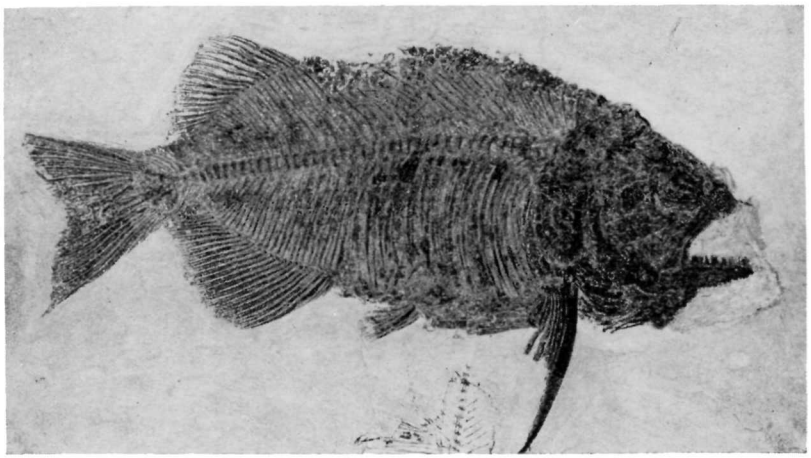
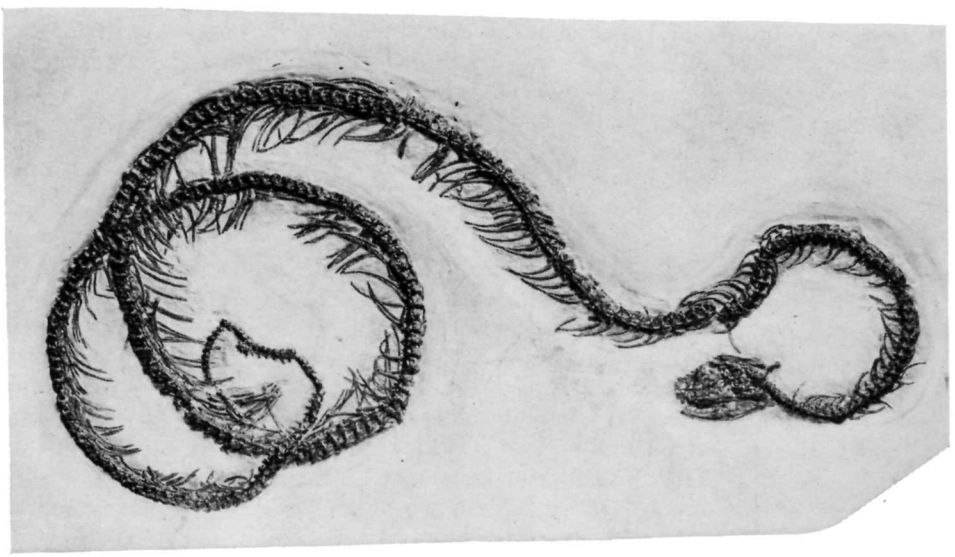
NATIONAL PARKS *Magazine*





Fossil fish and fossil snake from Green River shale in vicinity of proposed Fossil Butte National Monument, Wyoming

September 1966

The Trail and Campfire Country

An Editorial

THE RECENT HEARINGS CONDUCTED by the National Park Service at Gatlinburg, Tennessee and Bryson City, North Carolina, on the proposals for the establishment of wilderness areas in Great Smoky Mountains National Park were remarkable primarily for the strong sentiment displayed by the public for the protection of the roadless country within the park.

People of all age groups, from the very young to the very old, turned out to say that they wanted the Smokies preserved mainly as hiking and horseback country.

People from all over America came to these hearings, to urge that the trail and campfire country of the High Smokies be protected from the automobile traffic permanently.

John Preston, the Hearing Officer, whose grand record as a Park Superintendent is known to park protectionists, and whose understanding of people in the parks is profound, must have sensed, as we did, that behind these outpourings of sentiment for wilderness was a deep need on the part of city men and women all over America to put the pressures of urban society, and particularly the motor car, behind them for at least a short time, and to escape into the freedom of the great open spaces.

Four or five times as many witnesses spoke out for enlargement of this trail and campfire country in current planning, as contrasted with the picayune wilderness proposals advanced by the Service.

These were the people who knew how to shoulder a back-pack, striking out on foot for five, ten, or fifteen miles a day, taking delight in physical exercise, and in reliance on their own ability to care for themselves in the woods.

And the thing about it is that there were a great many of them. One had the impression that their numbers were growing rapidly. As congestion cramps our lives in the cities, more and more of us apparently feel this need to free ourselves, occasionally at least, from the artificial contrivances with which we are surrounded in town.

Automobile recreation—driving for pleasure—is credited statistically with being the chief American form of outdoor recreation; it is occasionally argued in consequence that we must build more and more roads to satisfy this urge, but quite clearly there is a counter-force in being: as the traffic spreads, and the noise and fumes with it, a resistance is developing which is grounded in the elemental human need for the preservation of physical and mental health, a need which can be satisfied only by ample outdoor space, free from the traffic.

The simple need for fresh air, for example, as contrasted with the noxious atmosphere of the cities, and even of the country highways, is a matter of vital importance to more and more people everywhere; our park planners need to recognize this demand much more fully than they have.

A need for silence, the deep silences of countryside and wilderness, is a profound human need of which people have never before in all history been so completely deprived as in the great urban agglomerations.

There is also a need for darkness at night, frustrated by the glare of the street lamps, and pole lamps at crowded vacation resorts; people need to see the stars, remembering the names of the constellations, reminding themselves of the infinities which stretch away from this small planet in every direction.

This trail and campfire country which is to be protected under the name of wilderness in the national parks, and also in the national forests, is dedicated to human needs of the utmost importance; to the most highly civilized purposes conceivable; to the opportunities for meditation, reflection, and self-observation which are imperatives for man, and which only the vastnesses of nature can provide.

The wilderness areas will serve valuable non-human purposes in the sense of the protection of plant and animal species other than man; such protection is essential in itself, but serves simultaneously our human interest in these other species; but the wilderness areas are also human refuges where people can escape the most destructive effects of those economic and technological developments which have got out of hand in our society.

This is not a question of closing out access to wild country for people; quite the contrary, it is a question of providing natural refuges for all persons willing and able to companion with the streams, forests, birds and mammals of the wild, and to draw spiritual renewal from the experience.

The great outpouring of protest against minimal wilderness planning at the Great Smokies hearing, and in favor of putting practically the entire park into the wilderness category, was a strong and unified voice calling for the enlargement of the trail and campfire country of America.

This voice, in our judgment, will make itself heard with increasing strength as the long series of future wilderness hearings unfolds, with respect both to the parks and to the forests, and as increasing numbers of Americans realize the vital stake they have in the protection and restoration of the natural environment everywhere.

—A.W.S.

NATIONAL PARKS *Magazine*

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Both front cover photographs courtesy American Museum of Natural History

Our front cover this month introduces readers to two former inhabitants of southwestern Wyoming. The fish at the top is *Phareodus*, and the snake below is *Boavus;* the photo of the snake actually is of a cast made with the kind permission of Mr. Edgar Weinberg of Uinta County, Wyoming. Both of these animals lived some 50 million years ago in a warm-water lake along with many other aquatic vertebrate forms. Some individuals among this assortment of Eocene lake life were destined to become celebrated in later time as among the most perfect fossil representatives of that epoch recovered by man anywhere; and nowadays the National Park Service looks toward the Fossil Basin of Wyoming as a likely site for a national monument, in which it can trace for the public the local story of life and times in the Eocene Epoch.

The Association and the Magazine

The National Parks Association is a completely independent, private, non-profit, public-service organization, educational and scientific in character, with over 32,000 members throughout the United States and abroad. It was established in 1919 by Stephen T. Mather, the first Director of the National Park Service. It publishes the monthly *National Parks Magazine*, received by all members.

The responsibilities of the Association relate primarily to the protection of the great national parks and monuments of America, in which it endeavors to cooperate with the Service, while functioning also as a constructive critic; and secondarily to the protection and restoration of the natural environment generally.

Dues are $6.50 annual, $10.50 supporting, $20 sustaining, $35 contributing, $200 life with no further dues, and $1000 patron with no further dues. Contributions and bequests are also needed. Dues in excess of $6.50 and contributions are deductible for Federal taxable income, and gifts and bequests are deductible for Federal gift and estate tax purposes. As an organization receiving such gifts, the Association is precluded by law and regulations from advocating or opposing legislation to any substantial extent; insofar as our authors may touch on legislation, they write as individuals.

Membership in the Association carries with it subscription to *National Parks Magazine*. School and library subscriptions are $5 a year; individual copies 50 cents. Letters and contributed manuscripts and photographs should be addressed to the Editor at Association headquarters. The Association is not responsible for loss or injury to manuscripts and photographs in transit. Return postage should accompany contributions.

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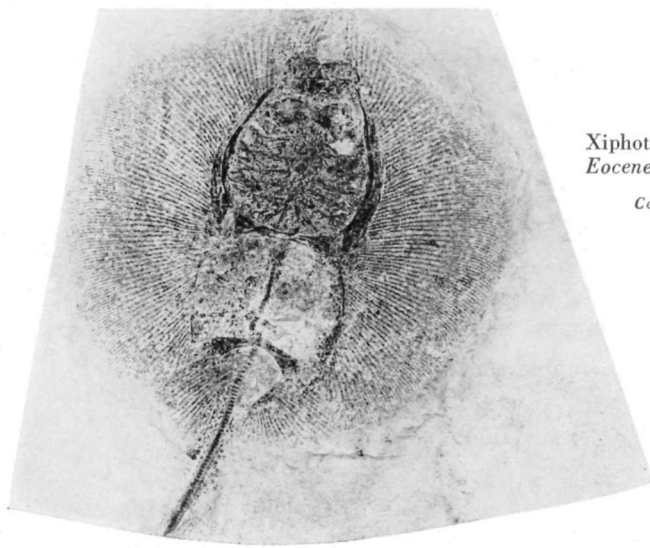


Xiphotrygon radians, *a fossil stingray from the Eocene Green River Formation, Fossil Butte, Wyoming*

Courtesy Smithsonian Institution

Mountain of the Stone Fishes

By Gilbert F. Stucker

JIM BRIDGER, DEAN OF WESTERN scouts, was fond of telling his campfire audiences of a mountain that was cursed by an Indian medicine man. Like the curse of Medusa in Greek mythology, it had turned everything into stone—the vegetation, wildlife, streams. Sun, moon and stars stood motionless and cold in a crystalline sky. Rain fell and flowers bloomed—but in stone. "Come with me," said Bridger, "and I'll show you peetrified trees a-growing, with peetrified birds on 'em a-singing peetrified songs."

This preposterous mountain existed partly in Bridger's imagination and partly in the Yellowstone region where the petrified forests, travertine "cataracts" and obsidian cliff had provided the basis of his tale.

He need not have traveled so far for his subject matter, nor departed so widely from the truth. Less than fifty beeline miles from his trading post on Black's Fork in what is now southwestern Wyoming was a mountain, stranger in many ways than his fiction.

The mountain is known today as Fossil Butte. Motorists driving U. S. Highway 30N west of Kemmerer, Wyoming, skirt the base of it—a long, bare ridge rising above the sage-mottled flats of Twin Creek Valley. High on its scarp face is an outcrop of banded, buff-colored Eocene marlstone. Between the fragile laminations in the rock—crushed flat—are the black, carbonized remains of fish. But for the crushing, many of the skeletons are almost as perfect as the day the creatures died some fifty million years ago.

For close to a century, this deposit has been excavated for its piscatorial riches. Tourists, novelty hunters, professional collectors from government agencies and natural history museums, private collectors and rock hounds came and took according to their wishes. Their "finds" ran the gamut from primitive stingrays through missile-shaped gars with shining ganoid scales to advanced forms such as perches.

Herrings were the most abundant. Some of the largest (*Diplomystus*) measured twenty inches in length, but the great majority belong to the small fry called *Knightia*—hundreds of their bodies frequently found massed together on a single slab. They and the equally small pirate perches un-

doubtedly proved excellent eating for the large-mouthed bowfins which prowled the waters. Bowfins were rare, if we may judge from the scarcity of their remains; only one complete skeleton is known from the locality—or from all of North America, for that matter. Its name is *Paramiatus gurleyi* and it holds the distinction of being the sole deep-bodied member of its tribe. Bowfins date from dinosaur times; a single form survives in the freshwaters of this continent.

The bass family was well represented by several species of prickly-rayed *Priscacaras*, the average being somewhat larger than the living bluegill sunfish. They, too, probably preyed on the small herrings and were, in turn, devoured by the gars and bowfins.

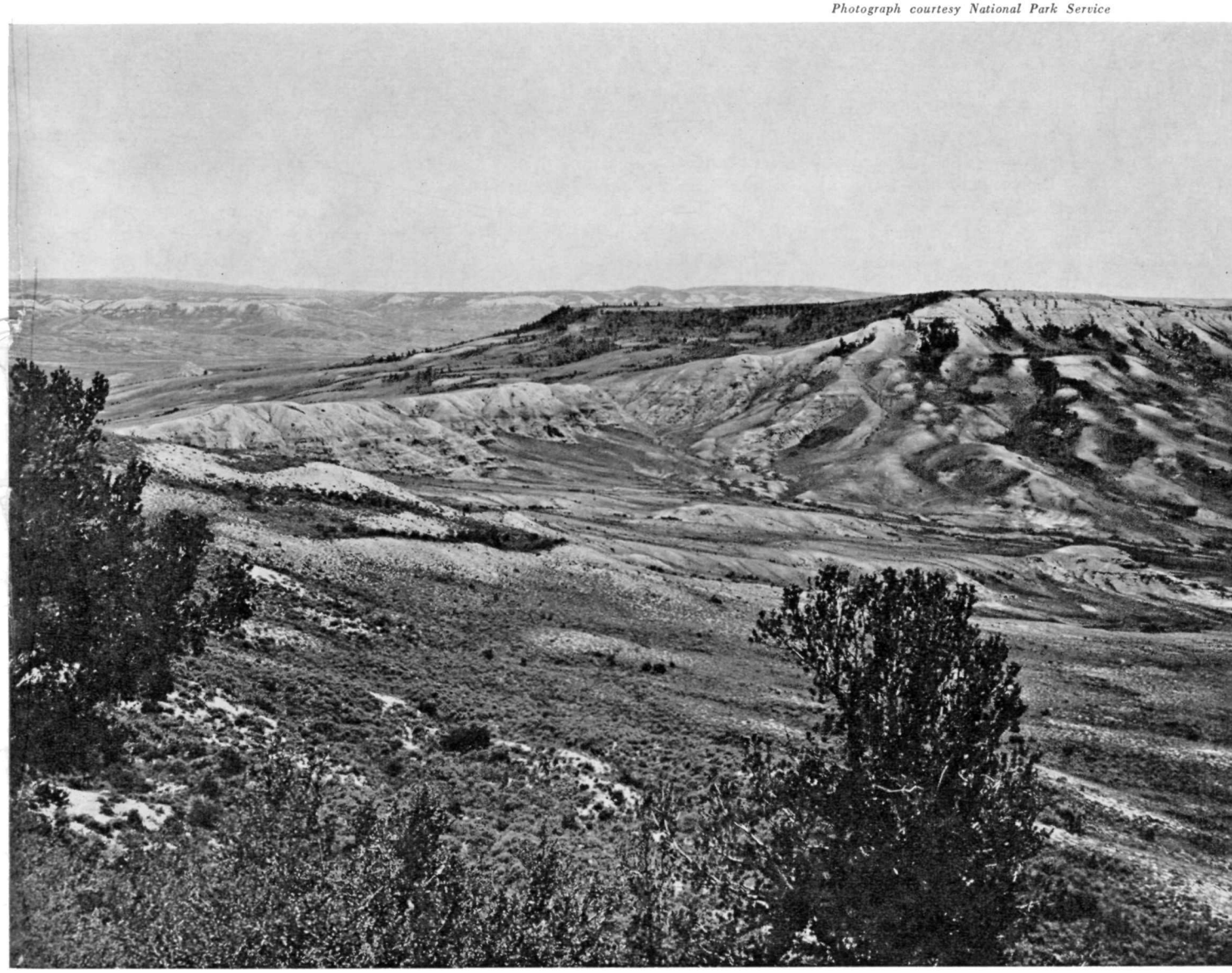
Specimens of *Phareodus* were not uncommon. The name of this fish, from *pharos*, "lighthouse," and *odon*, "tooth," suggests that it might have been rather large. But, alas for bigger and better monsters, the term refers to shape, not size.

Spoonbills, or paddlefish, also made a showing. Like their modern descendants, they were odd creatures with long, spatulate snouts which they used to stir up the bottom muds for the minute organisms they fed upon.

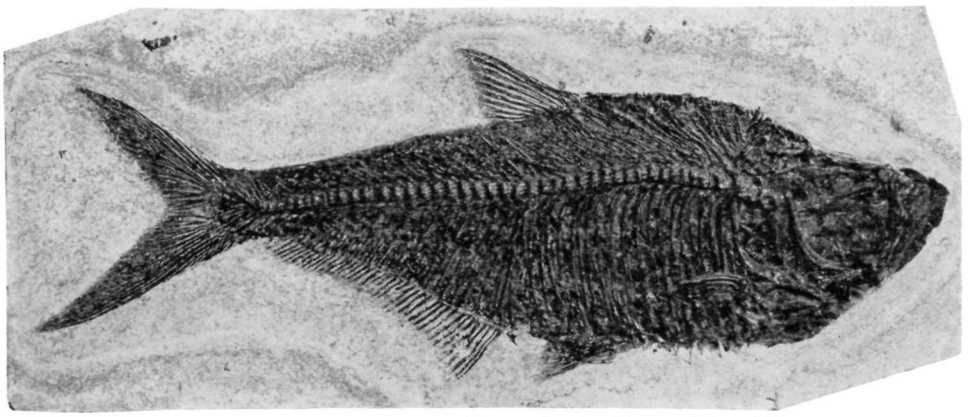
Bottom-feeding was the habit of another strange resident—the sandfish, *Notogoneus*. According to Dr. Bobb Schaeffer of the American Museum of Natural History, its presence in the fauna is an anomaly. "It has been found only in the deposits around Fossil (Butte) and . . . in the Early Tertiary of France," he states.

A variety of destinies awaited these fish, once they were exhumed. As curio items, they gave rise to a lively local trade, with the not-too-distant railroad station at Green River serving as principal outlet. Specimens brought from fifty cents to a dollar apiece on the platform. As business prospered, prices increased and were adjusted to the buying power of the traveling public. Tourist-car passengers had a choice of the common *Knightias* for $1.50 to $3.00, or "Sunfish" for slightly more. Holders of Pullman tickets were shown the larger, deep-bodied varieties which

Photograph courtesy National Park Service



From a point on Cundick Ridge the white and buff rocks of the Green River Formation are seen capping Fossil Butte, at right in photograph. Underlying strata belong to Wasatch Formation, which is exposed as "badlands" between the Ridge and the Butte.



Courtesy American Museum of Natural History

Most abundant remains in the ancient lake sediments of Fossil Butte are those of herrings. The 18-inch Diplomystus *above is among the largest.*

fetched $15 to $35, while stateroom customers were offered the "museum pieces," valued at a hundred dollars.

Countless specimens were figured and described in learned journals, exhibited in learned institutions. One of them, a gar, was displayed at the Chicago World's Fair in 1893. They appeared in novelty shops, libraries, clubs, on the walls of hotel lobbies, and over fireplaces in private homes.

In 1959 the National Park Service became interested in the celebrated Fossil Butte and launched a series of investigations into its educational and recreational possibilities. In both scientific and historical categories, the area was found to be eminently qualified for inclusion into the park system, and in 1964 the Service recommended that the butte and some 8,000 acres of adjacent land be preserved as a National Monument.

In implementing this proposal, the Park Service stands to preserve much more than the physical fact of a remarkable earth feature. For, Fossil Butte transcends itself in its relationships. It is a compound, a compendium, not only of the geological and paleontological happenings which transpired at the site, and of the human history involved in their discovery, but it participates in a larger pattern—of regional dimensions.

The sequence of events out of which this pattern evolved began with the chance discovery of a *Knightia* specimen by geologist John Evans in 1856. It was the first fossil vertebrate duly recorded from the Green River basin and was followed by many additional specimens which came to light during the next decade with the building of the Union Pacific Railroad. Construction crews, blasting through the shale hills west of railhead at Green River village, exposed a rich fossiliferous pocket which became famous as the "Petrified Fish Cut." Dr. F. V. Hayden, conducting the first geological survey of the region, examined the beds and, from their excellent exposures on the Green River, named them, in 1869, the Green River formation. The large fish collection obtained by his party was sent to the pioneer paleontologist, E. D. Cope, for study and description.

"A Third Locality"

Professor Cope maintained a close connection with the Hayden surveys throughout the '70's, himself visiting the region and making new discoveries of the fish beds north of the railroad near the mouth of La Barge Creek and on Fontanelle Creek. In reporting these two sites, he alluded to "a third locality, nearer the main line of the Wasatch Mountains"—the earliest reference, I believe, to the Twin Creek exposure or the "Fish Cliffs," as Fossil Butte was originally known.

Cope's rival, O. C. Marsh of Yale University, was also active on the scene, each new discovery on either side adding fuel to the comic-opera feud between them. Marsh brought back, among other prizes, the first gars and rays from the deposits.

Another worker was A. C. Peale, Hayden's ranking geologist. Much that was accomplished by the renowned U. S. Geological and Geographical Survey of the Territories in the Green River basin was due to him. He reaped a finny harvest from the beds at Fossil Butte, and this, along with the rest of the Hayden fish collection, eventually saw print in that formidable quarto volume known as "Cope's Bible"—1,002 text pages and 75 plates published as *The Vertebrata of the Tertiary Formations of the West* in 1884.

By that date, the fame of the butte was attracting other than scientific investigators—men like the Bell brothers who blew the fossils out of the ground with blasting powder; and still later, R. L. Craig and D. C. Haddenham who settled down to lifetime careers on the cliffs, supplying specimens to museums and the public at large. Of Haddenham's discoveries, the rarest was a fossil bird. Practically complete, the

skeleton suggested kinship with today's chanticleer of the jungles, the fowl-like chachalaca. It was named *Gallinuloides wyomingensis.*

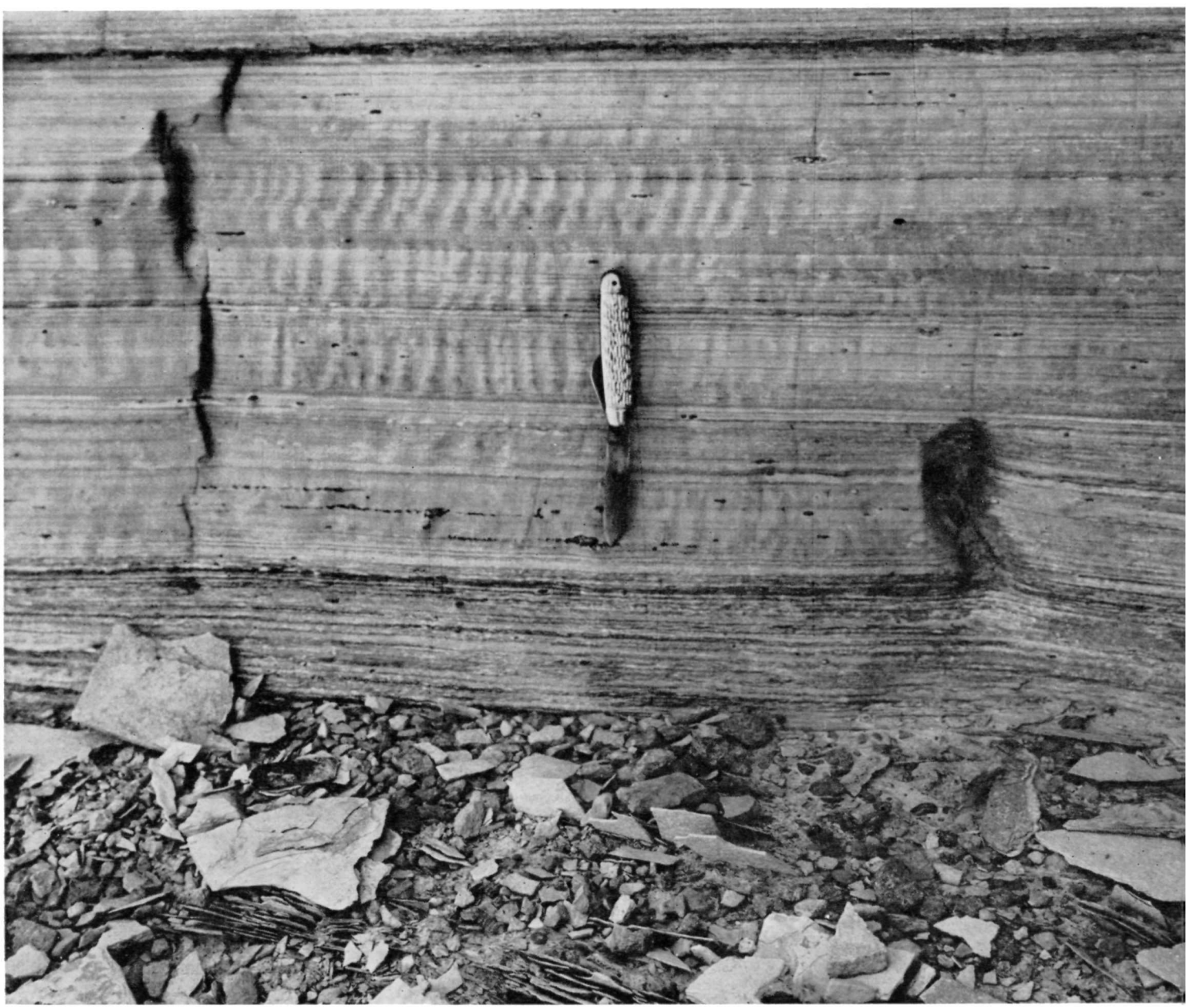
Equally rare was a fossil snake, the most perfect to be found in America. *Boavus* it has come to be known—"the grandfather of the constrictors." The sinuous 3-foot form came to the attention of science wrapped in an aura of mystery, which was left to the late Charles W. Gilmore of the U. S. National Museum to unwrap. No information accompanied the specimen, except that it was part of the estate of a deceased Wyoming merchant. Where or from what geologic age it came was a tantalizing question. The rock enclosing the bones appeared to be of Green River age, but . . .

In his perplexity, Gilmore turned to the one man who could help him—Wilmot H. Bradley of the U. S. Geological Survey. Help him, Bradley did. He not only traced the errant snake to the Green River formation through the rock's lithology, but, on the basis of a peculiarity in the bedding, showed it to come from the vicinity of Fossil Butte.

Dr. Bradley's familiarity with the Green River formation is of long standing. For more than forty years, he has sifted these ancient sediments for their meanings, his researches telescoping time and bringing the past into living focus.

The area of our interest was savanna country then, closed in by forests and slowly-rising mountains. Northward, one could see the beginnings of the

Dark fossil remains contrast with lighter limestone layers at Fossil Butte. Microscopically, the thin-layered rock of the Green River Formation such as that shown below is composed of very thin laminae of organic layers alternating with lighter-colored thicker layers, plainly seen in photograph.



Courtesy National Park Service

Courtesy National Park Service

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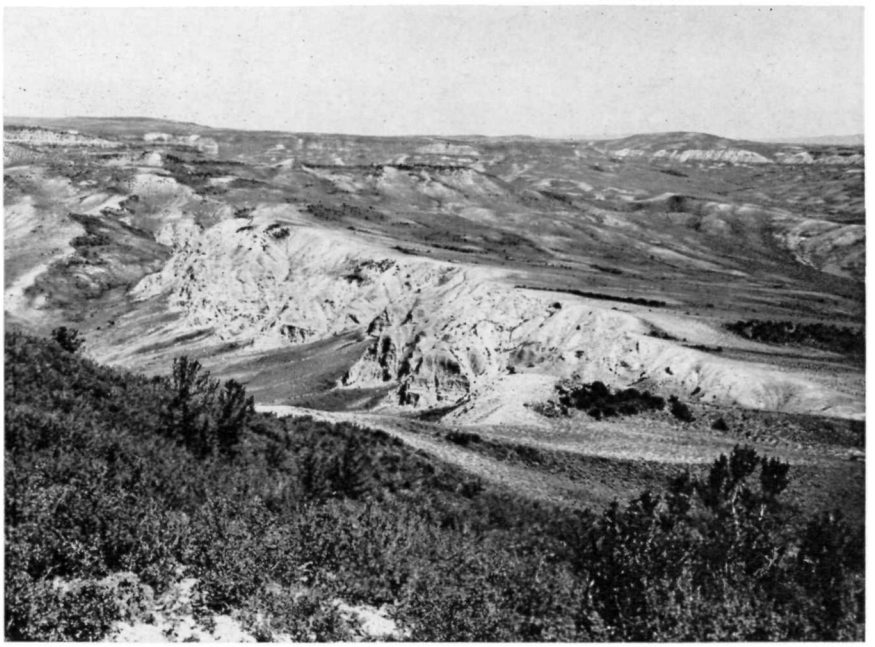
On higher, north-facing slopes and in such other places as moisture conditions allow there are scattered stands of limber pine, here and there mixed with aspen as in the photograph above. Picture was taken from Prow Point (map opposite).

Courtesy National Park Service



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At right, a view of Wasatch Formation "badlands" in their regional setting. Brilliant hues of red, purple, yellow and gray distinguish this formation from overlying Green River rocks, which here have been stripped away by erosion.

Wind River Range. Closer, arched the incipient Uintas. Three lakes occupied the intermontane basins, covering approximately 34,000 square miles in an area now comprising parts of Utah, Colorado and Wyoming. The largest, in Utah, has been termed Lake Uinta. A lesser body north of the Uintas was Gosiute Lake in which the present Rock Springs dome appeared as a large island. Immediately to the west, in a trough-shaped valley, lay the smallest of the trio—the lake of Fossil Butte.

The quick waters moved to the darting shapes of fish, bright bodies flashing in the sun. Protozoans swarmed, chiefly rhizopods. There were snails and clams, and minute shelled crustaceans known as ostracodes which populated the mud bottoms shelving out into the depths.

The depths, plunging a hundred feet or more below the surface, were dark stagnant places rife with hydrogen sulphide and without oxygen. What life was present resided in the anaerobic bacteria, the agents of decay. An intermittent "rain" of the tiny dead bodies of aquatic organisms, mixed with sediment, filtered down through the sun shafts into the shadows, to become part of the ooze which floored the bottom. There, bacterial action slowly decomposed the soft massed body parts, converting them into a jelly-like black sludge called *sapropel*, from the Greek *sapros*, "rotten," and *pelagos*, "sea." The harder shells and skeletons underwent a change also, in time becoming mineralized as fossils.

The deep deposits of these lakes were preserved in varves—thin alternating

bands of light and dark sediments which Dr. Bradley has indicated are seasonal in character. The dark layers, containing an abundance of organic matter, were undoubtedly deposited in the summer when biologic activity was high, while the light-colored mineral bands formed during the colder season.

The *sapropel* content, lithified as the ooze was compacted into rock, has come down to us as a major economic resource in the Green River oil shales. They contain an estimated 500 billion barrels of petroleum—"the world's largest deposit of hydrocarbons," according to the U. S. Bureau of Mines. The fossil content has come down to us as a resource, too—incalculably valuable in affording us an understanding of the past and the processes of creation.

A Wealth of Insects

Insect fossils are especially numerous. More than 300 species have been identified from the formation as a whole. Specimens include such delicate elements as antennae parts, cuticle-bearing hairs, chitinous skin and the infinitesimal scales of mosquito wings. The compound multi-faceted eye structures are often present, sometimes occurring in pairs. Solid lenses of fly maggots extend over many square miles, and in one place was found the first fossil mite discovered in this country.

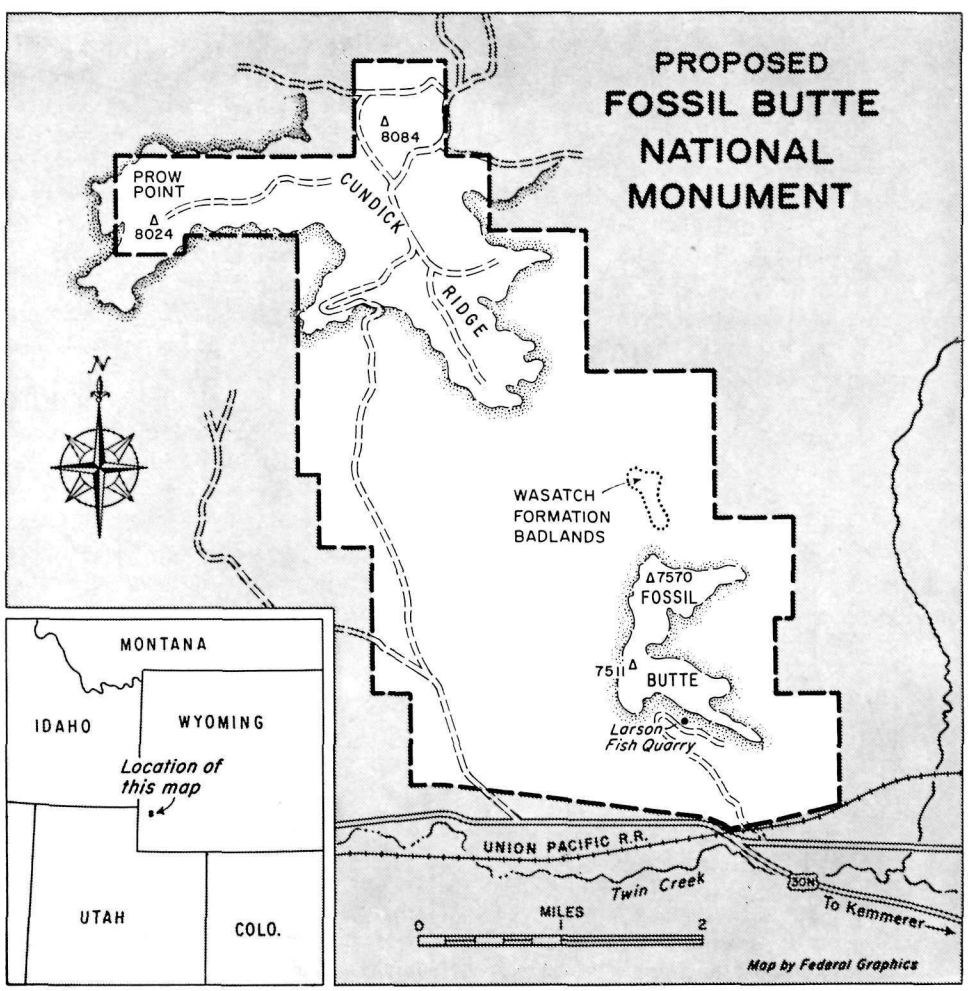
Plant remains offer promising rewards. Chert nodules contain fungus spores, tissues of moss or fern, perhaps bark cells. Pollen grains from forty different species have been studied . . . They tell of pine, fir and spruce in the mountains . . . of cypress, arborvitae and oak. Leaf specimens from Fossil Butte and elsewhere yield much information.

From them, paleobotanists have inferred a forest like that of our Gulf states, with rainfall averaging 35 inches a year, and a mean annual temperature of 65 degrees F. Low marshy banks rimmed the lakes and crocodile sloughs in a fringe of scouring rushes, pickerel weed, sedges and lily pads. Broom-like clusters of joint fir clung to sandy dunes. The shadows thickened away from shore where palms and mimosas struggled up through a tangle of vines and climbing ferns. Water elms were common, as were cycads and fig trees, honeysuckle trees, buckthorn and hackberry. On higher ground stood a prehistoric counterpart of our familiar eastern woodlands: willows, poplars and maples shading low-growing alder, pepperbush, myrtle and holly.

The animals living in this forest were many, strange and varied, their bones found today in the floodplain and stream deposits of Wasatch and Bridger age which intertongue with the Green River lake beds. Alert lemurs and tree shrews (tarsioids) moved among the leaves. *Paramys*, the ancestral squirrel and earliest of the rodents, scuttled through the underbrush looking for hickory nuts and acorns. Time had produced the first horses—small 4-toed creatures that kept to the shadows, hoping to elude the flesh-eating creodonts. Early opossums moved sluggishly about, and along the river banks could be heard the bustle of heavy-footed brutes resembling hippopotami. Where the trees thinned, opening into meadows, were tapir-like forms and cursorial rhinos. *Eotitanops*, and *Lambdotherium*, the commonest beast of its day, presented themselves—forerunners of a race of giant titanotheres that was to roam the western plains in herds, like buffalo.

In the evolution of life, theirs was a vital role. They and others of their kind constituted the pioneer stock of the mammals that struggled through the difficult racial beginnings. Some, like the early tarsioids and horses, gave rise to the more advanced forms of today; others became extinct.

Many paleontologists are at work on these forms from the remote periods of earth history—the fish, mammals, reptiles, insects and plants—studying their implications for human society. In the knowledge they give of the past, fossils contribute in many ways, none more important than the enlargement of our view of life, and this in turn to the enlargement and fulfillment of ourselves. What fosters this innner growth should be preserved; one of the places this can best be done is at Fossil Butte.



Wildlife and the Tsetse Fly in Rhodesia

By Archie S. Mossman

THE RHODESIAN GOVERNMENT HAS embarked upon a program of game killing as a means of preventing the spread of tsetse flies and the diseases they carry. After a temporary lull in the application of this method, game killing started in earnest again during 1964 and continues to the present. About 4000 square miles comprising some of the best game country in Rhodesia are included within the areas where the extermination of several wildlife species is being attempted. These species are elephant, buffalo, bush pig, warthog, kudu, and bushbuck. In the Gona-re-Zhou fenced area, all species are to be eliminated, and any of the larger species found close to the game fences enclosing any of the areas are shot.

Problems of Extermination

The purposeful extermination of any animal is usually a difficult undertaking, and the strip of country where game extermination is going on encircles three-fourths of Rhodesia, a country slightly larger than California. It is not possible to give an accurate estimate of the number of animals that must be killed in order to exterminate them. It is certain, however, that the numbers and the amount of meat involved are large. I would guess that by using standard hunting methods it will be possible to exterminate the buffalo and elephant, and possibly the kudu. Efforts will probably fail on the bushbuck and warthog and almost certainly hunters will fail to exterminate the bush pigs.

If this is such a difficult and uncertain undertaking, why have the Rhodesians embarked upon it? We will explore some of the reasons in this article.

The tsetse flies of Africa feed on the blood of reptiles, birds, and mammals, including man. They resemble a common house fly but are larger and have a long piercing proboscis with which they feed. Their bite resembles the painful bite of an American horse fly or deer fly. When feeding, the tsetse engorges itself until its abdomen is distinctly red and nearly tick tight. It then flies away to a shady area to rest and digest its meal. Unlike house flies which lay large numbers of eggs, tsetse are produced via a small number of larvae. These are deposited singly by the female fly. An hour or so after its deposition on loose soil, the larva has burrowed into it and pupated. Depending on how warm the soil is, the pupa will hatch into an adult fly three to eight weeks later. A female tsetse deposits only one larva every nine to ten days.

Cause of Sleeping Sickness

The several species of tsetses are distributors of microscopic organisms known as trypanosomes, which can cause diseases known as trypanosomiasis. The "tryps" live in such places as blood, the glands, and the cerebrospinal fluid that bathes the brain and spinal nerve cord of their vertebrate hosts. *Trypanosoma gambiense* causes a trypanosomiasis of man called West African or Gambian sleeping sickness. The organism swims through the blood very rapidly by means of its undulating membrane and hair-like flagellum. In fact, the only evidence of its presence when looking at fresh blood under the microscope is the spinning of red blood cells caused by its rapid passage between them. *T. gambiense* does not occur in Rhodesia, its place there being taken by *T. rhodensiense*. Rhodesia has two important trypanosomes carried by the two most important species of tsetse that occur within her borders, *Glossina morsitans* and *G. pallidipes*. Direct mechanical transmission by other biting insects is also possible.

Although sleeping sickness is a dangerous disease of man, the chances of contracting it in Rhodesia are not very great, even in areas where *Trypanosoma rhodensiense* occurs. This is largely because human population levels are low, hence the potential human reservoir for the disease is small in these areas. Treatment is usually successful if diagnosis is prompt.

Of more significance is *ngana*, a disease of cattle caused by *T. congolense*, *T. vivax* and *T. brucei*. It is primarily fear of ngana that results in the demands for control of tsetse in Rhodesia.

The trypanosomes multiply in the intestinal tracts of the tsetse and also in the mammalian hosts. After biting an infected host, the fly's bite can become infective in about three weeks. Once infected, tsetses remain infected for the rest of their lives. They live to be about four and a half months old in captivity. If they are like most animals, their life expectancy in the wild is probably shorter.

Ngana of cattle can be successfully treated and there are prophylactics which prevent cattle from contracting the disease. These are being used fairly successfully in some areas of Rhodesia. Formation of drug-resistant trypanosome strains has occurred but treatment and prophylaxis are still feasible. Both approaches cost money, which to a tribal subsistance economy is a considerable problem. Interestingly enough, there are at least two breeds of domestic "indigenous" cattle (*Bos indicus*) in Africa that live and reproduce in tsetse areas without benefit of any prophylaxis or treatment for trypanosomiasis.

Possibility of Immunization

Like these cattle, many species of wildlife seem immune to trypanosomiasis. It is said, however, that eland (*Taurotragus oryx*) raised outside trypanosome areas contract the disease and die when introduced into a tsetse region. Furthermore, eland removed from tsetse zones are said to lose their immunity. African buffalo are also reported to react in a similar manner. This suggests induced immunity which may be the case in the immune cattle mentioned above. Together, these point toward the possibilities of immunization and selective breeding as means to

combat ngana in cattle.

It has been fairly well established that bushbuck as well as man can harbor *T. rhodensiense*, and that common duiker as well as cattle harbor *T. brucei*. The presence of the trypanosomes and their identity in other species is incompletely known. Trypanosomes of some form have been found in at least thirty-two species of African mammals. Through the work of Dr. B. Weitz of the Lister Institute of Preventive Medicine at Hertfordshire, England, his associates and collaborators, we have a constantly improving understanding of the feeding habits of tsetse in terms of the blood obtained by the flies. By means of antigen-antibody methods somewhat similar to human blood grouping, they are able to identify with considerable accuracy the species or category of animal upon which a captured fly has fed. Their published results show that in some areas warthog, or at least pig blood, is the commonest food of the tsetse. Warthog and bush pig both are apparently infectible but the trypanosomes are very scanty in their blood, perhaps reducing their importance as carriers of the disease. Duiker are apparently important carriers of *T. brucei* but provide infrequent tsetse meals. All three species increased in abundance during a previous game extermination campaign in Rhodesia, the pigs first decreasing and then increasing in the face of increased hunting effort.

Other important blood sources for tsetse are bushbuck and kudu, while in some areas hartebeest and giraffe are very important. One tsetse in West Africa subsists largely on reptile blood. Bird and "cat" bloods are among those that have been identified from Rhodesian tsetse. In spite of the abundance of impala in the tsetse areas of Rhodesia, their blood is seldom detected in tsetse meals. However, they are infectable and their blood stays positive for a considerable period.

It seems to be generally assumed that black Africans cannot or will not live without their cattle. In fact, however, some are willing and able to live in tsetse areas where they cannot keep cattle. I know of one case where people of a tribe that normally keep cattle have actually moved from a tsetse free zone into a tsetse area. Likewise, the Tonga, a people the government moved out of the Zambezi Valley to make room for Kariba Dam, were living in tsetse country as do those still living along the Kariba shore and on the north bank of the Zambezi below the dam. These people support themselves largely by raising crops of various kinds and by gathering wild plants, grass seeds, and mopane bee honey. They eat some insects, capture birds, gather eggs, catch fish, and occasionally capture large mammals for food.

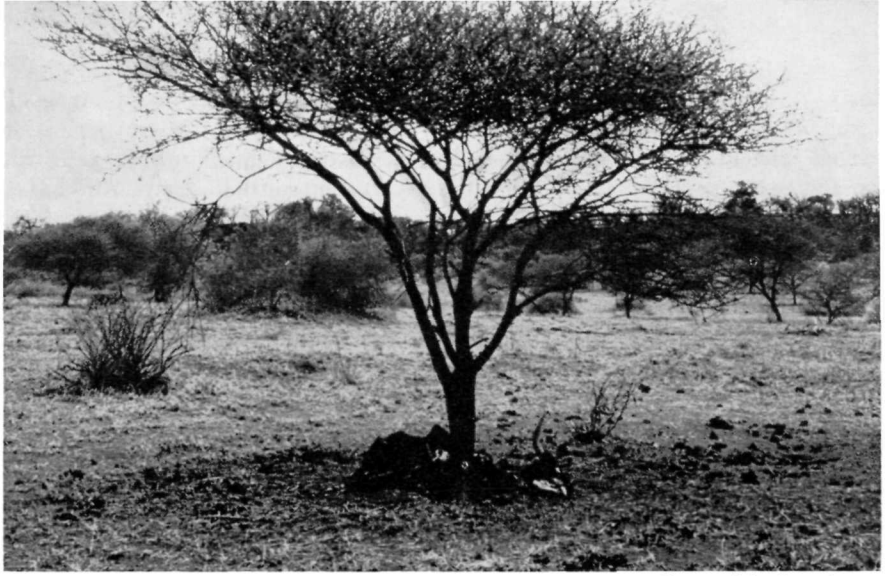
Farmers Endure Tsetse Fly

The case of European or white African farms and Native Purchase farms owned and operated by individual Africans is somewhat different. Within areas of adequate rainfall or where irrigation is practised, crop raising is feasible in the presence of tsetse. And in fact, the extensive habitat change resulting from such practise usually eliminates the tsetse. When this has happened the raising of domestic stock on an intensively managed basis is practicable.

The place where the tsetse problem is met most directly is in the dryer and hotter regions where arable farming is not possible. Here cattle ranching on an extensive basis occurs on large European-owned ranches. In fact, cost factors require a ranch of approximately 20,000 acres before a profit can be shown in much of this arid country. This is based on a breeding herd operation, and does not include the use of a ranch primarily as a holding ground for cattle bought from Africans on a

Rhodesian Information Service

Impalas shot in the tsetse control program on the edge of the Zambesi Valley are weighed.



Photograph by the author

Starvation was the fate of this cow, seen here on heavily overgrazed land of a European-owned Rhodesian ranch. Similar land nearby, used only by wildlife, is richly grassed.

speculative basis for resale. In these same regions, Africans on their reserves tend large herds of cattle, sheep, and goats. Because of economics, lack of knowledge, and plain malpractice, these hot dry areas are almost universally overgrazed. In fact, the overgrazing is so severe both in the Native Reserves and also on almost all European-owned cattle ranches that one can hardly believe it possible even while looking at it. To anyone concerned with the long-term interests of man in Africa, the tsetse fly, by preventing land occupation by stock raisers in Africa, has been man's most faithful ally. One does not doubt that a solution to the tsetse problem which results in introduction of domestic livestock as presently handled will simply spread the present devastation to the ultimate severe detriment of man himself.

Among the cattle-owning Africans, cattle are used for bride payments (lobolo). By their transfer of ownership they serve as the thread to knit together African society. However, other forms of lobolo, even money, are acceptable, so cattle are not really essential although desirable. Sheep and goats are commonly used for lobolo. All classes of livestock may feature in ritual, and also, of course, meat, milk, hides and other products are obtained from them.

The demand for livestock for all these uses among the Africans has increased many times since the occupation of the country by Europeans, and continues to do so at an accelerating rate. This is a direct result of the cessation of warfare, provision of health facilities and partial prevention of famine. The result has been far better survival of the Africans themselves. Since this is apparently combined with equal or greater emphasis on child-bearing, it is not surprising that Rhodesia has one of the most rapidly expanding human populations in the world. Each person wants as many livestock as possible, and, within his context, for good reason! As land is denuded by excessive grazing and browsing, insistent demands result in the opening of new lands to African occupation. These in turn are denuded, population grows, and the clamor for new lands becomes ever shriller; the prevention of famine ever more difficult. Kwashiorkor (protein deficiency disease) is widespread—partly from lack of food and partly from the ignorance of parents who do not realize that maize meal alone is an inadequate diet, especially for children. A baby suffering from this disease is a pathetic sight, and frequently dies.

Alternatives Needed

Prior to opening new lands for settlement and grazing by livestock many things should be considered. Alternative and complementary uses of the land should be given appropriate consideration. Not all land is most valuable for conventional farming. Rhodesia badly needs the immediate preservation of some real wilderness areas for their aesthetic, scientific, recreational, and tourist values. She also could well afford to have more national parks for somewhat the same reasons. Forestry is another important potential use for some of the lands, and the same could be said for properly run mining. Game ranching offers one of the most practical immediate uses for lands already stocked with wildlife. As has been demonstrated in Rhodesia, game ranching can be successfully combined with cattle ranching and with forestry.

Game ranching may seem strange to Americans because of our unique attitude toward the legal status of wildlife. Probably most people in the rest of the world do not think it a bit strange. What it amounts to is the commercial use of wild animals just as the rancher uses his tame goats, sheep, pigs and cattle. Game ranching as practiced in Rhodesia since 1960 utilizes virtually all the species of wild animals on any piece of land. Everything from hares, springhares and guineafowl to hippo, elephant, and ostrich are used to the extent that their populations can be cropped without danger to the breeding stock. This was initiated as a means of giving the wildlife a value and hence protecting them from extermination. A saying in Africa is that "You can't farm in a zoo." By "ranching the zoo" Rhodesians are finding that they can make more money than they could by raising domestic stock. Many do both on the same piece of land. These people have learned that shooting out game to

make more room for cattle is like killing the goose that lays the golden egg. The table (p. 15) provides a guide to some of the considerations by comparing the advantages and disadvantages of domestic livestock and wildlife.

There is no need to dwell on the advantages of domestic livestock. Almost all of us realize them and would never hope to see the last of beefsteaks, cheese, milk, and lamb chops. This, in fact, should make us all the more opposed to destructive grazing by livestock because it will ultimately reduce our supplies of these products.

In spite of those who say, "I couldn't stand to eat just wild meats!" there would be very little suffering in Africa if every last domestic animal eventually vanished from the continent. Instead of the cow, goat, sheep, pig, and chicken, the meat-eaters in Rhodesia alone would have a choice of about twenty-two big-mammal meat producers and about six gallinaceous birds, three bustards, twelve pigeon and pigeon-like birds and fifteen species of waterfowl. All produce good to excellent tasting flesh and are fully as nourishing as the comparable domestic meats. Each is acceptable to some of the inhabitants of Rhodesia.

Wildlife vs. Cattle

There is no lack of market for African game products, and as shown in the table, more meat can be produced by game than by domestic stock on the areas that have been studied in Africa.

How is it then that in the face of the extreme apparent difficulty in exterminating the six game species, and in the face of the proven greater economic value of game versus domestic stock, there is still this effort to exterminate game in order to replace it with domestic animals? One must remember that game-oriented people can see no intrinsic advantage to game conferred by either the tsetses or the trypanosomes they carry. In fact, it is possible that game could be more abundant and healthier without them. As an ecologist one cannot help but wonder what the effects of the absence of such an organism complex like tsetse and trypanosomes may be. It needs study. That is certain.

Many arguments have been advanced to support the killing of game as a means to control trypanosomiasis in cattle. Probably the strongest is, that following the great rinderpest epidemic of about 1896 a great reduction in the numbers of wild and domestic bovids was associated with a much reduced distribution and presumably abundance of tsetse flies. The contention is that the reduction, but not extinction, of game caused the reduction of tsetse. On the face of it, this is a beautiful correlation. As with all correlations, one should be cautious in drawing conclusions: there may not be a cause and effect relationship between the two.

Current efforts at reducing tsetse are based in part on the selective killing of game to eliminate those species that provide the blood meals and those that provide transport for the flies. It is hypothesized that elimination of the game species that are most fed upon by the tsetse will starve the tsetse and result in its extermination. Warthog appear to be the prime blood source for tsetse in some areas of Rhodesia. The intriguing thing is that according to the Merck Veterinary Manual, rinderpest has never been shown to occur in African wild swine or warthogs. It is therefore somewhat unlikely that these animals were severely reduced by the rinderpest epidemic. We thus might even question whether rinderpest and tsetse reduction had any direct connection at all. Perhaps the drastic reduction in numbers of bovids caused ecological changes that in turn affected tsetse abundance. In fact, the more or less simultaneous occurrence of the two phenomena might have been pure coincidence.

Another argument put forward in Rhodesia to support game destruction for tsetse control is the "result" of studies in the 200 square mile Nagupande area. Here it is claimed that selective removal of certain game species has caused a great reduction in the number of tsetse.

Dr. Mossman recently spent four years in Rhodesia, researching the use of big game animals for food to insure conservation of wildlife and teaching a game course at the College of Rhodesia and Nyasaland. He is now Associate Professor in Humboldt State College's Division of Natural Resources.

Before we go any further, it is essential to point out that trypanosomiasis is normally found before tsetse flies are detected in any area. That is to say, if any tsetse at all can be captured with current techniques, there are more than enough of them present so that trypanosomiasis will be prevalent. Usually ngana is noticed in cattle and then an intensive search turns up a few tsetse.

The Nagupande studies have not, as far as I am aware, resulted in the inability to capture tsetse flies. The animal killing techniques applied there included some that were far from selective such as the pollution of water holes with diesel fuel and the plugging of burrows with brush wood. The study had no experimental controls, and it was of short duration prior to the starting of general "selective" game destruction over approximately 4,000 square miles of Rhodesia. Its results have been unscientifically extrapolated to areas of a very different kind to support game destruction there. The Nagupande studies have not proven that game destruction will eliminate trypanosomiasis.

Lack of Scientific Control

Similar studies or field trials have been applied elsewhere. One author even described a substantial reduction in tsetse that occurred on a study area before the experimental manipulation started. He rightly pointed out the interpretive error that almost certainly would have been made had this reduction occurred *after* rather than *before* the experimental treatment was applied.

As regards their transport by game, there is little doubt tsetse are moved around to some extent while riding on mammals. I expect that they are moved by riding on mammals other than the buffalo and elephant which are being exterminated because of their role in transporting tsetse. Tsetse can fly, and I can see no reason why they might not hitch rides on birds; they certainly feed on them.

There appears to be no valid justification for widespread game destruction to control tsetse among any of the literature or studies known to me. If game were worthless or worse, one might feel that game destruction would be better than providing charity for those employed in its elimination. But,

the game animals are not worthless, and in fact are much more valuable in cold, hard cash than are the domestic stock with which people wish to replace them!

The fundamental problem in Rhodesia is a runaway human population increase. While every effort must be made to lower the birth rate, for humanitarian reasons provision must be made for those already born. One can look at the Rhodesian tsetse problem most reasonably from this point of view, realizing that serious political problems and problems of vested interests are also involved.

To many, the answer seems simple: open up new lands by clearing out game animals and with them the tsetse fly, and everyone profits. Existing enterprises are protected. "Game" is eliminated and hence all problems of disease transmission to domestic stock are solved with finality. Work for Africans is provided. New land for African settlement is opened up and hence the Land Apportionment Act need not be altered. Even the apparent costs are reduced below costs of other ways to "open up" land because pay for the shooters consists largely of the animals they kill. Add to this the neatness of counting in tails and passing out ammunition and rations plus the fun of the elephant and buffalo hunting for the supervisors and one can see why it gets strong backing based on a lot of wishful thinking and "looking out for number one."

Better Ways To Do the Job

There may be other ways to eliminate the tsetse fly and with it probably the trypanosomes. An A.I.D. study has been in progress in Rhodesia for about two years now. Its aim is the extermination of tsetse through the use of radio or chemical sterilants, a technique that proved to be fantastically successful in the elimination of the screw worm fly from Florida. Studies on the use of attractants to lure tsetse to death or to sterilization are progressing. The possible use of pesticides has been studied, and large applications under various conditions have been tried. In South Africa, a carefully controlled use of pesticides successfully eliminated tsetse from one area. However, these must be used with utmost caution. Studies aimed at biological control of the tsetse through parasitization are also progressing. All these approaches argue against game destruction if one acknowledges that wild animals are not worthless.

However, these arguments and the whole question of elimination of trypanosomiasis must be judged in the light of present conditions in Africa and in light of reasonable predictions of her future.

At present, about 4.15 million square miles or 37 per cent of Africa is occupied by tsetse. It is in these areas and some parks outside the tsetse zones where most of the existing game of Africa finds refuge. There is very little doubt that a sudden solution to the trypanosomiasis problem allowing the advance of conventional African agriculture into these areas will cause massive habitat changes. This will be accompanied by exploitative use of the wild animals and we will see the end of not only the impressive and valuable game helds but also the end of an opportunity for man to really profit from the hugely productive intact African eco-system. Rhodesia with its dry season and relatively flat topography has virtually no natural refuges from the destructive acts of man except through aridity and tsetse. Government schemes are developing water sources in the arid parts, so the tsetse remain practically the only non-human barrier to land settlement.

There is no good conservation reason for wanting to maintain trypanosomiasis as a deadly disease of man and beast *if* satisfactory safeguards for insuring conservative land use are found. The conservationist worthy of the name is not anti-man and pro-wildlife. He is concerned above all with the long-term welfare of man. I hope that those who support the extermination of wildlife in the attempt to control trypanosomiasis will bear this in mind if they read this article.

In providing food for the people of Rhodesia the most urgent need is for large quantities of high quality and culturally acceptable animal protein. Because of the high rate of human increase and the low carrying capacity for domestic livestock in the areas of Rhodesia now occupied by tsetse, there is no hope of providing for this need with domestic animals alone even if trypanosomiasis is completely removed from the country. The protein these areas can produce through management of wildlife is three and more times that possible with domestic livestock. Domestic livestock might well be usefully integrated into the system. However, even this will fail unless control of the human population increase is quickly achieved. Some parts of these areas can perhaps best be used for cultivated crops and intensive animal management, but this cannot be significant. The areas are simply not adapted by soil, water or climate to such agriculture except in small isolated pockets. Even these, in many cases, provide the essential dry season water and forage upon which the meat production of the surrounding areas absolutely depends.

The Positive Approach

The shooting of game to eliminate trypanosomiasis has a small chance of success. Even if it did work, the loss of the game is far more to be deplored than the elimination of trypanosomes is to be applauded. Considering the long-term welfare of man, there is no just reason to continue the killing of game in Rhodesia to eliminate trypanosomiasis except possibly in very narrow corridors on the periphery of tsetse zones when intelligently combined with other tsetse control techniques.

However, the killing is under way, and it must somehow be converted from a negative to a positive thing.

I believe this can be done as follows:

The exterminative shooting can be converted to sustained yield cropping of game within the tsetse zones, while the *advance* of tsetse is prevented by concerted effort on the periphery of tsetse areas. In spite of statements to the contrary, the game killing as presently practiced was not, and is not justifiable as a means of stopping tsetse advance, even if one accepts game killing as the best method.

There are many tools available to prevent tsetse advance, and even more to prevent or live with trypanosomiasis. Careful appraisal within each local area will determine which are most applicable. It is highly unlikely that any single method will work best in all areas. Most of the necessary general land capability surveys have been made so

that experts working at the local level should be able to devise ecologically sound and practically effective measures to stop tsetse advance. In some areas, it may be most sensible to simply rely on medication for ngana.

Where not already available, game surveys should be made quickly, and immediately following these, the tsetse shooting should be phased into sustained yield cropping of game. As much or more employment would be provided now and for a long, long time to come and badly needed protein would become available on a sustained basis. It would also substantially increase the revenue available to the country. The spoilage and waste would be avoided by a considerable increase in facilities and equipment to handle and process the animals obtained. If private enterprise were encouraged to participate, the production of taxable new wealth would be substantially increased. The possible involvement of local tribal units in such efforts should be imaginatively explored. Because of the necessary retrieval of the animals, opportunity for scientific study would be far greater than under the conditions of tsetse shooting.

Matching these efforts should be intensive research directed at the general problem of trypanosomiasis and at the sociological problems of human culture in Rhodesia. Several unexplored or slightly explored lines suggest themselves for trypanosomiasis control. The possibility of breeding trypanosome resistant stock and the possibility of inducing an immunity to the trypanosomes both in livestock and in man are but examples.

A Sociological Problem

It has been suggested that domestic eland could replace cattle as domestic stock in an African economy in tsetse areas. It is known that they can be handled like cattle, bear young well in tame herds, and so on. What is not known is the circumstances under which they would be adopted into African culture. Thus this becomes in large part a sociological problem.

The table below clearly shows that Rhodesia has at its disposal a wealth of wildlife resources. If properly used and conserved, these resources can fill a multitude of human needs—needs which are now not only going unfulfilled, but which are in themselves contributing to unrest, unsatisfaction, and a low standard of living for Rhodesia's teeming population.

It is not just study that is needed. There is already a considerable fund of knowledge relating to the sociology of Rhodesia upon which action can and should be taken. Similarly, quite a lot is known about the game production potential within some of the tsetse zones, so there is no reason to delay making the start.

If a positive approach such as this is taken in Rhodesia, other countries including the United States should be prepared to lend their support and encouragement. If we could guarantee this, we would have considerably more hope of seeing a constructive change in Rhodesian tsetse policy and with it an important constructive change in Rhodesian husbandry of her resources. ■

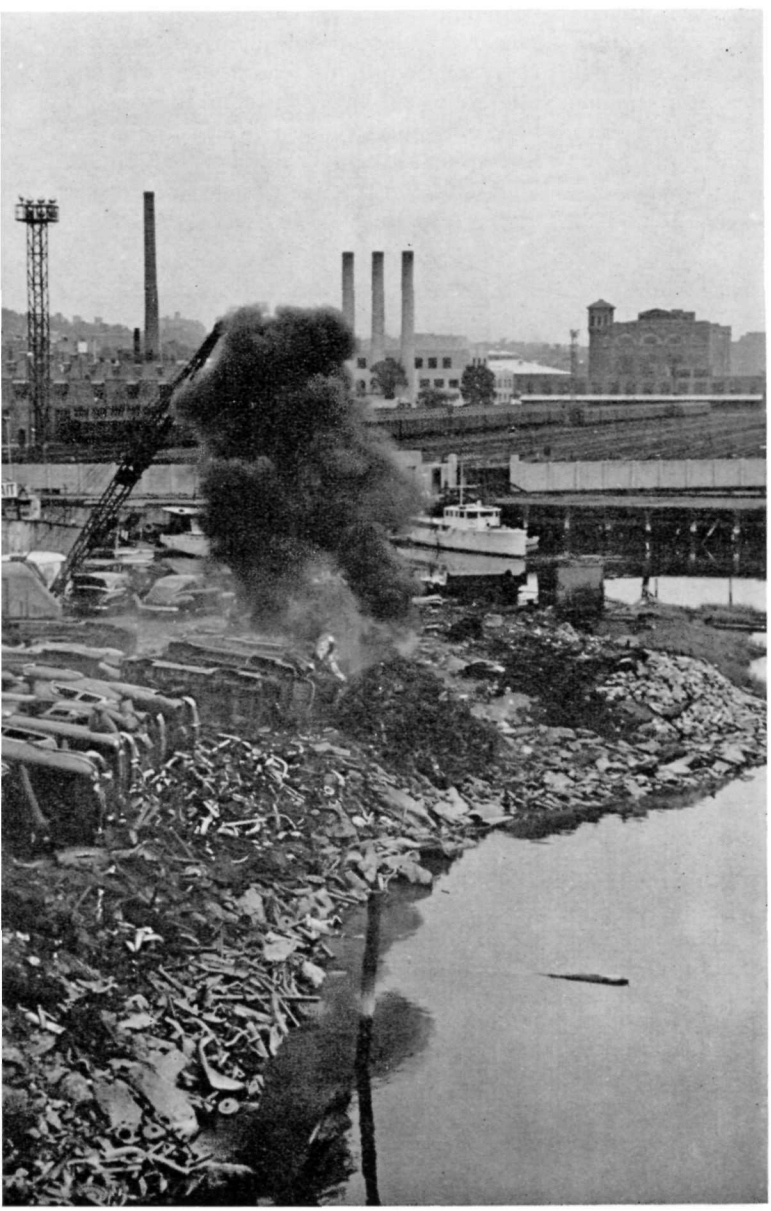
ADVANTAGES AND DISADVANTAGES OF WILDLIFE AND DOMESTIC STOCK FOR ANIMAL PRODUCTION IN AFRICA

Advantages of Wildlife	Wildlife Disadvantages	Advantages of Traditional Domestic Livestock	Domestic Livestock Disadvantages
1. Resistant to diseases, parasites, and heat. 2. Many species can and will travel far to water and some need not drink. 3. Feed on all levels of the vegetation and on most species of plants. Many well adapted to use low protein forage. 4. Most have substantially higher dressing percentages than domestic stock and produce relatively more lean meat. 5. Produce in the aggregate 3 or more times more meat per unit area per unit time than domestic stock. 6. Occupy virtually all habitats and need not be closely tended. 7. There is less reason in the African context to attempt "stockpiling" game than domestic stock. 8. Areas with abundant wildlife have high tourist potential: Hunting, photography and viewing of wildlife can bring revenue from sportsmen, photographers and others. 9. In Africa, people are probably more accustomed to eating game than to eating domestic stock. 10. Many wild animals have value in ritual. Sharing game may be "necessary" to placate a spirit and hence, "cure" disease, for example.	1. Do not provide milk for human consumption. (Domesticated eland could fill this need.) 2. Not as easily obtained for slaughter as domestic stock. 3. Not as easily seen and counted as domestic stock. 4. Not as readily usable for lobolo. 5. May conflict with domestic stock raising and with agricultural practice. These problems can be solved through research and common sense.	1. Useful in ritual. 2. Provide milk. 3. Can obtain them easily for slaughter. 4. Can be easily seen and counted and therefore one's wealth in stock can be easily determined. 5. Can be physically handed alive from one individual to another and therefore used for lobolo. 6. People are accustomed to using them, herding them, and so on.	1. Susceptible to many diseases, parasites and to heat. 2. Can feed (cattle especially) only a very limited distance from water. 3. Cattle are not very well adapted to low protein forage. Domestic stock cannot obtain or utilize much of the vegetation easily obtained and utilized for food by game. 4. Have relatively low yield of meat per pound live weight compared with game and have a high fat to lean ratio compared with game. This is a disadvantage where protein is a major need as in Africa. 5. Can produce considerably less meat per unit area per unit time than game. 6. Require constant attention to prevent wandering, disease and predation and successfully occupy only a limited number of habitats. 7. Domestic livestock can be and are "stockpiled" with disastrous results through overgrazing.

THE POLLUTION OF MAN'S ENVIRONMENT

By Ellery R. Fosdick

Consulting Engineer



1. World Environment

THE WORLD APPEARS TO BE MOVING toward dangerous and perhaps catastrophic environmental conditions with a relatively unknown end result because of the rapidly increasing rate of pollution. The people of the world, and their governments, must soon be brought to recognize this so that adequate corrective steps can be taken before it may be too late.

Man and his activities are increasingly out of equilibrium with the natural environment as a result of the growing world population and the by-products of modern industrialized and mechanized society. The pollution of the air, the water and the land by disposition of unwanted residues in them has reached alarming proportions. The steps which have been taken so far to improve the situation, and those which may be reasonably expected to be taken in the forseeable future, will in many cases only reduce the rate at which conditions worsen rather than change them for the better.

The effect of the pollution of man's environment in the world—or for that matter in relatively small areas—on a long-range basis has not been given much serious attention so far. The over-all long-range effect of the increasing amount of pollution in the world environment on man, climate and ecology is largely an unknown, although fortunately natural forces have been up to now shown considerable capacity to dispose of residues. Fortunately, also, the atmosphere is not a sink for pollutants but acts to transport, dilufe and finally to eject pollutants, most of which have a relatively short residence time. This is also essentially the case for fresh-water courses, although the residence time is somewhat longer in many cases than it is for pollutants in the atmosphere.

Photograph courtesy New York State Air Pollution Control District

"We almost bury ourselves in garbage which is largely the refuse of our affluent society." At left, a scene of land, air and water pollution as junked automobiles burn along a big-city waterfront.

The alarming concentration of pollutants in the atmosphere, hydrosphere and land will continue to increase until drastic changes are made in methods of disposal.

The natural sinks for pollutants, which are the land and the oceans, are capable of dispersing, degrading, depositing and binding large quantities of pollutants. The use of scarce land and water for the disposal of pollutants has, however, resulted in these being spoiled, sometimes beyond recovery.

Although there is now considerable proficiency in meteorological prediction the course taken by debris dispersed into the atmosphere, and some of the insidious effects of air pollution such as changes in temperature and precipitation, may not become known for generations. An inkling of the effect of atmospheric pollution is afforded by some of the acute short-range episodes already experienced in many of the large cities of the world.

The course of events for contaminants reaching streams, lakes, ground water and estuaries—that is, the hydrosphere—is also not well known, and cannot be reliably predicted at present. Similarly, knowledge with respect to the accumulation of potentially harmful materials in the land is insufficient, as are the processes of concentration of these materials in plants and in animals feeding upon such plant material.

The term pollution as used herein refers to a resource that is out of place, since substances that are considered undesirable pollutants under some circumstances may be valuable under others, as subsequently discussed. Some of these substances are natural materials that have long existed in the environment, such as small particles of dust and silt; whereas others are created by man, such as sewage, the sprays of agriculture, and junk piles.

The uncontrolled disposal of unwanted residues by the simple expediency of releasing them downwind into the atmosphere, or downstream into water courses, cannot be permitted much longer if we are to avoid some serious consequences, some of which are unpredictable.

2. *Atmospheric Pollution*

The air has become a vast sewer with a high concentration of pollutants over large cities. The emission of the principal pollutants in the United States into the atmosphere that is shown in the following tabulation gives an indication of the magnitude of air pollution:

Source	Million Tons Per Year in 1965
Transportation	74.8
Industry	23.4
Generation of Electricity	15.7[1]
Space Heating	7.8
Refuse Disposal	3.3
Total	125.0

[1] 31.4 million tons per year in 1980 and 62.8 million tons per year in 2000, based upon assumption that 50 percent of electric generation capacity will be nuclear powered by year 2000.

Photograph courtesy Federal Water Pollution Control Administration

An aerial view of Cleveland's harbor on Lake Erie, showing pollution (lighter shade between the converging jetties) drifting out to mix with the comparatively clean water of the lake offshore.

The major sources of individual atmospheric pollutants are: internal-combustion powered transportation (carbon monoxide, oxides of nitrogen, hydrocarbons); steam-electric generation of electricity (oxides of sulfur); industry (particulate matter, miscellaneous pollutants).

It is apparent from these data that attention needs to be given particularly to the atmospheric pollution caused by internal combustion engine-powered vehicles and by the generation of electricity using fossil fuels in steam boilers since these are the sources of the largest amount of air pollution and of most of the toxic residues that are released into the atmosphere. The outlook for a reversal of the ever-increasing amount of pollution from these sources is not favorable at present. For example, it is expected that there will be a 50 percent increase in the number of automobiles by 1980, with a corresponding increase in the air pollution from this source, unless smaller, more efficient engines not now in prospect are used; or some other type of prime mover, such as electric motor drive, is substituted. On the assumption of severe but realistic controls, but with no change in technology, the sulfur dioxide emission into the atmosphere, which converts to corrosive sulphuric acid, will increase by 75 percent by 1980.

Even this is an incomplete picture, since the huge amount of heat released into the atmosphere by man's activities, and its effect upon the climate of the world, has not been taken into account. The total amount of heat that is dissipated is very large, since almost all of the energy used by mankind, most of which is derived from fossil fuels, nuclear reactors, water power and food consumed, manifests itself directly as heat that ultimately reaches the atmosphere.

3. *Pollution of Water*

There will be enough fresh water available for our projected needs provided we can limit the current practice of permitting each user to add pollution, and if we reduce wasteful uses of water when other satisfactory means are available to meet the need. The following summary shows this clearly.

The average annual stream flow discharging from the continental United States into the oceans is 1,100 billion gallons a day, compared with the estimated average annual amount of water withdrawn for use from water supplies and returned polluted in the year of 1954 and projected for the year 2000 as shown below:

	Billion Gallons Per Day	
Year	*Withdrawn for Use*	*Returned Polluted*
1954	300	190
2000	889	730

The large withdrawal for use that is projected for the year 2000 should not be construed as an indication of a pending water shortage, since the extent to which water is used more than once on its way to the ocean is not reflected in this figure. Furthermore, the amount returned polluted indicates the large amount that would be available for reuse if each user were required to depollute his waste water before releasing it as effluent.

The water shown above as withdrawn for use is for irrigation, municipal use, manufacturing, mining and steam-electric-cooling. Of the above the major withdrawal in the year 2000 will be for steam-electric-cooling, which returns the water with little loss but at a higher temperature, which subsequently leads to a small loss during normal evaporative cooling in the water course. This addition of heat can effect the ecology of the stream. The requirement for cooling water can be greatly reduced by recirculation of the water in a cooling tower, which releases the heat to the atmosphere; and it may be possible to eliminate all need for cooling water if an efficient method of releasing the heat directly to the atmosphere is developed. The need for cooling water will be very small for the direct conversion of heat energy to electricity by electro-gasdynamic generation, which seems to offer a good probability of breakthrough.

The necessity for depollution of waste water becomes apparent when it is recognized that the oxygen-demanding wastes in the United States, such as municipal sewage and industrial waste, are growing rapidly with the increase in population and the increased use of water, with the inevitable result that the effluents from waste treatment plants, assuming that all waste water is treated, will by 1980 have a residual oxygen demand in excess of the capacity of all of the dry-weather flow of streams unless the efficiency of such waste-water treatment plants is materially increased.

4. *Pollution of the Land*

We almost bury ourselves in garbage which is largely the refuse of our affluent society. This refuse amounts to 800 million pounds a day in the United States. It consists of things like chemicals, bottles, tin cans, waste paper, junked automobiles, dead animals, plastics, rags, melon rinds, construction debris, ashes, or dead leaves. Much of this is now disposed of by burying it in the land, but we are running out of space for this purpose.

Pollutants placed in the land generally remain there for long periods of time. In addition, the placement of waste in the land may also pollute important supplies of ground water.

Methods must be found to reduce the amount of solid waste by changes, as for instance in the types of containers used for various items, so that these can be reduced to some reusable form; and by changing the form of waste so that it can enter water disposal systems. Solid wastes from urban areas are now disposed of chiefly by landfill and by incineration where the gases of combustion are dispersed into the atmosphere, and the residue is placed in the land. Disposal of solid wastes at sea is rapidly becoming inadequate, as are the other methods previously mentioned. Large surpluses of plant and animal wastes in many agricultural areas also pose a waste-disposal problem with the increasing alternative use of artificial fertilizers. The solid waste from industry and six million junked automobiles a year add to the problem.

5. *Pollution of the Oceans*

The tailings of man and nature ultimately flow into the oceanic waters, which retain them as a passive sink. This is the case for all saline waters including those in the ground. The oceanic waters are important as a source of food, for climate control, and potentially for a number of

important minerals found as depositions on the floor of the ocean; there are also vast quantities of valuable substances in solution in the waters. The time may come when the deliberate pollution of oceanic waters will have to be controlled if we are to fully utilize their resources. The use of the ocean as a sink for long-lived radioactive substances should, for example, be reexamined in the future. The pollution of tidal estuaries and beaches is now a serious problem.

6. Noise as a Pollutant

Noise is a form of pollution which, although not a cumulative residue that must be disposed of, may adversely affect man's environment; yet relatively little attention has been given to its control. The chief source of objectionable noise in many areas is from transportation facilities such as the ever-increasing number of airplanes, low-flying helicopters, automobiles, buses, trucks, powerboats and trains. Short-range, jet-propelled aircraft now using small airports located near centers of population have recently added to the relatively high level of noise from the air. The supersonic transport planes now being developed, which will spread their sonic booms around the world, will supply a finishing touch to the high level of noise in which many of us live. The approach to the noise problem so far is primarily one of how much noise man can tolerate rather than of concern about an invasion of his right not to be disturbed by noise.

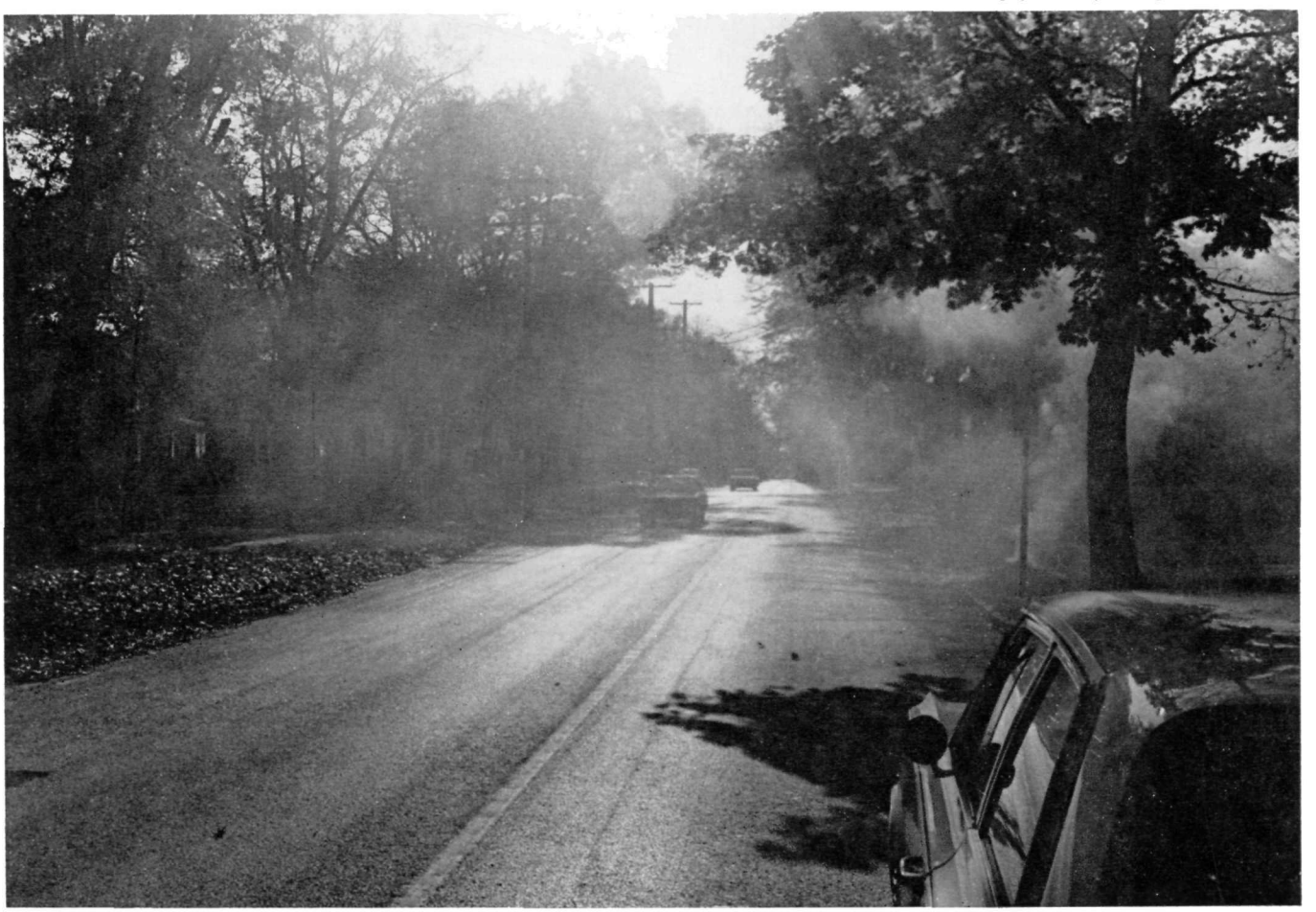
It is difficult to justify the disturbance to several hundred thousand people on the ground of a city by aircraft, carrying relatively few people, flying low over the city while taking off and landing at a nearby airport; yet there is no evidence of a serious, sustained effort to reduce noise from this source. A good example of this is the recent introduction of jet aircraft to the Washington National Airport in Washington, D. C., and plans to enlarge the facilities there despite the fact that the airport is adjacent to the heart of the city.

7. Conclusions

The existing methods of disposing of pollutants as unwanted residues cannot in most cases be followed much longer, as we are running out of dispersal media and sink capacity for them. Furthermore, this wasteful procedure follows the practice in most cases of disposing of useful and needed materials taken from exhaustible natural resources of the earth. In short, a systems approach to pollution problems, both urban and regional, is becoming necessary. The best approach appears to lie in the recovery and

Suburban leaf-burning in Muskegon, Michigan. "The existing methods of disposing of pollutants as unwanted residues cannot in most cases be followed much longer, as we are running out of dispersal media . . ."

Photograph courtesy Muskegon Chronicle



reuse of pollutants to the maximum extent practicable, as a part of the waste treatment of pollution that can be collected. In the case of pollution that cannot be readily collected it will be necessary to change the form of the pollutants, or perhaps to dilute them.

Many substances now discharged into the atmosphere have value, and techniques are now available for removing them. The incentive for removing these substances has not, however, been attractive so far in most cases.

The sludge and certain of the minerals contained in sewage, which are now wasted, have value to agriculture as humus and fertilizer. Here again the utilization of materials which are difficult to dispose of would solve this problem, and would also reduce the demand for fertilizer that is mined from the earth.

Solid waste such as garbage, which is increasingly difficult to dispose of, can be converted to a compost for use as a fertilizer or burned at high temperature to keep air pollution at a minimum and to produce heat that can be used to generate electric power or desalinate brackish or salt water for use in a municipal water system. A considerable amount of work has already been done in both of these areas, and while procedures are technically feasible the incentive has not been attractive so far.

The recovery and reuse of metal in discarded automobiles would not only remove unsightly junkyards but would also reduce the amount of new metal that must be mined. A step in this direction is the removal of copper from auto scrap to make it more acceptable to iron foundries. This is about to be tested in a pilot plant under a contract recently awarded by the Federal Government under authority of the Solid Waste Disposal Act of 1965.

A few steps toward initiating a gradual improvement in the handling and treatment of pollutants have already been taken by the Federal Government. The most important of these are:

The Federal Clean Air Act of 1963, which was intended to improve, strengthen and accelerate programs for the prevention and abatement of air pollution. Its stated purposes are:

(1) To protect the Nation's air resources so as to promote the public health and welfare and the productive capacity of its population;
(2) To initiate and accelerate a national research and development program to achieve the prevention and control of air pollution;
(3) To provide technical and financial assistance to State and local governments in connection with the development and execution of their air pollution prevention and control programs; and
(4) To encourage and assist the development and operation of regional air pollution control programs.

The Motor Vehicle Air Pollution Control Act of 1965, which amends the Clean Air Act to establish standards applicable to the emissions from new motor vehicles starting with 1968 model automobiles, with penalties for the violation of certain prohibited aets.

The Federal Water Pollution Control Act of 1956, as amended in 1961 and 1965, which has as its objective the enhancement of the quality and value of our water resources and the establishment of a national policy for the prevention, control and abatement of water pollution. To assist in carrying out the purposes of the Act, a Federal Water Pollution Control Administration was established. The Act provides for:

(1) The preparation and development of comprehensive programs for eliminating or reducing the pollution of interstate waters and tributaries thereof and improving the sanitary condition of surface and underground water.
(2) Encouraging cooperative activities by the States for the prevention and control of water pollution.
(3) Conducting and cooperating with others in conducting research investigations, experiments, demonstrations and studies relating to the causes, control and prevention of water pollution.
(4) Grants to others for the purpose of assisting in the development of any project which will demonstrate a new or improved method of controlling the discharge into any waters of untreated or inadequately treated sewage or other wastes, subject to certain limitations.
(5) Grants to others for the construction of necessary treatment works to prevent the discharge of untreated or inadequately treated sewage or other waste, subject to certain limitations.
(6) Establishment of a water pollution control advisory board to advise, consult and make recommendations on matters of policy relating to activities and functions under the Act.
(7) Establishment of enforcement measures against pollution of interstate or navigable streams.

The Federal Solid Waste Disposal Act of 1965, which has as its objectives:

(1) To initiate and accelerate a national research and development program for new and improved methods of proper and economic solid-waste disposal, including studies directed toward the conservation of natural resources by reducing the amount of waste and unsalvageable materials and by recovery and utilization of potential resources in solid wastes; and
(2) To provide technical and financial assistance to State and local governments and interstate agencies in the planning, development, and conduct of solid-waste disposal programs.

No Federal legislation for the abatement and control of noise has yet been enacted.

Technology now available for use in the abatement of pollution is not fully used, chiefly because of inadequate incentives. These incentives, which vary depending upon circumstances, are economic gain, avoidance of adverse public opinion, or freedom from penalties. It is probable that this situation will gradually improve as a result of the Federal laws mentioned above. The seemingly inevitable result of pollution problems will, it appears, be the establishment of more control over matters affecting the pollution of man's environment by the central government of each country, with increasing cooperation between the governments. ■

News and Commentary

Park Wilderness Hearings

The National Park Service has brought forth plans for wilderness preservation, under terms of the Wilderness Act, for two more major units of the national park system, and has announced dates for public hearings on both. The units are Craters of the Moon National Monument in Idaho and Lassen Volcanic National Park in northern California.

Preliminary Park Service plans call for classification of 40,800 acres of Craters of the Moon's 53,545-acre total as legal wilderness—about three-quarters of the monument. The public hearings will be held at the Butte County Memorial Building in Arco, Idaho, at 9:00 a.m. September 19; a packet containing the proposal, along with explanatory matter and a map of the monument with its proposed wilderness area may be obtained from the Superintendent of Craters of the Moon National Monument, P.O. Box 29, Arco, Idaho 83213, or from the Regional Director, National Park Service, 450 Golden Gate Avenue, P. O. Box 36063, San Francisco, California 94102.

Park Service preliminary plans for legal wilderness in Lassen Volcanic National Park encompass 49,800 acres of the park's 106,934-acre total, or considerably less than half. A packet with the materials mentioned above but covering this park may be obtained from the Superintendent, Lassen Volcanic National Park, Mineral, California 96063, or from the Regional Director of the Western Region, address as in the preceding paragraph. The public hearings on Lassen Volcanic Park will be held beginning at 9:00 a.m. on September 27 in the Lincoln Street School, 1151 Lincoln Street, Red Bluff, California.

Conservationists wishing to make statements at the hearings should notify the hearing officer of their desire to do so, addressing him at the monument or park superintendent's office; it should be kept in mind that the hearing record at both hearings will be kept open for ten days following conclusion of each hearing, and persons not able to attend may send statements to the Hearing Officer at the address of the superintendent of monument or park with a request that the statement be included in the official record.

A pattern of planning for wilderness in the parks and monuments which makes provision for relatively small wilderness and relatively large potential development areas appears to be continued in the Park Service preliminary plans for Craters of the Moon and Lassen Volcanic monument and park. At the first park system unit hearings covering wilderness planning for Great Smokies Park the National Parks Association strongly opposed dismemberment of the parks in this manner. Association members who might wish to present their views at the Craters of the Moon or Lassen Volcanic hearings, either orally or by written statement for the record, will find the Association's views on park wilderness summarized in the statement "Wilderness in the Smokies," which was printed as an insert in the August magazine. Separate copies of the statement are also available from the Association without charge, on request.

Forest Wilderness Hearings

In late July, the U. S. Forest Service held public hearings at Altadena, California, on its proposal to reclassify the Devil Canyon-Bear Canyon Primitive Area in the Angeles National Forest as the San Gabriel Wilderness of a little more than 36,000 acres. The National Parks Association, the Wilderness Society, and other national conservation organizations supported the Forest Service in its plans for the new Wilderness, which, with some boundary adjustments to exclude peripheral development and nonconforming uses, generally follows the boundaries of the primitive area.

The Forest Service has scheduled two more wilderness hearings on primitive areas for the near future. On September 9, it will hold public hearings in Bozeman, Montana, on its proposal for reclassification of the Spanish Peaks Primitive Area, in the Gallatin National Forest, as the Spanish Peaks Wilderness. Then, on September 15, public hearings will be held at Springerville, Arizona, on Service plans to create a Mount Baldy Wilderness from the present Mount Baldy Primitive Area in the Apache National Forest.

Dr. C. M. Goethe

Dr. C. M. Goethe of Sacramento, California, conservationist and philanthropist whose name has for many years been known both nationally and internationally, died in Sacramento during late July at the age of 91.

Dr. Goethe, to whom the National Parks Association was up to the time of his death deeply indebted for generosities, achieved lasting fame in the national park field; his name will always be associated with the early days of the National Park Service's program for park interpretation. For it was this conservationist who was credited with bringing to America, not long after the turn of the century, the nature guide idea which had been in successful operation in Europe. He and his wife first introduced this idea at Lake Tahoe in 1919 where Stephen T. Mather, first Park Service director, witnessed its success. At Mather's insistence it was tried the following summer at Yosemite National Park, where the idea took firm root and developed into the Service interpretive program as we know it today.

Helping the Polar Bear

The great white polar bear, *Thalarctos maritimus,* numbers of which may be dangerously low, was recently removed from the list of animals eligible for big-game record competitions by the Boone and Crockett Club, a hunting organization. Shortly thereafter the Executive Committee of the National Rifle Association voted to drop its annual trophy award for the animal. The actions are directed at discouraging hunters from killing the large mammals, since polar bear status is generally unknown and wandering habits of the mammal make it difficult to estimate numbers killed.

Although the bear has survived intensive primitive hunting since the 1700's, the comparatively recent use of long-range rifles and aircraft have greatly reduced its numbers; at the First International Scientific Meeting on the Polar Bear, held in Alaska in September, 1965, it was determined that there are only

(continued on page 22)

about 10,000 bears left, of which at least 1300 are killed yearly. To halt a possible trend toward extinction new regulations have been adopted by the Alaska Board of Fish and Game to limit hunter kills of polar bears, and it is hoped that not more than 300 of the animals will be killed by hunters each year.

New Post for Gabrielson

One of the nations' outstanding conservationists, Dr. Ira N. Gabrielson, has been appointed by Virginia Governor Mills E. Godwin to the Virginia Outdoor Recreation Commission.

Dr. Gabrielson is chairman of the Northern Virginia Regional Park Authority, and was first director of the U. S. Fish and Wildlife Service in 1940. He is author of six books on wildlife management and conservation, and is now president of the Washington, D. C.-based Wildlife Management Institute. Dr. Gabrielson will serve on the Commission with State Senator Fitzgerald Bemiss; Daniel G. Van Clief; Holman Willis, Jr.; and Dr. T. Roy Jarrett, Jr., all of Virginia.

Business and Population

At the end of this century the present human population of the world may double, and approximately 6.6 billion people will be jammed on this relatively small planet. This spiraling population, long a matter of grave concern to educators, conservationists, sociologists, scientists and others, has now begun to worry the business community. At a recent conference on "Population and Growth" sponsored by the National Industrial Conference Board, James F. Oates, Jr., Chairman of the Equitable Life Assurance Society of the United States, said that the businessman, for example, "feels deeply that foreign aid cannot be successful in the long run in raising living standards unless population growth levels off."

At the conference, programs to control population growth around the world were cited as being of great importance to all businessmen.

Detour for Park Roads?

In a formal press statement in June, Senator Ralph W. Yarborough of Texas released the text of what he has termed a "guiding policy" for highway planners concerning the building of roads through public parklands.

The policy is in the form of a proposed amendment to the Federal Highway Act, which would insert at the end of the bill the following provisions: "It is hereby declared to be the national policy that in carrying out the provisions of this title maximum effort should be made to preserve Federal, State, and local government parklands and historic sites and the beauty and historic value of such lands and sites. The Secretary shall cooperate with the States in developing highway plans and programs which carry out such policy. After July 1, 1968, the Secretary shall not approve under section 105 of this title any program for a project which requires the use for such project of any land from a Federal, State or local government park or historic site unless 1) there is no feasible alternative to the use of such land, 2) such program includes all possible planning to minimize any harm to such park or site resulting from such use, and 3) where possible and appropriate substitute land will be provided for such park or site. Any additional project costs incurred for the purpose of acquiring any such substitute lands shall be considered to be included in 'cost of rights-of-way' for the purposes of this title."

Plans for New Refuge

The U. S. Fish and Wildlife Service plans to create a wildlife refuge of 1300 acres of tidewater flats in Kent County, Maryland. The land, which is being acquired in large parcels by the Federal government, will cost $712,000 and will cover most of Eastman Neck Island at the mouth of the Chester River.

Reviews

THE APPALACHIANS. By Maurice Brooks. Houghton Mifflin Company, 2 Park St., Boston, Mass. 1965. 346 pages, illustrated. $6.95.

With Great Britain's *The New Naturalist* as an inspiration and with Roger Tory Peterson and John A. Livingston (former Executive Director of the Canadian Audubon Society) as editors, Houghton Mifflin has embarked on a series of books designed to explore the communities of plants and animals and the geology of North America and, as the editors observe, "to recapture the inquiring spirit of the old naturalists." *The Naturalist's America*, as the series is called, is off to a splendid start with *The Appalachians*.

There was a time, and not long ago, when the once-honorable term "naturalist" and what it stood for had come to seem merely quaint. It suggested a catholicity and ardor of interest that seemed not quite scientific. But the naturalist has made a triumphant comeback—as an ecologist—with a mission of seeing nature whole and, if possible, saving human society from its failure to do so. Of the old-new breed Maurice Brooks, professor of wildlife management at West Virginia University, is an admirable example.

He has, for one thing, been around—to the Shickshocks of the Gaspe, where the Appalachians rise from the sea, to the Arctic island of Mount Washington's summit, to the Cranberry Glades and semi-desert shale barrens of West Virginia, to the limestone caves of the newer Appalachians, to the North Carolina balds astonishingly visited by snow buntings, to the coves of the Smokies with their incomparable flora—always with an Argus-eyed regard for Swainson's warblers and rosebud orchids, yellow-nosed voles and red-cheeked salamanders, for a "lost" sedge, a hoped-for yellow-flowered rhododendron . . . and for panthers, which just *may* be there. For anyone who has ever known any part of this 2,000-mile-long, ancient range it is impossible to be exposed to Maurice Brooks' informed enthusiasm without feeling a hunger to return.

This book makes the reader so excitedly aware of the riches Appalachia offers that no explicit conservation message is needed. Yet it is strange to find nothing in it of the menace to the mountains of highways, strip-mining and the developer's bulldozer. And, the absence of any maps other than those of minute scale on the end-papers is unforgivable. For the rest, with its many well-chosen photographs and fine drawings by Lois and Louis Darling, *The Appalachians* is a notable and surely permanent addition to the national library of natural history.

—Charlton Ogburn, Jr.

CALIFORNIA CONDOR: VANISHING AMERICAN. By Dick Smith and Robert Easton. McNally and Loftin, 114 East De la Guerra, P.O. Box 1316, Santa Barbara, California 93102. Illustrated, 111 pages. $3.50.

"Since men have been on earth, condors have been flying." This simple statement, presented in Smith and Easton's comprehensive book, holds the key to the amazing history of the nearly-extinct California condor. The same band of about forty condors which now stubbornly resists extinction in a remote part of California's protected Los Padres National Forest are of the species which dates back "since the ice sheets receded and stone-age men came to inhabit what is now the southern part of the United States."

The condor is the ancient Thunderbird of Indian myth and religion, who was thought to cause thunder by the flapping of its eleven-foot wing span. In the Pleistocene Epoch the condor's ancestor, *Teratornis terribilis*, probably reached a wing span of eighteen feet or more; since then the bird has changed comparatively little.

Recorded observations of condors date from 1602, but the first Europeans "undoubtedly saw condors in California in the 1500's."

Such a long earthly history makes the possible demise of the species particularly tragic. Man alone is responsible for the death of the birds—and for no other reason than his apparent love of killing. Condors are harmless carrion eaters, but even today trigger-happy hunters are prone to wipe out the last remaining birds. A good deal of the story of condors, past and present, is told in this absorbing book. It makes excellent reading for all naturalists, and may well contribute to holding off the day when, by a final act of impertinent omniscience, man may destroy a great living link with the past and thus perhaps impair his ability to extend himself harmoniously into the future.

THE CONSERVATION DOCKET

Recent park and general conservation legislation introduced into Congress, not noted in previous instalments of the CONSERVATION DOCKET, is as follows:

S. 3608, Senator Nelson, for himself and Senators Gruening and Hartke, to prohibit the sale or shipment for use in the United States of the chemical compound called DDT. Referred to the Committee on Agriculture and Forestry.

H. R. 15293, Rep. Schmidhauser, relating to the use of revenue from oil shale deposits. Provides that a special account be set up for royalties, rentals, sales, etc., derived from oil shale lands, when and if they are leased or otherwise disposed of, by the U. S. Treasury and disbursed for the conservation and enlargement of human and natural resources. To the Committee on Armed Services.

H. R. 16102, Rep. Tunney, would amend section 170 (c) of the Internal Revenue Code of 1954 to provide a deduction from gross income for contributions and gifts to or use of certain conservation organizations. To the Committee on Ways and Means.

S. 3568, Sen. Saltonstall, for himself and Sen. Kennedy, would amend the organic act for Cape Cod National Seashore to provide $28,000,000 for acquisition and development rather than the present $16,000,000. To the Committee on Interior and Insular Affairs.

H. R. 15705, Rep. Moorhead, would redesignate the Department of the Interior as the Department of Natural Resources, with transfer of certain agencies to and from such a Department. To Committee on Government Operations.

H. R. 15808, Rep. Poague, would authorize a Dinosaur Trail National Monument in Texas to preserve "significant scientific features." To the Committee on Interior and Insular Affairs.

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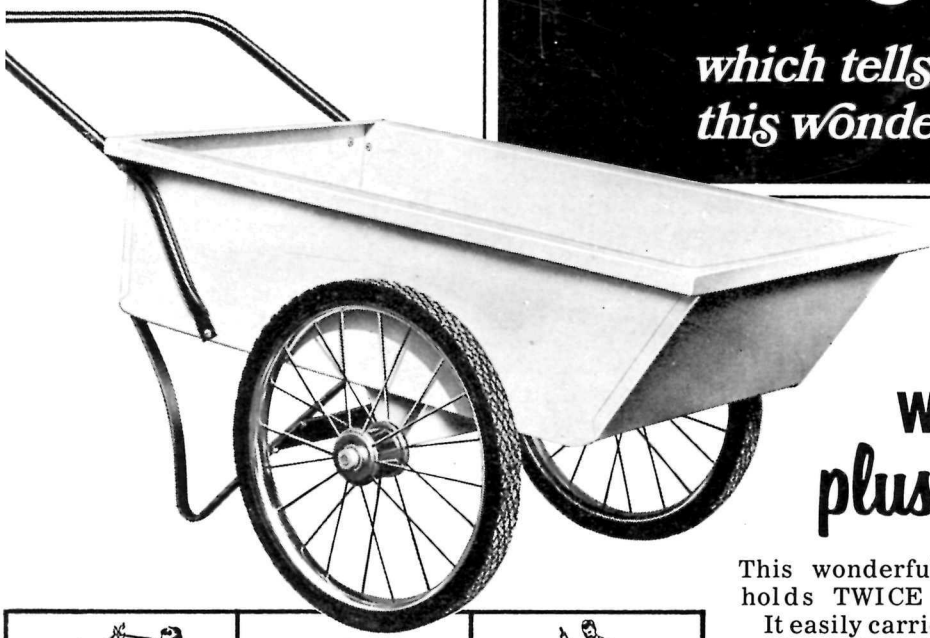

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