CHARACTERISTICS OF DENS AND SELECTION OF DENNING HABITAT FOR BEARS IN THE SOUTH XIAOXINGANLING MOUNTAINS, CHINA

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Abstract: In a sample of 55 dens of bears (*Selenarctos thibetanus ussuricus* and *Ursus arctos lasiotus*) in the South Xiaoxinganling Mountains, we found 3 types: tree dens (n = 23, 41.8%), ground dens (n = 30, 54.5%), and open-ground "nest" dens (n = 2, 3.6%). Most dens are lined with different bedding materials. Half of the tree den entrances face up, the rest mostly face east, southeast, and northwest. Most ground den entrances face northeast. The majority of dens are in mixed conifer-broadleaf forest on middle slopes that face east. Den trees generally are *Populus ussuriensis*, *Pinus koraiensis*, and *Tilia* spp. Average slope is 17.8 degrees for tree dens, 24.2 degrees for ground dens, and 28.5 degrees for open-ground "nest" dens. Human activity affects the distribution of dens (except for tree dens). Elevations range from 300 to 500 m for the majority of tree dens, from 400 to 700 m for most ground dens. The number of dens decreases as elevation increases. Dense understory plants are very important for ground dens and open-ground "nest" dens.

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There are only a few papers involving selection of denning habitat of Chinese bears (Ma Yiqing 1986*b*, Gao Yaoting 1987, Wang Xiaoming 1988, and Wu Jiayan 1983, etc.). Denning habitat of brown bears were reported in Europe (Slobodyan 1976, Pulliainen 1985, and Camarra 1987), and in the Soviet Union (Kistchinski 1972, Sharafudinov 1976, and Ustinov 1976). Lentfer (1972), Reynolds (1976), and Schoen (1986) reported on dens and habitat of brown bears and grizzly bears of Alaska. Den construction, environment in den, and habitat of grizzly bears in Yellowstone Park were described by Craighead and Craighead (1972). Lentz (1983) analyzed thermodynamy of dens, and discussed the characteristics of tree dens of Northeastern Georgia black bears. Tietje (1980) reported denning habitat, construction of dens, den entrance direction, and denning material, etc., in Alberta. Kolenosky (1986) also reported denning habitat of black bears in Canada. Manville (1986) analyzed the differences of habitat selections of different age and sex denning black bears in Michigan. Johnson (1981) explained the availability and selection of dens of black bears in Tennessee. Mack (1990) reported the construction, aspect, elevation, and slope of dens of black bears in south-central Montana.

Both black bears (*Selenactos thibetanus ussuricus*) and brown bears (*Ursus actos lasiotus*) occur in the Xiaoxinganling mountains (Ma Yiqing 1986*a*). Factors such as habitat destruction, hunting pressure, etc., affect black bears and brown bears almost the same in this region, and there is also the same conservation value for them. We discuss their selection of denning habitat together in this paper. Winter dormancy is a special technique allowing bears to complete gestation, to tolerate cold weather, and to overwinter. Hunting pressure is the highest during the denning period of bears.

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STUDY AREA

This research was conducted in Langxiang forest bureau in Tieli county of Yichun district, Heilongjiang province. Its geographical position is at 46°29-47°06'N and 129°30'-129°24'E. It is a mountainous district with an average slope of 12°, and an average elevation of 610 m. There are big rocks on the ridges of mountains. The climate is characterized by dry and cold winters with less wind and snow of 30-80 cm in depth, and mild and moist summers. Precipitation averages 618 mm/year. January minimum temperature is 30°C. Relative moisture is 72%. The frozen period lasts 180 days, when the earth is frozen 2.3 m in depth. Main species of forest community are korean pine (*Pinus koraiensis*), fir (*Abies nephrolepis*), dragon spruce (*Picea jezensis*), linden (*Tilia* spp.), birch (*Betula* spp.), and poplar (*Ulmus* spp.).

METHODS

Dens were visited in spring of 1988 after bears emerged from hibernation. We divided dens into fresh ones and old ones, based on paw marks, presence of bedding material, etc. Measurement of den and bed

were recorded. Habitat factors recorded at each den site included: entrance aspect, aspect of slope, species of den tree and DBH, entrance height above ground, forest type, slope, elevation, human disturbance, and density of under-story plants.

Directions were divided into east (E), west (W), south (S), north (N), southeast (SE), northwest (NW), southwest (SW), northeast (NE), and up. Human disturbance is the shortest distance from the den site to road, residential area, wood cutting place, etc., on the map. Density of understory vegetation is classed into none (Dl), less (D2), medium (D3), and dense (D4).

RESULTS AND DISCUSSION

Type and Construction of Dens

In a sample of 55 dens of bears, there were 3 types: tree dens (n = 23, 41.8%), ground den (n = 30, 54.5%), and open-ground "nest" dens (n = 2, 3.6%). A tree den's entrance is on the trunk; its tunnel and chamber are in the tree itself (A,B,C) (Fig.1). A ground den is under tree roots or a big rock; its tunnel and chamber are under ground level (F), or its chamber is in the inner part of the tree but above ground. The lower edge of the entrance of a ground den is the ground (G) or the floor of a natural cave (G). An open-ground "nest" den is like a bird's nest, consisting of brush and branches on the ground (D) (Fig. 1).

Tree den entrances occurred on natural broken trunks or big branches (A, B) 56.5% of the time, and 43.5% were on the sides of trunks, through openings enlarged by bears using their paws and teeth (C). Type E was included in ground dens, because its construction, preservation of heat, influence of climate, human disturbance, etc., are very similar to type F of ground dens. In ground dens, the ground level of the chamber is lower than that of the tunnel and the entrance (F), with a pile of earth and rocks in front of the entrance. There were 18 dens (60.0%) in the center of trees, 6 dens (20.0%) under roots, 2 dens (6.7%) under big rocks, and 4 rock caves (13.3%) in ground dens. Of all the dens, 85.5% depended on trees.

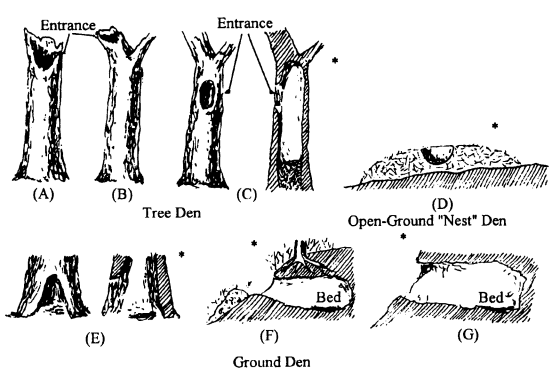

Fig. 1. Type and construction of dens (*side view).

Measurements of dens are shown in Tables 1 and 2. Volume of the chamber of tree dens has a positive relationship to den tree DBH. This may be because older trees with bigger DBH have more rotten wood in their centers. Two open-ground "nest" dens found by wood workers were used in winter of 1987-88. Bears may have used this type of den because they could not find ideal den sites.

All nest materials of tree dens were dry, rotten chunks in the center of den trees. Those of ground dens (E) were dry rotten chunks (55.6%), rotten chunks and dry leaves (16.7%), or dry leaves or leaves and branches (27.8%). Most ground dens (F, G) had dry leaves (62.5%), the rest had no nest materials. Dry and porous rotten wood chunks were the best nest material to conserve energy by reducing heat loss from the bear. Nest materials generally were collected near dens.

Aspects of Entrance and Den Site

About half of entrances of tree dens faced up (55.5%). Most side entrances (60.0%) faced E, SE, S, and NW. Frequency of ground den entrances facing NE was the greatest (26.7%). That of the total den entrances facing NE was the greatest (22.5%) (except tree dens facing up), 35.3% of tree dens on the slope facing E, 23.5% on SE slope. Most ground dens were distributed on E slope (30.0%), NW (26.7%), and NE (23.3%). More dens were on eastern slopes (32.7%) (Fig. 2) than any other.

Most side entrances facing E or SE, and S could get more solar energy and could reduce the influence of cold wind in winter. Most entrances were on natural rot or broken branches; this may affect the distribution of entrance aspect. The reason that most ground dens were on E or SE exposure is that most of them (80%) depended on trees that were sun plants. Most ridges of mountains run in the direction of south and north, and this may also affect the aspect of den sites.

Den Tree and Forest Type

The main species of den trees for tree dens were *Pinus koraiensis, Populus ussuriensis,* and *Tilia* spp. (Table 3). *Juglans mandschurica* scarcely was chosen. No ground dens were found under roots of *P. ussuriensis.*

Table 1. Dimensions of dens and den trees DBH (Unit: cm).

		Entrance			Chamber				
		W	H	X[a]	L[b]	W	H	D[c]	DBH
Tree den (12)	Mean	66.2	39.8	2,829.2	85.4	89.0	-	-	115
	Range	40-100	20-80	800-8,000	50-167	60-100	-	-	96-166
	SD	22	21	2,151	47	41	-	-	22
	N	10	10	10	5	5	-	-	12
Ground den (29)	Mean	56.9	50.2	3,189.4	-	113.0	66.7	155	-
	Range	25-115	15-150	750-1,7250	-	65-200	50-120	70-320	-
	SD	21.6	34.1	3,520.6	-	36.4	20.9	84.9	-
	N	28	29	28	-	27	12	27	-

[a] X: Entrance area (W*H).
[b] L: Length of chamber in tree den.
[c] D: Depth of chamber in ground den.

Average DBH of *P. ussuriensis, P. koraiensis,* and *T.* spp. were 174.9, 110.0, and 123.9 cm respectively. Bears may like to use older or thicker den trees. Ratios of top entrances (facing up) and side entrances height to height of den trees were 0.67, and 0.42, respectively, so most top entrances were distributed in the middle and upper trunks of den trees, and side ones in the middle and lower trunks.

Most tree dens were in the mixed conifer-broadleaf forest (CBF) (82.6%), broadleaf forest (BF) (13.0%), and conifer forest (CF) (4.3%). Most ground dens were distributed in CBF (53.3%) and BF (43.3%), with less in the CF (3.3%). Two open-ground "nest" dens were in the CBF and BF. All dens were in forest areas. In the CBF, 65.5% of the total dens were found: 30.9% in BF, and 3.6% in CF. Two factors affecting such results were that (a) less area of CF was left after a long period of deforestation, and (b) understory plants were the most dense in BF, medium in CBF, and least in CF. So bears may like to select tree dens in CBF, and ground dens in BF and CBF.

Table 2. Dimensions of open-ground "nest" dens and nest materials.

	Nest			Nest material			
No.	L	W	D	L	W	D	Nest material
1	65	65	60	135	135	70	Branches of fir
2	65	65	20	600	300	40	Brushes and young trees

Slope

Six tree dens in the range of 0-(10) m were at the bottom of the valley (Fig. 3). Average slope of tree dens was 17.8°. Slope may make bears less likely to use tree dens. More ground dens were in 10-(20) (36.7%), less in 0-(10) (3.3%). The steepest slope of a ground den was 57°, and the average was 24.2°. Open-ground "nest" dens had an average slope of 28.5°. Steep slope may be selected (Fig. 3) by bears as an aid in den construction because excavated material is more easily deposited downhill (Lentfer 1972). Snow shelters formed easily over den entrances to keep ground dens warm and safe.

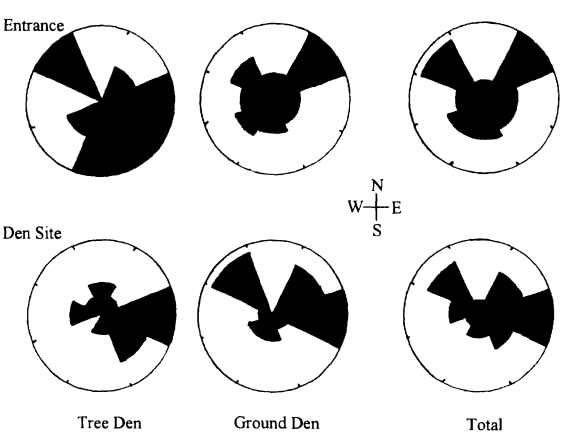

Fig. 2. Distribution of aspects of entrance and den site (tree dens facing up and open-ground "nest" dens are not included in A and B. 6 tree dens at valley bottom are not included in D and F. F includes open-ground "nest" dens).

Table 3. Species and characteristics of den trees.

Den type		Species	No.	%	DBH (cm)
Tree den		*Tilia* spp.	5	21.7	110.4
		Populus ussuriensis	11	47.8	159.9
		Pinus koraiensis	6	26.1	111.0
		Juglans mandshurica	1	4.3	96.0
Ground den	Inter root	*P. ussuriensis*	5	20.8	207.8
		T. spp.	7	29.2	134.0
		P. koraiensis	6	25.0	113.0
	Under root	*Picea jezensis*	1	4.2	21.0
		P. koraiensis	3	12.5	101.3
		T. spp.	2	8.3	122.3

Human Disturbance

Human disturbances were represented by distances between dens and human activity places (such as wood-cutting spot, village, road, etc.) (Fig. 4).

Five of 8 tree dens in 10-(100) m were only about 10 m away from the road. There was only 1 ground den in this range, and this den site was in a rocky valley with very dense brush. The rest of the ground dens were located near fewer human disturbances (>100 m). Two open-ground "nest" dens were in 500-(1,500) m. Tree dens with entrances high above ground and good concealment were affected less by animals and humans (Johnson 1981). Ground dens and open-ground "nest" dens were most affected.

Elevation

Most tree dens were in low elevations. The frequency of these den types decreased as elevation increased. Ground dens had the lowest frequency in 300-(400) m, and the highest in 400-(500) m (Table 4).

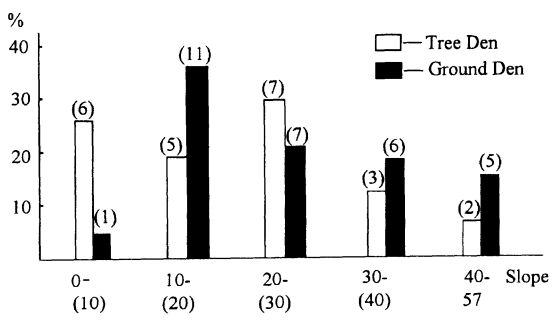

Fig. 3. Distribution of dens on different slope.

Open-ground "nest" dens were in 600-(700) m (Table 4). Average elevation of total den sites was 505.7 m (310-720 m). The main species of den trees mostly live on middle and low slopes. *P. ussuriensis* prefers riparian areas. Higher elevations are also colder. All these factors affect the tendency of tree dens to be smaller as elevation increases. Bears may prefer ground dens on well-drained sites where water seepage into dens would be minimal (Lentfer 1972, Ustinov 1976). Human disturbance and severe climate at higher elevations also may have affected bears selection of ground sites.

Understory Plants

Understory plants discussed here included young trees (<3m), brushes, herbs, etc. We only analyzed density of understory plants at fresh den sites because understory plants grew fast and varied quickly in a short period (Fig. 5).

Most of the tree dens (87.5%) were located in areas with few understory plants (D2) (Fig. 5). No tree dens were at D1 or D4. Density of understory plants may

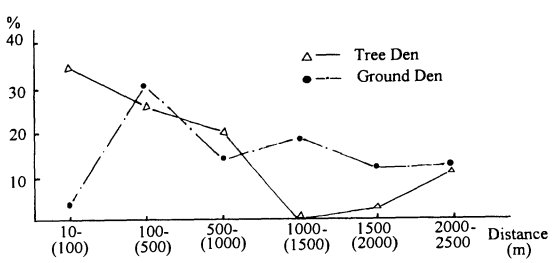

Fig. 4. Distribution of dens on different human disturbances.

Table 4. Distribution of dens in different elevation (Unit: m).

Den type		Elevation				
		300-(400)	400-(500)	500-(600)	600-(700)	above 700
Tree dens (23)	*n*[a]	8	7	4	3	1
	%	34.8	30.4	17.4	13.0	4.3
Ground dens (30)	*n*	1	12	9	6	2
	%	3.3	40.0	30.0	20.0	6.7
Total[b] (55)	*n*	9	19	13	11	3
	%	16.4	34.5	23.6	20.0	5.5

[a] *n*: number of dens.
[b] Total included 2 open-ground "nest" dens.

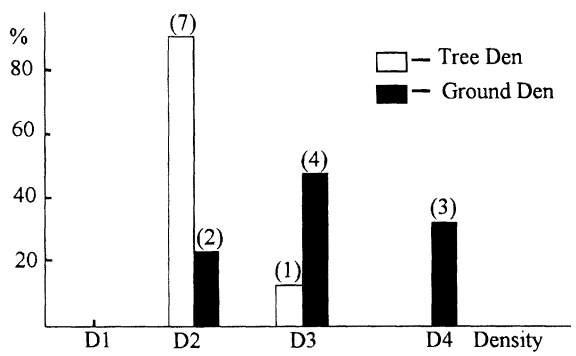

Fig. 5. Distribution of dens at different density of understory plants (only for fresh dens).

not be an important factor when bears selected tree dens. Dense understory vegetation is very necessary for ground dens (44.4% at D3, 33.3% at D4) and open-ground "nest" dens (both at D4).

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