great abundance he tests of *Globigerina* and related orms. The remains of *Globigerina*, along vith calcium carbonate remains of other lanktonic organisms, form a common ariety of limestone known as chalk.

G. 7.4 *Test of a species of* Globigerina *(center).*

The oldest foraminifers are simple forms found in rocks of the Early Paleozoic. The order did not become particularly varied or abundant until Late Paleozoic when families evolved which were about the size and shape of wheat grains. These were the numerous, diverse, and internally complex foraminifers loosely termed fusulinids. In some limestones, fusulinids comprise the entire bulk of the rock. Even when less abundant, they are useful index fossils for correlation of strata.

Foraminifers having a more modern appearance became abundant during the Mesozoic. It was in the Cretaceous Period that planktonic forms appeared and expanded rapidly. Like their Paleozoic ancestors, their remains provide excellent index fossils and are extensively used in petroleum exploration. Because they are sensitive indicators of water temperature and salinity, they have provided data useful in the study of ancient marine environments all over the world. Certain species obtained from cores of deep sea sediment are providing interesting measures of areal and temporal fluctuations of glacial climates during the Pleistocene Ice Age. In these studies, the temperature requirements of the foraminifers found in successive layers of the cores can be determined by direct comparison with living species. One can also study the isotopic composition of the calcium carbonate secreted by the once living animal. The ratio of isotopes varies according to the temperature of the water at the time the animal lived. It has been discovered that the ratio between the isotopes oxygen-18 and oxygen-16 in the tests decreases 0.02 percent for every 1°C. decrease in water temperature. Oceanic temperatures that prevailed many hundreds of thousands of years ago can be ascertained using these methods.

Radiolarians are sarcodinids with threadlike, radially directed pseudopodia which project from beautifully filigreed, latticelike opaline or proteinaceous skeletons (fig. 7.5). In some regions of the sea,

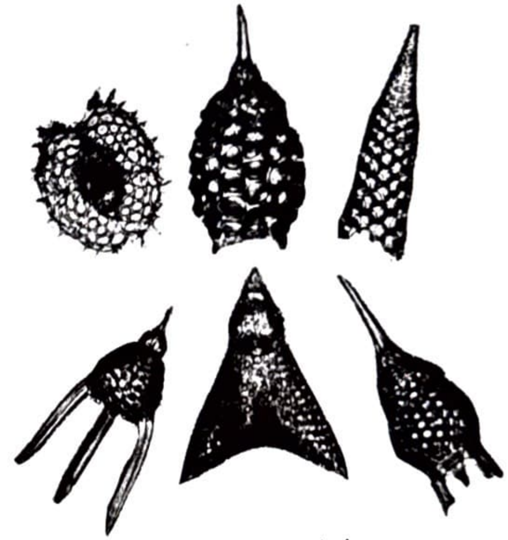

FIG. 7.5 *Radiolaria.*

radiolarian tests accumulate in deposits called radiolarian ooze. These oozes occur frequently in deeper or colder parts of the oceans. Because of the increased concentration of carbon dioxide in the colder waters, calcium carbonate tests of foraminifera often dissolve as they settle to the seafloor, or the initial secretion of a calcite test is inhibited. However, the siliceous radiolarians are unaffected and tend to accumulate. Radiolarians have been reported in rocks as old as Precambrian, but occur with greater certainty from the Devonian to the present.

Porifera

Porifera are sponges. Sponges appear to have evolved from colonial flagellate pro-

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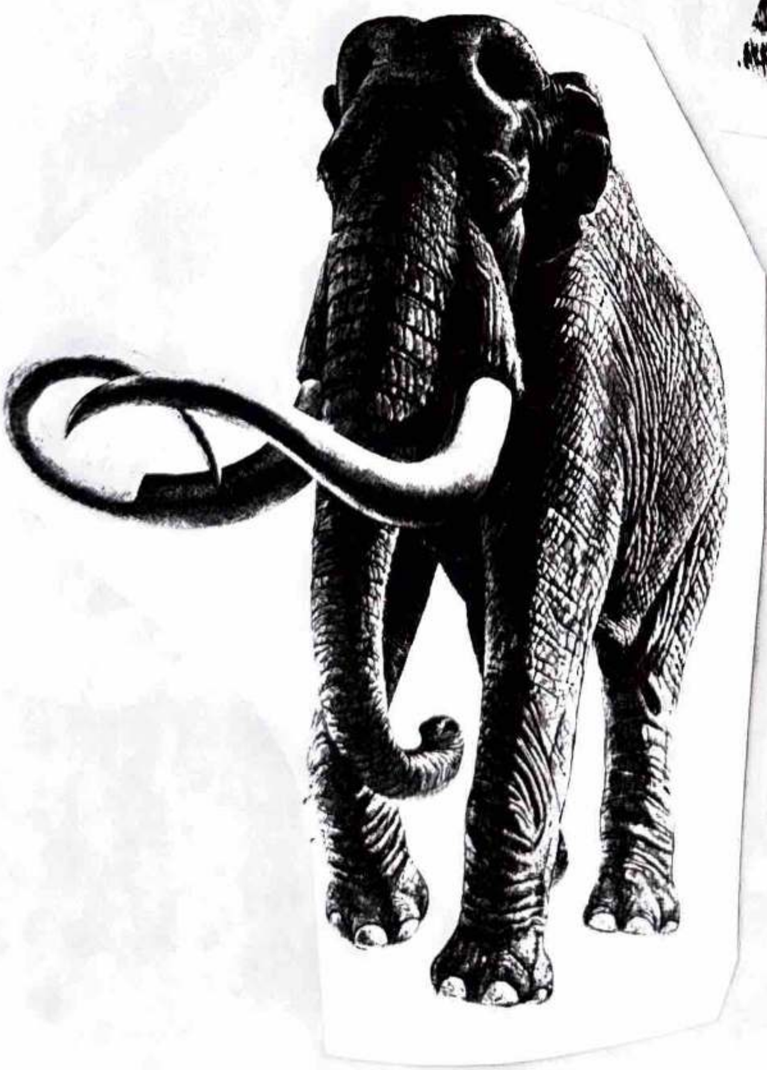
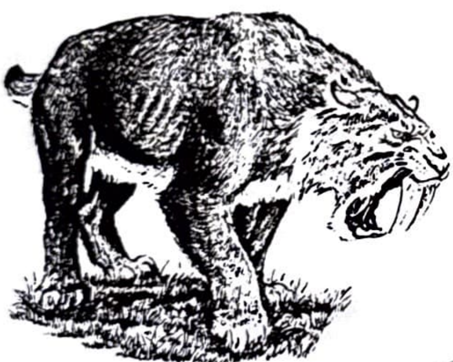
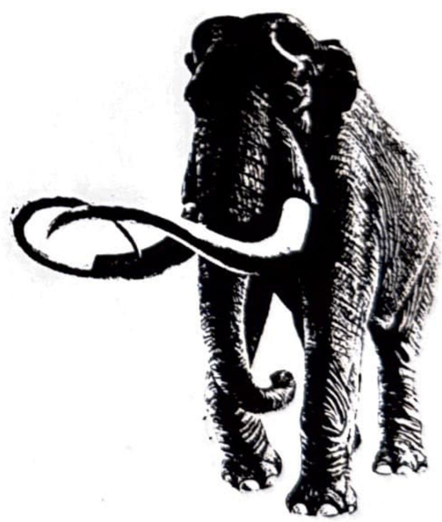
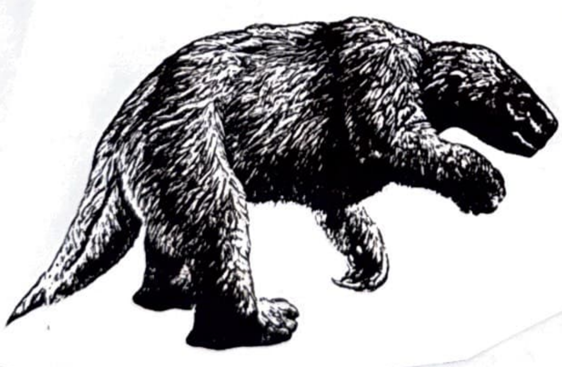








Reprinted from Norsk Hvalfangst-Tidende 1966, No. 3, pp. 47-60

Faunal Succession of Extinct North Pacific Marine Mammals

by EDWARD MITCHELL

(with restorations by Bonnie Dalzell)

A/S HANDELSTRYKKERIET
SANDEFJORD

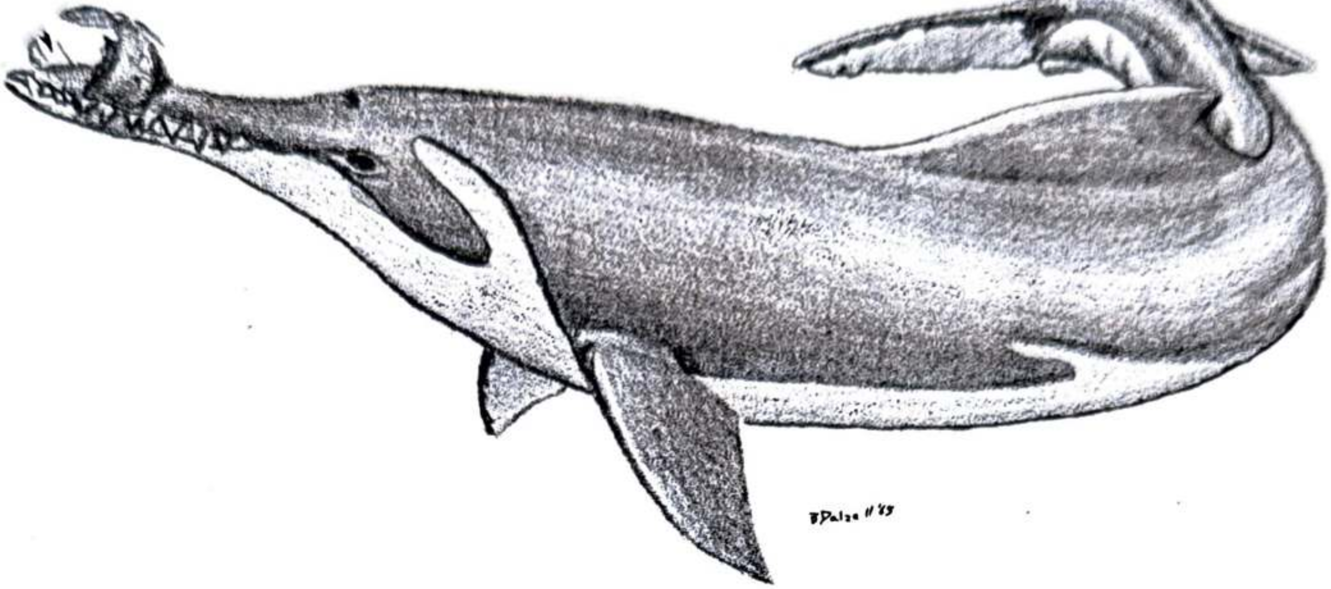


Figure 4. The color pattern on this restoration of an Early Miocene squalodont approximates the pattern on another rapacious but unrelated species, the living Killer Whale. The skull of this species was about three feet long and armed with many sharp teeth.

primitive sperm whale *Aulophyseter*, nine or more species of porpoises and dolphins (mostly delphinids), three kinds of cetotheres, the desmostylian *Desmostylus*, and two or more sea lions (*Allodesmus* and another kind). As far as the evidence goes, this type of assemblage seems to be quite typical of the Californian Middle Miocene, for at other localities *Allodesmus*, a smaller pinniped?, cetotheres, delphinoids, and desmostylians are commonly associated. But it is by no means certain that the Sharktooth Hill fauna is a strictly typical Middle Miocene assemblage because some evidence suggests that it might be an imbalanced or skewed sample, perhaps containing animals that were transported to the area after their death. Nevertheless it remains the best single control for this time period in the eastern North Pacific Ocean.

Cetotheres were primitive baleen whales of small to medium size, and were among the most common members of the Middle Miocene fauna in California. They can be likened to the California Gray Whale, which is their closest living relative and is probably descended from them. Some were large, some were small, but all had relatively short baleen. Perhaps some of them migrated latitudinally like their modern counterpart. They were abundant and slow-moving whales so were probably excellent targets for the many large predators of the Miocene seas.

The sperm whale *Aulophyseter* was a medium-sized whale with upper teeth not well rooted in sockets. In this and other characters it foreshadows features characteristic of the modern Sperm Whale. *Aulophyseter* has not yet been found at localities other than Sharktooth Hill, but here it occurs in profusion. Evidently what is now the south end of the San Joaquin Valley was a calving place or haunt for this species in the Miocene, for numerous remains of both adults and juveniles have been found there.

Desmostylians are a group of mammals which have no common name. No man has ever seen one of these beasts alive, since the last one died more than ten million years ago. Known in the fossil record since 1888 or earlier from many occurrences of their peculiar teeth, different species of desmostylians are only of late being recognized with some understanding of their anatomy. Almost all knowledge of these amphibious marine mammals is based on less than ten skulls and three good skeletons, few of which have been scientifically described.

The ancestry of the earliest of desmostylians, *Cornwallius sookensis* from Late Oligocene rocks on Vancouver Island, is quite unknown. Many paleontologists have assumed that desmostylians are related to sirenians (sea cows) and to proboscidians (elephants), because like manatees and elephants their tooth replacement mechanism

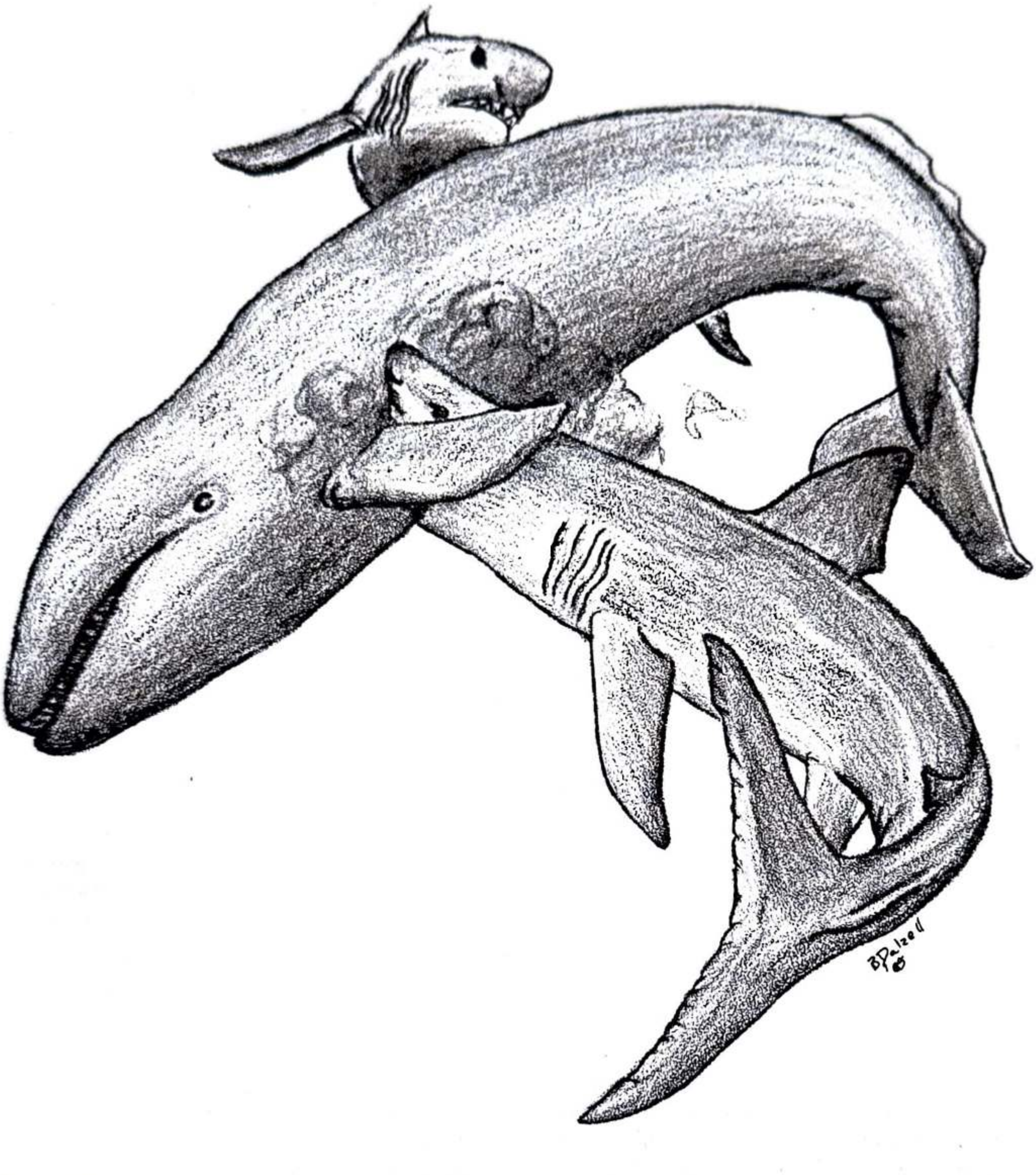


Figure 5. This restoration of the Middle Miocene cetothere *Cophocetus* from Oregon suggests that it was the prey of the giant shark *Carcharodon*. *Cophocetus* had a skull about four feet in length, with a very blunt snout. Small cetotheres like this were very abundant through the Middle Miocene in the eastern North Pacific, such that they might be termed the «cattle of the sea.»

Figure 6. *Desmatophoca* is one of the earliest sea lions yet found, but even at the time of its first appearance in Middle Miocene rocks it seems to have been a very modernistic type as far as sea lions go. About the size of living sea lions, this species had a very long and slender head with long canine teeth. Two young males here battle for territorial dominance on a rookery along what is now the coast of Oregon.

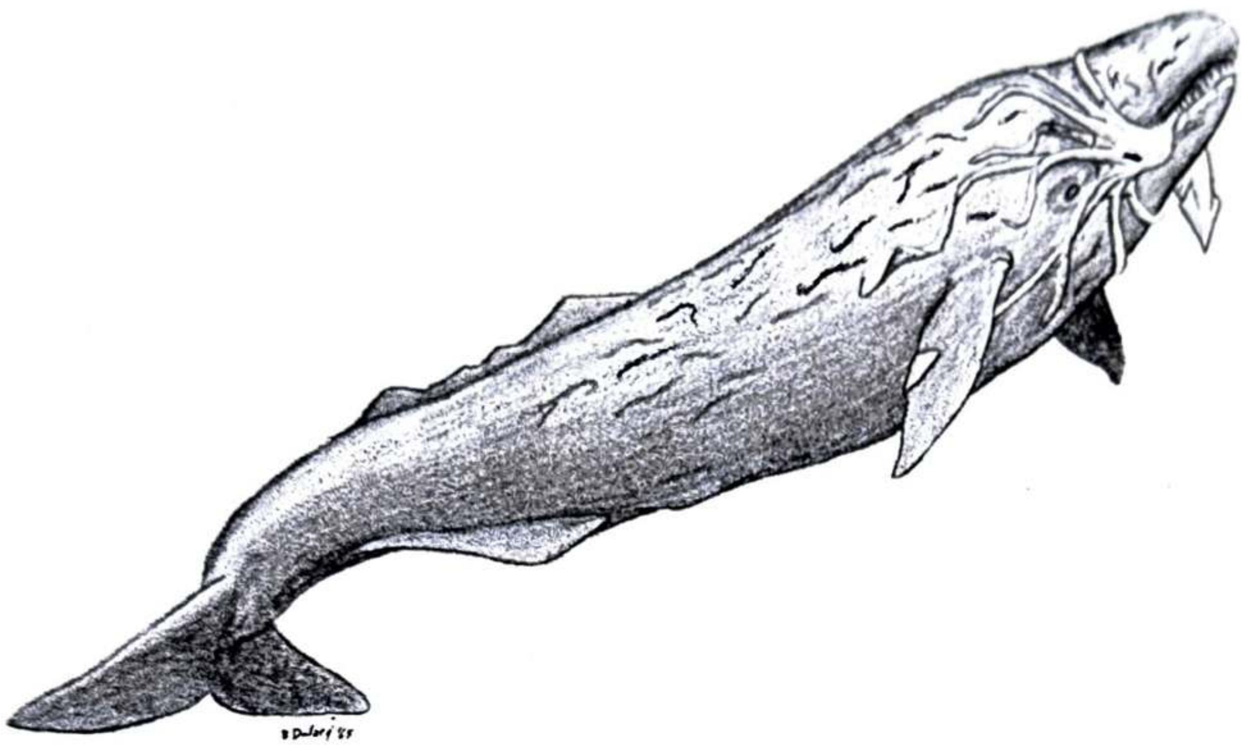


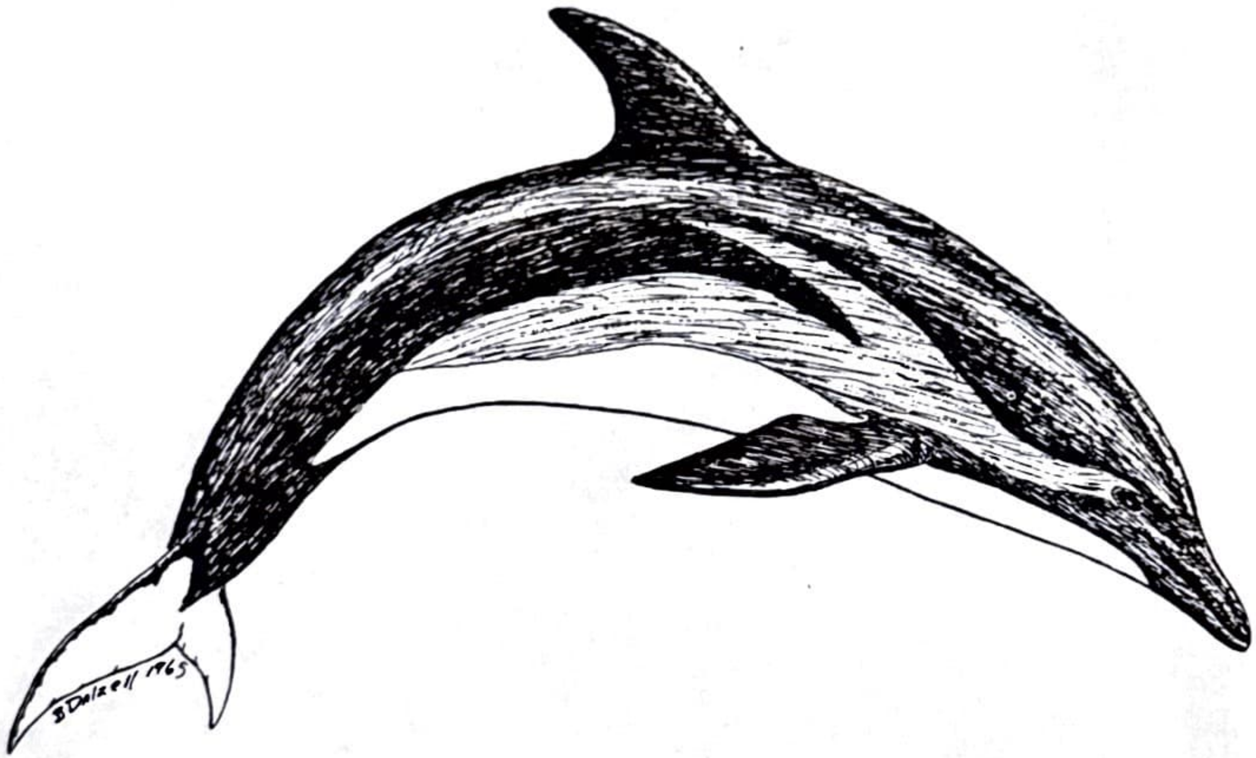
Figure 8. Although other species of fossil sperm whales are known from the North Pacific, the kind pictured here was perhaps involved in the ancestry of the living sperm whale. *Aulophyseter* evidently calved in the area of what is now called Sharktooth Hill in southern California. Its squid-eating habit is based less on evidence than on analogy with the modern sperm whale. Like most fossil whales, this one was smaller than its living relative.

differs from almost all other mammals. Rather than having teeth which erupt in place, the jaws of these animals contain a germinal capsule at the back end where new teeth are formed. The newly-formed teeth erupt and take their place at the back end of the tooth row, while older, worn teeth literally drop off the front end of the jaw. Since at least some desmostylians are thought to have had a similar tooth replacement mechanism, this seems like a good unifying feature. But the best proof of phyletic relationship is a graded morphologic series of fossils in the correct geologic sequence, and when considering this aspect, the dental mechanism is seen to be a secondary feature. For it has been demonstrated that the earliest sea cows did not have this special mechanism, nor did the earliest proboscidians, but each group developed it independently. And earlier desmostylians will probably be found to have had a normal type of tooth replacement also. Hence it is obvious that only a parallelism of evolutionary development is involved here.

So much for the desmostylians. Suffice it to say that they were a group of large quadrupedal mammals that frequented near-shore marine waters around the shores of the North Pacific from Japan to Baja California. They evidently lived a walrus-like or hippopotamus-like mode of life, but scientists have not yet decided whether they were carnivorous and ate clams, or were herbivorous and ate marine plants. Hence it is a little uncertain just what our resurrected desmostylid is engulfing in that cloud of mud.

Although very little information is published on the subject, some comments are offered here on the differences between Early and Middle Miocene faunas in the eastern North Pacific. There is suggestive evidence for a wider dispersal and greater numbers of desmostylians, both greater numbers of individuals and possibly of species, in the Middle Miocene. At this time, if not before, some desmostylians had attained lengths of up to ten or more feet and weights of many thousands of pounds. By the Middle Miocene sea lions had diversified in the North Pacific region and some types were quite common. Two of the best known kinds are *Desmatophoca* and *Allodesmus*. *Desmatophoca* was evidently a long-headed, slimly-built sea lion, in many ways like some modern species, but only a few bones of this animal have been discovered in

The Middle Miocene sea lion *Allodesmus* was a sea lion by ancestry only for it evolved in a direction away from typical forms and resembled some modern Antarctic earless seals like the Elephant Seal and the Leopard Seal. The proboscis, for example, is not commonly developed in living sea lions. Here two bulls engage in combat (Figure 9, above) and feed on large Halfbeaks (Figure 10, below). *Allodesmus* perhaps grew to lengths as great as any living pinniped. Some inferential evidence suggests that this large beast was covered not with fur like sea lions, but with blubber like Elephant Seals.



Modern types of delphinid (Figure 11, above) and phocoenid (Figure 12, below) porpoises with short snouts were abundant by the Middle and Late Miocene, and today most porpoises and dolphins are of this more advanced type. The coloration of the delphinid is of a generalized nature, such that the patterns of many living species could be derived from it. That extinct phocoenids fed upon cuttlefish, as in this representation, is unknown.

Figure 17. Ancestors of the modern Fur Seals were known in the Late Miocene or Early Pliocene. Here, a female *Pithanotaria* suns on a waveswept promontory in the area of what is now Santa Barbara, California. This animal may have been smaller than living Fur Seals, but differed only slightly from them.

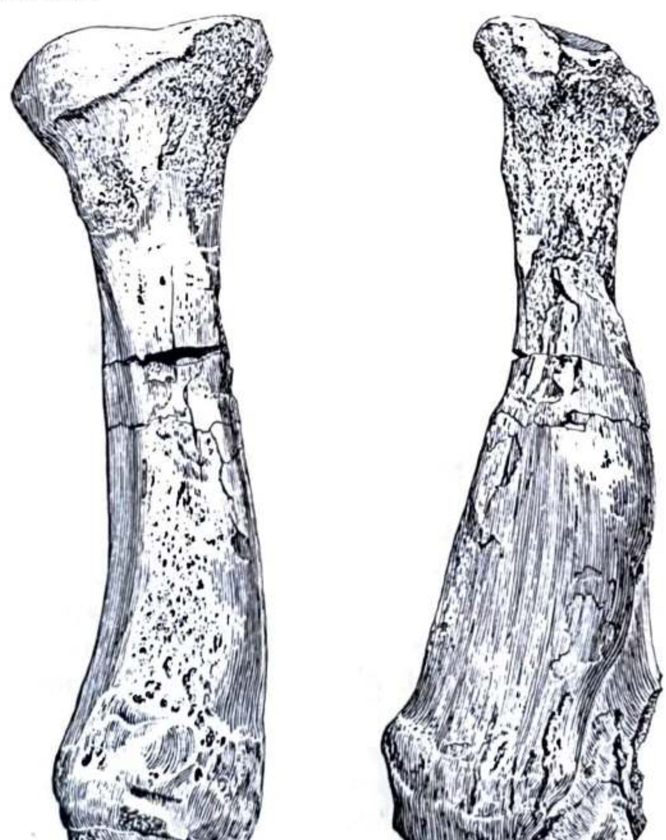


Figure 18. This radius or fore-arm bone beautifully illustrated by Miss Mary Butler, was found in the sea cliffs at Santa Cruz and is one of the few indications that walruses once inhabited the California coastline. This Pliocene walrus was much like the modern species but had proportionately shorter limbs.

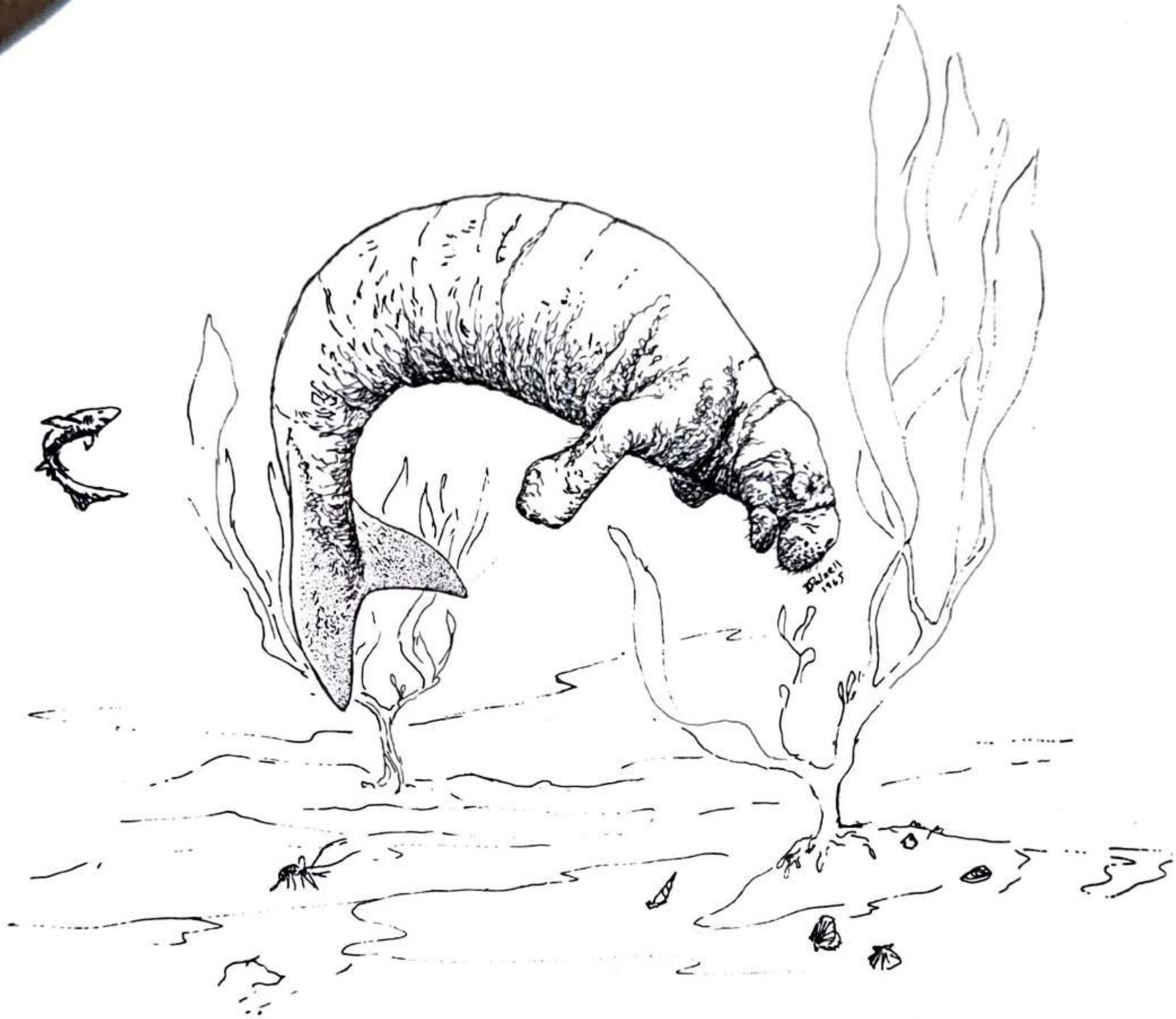


Figure 19. Only a few fossils of this sirenian, *Halianassa*, are known from California, but the available evidence suggests an animal like the living Dugong but with different proportions as shown in this restoration. A true marine herbivore, this sirenian probably frequented inshore waters in association with sea lions and small cetaceans.

the Pliocene, but not much is known of them. Sea lions, dolphins and porpoises, whales, seals, and other species were essentially modern types. The living sea otter appears in the latest Pliocene or earliest Pleistocene. Indeed, had one been able to cruise along the reefs and shingles of the California Coast in a boat a few million years ago, the marine mammal fauna would have appeared different only to a specialist in such matters. A dugong or two might spoil the illusion of modernity, but only until one remembered that the Steller Sea Cow can be considered a part of the modern fauna because it was hunted to extinction by man in the Bering Sea as late as 1768.

Marine mammals have been but little affected by the Pleistocene extinction which wrought such havoc with larger land mammals. Most of the living species of whales and seals are known or can be expected from the Pleistocene. But climatic fluctuations associated with the various ice ages probably helped shape new marine mammal species by forcing separation of some populations during climatic extremes.

In brief, it appears that desmostylians, cetotheres, squalodonts, long-beaked porpoises, otter-like carnivores and sea-lion-like pinnipeds occupied the eastern North Pacific in the Early Miocene. These marine mammals all carry through into Middle Miocene assemblages, with the addition of many short-beaked porpoises and dolphins, abundant sperm whales and diversified cetotheres. But by Late Miocene times there was wholesale extinction or emigration of desmostylians, cetotheres, squalodonts, long-beaked porpoises and some archaic sea

An Introduction to the

Biology of Marine Life

Second Edition

James L. Sumich
Grossmont College

wcb

Wm. C. Brown Company Publishers
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Protozoa

The phylum Protozoa encompasses a variety of microscopic animals. The unifying characteristic of the Protozoa is their unicellular nature. All protozoans consist of a single cell or are parts of loose aggregates of cells. Protozoans are structurally quite complex, and some biologists prefer to think of them as very small acellular animals rather than unicellular ones. This phylum includes the familiar freshwater *Amoeba* and *Paramecium,* some parasites, and many marine forms.

Marine protozoans are abundant in the plankton and also on the bottom. Asexual reproduction by cell division is common. Sexual reproduction, when it occurs, is often quite complex.

The order Foraminiferida is mostly marine. Its members are common in the plankton, but most are benthic or live attached to plants and other animals. Most "forams" are microscopic, although individuals of a few species are several mm in size. They have internal chambered shells which usually are composed of calcite ($CaCO_3$) or cemented sand grains. Penetrating this shell, or **test,** are numerous strands of cytoplasm called **pseudopodia** (fig. 3.1). The pseudopodia are used for locomotion and for collecting food.

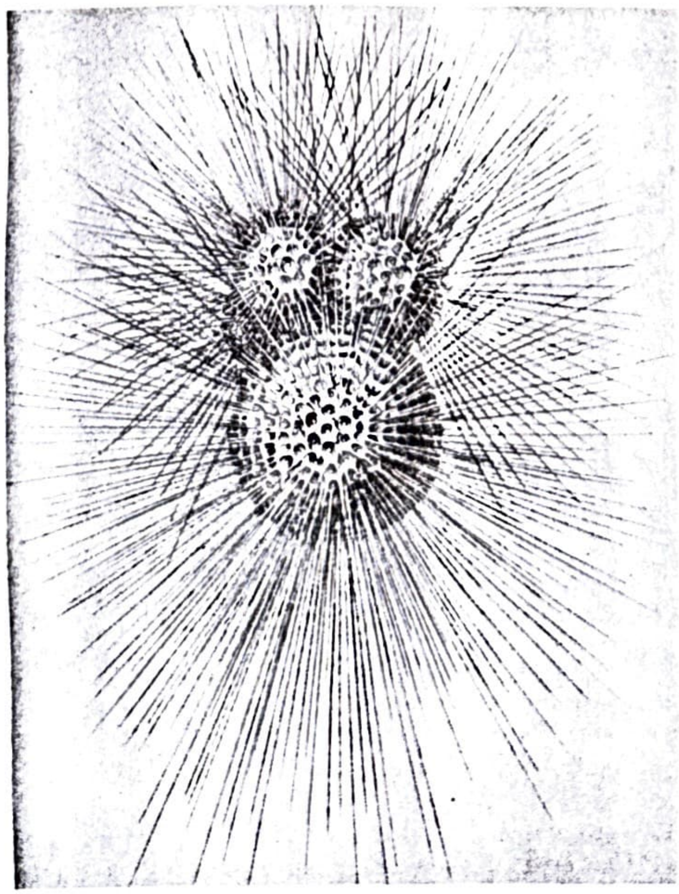
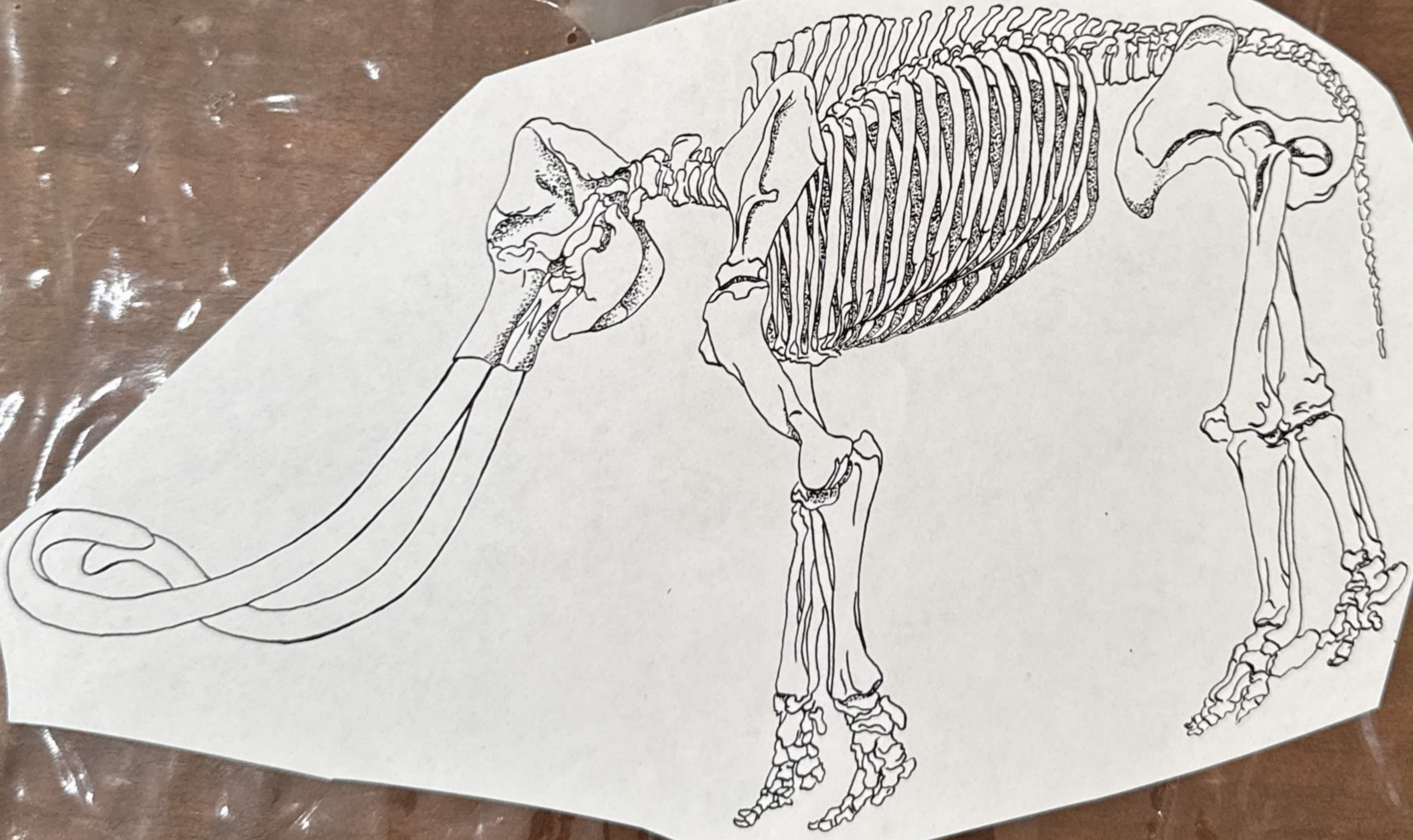
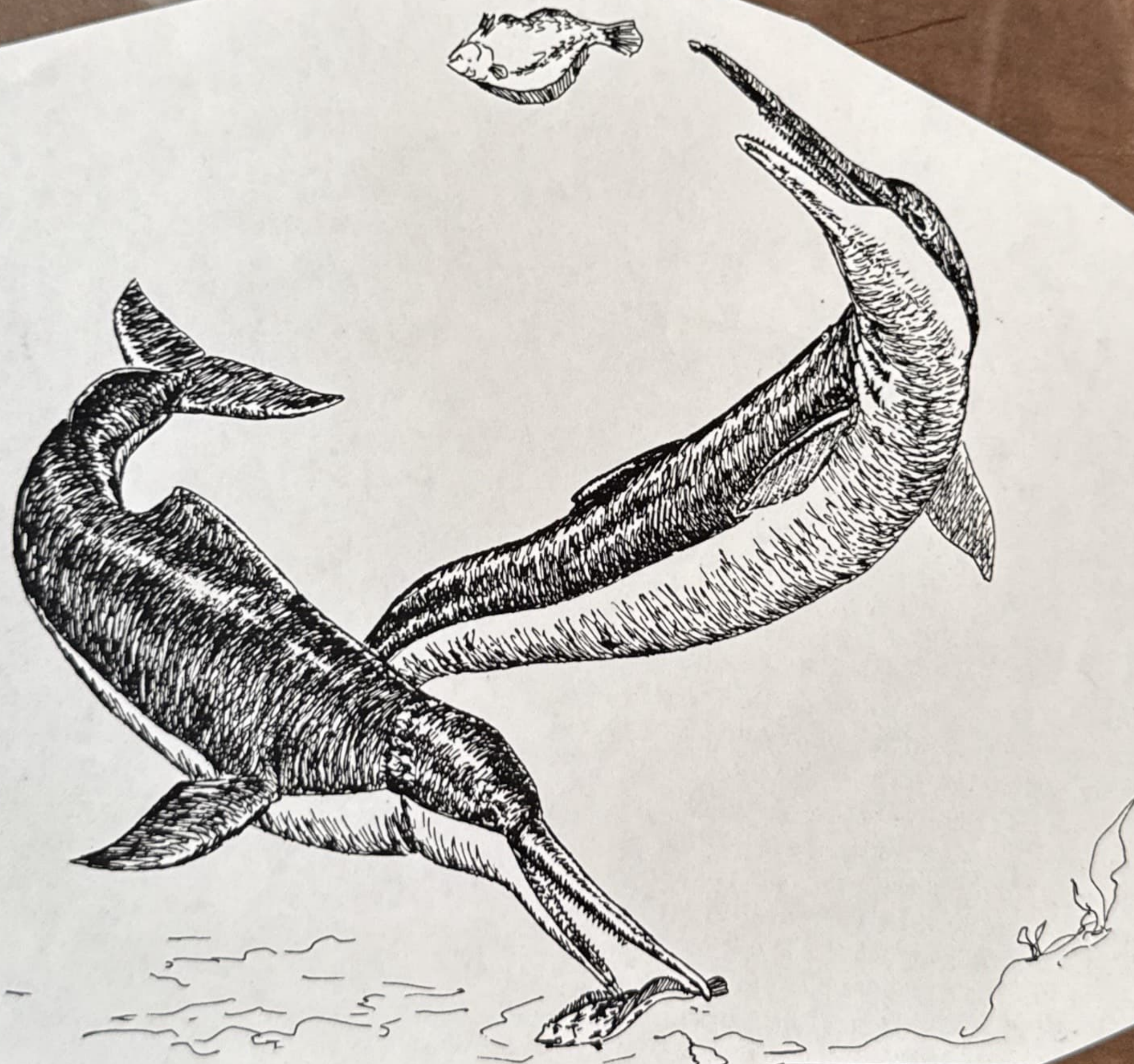


Fig. 3.1 A foram, *Globigerina,* with extended pseudopodia. From Brady 1884.



Imperial Mammoth

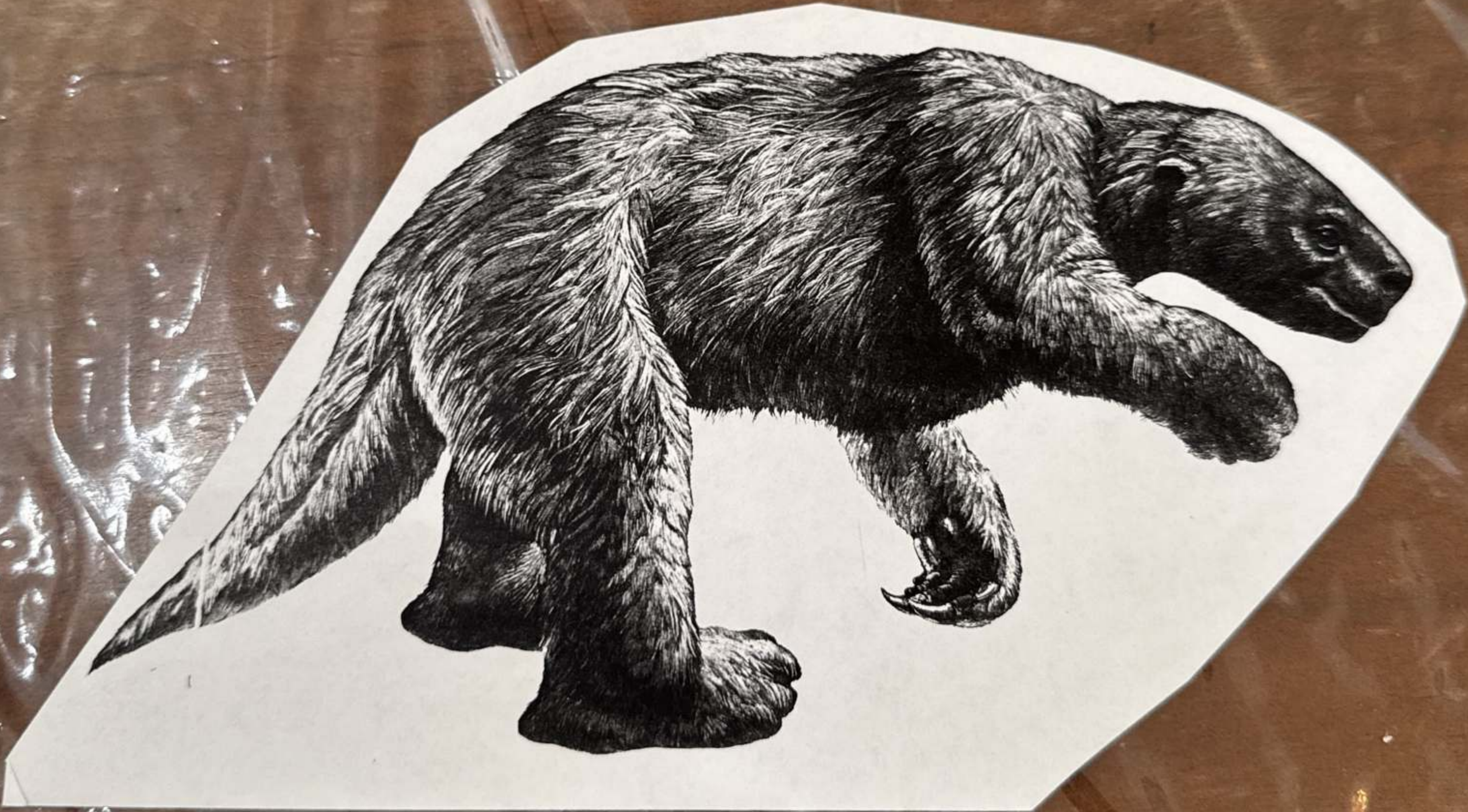


Early Miocene

long-snouted
porpoise

Saber Tooth
Cat

1.3
(1 of 5)



1.3
(1 of 5)

ground
sloth

ECOLOG

Record set straight on source of oil

John Westcott/The Register

The chalky white cliffs on Newport Beach's Back Bay are the remnants of diatoms, the tiny creatures from which Orange County got its oil.

The next time you ponder the question of where oil comes from, don't think big, as in dinosaurs. Think tiny, as in diatoms.

It seems natural to think of huge, lumbering dinosaurs leaving us those deposits of oil, and one oil company implied that was the case in a commercial aired several years ago.

But dinosaurs had nothing to do with it, said Carol Stadum, a geologist specializing in Orange County's past. In fact, dinosaurs never even lived in what is now Orange County, where rich reservoirs of oil have been tapped over the years.

The real source of all that oil is a microscopic, single-celled creature called a diatom.

Living in both fresh and salt water, diatoms are tiny water plants that have the ability to pull silica out of the water and form a glassy cell wall. Diatoms also produce much of the world's oxygen, Stadum said.

Diatoms occur in many shapes and sizes, and because diatom species easily are identifiable from their sturdy glass shells, they are invaluable to scientists. Because species have been pinpointed for different geologic time periods, ancient sediment can be dated by the types of diatoms in them.

Conditions in early "Orange County" — which millions of years ago was a warm, shallow ocean — apr[illegible] fect for [illegible]

Plenty of underwater volcanic activity and silt from river runoff ensured a big supply of silica in the water from which diatoms could draw, enabling them to bloom periodically to massive numbers before dying and falling to the ocean floor. A single diatom can bloom into a billion within a month, she said.

Oil production — a long, complex process of compression and heat over millions of years — requires stagnant conditions in which the water isn't circulated and oxygenated.

Dinosaurs have left spectacular fossils, but died under circumstances that made oil production very unlikely, Stadum said.

"Vertebrates don't die under stagnant conditions," she said.

Dinosaurs were never residents of Orange County, she said, because the huge reptiles of the central United States were separated from the West by an inland sea.

Besides the oil deposits that made boom towns out of Brea and Huntington Beach early in this century, other vestiges of ancient diatoms remain. The most obvious are the chalky white cliffs, about 15 million years old, that hover over Newport Beach's Back Bay area.

Oil would have developed from the softer, organic remains of the diatoms and not their shells, and later migrated into porous sandstone before man arrived to tap it. But the chalky material, called diatomite, has other uses. The diatomite found along parts of the coast from Monterey to Orange County, and called the Monterey Formation, has been mined for use as cigarette filters, swimming pool filters and polishing powders.

But don't expect Newport's white cliffs to be mined anytime soon.

"It could be," Stadum said. "But the land is just too valuable to be used that way."

— **John Westcott**/The Register

Los Angeles Times

FOSSILS: Digging the Old Bones in San Dimas

Marilyn Morgan beside plaster-covered jawbone of whale recovered at San Dimas building site.

LOU MACK / Los Angeles Times

Continued from Page 1

species of prehistoric dolphin, Barnes said.

"We should be seeing a lot more fossils from the San Gabriel Valley, but we don't have people following the tractors at every site," Barnes said. Now, he said, most fossils are "being ground up and made into fill."

Heinz Lumpp, director of community development for San Dimas, said that city began to require paleontological monitoring of its southwestern hills—known as the Via Verde area—about four years ago.

Lumpp said the decision to monitor such sites came about by accident as a result of a city Planning Commission request for a study of archeological artifacts in the Via Verde area, which Indians are known to have traversed. While conducting its study, the survey team discovered some fossils and reported that others would probably be found in the area.

Via Verde covers about 1,800 acres, Lummp said, and will be fully developed in the next five years. Paleontologists have monitored grading at three housing projects, and two of the three have produced significant fossils.

The first discoveries—a whale skull and other fossils—were made at a 260-acre site being developed for 262 homes by J. M. Peters. The most recent discoveries were unearthed at a 234-acre, 271-home project being graded by Boulevard Enterprises and Anaheim Hills Development Corp.

Grading began last week at a third site, a 140-acre, 189-home development by Standard Pacific Corp., but no fossil discoveries have been made there.

Grading at two sites developed by La Linda Homes and Shuwa Investments Corp. was approved before the paleontology policy was adopted.

City Manager Bob Poff said San Dimas officials are encouraged that fossils have been found in the Via Verde area as a result of the policy.

Lumpp said he thinks it is important to protect such resources despite the extra cost to developers.

Paleontologist Rodney Raschke, a partner with Morgan and Weir in Mission Viejo-based RMW Paleo Associates, declined to say how much his firm has been paid for the work done on the two San Dimas projects.

But the president of another company, Scientific Resource Survey Inc., said her firm charges $100 to $200 a day for such work.

"It depends on the qualifications of the paleontologist and the project," said Nancy Whitney-Desautels.

Constant monitoring is necessary in only a few cases, Raschke said, and some sites require the presence of a paleontologist for only a few hours a week.

Raschke said some developers fear that discovery of fossils might lead to costly construction delays. But, he said, such delays are rare.

He said it took two paleontologists two days to remove and package the most recent fossils found in San Dimas. The project did not cause grading delays because the graders were able to work around the area.

While San Dimas has led the San Gabriel Valley in working to preserve fossils, other cities appear to be unaware of the potential for similar finds in their areas.

Although the state Environmental Quality Act requires cities and counties to study the effects of proposed construction on the environment, it does not require a paleontologist to be on site during grading.

Some city officials said they rely on archeological studies to determine if an area might contain fossils. But Raschke said that unless archeologists have training in paleontology, they may not correctly identify fossil-rich sites.

"They are completely different disciplines," Raschke said. "Archeology looks for surface resources left by humans. Paleontology looks for subsurface resources left by nature."

Raschke said that some city officials are not aware of the difference. "They hear 'paleontology,' 'archeology' and 'geology' and it all runs together after a while," he said.

In West Covina, Assistant Planning Director Kenneth Hunter said that about 500 acres of hilly terrain will probably be developed over the next five years. Hunter said that an archeologist examined the site and determined that fossils found there would be of little scientific value.

As for the possibility of finding fossils in West Covina, Hunter said, "I don't think it has been a great concern to this department."

Portions of Walnut, south of San Dimas, lie in the the same geological formation that produced the whale fossils in San Dimas, Raschke said.

However, a paleontologist was not on site at the time when 800 acres of hilly Walnut terrain were graded in 1980 and 1981 for a 2,000-lot housing subdivision, said Planning Director George Schindo. He said the decision not to use an on-site paleontologist there was based on an archeological study that indicated that no significant fossils would be found.

"The bottom line is monitoring," Raschke said. "The hills have produced tantalizing little tidbits, but nothing really concrete.

"So often we're not able to collect them before the building is built," he said. "The faster they build, the more fossils they destroy."

Article I told you about

LOU MACK / Los Angeles Times

Paleontologist Marilyn Morgan with several fossils she has uncovered at Via Verde construction site in San Dimas.

Paleontologists Get Those Old Bones Out as Bulldozers Move In

By RENATE ROBEY, *Times Staff Writer*

Even as workers used heavy equipment to scrape away layers of earth at the San Dimas construction site, paleontologist Marilyn Morgan searched the area on foot carrying a small brush, an ice pick and a hammer.

Morgan was looking for the fossilized remains of marine life from an era—scientists say it was about 10 million years ago—when the San Gabriel Valley was part of the Pacific Ocean.

"The things that we pick up will help people in the future understand what happened on this planet in the past," Morgan said.

1985

Los Angeles Times
SAN GABRIEL VALLEY
Thursday, October 3, 1985

LOU MACK / Los Angeles Times

Paleontologist Marilyn Morgan with several fossils she has uncovered at Via Verde construction site in San Dimas.

2 whales in SG valley

Fossilized Remains of Whales

Earlier this year at the same site, Morgan discovered fossil remains of a whale, including two six-foot-long jawbones, along with bone fragments from sea lions and birds and several fossilized leaves. Last year, a colleague of Morgan's, Diana Weir, discovered the three-foot skull of a whale at a another construction site a mile away. The fossils from both sites have been shipped to the Los Angeles County Museum of Natural History for study. Museum officials say the discoveries are significant because they are among the very few fossils recovered from the San Gabriel Valley.

"The important thing is, if you don't get to them now you'll never see them," said Lawrence Barnes, curator of the natural history museum. "Once they (the sites) are built on, you don't get another chance."

Barnes and other paleontologists said that hundreds of other fossils could be retrieved from hilly areas in the San Gabriel Valley if more cities and unincorporated areas required on-site paleontological monitoring. He cited Alhambra, Covina, Diamond Bar, La Puente, Pomona, West Covina and Walnut as other areas that might be rich in fossils.

On-Site Paleontologist Required

As it is now, San Dimas is the only city in the area to require on-site monitoring of grading in a fossil-rich area. Under the policy, a developer must agree to retain an on-site paleontologist before plans are approved by the city.

Barnes said the San Gabriel Valley has the same kind of rock with the same potential for producing fossils as Orange and Kern counties, where more than 350,000 fossils have been unearthed in the last 15 years. Both of those counties have designated areas in which paleontological monitoring is required.

The discoveries there led to the recent identification of a new

Please see FOSSILS, Page 5

Imprint of a 10-million-year-old herring is found in a rock.

VIA VERDE CONSTRUCTION ACTIVITY