mulated larger quantities of calcium and manganese than did the other species collected.

Pepperbush (*Clethra alnifolia* L.) collected in only two locations in one year, also showed an unusual ability to accumulate cobalt, manganese, zinc and calcium. The leaves of this species contained more zinc than gallberry leaves and a quantity of cobalt equal to that found in blackgum.

The widespread occurrence of both blackgum and gallberry on uncultivated sites should contribute to their value as indicators of the cobalt and zinc status, respectively, of Coastal Plain soils.

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LADYBIRD BEETLES AND ARMY CUTWORM ADULTS AS FOOD FOR GRIZZLY BEARS IN MONTANA

This report describes and briefly discusses two instances of the use of insects as food by grizzly bears. The first involves the phenomenon of mountain aggregations of ladybird beetles. The second represents a clue to the adult behaviour of the economically important army cutworm, *Chorizagrotis auxiliaris* Grt.

Aggregations of overwintering ladybirds (Coleoptera: Coccinellidae) are known to occur in many parts of the world (Balduf 1935). Mountain and ridge tops are frequently sites of these aggregations although the beetles also gather below such points and even in valleys and plains. In western Montana, careful search during summer months under rocks on the tops of high peaks has invariably yielded scattered masses of dozens or hundreds of dead beetles, showing that past gatherings have occurred there. Specimens taken alive from several high ridge and summit areas have been identified by the Unit of Systematic Entomology, Entomology Division, Ottawa, as follows:

Coccinella nivicola monticola Mulsant; 8 August 1952, Squaw Peak, Huson; *C. transversoguttata quinquenotata* Kirby; 4 October 1952, Holland Lookout, Seeley Lake; *Hippodamia caseyi* Johnson; 28 June 1952, 8 August 1952, Squaw Peak, Huson: 20 September 1952, McDonald Peak, St. Ignatius; 16 May 1953, Lolo Peak, Lolo; *H. oregonensis oregonensis* Crotch: 4 October 1952, Holland Lookout, Seeley Lake.

McDonald Peak, in the Mission Mountains, is over 10,000 feet high. The peak and its vicinity are known locally to be frequented by grizzly bears (*Ursus horribilis*) during summer months. The abundance of these bears was the subject of considerable comment by Underhill and Underhill (1950). Two of us have independently observed grizzlies feeding on ladybird aggregations in rock slide areas near the peak.

On August 3, 1932, while climbing McDonald Peak, a group of twelve grizzly bears was encounered (by J.R.) in a high rocky basin, just below the summit. The bears were watched for several minutes and were seen to be overturning rocks and apparently feeding. After they had been disturbed and had left the area the site of their activity was examined. Ladybird beetles were present in large numbers under and among the rocks there. Snow banks were still abundant and the beetles apparently represented overwintering aggregations.

Since that time a number of trips have been made into the Mission Mountains in order to observe the bears. They have been seen on numerous occasions and moving pictures have been made of them near McDonald Peak. Some of the pictures show these animals on rock slide areas, moving rocks and apparently seeking food. Such behaviour might be associated with search for rodents; however, this is not likely in view of the site, the known presence of ladybird masses in the general area, and the previous observations on the bears.

Another of us (J.S.), in the summer of 1932, saw grizzly bears frequenting rock slides where ladybirds were abundant. These insects were of particular interest at that time because it was known that in certain parts of the country they were being collected and sold for release in orchards, as a means of controlling aphids and other insects. A resident of the Swan Valley, east of McDonald Peak, had reported seeing grizzly bears rolling rocks on the slopes of this peak and eating the ladybirds which they found in this way. The area was visited in order to collect samples of the beetles and to determine whether or not it would be possible to gather sufficient numbers of them to sell. At that time some of the bears were encountered above timberline on the east slope of the peak and were seen to be overturning rocks and apparently feeding. After they had moved away large masses of ladybirds were found beneath every good-sized rock in the area. It was estimated that some five to ten gallons of beetles could be collected per day in the vicinity. The species was not one of those in demand, however, and no further visits to the area were made.

There is little doubt that in each of these cases the bears were actually feeding on ladybird beetles when first seen. This appears to be the first reported instance of such predation on aggregations of these insects.

After hearing of the above observations an attempt was made (by J.C.) to determine whether or not there was any current use of these insects as food by the bears. This attempt led to an unexpected and interesting finding. On Sept. 19 and 20, 1952, a visit was made to McDonald Peak and vicinity and portions of all bear droppings found were collected. Fifteen samples were taken, mostly between 8,000 and 9,000 feet, where groups of timberline trees were scattered among rock ledges and grassy areas. All droppings were estimated to be a month or more old when found. In view of their locations and the known past occurrence of grizzly bears in the area it is safe to assume that they came from grizzlies, not black bears.

Microscopic examination of the samples revealed that nine of them consisted largely or entirely of moth remains. It was quite apparent, moreover, that only one species, or group of closely related species, was involved. No ladybird remains were seen in any of the samples and a few ant and midge parts comprised the only other insect material. Grass, sedge and shrub remnants, pine nut hulls, hairs and traces of soil made up the non-insect portions. By reconstructing the male genitalia, T. N. Freeman, Systematic Entomology Unit, Entomology Division, Ottawa, was able to identify *Chorizagrotis auxiliaris* Grt., the army cutworm, in the material.

This insect is endemic to the Great Plains and is a species of considerable economic importance in cultivated land areas of the semiarid region of western North America (Strickland 1916; Cook 1927; Seamans 1929; Walkden 1950). An aspect of the life history of this moth has long been puzzling. In a given locality an early summer flight period occurs, during which the females have undeveloped ovaries. This is followed by mid-summer disappearance of the moths. In late summer or early autumn they again appear and fly actively. This time the ovaries are fully developed and oviposition takes place. The second flight period involves smaller numbers of moths and specimens appear worn.

This pattern of flights was first interpreted as indicating two broods a season (Gillette 1904). Later studies have shown that this is not the case. It is usually considered that the moths estivate during the warmest part of the summer. In Alberta, inactive adults have been found in barns and houses, under clods of earth and in a variety of protected places, and are reported to stay in buildings throughout the summer (Seamans 1929). There is evidence, however, that during this time large numbers of the moths are present at higher altitudes, in nearby mountains.

Pepper (1932) reported that in Montana these moths were extremely abundant in outbreak areas early in the season but had completely disappeared by mid-summer. During several evenings in July, essentially unidirectional flight of numbers of them was observed. Pepper speculated on the possibility that they migrated to higher elevations and estivated there. He cited the case of *Agrotis ypsilon,* which shows a similar period of disappearance and is suspected of flying from Egypt to the Alps, or, in India, some 200 miles to the mountains there. Walkden (1950) recorded three observations of numbers of active adults in the mountains of Colorado and Nevada. Pepper later (personal communication, 1954) reported that two reliable observers had seen great numbers of these moths at higher altitudes in Montana. One of us (J.C.), on July 28, 1952, saw numbers of the moths, at dusk, flying about alpine flowers near the summit of Squaw Peak, Huson, Montana. Also, many of them were taken at various times in water pan traps near and at the top of this 8,000 foot peak in connection with other studies (Chapman 1954).

All reports of the moths at higher elevation indicate that they are active there and it is possible that they do not estivate at these elevations. Actually some feeding would be expected in connection with the development of ovaries which is known to take place before their reappearance in lower areas. Presumably, while in the mountains, the moths seek shelter during the daytime and in unfavorable weather under logs and rocks, as they are known to do in the lowlands. Thus, if large numbers of moths were in a mountain locality the bears would be able to find and eat quantities of them. The Mission Mountains border the Mission Valley, which is intensively cultivated, but the army cutworm was not reported to be abundant in this area during the summer of 1952 (Pepper *et al.* 1953).

Grizzly bears, like black bears, are quite omnivorous (Seton 1929; Holzworth 1930; Cooney 1941) and would be expected to eat any insects found in quantity. The feeding of black bears on crickets and grasshoppers in the Yellowstone National Park area was observed by Murie (1937), and Gurney (1953) cites a report of black bears feeding on grasshoppers stranded on mountain snowfields. In these cases also, availability of insects appeared to be the main factor in their selection as food.

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RELATION OF LIGHT INTENSITY TO BASAL AREA OF SHORTLEAF PINE STANDS IN GEORGIA

It is well-known to foresters that pines will not reestablish under the canopy of pine or pine-hardwood stands in the Piedmont region. There is considerable evidence that low shade of hardwood brush is just as detrimental to pine reproduction as high shade. The pines require overhead sunlight that is high enough in intensity for them to produce the food that is needed for vigorous growth of roots and shoots. The results of recent studies have shown the importance of adequate light intensity in the course of the regeneration of southern pine species.

In 1948, Wahlenberg reported on the effect of forest shade on growth of loblolly pine (*P. taeda* L.) seedlings in southern Arkansas. It was found that on favorable sites a canopy opening with a radius of 7.6 to 15.2 feet or larger was adequate for continuous pine production. This was regarded as the size of opening created by the removal of a single tree. However, the growth was more rapid and survival better in the larger openings. Further evidence of the importance of light is shown by a study that Oosting and Kramer (1946) made of the relation of water and light to shortleaf pine (*P. echinata* Mill.) reproduction in the Piedmont of North Carolina. They concluded that light was probably more controlling than soil moisture in the complex of factors that limit the establishment of shortleaf pine seedlings in forest stands. Brinkman and Swarthout (1942) observed that loblolly pine and shortleaf pine in east-central Alabama did not reproduce unless the overhead space was 50 per cent open in old-field stands or 65 per cent open in natural stands. They concluded that pine reproduction is definitely restricted when the overstory competition leaves less than 40 per cent open space in the canopy. Liming (1946) reported that the height growth of planted shortleaf pine increased progressively as the overhead release in a 40-year old hickory stand increased from zero to 100 per cent. These and other reports indicate that the course of pine reproduction in partially cut mature stands depends on the amount of sunlight that the seedlings receive for growth. Thus, the use of partial cuttings has introduced the need of a method for estimating the amount of cutting needed to get any desired light intensity beneath the canopy. To obtain information on this subject, a study was made of the relation of basal area to light intensity in pure shortleaf pine stands.

Methods

The data used in the study were taken in pure even-aged shortleaf pine stands located in six counties in the northeastern part of the Georgia Piedmont. For uniformity of results, the only stands selected were those that exhibited no observable evidence of disturbance by cutting, fire, or grazing during the previous ten years. The measurements were taken on a single ¼ acre square plot in each of the widely distributed stands. Diameter outside bark at breast height was taken on all trees on each plot. For calculation purposes, the diameters were arranged in 1-inch classes.

Light intensity at breast height in the understory was measured with a Weston illumination meter (Model 756) which records sunlight in footcandles. A sphere globe of opal glass was attached to the light absorbing unit containing the photoelectric cell. Light measurements were made on clear days between 9:00 a.m. and 3:00 p.m. The average light intensity was obtained from 10 rows of 10 readings made each way on the plot, giving a total of 100 readings. A measurement of full sunlight was made in the open near the stand at the time the plot was measured. For comparative purposes, the average light intensity of each plot was calculated as a percentage of full sunlight.

Age of the stands selected varied from 30 to 100 years. The basal areas of all plots were well-distributed throughout a range of 35 to 163 square feet per acre. Sampling had to be limited to plots with 35 or more square feet of basal area because the relation of light intensity to basal area became increasingly erratic in open stands. Light intensities on all plots ranged from a minimum of 12 per cent to a maximum of 63 per cent of full sunlight.

Results

An analysis of the data taken on 31 plots showed a strong correlation between average percentage of full sunlight and basal area. The logarithmic equation for the basal area-light intensity relationship was solved by the use of the method given by Goulden (1947). The following equation was derived: $\log y = 3.5177 + (-1.0586) \log x$. The corrected light intensity values used for curve shown in Figure 1 were calculated by substituting the basal area values in the equation. The corrected light intensity values are also given in Table I.

A feature of the curve that is of special interest is the manner in which the light intensity varied with basal area above and below 100 square feet. From 100 to 40 square feet the total increase in light intensity was 41 per cent as compared with only 9 per cent from 160 to