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Thomas M. Campbell III
*Colorado State University, Fort Collins*

Tim W. Clark
*Idaho State University, Pocatello, Idaho*

SHORT-TERM EFFECTS OF LOGGING ON RED-BACKED VOLES AND DEER MICE

Thomas M. Campbell III[1] and Tim W. Clark[2]

Abstract.— Clearcutting and selective logging effects on red-backed voles (*Clethrionomys gapperi*) and deer mice (*Peromyscus maniculatus*) were studied (September–November, 1975; June–October, 1976) in Bridger-Teton National Forest, Wyoming. Five selective cuts (total 137 ha) removed 57 percent (range 34–74 percent) of the trees. One clearcut (9.6 ha) eliminate 84 percent of the trees. Soils remained mesic in selective cuts, but became xeric in the clearcut. Snap-trapping indicated that voles were most abundant on the unlogged and selectively cut mesic sites (76 percent of 408 captures), whereas deer mice were more common on the xeric clearcut (80 percent of 60 captures). Species composition remained unchanged on selective cuts following logging (77 percent voles of 256 captures), but changed from predominantly voles to mostly deer mice (80 percent of 60 captures) in the clearcut. Intraspecific age and sex ratios, litter sizes, and morphological measurements were compared between logged and unlogged areas.

The short-term logging effects on the structure and dynamics (i.e., habitat, numbers, and morphological and reproductive characteristics) of red-backed voles (*Clethrionomys gapperi*) and deer mice (*Peromyscus maniculatus*) were examined on a 646 ha study area in the Bridger-Teton National Forest, about 40 km north and 8 km east of Jackson, Wyoming. It is on the backslope of an escarpment that runs west from Mt. Leidy to a point southwest of Toppings Lakes. This backslope is a series of benches with 15 to 40 percent slopes (Brady 1974) at elevations of 2300 to 2700 m. Soils include loams at the surface, with silty clay to clay loam subsoils (Knight 1973).

Climate is characterized by long, cold winters with deep snow, a short growing season (average 60 days), and a low mean annual temperature of 1 C. Snowfall averages 345 cm annually and can occur any month. Mean annual precipitation is 69 cm, predominantly snow (Department of Commerce 1975).

Jackson Hole vegetation has been described by Read (1952), and Beetle (1961). A climax spruce-fir (*Picea engelmannii-Abies lasiocarpa*) forest covers the study area except on recent burns (last 80 years) and at lower elevations, where lodgepole pine (*Pinus contorta*) is dominant, and in areas of intermixed coniferous forest and meadows where Douglas fir (*Pseudotsuga menziesii*) also occurs. Limber pine (*Pinus flexilis*) is sparsely scattered throughout. Understory is dominated by highbrush huckleberry (*Vaccinium globulare*), grouse whortleberry (*V. scoparium*), mountain ash (*Sorbus scopulina*), and sedges (*Carex spp.*).

## Methods

The density of all trees (dbh > 15 cm), saplings (dbh 7.5–15 cm), and seedlings (dbh < 7.5 cm regardless of height) by species was measured on 10 randomly placed quadrats (0.004 ha each) in each of the six harvest blocks before and after logging. Soil beneath the ground litter was classified as mesic if it felt damp or xeric if it felt dry.

Small mammals were snap-trapped on each harvest block just prior to and immediately after logging and on each harvested block and adjacent undisturbed sites for up to one year thereafter at monthly intervals. Each sample consisted of 60 traps in three lines with 10 trap stations 16 m apart per line and 2 traps 3 m apart per station. Traps were baited with peanut butter and checked daily for 3 consecutive days for a total of 180 trap days (TD) per sample (one trap set for 24 hours equals one trap day). The species; sex; age (juvenile or adult); length of body, tail,

[1]Department of Fishery and Wildlife Biology, Colorado State University, Fort Collins, Colorado 80522. Reprints: Box 2705, Jackson, Wyoming 83001.
[2]Department of Biology, Idaho State University, Pocatello, Idaho 83209.

right hind foot, and right ear; and reproductive status were recorded for all individuals trapped. Testes length for males and numbers of embryos or placental scars for females were also recorded. Age was based on pelage, size, and reproductive status.

Statistical tests were based on the Chi square method of analysis unless otherwise indicated.

## RESULTS AND DISCUSSION

### Effects of Logging on Vegetation

Collectively, logging altered approximately 24 percent of the study area. Table 1 shows the harvest schedule. Selective cutting removed a mean of 52, 52, and 77 percent of the trees, saplings, and seedlings, respectively, and mesic ground conditions persisted for one year on these sites (Table 2). Clearcutting removed 88, 70, and 79 percent of the trees, saplings, and seedlings, respectively, but ground conditions changed from mesic to xeric within 9 months after harvest. Although not quantitatively measured, logging and skidding drastically disturbed understory vegetation and litter in both clear and selective cuts.

### Effects of Logging on Small Mammals

Five species were captured: red-backed voles, deer mice, western jumping mice (*Zapus princeps*), yellow pine chipmunk (*Eutamius amoenus*), and masked shrews (*Sorex cinereus*). Ninety-eight percent of 478 captures were voles and deer mice; only these two species are discussed here.

ABUNDANCE: Voles were significantly ($P<0.01$) more abundant on mesic soils (76 percent of 408 captures, Fig. 1) throughout the study, but deer mice were significantly ($P<0.01$) more numerous on the one xeric site sampled 10 months after clearcutting (80

TABLE 1. Logging schedule for the six timber harvest blocks, Toppings Lakes Study Area, Bridger-Teton National Forest, Wyoming.

| Block No. | Size (ha) | Harvest method | Harvest schedule: Cut | Skidded | Interval (days) |
|---|---|---|---|---|---|
| 1 | 19.4 | Selective cut | 8/19/76 | 8/21/76 | 2 |
| 2 | 9.6 | Clearcut | 9/08/75 | 9/10/75 | 2 |
| 3 | 75.0 | Selective cut | 9/15/76 | 10/31/76 | 46 |
| 4[a] | 8.1 | Selective cut | 9/10/76 | 9/10/76 | 0 |
| 5 | 9.6 | Selective cut | 9/09/75 | 8/20/76 | 315 |
| 6 | 36.4 | Selective cut | 9/13/76 | 9/23/76 | 10 |

[a]Logging was suspended after 4 ha were logged and it became apparent that the expected timber volumes were not there.

TABLE 2. The changes in tree overstory densities for clear and selective cuts on the Toppings Lakes Study Area, Bridger-Teton National Forest, Wyoming.

| | Mean size of harvest block (ha)[a] | Mean number per hectare[a]: before logging | after logging |
|---|---|---|---|
| Selective cuts | 29.7 ± 27.7 SD | | |
| Trees | | 1064 ± 233 | 507 ± 47 |
| Saplings | | 866 ± 84 | 416 ± 196 |
| Seedlings | | 11027 ± 4124 | 2592 ± 545 |
| Clearcut | 9.6 | | |
| Trees | | 1213 | 150 |
| Saplings | | 743 | 230 |
| Seedlings | | 17203 | 3770 |

[a]Means and standard deviations for selective cuts (N = 5).

percent of 60 captures). Koehler et al. (1975) found similar results in Idaho on undisturbed mesic sites and on sites xerified by forest fire. Red-backed voles apparently require a heavy cover of vegetation or logs (Gashwiler 1959, LaBue and Darnell 1959, Hooven 1969, Krefting and Ahlgren 1974) and reside primarily in cool, damp forests (Townsend 1935, Bailey 1936). The greater diversity of understory plants of mesic sites (Daubenmire and Daubenmire 1968) apparently provide food and cover for red-backed voles, but deer mice prefer xeric habitats.

Species composition on logged and unlogged mesic sites (selective cut #5) did not differ significantly ($P>0.10$) one year after logging (Fig. 2). Conversely, the disturbed xeric site (clearcut 2) had a highly significant ($P<0.01$) change in species composition following harvest (Fig. 2). Preharvest and immediate postharvest data (September and October 1975, respectively) showed a community composed primarily of red-backed voles (73 percent of 113 captures). Nine to 12 months after harvest (June to September, following winter inaccessibility) composition had changed to 80 percent deer mice of 60 rodent captures. These deer mouse capture rates indicate a larger population than that on the original, undisturbed forest. This is attributed to the xerification of this site as a result of logging. Similar increases of deer mice were observed by Tevis (1956), Gashwiler (1959, 1970), Koehler et al. (1975), and Hooven and Black (1976) in forests altered by timber harvest and forest fires. Clearcuts may be more attractive to deer mice (Gashwiler 1959) because they tend to move into disturbed, depopulated areas (Stickel 1946).

AGE RATIOS: On newly logged selective cuts, juveniles outnumbered adults 4.1 : 1.0 for red-backed voles and 5.0 : 1.0 for deer mice, but 9 to 12 months later juveniles had decreased significantly ($P<0.01$) to 0.8 : 1.0 for voles and 0.6 : 1.0 for deer mice. Juveniles also outnumbered adults on the newly clearcut site 1.6 : 1.0 for voles and 1.8 : 1.0 for deer mice.

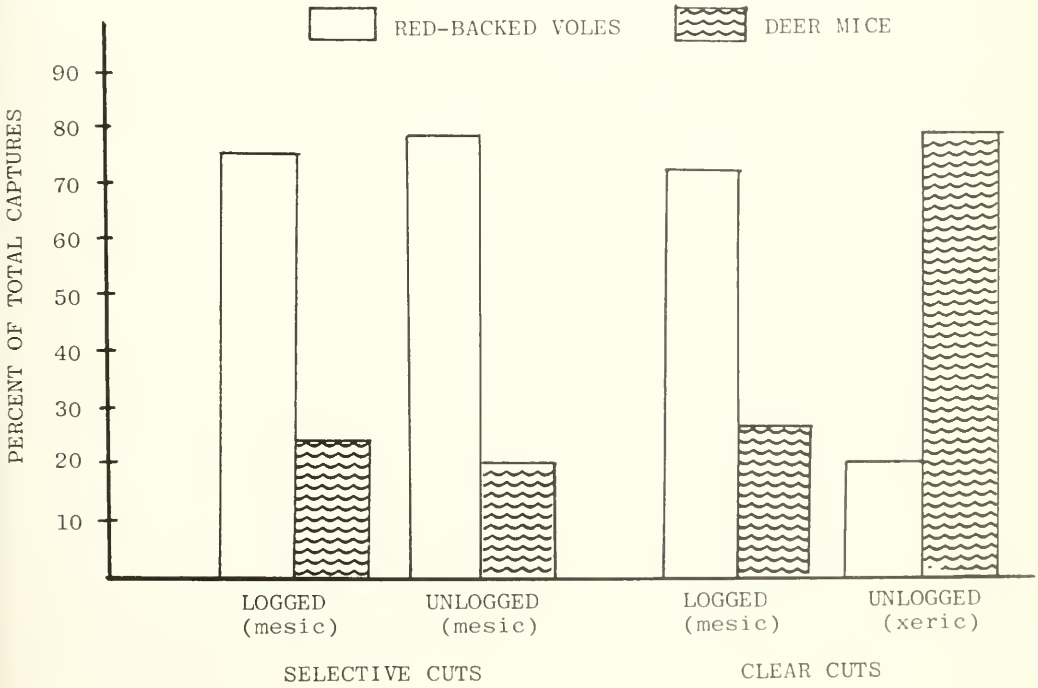


Fig. 1. Percent captures of red-backed voles and deer mice on logged and unlogged areas, Bridger-Teton National Forest, Wyoming. Figures at the top of the bars equal the number of animals trapped.

Juveniles also comprised 75 percent of all deer mice captured in a recent burn (Sims and Buckner 1972). Powell (1972) found three times as many red-backed vole juveniles in a recently blown down forest than in an undisturbed forest. He concluded that standing forests were preferred red-backed vole habitat and adults drove juveniles into the less preferred, disturbed habitat (presumably via aggressive behavior).

SEX RATIOS: The overall sex ratio for red-backed voles was 1.2M:1.0F, comparable to 1.3M:1.0F found in an Oregon study (Gashwiler 1959). Adults had an even sex ratio, but juvenile males significantly ($P<0.05$) outnumbered juvenile females (1.5M:1.0F). Vole sex ratios (adults, juveniles, and total) did not differ significantly ($P>0.05$) in unlogged mesic, logged mesic, or logged xeric sites.

Sex ratios for all deer mice captured (1.0 M:1.0 F); for adults (1.6 M:1.0 F); for juveniles (0.6 M:1.0 F); and for logged mesic, un-

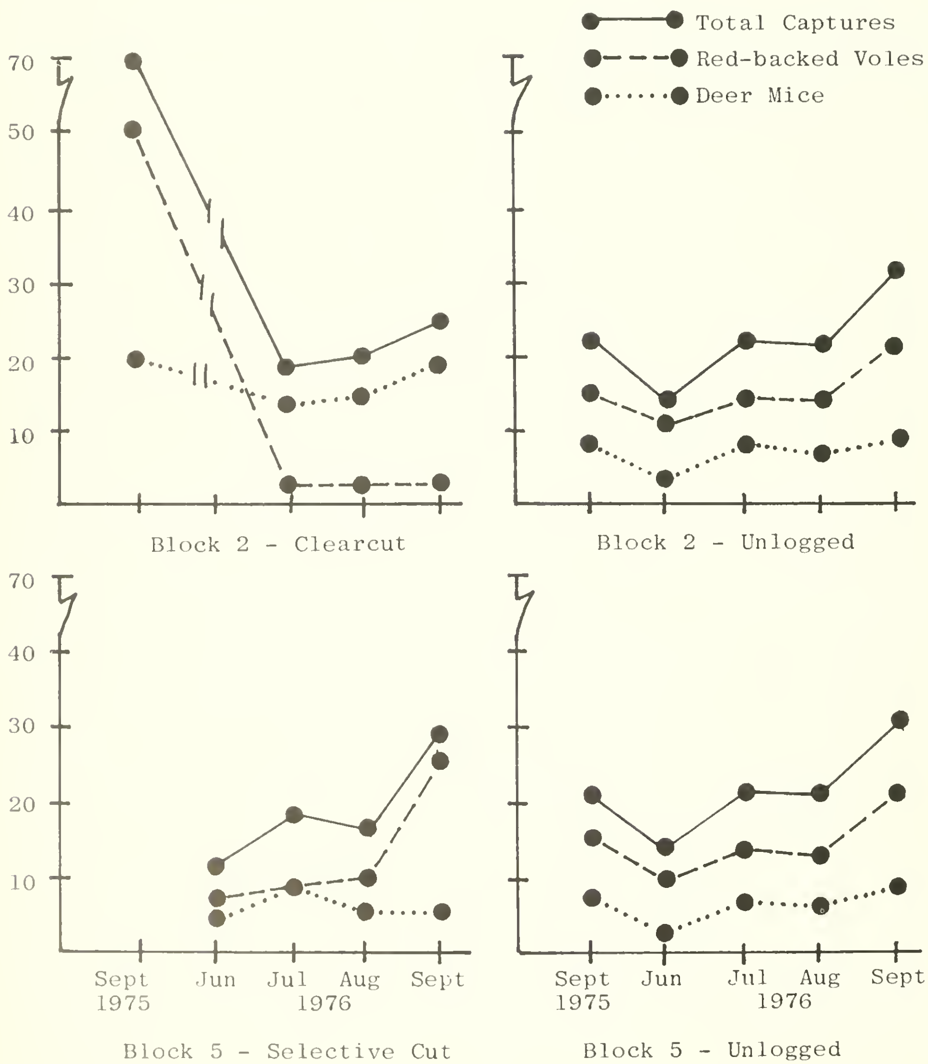


Fig. 2. Numbers of red-backed voles and deer mice trapped on logged and unlogged sites, Bridger-Teton National Forest, Wyoming (September 1975, June–September 1976).

logged mesic, or logged xeric sites did not differ significantly ($P>0.05$) from 1.0 M : 1.0 F.

REPRODUCTION: Reproductive data for June–September 1976 showed that most reproduction ceased after August (Tables 3 and 4). Males of both species with scrotal testes were captured through August but not in September. Packard (1968) and Clark (1973) used male rodents exhibiting scrotal testes as an indication of population breeding. Females of both species carried embryos and were lactating from June to September, but September embryos were near term (Table 4).

Mean litter size and SD based on embryo and placental scar counts was 6.0 ± 0.9 (range 4–9) for 44 red-backed voles and 6.1 ± 0.3 (range 6–7) for 10 deer mice. These were similar to other studies of red-backed voles in Grand Teton National Park (Clark 1973) and of deer mice in northwestern Wyoming (Clark 1975, Long 1964). Reproductive timing or litter sizes for either species did not differ between logged and unlogged areas.

BODY MEASUREMENTS: Linear measurements for red-backed voles and deer mice are shown in Tables 5 and 6, respectively. Adult females of both species were insignificantly larger than males. No significant ($P>0.05$, AOV) intraspecific age differences in measurement of either sex were observed between logged and unlogged areas 9 to 12 months after harvest. Male red-backed voles from this study and nearby Grand Teton National Park ($N=7$, Clark 1973) did not differ significantly ($P>0.10$, t-test).

## CONCLUSIONS

Both selective cutting that removed about 57 percent of the trees and clearcutting of spruce-fir forest resulted in an increase of juvenile red-backed voles and deer mice two weeks to a month after logging that was not apparent 9 to 12 months later. Clearcutting changed species composition 9 to 12 months later from predominantly red-backed voles on unlogged areas to predominantly deer mice. The change was attributed to soil xeri-

TABLE 3. Male reproductive condition of red-backed voles and deer mice, Bridger-Teton National Forest, Wyoming (June–September 1976).

| | Number of red-backed voles | | | | | Number of deer mice | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Condition | June | July | Aug. | Sept. | Total | June | July | Aug. | Sept. | Total |
| Scrotal | 9 | 7 | 12 | 0 | 28 | 4 | 9 | 1 | 0 | 14 |
| Nonscrotal | 0 | 0 | 11 | 9 | 20 | 0 | 1 | 13 | 6 | 20 |
| Total | 9 | 7 | 23 | 9 | 48 | 4 | 10 | 14 | 6 | 34 |

TABLE 4. Reproductive condition of red-backed vole and deer mouse adult females, Bridger-Teton National Forest, Wyoming (June–September 1976).

| | Number of red-backed voles | | | | | Number of deer mice | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Condition | June | July | Aug. | Sept. | Total | June | July | Aug. | Sept. | Total |
| Number of females examined | 8 | 5 | 13 | 18 | 44 | 1 | 6 | 10 | 1 | 18 |
| Percent pregnant | 50 | 80 | 23 | 72 | 54 | 100 | 67 | 20 | 100 | 44 |
| Number of embryos | | | | | | | | | | |
| Mean | 6.3 | 6.8 | 6 | 5.9 | 6.1 | 6 | 6.5 | 6 | 6 | 6.3 |
| Range | 6–7 | 5–9 | 6 | 4–9 | 4–9 | 6 | 6–7 | 6 | 6 | 6–7 |
| Percent with placental scars | 50 | 40 | 77 | 28 | 48 | 0 | 33 | 80 | 0 | 56 |
| Number of placental scars | | | | | | | | | | |
| Mean | 5.5 | 6 | 6 | 5.6 | 5.8 | 0 | 6 | 6 | 0 | 6 |
| Range | 5–6 | 6 | 6 | 4–6 | 4–6 | 0 | 6 | 6 | 0 | 0–6 |
| Number of females lactating | 4 | 6 | 13 | 17 | 40 | 1 | 5 | 10 | 1 | 17 |

fication on the clearcut. Voles continued to predominate on selectively cut sites, and soils remained mesic there. For both species adults consistently outnumbered juveniles in June, July, and August in both logged and unlogged areas, but juveniles outnumbered adults in areas newly logged in September. Sex ratios, timing of reproduction, litter size, and body measurements for both species did not differ significantly between unlogged, selectively cut, or clearcut areas 9 to 12 months after logging.

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TABLE 5. Body measurements of 258 red-backed voles from unlogged, clearcut, and selectively cut areas, Bridger-Teton National Forest, Wyoming (June–September 1976).

| | Mean length, SD, and (range) in mm | | | |
|---|---|---|---|---|
| Sex and age* | Body | Tail | Ear | Hind Foot |
| Control | | | | |
| M2+ (n=18) | 139.4 ± 8.8(119–152) | 39.1 ± 2.6(34–45) | 15.8 ± 1.8(13–21) | 18.4 ± 0.9(17–19) |
| F2+ (n=23) | 143.4 ± 10.9(118–158) | 40.5 ± 4.4(26–47) | 16.5 ± 1.1(14–19) | 18.0 ± 1.0(16–19) |
| M1- (n=40) | 115.2 ± 12.1(88–137) | 33.0 ± 4.5(26–43) | 14.9 ± 1.8(10–17) | 16.9 ± 1.2(15–18) |
| F1- (n=26) | 112.2 ± 10.5(90–132) | 33.2 ± 3.7(25–42) | 14.9 ± 1.7(10–18) | 17.0 ± 0.7(15–18) |
| Clearcut | | | | |
| M2+ (n=3) | 147.7 ± 6.4(144–155) | 41.0 ± 3.5(39–45) | 14.3 ± 0.6(14–15) | 18.7 ± 0.6(18–19) |
| F2+ (n=4) | 139.6 ± 10.4(125–147) | 40.3 ± 2.9(37–44) | 17.0 ± 0.8(16–18) | 17.8 ± 1.0(17–19) |
| M1- (n=4) | 113.3 ± 13.8(100–130) | 33.5 ± 6.2(27–40) | 13.0 ± 2.0(12–16) | 16.8 ± 0.5(16–17) |
| F1- (n=1) | 117.0 — — | 35.0 — — | 17.0 — — | 18.0 — — |
| Selective cut | | | | |
| M2+ (n=27) | 138.9 ± 10.1 (115–160) | 40.8 ± 3.5(26–48) | 15.9 ± 1.7(12–18) | 18.4 ± 1.0(16–19) |
| F2+ (n=17) | 142.7 ± 11.2(122–159) | 40.6 ± 4.7(37–47) | 15.9 ± 1.8(11–18) | 17.9 ± 0.8(16–19) |
| M1- (n=59) | 121.9 ± 8.5(96–137) | 35.6 ± 3.5(26–42) | 15.6 ± 1.6(11–19) | 17.3 ± 0.7(16–19) |
| F1- (n=36) | 115.0 ± 10.7(93–138) | 33.5 ± 3.6(25–40) | 15.4 ± 1.9(10–18) | 17.2 ± 0.7(16–19) |

*2+ = adult; 1- = juvenile.

TABLE 6. Body measurements of 118 deer mice from unlogged, clearcut, and selectively cut areas, Bridger-Teton National Forest, Wyoming (June-September 1976).

| | Mean length, SD, and (range) in mm | | | |
|---|---|---|---|---|
| Sex and age* | Body | Tail | Ear | Hind foot |
| Control | | | | |
| M2+ (n=11) | 157.5 ± 11.1(140–175) | 68.4 ± 4.8(62–77) | 18.5 ± 0.8(13–20) | 18.4 ± 0.9(19–20) |
| F2+ (n=5) | 156.6 ± 10.1(146–170) | 69.2 ± 4.3(63–73) | 18.8 ± 0.5(13–19) | 19.6 ± 0.9(19–21) |
| M1- (n=8) | 139.4 ± 5.0(133–146) | 63.9 ± 2.0(61–66) | 18.3 ± 1.0(17–20) | 19.1 ± 0.6(18–20) |
| F1- (n=9) | 146.0 ± 6.3(137–155) | 67.0 ± 3.4(62–72) | 18.8 ± 0.8(17–20) | 18.6 ± 1.0(17–20) |
| Clearcut | | | | |
| M2+ (n=12) | 158.7 ± 11.1(148–175) | 69.8 ± 5.0(63–77) | 18.0 ± 1.7(15–20) | 19.4 ± 0.7(19–21) |
| F2+ (n=10) | 166.3 ± 14.3(144–188) | 73.4 ± 7.1(62–85) | 18.3 ± 1.3(17–20) | 19.3 ± 0.7(18–20) |
| M1- (n=9) | 146.4 ± 7.2(133–156) | 67.4 ± 3.6(61–74) | 18.7 ± 1.0(18–20) | 19.1 ± 0.9(18–20) |
| F1- (n=17) | 142.5 ± 7.6(130–155) | 63.4 ± 5.2(55–72) | 17.6 ± 1.8(14–20) | 18.5 ± 1.0(17–20) |
| Selective cut | | | | |
| M2+ (n=12) | 154.1 ± 10.1(141–174) | 67.4 ± 5.2(61–76) | 18.3 ± 1.4(15–20) | 19.1 ± 0.5(18–20) |
| F2+ (n=4) | 160.1 ± 17.8(145–183) | 69.8 ± 8.3(62–80) | 18.5 ± 1.0(17–19) | 19.3 ± 1.0(18–20) |
| M1- (n=6) | 146.8 ± 6.6(139–157) | 66.5 ± 3.7(64–74) | 18.2 ± 0.8(17–19) | 19.2 ± 1.0(18–20) |
| F1- (n=15) | 143.2 ± 9.6(128–160) | 65.0 ± 5.0(57–74) | 17.9 ± 1.5(16–20) | 18.8 ± 0.8(17–20) |

*2+ = adult; 1- = juvenile.

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