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A comparison of relative abundance and biomass of ground-dwelling arthropods under different forest management practices

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Abstract

Habitat structural characteristics and relative abundance and biomass of ground-dwelling arthropods were compared among four replicated stand treatments: intense burning and salvage logging; clearcutting followed by roller-chopping (100% soil surface disturbance); clearcutting followed by bracke seeding (30% soil surface disturbance); and naturally regenerated mature, forested sand pine scrub. Arthropods were classified by taxa and by mean maximum width. Monthly trends in abundance and biomass of arthropods captured are described. Mature forest differed from the three disturbance treatments in most habitat structural features, but disturbance treatments were similar. Total numbers and dry weight did not differ among treatments but more individuals and biomass of arthropods less than 5 mm mean maximum width occurred in burned sites. There were significantly more arthropods 10 mm or less in mean maximum width than over 10 mm, but arthropods 5-10 mm had the highest biomass. The relative abundance of some taxa differed among treatments, and taxa differed in monthly capture rates. Total numbers and biomass of captured arthropods were greatest from late May through November.

Keywords: Arthropod prey; Arthropod abundance; Arthropod biomass; Arthropod seasonality; Sand pine scrub; Arthropod communities; Prey availability; Forest management

1. Introduction

Along with numerous other ecological roles, terrestrial arthropods serve as an important food base for numerous vertebrate and invertebrate species (Pearson and Derr, 1986; Van Horne and Bader, 1990). Their key role in food webs makes arthropod assemblages an important indicator in assessing impacts of forest management practices on ecosystem function (Kremen et al., 1993). While numerous studies have addressed the effects of forestry practices on specific arthropod taxa (Brown and Hyman, 1986; Pearson and Derr, 1986; McIver et al., 1992; Greenberg and Thomas, 1995; Butterfield et al., 1995) or communities (Southwood et al., 1979; Schowalter, 1995; Theenhaus and Schaefer, 1995), few have considered effects from the perspective of potential prey availability.

Numerous studies have addressed prey size as one

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determinant of prey selection (Simon, 1976; Pearson and Mury, 1979; Pearson, 1980; Sherry and McDade, 1982; DeMarco, 1985; Van Horne and Bader, 1990). Optimal foraging theory predicts that predators will maximize their energy intake given morphological and environmental constraints and energetic cost (Krebs et al., 1983). Clearly, feeding specializations and food preferences also affect prey selection.

Although predator mouth gape limits ingestible prey circumference or width (Sherry and McDade, 1982; DeMarco, 1985), most prey size selection studies base prey size on body length (e.g. Sexton et al., 1972; Simon, 1976; Perez-Mellado et al., 1989) or volume (e.g. Schoener, 1967; Schoener and Gorman, 1968) rather than maximum width. Relationships between arthropod length and dry weight have been established (Rogers et al., 1976; Rogers et al., 1977), as have relationships between dry weight and energy content of many arthropod orders (Bryant, 1973; Calver and Wooller, 1982).

In this paper we address three major questions. First, do differences in the relative abundance and biomass of ground-dwelling arthropods exist among stands of sand pine scrub subjected to four different silvicultural treatments? Second, are there differences in the relative availability of specific size classes and taxa of terrestrial arthropods among the four treatments? Third, what are the seasonal patterns in availability of terrestrial arthropods? These questions may have important implications in managing for higher vertebrates dependent upon the terrestrial arthropod food resource base.

2. Materials and methods

2.1. Site description

We conducted the study in xeric sand pine scrub habitat of the Ocala National Forest (ONF), Marion county, Florida. Xeric scrub occurs in infertile sandy soils (Kalisz and Stone, 1984) along coastal areas and inland ridges of Florida and extreme southern Alabama. Sclerophyllous shrubs including *Quercus myrtifolia* Willd. (myrtle oak), *Quercus geminata* Small (sand live oak), *Quercus chapmannii* Sarg. (Chapman's oak), *Lyonia ferruginea* Nutt. (rusty lyonia), and two species of palmetto, *Serenoa repens* Small (saw palmetto) and *Sabal etonia* Swingle ex. Nash. (scrub palmetto) create a thick, scrubby understory. *Pinus clausa* Vasey ex Sarg. (sand pine) also is dominant in sand pine scrub, a variant of the xeric scrub ecosystem. The ONF contains the largest remaining area of sand pine scrub, which is considered prime land for conversion to citrus and urban development.

Large quantities of seed (recorded as over 2.47 million ha^{-1}) (Cooper et al., 1959) are released by semi-serotinous cones of the Ocala, or peninsular variety of sand pine (*Pinus c. clausa*) following wildfire, creating a naturally even-aged, monospecific canopy. Prior to recent decades of fire suppression, a forest mosaic of temporally shifting age classes (Rawlings, 1933; Webber, 1935; Bartram, 1955; Myers, 1990) was maintained by low-frequency, high-intensity and large-scale wildfire. Low scrub dominated by sclerophyllous shrubs and young *P. c. clausa* existed where fire intervals were relatively short (15 years or less). During longer fire intervals or in sites protected from fire, *P. c. clausa* reached canopy height.

Currently, ONF sand pine scrub is harvested in 8–24 ha stands by clearcutting. Nearly all aboveground vegetation is crushed and killed by heavy machinery used during the clearcutting operation. Either roller-chopping and broadcast seeding or 'bracke-seeding' are commonly employed post-harvest site preparation techniques. Roller-chopper blades penetrate the soil to a maximum depth of 15 cm, creating nearly 100% soil surface disturbance. Bracke-seeding entails direct seeding along small, machine-created ridges (about 8 cm high), patch-scarifying approximately 30% of the soil surface (Outcalt, 1990). Wildfires are usually suppressed in sand pine scrub because of the wood fiber value and the possibility of large-scale, uncontrolled burns. Burned sites are usually salvage-logged.

Many aspects of plant community recovery and habitat structure are similar in clearcuts and wildfire sites (Campbell and Christman, 1982; Abrahamson, 1984a,b; Schmalzer and Hinkle, 1992; Greenberg et al., 1995a). Important habitat differences are:

1. the absence of fire-associated cues for attracting pyrophyllic arthropods to clearcuts;
2. the presence of few standing trees or snags in clearcuts versus an abundance of snags for several

years following a wildfire (unless salvage-logged, as in this study);
3. more slash piles and less bole-sized woody debris in clearcuts (C.H. Greenberg, personal observation);
4. landscape patterns such as patch size and connectivity.

2.2. Methods

Ground-dwelling arthropods were sampled using drift fence arrays with pitfall traps in three replicated 5- to 7-year-old disturbance treatments and mature forested sand pine scrub ($n = 3$ sites each). The disturbance treatments were:
1. high intensity burn, salvage logged, then naturally regenerated (BURN);
2. clearcut, roller chopped, and broadcast seeded (CHOP);
3. clearcut, then bracke seeded (BRACKE).

Mature (over 55 years) sand pine forest (MATURE) stands that had been naturally regenerated following a stand replacing fire in 1935 were used as a control. Selection criteria for stands were: (1) similar soil type, topography, and elevation; (2) same (known) disturbance history and pretreatment age (identical to MATURE); (3) disturbance treatment (not including MATURE) was administered during the same time period (± 1.5 years) (Table 1); (4) area over 8.5 ha; (5) located over 0.9 km from known water sources.

Pinus c. clausa density and height were measured in five 100-m^2 plots per site (or in a 20 m^2 subplot if density was high). The line-intercept technique (Mueller-Dombois and Ellenberg, 1974) was used along three randomly established 10-m line transects to estimate percent cover of vegetation and microsite characteristics. Cover categories measured included herb, shrub, pine, woody debris, leaf litter, and bare ground. A spherical densiometer was used at the midpoint of each line transect to estimate *P. c. clausa* canopy cover in MATURE.

Drift fence arrays were designed and concurrently used for live-trapping herpetofauna (Greenberg et al., 1994), hence no killing agent was used in pitfall traps. Arrays appeared to effectively capture most surface-active arthropods, but may under-represent some taxa that could escape, such as climbing species. We assumed that consumption of arthropods by vertebrates or invertebrates while in the traps was minimal; any effects were similar among treatments.

Arrays (modified from Campbell and Christman, 1982) consisted of eight 7.6-m lengths of 0.5-m-high galvanized metal flashing spaced 7.6 m apart and arranged in an 'L' shaped pattern (four lengths per leg). Two 18.9-l plastic paint buckets, 28.5 cm in diameter, were sunk flush with the ground at both ends of each fence (16 buckets per site). To permit drainage, 1.25 cm holes were drilled in the bucket bottoms. Sticks used to block drill holes effectively prevented most escapes. Arrays were located over 25 m from roads or stand edges (except for two drift fences of one array).

Arthropods were sampled monthly for one 48-h period from October 1991 through September 1992. Specimens were preserved in 70% ethyl alcohol for laboratory identification and measurements.

Arthropods were counted and identified to family level or lower if practical. Individuals within the same taxa having a wide size range due to obvious sexual dimorphism such as *Anisomorpha buprestoides* (Stoll) (walking sticks), age or unknown species variation within a genus were tallied by length class. *Ceuthophilus* spp. (camel crickets) and *Lycosa* spp. (Wolf spiders) spanned all three recognized length classes (0–10, 11–20, and over 20 mm), and Gryllidae spp. (field and tree crickets)

Table 1
Dates of treatment administration and vegetation sampling in three treatments and mature forested sand pine scrub

Treatment	Burn	Clearcut or salvage	Site preparation	Sand pine seed	Sample
Burn–salvage (HIBS)	May 1985	June–Oct. 1985	N/A	N/A	Summer 1991
Chop (RC)	N/A	Apr. 1983–Feb. 1985	June 1986	Winter 1986–1987	Summer 1991
Bracke (BK)	N/A	Fall 1986	Winter 1986–1987	Winter 1986–1987	Summer 1991
Mature (MF)	Spring 1935	N/A	N/A	N/A	Summer 1991

Table 2
Structural characteristics (mean ± SE) of sand pine scrub habitat in three 5–7 year post-disturbance treatments and 55-year-old mature forest ($n = 5$ sites per treatment), Ocala National Forest, Florida. Different letters denote significant differences among treatments ($P < 0.05$)

Treatment	Pine			Shrub	Non-woody plants	Leaf litter	Bare ground	Woody debris
	Stems ha^{-1}	Height (m)	Foliar (% cover)	(% cover)	(% cover)	(% cover)	(% cover)	(% cover)
Burn-salvage (HIBS)	4076.0 ± 653.0a	2.7 ± 0.1a	41.8 ± 11.7ab	51.2 ± 7.9ab	6.8 ± 3.4ab	66.6 ± 7.3ab	16.8 ± 4.9a	20.3 ± 8.1a
Chop (RC)	3496.0 ± 270.1a	2.8 ± 0.1a	45.8 ± 9.0a	42.9 ± 7.3a	13.7 ± 6.4a	70.2 ± 7.1a	22.9 ± 5.9a	2.1 ± 2.2b
Bracke (BK)	3080.0 ± 388.4a	1.9 ± 0.1b	21.2 ± 7.5b	59.0 ± 8.1b	4.9 ± 2.1b	57.1 ± 8.6b	21.5 ± 6.5a	20.8 ± 6.7a
Mature (MF)	641.7 ± 64.8b	16.7 ± 0.6c	83.9 ± 4.5c	73.4 ± 7.8c	35.9 ± 10.3c	99.6 ± 0.6c	0.3 ± 0.5b	5.3 ± 1.8c

spanned the first two length classes. Only common taxa (at least 60 specimens sampled) were included in data analysis.

Wet length and maximum width were measured for 30 specimens each of common taxa and length classes within taxa. Specimens were then oven dried at 84–99°C and weighed periodically until weight loss reached asymptote. Specimens were temporarily held in a desiccator between removal from the drying oven and immediate weighing to the nearest 0.1 mg. Total dry mass was estimated by multiplying the number of individuals sampled by the mean dry weight of that taxa and/or length class.

For purposes of data analysis, taxa were classified

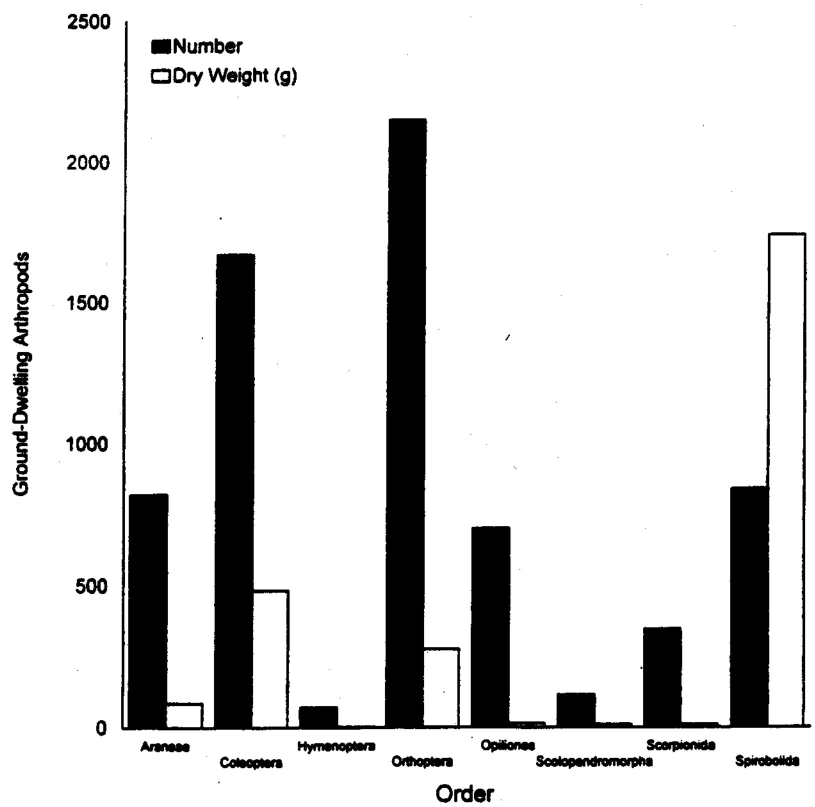

Fig. 1. Total number and biomass of eight commonly captured orders of ground-dwelling arthropods in sand pine scrub, Ocala National Forest, Florida.

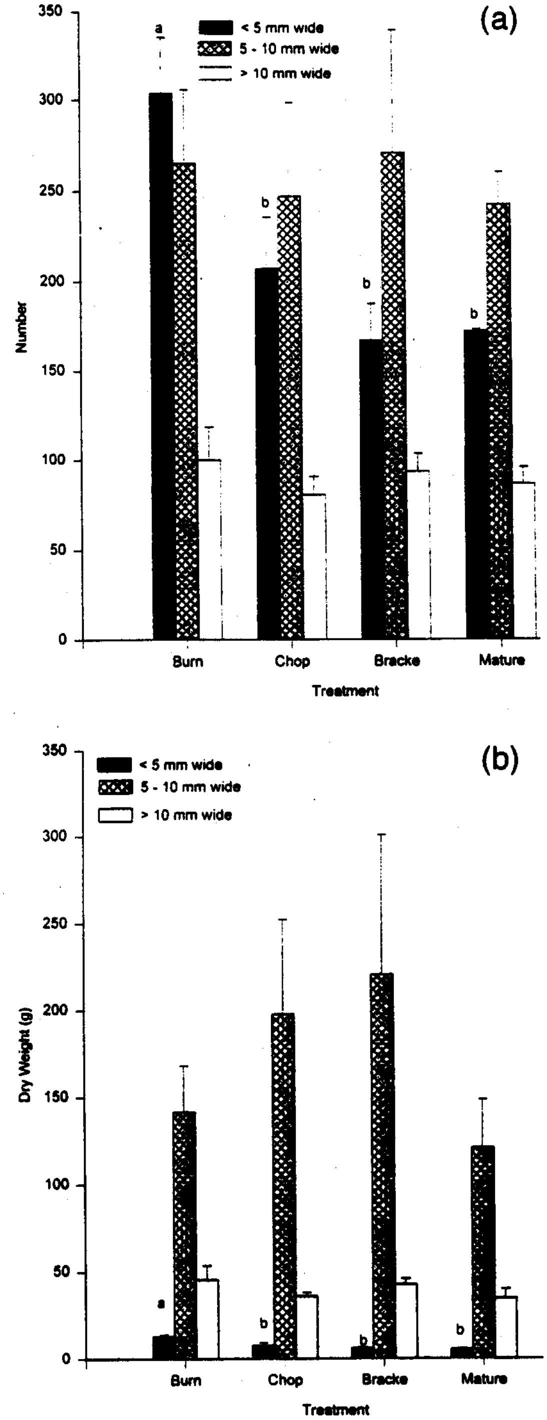

Fig. 2. Mean (± SE) number (a) and biomass (b) of ground-dwelling arthropods in three maximum width classes trapped in three replicated ($n = 3$) disturbance treatments and mature forested sand pine scrub, Ocala National Forest, Florida. Different letters denote significant differences among treatments ($P < 0.05$).

Table 3
Mean (± SE) length, width and weight of commonly captured terrestrial arthropod taxa, Ocala National Forest, Florida

Order, family and species	Mean length (n = 30) (mm)	Mean maximum width (n = 30) (mm)	Mean weight (n = 30) (mg)
(A) Width class I (< 5 mm wide)			
Araneae			
Lycosidae: wolf spiders			
Lycosa spp. (< 10 mm length)	6.4 ± 0.2	2.9 ± 0.1	6.4 ± 0.5
Hymenoptera			
Mutillidae: velvet ants			
Dasymutilla occidentalis (L.)	11.3 ± 0.3	3.9 ± 0.1	24.1 ± 2.0
Opiliones			
Sclerosomatidae: daddy longlegs			
Eumesosoma spp.	6.1 ± 0.2	3.6 ± 0.1	9.4 ± 0.7
Orthoptera			
Blattidae: roaches			
Blattidae spp.	12.2 ± 0.5	4.9 ± 0.1	17.2 ± 2.7
Gryllidae: field and tree crickets			
Gryllidae spp.	8.6 ± 0.3	2.9 ± 0.1	5.5 ± 0.6
Gryllacrididae: camel crickets			
Ceuthophilus spp. (< 10 length)	7.6 ± 0.3	2.8 ± 0.1	14.5 ± 1.5
Ceuthophilus spp. (10–20 mm length)	14.9 ± 0.5	4.0 ± 0.2	88.3 ±
Phasmidae: walkingsticks			
Anisomorpha buprestoides (Stoll) (male)	42.7 ± 0.4	4.3 ± 0.1	70.0 ± 2.0
Scolopendromorpha			
Cryptopidae: centipedes			
Scolopocryptops sexspinosus (Say)	43.9 ± 1.6	4.1 ± 0.2	87.7 ± 9.7
Scorpionida			
Buthidae: scorpions			
Ceutruroides hentzi (Banks)	32.1 ± 1.2	3.7 ± 0.1	28.4 ± 2.8
(B) Width class II (5–10 mm wide)			
Araneae			
Lycosidae: wolf spiders			
Lycosa spp. (10–20 mm length)	14.2 ± 0.4	5.4 ± 0.2	71.2 ± 5.6
Coleoptera			
Tenebrionidae: darkling beetles			
Polypleurus sp.	13.8 ± 0.2	5.4 ± 0.1	40.2 ± 0.8
Helops sp.	13.3 ± 0.4	5.5 ± 0.2	26.6 ± 2.2
Polopinus youngi Kritsky	19.0 ± 0.3	6.8 ± 0.1	65.0 ± 3.2
Carabidae: ground beetles			
Pasimachus subsulcatus Say	20.6 ± 0.1	8.8 ± 0.1	128.2 ± 3.0
Opiliones			
Sclerosomatidae: daddy longlegs			
Hadrobunus spp.	7.4 ± 0.2	6.6 ± 1.7	23.1 ± 2.1
Orthoptera			
Gryllidae: field and tree crickets			
Gryllus spp.	24.7 ± 0.5	7.1 ± 0.2	183.0 ± 11.3

Table 3 (continued)

Order, family and species	Mean length ($n = 30$) (mm)	Mean maximum width ($n = 30$) (mm)	Mean weight ($n = 30$) (mg)
(B) Width class II (5–10 mm wide)			
Gryllacrididae: camel crickets			
Ceuthophilus spp. (> 20 mm length)	24.0 ± 0.4	7.3 ± 0.2	248.2 ± 12.2
Phasmidae: walkingsticks			
Female *Anisomorpha buprestoides* (Stoll)	68.4 ± 0.6	9.4 ± 0.1	341.7 ± 14.3
Spirobolida			
Spirobolidae: millipedes			
Narceus spp.	106.2 ± 1.9	7.5 ± 0.1	2074.1 ± 63.2
(C) Width class III (> 10 mm wide)			
Araneae			
Lycosidae: wolf spiders	23.3 ± 0.3	10.5 ± 0.3	292.8 ± 10.3
Lycosa spp. (> 20 mm length)			
Coleoptera			
Scarabaeidae: scarab beetles			
Peltotrupes youngi Howden	17.1 ± 0.6	11.0 ± 0.2	104.3 ± 4.1
Strategus antaeus (Drury)	30.5 ± 0.4	17.3 ± 0.4	1468.2 ± 75.3
Carabidae: ground beetles			
Pasimachus strenuus LeConte	35.6 ± 0.3	13.8 ± 0.1	415.8 ± 20.4

into three width classes (WC) based on maximum wet width: less than 5 mm (WCI), 5–10 mm (WCII), and over 10 mm (WCIII). Width classes were chosen to reflect the range of prey circumferences measured from a mid-sized Florida lizard species, *Sceloporus undulatus* (fence lizard) in the field (DeMarco, 1985).

2.3. Data analysis

Analysis of variance (ANOVA) (Statistical Analysis Systems Institute, Inc., 1989) was used to determine differences in the relative abundance and dry mass of total arthropods, individual taxa, and length classes within taxa among treatments. ANOVA was also used to test for differences in relative arthropod abundance and dry mass within width classes among treatments. Samples and treatments were pooled to test for ecosystem-wide differences in arthropod relative abundance and dry weight among the three width classes. Finally, monthly variation in total numbers of arthropods captured and dry mass is described by width class.

3. Results

All disturbance treatments had higher stem density and lower foliar cover and height of *P. c. clausa* than MATURE. BURN, CHOP, and BRACKE also had significantly more bare ground and less leaf litter, nonwoody plant, and shrub cover than MATURE (lichens were the dominant nonwoody plant in MATURE) (Table 2) (see also Greenberg et al., 1995a).

Eight taxonomic orders of ground-dwelling arthropods were commonly captured (Fig. 1). Orthoptera, Coleoptera, Spirobolida, and Araneae were numerically dominant and contributed the greatest proportion of dry mass. Mean length, width, and weight of commonly captured taxa of three width classes are presented in Table 3.

Total arthropod numbers ($F = 1.27$, $P = 0.3472$) and dry weight did not differ among treatments ($F = 0.80$, $P = 0.5291$). However, within WCI there were significantly more individuals ($F = 7.17$, $P = 0.0118$) and higher biomass ($F = 11.18$, $P = 0.0031$) in BURN than in other treatments or MATURE (Fig. 2). This was partly due to significantly more WCI *Ceuthophilus* spp. (Gryllacrididae, $F = 8.11$, $P = 0.0083$) and WCI (male) *A. buprestoides* (Phasmidae, $F = 5.25$, $P = 0.0270$) in BURN (Table 4) than in other treatments or MATURE.

Some taxa exhibited significant differences in abundance among treatments. Significantly more

Table 4
Mean (± SE) number of individuals in three disturbance treatments and mature sand pine scrub, Ocala National Forest, Florida

Order, family and species	Treatment			
	Burn ($n = 3$)	Chop ($n = 3$)	Brache ($n = 3$)	Mature ($n = 3$)
Araneae				
Lycosidae: wolf spiders				
Lycosa spp. (< 10 mm length)	25.7 ± 7.3a	15.0 ± 2.1a	16.0 ± 4.5a	57.3 ± 4.5b
Lycosa spp. (10–20 mm length)	22.0 ± 5.7	30.3 ± 11.3	19.3 ± 6.4	15.0 ± 1.5
Lycosa spp. (> 20 mm length)	17.7 ± 5.2	20.3 ± 10.9	16.3 ± 3.0	18.0 ± 1.5
Coleoptera				
Carabidae: ground beetles				
Pasimachus strenuus LeConte	66.3 ± 5.4	54.3 ± 3.4	69.0 ± 13.0	55.3 ± 12.2
P. subsulcatus Say	29.7 ± 6.6	20.0 ± 6.2	45.3 ± 9.9	30.0 ± 12.5
Scarabaeidae: scarab beetles				
Peltotrupes youngi Howden	7.7 ± 6.7	0.7 ± 0.3	2.0 ± 0.6	9.3 ± 3.3
Strategus antaeus (Drury)	8.0 ± 3.5	5.0 ± 1.0	6.0 ± 1.5	3.7 ± 0.7
Tenebroinidae: darkling beetles				
Helops sp.	10.7 ± 5.2	13.3 ± 10.0	18.7 ± 4.9	0.0 ± 0.0
Polopinus youngi Kritsky	15.7 ± 4.4	17.3 ± 6.7	26.7 ± 13.9	6.0 ± 2.5
Polypleurus sp.	7.3 ± 1.2	3.7 ± 0.9	5.3 ± 0.7	11.3 ± 4.1
Hymenoptera				
Mutillidae: velvet ants				
Dasymutilla occidentalis (L.)	6.33 ± 1.5	6.33 ± 2.4	6.33 ± 2.0	4.33 ± 1.3
Opiliones				
Sclerosomatidae: daddy longlegs				
Eumesosoma spp.	36.7 ± 11.4	22.3 ± 4.4	17.7 ± 7.7	8.0 ± 0.5
Hadrobunus spp.	13.0 ± 1.7a	28.7 ± 12.7a	19.0 ± 1.5a	87.7 ± 29.2b
Orthoptera				
Blattidae: roaches				
Blattidae spp.	26.0 ± 6.6a	43.8 ± 6.7b	23.0 ± 5.0a	16.3 ± 0.3a
Gryllacrididae: camel crickets				
Ceuthophilus spp. (< 10 mm length)	43.3 ± 8.5a	16.3 ± 1.7b	13.7 ± 5.8b	9.0 ± 3.2b
Ceuthophilus spp. (10–20 mm length)	68.7 ± 6.2a	42.3 ± 9.7b	31.0 ± 1.2b	30.3 ± 2.7b
Ceuthophilus spp. (> 20 mm length)	21.7 ± 5.5	22.7 ± 8.1	7.7 ± 2.0	18.0 ± 12.1
Gryllidae: field and tree crickets				
Gryllidae spp.	10.7 ± 0.3a	8.3 ± 1.8a	4.7 ± 0.3b	8.7 ± 1.2a
Gryllus spp.	14.3 ± 1.5	15.7 ± 3.7	14.3 ± 5.4	11.7 ± 4.1
Phasmatidae: walkingsticks				
Anisomorpha buprestoides (Stoll) (male)	56.3 ± 19.4a	7.8 ± 7.0b	11.7 ± 5.4b	3.7 ± 3.2b
A. buprestoides (Stoll) (female)	84.0 ± 17.1a	9.0 ± 8.0b	18.0 ± 8.9b	4.7 ± 4.2b
Scolopendromorpha				
Cryptopidea: centipedes				
Scolopocryptops sexspinosus (Say)	9.7 ± 0.8	11.3 ± 3.8	6.7 ± 1.7	10.3 ± 2.6
Scorpionida				
Buthidae: scorpions				
Ceutruroides hentzi (Banks)	20.3 ± 2.7	34.3 ± 7.3	36.3 ± 3.2	24.0 ± 7.2
Spirobolidae				
Spirobolidae: millipedes				
Narceus spp.	47.0 ± 10.3	86.3 ± 24.0	96.3 ± 36.2	50.0 ± 11.0

Different letters within rows denote significant differences among treatments ($P < 0.05$).

WCI *Lycosa* spp. (Araneae, $F = 15.99$, $P = 0.0010$) and *Hadrobunus* spp. (daddy longlegs) (Opiliones, $F = 4.64$, $P = 0.0368$) occurred in MATURE than in disturbance treatments (Table 4). *Ceuthophilus* spp. (Gryllacrididae, $F = 5.61$, $P = 0.0228$) and *A. buprestoides* (Phasmidae, $F = 8.44$, $P = 0.0073$) were more abundant in BURN than in other treatments. Blattidae spp. (roaches) were significantly more abundant in CHOP than other treatments ($F = 4.82$, $P = 0.0334$), and Gryllidae spp. were more common in BRACKE than other treatments ($F = 5.23$, $P = 0.0273$).

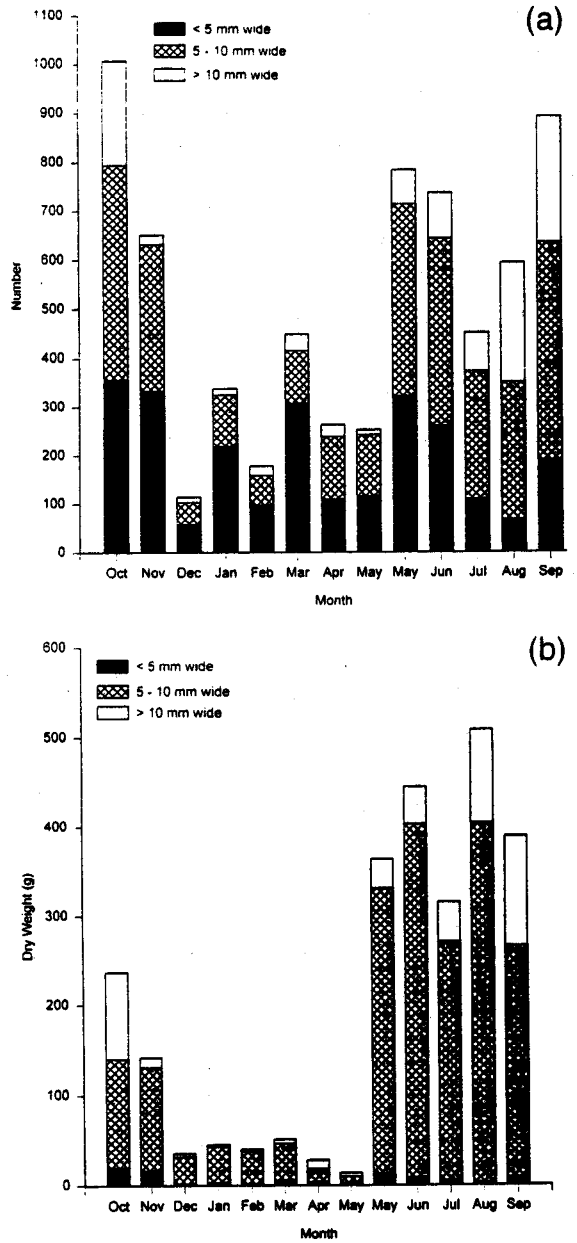

Fig. 3. Pooled ($n = 12$ total samples of four treatments)/ monthly number (a) and biomass (b) of ground-dwelling arthropods in three maximum width classes in sand pine scrub, Ocala National Forest, Florida.

Across treatments, WCI and WCII arthropods were significantly more abundant than WCIII arthropods ($F = 26.32$, $P = 0.0001$) (Fig. 2(a)). However, WCII arthropods contributed significantly more to total biomass than either WCI or WCIII arthropods ($F = 33.95$, $P = 0.0001$) (Fig. 2(b)).

Arthropod biomass and numbers captured were highest from late May through November (Fig. 3). An increase in WCI abundance and dry mass in March was partly due to a rise in capture rates of WCI *Lycosa* spp., WCI *Ceuthophilus* spp., and Blattidae spp. Other taxa deviating noticeably from the pooled seasonal trend were *Eumesosomas* spp. that were most frequently captured in January, and some coleopterans (see Greenberg and Thomas, 1995).

4. Discussion

Our study suggests that silviculturally disturbed, burned and salvaged, and mature sand pine scrub support a similar biomass and abundance of surface-active ground-dwelling arthropods. However, differences in the abundance of some taxa among treatments numerous studies suggest that different taxa and guilds respond differently to unmeasured habitat features related to silvicultural treatment or successional age. Responses are likely due to differences in microclimate, plant productivity or diversity, and habitat structural diversity created by forestry practices (Southwood et al., 1979; Brown and Hyman, 1986; Van Horne and Bader, 1990; McIver et al., 1992; Schowalter, 1995; Theenhaus and Schaefer, 1995). Greater numbers of litter-dwelling *Lycosa* spp. and *Hadrobunus* spp. in MATURE may be attributed to higher percent cover and depth of leaf litter relative to disturbance treatments.

McCoy (1986) suggested that vegetation structure and predation affect abundance of some ground-dwelling beetle populations in Florida sandhills. Plots with dense ground cover contained more individuals of common beetle species and coincidentally fewer individuals of their amphibian and reptilian predators (McCoy, 1986). Pearson and Derr (1986) also reported more predatory tiger beetles co-occurring in a habitat with more individuals and sizes of arthropod prey than other habitats surveyed. However, concurrent herpetofaunal trapping (Greenberg et al., 1994) did not suggest a similar relationship for either coleopterans alone (Greenberg and Thomas, 1995) nor other sampled arthropods.

The abundance and biomass of arthropods of 10 mm or less mean maximum width are expected to be higher than those over 10 mm, given niche availability in relation to size. However, differences in the distribution of some taxa and/or width classes among treatments is difficult to explain. Greater dry mass and relative abundance of WCI (primarily *Ceuthophilus* spp. and *A. buprestoides*) in BURN cannot be attributed to greater shrub cover nor fresh plant growth since BURN sites were 5 years post-burn. Similarly, a biological explanation for greater numbers of Blattidae spp. in CHOP or Gryllidae spp. in BRACKE is not readily apparent. Uneven distribution of population densities across locales may partially explain results.

Although a seasonal trend in total numbers of arthropods captured was apparent, individual taxa exhibited different monthly or seasonal activity patterns (see Greenberg and Thomas, 1995). Other studies have also observed similar inter-taxonomic differences in adult activity periods for eastern forest insects. Increased March captures of WCI *Lycosa* spp. and *Ceuthophilus* spp. may be due to hatchings.

Total monthly numbers of arthropods captured corresponded roughly with periods of highest insectivorous lizard activity (Greenberg et al., 1994). Both arthropods and reptiles tend to be more active during warmer months. High arthropod abundance also coincides with the breeding season for migratory birds when many become primarily insectivorous (Greenberg et al., 1995b). However, in Florida, many birds begin breeding activity as early as March when ground-dwelling arthropod abundance and mass were still relatively low.

It is impossible to generalize on overall relative prey abundance among treatments, since shrub-dwelling and arboreal arthropods were not sampled. Van Horne and Bader (1990) reported greater arthropod prey abundance on shrubs in a forest than a clearcut, but the opposite for ground-dwelling arthropods. However, differences may be important for predators on arthropods that are restricted to ground foraging. Because mouth gape is a constraint on prey size taken, the distribution of prey items among width classes could affect ground-foraging predators. We are aware that all arthropods within width classes are not equally available for consumption nor do they provide the same energy content per unit weight. Differences in defense strategy (e.g. cryptic coloration or behavior, body size, chemical, or physical defense) affect their vulnerability to predation, and differences in digestibility affect the energy content of each arthropod taxa. Future studies addressing prey availability, selection and digestibility would contribute to the understanding of forest management in relation to predators and their arthropod prey.

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