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Blood Chemistry and Hematology of the Asiatic Black Bear (*Ursus thibetanus ussuricus*) in South Korea

Department of Veterinary Medicine
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Abstract

To establish blood chemical and hematologic reference values for the Asiatic black bears (*Ursus thibetanus ussuricus*) in Mt. Jirisan, South Korea. Total 234 blood samples from 29 females and 26 males with ages ranging from 1 to 14 years were analyzed for 18 hematologic and 29 blood chemical parameters from 2005 to 2014. Captured bears were chemically immobilized using a tiletamine/zolazepam and medetomidine combination. All bears were clinically healthy at the time of blood sampling. Females had significantly higher ($P < 0.05$) levels of GLU, PLT, PCT and PDWc than males, but lower levels of TG, MCH than males. Several parameters varied with age, habitat and season. Levels of CRE, TP, ALB, GGT, Hb, HCT, MCV and MCH increased with age, in contrast, U/C ratio, Ca, LDH, ALP, CPK, CKMB ($P < 0.01$), K, Mg ($P < 0.05$), LYM, RDWc, PLT and PDWc ($P < 0.01$) levels decreased with age. Levels of AST, GGT, BUN, CRE, ALB ($P < 0.01$), CRP and HDLC ($P < 0.05$) levels were higher in captive bears than free-ranging bears, while TCHO, UA ($P < 0.05$), LDH, NH_3, ALP, Na, TG, Cl, CPK, CKMB, WBC, PLT, MPV, PDWc ($P < 0.01$), LYM and PCT ($P < 0.05$) were higher in free-ranging bears. Further, CRE, TP, TCHO, TG, Mg, WBC, GRA, MON ratio, Hb and PLT levels were higher (P < 0.01) in hibernating bears than in active status. However, GLU, BUN, U/C ratio, NH_3, IP, AST, ALT, LDH, AMY, CRP, HDLC, ALP, CPK, LYM ratio, MCH, MCHC, RDWc (P < 0.01), LYM and HCT (P < 0.05) levels were significantly lower in hibernating group. Significant differences in blood chemical and hematologic parameters between these groups may be influence by differences in nutrition as well as in physiologic conditions related to exercise and stress such as capture or anesthesia situations. This results will provide normal reference values that may be useful to diagnose disease or to assess health condition of the Asiatic black bears.

Key words: Hematology, Blood chemistry, Asiatic black bear(*Ursus thibetanus ussuricus*), Mt. Jirisan

Ⅰ. Introduction

The Asiatic black bear is classified as 7 subspecies and distributed through much of southern Asia, northeastern China, far eastern Russia and Japan (Servheen, 1990). A small remnant population exists in South Korea is belong to same subspecies bear family in Korean peninsula, far eastern Russia, northeastern China areas (Fig. 1).

The Asiatic black bear was classified as vulnerable in the International Union for the Conservation of Nature and Natural Resources (IUCN) Red List of Threatened Species in 1990 and has been included on CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora, CITES) - Appendix I since 1979. The Asiatic black bear is designated as a national monument (No. 329, 1982) within the Cultural Properties Protection Law and also as an Endangered Wild Animal (Level Ⅰ), listed a protected species in South Korea. In the past, large number of bears were used to range across the entire Korean peninsula. However, their numbers were declined rapidly due to indiscriminate poaching and destruction of habitat. The species restoration projects are designed to rebuild populations of endangered wild animals and plants, increase the diversity of ecosystems, and restore their health on the Korean peninsula finally (Ministry of Environment, ROK, 2006).

In this regard, the project of the Asiatic black bear is carried out by the Species Restoration Technology Institute of the Korea National Park Service (KNPS), according to the Ministry of Environment (MOE)'s master plan to restore endangered wild animals and plants. The aim of this project is primarily to increase the population of Asiatic black bear up to 50 in Mt. Jirisan since 2004-2020, which is the level that can maintain their lives by themselves.

Recently, blood chemical and hematologic characters are becoming increasingly important diagnostic tools for physiological and taxonomic studies of the Ursidae.

There were reported in other bear species such as European brown bears (Hubber *et al*, 1997; Kusak *et al*, 2005), Polar bears (Derocher *et al*, 1990; Tryland *et al*, 2002), American black bears (Matula *et al*, 1980; Storm *et al*, 1988) and so on. However, there is no reports in Asiatic black bears (*Ursus thibetanus ussuricus*).

In this study, we have surveyed the normal reference values of the blood chemistry and hematology in Asiatic black bears and to confirm the differences by sex, age, habitat and season.

Ⅱ. Materials and Methods

1. Study area

This study was carried out in Mt. Jirisan which spread across 1 city and 4 counties in three-provinces; Hadong, Hamyang, Sancheong of Gyeongnam province, Gurye of Jeonnam province, and Namwon of Jeonbuk province in South Korea (35° 12′ 40″ - 35° 26′ 40″N, 127° 27′ 20″−127° 49′ 40″E, Fig. 2).

2. Animals

The blood chemical and hematologic values of total 55 Asiatic black bears (Male: 26, female: 29) were surveyed from 2005 to 2014 (Table 1). Their ages were from 1 to 14 years and all bears appeared clinically healthy at the time of blood sampling.

1) Free-ranging

The released bears were captured by tracing and traps; mostly culvert trap, rarely spring-activated foot snares for tagging of radio transmitters, health monitoring, emergency rescue and habitat translocation in all year round.

2) Captive

The captive bears were captured for their health monitoring and reproductive research in the Species Restoration Technology Institute of Korea National Park Service. In the facility, the bears were fed commercial dried pellets (Dry Omnivore Diet Food, Zupreem, KS, USA), various seasonal fruits, vegetables and chestnuts. And the bears were induced to hibernate in winter season for maintaining their unique physiology and ecology.

3. Anesthesia and Blood sample collection

Prior to collection, the bears were anesthetized using a dosage of 2 mg/kg tiletamine/zolazepam (Zoletil 50®, Virbac, France) and 0.04 mg/kg medetomidine (Dormitor®, Pfizer, Filand). Drugs were administered using a CO_2 powered immobilizing gun (CO_2 PI, Dan-Inject Aps, Denmark). Blood samples were withdrawn mostly from femoral vein/or artery and rarely jugular vein. Blood samples were collected in vaccutainers containing K3EDTA (VACUETTE®, Greiner Bio One, USA) and Lithium heparin (G-TUBE™, Green Cross MS., South Korea) respectively. They were stored at 4℃ and analyzed within 24 hr at the Wildlife Medical Center (Species Restoration Technology Institute of KNPS, South Korea).

4. Blood chemical and Hematologic Analysis

All the blood samples were analyzed 29 blood chemical and 18 hematologic parameters using a blood biochemistry analyzer (DRI-CHEM 3500i, Fuji, Japan) and a hematology analyzer (VetScan®HM2, Abaxis, USA) respectively.

Blood chemical parameters (29) are glucose (GLU), blood urea nitrogen (BUN), creatinine (CRE), blood urea nitrogen versus creatinine (U/C) ratio, total cholesterol (TCHO), ammonia (NH_3), total bilirubin (TBIL), calcium (Ca), inorganic phosphorus (IP), total protein (TP), albumin (ALB), asparate aminotransferase (AST), alanine aminotransferase (ALT), gamma glutamyltransferase (GGT), lactate dehydrogenase (LDH), amylase (AMY), sodium (Na), potassium (K), chloride (Cl), C-reactive protein (CRP), direct bilirubin (DBIL), hemoglobin (Hb), high-density lipoprotein cholesterol (HDLC), triglycerides (TG), alkaline phosphatase (ALP), creatine phosphokinase (CPK), creatine kinase MB (CKMB), magnesium (Mg) and uric acid (UA) respectively.

Hematologic parameters (18) were white blood cell (WBC), lymphocyte (LYM), monocyte (MON), granulocyte (GRA), red blood cell (RBC), hemoglobin (Hb), hematocrit (HCT), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), red blood cell distribution width (RDWc), platelet (PLT), platelet hematocrit (PCT), mean platelet volume (MPV) and platelet distribution width (PDWc).

5. Statistical analysis

The bears were categorized and analyzed based on: 1) sex (male and female), 2) age (1–2 years, 3–4 years and ≥5 years), 3) habitat (free-ranging and captive), 4) season (activity; Apr.–Dec. and hibernation; Jan.–Mar.). Total 234 case of blood chemical and 221 hematologic parameters were analyzed in this study.

All statistical analyses were performed using SPSS *Ver* 18. The distribution for each variable was evaluated before and after categorization. Outliers (> 3SD) were rare occurrence and were removed from the analyses. For normally distributed variables, a 95% confidence interval for means was calculated.

Homogeneity of variance for each variable was tested using the Levene's test for equality of variances. Basic statistics including mean, median, standard deviation, and 25% and 75% quartiles were determined for each variable.

For comparison between group differences were made either using a Student *t*-test (two groups) or by using a one-way analysis of variance (ANOVA; > two groups). If significant *P* values occurred in the ANOVA, specific between group differences were evaluated using the post hoc Tukey HSD test. For all the above statistics, values of $P < 0.05$ were considered significant.

III. Results

Total 234 cases of blood samples were collected from 55 individuals (Table 1). Blood samples were collected at least ≥1 time from individuals respectively. All bears were apparently healthy at capture and showed no obvious signs of disease.

1. Blood chemistry

Mean, median, SD, as well as 25% and 75% quartiles for the blood chemistry of the bears are presented in Table 2.

1) Sex

The mean values for 2 of 29 blood chemical parameters of females differed ($P < 0.05$) from those of males (Table 3). Females had a significantly (P=0.036) higher mean level of GLU than males, 100.2 (SD=40.4) and 90.0 (SD=31.0) ㎎/㎗, respectively. In addition, males had a significantly (P=0.032) higher mean level of TG than females, 188.8 (SD=107.6) and 161.1 (SD=75.5) ㎎/㎗.

2) Age

The mean values for 16 of 29 blood chemical parameters of 1-2 years differed ($P < 0.05$) from those of 3-4 years and ≥5 years or both (Table 4). CRE, TP, ALB and GGT levels were lower ($P < 0.01$ for all) in 1-2 years than in 3-4 years and ≥ 5 years. However, U/C ratio, Ca, LDH, ALP, CPK, CKMB ($P < 0.01$ for all), K (P=0.013) and Mg (P=0.024) levels were higher in 1-2 years than in 3-4 years and ≥5 years. Especially, ALP, CPK and CKMB levels were found significantly higher more than two times in 1-2 years compared to ≥5 years. And NH_3, IP and UA levels were lower ($P < 0.01$) in ≥5 years than in any other groups, while CRP levels were higher ($P < 0.01$) in ≥5 years than in 1-2 years and 3-4 years group (Table 4).

3) Habitat

The parameters that varied significantly between the different habitat groups were presented in Table 5. The mean values for 17 of 29 different blood chemical parameters of free-ranging group differed (P < 0.05) from captive group. Levels of AST, GGT, BUN, CRE, ALB (P < 0.01 for all), CRP (P=0.024), HDLC (P=0.037) were higher in captive group than in free-ranging group. In contrast, TCHO (P=0.012), UA (P=0.024), LDH, NH_3, TG, ALP, Na, Cl, CPK, CKMB were lower (P < 0.01 for all) in the captive group than in the free-ranging group.

4) Season

The parameters that varied significantly between the different season groups were presented in Table 6. The mean values for 19 of 29 plasma chemical parameters of hibernation group differed (P < 0.05) from activity group. CRE, TP, TCHO, TG, Mg, Hb levels were higher (P < 0.01 for all) in hibernation group than in active group. However, GLU, BUN, U/C ratio, NH_3, IP, AST, ALT, LDH, AMY, CRP, HDLC, ALP and CPK (P < 0.01 for all) levels were lower in hibernation group than in activity group.

2. Hematology

Total 221 cases of blood samples were collected at least ≥1 time from 55 individuals, However, none of those were hemolyzed as assessed by visual inspection. (Table 1). Mean, median, SD, as well as 25% and 75% quartiles for the hematology of Asiatic black bears were presented in Table 7.

1) Sex

The parameters that varied significantly between the different sex groups were presented in Table 8. Females had a significantly higher mean level of PLT, PCT, PDWc (P < 0.05 for all) and MPV (P=0.055) than males, respectively.

In contrast, males had a significantly higher (P=0.044) mean level of MCH than females.

2) Age

The mean values for 9 of 18 hematologic parameters of 1-2 years differed ($P < 0.05$) from those of 3-4 years and ≥5 years or both (Table 9). Hb, HCT, MCV, MCH levels were lower ($P < 0.01$ for all) in 1-2 years than in 3-4 years and ≥5 years group. However, LYM, RDWc, PLT, PDWc ($P < 0.01$ for all) levels were higher in 1-2 years compared to other groups.

3) Habitat

A few variations were noted between the different habitat groups (Table 10). The mean values for 6 of 18 hematologies of free-ranging bears differed ($P < 0.05$) from captive bears. Levels of WBC, PLT, MPV, PDWc ($P < 0.01$ for all), LYM (P=0.029), PCT (P=0.02) were higher in the free-ranging group than in the captive group.

4) Season

The parameters that varied significantly between the different season groups were presented in Table 11. The mean values for 11 of 18 hematologic parameters in the hibernation group differed ($P < 0.05$) from the activity group. WBC, GRA, MON ratio, Hb, PLT levels were higher ($P < 0.01$ for all) in the hibernation group compared to the activity group. However, MCH, MCHC, RDWc, LYM ratio ($P < 0.01$ for all), LYM, HCT ($P < 0.05$ for all) levels were lower in the hibernation group than in the activity group.

IV. Discussion

This study was conducted to establish a reference values of blood chemistry and hematology in Asiatic black bear (*Ursus thibetanus ussuricus*) and to compare the differences in views of sex, age, habitat and season.

Matula *et al* (1980) reported that a lower Ca level in females was the only serum chemistry value that was significantly different between sexes in captured black bears. However, among the 29 blood chemical parameters, GLU and TG values showed significant differences between sexes in this study (P < 0.05). And, although the differences were not significant, higher levels of IP, Ca and CPK in males than females showed a similar tendency between sexes compared to those of in polar bears from Svalbard (Tryland *et al.*, 2002) and in grizzly bears from Croatia respectively. (Huber *et al.*, 1997).

On the other hand, a few parameters of hematology were significantly different between the sex groups. Shanmugam *et al* (2008) reported higher levels of MCV, MCH and lower levels of PLT, PCT, MPV and PDWc in males of Sloth bear from India. Those results have a thread of connection with our studies except for the parameter of MCV.

The difference in PLT levels between the sexes have been already reported also even in human (Bain, 1985). According to the study of PLT function in mice, there are sexually dimorphic functional differences, i.e, platelets of female mice are intrinsically more sensitive to agonists than are platelets of males (Leng *et al.*, 2004). And the involvement of estradiol in triggering proplatelet formation (Nagata *et al.*, 2003) and platelet potentiation (Moro *et al.,* 2005) have also been reported. Since the levels of MPV and PDWc can reflect platelet activity, high MPV and PDWc is the markers associated with thrombogenic activation (Khandekar *et al.*, 2006).

Kusak *et al* (2005) reported higher levels of WBC and segmented neutrophils from the male of Brown bears in Croatia. Although not significant, there was similar tendency of higher WBC and GRA levels in male bears in this study.

Several parameters were significantly different among the three age groups. The levels of the ALP, Ca, IP, K and U/C ratio decreased with age. Those levels were significantly higher in 1-2 years group compared to other age groups. Especially, regarding to ALP, it exists in different forms of isoenzyme and is responsible for the hydrolysis of monophosphate esters in different tissues. The isoenzyme from bone marrow is produced by osteoblasts, and blood levels of young and rapidly growing animals might be three times higher than those of adults (Duncan *et al*., 1994). High level of Ca indicates rapid growth of bone in young bears and these results in this study corresponds with previous studies in black bears from Pennsylvania and wild Polar bears from Canada (Lee *et al.*, 1977; Storm *et al.*, 1988).

And also, the level of the CPK and CKMB decreased with age. The levels were significantly higher in 1-2 years group compared to 3–4 years and ≥5 years groups. This tendency corresponds with that of free-ranging polar bears from Svalbard in Norway. (Tryland *et al*., 2002). The increase of blood CPK level is often associated with cardiac or skeletal muscle injury, although wide range of blood CPK levels have been associated with capture, struggling, and blood sampling as reported in sea otters (*Enhydra lutris*) (Williams and Pulley, 1983). The higher CPK, CKMB levels found in young individuals could be a result from much more increased stresses during immobilization treatment compared to those of adult bears (Tryland *et al.*, 2002).

LDH level also decreased with age, being significantly higher in young individuals compared to adults. High level of LDH, which exists in liver, kidney, pancreas, intestine, cardiac and skeletal muscle, and brain, is usually associated with cell damage or necrosis of those organs (Bossart *et al.*, 2001). High LDH level of young bears in this study could be influenced by trapping and immobilization method as mentioned by Lee *et al*. (1977).

Meanwhile, the levels of TP, ALB, CRE and GGT increased with age, being significantly lower in 1-2 years compared to 3–4 years and ≥5 years group, which correspond with those findings in black bears from Pennsylvania (Storm *et al.*, 1988).

Adult bears showed significantly higher Hb, HCT, MCV and MCH levels than the other age groups. These differences are related to the dietary stuff which may permit adult bears to produce relatively more Hb and larger RBC than younger age groups; similar to the patterns observed in wolves (Seal *et al.*, 1975). Matula *et al* (1980) observed significantly increased Hb and HCT levels with age in the black bears, indicating that younger bears may have hypochromic microcytic anemia. It is similar phenomenum that of hypochromic anemia observed in human infants and children which is attributed to the iron deficiency due to the demand of growth. Pearson and Halloran (1972) also reported that young bears had lower levels of RBC, HCT and Hb concentrations than older animals. Although not significant, we found similar tendency, i.e, RBC was the most lowest level in 1-2 years group. In contrast, bears group older than 5 years showed significantly lower level of RDWc, PLT and PDWc.

There are some evidences on the levels of parameters related to the PLT which are decreased with age, although there is no proven explanation about these age-related changes (Balduini and Noris, 2014). Comparison study among age groups from newborn infants through adults in human also revealed progressive declines in the numbers of WBC, total LYM (Erkeller-Yuksel *et al.*, 1992).

In comparison of habitat groups, several parameters were different significantly between the free-ranging and captive groups. Those parameters considered to be mostly influenced by dietary intake.

BUN values were significantly higher ($P < 0.05$) in captive bears than free-ranging bears. This difference may be related to the amount of protein in the diet as their metabolism in mammals results in urea excretion. (Huber *et al.*, 1997).

Although not significant, we found a tendency of slightly higher TP level in the captive bears compared to that of free-ranging bears. High levels of TP in the captive status is related to the food of good quality and stable availability compared to the free-ranging bears (Kuntze, 1995).

In addition, we found lower levels of AST and ALT, and higher levels of LDH, CPK and CKMB in the free-ranging bears. As it was described in many previous studies, these elevated levels of blood chemical parameters may be attributed to stresses such as immobilization and translocation. (Geraci and Medway, 1973; Aubin and Greig, 2001; Morton *et al.*, 1995; Bossart *et al.*, 2001; Tryland *et al.*, 2002).

High levels of GGT, TP, ALB, BUN and U/C ratio in the captive bears compared to the free-ranging bears, were correspond with the findings in American black bears from Pennsylvania (Storm *et al.*, 1998).

Similar to the results of hematologic parameters by Kusak *et al* (2005), there were significant differences in the levels of WBC and PLT. Stresses cause corticosteroid hormone release from the adrenal, which is associated with leukocytosis, neutrophilia, eosinopenia, and lymphopenia (Feldman, 2000). Therefore, differences in hematologic and blood chemical parameters between the free-ranging and the captive bears may thus reflect differences in nutrition as well as in physiologic conditions related to exercise and stress (Torgerson, 1990).

Generally, seasonal variation in blood parameters is a response to changes in their environment, most often food resources, immobilization method and capture situation. And most importantly, seasonal variation in blood parameters was also associated with winter dormancy of black bears (Nelson *et al.*, 1973).

We found variations in the levels of WBC, LYM, MCH, MCHC, RDWc and PLT, and 18 parameters of blood chemistry depending on season (Table 6, Table 11).

The most remarkable parameters in seasonal differences is the level of U/C ratio and blood lipids. Low levels of U/C ratio in hibernating status indicated that these bears were fasting during the winter. Like American black bears, brown bears (*U. arctos*) and polar bears (*U. maritimus*), the Asiatic black bears experience winter periods of low food availability. They have evolved physiologic adaptations to the starvation, and in periods of food abundance they build up adipose depots to provide energy when food is scarce (Derocher *et al.*, 1990). In a fasting state, such as hibernation period or other periods of limited food availability, urea is continuously formed, and the urea nitrogen is recycled into plasma proteins, which results in reduced urine formation and a low level of U/C ratio (Nelson *et al.*, 1983).

Hellgren *et al.* (1989) reported the increasing CRE levels during hibernation period in black bears. This may be related to the reduced rate of creatinine clearance associated with reduced renal plasma flow and glomerular filtration pressure during hibernation (Brown *et al.*, 1971).

Also, the amount of TG and TCHO were higher in hibernating status compared to active status. These may be an the indication of a fasting hyperlipidemia, which is found in animals that have been fasting for at least 12 hrs and which is different from the transient rise of TG and TCHO levels following the fat rich meals (Duncan *et al.*, 1994). Concentrations of blood lipids (cholesterol, phospholipid, triglycerides, free fatty acids, and ketone bodies) also increase during the dormant phase (Nelson *et al.,* 1973; Ahlquist *et al*., 1984; Franzmann and Schwartz 1988; Hellgren *et al.*, 1989, 1993), apparently as a result of increased catabolism and reduced anabolism of fat (Hellgren *et al.*, 1990). Herminghuysen *et al* (1995) reported decreased activity of lipoprotein lipase which is an enzyme important in storage of TG in adipocytes during hibernation in black bears.

AST, ALT, LDH and CPK values, which are good indicators of muscle damage (Huber *et al.*, 1997), were higher in activity period compared to hibernation in the bears. It may be occurred by the effort of the bears to escape from the immobilized situation.

Hb is a major constituent of red blood cell which has the function of oxygen transport and its level is used to evaluate physical condition of animals. In previous studies on bear species, Hb level was increased with decrease of temperature (Hellgreen et al., 1989; Erickson and Youatt, 1961). We also found higher levels of Hb in hibernating bears due to the low temperature.

Study Limitations

Our study had some limitations. Each value between sex, habitat and season groups was analyzed without regard to age. Therefore it was hard to make sure that differences among groups were significant regardless of age.

In addition several values may be influenced by unique physical conditions or characteristics of some individuals with more blood collection frequency.

V. Conclusions

Total 234 blood samples from 29 females and 26 males with ages ranging from 1 to 14 years were analyzed for 18 hematologic and 29 blood chemical parameters from 2005 to 2014. And we have reached the following conclusions.

1. Females had significantly higher ($P < 0.05$) levels of GLU than males, but lower levels of TG than males.

2. Levels of CRE, TP, ALB increased with age, in contrast, U/C ratio, Ca, LDH, ALP, CPK, CKMB ($P < 0.01$), K, Mg ($P < 0.05$) levels decreased with age.

3. Levels of AST, GGT, BUN, CRE, ALB ($P < 0.01$), CRP and HDLC ($P < 0.05$) levels were higher in captive bears than free-ranging bears, while TCHO, UA ($P < 0.05$), LDH, NH_3, ALP, Na, TG, Cl, CPK, CKMB ($P < 0.01$) were higher in free-ranging bears.

4. CRE, TP, TCHO, TG, Mg, Hb levels were higher ($P < 0.01$) in hibernating bears than in active status. However, GLU, BUN, U/C ratio, NH_3, IP, AST, ALT, LDH, AMY, CRP, HDLC, ALP, CPK ($P < 0.01$) levels were significantly lower in hibernating group.

5. Females had significantly higher ($P < 0.05$) levels of PLT, PCT and PDWc than males, but lower levels of MCH than males.

6. Levels of Hb, HCT, MCV and MCH increased with age, in contrast, LYM, RDWc, PLT and PDWc ($P < 0.01$) levels decreased with age.

7. Levels of WBC, PLT, MPV, PDWc ($P < 0.01$), LYM and PCT ($P < 0.05$) were higher in free-ranging bears.

8. WBC, GRA, MON ratio, Hb and PLT levels were higher ($P < 0.01$) in hibernating bears than in active status. However, LYM ratio, MCH, MCHC, RDWc ($P < 0.01$), LYM and HCT ($P < 0.05$) levels were significantly lower in hibernating group.

This study is the first report which related to blood chemistry and hematology for the Asiatic black bear (*Ursus thibetanus ussuricus*). Results of this study will be helpful to establish the reference values that can be useful for evaluation of health status in Asiatic black bears under various environmental conditions.

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Tables and Figures

Table 1. The number of case associated with sex, age and habitat groups of 55 Asiatic black bears from Mt. Jirisan in South Korea

Item	Age (yr)	Female			Male			Total
		free-ranging	captive	sub-total	free-ranging	captive	sub-total	
Blood chemistry	1~2	20	8	28	26	8	34	62
	3~4	28	7	35	15	6	21	56
	≥5	14	29	43	24	49	73	116
	Total	62	44	106	65	63	128	234
Hematology	1~2	19	8	27	23	8	31	58
	3~4	21	7	28	15	6	21	49
	≥5	14	29	43	22	49	71	114
	Total	54	44	98	60	63	123	221

Table 2. Blood chemical values of Asiatic black bears from Mt. Jirsan in South Korea

Parameters (units)	All bear			
	n	Mean ± SD	Median	25 - 75% quatiles
GLU (mg/dℓ)	230	94.6±35.9	90	73.0~118
BUN (mg/dℓ)	234	8.4±7.6	6.9	1.6~13.6
CRE (mg/dℓ)	231	1.8±1.2	1.5	1.1~2.3
U/C (%)	228	6.7±10.3	4	0.7~9.5
TCHO (mg/dℓ)	231	284.2±72.1	278	232~322
NH_3 (μg/dℓ)	187	71.8±43.3	58	45~83
TBIL (mg/dℓ)	226	0.5±0.5	0.4	0.3~0.6
Ca (mg/dℓ)	230	8.3±1.6	8.4	7.9~9
IP (mg/dℓ)	233	5.2±1.8	4.9	4.2~5.8
TP (g/dℓ)	231	7±0.7	7	6.6~7.4
ALB (g/dℓ)	234	4±0.8	4.1	3.5~4.5
AST (U/ℓ)	212	71.6±43.4	62	46.3~84
ALT (U/ℓ)	230	27.9±21.6	24	14~34.3
GGT (U/ℓ)	202	60.1±60.9	40	30~62
LDH (U/ℓ)	203	538.3±178.9	523	394~657
AMY (U/ℓ)	230	45.5±71.5	26	15~48.5

Table 2. (Continued)

Parameters (units)	All bear			
	n	Mean ± SD	Median	25 - 75% quatiles
Na (mEq/ℓ)	201	127.4±14.6	132	121~138
K (mEq/ℓ)	193	3.8±0.7	3.7	3.4~4.2
Cl (mEq/ℓ)	199	99±25	100	91~106
CRP (mg/dℓ)	189	1.3±0.7	1.6	0.4~1.8
DBIL (mg/dℓ)	191	0.1±0.1	0.1	0.1~0.1
Hb (g/dℓ)	187	15.6±2.8	15.7	14.1~17.2
HDLC (mg/dℓ)	193	98.9±22.6	110	103.5~110
TG (mg/dℓ)	204	176.5±95.4	149	108.0~204.5
ALP (U/ℓ)	220	127.9±81.7	110	68.3~171
CPK (U/ℓ)	200	117.2±127.8	77	58.3~128.8
CKMB (U/ℓ)	203	146.1±90.9	125	70.0~204
Mg (U/dℓ)	203	1.7±0.3	1.7	1.6~1.9
UA (U/dℓ)	202	0.8±0.5	0.7	0.6~1.0

Table 3. Mean values of blood chemical parameters by sex groups

Parameters (units)	Male		Female		*p* - value
	n	Mean±SD	n	Mean±SD	
GLU (mg/dℓ)	126	90±31	104	100.2±40.4	**0.036**
BUN (mg/dℓ)	128	7.8±7.3	106	9±7.8	0.246
CRE (mg/dℓ)	126	1.9±1.4	105	1.7±0.9	0.258
U/C (%)	126	5.7±6.2	102	7.9±13.6	0.111
TCHO (mg/dℓ)	127	288.8±77.5	104	278.6±64.9	0.273
NH_3 (μg/dℓ)	105	70.4±40.1	82	73.6±47.2	0.618
TBIL (mg/dℓ)	125	0.5±0.6	101	0.5±0.2	0.423
Ca (mg/dℓ)	126	8.4±1.3	104	8.2±1.7	0.476
IP (mg/dℓ)	127	5.4±1.8	106	5.1±1.7	0.251
TP (g/dℓ)	125	7±0.7	106	6.9±0.7	0.561
ALB (g/dℓ)	128	4±0.8	106	4±0.7	0.552
AST (U/ℓ)	117	68.8±32.5	95	75.1±53.9	0.293
ALT (U/ℓ)	126	26.5±24.2	104	29.5±18.1	0.298
GGT (U/ℓ)	111	55.7±53.6	91	65.5±68.7	0.268
LDH (U/ℓ)	112	520.5±179.7	91	560.3±176.4	0.116
AMY (U/ℓ)	126	46.2±83.9	104	44.6±53.2	0.864

Table 3. (Continued)

Parameters (units)	Male		Female		*p* - value
	n	Mean±SD	n	Mean±SD	
Na (mEq/ℓ)	114	126.7±14.6	87	128.3±14.7	0.426
K (mEq/ℓ)	107	3.7±0.7	86	3.8±0.8	0.719
Cl (mEq/ℓ)	112	98.7±24.3	87	99.5±25.9	0.811
CRP (mg/dℓ)	106	1.3±0.7	83	1.3±0.8	0.964
DBIL (mg/dℓ)	108	0.1±0.1	83	0.1±0.1	0.668
Hb (g/dℓ)	106	15.8±3.1	81	15.2±2.4	0.163
HDLC (mg/dℓ)	104	96.9±25.5	89	101.3±18.5	0.167
TG (mg/dℓ)	113	188.8±107.6	91	161.1±75.5	**0.032**
ALP (U/ℓ)	117	132.8±82.4	103	122.3±81	0.343
CPK (U/ℓ)	108	119.1±153.8	92	114.9±88.7	0.815
CKMB (U/ℓ)	111	146.9±94.4	92	145.2±87.1	0.891
Mg (U/dℓ)	111	1.7±0.3	92	1.7±0.3	0.528
UA (U/dℓ)	110	0.8±0.4	92	0.9±0.7	0.622

1) Statistical significances ($P < 0.05$) were tested by Student *t*-test of variances among groups.

Table 4. Mean values of blood chemical parameters in three different age groups

Parameters (units)	**1-2 yrs**			**3-4 yrs**			**≥5 yrs**			***p* - value**[1)]
	n	**Mean**	**SD**	**n**	**Mean**	**SD**	**n**	**Mean**	**SD**	
GLU (mg/dℓ)	61	102.2	37.1	55	89.3	35.3	114	93	35.2	0.124
BUN (mg/dℓ)	62	9.3	8.5	56	9.5	7	116	7.3	7.3	0.114
CRE (mg/dℓ)	62	1.1[a]	0.6	55	1.6[b]	0.9	114	2.3[c]	1.3	**< 0.001**
U/C (%)	59	9.8[b]	9.2	55	9[b]	16.7	114	4[a]	4.5	**< 0.001**
TCHO (mg/dℓ)	62	273	74.9	54	295.8	79.5	115	284.8	66.5	0.234
NH_3 (µg/dℓ)	40	85.1[b]	45.1	38	94.6[b]	59	109	59[a]	29.7	**< 0.001**
TBIL (mg/dℓ)	60	0.5	0.9	54	0.5	0.3	112	0.5	(0.2)	0.986
Ca (mg/dℓ)	60	8.7[b]	1.5	56	8.5[a, b]	1.2	114	7.9[a]	1.7	**0.003**

Table 4. (Continued)

Parameters (units)	**1-2 yrs**			**3-4 yrs**			**≥5 yrs**			***p* - value**[1)]
	n	**Mean**	**SD**	**n**	**Mean**	**SD**	**n**	**Mean**	**SD**	
IP (mg/dℓ)	62	5.5[b]	2.0	55	5.9[b]	2.4	116	4.8[a]	1.0	**< 0.001**
TP (g/dℓ)	61	6.6[a]	0.6	56	6.9[b]	0.7	114	7.2[c]	0.6	**< 0.001**
ALB (g/dℓ)	62	3.4[a]	0.7	56	4.1[b]	0.8	116	4.3[b]	0.6	**< 0.001**
AST (U/ℓ)	46	69.8	28.8	55	66.7	44.6	111	74.8	47.7	0.507
ALT (U/ℓ)	62	28.1	14.1	55	30.4	31.4	113	26.6	19.2	0.569
GGT (U/ℓ)	43	37.5[a]	15	46	47.1[a]	45.9	113	74.1[b]	72.5	**0.001**
LDH (U/ℓ)	44	698.8[c]	162.1	43	566.3[b]	172.8	116	467.1[a]	142.2	**< 0.001**
AMY (U/ℓ)	60	59.2	49.6	54	53.2	122.8	116	34.8	41.6	0.065

Table 4. (Continued)

Parameters (units)	1-2 yrs			3-4 yrs			≥5 yrs			p - value[1)]
	n	Mean	SD	n	Mean	SD	n	Mean	SD	
Na (mEq/ℓ)	43	128.2	15.4	48	129.9	11.7	110	126	15.4	0.274
K (mEq/ℓ)	42	4[b]	0.7	47	3.9[a, b]	0.9	104	3.6[a]	0.7	**0.013**
Cl (mEq/ℓ)	40	97.6	14.2	48	98.6	11.9	111	99.7	31.4	0.898
CRP (mg/dℓ)	40	1.1[a]	0.8	40	1.1[a]	0.7	109	1.5[b]	0.7	**0.001**
DBIL (mg/dℓ)	44	15.1	3.2	36	15.7	2.6	107	15.8	2.7	0.379
Hb (g/dℓ)	44	0.1	0.0	37	0.1	0.1	110	0.1	0.1	0.933
HDLC (mg/dℓ)	43	103.1	15.9	42	97.7	24.3	108	97.7	24.1	0.389
TG (mg/dℓ)	45	170.4	87.2	44	196.1	110.9	115	171.3	91.9	0.306
ALP (U/ℓ)	58	174.3[b]	105.1	53	163.8[b]	67.8	109	85.7[a]	43.8	**< 0.001**

Table 4. (Continued)

Parameters (units)	1-2 yrs			3-4 yrs			≥5 yrs			p - value[1)]
	n	Mean	SD	n	Mean	SD	n	Mean	SD	
CPK (u/ℓ)	42	216.9[c]	223.2	43	135.8[b]	96.5	115	73.8[a]	38.1	**< 0.001**
CKMB (u/ℓ)	44	249[c]	67.5	43	175.2[b]	85.6	116	96.3[a]	57.3	**< 0.001**
Mg (U/dℓ)	44	1.8[b]	0.4	43	1.7[a]	0.3	116	1.7[a]	0.3	**0.024**
UA (U/dℓ)	44	0.9[a, b]	0.5	43	1.0[b]	0.9	115	0.7[a]	0.3	**0.006**

1) Statistical significances ($P < 0.05$) were tested by One way analysis of variances among groups.
a, b, c : The same letters indicate non-significant difference between groups based on Tukey HSD multiple comparison test.

Table 5. Mean values of blood chemical parameters by habitat groups

Parameters (units)	Free-ranging			Captive			p - value[1)]
	n	**Mean**	**SD**	**n**	**Mean**	**SD**	
GLU (mg/dℓ)	125	94.1	38.9	105	95.2	32.1	0.819
BUN (mg/dℓ)	127	7.2	7.7	107	9.8	7.2	**0.009**
CRE (mg/dℓ)	126	1.6	0.9	105	2.1	1.4	**0.004**
U/C (%)	126	7.3	13.1	102	5.9	5.0	0.278
TCHO (mg/dℓ)	124	295.2	74.0	107	271.5	68.0	**0.012**
NH_3 (μg/dℓ)	87	85.0	44.8	100	60.3	38.6	< **0.001**
TBIL (mg/dℓ)	124	0.5	0.2	102	0.6	0.7	0.112
Ca (mg/dℓ)	124	8.4	1.5	106	8.1	1.6	0.063
IP (mg/dℓ)	126	5.1	1.8	107	5.4	1.8	0.152
TP (g/dℓ)	125	6.9	0.7	106	7.0	0.7	0.292
ALB (g/dℓ)	127	3.8	0.8	107	4.3	0.6	< **0.001**
AST (U/ℓ)	110	62.3	36.8	102	81.7	47.7	**0.001**
ALT (U/ℓ)	126	25.5	22.2	104	30.8	20.7	0.069
GGT (U/ℓ)	99	36.7	16.6	103	82.7	77.4	< **0.001**
LDH (U/ℓ)	98	588.8	184.6	105	491.2	160.5	< **0.001**
AMY (U/ℓ)	127	50.6	88	103	39.2	42.9	0.232
Na (mEq/ℓ)	97	130.9	12.6	104	124.0	15.6	**0.001**
K (mEq/ℓ)	94	3.8	0.7	99	3.7	0.8	0.195
Cl (mEq/ℓ)	96	104.9	31.7	103	93.5	14.4	**0.001**
CRP (mg/dℓ)	88	1.2	0.8	101	1.4	0.7	**0.024**

Table 5. (Continued)

Parameters (units)	Free-ranging			Captive			p - value[1)]
	n	Mean	SD	n	Mean	SD	
DBIL (mg/dℓ)	90	0.1	0.1	101	0.1	0.1	0.788
Hb (g/dℓ)	92	15.8	3.2	95	15.3	2.4	0.238
HDLC (mg/dℓ)	93	95.4	25.9	100	102.2	18.6	**0.037**
TG (mg/dℓ)	99	195.4	104.5	105	158.7	82.6	**0.006**
ALP (U/ℓ)	121	148.8	81.8	99	102.2	74.3	**< 0.001**
CPK (U/ℓ)	99	141.7	158.5	101	93.1	81.8	**0.007**
CKMB (U/ℓ)	98	178.9	82.5	105	115.5	88.0	**< 0.001**
Mg (U/dℓ)	99	1.7	0.4	104	1.7	0.3	0.396
UA (U/dℓ)	98	0.9	0.3	104	0.8	0.7	**0.024**

1) Statistical significances ($P < 0.05$) were tested by Student *t*-test of variances among groups.

Table 6. Mean values of blood chemical parameters in two different season groups

Parameters (units)	Activity			Hibernation			*p* - value[1)]
	n	Mean	SD	n	Mean	SD	
GLU (mg/dℓ)	168	97.0	38.4	62	88.0	27.0	**0.049**
BUN (mg/dℓ)	171	10.1	7.5	63	3.7	5.8	< **0.001**
CRE (mg/dℓ)	168	1.5	1.1	63	2.6	1.0	< **0.001**
U/C (%)	165	7.9	6.8	63	3.5	15.8	**0.004**
TCHO (mg/dℓ)	169	266.4	62.6	62	332.9	74.5	< **0.001**
NH_3 (μg/dℓ)	137	75.6	45.1	50	61.3	36.2	**0.045**
TBIL (mg/dℓ)	164	0.5	0.2	62	0.6	0.8	0.382
Ca (mg/dℓ)	171	8.2	1.7	59	8.4	1.0	0.195
IP (mg/dℓ)	170	5.6	1.9	63	4.3	1.0	< **0.001**
TP (g/dℓ)	170	6.9	0.7	61	7.1	0.5	**0.009**
ALB (g/dℓ)	171	4.0	0.8	63	4.0	0.8	0.753
AST (U/ℓ)	156	79.8	46.8	56	48.9	18.4	< **0.001**
ALT (U/ℓ)	167	32.7	22.2	63	15.2	13.6	< **0.001**
GGT (U/ℓ)	148	64.9	65.9	54	47.1	42.4	0.067
LDH (U/ℓ)	149	593.3	168.9	54	386.7	102.1	< **0.001**
AMY (U/ℓ)	167	52.6	81.6	63	26.7	23.7	< **0.001**
Na (mEq/ℓ)	147	127.5	15.2	54	127.1	13	0.850
K (mEq/ℓ)	139	3.8	0.8	54	3.7	0.7	0.762
Cl (mEq/ℓ)	145	99.7	28.1	54	97.3	13.5	0.552
CRP (mg/dℓ)	139	1.4	0.7	50	1.1	0.8	**0.013**
DBIL (mg/dℓ)	139	0.1	0.1	52	0.1	0.2	0.427
Hb (g/dℓ)	134	16.5	3.0	53	18.2	2.6	< **0.001**

Table 6. (Continued)

Parameters (units)	Activity			Hibernation			*p* - value[1)]
	n	Mean	SD	n	Mean	SD	
HDLC (mg/dℓ)	146	106.0	11.9	47	77.0	32.3	**< 0.001**
TG (mg/dℓ)	151	143.1	62.9	53	271.7	108	**< 0.001**
ALP (U/ℓ)	158	136.2	86.7	62	106.5	63.2	**0.006**
CPK (U/ℓ)	146	130.2	143.2	54	82.0	58.9	**0.001**
CKMB (U/ℓ)	149	151.5	93.9	54	131.4	81.2	0.138
Mg (U/dℓ)	149	1.7	0.3	54	1.8	0.2	**0.003**
UA (U/dℓ)	149	0.9	(0.6)	53	0.8	0.3	0.305

1) Statistical significances ($P < 0.05$) were tested by Student *t*-test of variances among groups.

Table 7. Hematologic values of Asiatic black bears from Mt. Jirisan in South Korea

Parameters (units)	All bear			
	n	Mean ± SD	Median	25 - 75% quatiles
WBC ($10^9/\ell$)	122	8.1±3.5	7.5	5.6~9.3
LYM ($10^9/\ell$)	120	1.4±1.7	0.8	0.5~1.6
MON ($10^9/\ell$)	107	0.4±0.3	0.4	0.2~0.5
GRA ($10^9/\ell$)	121	7.0±8.0	5.8	4.2~7.8
LYM (%)	121	18.0±17.5	13.4	6.0~24.1
MONO (%)	107	5.0±2.3	5.2	3.2~6.5
GRA (%)	121	84.3±76.3	81.3	73.0~89.3
RBC ($10^{12}/\ell$)	108	7.3±1.2	7.3	6.7~8.0
Hb (g/dℓ)	123	17.2±3.1	17.6	15.1~19.3
HCT (%)	123	48.1±8.9	48.2	42.9~53.4
MCV (fl)	108	67.1±7.7	67.0	64.0~72.0
MCH (pg)	107	24.4±2.3	24.4	22.8~25.4
MCHC (g/dℓ)	122	35.6±3.0	35.5	34.0~36.9
RDWc (%)	108	17.4±2.3	17.3	16.5~18.2
PLT ($10^9/\ell$)	120	321.1±230.0	281.5	166.8~466.0
PCT (%)	104	0.3±0.2	0.2	0.1~0.4
MPV (fl)	104	7.7±0.8	7.5	7.1~8.1
PDWc (%)	104	31.7±2.2	31.7	30.2~33.0

Table 8. Mean values of hematologic parameters by sex groups

Parameters (units)	Male		Female		p - value[1)]
	n	Mean±SD	n	Mean±SD	
WBC (10^9/ℓ)	122	8.1±3.5	98	7.7±3.1	0.429
LYM (10^9/ℓ)	120	1.4±1.7	98	1.3±1.1	0.685
MON (10^9/ℓ)	107	0.4±0.3	85	0.8±3.5	0.305
GRA (10^9/ℓ)	121	7.0±8.0	98	6.0±3.1	0.243
LYM (%)	121	18.0±17.5	97	18.6±14.2	0.787
MONO (%)	107	5.0±2.3	85	4.8±2.2	0.600
GRA (%)	121	84.3±76.3	96	77.1±14.0	0.367
RBC (10^{12}/ℓ)	108	7.3±1.2	85	7.4±1.7	0.573
Hb (g/dℓ)	123	17.2±3.1	98	17.1±2.7	0.753
HCT (%)	123	48.1±8.9	98	49.0±7.6	0.451
MCV (fl)	108	67.1±7.7	85	67.9±4.5	0.348
MCH (pg)	107	24.4±2.3	85	23.7±2.0	**0.044**
MCHC (g/dℓ)	122	35.6±3.0	98	34.9±2.7	0.069
RDWc (%)	108	17.4±2.3	85	17.5±1.3	0.673
PLT (10^9/ℓ)	120	321.1±230.0	95	393.1±206.7	**0.018**
PCT (%)	104	0.3±0.2	81	0.4±0.5	**0.033**
MPV (fl)	104	7.7±0.8	81	8.0±0.8	0.055
PDWc (%)	104	31.7±2.2	81	32.6±2.6	**0.012**

Table 9. Mean values of hematologic parameters in three different age groups

Parameters (units)	1-2 yrs			3-4 yrs			≥5 yrs			*p*-value[1)]
	n	Mean	SD	n	Mean	SD	n	Mean	SD	
WBC ($10^9/\ell$)	57	8.5	3.0	49	8.0	4.2	114	7.6	3	0.239
LYM ($10^9/\ell$)	57	1.9[b]	2.1	48	1.4[a, b]	1.3	113	1.0[a]	1.0	**0.002**
MON ($10^9/\ell$)	43	0.5	0.3	35	0.4	0.2	114	0.6	3.1	0.874
GRA ($10^9/\ell$)	57	6.2	3.1	48	6.3	4.0	114	6.9	8.1	0.685
LYM (%)	57	22.9[b]	20	47	21.1[a, b]	16.3	114	14.7[a]	12.7	**0.003**
MON (%)	43	5.2	2.2	35	5.2	2.1	114	4.7	2.3	0.232
GRA (%)	56	73	20.5	47	75	15.6	114	87.6	77.3	0.216
RBC ($10^{12}/\ell$)	43	7.2	1.1	36	7.4	2.7	114	7.3	1.0	0.773
Hb (g/dl)	58	16.2[a]	3.4	49	16.4[a]	3.5	114	17.9[b]	2.1	< **0.001**

Table 9. (Continued)

Parameters (units)	1-2 yrs			3-4 yrs			≥5 yrs			*p* - value[1)]
	n	Mean	SD	n	Mean	SD	n	Mean	SD	
HCT (%)	58	45.3[a]	8.5	49	47.5[a, b]	10.3	114	50.6[b]	6.7	**< 0.001**
MCV (fl)	43	63.1[a]	3.5	36	69.1[b]	3.6	114	68.6[b]	7.3	**< 0.001**
MCH (pg)	43	22.9[a]	2.3	35	24[b]	1.4	114	24.6[b]	2.2	**< 0.001**
MCHC (g/dℓ)	58	35.7	3.1	48	34.6	2.3	114	35.4	3.0	0.145
RDWc (%)	43	18.2[b]	3.2	36	17.3[a]	1.4	114	17.2[a]	1.3	**0.010**
PLT (10^9/ℓ)	52	442.8[b]	262.8	49	417.1[b]	238.8	114	284.3[a]	167.5	**< 0.001**
PCT (%)	38	0.4	0.2	35	0.4	0.2	112	0.3	0.5	0.295
MPV (fl)	38	8.1	0.9	35	7.9	0.8	112	7.8	0.8	0.086
PDWc (%)	38	33.6	2.7	35	31.9	2.9	112	31.7	2.0	**< 0.001**

1) Statistical significances (P < 0.05) were tested by One way analysis of variances among groups.

a, b, c : The same letters indicate non-significant difference between groups based on Tukey HSD multiple comparison test.

Table 10. Mean values of hematologic parameters by habitat groups

Parameters (units)	Free-ranging			Captive			p - value[1)]
	n	Mean	SD	n	Mean	SD	
WBC ($10^9/\ell$)	114	8.8	3.7	106	6.9	2.5	**< 0.001**
LYM ($10^9/\ell$)	113	1.5	1.8	105	1.1	1.0	**0.029**
MON ($10^9/\ell$)	88	0.8	3.5	104	0.4	0.2	0.231
GRA ($10^9/\ell$)	114	6.8	3.9	105	6.3	8.2	0.532
LYM (%)	113	19.4	18.5	105	17.0	12.9	0.254
MONO (%)	88	4.7	2.4	104	5.1	2.1	0.228
GRA (%)	112	76.9	18.6	105	85.7	80.7	0.262
RBC ($10^{12}/\ell$)	88	7.4	1.7	105	7.2	1.3	0.238
Hb (g/dℓ)	114	17.1	2.8	107	17.1	3.0	0.971
HCT (%)	114	48.6	8.1	107	48.4	8.7	0.815
MCV (fl)	88	67.0	8.2	105	67.8	4.6	0.348
MCH (pg)	88	24.2	2.1	104	24.0	2.3	0.623
MCHC (g/dℓ)	114	35.4	2.8	106	35.2	3.0	0.718
RDWc (%)	88	17.7	2.5	105	17.2	1.3	0.123
PLT ($10^9/\ell$)	112	394.5	231.5	103	307.7	203.8	**0.004**
PCT (%)	85	0.4	0.5	100	0.2	0.2	**0.020**
MPV (fl)	85	8.1	0.9	100	7.7	0.7	**0.002**
PDWc (%)	85	32.7	2.6	100	31.6	2.1	**0.003**

1) Statistical significances ($P < 0.05$) were tested by Student *t*-test of variances among groups.

Table 11. Mean values of hematologic parameters in two different season groups

Parameters (units)	Activity			Hibernation			*p* - value[1)]
	n	**Mean**	**SD**	**n**	**Mean**	**SD**	
WBC (10^9/ℓ)	61	6.7	3.3	159	8.4	3.3	**0.001**
LYM (10^9/ℓ)	61	1.8	2.2	157	1.1	1.1	**0.026**
MON (10^9/ℓ)	53	0.9	4.5	139	0.4	0.2	0.481
GRA (10^9/ℓ)	61	4.7	3.1	158	7.3	7.0	**0.005**
LYM (%)	61	26.5	19.0	157	15.0	13.6	< **0.001**
MONO (%)	53	4.0	2.1	139	5.2	2.2	**0.001**
GRA (%)	60	69.7	19.7	157	85.5	66.3	0.072
RBC (10^{12}/ℓ)	53	7.6	0.9	140	7.2	1.6	0.121
Hb (g/dℓ)	62	16.7	3.1	159	18.3	2.3	< **0.001**
HCT (%)	62	50.7	6.5	159	47.7	8.9	**0.016**
MCV (fl)	53	68.2	4.4	140	67.2	7.1	0.329
MCH (pg)	53	24.8	1.8	139	23.8	2.3	**0.004**
MCHC (g/dℓ)	62	36.1	2.4	158	35.0	3.0	**0.006**
RDWc (%)	53	18.5	1.9	140	17.0	1.8	< **0.001**
PLT (10^9/ℓ)	60	255.9	162.3	155	390.4	231.5	< **0.001**
PCT (%)	51	0.3	0.7	134	0.3	0.2	0.483
MPV (fl)	51	7.9	0.9	134	7.8	0.8	0.785
PDWc (%)	51	31.9	2.8	134	32.2	2.3	0.364

1) Statistical significances ($P < 0.05$) were tested by Student *t*-test of variances among groups.

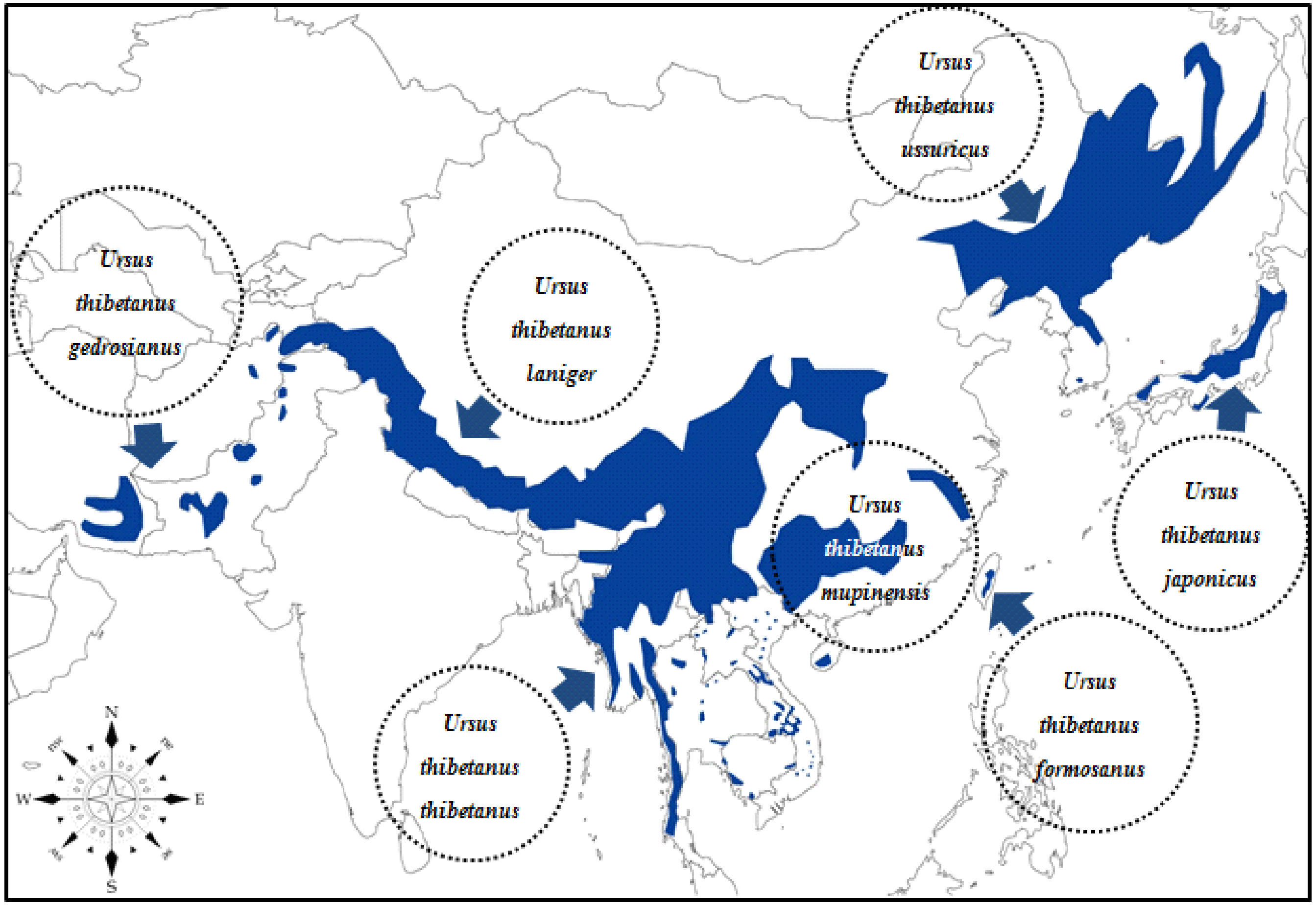

Fig 1. Geographic distribution of 7 sub-species of the Asiatic black bears. This map is modified from IUCN Red List of Threatened Species (IUCN Bear Specialist Group. 2014).

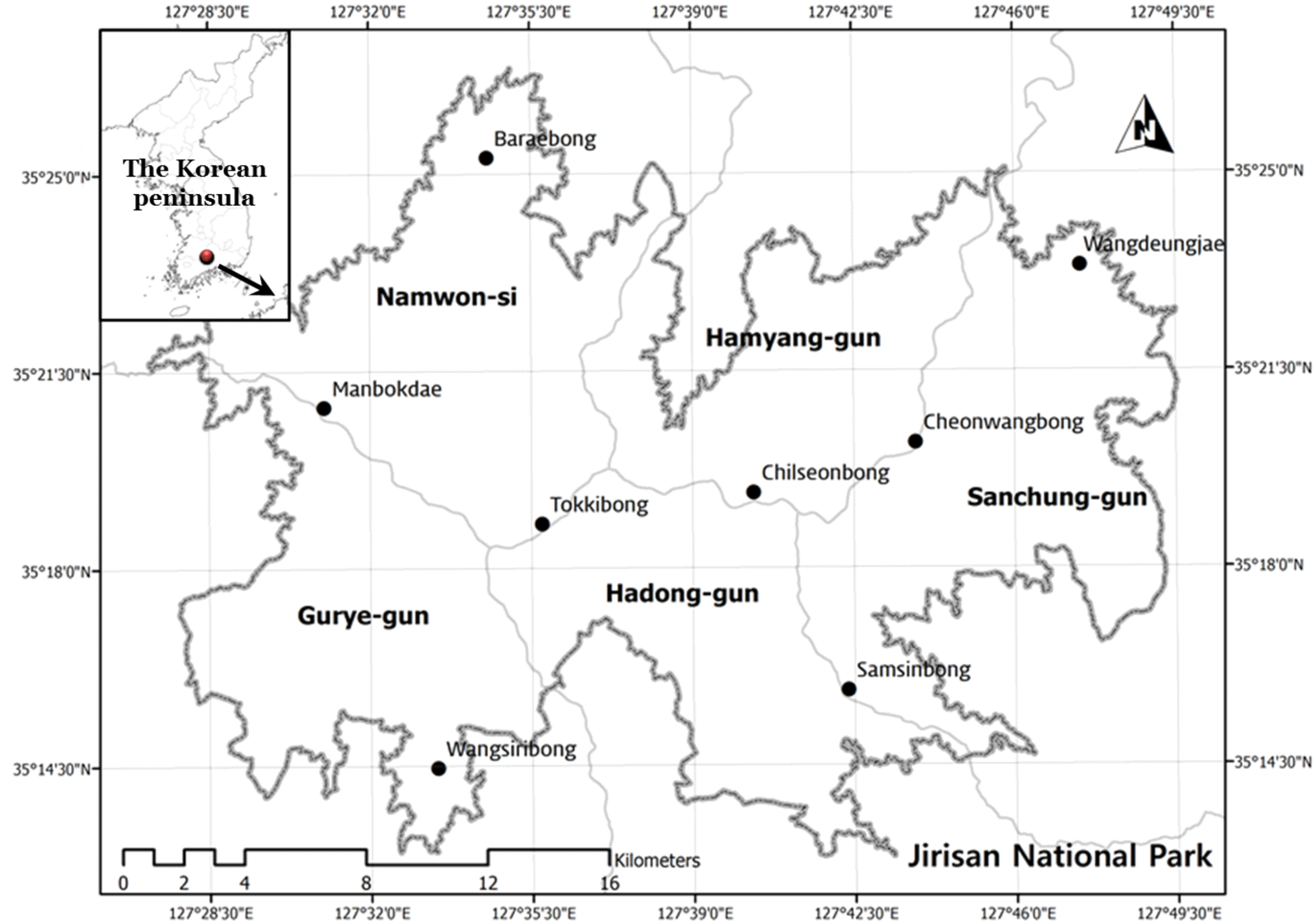

Fig 2. The map of the study areas (Mt. Jirisan, Korea National Park, South korea).

국문초록

국내에 서식하는 반달가슴곰의 혈액학 및 혈액화학적 조사

양 정 진
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반달가슴곰 (*Ursus thibetanus ussuricus*)의 정상 혈액학 및 혈액화학적 참고치를 확립하기 위하여 반달가슴곰 복원프로젝트의 일환으로 2005년부터 2014년도까지 지리산국립공원에 방사 또는 증식·사육하는 1∼14년생 반달가슴곰 암컷 29마리, 수컷 26마리를 대상으로 총 234건의 혈액시료를 채취하여 18종의 혈액검사와 29종의 혈장 생화학적 검사를 실시하였다. 성별, 연령별, 서식환경별, 계절별로 군을 나누어 각 군별로 혈액 및 혈액화학적 수치를 비교 분석하였다. 성별 그룹에서 암컷은 수컷에 비해 GLU, PLT, PCT, PDWc의 항목에서 평균적으로 높은 값을, TG, MCH의 항목은 수컷에 비해 낮은 값을(P < 0.05) 나타내었다. 연령별 그룹에서 CRE, TP, ALB, GGT, HGB, HCT, MCV, MCH의 값은 연령이 증가함에 따라 증가하였으나 (P < 0.01), U/C 비율, CA, LDH, ALP, CPK, CKMB, LYM, RDWc, PLT, PDWc (P < 0.01), K^+, Mg (P < 0.05)의 수치들은 연령이 증가함에 따라 감소함을 확인하였다. 서식 환경별 그룹에서 AST, GGT, BUN, CRE, ALB (P < 0.01), CRP, HDLC (P < 0.05)의 값은 자연에 방사된 야생곰보다 사육곰에서 높게 나타났으며, 반면 TCHO, UA, LYM, PCT (P < 0.05), LDH, NH_3^+, ALP, Na^+, TG, CL^-, CPK, CKMB, WBC, PLT, MPV, PDWc (P < 0.01) 값은 자연에 방사된 야생곰에서 보다 낮게 관찰되었다. 또한, 겨울철 동면기의 곰은 CRE, TP, TCHO, TG, Mg, WBC, GRA, MON 비율, HGB, PLT 항목에서 활동기의 곰에 비해서 높은 값을 나타내었으며 (P < 0.01), GLU, BUN, U/C ratio, NH_3^+, IP, AST,

ALT, LDH, AMY, CRP, HDLC, ALP, CPK, LYM 비율, MCH, MCHC, RDWc ($P < 0.01$), LYM, HCT ($P < 0.05$) 값은 활동기의 곰에 비해서 동면하는 곰에서 낮은 값을 나타내었다. 각 그룹별 혈액학적 분석 수치의 의미있는 차이는 포획 당시 반달가슴곰의 영양상태의 차이, 포획 또는 마취 상황과 같은 스트레스나 운동 유발 요인 등과 관련한 생리적 조건 등에 의해 영향을 받은 것으로 판단된다. 본 연구는 우수리아종 반달가슴곰의 혈액 및 혈액화학적 분석 연구에 대한 최초의 보고이며, 이를 통해 확립된 혈액학적, 혈액화학적 참고치는 야생 반달가슴곰 복원을 위한 개체의 건강성 평가 및 반달가슴곰의 질병 진단을 수행함에 있어 기초적인 참고 자료로 유용하게 활용될 것으로 기대된다.

주요어: 혈액검사, 혈액화학적 검사, 반달가슴곰(*Ursus thibetanus ussuricus*), 지리산국립공원