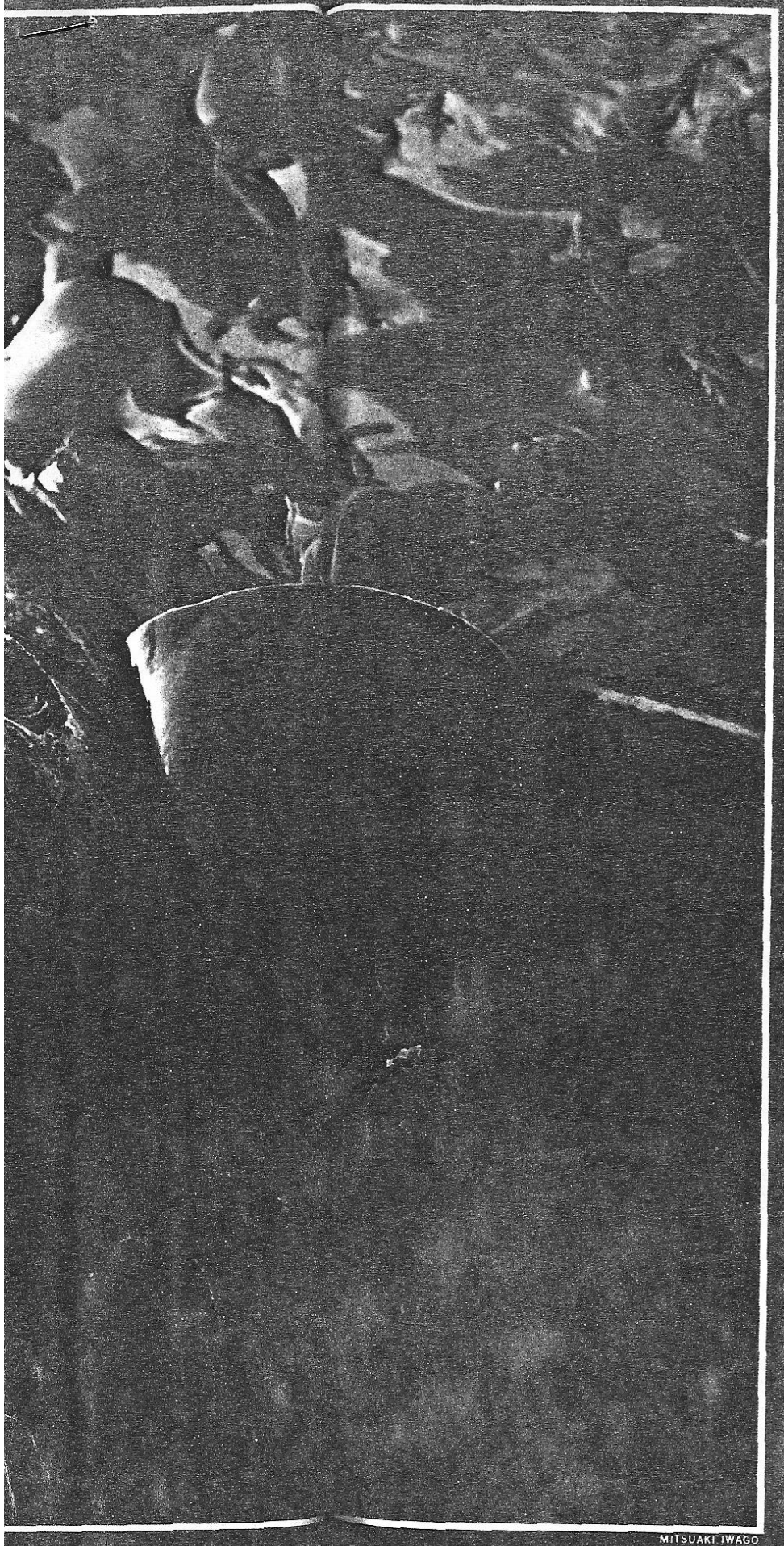


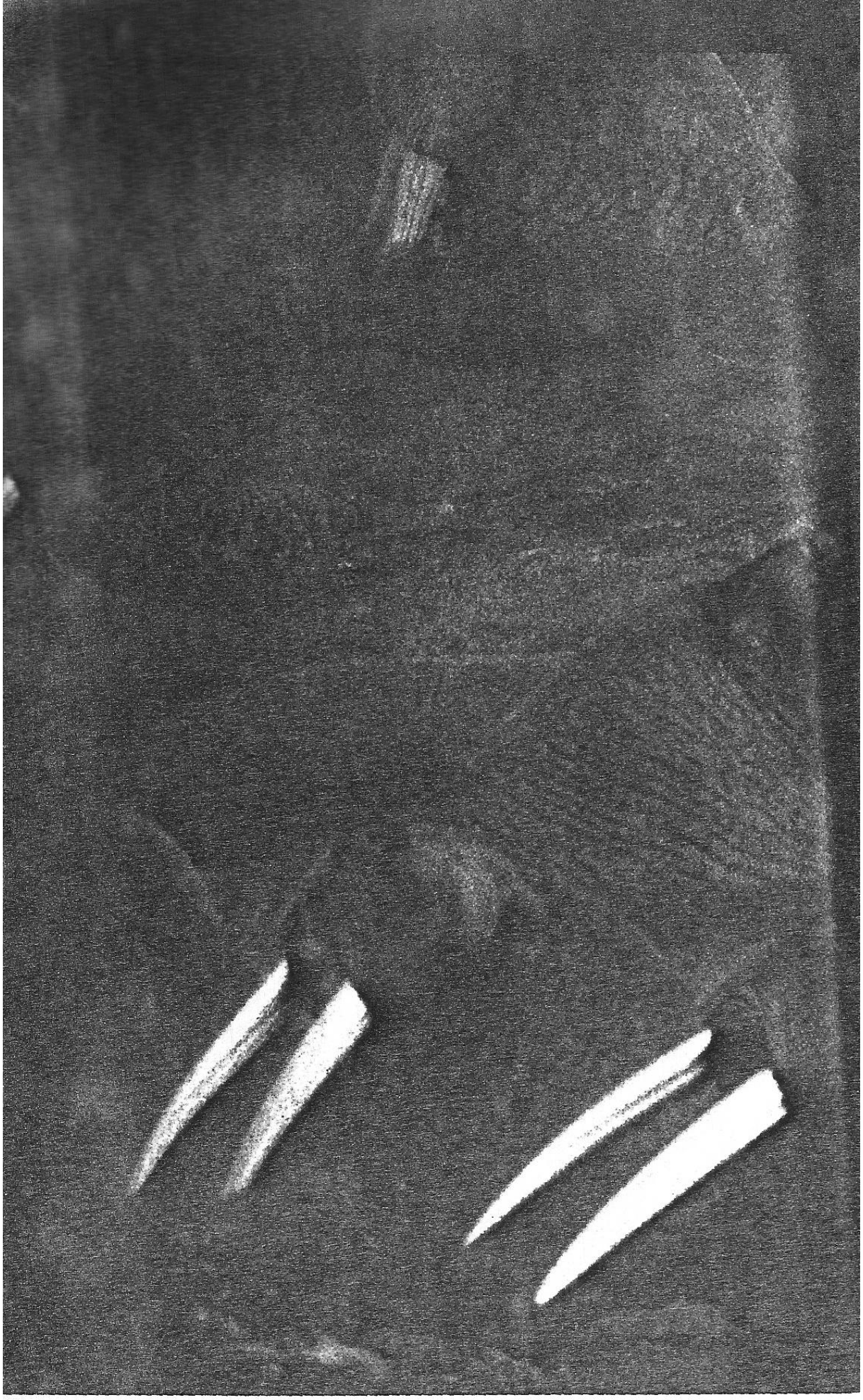
MITSUAKI IWAGO

Pushed to the brink of extinction by centuries of exploitation for furs and oil, pinnipeds–or "fin-feet"–have rebounded, thanks to their natural resilience. But new threats created by man's negligence pare away at some populations of

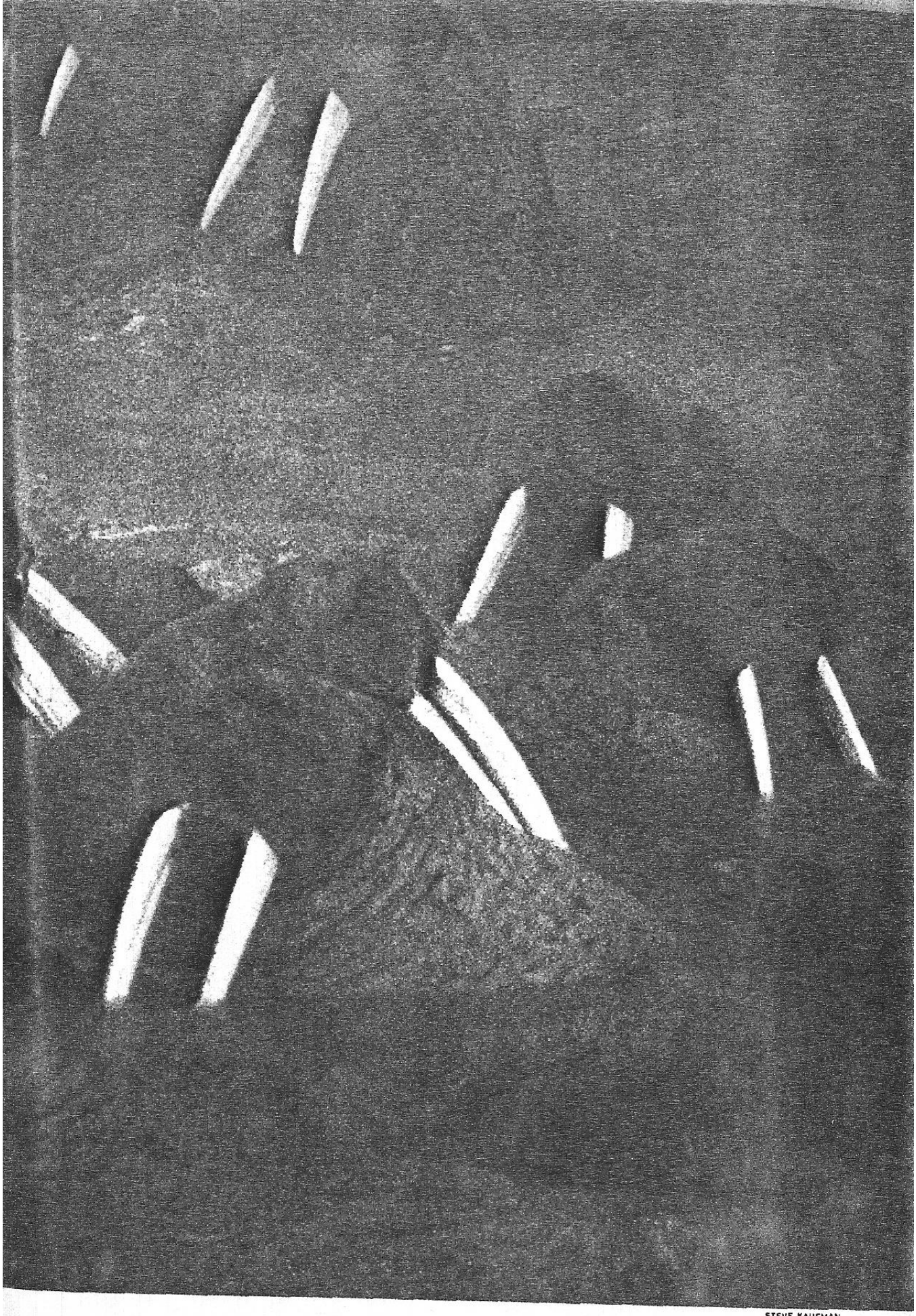
Seals and Their Kin

By ROGER L. GENTRY

With rasping growl, a southern elephant seal warns an intruder on the Kerguélen Islands in the Indian Ocean. These are the largest pinnipeds—amphibious mammals with paddle-like limbs that include seals, sea lions, and walruses.

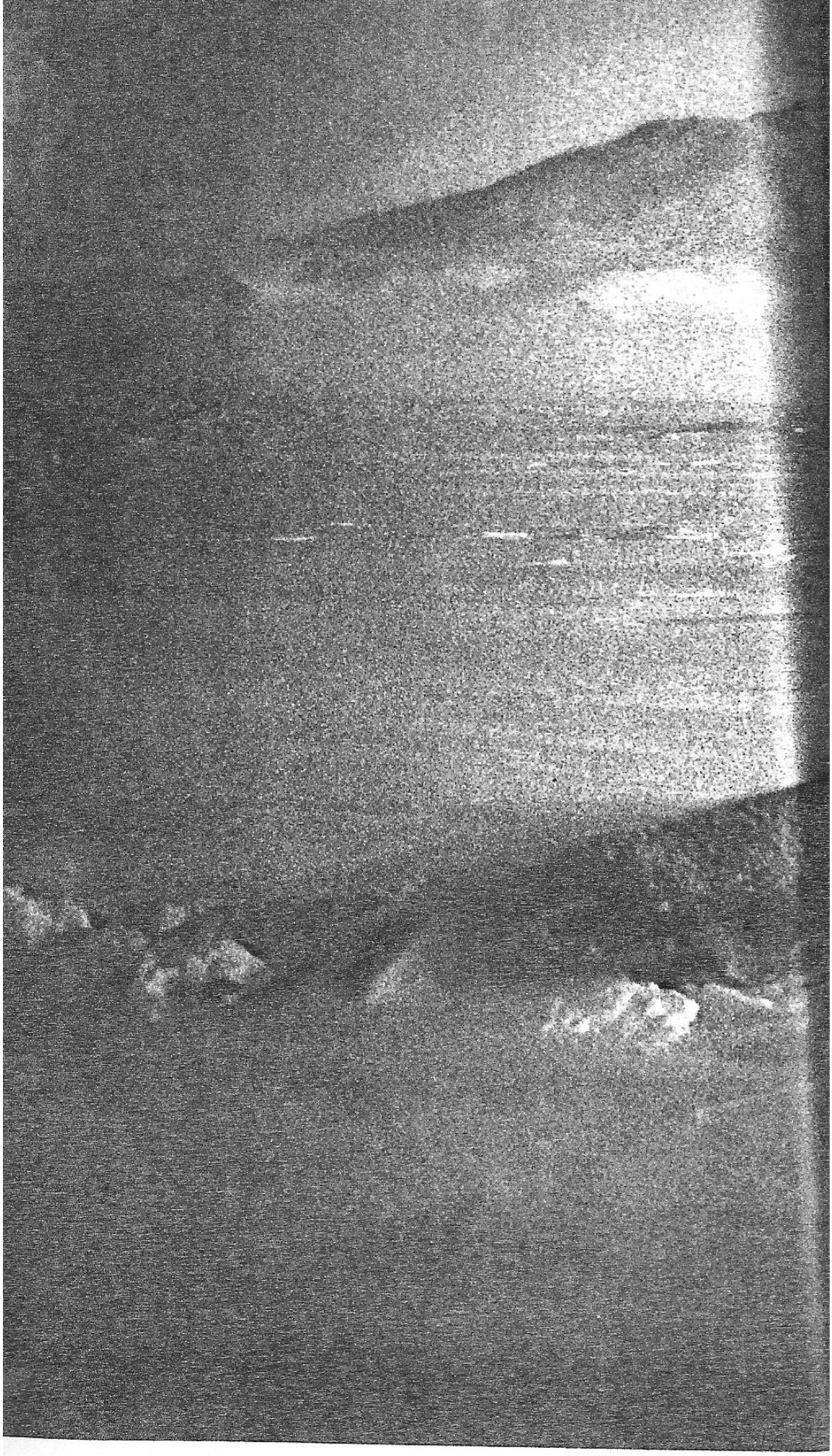


Male walruses materialize from fog's soft focus at Cape Newenham, Alaska, in summer. Bottom feeders, walruses eat clams, crabs,

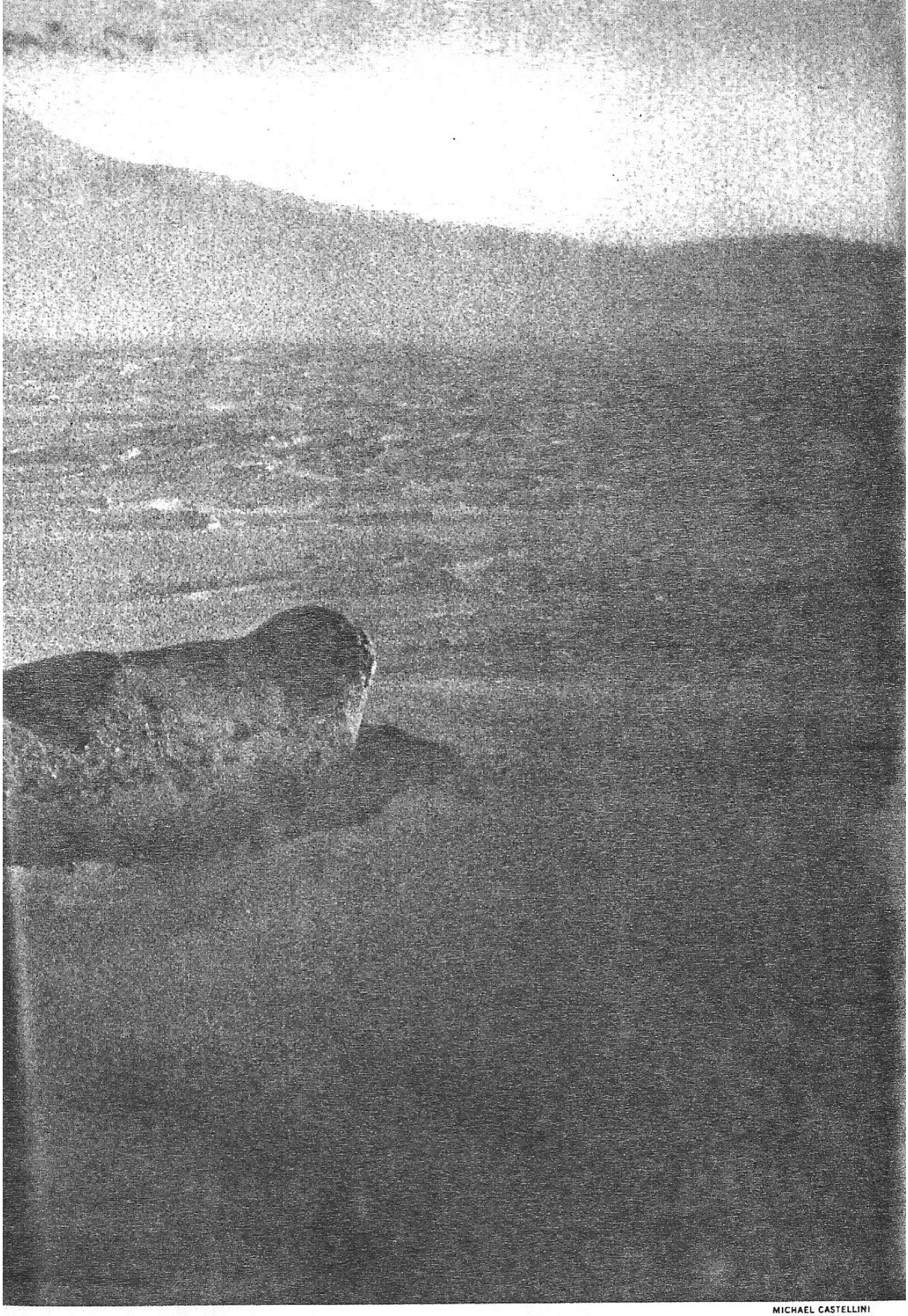


STEVE KAUFMAN

and worms that they ferret out with highly sensitive whiskers. Breeding occurs in winter, underwater amid ice floes.



Frosted by overnight snow, a Weddell seal rouses from sleep on a blanched Antarctic landscape. A plume of steam escapes Mount



MICHAEL CASTELLINI

Erebus, an active volcano. Protected by their remote habitat, these seals have not been extensively hunted and do not fear man.

WITH EARSPLITTING BARKS aimed at our approaching boat, 200 sea lions rose from the beach on California's Año Nuevo Island.

A wave suddenly threatened to capsize us into the path of the animals, which were now racing toward us surprisingly fast for their 400-pound size.

In alarm I glanced around at my colleagues from the Stanford Research Institute. Unlike me, they were all experienced seal biologists. From their bored expressions I gathered I was the only one who realized we were about to be attacked and drowned.

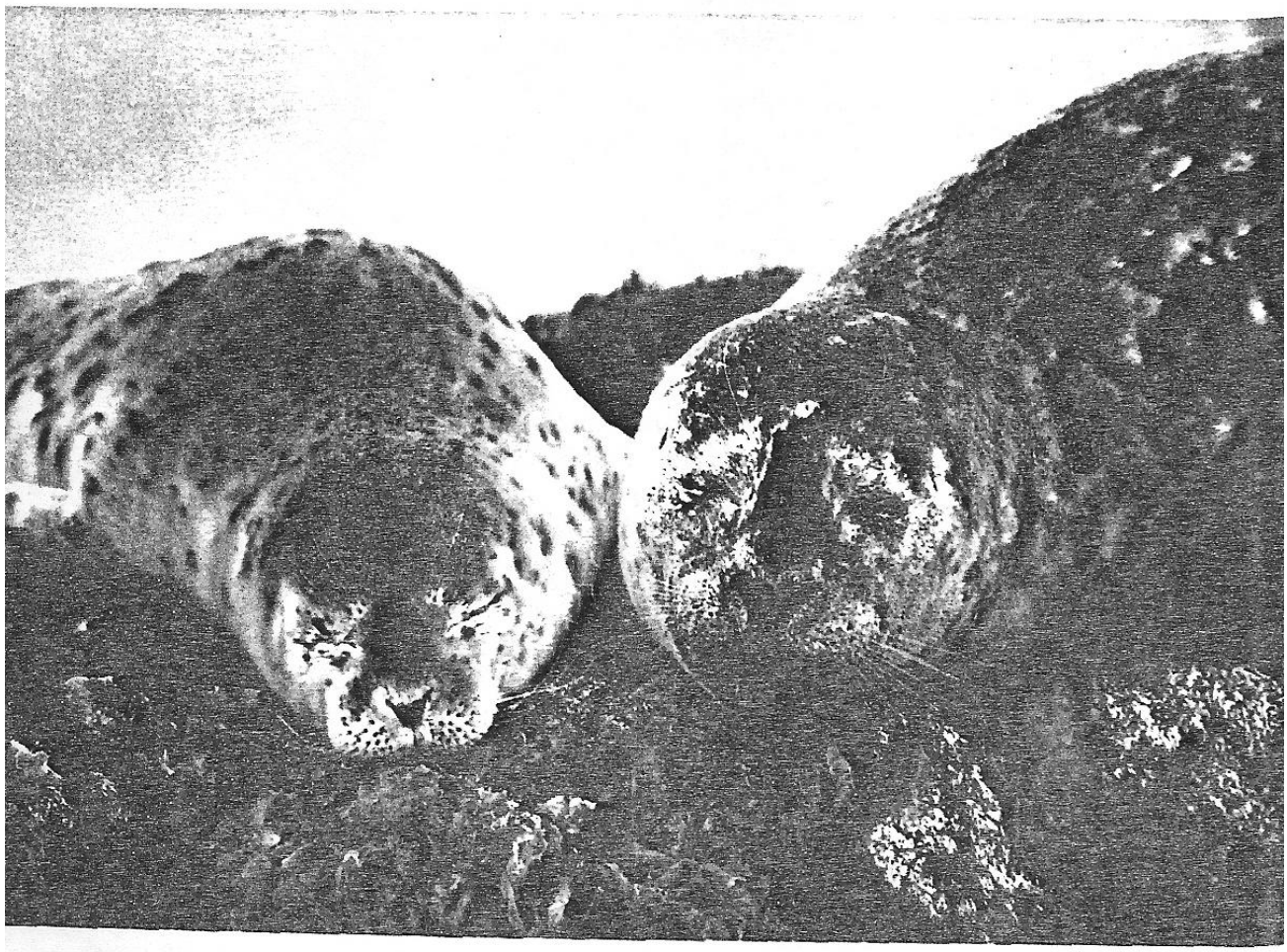
I said something useful like "WUGH!" as the others unexpectedly vaulted into the surf. But instead of abandoning the boat, they only steadied it. To my surprise the closely packed throng of chocolate-colored animals divided neatly around the boat, surged past my friends' legs, and gathered in a raucous mob 20 feet offshore.

Panting from another routine landing, our leader and my new employer, Dr. Thomas Poulter, turned to me and said dryly: "If you're through resting now, would you mind just stepping out of the boat?"

I apologized later for being so useless during the landing. But as a new student of seal behavior I couldn't confess how badly I had misinterpreted the intentions of the first wild seals I had ever met.

That summer day in 1963 literally launched my career in seal biology. It introduced me to the first of 18 types of seals—about half the world's 34 species—that I have studied over the years. The quest has led me to New Zealand, the arid beaches of South Africa and Australia, and ultimately to Alaska and the vast Antarctic ice fields.

Wildlife biologist **Roger L. Gentry** has studied Hooker's sea lions in New Zealand under research grants from the Society.



FRANÇOIS GOHIER

On the rocks, *a harbor seal mother and pup sleep on a Monterey Peninsula shore. Harbor seals have a wide range, inhabiting both coasts of the North Atlantic and Pacific Oceans. Pups can swim almost immediately and sometimes must, if born during a high tide that submerges their shoreline birthplace.*

A quarter of a century may seem a long time to devote to such an esoteric pursuit. But seals are so diverse, so unusual in their life-styles, and breed in such amazing corners of the world that it is easy to be drawn back year after year.

It is not merely the mystique of seals that draws researchers on: The more we learn about seals, the more concerned we become for their welfare. Modern seals face many problems, not the least of which is recovery from near extermination by sealers over the past two centuries. And though most seal populations are healthy today, there is still cause for concern as they increasingly compete with man for food and suffer from man's abuse of the oceans. In facing these problems, the best ally seals can have is an educated human society.

One of the wonders of seals is the fact that they are amphibious. Generally speaking, they mate and give birth on land as most mammals do, but they feed at sea as whales do. Seals have webbed flippers modified to resemble paddles that can stroke independently. In fact, Pinnipedia—the name of the order that includes all seals—means "fin- or wing-footed."

Pinniped names are wonderfully confusing. To simplify them, I will use the catchall term "seal" for all pinnipeds. The order Pinnipedia contains three families: walruses, so-called true seals, and eared seals. (See the supplement chart **Pinnipeds Around the World**.) The last group includes sea lions and fur seals; named for their small but visible ears, they evolved from the same land ancestors that gave rise to dogs and bears.

True seals and eared seals differ in movement as well as appearance. True seals hunch caterpillar fashion on land and use their fishtail-like rear flippers for swimming. By contrast, eared seals use all four limbs for walking on land and ice and their front flippers for swimming. Walruses, which do not have visible ears, walk like eared seals but swim like true seals.

Until recently it was believed that true seals (so named because they were the first to be described by European scientists) developed about 15 million years ago on the shores of the northern Atlantic, and that modern eared seals appeared first in the northern Pacific during the heyday of the walrus, some 12 million years ago. As this is written, however, paleontologists are actively reevaluating old assumptions and studying new fossil evidence. Although final conclusions are not yet in, it may turn out that true seals originated in the northern Pacific along with eared seals, and some lines of evidence even suggest that walruses are more closely related to true seals than to eared seals.

There is no question that at least one early species of true seal found a home in the Pacific. It survives as the endangered Hawaiian monk seal, considered a "living fossil" because of its age. Other true seals spread north and south, eventually populating Arctic and Antarctic waters. Some even invaded freshwater lakes such as Baikal in the Soviet Union.

IT WAS THE RICHNESS and diversity of food in the oceans that allowed seals to spread and multiply. Today's pinnipeds eat a variety of fish and invertebrates. There are also some specialists, like the crabeater seal, whose name is misleading because it actually eats small shrimplike crustaceans known as krill.

Some seals eat seabirds. A group of friends and I were once crossing Arthur Harbor on the Antarctic Peninsula in a whaleboat when suddenly an Adélie penguin burst from the water like a Polaris missile and landed in the back of our boat. It ran squawking to the highest point of our bow, then turned toward us, panting, with blood streaming down its white breast. Silently a leopard seal surfaced where the penguin had left the water and intently followed us. We were amazed that the bird, which later died, could ever have escaped that huge mouth.

Leopard seals, walruses, and some sea lions eat other seals. At St. George Island, Alaska, Steller sea lions kill and eat as many as 6 percent of all the northern fur seal pups born each year.

On tiny Enderby Island in New Zealand's Auckland Islands group, marine mammal biologist Martin Cawthorn had a far different introduction to pinnipeds from mine. He had come to study the female Hooker's sea lion. "There were no females on shore when I first arrived," he told me, "so I lay down on the grass to observe the males. Soon a lone

adult female emerged from the surf, looked around, and headed straight for me. She sniffed along my leg, then snuggled into the curve of my body and fell asleep. So did I, after counting her pulse and breathing rate."

Whether seals fear humans or tolerate them is probably traceable to their history with land predators. Those such as the Arctic ringed seal that have been preyed upon by land animals treat man as an enemy. Others view man as an object of curiosity.

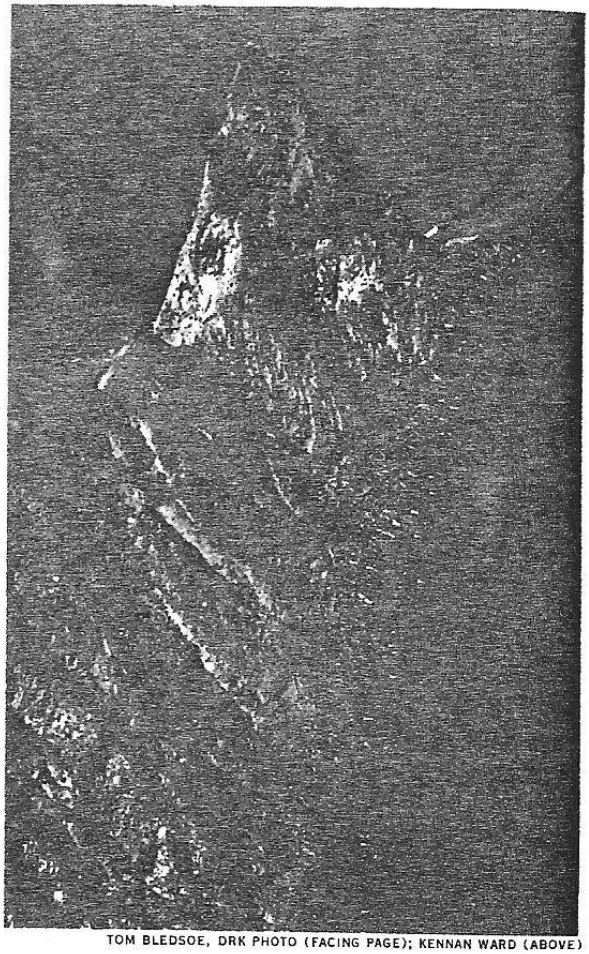
But not all seal behavior is determined by whether they have faced land predators. A woman once asked me if it was true, as she had read, that harp seal females nurse their pups for only six weeks. When I told her it was more like ten days, she was skeptical. "I'm sure they are better mothers than *that!*" she exclaimed.

The lady was a victim of her human heritage—maternal love has little influence on how seals nurse. Ancestry is a key. For example, eared seal mothers alternate between feeding themselves at sea and nursing their young on shore. But true seal females store up great layers of fat before giving birth, then transfer the fat to their pups as incredibly rich milk. Unlike eared seals, true seal mothers seldom leave their pups to feed until they are weaned.

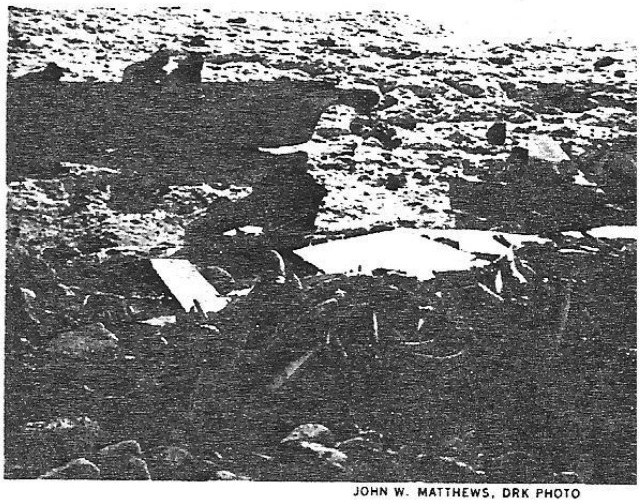
SEALS ARE QUITE LARGE, as mammals go. Adults range in weight from the 85-pound female ringed seal to the 8,500-pound southern elephant seal male. Large body size helps seals stay warm in cold oceans.

In some species males grow to four times the weight of females. Greater size may give these males an advantage in breeding by helping them to remain on shore longer. Larger males store more fat, which provides the fuel and water for long fasts. Northern fur seal males in Alaska weigh an average of 450 pounds and can abstain from food and water for 70 days.

Most seals are long-lived, attaining 20 years or more. This longevity, combined with short breeding seasons, makes it hard for scientists to learn much about individuals in only one season. It often takes years to understand even the basics of seal biology. And those years in the field are seldom comfortable. Summers are rarely warm,



TOM BLEDSOE, DRK PHOTO (FACING PAGE); KENNAN WARD (ABOVE)



JOHN W. MATTHEWS, DRK PHOTO

Wall-to-wall walruses *carpet Alaska's Round Island, where males congregate in summer* ***(facing page)****. They spend several days on beaches like one at the island's north end* ***(top)****, then leave en masse to feed. Valuable ivory tusks await the carvers' tools on a Bering Strait beach* ***(above)****. For native peoples the harvest is unlimited; they took some 3,000 last year. While walruses face no immediate threat, limitless kills could have future repercussions.*

and breeding areas are often too dangerous for a researcher's family to go along. Every May as I leave home my daughters, Erin, 11, and Alison, 8, ask wistfully, "Dad, can't you find a different job?"

To understand seal behavior, it helps to forget how we ourselves behave. Seals act toward each other like humans that never meet a friend; that is, they are formal. Even in dense groups seals do not form social bonds except with their own young. Each animal acts on its own behalf, and for its own benefit. Thus, seals simply don't have the behavioral means to mount a group attack of the kind I feared from those male California sea lions on Año Nuevo Island.

But that is not to say that individuals will not bite. They will, and from a tender age. Of the six species that have bitten me, a 400-pound northern elephant seal pup was the most impressive. It seized my left forearm and, with a completely benign look on its face, bit down with nearly bone-crushing pressure. Fortunately, I escaped with only a large cut.

Within the same species, seals bite each other too, but only under special circumstances and usually at breeding season. Most disputes among male pinnipeds are resolved by ceremonial threats, not by fighting. Ceremonial or not, the threat of harm is real. Several times during my studies of Steller sea lions at Año Nuevo, one-ton males thrust their huge heads through the window of my blind to threaten me as a suspected rival. I usually decided I had collected enough data for the day and left by the back door.

SEALS will not produce pups just anywhere; the areas are very specific. This is especially true for species that migrate long distances to mate. Female northern fur seals, for example, give birth within about ten yards of the same spot year after year, many on the site of their own birth. Female seals usually bear only one pup at a time, probably because the young must be fairly large to survive the cold oceans. Besides, feeding one large pup is all most mothers can manage.

Females normally mate only a few days after giving birth. Technically they are pregnant 12 months of the year, but development of the fertilized egg temporarily halts after about a week. For three or four months it floats around the uterus before implanting

FLIP NICKLIN (LEFT); MICHAEL CASTELLINI

Playing fetch, *a California sea lion clamps a retrieval line onto a dummy missile as part of the U. S. Navy's Quick Find program* ***(left)****. The animals can recover objects more safely and economically than can divers or mechanical submersibles. Biologists approach a Weddell seal* ***(above)*** *at McMurdo Station, Antarctica, to immobilize it with a hood and remove an instrument that has recorded its dives.*

in the uterine wall, where development resumes. An eight- or nine-month active gestation period follows, assuring birth at the right season.

Unlike dogs and cats, seal young are not helpless at birth. They sometimes have their eyes open, and their rubbery flippers flailing wildly, before they are completely out of the birth canal. Most seals can swim on the day of their birth.

Pups start life well equipped with inherited behavior, probably because they don't stay long with their mothers and never form long-lasting groups or packs where they could learn proper behavior. They therefore have no need for—and little opportunity to learn—complex ways of relating to others.

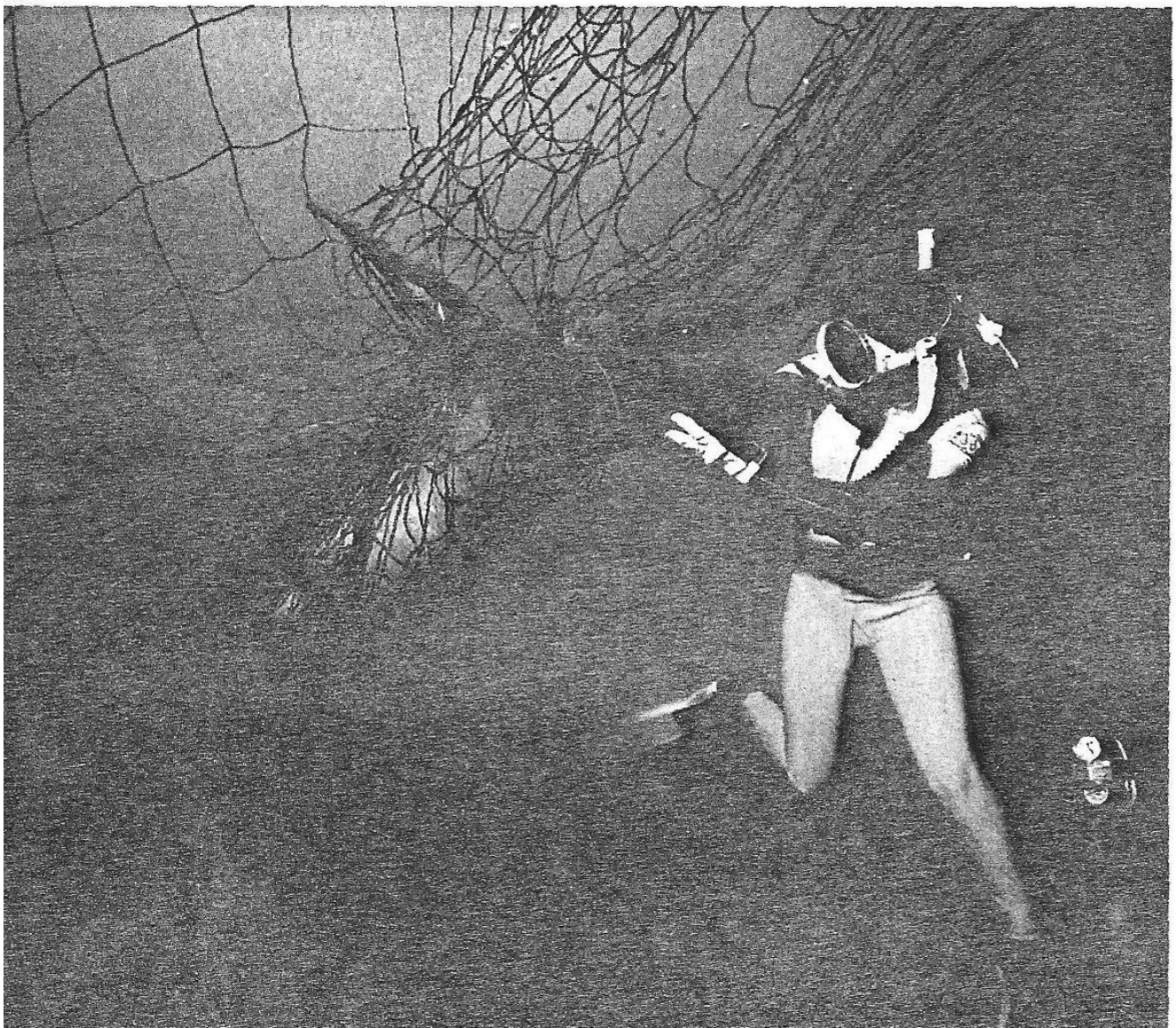
Seals are not the top predators in the oceans; they, too, have enemies, especially sharks and killer whales. My colleague Dr. Burney Le Boeuf, of the University of California at Santa Cruz, graphically describes dissecting a white shark that washed up near Año Nuevo Island.

"We opened its stomach," Burney says, "and found part of a young elephant seal inside in really big chunks. It was so fresh the seal still had all its hair. The head had been completely severed from the body, and, because its eyes were closed, it had a serene look on its face, like a statue of Buddha."

WHEN WE HUMANS try to free-dive in cold water without a face mask, we sense the problems that must have confronted the terrestrial ancestors of pinnipeds. Underwater we are nearsighted, hard of hearing, and cold, and most of us can dive to 30 feet only with pain and difficulty.

But seals have solved all these problems. In dim light, thanks to their large eyes, they see better underwater than humans do in air. Their sharp vision is essential for finding food at great depths.

Nor is the undersea world of seals a silent one. Some seals make clicking sounds like those of a thumbnail drawn across the teeth



of a comb. Other seals make long sweeping trills, and walruses sometimes gong like church bells. We know that seals can discriminate among sounds four times higher in pitch than humans can, and they can locate sounds well. Whether wild seals use echolocation, however, is still an open question.

Because seals dive far deeper than we do, we would expect that their physiology would have many unique properties. But after working on diving physiology of seals for years, my friend Dr. Gerald Kooyman, of Scripps Institution of Oceanography in La Jolla, concludes otherwise. "Seals have no traits for diving that are totally unique among mammals," Gerry says. "They've only exaggerated a few traits that other mammals, man included, already have."

One of these traits is the need for oxygen by muscles in order to function. Half of a seal's required oxygen on a dive is stored in myoglobin, a pigment similar to hemoglobin, that makes seals' muscles almost black.

Seal meat's dark color and gamy flavor don't prevent its being eaten by many peoples of the world. Even the British, with their traditional love of beef, have learned to appreciate seal meat. At one of their Antarctic research bases I was given a wonderfully funny cookbook with a chapter on the gourmet cooking of seal meat. It particularly praised "Tournados of Seal Portugaise," and claimed seal brains to be a true delicacy of the Antarctic.

When seals dive, they stop breathing. For very deep dives they conserve their oxygen stores by stopping or slowing blood circulation to all but critical organs. They can also slow their heart rate, sometimes to a mere 10 percent of the rate at the surface.

Man shares some of these same traits. Reduced heart rate and slowed circulation along with lowered body temperature and holding the breath are all involved when people survive accidental submersion in very cold water for as long as half an hour.

But how do diving seals avoid the bends, the condition caused when nitrogen that has been dissolved in the blood under pressure suddenly forms bubbles as the pressure decreases? According to Dr. Sam Ridgway, physiologist with the U. S. Naval Ocean Systems Center in San Diego, seals avoid the bends by not absorbing nitrogen in the first place. "The lungs of marine mammals," Dr. Ridgway explains, "are designed to collapse under the pressures exerted on deep dives. Air from the collapsed lungs is forced back into the animal's windpipe, where the nitrogen simply can't be absorbed by the blood."

BOB SLOAN (LEFT); MICHAEL GOEBEL

Deadly net *proved fatal to a California sea lion (left). Fishing gear kills many pinnipeds, but statistics are unreliable. Animals drown, never to be found; some work loose, only to be snared again. Five snared seal pups (above) washed ashore on the Pribilof Islands. A biologist found, photographed, and released them.*

FOR ALL THE HARDSHIPS involved in the study of seals, we researchers have occasional moments of pure exhilaration over some new idea or discovery. One of those moments came for me in 1975, when Gerry Kooyman and I recovered a dive instrument we had sent to sea on a female northern fur seal. It was a simple mechanical instrument that scratched a line on a moving strip of paper to record changing depth. Until that time most of what was known of fur seals at sea was learned from animals that had been shot. Gerry's new instrument had been attached to the seal for a week, and we weren't sure it would work.

The great day came when Gerry retrieved the instrument *(Continued on page 494)*

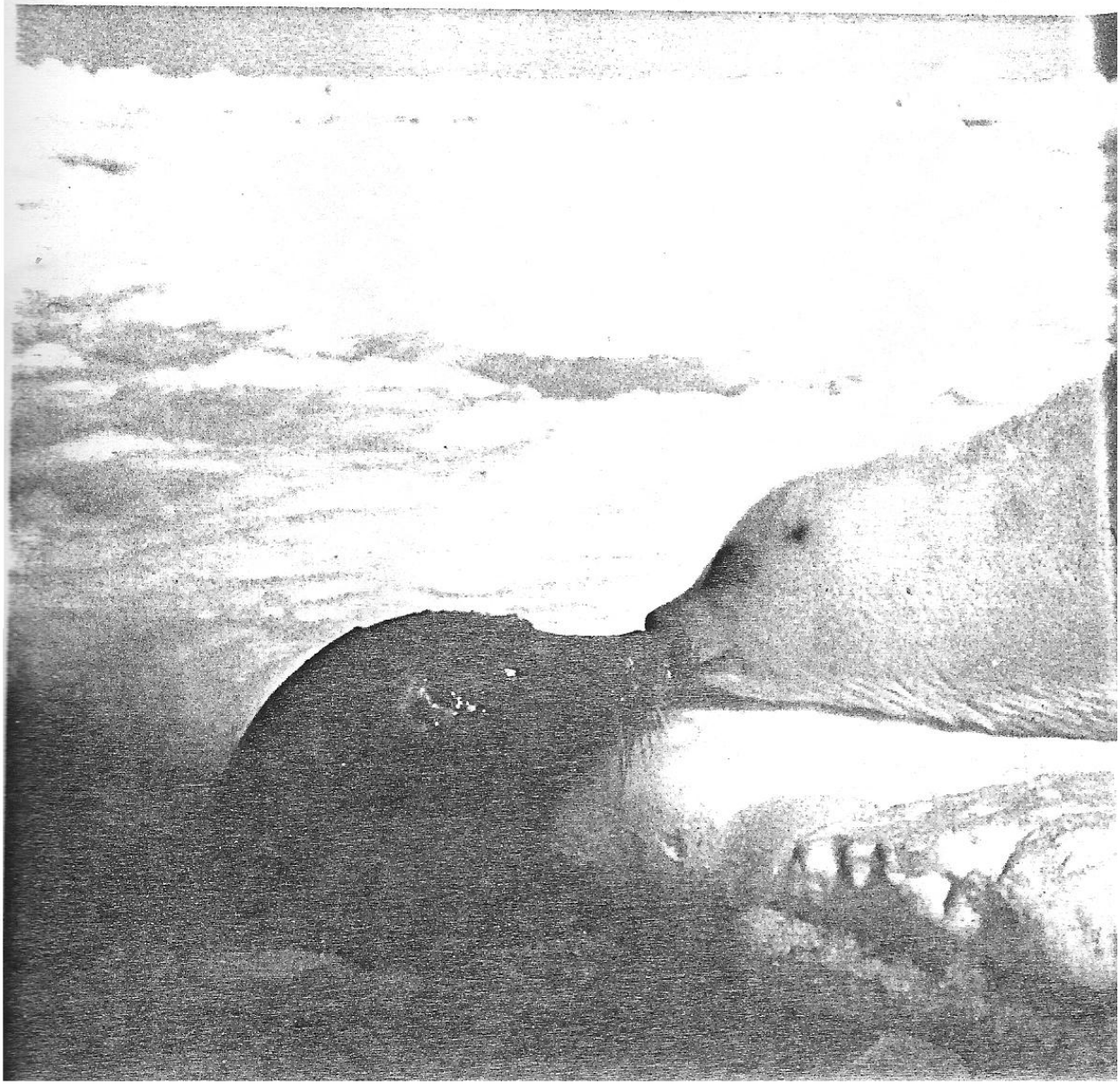
from the apparently unconcerned female. Four of us crowded around him. With hands shaking, Gerry opened the instrument case.

"Look at that!" he croaked, in a voice strained with excitement. There, in a faint trace on the paper strip, was a line representing hundreds of dives, many to 300 feet or more. It was hard to grasp the significance of the event. This hundred-pound female fur seal was routinely diving at least ten times deeper than most humans can. But more important, the diving instrument worked. We had a new tool for measuring what seals do at sea.

Thanks to Gerry's instrument, and to new ones since, we have learned more about the diving ability of seals in the wild during the past decade than in all the years before. Using such instruments, Gerry and I, along with a dozen colleagues, have recently compared diving in fur seals worldwide. We've found that they are fast divers: Animals weighing 100 pounds can go to 600 feet and back in five minutes or less. Gerry's conclusion: "Seals are a lot better athletes than most people realize."

Further research has taught us a great deal more. Generally, the larger the seal the deeper it can dive. A 240-pound Hooker's sea lion female at Enderby Island dived repeatedly to 1,400 feet. A Weddell seal dived to 1,900 feet, and a northern elephant seal was recorded at an incredible 2,900 feet by Burney Le Boeuf. There are probably species of whales and porpoises that do not dive to such a depth.

It appears that seals expend the least possible effort when feeding. They can usually find food at less than their maximum depth. Fur seals normally feed on fish or krill at less than 300 feet, Hooker's sea lions feed on squid at about 600 feet, and northern elephant seals feed, possibly on ratfish, at around 1,500 feet.



Stupid predators do not last long. Pinnipeds have evolved a high level of intelligence, in part because their prey are hard to find. Psychologist Dr. Ronald Schusterman, of the University of California at Santa Cruz, has studied sea lions' learning abilities for many years. "They can perform complex learning tasks that only the highest mammals, such as apes and dolphins, can perform," he says.

Dr. Schusterman recently demonstrated that sea lions have the conceptual skills necessary to learn an artificial language. After an animal has learned words and signals for objects and actions, it can carry out very complex commands, such as: Take the large white cube over to the small black ball. Sea lions can follow such commands without practice, even when as many as ten such objects are involved. In short, pinnipeds, like porpoises, are able to comprehend a simplified human language.

SKIN LOSES HEAT many times faster to water than to air. To retard this heat loss while they are in water, seals, like whales, have developed blubber, a special dense form of fat that insulates the body core. To lose heat, seals flush warm blood into their normally cool flippers, like a radiator.

Ironically the fur and blubber that allow seals to survive in the cold seas very nearly led to the extermination of some of them. Seal oil for lamps and pelts for leather or furs set off large-scale commercial hunting in the 18th and 19th centuries—the darkest years in seal history.

Humans have killed seals for food since Stone Age times, judging from ancient seal clubs and bones found along Denmark's Kattegat strait. But the advent of fast sailing vessels and later steamships capable of penetrating ice packs opened up the most remote seal haunts. In their shortsighted

FRED BRUEMMER (LEFT); TOM BLEDSOE, DRK PHOTO

Seeing nose to nose, *a mother harp seal nuzzles her baby in the Gulf of St. Lawrence* ***(left)****. Known as whitecoats, newborns shed their snowy pelts and turn gray within four weeks. Hundreds of thousands of pups were once killed for fur. A 1983 Common Market ban on seal-product imports reduced demand and ended Canada's whitecoat harvest. Fewer than a thousand were taken in Norway last year. Adults are still legally hunted. Aleuts harvest northern fur seals on St. Paul Island in the Pribilofs* ***(above)****. The kill, limited to young males, is only for sustenance.*

Lounging room only: *Northern elephant seals and smaller California sea lions share limited space* ***(below right)*** *in the Farallon Islands off California. On the mainland tourists visit Año Nuevo State Reserve's growing elephant seal population to observe behavior such as two males fighting* ***(far right)****. By 1890 fewer than a hundred elephant seals remained. With hunting suspended, the seals proliferated and now number about 100,000. Violent battles between males* ***(right)*** *occur at territorial boundaries or near females. Usually losers signal submission and leave.*

greed, early sealers killed all they could find, with little thought of species survival or even continuing profit.

Walruses and true seals, such as the harp and hooded, sustained the first major slaughter, largely for ivory, oil, and skins. Both northern and southern elephant seals were killed for oil.

When an efficient way was found in the 1800s to rid fur seal hides of their outer guard hair, leaving only the soft, durable underfur, millions of those animals were slaughtered for garments. The trade was enormously lucrative: Revenues from northern fur seal skins equaled the entire Alaska purchase price—$7,200,000—in less than six years. Elsewhere some of the world's largest fur seal colonies, such as that of the South Shetland Islands, were virtually exterminated in only four years.

Not even sea lions escaped the slaughter. Steller sea lions in California were killed in part because their 16-inch-long whiskers proved ideal for cleaning opium pipes.

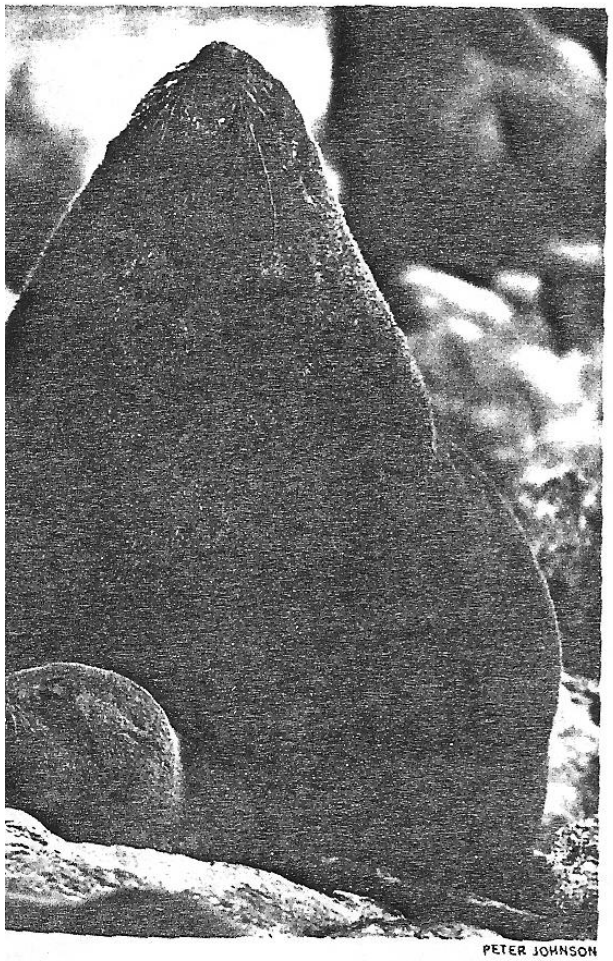
The era of unregulated seal killing ended when populations became "economically extinct"—that is, no longer profitable enough to hunt—in the mid to late 19th century. Luckily this happened before the last individuals were killed, and no species we know of actually became extinct. But the Juan Fernández, Galápagos, and Guadalupe fur seals very nearly did.

At least a hundred years have passed since the heaviest killing of most seals. Today species that were reduced are recovering, and most species are now healthy.

On a worldwide scale only two species, the Mediterranean and Hawaiian monk seals, are in danger of becoming extinct in the foreseeable future. The Hawaiian species' prognosis is the better of the two. There has not been a confirmed sighting of a close relative, the Caribbean monk seal, since 1952, and it may already have succumbed.

But large-scale sealing is no longer a threat to most pinnipeds. Even the harp seal kill in Canada, Greenland, and Norway has been much reduced; about 60,000 are taken each year, down from the 350,000 in 1963. Increasing costs and growing repugnance toward wearing furs have finally put the era of massive killing behind us.

For the Pacific walrus there is still concern about modern harvesting. In 1986 10,000 to 12,000 animals were killed by Alaska natives and Soviet harvesters. The size of the kill has been increasing and may now be more than the slowly reproducing walrus can sustain.



PETER JOHNSON

***Five times as heavy** as the female he mates with, a male South African fur seal shows the size differential between sexes. A bull may mate with 30 females during the summer breeding season.*

UNFORTUNATELY the end of unregulated seal killing did not end conflicts between seals and man. Today's problems are far more pervasive and complex. No one knows, for example, why the northern fur seal and Steller sea lion have recently declined, and many scientists are concerned.

A major problem facing seals is the overlap of their ranges with those of commercial fisheries. A comprehensive study in California showed that this overlap cost the combined fisheries $600,000 and took the lives of about 2,200 seals in a single year, mostly California sea lions and harbor seals. But this is a rare study. The cost is so great and the issues so complex that most jurisdictions have not tried to repeat it.

One difficulty is that we don't always know what or how much seals eat or, equally important, what they pass up. In the absence of this information seals are sometimes used as scapegoats to explain declining fishery catches. Years ago some Oregon salmon fishermen complained to a state game warden that a large Steller sea lion at a river mouth was eating spawning salmon. When the animal was shot, its stomach was found to be full—not of salmon but of lamprey eels, known salmon predators.

Fish is one issue, fishing gear another. According to Dr. Riki Ott, a biologist and gillnetter in Alaska's salmon industry, damage to nets caused by sea lions, especially, results in a twofold cost. "First," she told me, "it takes time and money to repair the nets, and, second, repair time means less fishing time where seasons are already short."

Fishermen have mixed feelings toward other seals, and can even appreciate them as fellow fishermen. "Harbor seals," Dr. Ott told me, "usually pick fish cleanly out of nets. But fishermen, after all, are businessmen, and they'll treat any serious conflict as a business matter."

According to a 1972 U. S. law, if a seal species becomes depleted, then any fishery that takes them accidentally could be fined. Thus, seal conservation is in the best interests of fishermen if they wish to preserve their own livelihood.

Sea lions and harbor seals are the most likely pinnipeds to drown in fishing nets. Perhaps the most alarming case of drowning is the loss of rare Hooker's sea lions in squid trawls off New Zealand. Of the world's 5,000 Hooker's sea lions, 75 females were accidentally drowned in a single year.

Another modern specter is the problem of entanglement in marine debris, both floating and submerged. Fishing nets, monofilament lines, plastic strapping rings, even plastic six-pack bottle and can holders in the ocean end up around the necks of seals and undoubtedly kill some in a horrible way. The question is how many?

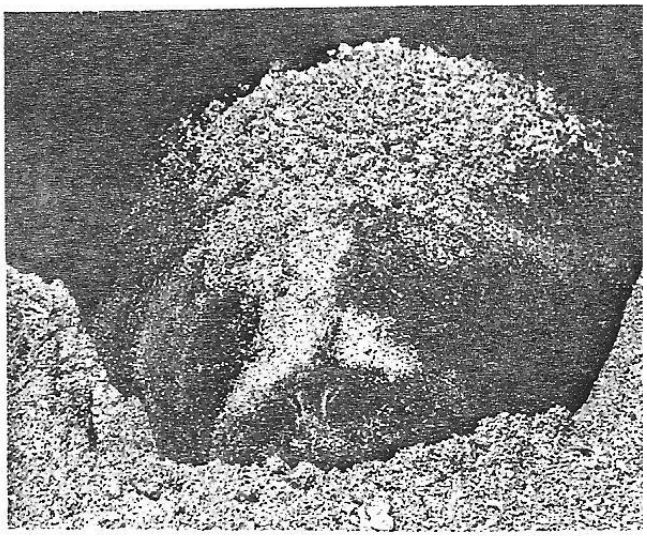
Knowing the real entanglement rate of any species is nearly impossible. An unknown number may become entangled and die at sea without being counted by researchers. On the other hand, as many as 50 percent of tagged northern fur seals that had nets around their necks lost the nets within a year. One returned with a green net one year and a gray net the next.

Chemical pollution of the oceans is another problem for pinnipeds. Being near the top of the food chain, they tend to concentrate pollutants in their tissues. Pesticide residues have even been found in the blubber of seals in remote Antarctica. The biological effects of such contamination are not entirely known.

THE REAL ESSENCE of modern problems facing pinnipeds is that we can't measure well any single factor that affects their survival. At the same time we have yet to measure the negative and positive impacts that seals have on fisheries. Where do we begin the process of rational problem solving?

Ourthelutions are limited by the fact that we can take no direct actions to stimulate population growth in pinnipeds. Females almost always produce only one pup a year. The best we can do is leave them alone, reduce man's impact on the oceans where possible, and try to keep seal populations from declining. A healthy seal population may be able to maintain constant numbers in the face of entanglement, pollution, and competition with fisheries. But it may be impossible for a reduced seal population to recover in the face of such hazards.

***Hunkered down** in damp sand to cool off, a monk seal naps in the Northwestern Hawaiian Islands. Some 1,400 live here, but human disturbance and sharks take a toll, and extinction is possible.*



FRANS LANTING

Reducing ocean pollution and the loss of fishing gear are obvious ways to help pinnipeds and other wildlife. A 1972 treaty on ocean dumping is in effect, but it concerns chemical pollution more than floating fishing debris.

Several current international treaties also aid the conservation of seals. Unfortunately one of the oldest of these, concerning the northern fur seal—which must be ratified periodically—was not renewed last time by the United States. Animal protection groups and the Aleut people of the Pribilof Islands argue over the taking of seals and the sale of their pelts and "seal sticks," or penis bones, which are thought by some Asian cultures to be aphrodisiacs. Until the two groups agree, re-ratification of the fur seal treaty is stalled, and the seals are declining at an alarming rate.

The conflict between seals and fisheries can be resolved by getting more information about the numbers and ecological role of pinnipeds and by educating fishermen about these findings. Without new information and public participation, no consensus will be reached on seal management.

Much of the information we need about pinniped diet and foraging behavior will come from instruments. Even simple mechanical recorders can show how deep, how often, and at what times of day seals dive for

food. These simple measures, applied over time, should provide an index of the amount of food available to seals.

With these recorders Martin Cawthorn, Wendy Roberts, and I, jointly sponsored by the National Geographic Society and the U. S. and New Zealand governments, have been measuring the foraging behavior of Hooker's sea lions at New Zealand's Enderby Island. If we can determine how far offshore and how deep these sea lions feed, perhaps the squid fishery there can be geographically limited to reduce the accidental killing of these rare animals.

Still newer instruments promise even more useful information. With microprocessors that are in effect small submersible computers, we can record not just diving behavior but also virtually any action or process that can be converted to an electronic signal. Already these units are recording seal heart rate and swim speed. The instruments can collect blood samples during dives for physiological measurements. It will soon be possible to determine water temperature and salinity where seals feed and migrate. The small size of these instruments will allow us to collect data on any seal, young or old.

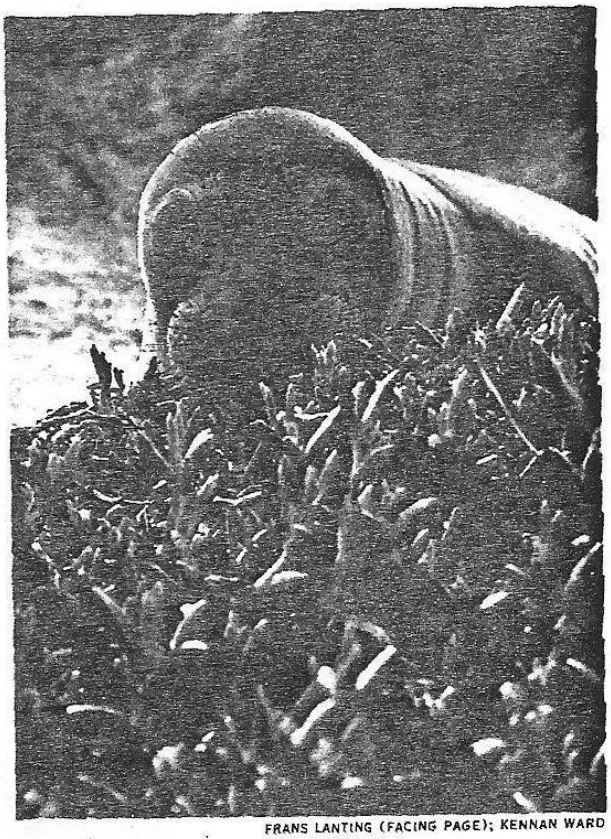
In the not too distant future the locations of seals at sea will be routinely correlated with satellite images of ocean surface temperatures and other features.

Ironically research funds for pinniped studies have been decreasing at a time when new technology promises the most fruitful results ever obtainable. To get funds, many researchers have had to justify their pinniped work in terms of fisheries, rather than on its own merit.

WE CAN EXPECT conflicts to occur between seals and fishermen as long as both exist. These problems can be mitigated somewhat by education, legislation, and more treaties for research and conservation. International treaties already in effect could serve as models for others.

Most seal species are resilient enough to accommodate slow changes in their environment. As long as man's influence on the oceans doesn't escalate rapidly, seals will continue to thrive. Seals existed in balance with their prey for millions of years before man arrived on the seas; they can do so again if they are allowed to.

A logjam of elephant seals crowds Año Nuevo Island (facing page). Elsewhere on the island a pup peers over an ice plant (below). Although natural survivors, seals remain vulnerable where their interests conflict with man's.



FRANS LANTING (FACING PAGE); KENNAN WARD

Pinnipeds have begun to act as a portal for viewing the oceans. Instruments have begun to show how seals forage and move in the seas. These same instruments, speaking through satellites, can also tell us more about the oceans and about those properties in them that control the lives of both seals and whales.

No matter how much one knows about seals, they leave us with a profound sense of wonder. Anyone who has huddled in 75-mile-an-hour winds watching baby seals actually playing in 15-foot surf knows that feeling. And those lucky enough to see seals thriving in frozen polar expanses or flying with birdlike grace underwater certainly feel it. Our unspoken response is always "How do they do that?" Even though, technically, we come closer to answering that question each year, our sense of wonder still remains. □