

PART I : BEAR BEHAVIOR

Paper 1

Ingestive Behaviors of the American Black Bear

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INTRODUCTION

This paper describes the behaviors associated with procurement and consumption of food by captive black bears. The few prior studies are largely anecdotal and associated with food habit studies. Murie (1937) briefly describes the foraging of an adult female for grasshoppers. He notes that the bear frequently overturned bison chips in search of food. Cottam *et al.* (1939 - p. 314) state that in Virginia 'the black bear is much more of a clean feeder than might be expected.' He reports finding little debris (leaves and twigs) of the plants from which fruits or seeds are consumed. Chatelain (1950) reports that black bears on the Kenai Peninsula of Alaska consume considerable debris and Frame (unpublished) notes fishing behavior along a river.

Three major categories of behavior will be discussed; foraging, predation, and consumption. Data for all three categories were obtained using various techniques of observation; written notes, super-8 ciné film, and video-tape. Most observations involved the same captive female bears studied by Burghardt & Burghardt (1972), Burghardt (1975), Jordan (this volume) and Pruitt (this volume). Details may be found in Bacon (1973).

FORAGING

Although particular behavioral sequences of foraging, including searching for and orientation to selected food items, depend upon the situations encountered, the components of the observed behaviors are relatively consistent and uncomplicated. Such consistency occurring in semi-natural conditions indicates that the behaviors described here are representative of patterns involved in the attainment of food by black bears in natural conditions. Although stereotypy may seem unusual for a member of the order Carnivora, it is understandable in view of the black bear's largely vegetarian diet. Predation upon other than sessile invertebrates and social insects was seldom observed and was not considered a component of foraging.

Olfactory Scanning

Bears use their noses in two ways: to sniff the air and to sniff (smell) objects within the enclosure, including the fence and the ground. When the bear sniffs



Fig. 1 Non-directional olfactory scanning, sniffing the air.



Fig. 2 Olfactory orientation, sniff close (Sc).

the air (S air), it is orienting toward a relatively distant odor. During this behavior, it generally does not move. Regardless of body position, the head is raised with the nose extended upward. This type of orientation is observed when the bears are in a variety of body postures including sitting on the haunches, standing on all fours, and standing on the back legs while resting against a tree or fence. The mouth is either open or closed depending upon the intensity of the orientation. If the bear is sniffing intently, the mouth is open and exhalations may be heard from a few m distance. The inhalation appears to be slow but becomes faster with greater arousal of interest. The S air is illustrated in Figure 1.

Sniffing or smelling objects within the enclosure involves several levels of intensity. At the lowest intensity the bears usually hold their noses close to the ground or objects being smelled and there is little actual contact. Depending upon the distance, this is called sniff medium (Sm) or sniff close (Sc). Figure 2 illustrates the Sc. With Sc the bear would place the upper lip within two cm of the object. Further distances, from approximately two to ten cm, are labeled Sm. A higher intensity is the sniff mash (Smh) where the bear pushes the front of its nose firmly onto the object being smelled. The Smh occurs as the bear smells the ground, logs, and the pockets of the investigators. It is generally associated with the presence of food. Sniffing objects within the enclosure also occurs with a variety of body postures. In addition to the postures in which the S air occurred, Sc and Sm were observed when the bears were lying down.

The inhalation rates during Sc and Sm are 1.2 to 1.6 inhalations per second. This appeared to be a consistent rate. Inhalation when the bear sniffs the air is much slower. As the bear inhales, the lower portions of the upper lip extend; the lip is drawn back as the animal exhales. Contact with objects being smelled is frequently accomplished with the upper lip as it extends. During foraging the upper lip is often used to move forest litter. The ears seldom move during the olfactory scanning and are maintained in an outward position known as the lateral 45° position (Pruitt 1974).

Ambulatory Movements

Two major patterns of movement were observed, apparent random walking and direct movement toward a food object. The predominant pattern that differentiated appetitive ambulation from other forms of movement such as pacing, running play and fright reactions, is the general orientation of the bear toward the ground. As the bear wanders in search of food, the body line along the back and top of the head form an arc. The difference in angle of the head relative to the ground between food searching and other types of walking is subtle, but it can be distinguished by the experienced observer. When the bear is not searching for food, the head is held more upward than that of the foraging bear, whose head is closer to the ground.

A more obvious indication of foraging is the random breaking of stride to orient toward or sniff the ground and various objects. In this apparently random walking, the bears walk in a *Left-front, Right-rear, Right-front, Left-rear* pace frequently broken by olfactory orientation. The speed of forward movement in random walking varies greatly. In a fifteen minute video tape sequence of foraging behaviors, the maximum speed recorded was one m per second. The frequency of orientation toward objects varies according to the food available. When raisins are scattered in the enclosure, the bears seldom orient away from the ground. The ear position during the apparent random walking is the lateral 45° position with infrequent ear movements.



Fig. 3 One of the subjects foraging.

In direct movement toward food, the bear moves deliberately with no breaking of stride or olfactory orientation. The primary orientation appears to be visual as the head is not oriented toward the ground but rather toward the food being approached. Thus, the movement is similar to non-food walking. Although the direct movement sometimes involves running, the bear generally walks briskly and slightly more rapidly than the maximum speed of the apparent random walking. Again the ears are maintained in the lateral 45° position and do not move.

Use of the Front Paws

The front paws are frequently used during foraging; in digging, raking, turning over objects, lifting and pulling. Digging resulted in actual movement of earth. Limited digging in an area generally consists of small, shallow holes which are often enlarged over a period of time. Digging usually occurs adjacent to rocks, root systems of trees, and the concrete in which the fence was embedded. Figure 4 illustrates the results of long-term digging around the roots of a large pine. This would presumably be rarely, if ever, as localized under natural conditions.

As the bear digs, it stands on all fours with the nose near the ground. The hind feet are together and the paws are used one at a time. While a bear digs, it is always smelling the ground. The front claws are used to move the earth. A front leg is extended, lowered to the ground, and pulled back along the ground in a single motion. The front leg motion is always parallel to the body line, and the earth is always pulled toward, never away from the body (Fig. 5).



Fig. 4 Results of digging around roots of large pine.

Video tape analysis illustrated that the speed approximated 0.8 seconds per digging movement. After three to four digging movements, the bear would stop and Sc or Smh the ground. In a 10-minute recording, an average of 27 digging movements per minute occurred.

Raking is identical to digging except that only the litter on the ground was moved. Raking is used to move the surface litter, draw objects toward the animal, or move specific objects such as rocks and branches. Figure 6 illustrates a bear raking straw toward the den for use as bedding material.

The bears are adept at lifting and turning over rocks, logs and other objects on the ground. When bent downward, the claws of the front foot could almost touch the front pad of the foot. In this way the animals could partially grasp objects. To lift and turn over objects the bear would grasp the side of the object farthest away and pull it upward and back toward its body. Although a bear may turn the bottom of the front paws perpendicular to the ground, it



Fig. 5 Typical digging posture.



Fig. 6 Kit raking straw toward the den.

never seemed to flip objects by a rotation of the foreleg. Also, the bears never lifted an object with the pads of the front foot turned upward. Instead, all lifting was a continuation of the raking motion with the claws turned downward and back.

The front paws are also used to pull at objects such as the bark of a tree. In debarking logs the bears would hook the claws of one paw under the bark and pull toward the body. The other front foot was used for support against the log.

PREDATION

Both bears used a forepaw for initial contact with prey animals, usually via slapping. The bears would quickly snap up an insect in their mouth, but generally they trapped it beneath the paw. Often they used both front paws in apparent attempts to cover and crush the prey. The reaction to an introduced uninjured mouse (*Peromyscus* sp.) was similar to that toward insects. Both bears chased the mouse with a series of front paw slaps. The bears' approach to a water snake (*Natrix sipedon*) was similar in that the forepaws were used to initiate contact with the snake. Unlike the insects and mouse, however, the snake exhibited an aggressive defense. During the interaction with the snake, the bears cautiously raked and pulled the animal toward them but made no crushing slap. The sequence of approach and paw slap of a butterfly is shown in Figure 7 traced from a super-8 ciné sequence. The orientation appears to

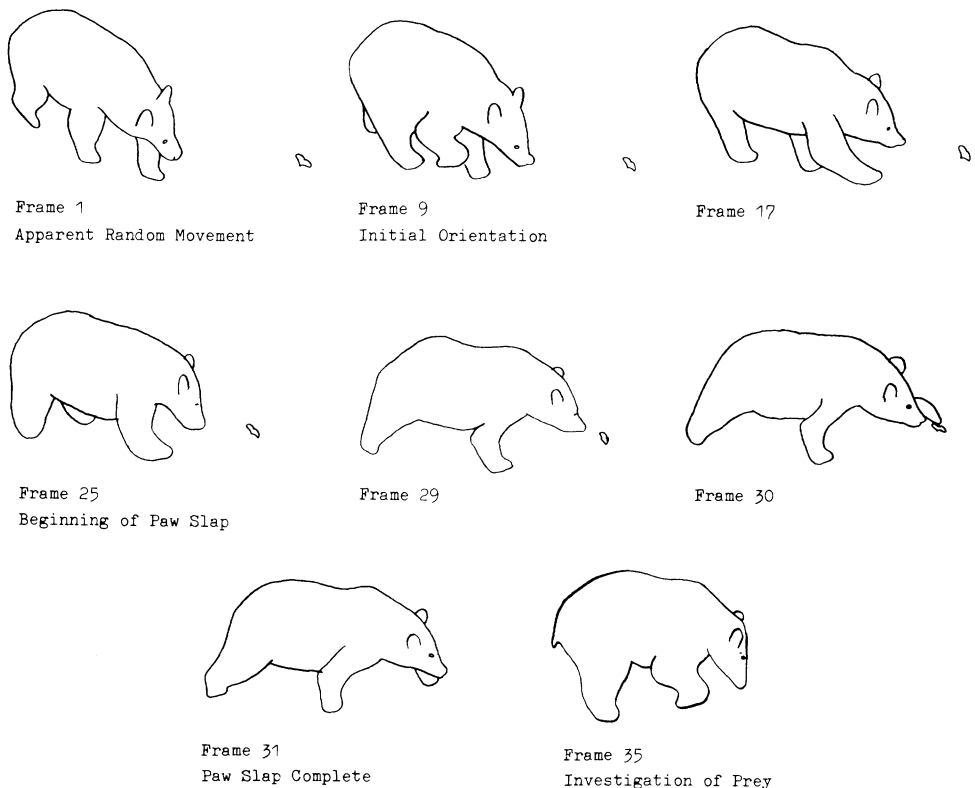


Fig. 7 Sequence of butterfly catching (18 frames per second).

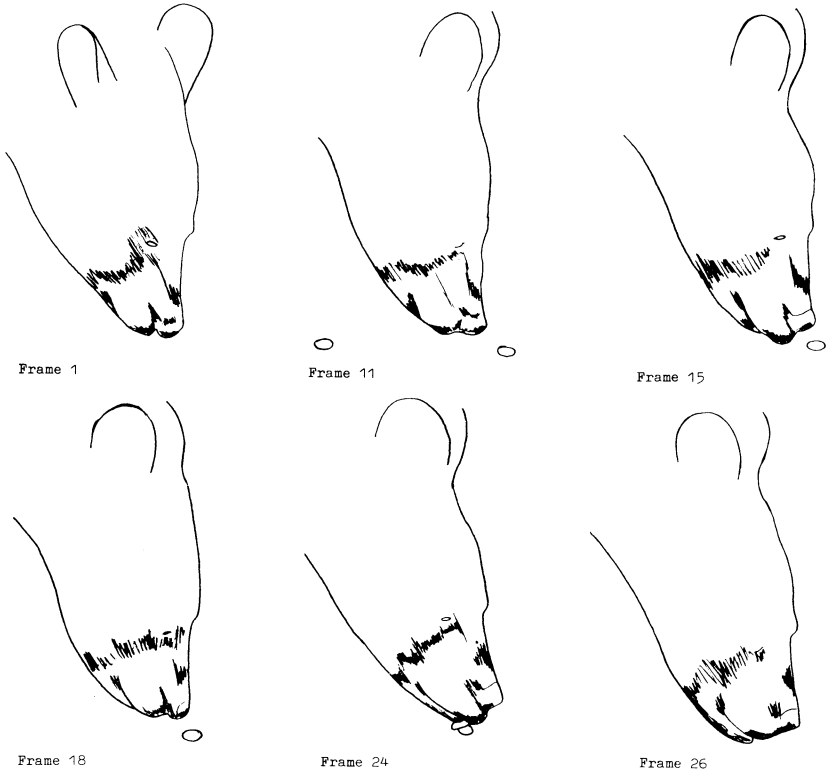


Fig. 8 Orientation and procurement of acorn (18 frames per second).

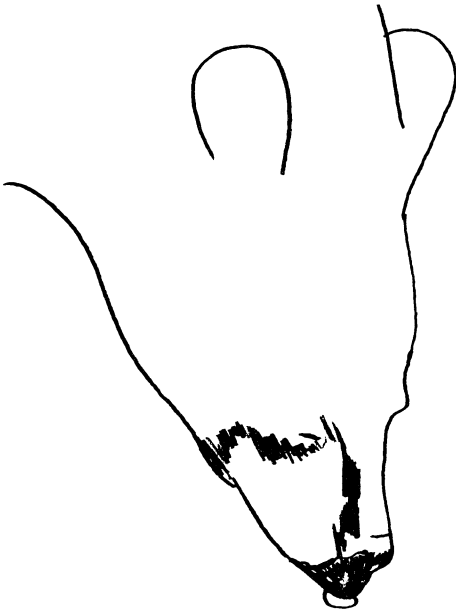


Fig. 9 Extension of upper lip in picking up acorn.

be visual and the ears remain in the lateral 45° position throughout the sequence.

Eisenberg and Leyhausen (1972) believe the use of the forepaws to grasp prey is a recent advance in prey capture that has evolved several times within various orders of mammals. Insectivores, dasyurid marsupials and small carnivores may use the forepaws to pin small prey to the ground before administering a killing bite or series of bites. However, only the Felidae favor use of the forepaws to clasp prey prior to killing.

Another use of the forepaws is considered unique to the Felidae (Ewer 1968). The serval (*Felis serval*) crushes prey, particularly those exhibiting agonistic responses, with a downward, slapping blow of a forepaw. Ewer believes that the paw slap in these cats functions to keep their heads away from potentially hazardous prey. The bears' use of the forepaw with the snake appeared to serve this function but no paw slap was observed. However, when an injured mouse was introduced to one bear, she oriented to the mouse, smelled it, delivered a crushing slap with the right forepaw, smelled the mouse again, and delivered another rapid slap with the left paw prior to taking the mouse into her mouth. The bear appeared to use the forepaw to kill or disable the prey prior to eating it.



Fig. 10 Kit using forepaw upon which to rest uneaten pieces of acorn.

CONSUMPTION

The major classes of vegetative foods bears consume in the Great Smoky Mountains National Park are nuts, berries and grasses (Beeman and Pelton 1974). In this study we observed how bears ate acorns, blackberries and grass.

Consumption of Acorns

Orientation to acorns appears to occur by both sight and smell. A film analysis indicates that the initial orientation is visual. This, of course, assumes that the bear is already in the vicinity of available food and does not discount a general olfactory alerting or prior scanning. While details of the orientation and procurement of food vary with the specific situation, the visual and olfactory orientation, along with procurement via tongue and upper lip, is fairly consistent.

Figure 8 illustrates a sequence of orientation and procurement of an acorn by Kit. Frame 1 is the first obvious orientation toward and acorn. The distance is approximately 16 cm. Since other acorns are scattered nearby and no upper lip movement associated with sniffing occurred, this initial orientation is considered visual. In frame 11 the bear is approximately 6 cm from the acorn. At this point the upper lip extension of the Sniff Close (Sc) begins. In frame 15 the upper lip is maximally extended and withdrawn three frames later (frame 18). This Sc possibly serves as a reliability check for the object to which the bear is orienting.

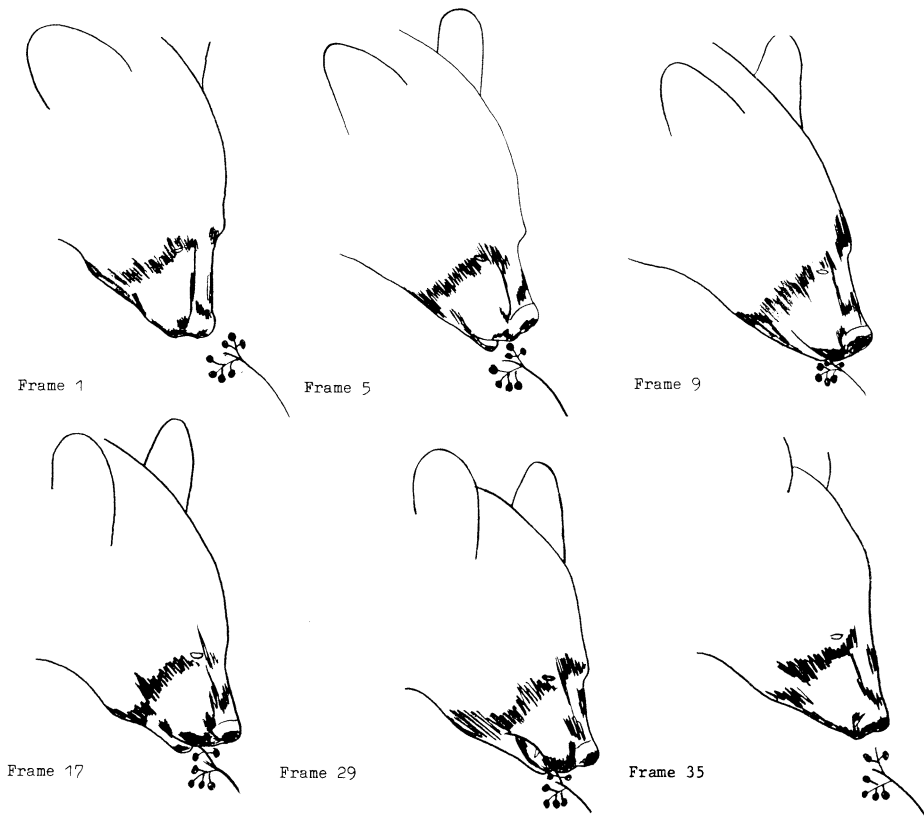


Fig. 11 Procurement of blackberries. (18 frames per second).

Immediately after olfactory orientation the bear obtains the acorn. Contact with the food occurs in frame 24. The tongue is extended and the acorn is picked up between the tongue and extended upper lip (frame 26). The extension of the upper lip often masks the role of the tongue in picking up the acorns. This is illustrated in Figure 9. This sketch of Kate is one frame prior to ingestion of the food. The upper lip is extended partially over the acorn and the tongue is not visible.

After the bear has obtained the acorn it is transferred to the rear of the mouth and chewed. The bear separates most of the hull from the meat, pushes the pieces of the hull out of the front and side of the mouth so that little of the hull is eaten. Interestingly, during the initial chewing of an acorn, pieces are often allowed to drop on the top of the front foot or on the leg. Later the bear would pick up the fallen pieces. However, debris is never observed falling on the foot. Using the front feet on which to rest uneaten food was frequently observed in the two subjects (Fig. 10). This was also observed in another enclosed black bear (R. Jordan pers. comm.). After most of the hull was removed, the chewing rate is rapid, up to three times per second.

The body position during acorn eating appears to depend on the situation. In the films the two bears are usually standing on all four feet, although they also assumed lying on the stomach and sitting positions. The ears are always at lateral 45° while the bears are orienting to food or eating. Frequently while eating both bears would look away from the food to other stimuli in and around the enclosure. At these times the ears move forward toward the sound or object to which the subject is orienting.

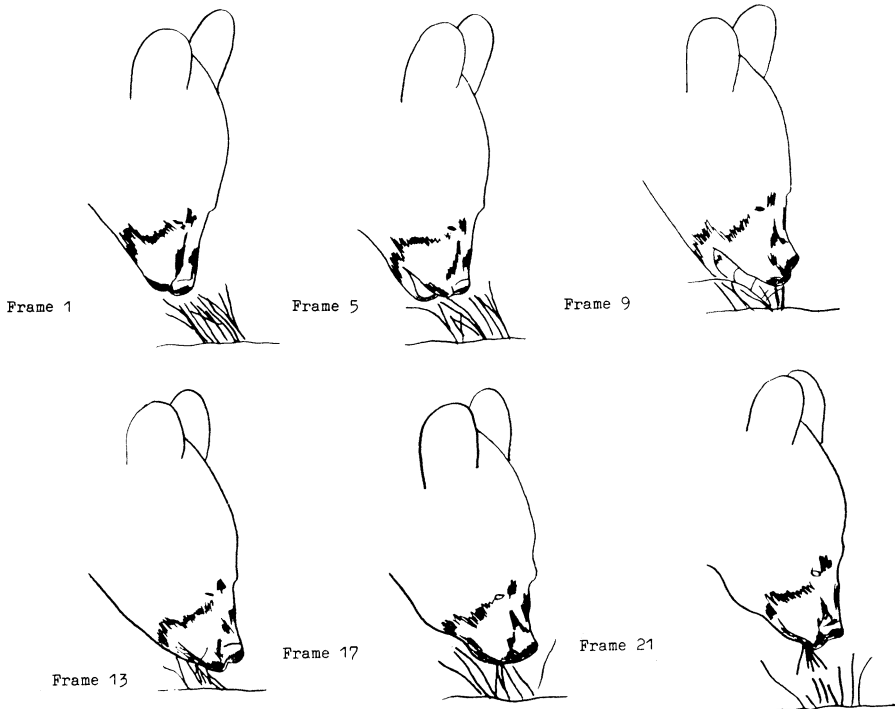


Fig. 12 Procurement of grass (18 frames per second).

Consumption of Blackberries

Orientation to blackberries is primarily visual. This may have been due to the lack of necessity to search for the food items. Unlike acorns scattered randomly on the ground, the blackberries were conveniently located on bushes placed in the enclosure. Very few overt Sc's are found in the film analysis. There is, however, obvious head nodding. This consists of lowering the nose slightly prior to movement toward a berry or group of berries. This lowering of the head could possibly bring the food into a clearer field of vision. The head nodding is illustrated in frames 1 and 5 of Figure 11 which contains tracings of a typical procurement sequence. The berry is approached and grasped behind the incisors in frame 9. Frames 17 and 29 are good examples of the incisor bite. The bear then pulls the head from the bush and the berry is removed from its stem (frame 35). In this manner very little of the stem is ingested. The bears use their tongues to guide the berries into the mouth, although berries were also obtained without the use of the tongue.

The rate of chewing is approximately the same as with acorns. The front paws are used only to hold or manipulate the bush. Holding consists of standing on the stems of the bush which appears to steady the plant. The lateral 45° ear position again occurs throughout ingestion.

Consumption of Grass

During procurement of grass (Figure 12), the mouth is opened wide and the bear bites into it with the incisors. The animal then lifts its head and pulls the grass from the ground. In eating grass the mouth is opened much wider than in eating either acorns or blackberries. The tongue is used to procure loose blades, but intact grass is initially grasped by the front teeth without the use of the tongue.

Chewing is more pronounced and slower than in the consumption of acorns and blackberries. The bear clearly manipulates the grass with the tongue during chewing. The front paws are used much more while eating grass than during consumption of the other two foods. Both bears used their paws to rake through the grass, hold it down, and lift the grass closer to their mouths. The body position varies from standing on all fours to lying on the stomach. The ears are again lateral 45° position during the ingestion.

DISCUSSION

Black bears are particularly clean and even delicate feeders. Although many foods are eaten in their entirety (e.g. apples, pears, whole fish), very little debris is ingested as they consume acorns, blackberries and grass. Most debris is either spat out or avoided. These results agree with observations on the black bear in Virginia (Cottam *et al.* 1939).

Orientation to food items appears to involve both sight and smell, both of which are well developed and efficiently integrated. The apparently frequent use of sight suggests the presence of a high degree of visual acuity and pattern discrimination. While the captive conditions undoubtedly affected the intensity and duration of the ingestive behaviors seen here, we feel that the topography and sequencing are probably quite normal. Since observations of wild black bears eating native food are scarce, it is hoped that other investigators will take advantage of chance or unusual situations to film and record observations in order to evaluate further and to extend these results. Detailed comparison

of the topography of feeding behaviors with other bear species and mammals in general is also of importance.

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