MCZ newsletter
MUSEUM OF COMPARATIVE ZOOLOGY

Harvard University
Cambridge, Massachusetts
Volume 3, Number 3
Spring, 1974

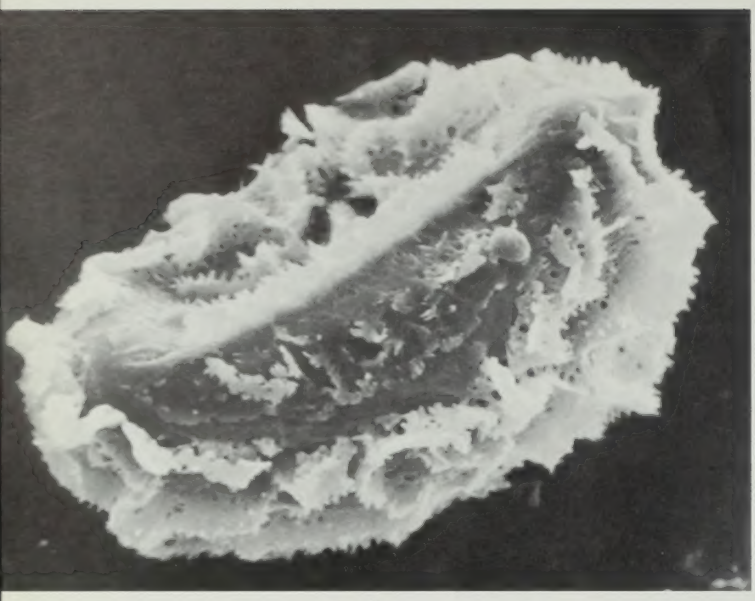
NEW LIVING INVERTEBRATES HALL PLANNED

A view of the Marine Invertebrate Section of the new Living Invertebrates Hall is shown in this rough working drawing by Carol Campbell, Exhibits Preparator. The exact contents of all the cases have not yet been determined but there will definitely be a giant octopus suspended from the ceiling. Gifts to help complete particular cases will be actively sought and a descriptive brochure will be available in the Fall.

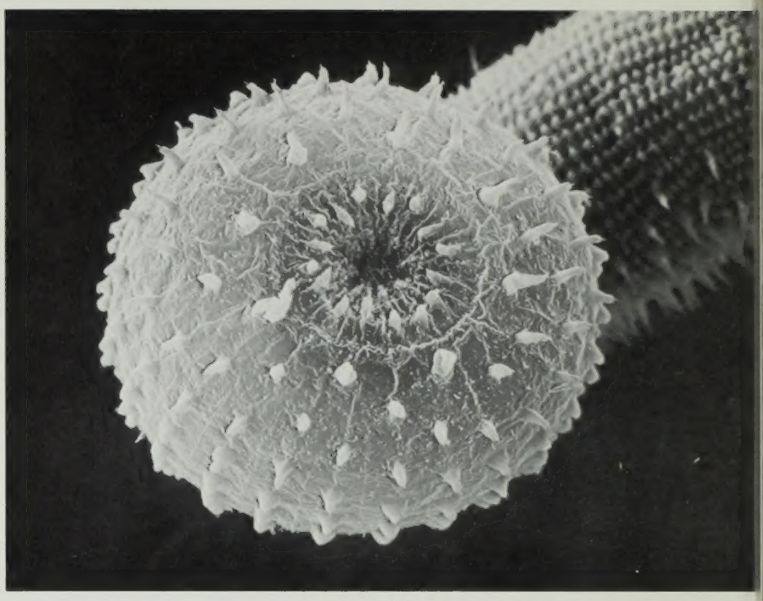
The challenge of creating an entirely new exhibit hall devoted to living invertebrates has inspired the MCZ's large staff of curator/professors in this area. The MCZ's unusually fine material will be displayed in such a way as to complement the teaching curriculum of the basic biology courses on invertebrates. Besides the displays of the major groups, there will be exhibits detailing life histories and ecological relationships. Ant hills and insect nests will demonstrate the complexities of insect social behavior.

It is hoped that in the years to come, as other exhibit halls are refurbished and updated, they will also be planned in conjunction with the teaching of basic courses in the appropriate areas.

Exhibit Preparator Carol Campbell is being expertly assisted by Dr. Martin Naumann, an entomologist, and they project that the new hall, which will be completed in sections, will be finished within two years. Formerly one of the glass flower halls and part of a space swap with the Botanical Museum, it will form a striking entry point to the exhibit area of the MCZ.



a)



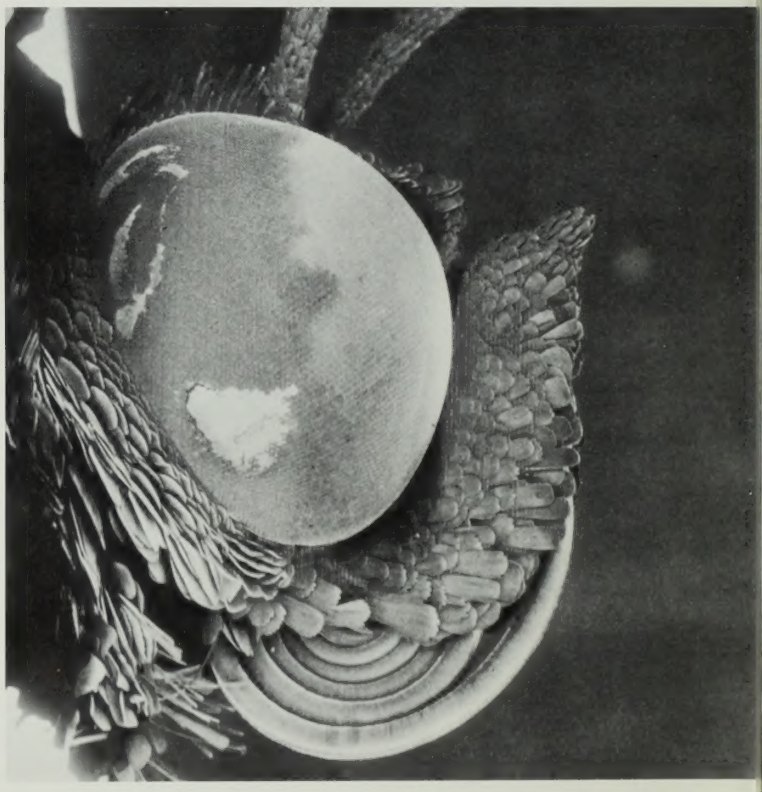
b)

WHAT ARE THEY?

(Answers on next page)

c)

d)



The MCZ Newsletter is published three times a year by the Museum of Comparative Zoology, Harvard University, Oxford Street, Cambridge, Massachusetts 02138; A.W. Crompton, Director.

Editor: Gabrielle Dundon
Photographers: A.H. Coleman
Paula Chandoha

One of the results of Photographic Assistant Paula Chandoha's winter trip to Kenya and Tanzania with her animal photographer father. These lion cubs live on the Masai Mara Game Reserve, Kenya.

IN THE SPRING
THE BIRD DEPARTMENT GOES TO COLOMBIA

For the third consecutive year, through the financial support of some loyal friends, Dr. Raymond A. Paynter, Jr., Curator of Birds, took a group of undergraduate students south during the Spring recess. This year they returned to Colombia where Dr. Paynter introduced his students to the most diversified birdlife on earth and to Colombia's great variety of habitats, ranging from Andean tundra to tropical rainforest.

The group drove more than 1000 miles in central Colombia, much of it over dirt mountain roads, unsullied by guard rails. They were fortunate to see some of Colombia's fast-disappearing montane, as well as other habitats now vanishing from more populated parts of the country. Despite narrow roads, rain, and landslides, disaster nearly struck only twice: once when a mudslide had covered the road and once when the car had to be pushed from the edge of a cliff 150 feet above a rushing mountain stream.

Although the trip was intended as an introductory overview of the enormously rich avifauna of South America, students John Fitzpatrick and Richard Webster were lucky in that they were able to observe many of the species they have been studying in the museum. Dr. Paynter and Steve Simkins had less success with "their" species, while David Duffy, after two trips to Colombia, is still looking forward to spotting his first Torrent Duck, the species he has been working on.

ANSWERS:

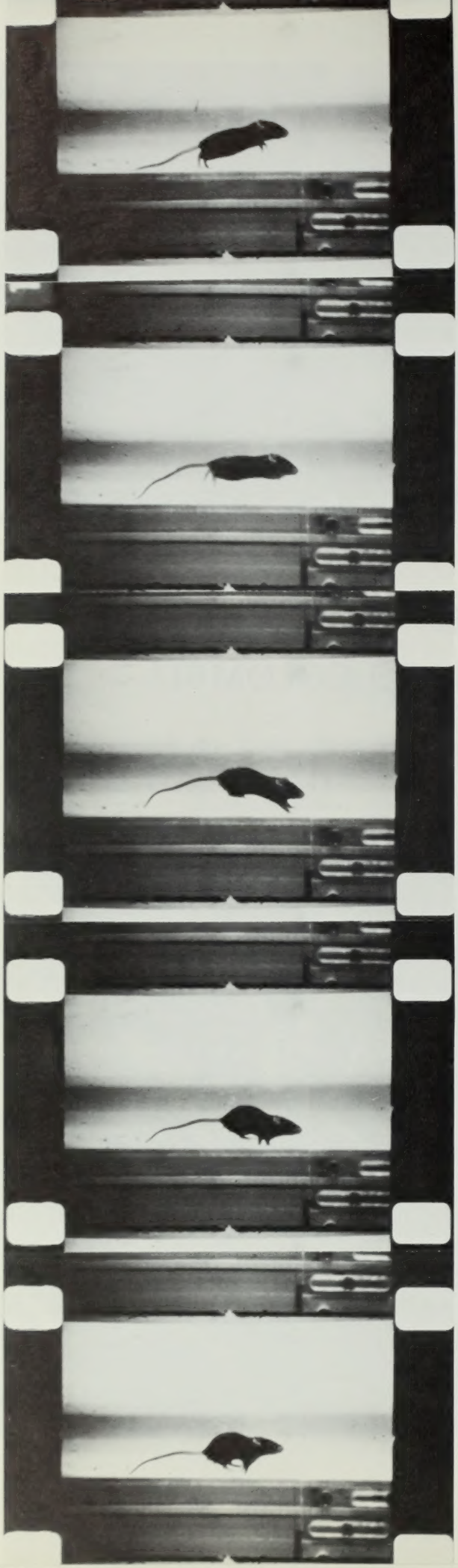
a) Massachusetts fern spore magnified 1980 times, photographed by Dr. Alice F. Tryon. The complexities of this infinitesimal spore were hidden to human eye before the advent of the scanning electron microscope.

b) A view into the mouth of a priapulid worm magnified 230 times, photographed by C. Bradford Calloway, graduate student in invertebrates. The tubules of this tiny creature (it is no larger than a millimeter, approximately the same size as the grains of sand it lives between) are newly visible with the aid of the scanning electron microscope.

c) A fly's eye. The facets of a sciomyzid fly's eye magnified 2400 times, photographed by Dr. Robert E. Silberglied. It is composed of many facets which together provide information to compose "mosaic" images.

d) The head of the butterfly *Eurema lisa* magnified 41 times, also photographed by Dr. Silberglied. The round object in the center is the eye, the antennae extend above it, and the coil is the "tongue".

Why the photographs and why the answers? Simply to announce that, thanks to a very generous grant from the National Science Foundation, it will soon be possible to take photographs like these on the MCZ's own scanning electron microscope to be located in the basement of the MCZ Laboratories. Needless to say, the addition of such a useful research tool is an important event in the life of an institution and the entire staff is indebted to the dedicated efforts of the SEM Committee consisting of Drs. J. F. Lawrence, R. E. Silberglied (Chairman), A. F. Tryon (of the Gray Herbarium), R. D. Turner and R. M. Woollacott.



With seemingly limitless ingenuity, a large number of students are using a variety of techniques and a diverse menagerie of animals to answer some basic questions about locomotion, mastication, structure, and physiology. With the guidance, frequently accompanied by amazement and/or consternation, of Professors C. Richard Taylor, A. W. Crompton, Karel F. Liem, and Farish A. Jenkins, Jr., the students have constructed experiments using imaginative variations of basically simple techniques.

Locomotion

How do you measure the energetic costs of locomotion? By constructing a treadmill, letting the animal run on it, and measuring the oxygen consumption. If the animal is a vertical climber, like a flying squirrel for instance, you construct a vertically-moving treadmill and add bark to simulate a tree. This device enabled Tom Shatten to study how the flying squirrels' claws provide support for gripping and to examine how the claws on the hind legs rotate, allowing the animal to run down as easily as up. Cats, on the other hand, do not possess this rotating mechanism and that's why firemen often have to rescue them out of high treetops.

Polly Parsons and Tom Holton are studying the energetics of forelimb swinging (brachiation) by using spider monkeys on a specially-constructed aerial treadmill. They are using film analysis to find out whether the monkeys act as pendulums when they brachiate.

Spider locomotion is Bill Kirber's project and while his trained tarantulas stroll on a treadmill, he's observed that spiders only have muscles to bend their legs; they stretch them by means of fluid pressure (in the same way that worms move). With the aid of electromyography, a device which records the electrical activity during muscle movement, he is able to ascertain when and how pressures are generated and coordinated.

Jamie Deckoff has constructed a "pegmill" to measure snake locomotion. Snakes move with the aid of vertical projections (they are practically incapable of moving on a sheet of glass) and with the use of adjustable pegs Jamie hopes to be able to measure the "stride" of different sized snakes. She is working with several black racers, a corn snake, and a seven-foot reticulated python (which used to be part of the act of a stripper in Boston's Combat Zone!).

Comparative stride and gait is also being studied by Norman Heglund. With the aid of a treadmill and high-speed film he is comparing the stride frequency and gait of different sized animals to determine the relationship between animal size and the energetic costs of locomotion. At which point does a mouse or a horse change from a trot to a gallop? The mouse on the left cooperatively allowed itself to be filmed in action. A visit to a local race track was necessary to measure the horse's gait and stride frequency.

Mark Sullivan and Alec Danso are making a similar study on bipedal running. They are using humans, turkeys, pheasants, quail, and possibly monkeys to find out if hopping is really bipedal galloping.

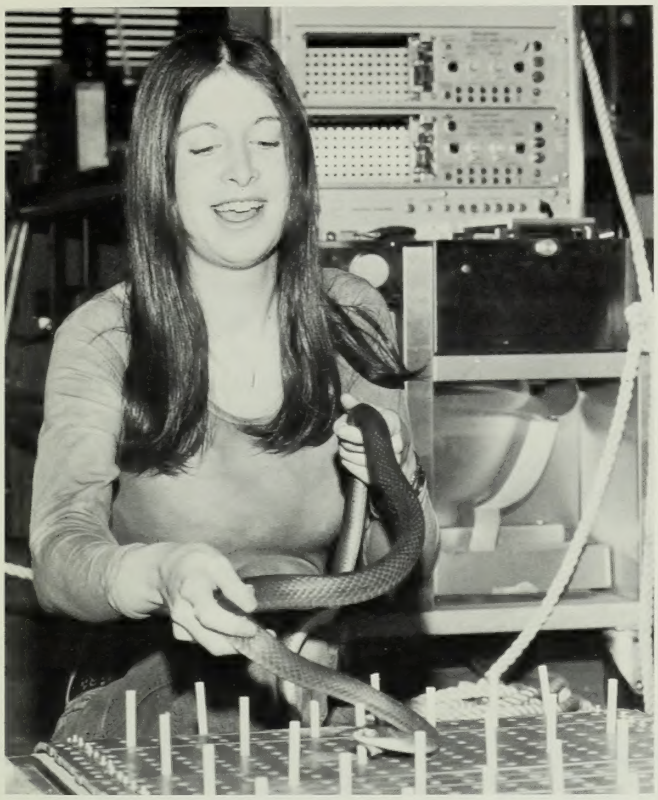
Is kangaroo hopping analogous to pogo-sticking? This is the question being asked by Pam Chassin and Roy Geronemus and they are comparing height of jump, oxygen consumption, hop frequency, and angle of take-off of both kangaroo and pogo-sticker to find out.

X-Ray Studies

X-ray films allow the researcher to study structural-functional relationships in action. Scott Camazine is exploring the interrelationship between the hindlimb posture, movement, and pelvic structure in the raccoon, the red fox, and the cat; Thayer Simmons is interested in the function of the superficial muscles on the cat's femur; Tom King is concentrating on the ankle of a variety of animals (and claims to have brought a hitherto undescribed joint to light); and Rick Bassett is studying the ankle and foot of the crocodile.

That mice gallop can be seen in this sequence from Norman Heglund's high speed film. A mouse's legs move faster than the human eye can register and the fact that it gallops was not appreciated until high speed films were analyzed.

KANGAROOS AND POGO-STICKERS HOP, GEESE DROP OUT OF PLANES, MICE GALLOP TO PROVIDE ANSWERS TO STUDENTS' QUESTIONS



Jamie Deckoff coaxes one of her black racers to weave its way through her "pegmill".

The intricacies of jaw mechanics are also being subjected to x-ray scrutiny. Andy Chester has trained a rather vicious opossum to chew more or less on command, while Emmett Schmidt is tangling with a parrot whose large beak simplifies the recording of jaw movements while sharpening the defense mechanism of the researcher.

Physiology Experiments

Among the novel experiments being conducted by the students, perhaps the most dramatic involves dropping Canadian geese out of an airplane flying at 25,000 feet, with sensors implanted in the lungs, to find out how these birds, with hemoglobin similar to that of mammals, can breathe in such thin air. Tom Dryer, who is practicing on chickens, thinks the specially adapted plumbing of the respiratory system will provide the answer.

Jim Jagger is finding out if the primitive insectivore, the Madagascan tenrec, operates like a mammal or a reptile. It appears that it takes the best from both. A reptile requires about one-third of the energy it takes a mammal to run at the same speed, provided they are both the same size, but the reptile's temperature follows that of the environment while a mammal maintains its own constant temperature, giving it the advantage when it comes to activities like nocturnal foraging. The remarkable tenrec maintains a constant body temperature but does so with the low energy needs of the reptile. No doubt this animal will provide new insight into the evolution from reptiles to mammals.

One of Howie Seeherman's projects is the determination of the anaerobic (without oxygen) scope of mammalian muscle as a function of size. Gary Collin and Martin Kernberg are directly measuring the loss of heat through the blood flow to a dog's tongue during second stage panting (i.e., when it's very hot) to determine the tongue's effectiveness as a dissipator of heat.

It is easy to understand how the mammalian heart, with its four chambers, keeps the oxygenated and de-oxygenated blood separated. But how does the amphibian with its three-chambered heart manage it? To find out, Gordon Leff and Gerald Heslinga have surgically implanted catheters in some large horned toads to allow them to analyze their blood while they exercise.

Obviously, the awe-inspiring complexities of the animal kingdom are providing a lively challenge for this resourceful group of students. It is fortunate that the MCZ and Concord Field Station now have the modern scientific tools to make these studies possible.

To study the jaw and beak mechanism of a parrot, Emmett Schmidt x-rays it while the bird chews.

Professor Arthur J. Cain

A SPRING VISITOR

Professor Arthur J. Cain always seemed to be smiling during his spring visit to the MCZ as a Visiting Professor. He confessed he was "delighted to be away from the administrative responsibilities" of his position as Derby Professor and Head of the Department of Zoology at Liverpool University and revelled in his first opportunity in ten years to do some uninterrupted research. Professor Cain's broad interests include evolution, natural selection, the theory of taxonomy, and the history of biology and he shared some of his scholarship in these areas in several eloquent lectures, including two on Erasmus Darwin, "the grand analoger". He also lectured on his more specific research area, "Natural Selection in Banded Snails".

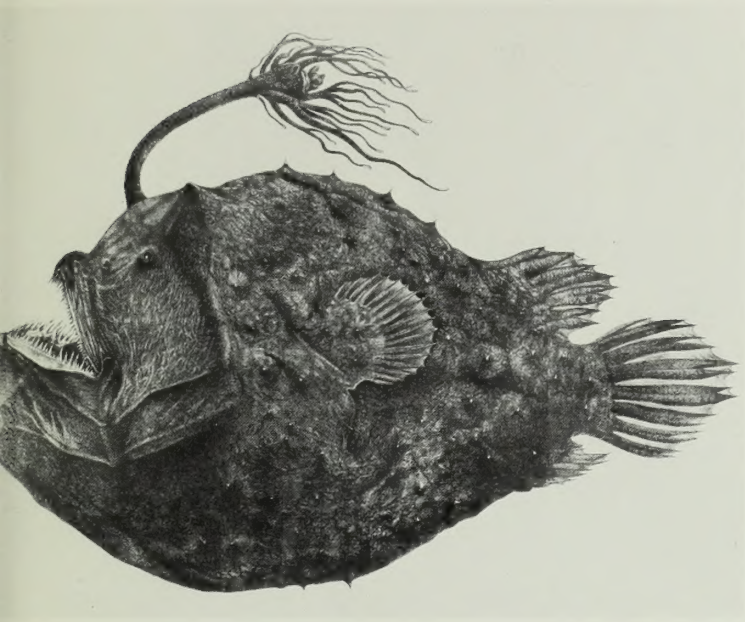
An active field biologist, Professor Cain has led expeditions to many parts of the world including the Solomon Islands, Guiana and East Africa. His book, *Animal Species and Their Evolution*, published in 1954, has been translated into four languages. An avid conversationalist, he is not loathe to share an irreverent anecdote about many of the illustrious scientists of the century.

One of the primary functions of a visiting professor is to serve as a gadfly, stinging the resident population into new awareness and giving it a fresh perspective. In this respect Professor Cain receives top marks. He managed to meet and talk with a large number of local scientists and his stimulating effect will be felt for a long time to come.

LIBRARY'S PICTORIAL TREASURES GET TAKEN TO THE CLEANERS

Caged in with the treasures of the MCZ Archives, Ann Blum, Archives Assistant, contemplates the future of one of the many invaluable paintings and drawings which are currently undergoing rejuvenation, thanks to a generous grant from the Massachusetts Council on the Arts and Humanities. It is appropriate that this latest chapter in the history of the relationship of the Museum to the State coincides with the 100th anniversary of founder Louis Agassiz's death. It was in 1859 that Agassiz first approached the legislature and convincingly pointed out the advantages to the State of supporting a teaching institution of natural history. He foresaw that teachers, students, agriculture, and morals all stood to benefit for generations to come. Fortunately for the MCZ, Agassiz's persuasiveness lives on today making it possible to preserve the important pictorial material cared for in the Archives.

ANGLING IN THE DARK



Female luring with her wormy esca (bait).

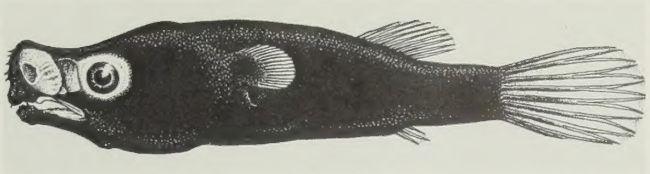
In the total darkness of the ocean's deepest depths lives a very strange group of fishes known as deep-sea anglers. They are thus named because the female lures males and food by means of an exotically-shaped esca (the Greek word for "bait") at the end of which is a bioluminescent organ.

Survival in the deep where the food supply is limited has resulted in extreme differentiation in the sexes. In fact, the differentiation is so extreme that the female may be as much as 25 times the size of the male. Only the females eat. The male's only function in life is to find a female and since this is not easy, given the low population density in this deep zone, once he finds one he often becomes parasitically attached to her by means of special hook-like teeth and shares her blood and consequently her food supply. Females have been found with as many as three males attached.

Hormonal communication by way of the blood probably synchronizes development of the male and female sex organs. Egg and sperm are shed simultaneously and fertilization takes place in the surrounding water.

Dr. Theodore W. Pietsch, who came to the MCZ's Fish Department from the University of Southern California this year, is studying these intriguing fishes despite obvious obstacles. Since they are narrowly adapted to a cold, dark, highly pressurized environment, it is almost impossible for them to survive at the surface. The longest Dr. Pietsch has been able to keep a female alive is eight days. So the research must be limited to the study of dead specimens.

One of the most remarkable features of these fishes is the enormous variety of the escae. They sometimes exceed the length of the entire fish and have all manner of curiously-shaped projections, which besides food, specifically attract the male of their own species.



Dwarfed male with large nostrils (the better to smell her with) and large eyes (the better to see her in the dark) with hooks poised ready to attach.

Lines to an Angler Fish

(for Ted Pietsch)

Aloof and quasi indestructible
For all the world like some religious sages
The angler ineluctable
Rests on its venter
And passeth for a piece of the rock of ages.

Casting for its bread upon the waters
The phony worm at the end of a dorsal ray
It robs the sea of sons and daughters
Converting, with a violent gulp,
Would-be predators to prey.

John M. Burns
December 5, 1973

FRIENDS OF THE MCZ TO GO TO SEA . . . .

. . . off Baja California next January 28 to February 4 to see gray whales, elephant seals, sea lions, volcanic islands, tropical birds, exotic fish and the other inhabitants of this wilderness area. The response has been enthusiastic and there are only a few more berths left on the boat, according to Herbert Pratt, President of the Friends. An extra three-day visit to San Diego to see the attractions, including the spectacular zoo, wild animal park, Scripps Aquarium, and Sea World, is optional.

On April 23, the Friends were treated to a fascinating lecture by Dr. Robert L. Trivers, Assistant Professor of Biology here at Harvard. His discussion of parent-offspring conflict gave a biological basis for the weaning period during which the mother-child relationship is characterized by the clash of opposing desires. After the talk the Friends gathered in the Agassiz Room to meet the speaker and each other.

FROM THE FIELD STATION

By William K. Newbury

There's good news on many fronts. Our efforts this past winter are bearing fruit. The Field Station will be buzzing with activity this summer with more than a dozen undergraduates, several faculty and over forty local residents all working on research projects in the Estabrook Woods.

We received $14,000 from the National Science Foundation to enable twelve undergraduates to carry out field projects this summer. The students, supervised by Harvard faculty members, will study insects in their different habitats (Dr. J. F. Lawrence), the forest canopy (Mr. C. D. Oliver), the behavior of wild bees (Dr. R. E. Silberglied), the population biology of violets (Dr. O. T. Solbrig), the land use history of the Estabrook Woods (Dr. D. S. Woodruff), and the biological productivity of a lake (Dr. W. H. Bossert). The students will complete honors theses based on the results of these studies.

Similar projects are being carried out by more than forty residents of the surrounding communities who responded to my announcement in the local newspapers. More than half have already begun their research. Obviously they want to complete their work before the mosquitoes come out! In fact, Peter Rubel, the son of an MCZ Friend, has already completed a project. He has identified and aged specimens of 14 tree species found in the Woods, and signs are now being prepared to display the information on those particular trees.

With the help of 50 local volunteers, we conducted a study of winter recreation in the Estabrook Woods during February. As one of the few large areas close to Boston with good trails and no roads or houses, it is a valuable area for hikers and cross-country skiers as well as for biologists and ecologists. With a good snow cover more than 600 people per day used the Woods for recreation on weekends, and 80% of those people were skiers. When the ground was bare, however, only 200 people visited the Woods on a Saturday or Sunday. People traveled from all over eastern Massachusetts to this area. Now that we know the magnitude of winter recreation there, we plan to monitor the impact of this use on the ecology of the area.

We are very excited about both the results of our pilot projects and the interest and enthusiasm of the participants. We are about to submit an application to the National Science Foundation seeking funds to run our field study program for the next three years. We are keeping our fingers crossed.

Photo by Robert E. Silberglied

Spring slithers into the Estabrook Woods.

JOINTS STUDIED AT CONCORD FIELD STATION

Why do some animals (including humans) get arthritis while others don't? Dr. Eric Radin, an orthopedic surgeon at Children's Hospital, is investigating how the natural defense mechanism in some animals (like rabbits) prevents them from developing arthritis when the bones and joints are subjected to enforced exercise while others (sheep, for instance), get the disease.

The activities of daily living subject animals' bones and joints to repetitive impulsive loads. Animals are constantly shifting positions, even in sleep. Dr. Radin wants to know why this constant load-shifting takes place (can the body not withstand steady loads?), and how this affects body wear. It is known that the spongy porous bone at the ends of the long bones just under the joints (which differs markedly from the hard dense bone along the middle of the bony shafts) works as a shock absorber. With repeated shocks the spongy bone normally cracks and upon healing, can be stronger but less absorbent to shock. Under such circumstances, the joint may degenerate.

Using the facilities of the Concord Field Station and ably assisted by Pamela Hall, Charles Prodd, Ted Nalwalk and some rabbits and sheep, Dr. Radin hopes to find a cure more effective than the ones currently available for this prevalent but poorly understood condition. The other members of Dr. Radin's group bring expertise in other disciplines to bear on the problem, allowing it to be viewed from several perspectives. These include Igor Paul, Professor of Mechanical Engineering (who builds the testing equipment); Robert Rose, Professor of Metallurgy and Material Sciences (who understands bone as a material), both at MIT; and Dr. Alan Schiller, a pathologist at Massachusetts General Hospital. Dr. Radin studied comparative anatomy at Amherst before attending Harvard Medical School and brings his keen interest in structural-functional relationships to bear in both his clinical and research work and in his occasional lectures to the course on vertebrate evolution, Biology 139.