Distribution of a Costa Rican Wet Forest Velvet Worm (Onychophora: Peripatidae)

T. P. MCGLYNN[1] AND C. D. KELLEY[2]

Ann. Entomol. Soc. Am. 92(1): 53–55 (1999)

ABSTRACT The ecology of New World onychophorans is poorly known because individuals are rare and difficult to locate in the field. The only descriptions of density and microhabitat associations are based on the field observations of a few individuals. This paper presents the results of a 300-m^2 search of leaf litter in a wet tropical forest at La Selva Biological Station, Republic of Costa Rica, during the dry season over a period of 4 mo. Density of this *Epiperipatus* sp. was 0.11 individuals per square meter. The age structure of the population was biased toward juveniles, but did not include newly born onychophorans; this suggests that reproduction occurs during the wet season. *Epiperipatus* sp. nonrandomly selects microhabitats. It is strikingly associated with ants; 1-m^2 plots containing onychophorans contained a mean of 7.4 ant nests, whereas plots without onychophorans had a mean of only 4.7 ant nests. In 2 instances, onychophorans were located inside large and active ant nests.

KEY WORDS *Epiperipatus*, microhabitat, ants, leaf litter

THE PHYLOGENY AND historical biogeography of the phylum Onychophora are important to invertebrate systematists because of many traits shared with arthropods and annelids (Monge-Najera 1995). Nonetheless, the basic natural history of this phylum is relatively mysterious (but see Read and Hughes 1987, Monge-Najera and Morera 1994, Monge-Najera 1995, New 1995). Field observations are necessary for the conservation of most members of the phylum, which are rare and distributed within narrow geographic boundaries (New 1995). Because these animals are so rare in the Neotropics, we know little about their basic life history and ecology.

The few ecological studies of onychophorans focus on the family Peripatopisdae in Australia and Southeast Asia (e.g., Leishman and Eldridge 1990, Mesibov and Ruhberg 1991, Scott and Rowell 1991). The only records of population age structure, density, and microhabitat associations for New World velvet worms of the family Peripatidae are based on a search of 16 m^2 in Costa Rica, and personal communications included in the same article (Monge-Najera and Alfaro 1995).

This study is a result of the discovery of onychophorans during an investigation of leaf litter ant community ecology. We searched for onychophorans over 4 mo. Velvet worms are nocturnally active and hide in twigs, leaf litter, and inside logs during the day. Because leaf litter ants inhabit this microhabitat in addition to Onychophora (Byrne 1994, Kaspari 1996), they may compete both for prey and nest space. We present the density, size distribution, and microhabitat selection of *Epiperipatus* sp. in a tropical wet forest in Costa Rica. This undescribed species will be described later by Julian Monge-Najera of the University of Costa Rica (J. Monge-Najera, personal communication.

Materials and Methods

La Selva Biological Station, Heredia Province, Sarapiquí Canton, is in the Caribbean lowlands of Costa Rica and receives ≈4 m of rainfall yearly (McDade and Hartshorn 1994). The study period was January–May 1997, the dry season.

Using Geographic Information System (GIS) data on soil type at La Selva, an upper terrace inceptisol was selected for the creation of 300 plots, each 1 m^2. These plots were located within grids (10 × 5 m) in 3 ha of old-growth forest near the intersection of the Camino Circular Cercano and Sendero Suroeste on the La Selva trail system. Using the La Selva GIS, the field site was bounded by the the 1100 and 1300 lines on the 32° axis and the 600 and 800 lines on the 122° axis. The plots were collected at a rate of at least 15 plots per week.

We measured several microhabitat characteristics for every plot that was searched. The percentage of understory cover under 1 m was estimated, and canopy cover above 1 m was measured with a spherical densiometer. Using a wire inserted into the litter at 8 points within each plot, we measured litter depth (see Kaspari 1996). We counted the number of palms and the number of leaf litter ant nests within each plot. We also measured the distance to the closest canopy tree (>20 m in height) and the nearest treefall.

We brought all matter resting on the ground into the laboratory in plastic bags, and searched intensively for

[1] Environmental, Population, and Organismic Biology, University of Colorado, Boulder, CO 80309–0334.
[2] Department of Biology, Department Box 1152, Maharishi University of Management, Fairfield, IA 52557.

all ant colonies and onychophorans. All litter was examined; curled leaves were opened, and twigs, sticks, pieces of wood, bark, petioles, nuts, and seed pods were broken open. Because the smallest onychophoran is larger than most leaf litter ant colonies (colony volumes are usually <10 ml), no individuals passed undetected in the leaf litter collected. Although some of the plots contained treatments of food addition or litter reduction to study ant communities, *Epiperipatus* sp. inhabited all the plot types with equivalent frequencies.

Once an onychophoran was discovered, its weight was measured to 0.01 g on an electronic balance. We measured weight before release of adhesive secretion, except for 1 stressed individual. Length was measured while the animal was moving by the following method: a mark on a piece of paper was drawn, and the worm was placed to walk near the line. When the mark was positioned at one end of the straight animal, the paper under the other end of the animal was marked, and the the distance between the 2 marks was measured to 1-mm accuracy. Although onychophorans can walk when they are not at full extension, we measured individuals only when they appeared to be at full extension. Voucher specimens were deposited at the University of Costa Rica and University of Colorado Museum. All individuals collected were conspecific, and there are no reports of other onychophoran species occurring at the field station. The onychophoran was identified to genus using an SEM of the dorsal surface of a worm. Except for the voucher specimens, all individuals were returned to the same type of forest where they were found, far enough away to prevent recollection of individuals.

Results

Thirty-three individuals were located within a total of 300 1-m^2 plots, yielding a density of 0.11 individuals per square meter. Two plots contained >1 onychophoran; 1 plot contained 2 wrapped around one another in a twig, and another contained 3 together in a large curled up leaf. Otherwise, the remaining animals were found alone. The mean weight of individuals was 0.37 ± 0.009 g (mean ± SE), ranging from 0.06 to 1.87 g. The length of live animals walking at extension was 41.8 ± 3.25 mm, ranging from 23 to 82 mm. Because in our study all individuals were located by exhaustive search, the natural size distribution of *Epiperipatus* sp. is provided (Fig. 1).

The associations of *Epiperipatus* sp. with microhabitat characteristics are summarized in Table 1. Our measures of biotic components in plots containing onychophorans indicate a positive association with both ants and understory plants. Soil pH within 8 randomly selected plots containing onychophorans ranged from 3.82 to 4.49, with an average of 4.16.

Discussion

Three main conclusions may be drawn from our discoveries of onychophorans. First, we have an accurate density estimate for field populations of *Epiperipatus* sp. Second, the age structure of field populations sampled in the dry season suggests that reproduction occurs during the wet season. Third, onychophorans have preferred microhabitats for resting in the daytime, including a strong positive association with leaf litter ant nests.

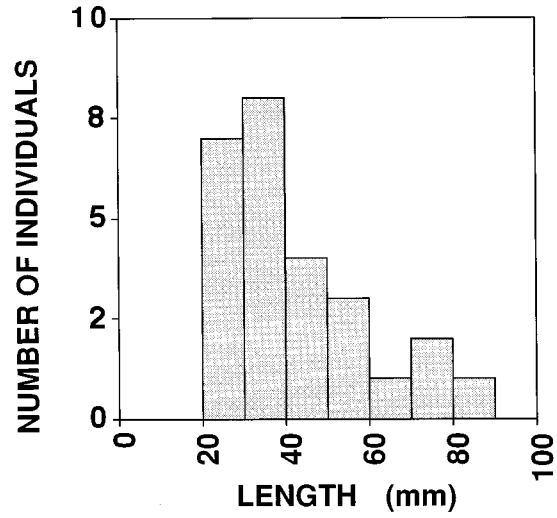

Fig. 1. The size distribution of field-collected *Epiperipatus* sp. at La Selva Biological Station, Costa Rica. Because weight and length are allometrically associated (logarithms of weight and length, $r^2 = 0.83$), only length is presented graphically.

Previous estimates of onychophoran densities in other wet forests, based on personal communications from researchers in the Neotropics and Southeast Asia, range from 2 to 100 times greater than that discovered in the current research (Monge-Najera and Alfaro 1995). Our lower density value may more accurately reflect onychophoran densities throughout the entire forest. Because our randomly selected plots did not overlap with many rotten logs, a potentially preferred habitat, this may account for our low density estimate.

All current knowledge about reproduction and life histories of Neotropical onychophorans comes from laboratory studies of individuals reared in captivity or captured from the wild. The following inferences are from our field collections: (1) no individuals were <23 mm, which is larger than newborn individuals. This suggests that no reproduction occurred during the period of our field study. However, most individuals in our study were less than adult size and were probably born within the past year; (2) the large number of juveniles, and the absence of newborns, suggest that reproduction in this population was in the wet season before the study period. Onychophorans do not grow quickly, and do not reach reproductive maturity in a single season (Monge-Najera 1995).

Experienced collectors of onychophorans avoid areas which have increased numbers of ants because onychophorans and ants are thought to be negatively

Table 1. Microhabitat associations of *Epiperipatus* sp. in 1-m^2 plots of leaf litter at La Selva Biological Station, Costa Rica

Microhabitat	Plots with *Epiperipatus* sp. (n = 30)	Plots without *Epiperipatus* sp. (n = 270)	t^a	P
Depth of leaf litter in plot, mm	19.07 ± 0.59	20.67 ± 1.46	−0.87	NS
Distance to canopy trees, m	4.87 ± 0.24	3.87 ± 0.44	1.36	NS
Distance to nearest treefall, m	3.30 ± 0.20	3.82 ± 0.53	−0.83	NS
No. ant nests	4.73 ± 0.24	7.37 ± 0.93	−3.45	<0.001
% cover by understory plants under 1 m	27.5 ± 1.32	37.67 ± 4.85	−2.37	<0.05
No. palm stems in plot	0.96 ± 0.10	1.47 ± 0.50	−1.46	NS
% cover by plant canopy over above 1 m	96.63 ± 0.07	96.64 ± 0.18	−0.04	NS

[a] Student t-tests compared all plots that contained and those that lacked onychophorans; NS, not signficant.

associated (J. Monge-Najera, personal communication). However, we found that the diurnal rest areas of Onychophora and the leaf litter nests of ants are positively associated. The association with ants is the result of an increase in the depth of leaf litter (Table 1). Perhaps there are more habitat sites for onychophorans in areas with greater nest site availability for ants. We did not attempt to quantify which twigs, leaves, and pieces of wood were suitable for habitation; however, nest site availability is less important to ants than disturbance and food availability (Byrne 1994). Although little is known about onychophoran prey selection in Costa Rica, these animals probably feed on collembolans and isopods, which ants also eat (Monge-Najera, personal communication). Because resources for predators such as ants and Onychophora may be highly variable down to the scale of 1 square meter (Kaspari 1996), they may share the same sites because of localized concentrations of food availability. In addition to the striking association with leaf litter ants, *Epiperipatus* sp. occurred in sites with significantly more plant cover in the understory. The increased understory cover could be associated with an increase in prey density, or perhaps with a more humid microclimate.

Twice, individuals were inside ant nests. In the 1st case, a single individual was inside a large twig with a colony of an undescribed *Pheidole* species. In the 2nd, 2 large individuals were twisted together inside a fallen bromeliad leaf which contained a large nest of a 2nd *Pheidole* species. The ants appeared to ignore the onychophorans, although they were crawling all over the individual in the same way they walked around the inside of their nesting material. According to Byrne (1994) and Kaspari (1996), leaf litter ants frequently use hollow twigs as nest sites but also occur in rolled leaves, pieces of wood or bark, nuts, and seed pods. These litter components are similar to the areas inhabited by *Epiperipatus* sp. in our searches. Because nest sites do not limit the leaf litter ant community, ants and onychophorans would not be located together in the same twig as a result of the scarcity of twigs in a given site in the forest.

Acknowledgments

J. Monge-Najera was of great assistance in identification of the onychophorans. We offer many thanks to C. Meloche for patient support with scanning electron microscopy. M. Springer, E. F. Arnold, B. Bascomb, and L. Rowland assisted with field work. M. Breed, A. Chapman, S. James, J. Longino, J. Monge-Najera, and C. W. Schaefer kindly reviewed drafts of the manuscript. This work was supported by grants from the Organization for Tropical Studies and the Andrew Mellon Foundation to T.P.M.

References Cited

Byrne, M. M. 1994. Ecology of twig-dwelling ants in a wet lowland tropical forest. Biotropica 26: 61–72.

Kaspari, M. 1996. Litter ant patchiness at the 1-m^2 scale: disturbance dynamics in three Neotropical forests. Oecologia (Berl.) 107: 265–273.

Leishman, M. R., and M.D.B. Eldridge. 1990. Life history characteristics of two sympatric onychophoran species from the Blue Mountains, New South Wales. Proc. Linn. Soc. N.S.W. 112: 175–185.

McDade L. A., and G. S. Hartshorn. 1994. La Selva Biological Station, pp. 6–14. *In* L. A. McDade, K. S. Bawa, H. A. Hespenheide, and G. S. Hartshorn [eds.], La Selva: ecology and natural history of a neotropical rain forest. University of Chicago Press, Chicago.

Mesibov, R., and H. Ruhberg. 1991. Ecology and conservation of *Tasmanipatus barretti* and *T. anophthalmus*, parapatric onychophorans (Onychophora: Peripatopsidae) from northeastern Tasmania. Pap. Proc. R. Soc. Tasman. 125: 11–16.

Monge-Najera, J. 1995. Phylogeny, biogeography, and reproductive trends in the Onychophora. Zool. J. Linn. Soc. 114: 21–60.

Monge-Najera, J., and J. P. Alfaro. 1995. Geographic variation of habitats in Costa Rican velvet worms (Onychophora: Peripatidae). Biogeographica 71: 97–108.

Monge-Najera, J., and B. Morera. 1994. Morphological and physiological characteristics of two species of *Epiperipatus* from Costa Rica (Onychophora: Peripatidae). Rev. Biol. Trop. 42: 181–188.

New, T. R. 1995. Onychophora in invertebrate conservation: priorities, practice, and prospects. Zool. J. Linn. Soc. 114: 77–89.

Read, V. M. St. J., and R. N. Hughes. 1987. Feeding behaviour and prey choice in *Macroperipatus torquatus* (Onychophora). Proc. R. Soc. Lond. Ser. B Biol. Sci. 230: 483–506.

Scott, I.A.W., and D. M. Rowell. 1991. Population biology of *Euperipatoides leuckartii* (Onychophora: Peripatopsidae). Aust. J. Zool. 39: 499–508.

Received for publication 26 December 1997; accepted 20 August 1998.