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**A BIOGEOGRAPHICAL STUDY OF CURRENTLY IDENTIFIED OREGON PSEUDOSCORPIONS
WITH AN EMPHASIS ON WESTERN OREGON FORMS**

by

ELLEN MARING BENEDICT

**A dissertation submitted in partial fulfillment of the
requirements for the degree of**

DOCTOR OF PHILOSOPHY

in

ENVIRONMENTAL SCIENCES AND RESOURCES--BIOLOGY

Portland State University

1978

TO THE OFFICE OF GRADUATE STUDIES AND RESEARCH:

The members of the Committee approve the dissertation of
Ellen Maring Benedict presented May 16, 1978.

David R. Malcolm, Chairman

Richard B. Forbes

Earl Rosenwinkel

Leonard Simpson

Carl Bachhuber

Alfred Levinson

APPROVED:

W. Herman Taylor, Head, Department of Biology

Stanley E. Rauch, Dean, Graduate Studies and Research

AN ABSTRACT OF THE DISSERTATION OF Ellen Maring Benedict for the Doctor
of Philosophy in Environmental Sciences and Resources-Biology presented
May 16, 1978.

Title: A Biogeographical Study of Currently Identified Oregon
Pseudoscorpions with an Emphasis on Western Oregon Forms.

APPROVED BY MEMBERS OF THE DISSERTATION COMMITTEE:

David R. Malcolm, Chairman

Richard B. Forbes

Earl Rosenwinkel

Leonard Simpson

Carl Bachhuber

Alfred Levinson

The biogeography of the 50 currently identified Oregon species is reported from analyses of data from 2220 Berlese samples collected in a stratified, extensive sampling procedure, and from collection data on several hundred specimens from major private and public collections of pseudoscorpions. Individual species accounts including maps and data relating to geographical and seasonal distribution and habitats are provided, distributional areas and habitat types are categorized, dispersal mechanisms including examples of phoresy are presented and an illustrated key to Oregon species is given.

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INTRODUCTION

Although Americans are gradually becoming aware of the complex interactions of macroscopic terrestrial and aquatic organisms, similar attention has yet to focus upon the millions of tiny organisms of the soil and related cryptozoic habitats (van der Drift 1951; Kuhnelt 1961; Savory 1966, 1968; Burges & Raw 1967; Schaller 1968; Wallwork 1970, 1976). Though not rare, tiny soil animals are often overlooked owing to their cryptic habits. So few basic studies exist, in fact, that it is often necessary to conduct taxonomic and pedological investigations before ecological studies can profitably be initiated (di Castri 1970; van der Drift 1970).

PSEUDOSCORPIONS AS CRYPTOZOANS

As with many other cryptozoans, very little is known about the ecology of the nearly 2000 currently described species and subspecies of pseudoscorpions (Chamberlin & Malcolm 1960). These tiny predators occur in a wide diversity of habitats including mosses, leaf litter, soil, decomposing wood, bark, animal nests, domestic animal litter, human habitations and caves (Weygoldt 1969; Muchmore 1973). As a result of their size (body length 1-7 mm) and their tendencies to retreat into crevices, pseudoscorpions are generally not seen. Yet, in favorable habitats, they occur in fairly high densities (Ressl & Beier 1958; Gabbutt & Vachon 1963; Gabbutt 1967, 1970). Unfortunately, the determination of individuals to species requires tedious microscope techniques (Chamberlin 1931; Hoff 1949; Lawson 1968; Nelson 1971). This has

tended to discourage the study of pseudoscorpions; consequently, there are few specialists with adequate knowledge to identify specimens. As a result there are many undescribed or incompletely described species, a fact which contributes to the paucity of ecological studies, including biogeographical investigations of North American species.

Pseudoscorpion faunal studies of large areas of the United States are few in number. Hoff (1958) categorized approximately 160 species from the United States and Canada according to systematic hierarchies and to political subdivision (state or province) of reported localities, but did not include habitat data. Ordinal works with habitat data have been prepared for limited areas or selected habitats of the southeastern states (Lawson 1968), Michigan (Nelson 1975), Illinois (Hoff 1949), New Mexico (Hoff 1959), and Colorado (Hoff 1961), but not for the Pacific Northwest.

Therefore, in 1971 a biogeographical study was initiated in the Pacific Northwest. Oregon was selected as the study area because the topography, climate and biotic communities were especially diverse (Franklin & Dyrness 1973) and it appeared that the pseudoscorpion fauna would be equally diverse. Prior to the study, only 13 species from three families were recognized from Oregon; currently 50 species from nine families are identified from the state (Banks 1895; Chamberlin 1929a, 1930, 1952, 1962; Hoff 1950; Malcolm & Chamberlin 1961; Schuster 1966a; Muchmore 1968, 1975a; Benedict & Malcolm 1970, 1973, 1977, 1978a, 1978b, 1978c; Benedict 1977, 1978a, 1978b).

This dissertation is a report of this biogeographical investigation and contains individual species accounts, analyses of distributional areas and habitats, and records of phoresy. Appendix I provides

an Oregon map with county names, Appendix II a map with vegetation zones, Appendix III a generalized diagram of pseudoscorpion body form, and Appendix IV an illustrated key to species. For background on Oregon geology, refer to Baldwin (1976) and McKee (1972), on geography to Dicken (1973) and Loy et al. (1976), and on plant names to Peck (1961) and Hitchcock & Cronquist (1973).

ENVIRONMENTAL IMPLICATIONS OF THIS STUDY

This study provides valuable information not only to specialists of cryptozoan taxa and to soil ecologists, but to monitors assessing the effects of various environmental contaminants in forest and brushlands of Oregon. Pseudoscorpions function as tertiary predators (Cloudsley-Thompson 1958) in cryptozoan environments and, as such, are significant in the enormously complex, dynamic activities involved in soil fertility processes (Edwards et al. 1970; Cromack et al. 1977; Crossley 1977; McBrayer 1977; Webb 1977). As noted at the 1967 Paris Symposium on Methods of Study in Soil Ecology (Phillipson 1970), it is practically impossible to understand interactions of species unless individuals can be identified. This study provides the means by which a number of Oregon pseudoscorpion species can be identified, not only by reference to the key (Appendix IV) but by knowledge of their habitats and distribution.

A growing concern is beginning to be expressed about the need for study of the effects of human activities on cryptozoans (Wallwork 1976). Poulson and Kane (1977), in their discussion of ecological diversity and stability, observed that disturbances have multiple effects and are likely to disrupt an ecosystem more than expected. Manley (1969) and Wallwork

(1976) emphasize that cryptozoans including pseudoscorpions must be studied if nutrient cycles and pesticide interactions in soil ecosystems are to be understood. Such interactions are not well-studied in forest habitats (Edwards et al. 1970; Mattson 1977), especially in the western United States. Nor is it really possible to achieve much understanding of the interactions of individual species until more of them become known.

A case in point is the 1974 DDT Tussock Moth Monitoring Program in the Wallowa-Whitman National Forest in northeastern Oregon; the study included a crude census of soil animals in relation to levels of DDT residues (Westgarth 1975). Since the type of data accumulated in the current biogeographical study had not been gathered for northeastern Oregon, it was not possible to identify soil animals to species, nor to design an effective, efficient and low-cost monitoring procedure from available information. Despite the inadequacies of this pioneering monitoring effort in the Pacific Northwest, analysis of data appeared to indicate that densities of the two pseudoscorpion species decreased in the presence of high DDT residue levels (Gruber & Benedict 1978). This may be significant in view of the fact that pseudoscorpions are predators of other cryptozoans, and are considered important in soil arthropod population dynamics, food chain interactions and humification-fertility processes (Manley 1969).

METHODS AND MATERIALS

Data for this study were obtained from three basic sources: specimens newly-collected since 1971 from habitats of both randomly and non-randomly selected townships of Oregon, specimens from previously existing private and public collections (see acknowledgments), and specimens reported in the literature.

SAMPLING PROCEDURE

Oregon's size (251,000 km²) required that a system for selecting sampling sites be developed. For this purpose, Oregon was arbitrarily divided into two portions: western Oregon (area west of the crest of the Cascade Mountains) and eastern Oregon (east of Cascade crest). Western Oregon was further stratified into 45 units of approximately 20 townships each (Map 1). Within one or two randomly selected townships in each unit, samples were collected from each habitat type (if present) listed in Table I; 1093 samples were thus collected. In addition, 637 samples were judgmentally collected from similar or special habitats (e.g., serpentine soil, redwood litter, bogs) in non-randomly selected townships. Eastern Oregon (Map 2) samples were entirely judgmental and therefore from non-randomly selected townships. Over 2200 Berlese samples from Oregon habitats (Table I) were collected, processed and sorted during the course of this investigation. Pseudoscorpions were recovered from approximately 1400 of the 1730 samples from western Oregon and from approximately 250 of the 490 samples from eastern Oregon. This is the first major investigation

Map 1. Western Oregon, showing the 45 stratified sample units of approximately 20 townships each.

Map 2. Oregon, showing locations of eastern Oregon collections.

of North American pseudoscorpions which has included stratified random sampling in an area as large as western Oregon (75,000 km²).

TABLE I
COMMON HABITATS SAMPLED

Woody plant litter	Bark
Deciduous	Living trees
Coniferous	Snags
Sclerophyllous	Stumps
	Logs
Epiphytes	Rotted wood
On rocks	Tree hollows
On trees	Snags
On logs	Stumps
	Logs
Caves	Animal Nests
Under or on rocks	Domestic animal shelters
Under boards	Human habitations

Preliminary experiments with various samplers of different types and sizes were conducted, as the style used must be determined by the type and uniformity of substrate, the density of organisms and by convenience. Corers and shovels were found to be impractical with materials as diverse as leaf litter, slabs of bark from rotted logs and mosses from tree trunks. Therefore for the purposes of this study, a "sample" was the amount of material gathered by handfuls from a specific micro-habitat (e.g., mosses from a single rock, rotted wood from a single log) to fill a plastic bag, 28 x 15 x 45 cm in size. The preliminary experiments revealed that this amount of material from Oregon habitats was

generally large enough to contain pseudoscorpions if they occurred, and yet was small enough to handle conveniently along with 20 or more similar bags of materials from a single collecting trip.

PREPARATION AND DEPOSITION OF SPECIMENS

Organisms from samples were heat-extracted for three or four days in 30 cm diameter, controlled draft Berlese funnels (Wallwork 1970) fitted with 25-watt light bulbs. Pseudoscorpions were (according to systematic status of the taxon) either dissected, mounted on microslides in Hoyer's medium and measured (Chamberlin 1931; Benedict & Malcolm 1977), or preserved in alcohol and identified under a stereomicroscope. Pseudoscorpions are deposited in a reference collection of the American Museum of Natural History and in the Benedict-Chamberlin-Malcolm Collection.

Numerous other cryptozoans were extracted in the Berlese residues and have been sent to the following specialists: Chilopoda to Andrew Weaver (College of Wooster); Diplopoda and Opiliones to William Shear (Hampden-Sydney College); Coleoptera to Stewart Peck (Carleton College), Robert Schuster (University of California at Davis), Loren Russell (Oregon State University), and the Canadian Museum; Araneida, in part, to Herbert Levi (Museum of Comparative Zoology, Harvard) and Willis Gertsch (Portal, Arizona); Acari, in part, to G.W. Krantz (Oregon State University); unsorted organisms to the Field Museum of Natural History. From these specimens, a number of range extensions into Oregon and new species have already been described (Gertsch 1973; Shear 1973, 1974, 1975).

SPECIES ACCOUNTS OF OREGON PSEUDOSCORPIONS

When this study began in 1971, only 13 species of three families were reported from Oregon; Maps 3-6 show Oregon localities reported prior to 1971. Banks (1895) reported the first two species, Microcreagris theveneti (Simon) from Portland and Astoria (Map 5) and Parachelifer scabriculus (Simon) from Hood River (Map 6). Collidge (1908) included only these two species from Oregon in his list of North American species. The third species, Apochthonius occidentalis Chamberlin (Map 3), has the distinction of being the first species to be described with an Oregon type locality (Chamberlin 1929a). Parobisium hesperum (Chamberlin) from Cannon Beach (Map 5) was the second species described with an Oregon type locality (Chamberlin 1930). In the same paper, Chamberlin (1930) also reported Microcreagris cingara Chamberlin from Lane County (Map 5), although Hoff (1958) later considered it to be a doubtful species for Oregon. In the 1950's, Hoff (1950) reported the cosmopolitan species Chelifer cancroides (L.) from two Oregon counties (Map 6), and Chamberlin (1952) reported Haplo-chelifer philipi (Chamberlin) from four Oregon counties (Map 6).

When Hoff (1958) published his list of North American species these records were the only ones reported from Oregon. Oregon species were so little known that Hoff included only one among the seven species listed from Washington, two among the five from Idaho, two among the three from Nevada, and four among the 49 from California. Of these, C. cancroides and H. philipi were known from all but Washington.

Map 3. Reported Oregon localities of heterosphyronid species prior to 1970; Anochthonius occidentalis ○, Chthonius oregonicus □, Kleptochthonius geophilus Δ, K. oregonus ▲, Pseudotyrannochthonius incognitus ●, P. newelli ○.

Map 4. Oregon localities reported by Benedict & Malcolm (1970) for Pseudotyrannochthonius incognitus (P. newelli, junior synonym) ●.

Map 5. Reported Oregon localities of diplosphyronid species prior to 1971: Microcreagris cingara ■ , M. columbiana ○ , M. theveneti ● , Parobisium charlotteae ● , P. hesperum ○ .

Map 6. Reported Oregon localities of monosphyronid species prior to 1971: Chelifer cancroides ■ , Haplochelifer philipi ▲ , Parachelifer scabriculus ● .

During the 1960's, seven additional species were described with Oregon type localities (Maps 3-6): Kleptochthonius (Kleptochthonius) oregonus Malcolm and Chamberlin (1961), K. (K.) geophilis Malcolm and Chamberlin (1961), Parobisium charlotteae Chamberlin (1962), M. columbiana Chamberlin (1962), Pseudotyrannochthonius incognitus (Schuster) (1966a), P. newelli Muchmore (1967a) and Chthonius (Hesperochthonius) oregonicus Muchmore (1968). In 1970, Benedict and Malcolm recognized P. newelli as a junior synonym of P. incognitus and reported the species from more than 30 Oregon localities (Map 4).

My cursory examination in 1971 of Oregon specimens from the Chamberlin-Malcolm Collection indicated that the Oregon fauna would probably consist of approximately 30 species when all specimens were identified. This estimate was consistent with the number of species listed at that time for other areas: 49 species from California (Hoff 1958), 39 from New Mexico (Hoff 1959), 30 from Colorado (Hoff 1961), 26 from Illinois (Hoff 1949), 29 from Michigan (Nelson 1971), and 18 from leaf litter habitats of the southeastern states (Lawson 1968). The analyses since 1971 of Oregon specimens from all sources have revealed at least twice the expected number of species.

The exact number of Oregon species is unknown at the present time as most Oregon localities have not been intensively sampled nor have all the collected specimens been determined to species. In order to identify most Oregon species, it has been necessary to examine and measure the type series and often hundreds of other specimens from many states (Benedict & Malcolm 1970, 1973, 1974, 1978a, 1978b, 1978c, 1978d; Muchmore & Benedict 1976; Benedict 1977, 1978a, 1978b). Consequently,

considerable systematic work involving Oregon taxa remains. Several "species", even though distinct taxa, can be discussed only under generic names. Approximately 12 species of the superfamily Neobisioidea present systematic problems beyond the scope of this study, and cannot be treated under separate species accounts. Despite systematic difficulties, 21 species have been reported from Oregon since 1971 (Benedict & Malcolm 1973, 1977, 1978a, 1978b, 1978c; Muchmore 1975a; Benedict 1977, 1978a, 1978b) as a direct result of this study. Sixteen additional species are being reported for the first time in this work, bringing the total identified species from Oregon to 50.

The following species accounts include available data on geographical distribution, habitats, seasonal distribution and comments about systematic aspects of taxa. Manley's (1969) precedent for Michigan species is followed in listing months during which adults and/or nymphs were collected. For most taxa insufficient data exist to draw conclusions about seasonal distribution of life stages. Thus, it should not be assumed that adults or nymphs are absent during unlisted months for which collections may be lacking.

ORDER PSEUDOSCORPIONIDA (CHELONETHIDA)

This arachnid order includes approximately 2000 described species and subspecies (Chamberlin & Malcolm 1960; Savory 1964). These species have been assigned to three suborders and 20 families (Chamberlin 1931; Beier 1932a, 1932b; Weygoldt 1969) distributed throughout the world. Fifty species are identified from Oregon.

SUBORDER HETEROSPHYRONIDA Chamberlin 1929

This suborder is represented in the United States by two families, Tridenchthoniidae Balzan and Chthoniidae Hansen, both of the superfamily Chthonioidea Chamberlin.

SUPERFAMILY CHTHONIOIDEA Chamberlin 1929

Only the family Chthoniidae is reported from Oregon.

FAMILY CHTHONIIDAE Hansen 1893

Chthoniids (Fig. 1), assigned to more than 35 genera throughout the world and represented by eight genera in Oregon (Maps 7-14), are cosmopolitan in distribution except for the extreme northern and southern latitudes (Chamberlin 1931). Chthoniids, as inhabitants of moist soil and litter, are probably the most common pseudoscorpions in western Oregon, both in terms of numbers of animals and of species. This, no doubt, is related to the number of relatively moist habitats in the extensive forests, woodlands and brushlands. Prior to 1971, only five of the currently recognized chthoniid species were reported from Oregon (Maps 3-6): Apochthonius occidentalis (Fig. 1), Kleptochthonius oregonus, K. geophilus, Pseudotyrannochthonius incognitus and Chthonius oregonicus. Eleven additional chthoniid species have been identified as a result of this study. These 16 species, discussed under the species accounts below, are separable by the characters in the key.

Apochthonius Chamberlin 1929

Although a specimen of A. occidentalis was collected in Oregon as

Figure 1. Apochthonius occidentalis Chamberlin, a common leaf litter-inhabiting chthoniid species from western Oregon. (Body length 1-2 mm).

early as 1921 (Chamberlin 1929a) and specimens of Apochthonius occur in nearly every western Oregon leaf litter sample (at elevations 0-1200 m), this genus was reported previously from Oregon from fewer than two dozen specimens (Chamberlin 1929a; Benedict & Malcolm 1973; Benedict 1978b). This situation stems not from low population densities as suggested by Schuster (1966b) but from an impasse resulting from inadequate species descriptions, poor preparation of certain type specimens, and a lack of data concerning intraspecific and interspecific variations. Even though recent studies (Benedict & Malcolm 1973; Muchmore & Benedict 1976; Muchmore 1967b, 1976) solved several systematic problems, most non-cavernicolous species of Apochthonius need redescribing. At the present time, four species can be reported from Oregon.

Apochthonius forbesi Benedict (in press)

Geographical distribution. Oregon (Map 7). This species is known only from the sink in which Charcoal Cave No. I is located. The sink, approximately 10 m deep by 25 m wide and 45 m long, is one of a series of collapsed segments of the Arnold Lavatube System (Greeley 1971).

Habitat. Leaf litter. A. forbesi inhabits the moss-litter layer beneath mountain spray (Holodiscus dumosus (Hook.) Heller) and squaw currant (Ribes cereum Dougl.), which grow on the floor of Charcoal Sink. Interestingly, not only do the semi-mesic sinks of the Arnold System contain different shrub species than the surface above, but different pseudoscorpion species were collected from the two levels. A. forbesi and Syarinus sp. inhabit the sink, while Dactylochelifer silvestris Hoff and Haplochelifer philipi inhabit the semi-xeric litter beneath ponderosa pine (Pinus ponderosa (Dougl. ex. Loud.)) and green manzanita

Map 7. Distribution in Oregon: *Apochthonius forbesi* ○ ,
A. malheuri ■ , *A. minimus* ● .

Map 8. Distribution in Oregon: *Apochthonius occidentalis* ● .

(Arctostaphylos patula Greene) of the surface. The area, located at an elevation of 1385 m, receives an average annual precipitation of about 320 mm and is ectonal between open stands of ponderosa pine forest and sagebrush (Artemisia spp.) shrub-grasslands (Franklin & Dyrness 1973).

Seasonal distribution. Oregon adults of A. forbesi were collected in June; nymphs are unknown.

Remarks. See Benedict (1978b) for a detailed description of this species. Although the total specialization of A. forbesi for subterranean existence is not as marked as that observed for many cavernicolous species of the genus (e.g., A. malheuri Benedict & Malcolm), it is still apparent. In contrast to other Oregon leaf litter species of the genus, A. forbesi has somewhat less pigment and/or thinner cuticle, weaker eyes, slimmer appendages and greater size.

Apochthonius malheuri Benedict & Malcolm 1973

Geographical distribution. Oregon (Map 7). This species is known only from Malheur Cave, a unitary lavatube nearly 1000 m in length, which is located in semi-arid Harney County at an elevation of 1220 m.

Habitat. Cave. Specimens were recovered from well-rotted wood and debris removed from crevices and undersurfaces of rocks in the humid deep Twilight to True Dark Zones (Howarth 1973) between 200 and 365 m downtube from the entrance (Benedict & Malcolm 1973). Malheur Cave is unusual among lavatubes of the Pacific Northwest in that it contains a cool-thermal lake (Palmer 1975) with a maximum measured depth of 7 m. Consequently, the cave is up to 10°C warmer in the True Dark Zone (Benedict et al. 1977) than the expected temperature of 7.8°C,

the average annual temperature of the area. The area averaged 290 mm of precipitation annually.

Seasonal distribution. Oregon adults were collected in August and September, nymphs of all three stages in September and October.

Remarks. See Benedict and Malcolm (1973) for a detailed description of A. malheuri. This is the first species of Apochthonius reported from a cave west of Missouri and Arkansas. It exhibits typical troglobitic modifications (Chamberlin & Malcolm 1960) of attenuation, giantism, depletion of pigment and loss of photoreceptors (Benedict & Malcolm 1973). Malheur Cave also contains three apparently endemic, aquatic, cavernicolous invertebrate species: the flatworm Kenkia rhychida Hyman, the amphipod Stygobromus hubbsi Shoemaker and an undescribed isopod of the genus Asellus (L. Fleming, pers. comm.).

Apochthonius minimus Schuster 1966

Geographical distribution. Oregon (Map 7), Washington. This species was reported previously from two localities: the Olympic peninsula of northwestern Washington (Schuster 1966b) and Douglas County, Oregon (Benedict & Malcolm 1973). It is now known from 76 additional Oregon collections taken at elevations from 0-1675 m. Although A. minimus was collected as high as 1675 m on Mt. Ashland, it is more common in the lowlands from 0-610 m.

Habitats. Leaf litter and mosses. A. minimus occurred in samples of litter from beneath such dominant species as bigleaf maple (Acer macrophyllum Pursh), red alder (Alnus rubra Bong.), Douglas-fir (Pseudotsuga menziesii (Mirb.) Franco), western hemlock (Tsuga heterophylla (Raf.) Sarg.), Oregon white oak (Quercus garryana Dougl.),

California black oak (Q. kelloggii Newb.), canyon live oak (Q. chrysolepis Liebm.), Oregon ash (Fraxinus latifolia Benth.), black cottonwood (Populus trichocarpa Torr. & Gray), California laurel (Umbellularia californica (Hook. & Arn.) Nutt.), Sitka spruce (Picea sitchensis (Bong.) Carr.), ponderosa pine, lodgepole pine (Pinus contorta Dougl. ex Loud.), sugar pine (P. lambertiana Dougl.), grand fir (Abies grandis (Dougl.) Lindl.), incense cedar (Libocedrus decurrens Torr.), and madrone (Arbutus menziesii Pursh). Chamberlin (unpubl. record), also collected it from "under board, edge of marsh at north end of Coos Bay." The single known eastern Oregon collection, also by Chamberlin (unpubl. record), was taken in Wallowa County (approx. 910 m elev.) from "bark rotting pine stump."

Seasonal distribution. Oregon adults were collected every month of the year. Nymphs, while present, were not sorted separately.

Remarks. This species should be redescribed from large series of specimens from throughout its range. When A. minimus and A. occidentalis occur in the same collection, adults of A. minimus are one-third smaller than those of A. occidentalis. The coxal spines also differ (see key).

Apochthonius occidentalis Chamberlin 1929

Geographical distribution. California, New Mexico, Oregon (Map 8), Washington. This species has been reported previously, under this name, only from Portland, Oregon (Chamberlin 1929a). However, my examination of several hundred specimens of Apochthonius, including the types of nearly every described species, reveals that A. intermedius Chamberlin (1929b) from Friday Harbor, Washington; A. magnanimus Hoff (1956a) from San Miguel and Santa Fe Counties, New Mexico; A. maximus Schuster (1966b)

from northern California; Apochthonius sp. (Benedict & Malcolm 1970) from northern California, western Oregon and western Washington; and Apochthonius sp. (Muchmore & Benedict 1976) from southeastern Oregon, all share a common range of variation in the expression of morphological characteristics and are, therefore, synonymous. Since A. occidentalis (Chamberlin 1929a) has priority over A. intermedius (Chamberlin 1929b), the taxon is rightfully named A. occidentalis.

Oregon specimens are known from every county west of the Cascade Mountains and from two counties east of the crest. The species occurs in Oregon at elevations from 0-1700 m.

Habitats. Leaf litter, mosses. In western Oregon, A. occidentalis is exceedingly common in the litter-epiphyte layer associated with red alder, white alder (Alnus rhombifolia Nutt.), bigleaf maple, vine maple (Acer circinatum Pursh), black cottonwood, Oregon oak, Oregon ash, Douglas-fir, western hemlock, Sitka spruce, western white pine (Pinus monticola Dougl. ex D. Don), ponderosa pine, Jeffrey pine (P. jeffreyi Grev. & Balf.), lodgepole pine, sugar pine, Port Orford cedar, western red cedar (Thuja plicata Donn), canyon live oak, madrone, tan oak (Lithocarpus densiflorus (Hook.) Nutt, ex T. & G.), California laurel, manzanita (Arctostaphylos spp.), silktassel (Garry elliptica Dougl.), salal (Gaultheria shallon Pursh), and scotch broom (Cytisus scoparius (L.) Link). A. occidentalis even occurs in the litter-strewn grasses and in clearings overgrown with bracken fern (Pteridium aquilinum (L.) Kuhn). It inhabits sandy, very shallow litter beneath low, deformed lodgepole pines which grow within sight of the Pacific Ocean. It was recovered from samples of mosses and lichens growing on

bark and on rocks, debris from the hollow of a bigleaf maple tree, bark attached to a drift log, a pack rat (Neotoma sp.) nest in an old shed and another pack rat nest on the ground in a Douglas-fir forest.

In eastern Oregon, A. occidentalis was recovered from a mixed litter sample from Pacific silver fir (Abies amabilis (Dougl.) Forbes) and mountain hemlock (Tsuga mertensiana (Bong.) Carr.) near Clear Lake in Wasco County. It was also taken in two samples of leaf litter from chokecherry (Prunus virginiana L.) and mountain spray growing in riparian communities of the Blitzen River drainage on the western slope of Steens Mountain at 1220 m and 1700 m elevation.

Seasonal distribution. Adults were collected from western Oregon during every month of the year, often 20 to 30 in a single sample. Nymphs, especially common during summer months, were collected frequently in the same samples with adults but were not sorted separately.

Remarks. A detailed redescription, complete with measurements and figures illustrating intraspecific variation, is in manuscript. See remarks under A. minimus for information about separating A. occidentalis from A. minimus.

Chthonius C. Koch 1843

One species of this genus is reported from Oregon (Muchmore 1968). See Muchmore (1968) and Lawson (1968) for descriptive details of the genus.

Chthonius (Hesperochthonius) oregonicus Muchmore 1968

Geographical distribution. Oregon (Map 9). This species has been reported previously from two localities in Coos County, Oregon (Muchmore

1968). Now it is known from one additional collection from Charleston (Coos County). All known specimens are from localities at elevations near 0 m in the Sitka Spruce Zone.

Habitats. Leaf litter. Earlier records lacked habitat data (Muchmore 1968) but my specimen came from a sample of mixed leaf litter of Sitka spruce, Port Orford cedar and red alder.

Seasonal distribution. Adults were collected in April and September; nymphs are unknown.

Remarks. See Muchmore (1968) for a detailed description of C. oregonicus.

Kleptochthonius Chamberlin 1949

Two species of this genus have been reported from Oregon, K. geophilus and K. oregonus (Malcolm & Chamberlin 1961). Since most Oregon specimens appear to be intermediates between the two species, further study may reveal that K. geophilus is a junior synonym of K. oregonus. Data are given under K. oregonus as it has page priority. See Malcolm and Chamberlin (1961) and Muchmore (1974a) for descriptive data concerning the genus.

Kleptochthonius (Kleptochthonius) geophilus Malcolm & Chamberlin 1961

Geographical distribution. Oregon (Map 9). This species is known from only one locality at an elevation near 0 m in Curry County, Oregon (Malcolm & Chamberlin 1961). It was not collected in my samples.

Habitat. Leaf litter of red alder.

Seasonal distribution. Oregon adults and nymphs were collected in April.

Map 9. Distribution in Oregon: *Chthonius oregonicus* ■ ,
Kleptochthonius geophilus ○ , *K. oregonus* ● .

Map 10. Distribution in Oregon: *Lechytia hoffi* ■ ,
Malcolmochthonius malcolmi ○ , *M. oregonus* ● .

Remarks. This species may be a junior synonym of K. oregonus.

Kleptochthonius (Kleptochthonius) oregonus Malcolm & Chamberlin 1961

Geographical distribution. Oregon (Map 9). This species was reported previously from one locality in Josephine County, Oregon (Malcolm & Chamberlin 1961). Now it is known from more than 50 samples from southwestern Oregon taken at elevations from 120-1525 m in the Western Hemlock, Mixed Conifer and Mixed Evergreen Zones of the Siskiyou Mountains and western Cascade Mountains.

Habitats. Leaf litter. K. oregonus was collected with about an equal frequency from sclerophyllous litter of madrone, tan oak, canyon live oak, chinkapin (Castanopsis chrysophylla (Dougl.) A. DC.) and manzanita; deciduous litter of bigleaf maple, Oregon white oak and California black oak; and coniferous litter of Douglas-fir, white fir (Abies concolor (Gord. & Glend.) Lindl.), incense cedar, ponderosa pine and sugar pine. It also occurred in a sample of moss from a bigleaf maple tree, from bark of a willow tree (Salix sp.), from wood of a rotted stump and from wood of a Douglas-fir log.

Seasonal distribution. Oregon adults were recovered from September through February and in April. Nymphs were not sorted separately.

Remarks. Although Malcolm and Chamberlin (1961) provided excellent descriptions of K. geophilus and K. oregonus, a redescription is needed in view of recent findings. See remarks under K. geophilus.

Lechytia Balzan 1891

One species, Lechytia hoffi Muchmore, has been reported from Oregon (Muchmore 1975). Although only recently described by Muchmore

(1975a), L. hoffi has a long, confused history under the name of "Lechytia pacifica (Banks)." The first specimens of the taxon were reported from Mt. Hamilton, California (Chamberlin 1925) and misidentified as Roncus pacificus Banks (1893). Chamberlin, at the same time, transferred R. pacificus to Lechytia; hence subsequent records and references concerning L. hoffi up to 1968 are under L. pacifica (Chamberlin 1929a, 1931; Beier 1932a; Hoff 1952, 1956a, 1958, 1961, 1963; Hoff & Clawson 1952). In 1968, Schuster reported that Banks' type specimens of Roncus pacificus belonged to the genus Mundochthonius Chamberlin, instead of Lechytia. This left the western North American species of Lechytia without a specific name. Muchmore (1975a), therefore, named the taxon Lechytia hoffi and described it from large series of specimens.

Lechytia hoffi Muchmore 1975

Geographical distribution. Arizona, California, Colorado, Nevada, New Mexico, Oregon (Map 10), South Dakota, Utah and Washington. Muchmore (1975a) reported L. hoffi from localities in nine states including one in Harney County, Oregon (Benedict Collection). Oregon specimens were recovered from at least 25 samples collected at elevations from 150-1525 m east and west of the Cascade Mountains.

Habitats. Leaf litter, bark, rotted wood. In New Mexico and Colorado, L. hoffi appears adapted to living in relatively dry litter of juniper, pinyons and ponderosa pine (Hoff 1961). Oregon specimens are from samples of material from ponderosa pine, western juniper (Juniperus occidentalis Hooke.), Douglas-fir, madrone, manzanita, Oregon white oak and red alder. L. hoffi occurred in bark samples

from stumps, logs and living trees, rotted wood of stumps and snags, tree hollows, and in litter of woody plants. L. hoffi was also recovered from debris of harvester ant nests.

Seasonal distribution. Oregon adults were collected in May, June, July, September and November; nymphs were not sorted separately.

Remarks. See Muchmore (1975a) for a modern-style description of L. hoffi.

Malcolmochthonius Benedict 1978

Two species of this genus are reported from Oregon (Benedict 1978a). See Benedict (1978a) for a detailed description of the genus.

Malcolmochthonius malcolmi Benedict 1978

Geographical distribution. California, Oregon (Map 10). This species is known from Humboldt County, California, and Curry County, Oregon (Benedict 1978a). Oregon specimens were collected from seven localities at elevations from 0-900 m in the Sitka Spruce, Western Hemlock and Mixed Evergreen Zones of the western Siskiyou Mountains.

Habitats. Leaf litter. The California specimen was collected from the litter of coast redwood (Sequoia sempervirens (D. Don) Endl.). Oregon specimens came from litter of Sitka spruce, sugar pine, knobcone pine (Pinus attenuata Lemm.), Douglas-fir, tan oak, madrone and manzanita.

Seasonal distribution. Oregon adults were collected in February, March, May and August; nymphs are unknown.

Remarks. See Benedict (1978a) for a detailed description of M. malcolmi.

Malcolmochthonius oregonus Benedict 1978

Geographical distribution. Oregon (Map 10). This species is known from one locality at an elevation of 250 m in the Mixed Evergreen Zone of Curry County.

Habitats. Leaf litter of mixed Douglas-fir and tan oak.

Seasonal distribution. An Oregon adult was collected in May; nymphs are unknown.

Remarks. See Benedict (1978a) for a detailed description of M. oregonus.

Mundochthonius Chamberlin 1929

This genus has not been reported previously from Oregon except as "Mundochthonius" from specimens in the same collections with Pseudotyrannochthonius incognitus (Benedict & Malcolm 1970). Individuals of Mundochthonius are nearly as common in the leaf litter habitats of western Oregon as those of Apochthonius. The dearth of Oregon records results from several factors. There is, and has been a paucity of chelonethologists studying western North American chthoniids. Three of the four described western species, M. erosidens Chamberlin (1929a), M. magnus Chamberlin (1929a) and M. pacificus (Banks) (1893) lack adequate descriptions, and were reported previously only from type series. Even M. montanus Chamberlin (1929a), reported from a number of Colorado and New Mexico specimens (Chamberlin 1929a; Hoff 1956a, 1961), is still incompletely described. The misdetermination of M. pacificus has caused considerable confusion (see discussion under Lechytia).

My study of the type specimens of most described species of the

genus (Benedict & Malcolm 1973) and of hundreds of specimens from western North American localities, reveals that there are four to six species from Oregon. Three can now be identified by name: M. magnus, M. erosidens and M. pacificus. The other "species", while common, cannot be characterized at this time and are not discussed further in this work.

Mundochthonius erosidens Chamberlin 1929

Geographical distribution. California, Oregon (Map 11). This species has been reported previously from one specimen collected in 1923 from San Mateo County, California (Chamberlin 1929a). It is now known from 16 collections taken at elevations from 60-2285 m in western Oregon.

Habitats. Leaf litter, rotted wood. The California specimen was collected from under a rock of a damp serpentine outcrop. From Oregon, M. erosidens was collected from litter of snowbrush ceanothus (Ceanothus velutinus Dougl. ex Hook.), western hemlock, Douglas-fir, western red cedar, bigleaf maple, California laurel and green manzanita. It also occurred in tree hollows of red alder, California laurel and Shasta fir (Abies magnifica Murr.), in rotted wood of a stump, and in a California laurel snag.

Seasonal distribution. Oregon adults were collected in August through October, and in February and May. Nymphs were not separated from adults.

Remarks. Although M. erosidens is the type species of Mundochthonius, it has not been redescribed since Chamberlin's exceedingly brief description of 1929.

Map 11. Distribution in Oregon: Mundochthonius erosidens ○ ,
M. magnus ● .

Map 12. Distribution in Oregon: Mundochthonius pacificus ● .

Mundochthonius magnus Chamberlin 1929

Geographical distribution. California, Oregon (Map 11). This species has been reported previously from one specimen collected in San Mateo County, California (Chamberlin 1929a). It is now known from 13 collections taken at elevations from 0-1220 m in Coos and Curry Counties, Oregon, in the Western Hemlock and Mixed Evergreen Zones.

Habitats. Leaf litter. Habitat data for the California specimen are lacking. Oregon specimens came from litter of canyon live oak, tan oak, bigleaf maple, red alder, Douglas-fir and western white pine.

Seasonal distribution. Oregon adults were collected from February through May and in August and September. Nymphs were not recorded separately.

Remarks. This species has not been redescribed since the original very brief description of 1929.

Mundochthonius pacificus (Banks) 1893

Geographical distribution. California, Idaho, Oregon (Map 12), Washington. Records of M. pacificus and L. hoffi were confused for approximately 40 years; prior to 1968 all records except those from Washington pertained to the genus Lechytia. Schuster (1968) redescribed "pacificus" from Banks' (1893) types and recognized it as a species of Mundochthonius. Schuster also mentioned specimens of M. pacificus from California and Idaho but did not give locality or habitat data. Oregon specimens of M. pacificus are known from 15 collections taken at elevations from 0-1000 m, mostly in the Interior Valley and Western Hemlock Zones.

Habitats. Leaf litter, moss, bark. Washington specimens (Malcolm Collection, unpubl. records) were recovered from samples of Douglas-fir litter. Oregon specimens occurred in samples of litter (Douglas-fir, California laurel), bark of living trees (Sitka spruce) and snags (red alder), tree hollows (tan oak, red alder), moss on tree trunks and branches, and debris of a shrew's nest.

Seasonal distribution. Oregon adults were collected from February through August and in November. Nymphs were not recorded separately.

Remarks. Although Schuster (1968) redescribed this species from the type series, a redescription is needed based on a large series of specimens reflecting intraspecific variation.

Neochthonius Chamberlin 1929

One species of this genus is now being reported from Oregon. See Muchmore (1969a) for a brief discussion of this genus.

Neochthonius amplus (Schuster) 1962

Geographical distribution. California, Oregon (Map 13). This species has been reported previously from Yolo County, California (Schuster 1962). It is now known from 12 collections taken at elevations from 0-450 m in the Interior Valley Zones of Curry, Josephine, Jackson, Douglas, Yamhill and Washington Counties, Oregon.

Habitats. Leaf litter. California specimens came from soil, leaf litter and decomposing wood beneath elderberry (Sambucus sp.) and valley oak (Quercus lobata Nee). Oregon specimens were recovered from litter samples taken beneath Oregon oak, California black oak, canyon live oak, bigleaf maple, manzanita, madrone, and Douglas-fir. These habitats

occur in drier forests of western Oregon.

Seasonal distribution. Oregon adults have been recovered in January, March, April, August and October. Nymphs are unknown.

Remarks. A detailed description is needed for this species. It was originally described under the name of Kewochthonius amplius, then Muchmore (1969a) transferred it to the genus Neochthonius.

Pseudotyrannochthonius Beier 1932

Two species, P. gracilis and P. incognitus, occur in Oregon. See Benedict and Malcolm (1970) for a detailed study of the genus in the Pacific Northwest. P. newelli was recognized as a junior synonym of P. incognitus.

Pseudotyrannochthonius gracilis Benedict & Malcolm 1970

Geographical distribution. California, Oregon (Map 14), Washington. Reported previously from southwestern Washington and northwestern California (Benedict & Malcolm 1970), P. gracilis has now been collected from two localities in southwestern Oregon near the California border at elevations of 450 m (Jackson County) and 1220 m (Josephine County).

Habitat. Leaf litter and debris. Benedict and Malcolm (1970:50) considered this species to be associated with "either moss or coniferous duff rather than deciduous debris." One of the two Oregon specimens came from Douglas-fir litter and the other one from "the lower crawlway in total darkness" in Oregon Cave (Benedict Collection, unpubl. record).

Seasonal distribution. Oregon adults of P. gracilis have been collected from November through February. Nymphs are unknown.

Remarks. See Benedict and Malcolm (1970) for a detailed

Map 13. Distribution in Oregon: Neochthonius amplus ● .

Map 14. Distribution in Oregon: Pseudotyranochthonius praticilis
○ , P. incognitus ● .

description of this species. The Oregon specimens are clearly conspecific with those from Washington and California but are slightly larger (see measurements in Appendix IV).

Pseudotyrannochthonius incognitus (Schuster) 1966

Geographical distribution. California, Idaho, Oregon (Map 14), Washington. Aside from a single collection from Shoshone County, Idaho (Schuster 1966a), P. incognitus is known from localities west of the Cascade Mountains between Skamania County, Washington, and Humboldt County, California. It is currently known from over 160 collections taken at elevations from 0-1220 m in the Western Hemlock, Sitka Spruce, Interior Valley and Mixed Evergreen Zones.

Habitats. Leaf litter, soil and decaying wood. Benedict and Malcolm (1970) reported P. incognitus (Map 4) from the lowlands (0-600 m) from samples of leaf litter, soil and decaying wood of bigleaf maple, vine maple, red alder, Oregon white oak, California black oak, Douglas-fir, western hemlock, western red cedar and Sitka spruce. In the present study, P. incognitus occurred in more than 110 western Oregon samples from mosses and lichens on the ground, rocks and tree trunks, deciduous-coniferous debris mixed with sclerophyllous litter of canyon live oak, California laurel, tan oak, madrone and manzanita, and in a sample of pure sugar pine litter from the Mixed Evergreen Zone of Curry County. P. incognitus was not recovered in samples from the Rogue River portion of the Interior Valley Zone or from eastern Oregon.

Seasonal distribution. Oregon adults were collected during all months of the year, nymphs only from July through November. Protonymphs are unknown.

Remarks. See Benedict and Malcolm (1970) for a detailed description of this species.

SUBORDER DIPLOSPHYRONIDA Chamberlin 1929

This suborder is represented in the United States by two superfamilies, Neobisioidea Chamberlin and Garypoidea Chamberlin. Species of both superfamilies occur in Oregon.

SUPERFAMILY NEOBISIOIDEA Chamberlin 1930

This superfamily is represented in the United States by three families, Neobisiidae Chamberlin, Syarinidae Chamberlin and Ideoroncidae Chamberlin. The latter is unknown from Oregon. Approximately 12 species of Neobisiidae and one or two species of Syarinidae occur in Oregon. Complex systematic problems beyond the scope of this study prevent most of these species from being characterized at this time.

FAMILY NEOBISIIDAE Chamberlin 1930

Neobisiids (Fig. 2) occur primarily in the Northern Hemisphere (Chamberlin 1931) and commonly inhabit leaf litter, soil, mosses and caves (Chamberlin & Malcolm 1960). In western Oregon, chthoniids and neobisiids generally occur in the same samples, with chthoniids present in greater numbers but neobisiids in greater biomass.

Prior to this study, five species had been reported from Oregon (Map 5). Microcreagris theveneti (Simon) was reported in Banks (1895: 11) "in moss and rotted wood, Portland and Astoria, Oregon (Hubbard); Portland, Oregon (Schwarz)" and as "common in the coast regions of Oregon" (Banks 1910:37). Parobisium hesperum (Chamberlin) is the second

Figure 2. Halobisium occidentale Beier, a neobisiid species of the high tidal zone. (Body length 3-4 mm).

species of any family to have been described initially from an Oregon locality, i.e., from rubble beneath a log above high tide line at Cannon Beach, Clatsop County (Chamberlin 1930). Microcreagris cingara Chamberlin was reported from Springfield, Lane County, by Chamberlin in 1930. In 1962, Chamberlin described P. charlotteae Chamberlin from Redmond Cave, Deschutes County, and M. columbiana Chamberlin from a well at Clatskanie, Clatsop County. Even though neobisiids are fairly abundant in western Oregon and are well-represented in the samples, there are few criteria available for assigning most specimens to species, even the species mentioned above. Therefore, these species are not treated under separate species accounts.

There is, however, one very distinctive littoral species, Halobisium occidentale Beier, which can now be reported from Oregon.

Halobisium Chamberlin 1930

This genus is currently under study by Shulte (1976, pers. comm.). One species is known to occur along the Oregon coastline.

Halobisium occidentale Beier 1931

Geographical distribution. Alaska, California, Oregon (Map 15), Washington. This species was reported previously from Palo Alto, California (Beier 1931, 1932a). Now it is known from a number of coastal localities from California through Alaska (Chamberlin-Malcolm-Benedict Collection, unpubl. records), where it occurs in the high tide zone (Shulte 1976).

Habitats. Tidal flats. Chamberlin (1930) collected more than 45 specimens near Palo Alto, California, from under boards and driftwood in Salicornia salt marshes which flood at high tide. H. occidentale is

Map 15. Distribution in Oregon: Halobisium occidentale ● .

known from six Oregon localities where it was collected under boards and debris of Salicornia-saltgrass tidal flats, in estuary-water soaked bark of a Sitka spruce tree-root, in a log eaten by boring clams (Teredo sp.) in the high tide zone, and in a gribble burrow (Limnoria sp.) in wood from a slough (Benedict-Chamberlin-Malcolm Collection). Washington specimens (from Puget Sound area and Bay Center) did not include habitat data (Chamberlin Collection). From Alaska ("Glacier Bay, north side of Lagoon Island, 87 km 283° fm Juneau"), eight specimens were collected "under 50 rocks 5-10 m down from high tide, 14 IX 1977" (Burke Museum Collection).

Seasonal distribution. Oregon adults were collected in March, April, May, July and August; nymphs are unknown.

Remarks. Shulte (pers. comm.) is redescribing this species.

FAMILY SYARINIDAE Chamberlin 1930

This family is well represented in Oregon by the genus Syarinus Chamberlin (Fig. 3) but individual species have yet to be identified. Specimens of Syarinus were collected from leaf litter in montane areas of the Steens Mountain (Harney County) and the western Cascade Mountains (Lane County), and from the sinks of the Arnold Lavatube System (Deschutes County). Specimens were also collected from bark samples from humid coastal forests (Lincoln County). Oregon specimens appear to represent at least two species.

SUPERFAMILY GARYPOIDEA Chamberlin 1930

This superfamily is represented in the United States by three families, Garypidae Hansen, Olpiidae Chamberlin and Menthidae Chamberlin.

Figure 3. Syarinus sp., a leaf litter-inhabiting syarinid species from eastern Oregon. (Body length 2-3 mm).

Of these, only garypids and olpiids are reported from Oregon (Benedict & Malcolm 1977).

FAMILY GARYPIDAE Hansen 1894

Garypids (Fig. 4), assigned to about 20 genera, are considered as mostly tropical and subtropical in distribution (Hoff 1964). Of the approximately six species known from the United States, Benedict and Malcolm (1977) recently reported the first records from Oregon of this family. Larca chamberlini Benedict and Malcolm was described from western Oregon and Archeolarca rotunda Hoff and Clawson was reported from eastern Oregon. In addition to these two species, a specimen of Larca notha Hoff is now reported from Harney County, Oregon.

Archeolarca Hoff & Clawson 1952

One species of this genus is reported from Oregon (Benedict & Malcolm 1977). See Hoff and Clawson (1952) for a detailed description of the genus.

Archeolarca rotunda Hoff & Clawson 1952

Geographical distribution. Oregon (Map 16), New Mexico, Utah.

Habitats. Only 23 specimens of this species have been reported from its entire range, all from rodent debris. Twenty-two of the specimens came from nests of pack rats (Neotoma cinerea (Ord) and N. albigula Hartley) and porcupine (Erethizon dorsatum epixanthum Brandt) in Utah (Hoff & Clawson 1952) and in New Mexico (Hoff 1956b). One male was extracted from Neotoma (prob. N. cinerea) debris from Unnamed Cave, Arnold Lavatube System, Deschutes County, Oregon (Benedict & Malcolm 1977).

Figure 4. Archeolarca rotunda Hoff & Clawson, a garypid species from animal nests. (Body length 2.4-2.6 mm).

Map 16. Distribution in Oregon: Archeolarca rotunda ■ ,
Larca chamberlini ○ , L. notha ● .

Seasonal distribution. The Oregon specimen, a male, was collected in June. While nymphs are unknown for Oregon, they have been collected in Utah and New Mexico during October, November, February, March and April.

Remarks. Although A. rotunda was collected from a cave, it does not exhibit troglotic tendencies; instead it is associated with rodents which inhabit the cave. Hoff & Clawson (1952) provided a detailed description of this species.

Larca Chamberlin 1930

This genus is represented in Oregon by two species, L. chamberlini and L. notha. See Benedict and Malcolm (1977) for a detailed study of the genus.

Larca chamberlini Benedict & Malcolm 1977

Geographical distribution. California, Oregon (Map 15). This species was reported previously from four specimens from northern California and Benton County, Oregon (Benedict & Malcolm 1977). Now it is known from two additional Oregon specimens, one from Clatsop County and the other one from Benton County. Oregon specimens have been collected at elevations near 0 m in the Sitka Spruce and Interior Valley Zones.

Habitats. Mosses, old buildings. During the 1940's, four specimens were collected at four localities in Yuba County, California and Benton County, Oregon (Benedict & Malcolm 1977). These specimens were either phoretic on mosquitoes or associated with mosquitoes in old buildings. In 1973, I recovered a nymph from mosses festooning a Sitka spruce tree in Clatsop County, Oregon.

Seasonal distribution. Oregon adults were collected in October and November, a nymph in July.

Remarks. See Benedict and Malcolm (1977) for a detailed description.

Larca notha Hoff 1961

Geographical distribution. Colorado, Oregon (Map 16). Known previously from Larimer County, Colorado (Hoff 1961), L. notha is now reported from Harney County, Oregon, where it was collected at an elevation of 1220 m.

Habitats. Leaf litter. The Colorado specimen was collected from litter of quaking aspen (Populus tremuloides Michx.). The Oregon specimen was collected from debris caught between multiple trunks of mountain alder (Alnus incana (L.) Moench) growing in the riparian community along the Blitzen River at a site approximately 450 m lower in elevation than the nearest aspen grove on Steens Mountain.

Seasonal distribution. The Oregon adult was collected in March.

Remarks. See Hoff (1961) for a detailed description of L. notha.

FAMILY OLPIIDAE Chamberlin 1930

Olpiids (Fig. 5), with about 30 assigned species, appear to exhibit their greatest divergence in the arid tropics and subtropics (Chamberlin 1930). Fewer than 12 species are known from the United States and only two species have been reported from Oregon (Benedict & Malcolm 1977): Oreolpium nympha Benedict and Malcolm and Pseudogarypinus frontalis (Banks).

Figure 5. Pseudogarypinus frontalis (Banks), a leaf litter and bark-inhabiting olpiid species from southwestern Oregon. (Body length 3.0-4.6 mm).

Oreolpium Benedict & Malcolm 1977

One species of this genus is reported from Oregon (Benedict & Malcolm 1977). See Benedict and Malcolm (1977) for a detailed description of this genus.

Oreolpium nymphum Benedict & Malcolm 1977

Geographical distribution. Oregon (Map 17). This species is known only from widely scattered localities in western Oregon (Benedict & Malcolm 1977). It occurs at elevations from 305-1675 m in the Western Hemlock and Mixed Conifer Zones in the Cascade and Siskiyou Mountains between Marion County and the California-Oregon border.

Habitats. Bark. Ten collections came from samples of well-rotted bark of old-growth 0.6-2.5 m (dbh) conifers (Douglas-fir, western hemlock, sugar pine, ponderosa pine), but not from litter samples beneath these individual trees. O. nymphum did occur in one sample of mixed Douglas-fir-myrtle-oak-maple litter collected at 150 m in a riparian community along the Umpqua River.

Seasonal distribution. Adults were collected in April, August, September and October. Nymphs were taken in September.

Remarks. See Benedict & Malcolm (1977) for a detailed description.

Pseudogarypinus Beier 1931

One species of this genus is reported from Oregon (Benedict & Malcolm 1977). See Benedict & Malcolm (1977) for a detailed redescription of this genus.

Map 17. Distribution in Oregon: *Oreolpium nymphum* ○ ,
Pseudogarypinus frontalis ● .

Pseudogarypinus frontalis (Banks) 1909

Geographical distribution. California, Colorado, New Mexico, Oregon (Map 18), Utah, Washington. This species is distributed at widely scattered localities from the Rocky Mountains to within a few miles of the Pacific Ocean (Benedict & Malcolm 1977). Oregon specimens were collected from Jackson and Josephine Counties at elevations from 150-1465 m in the Interior Valley and Mixed Conifer Zones of the Siskiyou Mountains.

Habitats. Leaf litter, bark. Benedict and Malcolm (1977) in their recent study compiled habitat data for all known collections of P. frontalis and reported it from leaf litter, wood of living and dead trees, stumps and logs, bark of living trees, and rock crevices. The 12 Oregon specimens were collected in four samples of leaf litter (sugar pine, Jeffrey pine, California black oak, canyon live oak) and in two samples of bark from living trees (Douglas-fir, madrone).

Seasonal distribution. Oregon adults were collected in April, August, September and November, nymphs in September. One female bore six eggs (April collection).

Remarks. See Benedict and Malcolm (1977) for a detailed redescription based on the restudy of syntypes and a large series of specimens from throughout its range. P. marianae was also recognized as a junior synonym of P. frontalis.

SUBORDER MONOSPHYRONIDA Chamberlin 1929

This suborder is represented in the United States by three superfamilies, Feaelloidea Chamberlin, Cheiridioidea Chamberlin and

Cheliferioidea Chamberlin. All three occur in Oregon.

SUPERFAMILY FEAELLOIDEA Chamberlin 1930

This superfamily is represented in the United States by one family, Pseudogarypidae Chamberlin. See Benedict and Malcolm (1978a) for a detailed study of Pseudogarypidae.

FAMILY PSEUDOGARYPIDAE Chamberlin 1930

The family Pseudogarypidae includes several fossil species from Europe, six extant species from North America (Fig. 6) and one extant species from Tasmania (Benedict & Malcolm 1978a, Muchmore pers. comm.).

Pseudogarypus Ellingsen 1909

The first valid pseudogarypid records from Oregon were only recently reported (Benedict & Malcolm 1978a), despite Chamberlin's (1931:231) mention of "a hitherto undescribed form from Oregon." The species in question apparently is Pseudogarypus hesperus which Chamberlin (1931) diagnosed without reporting Oregon records. Nearly 50 years later, Benedict and Malcolm (1978a) provided the first records from Oregon for both P. hesperus and P. bicornis (Banks). The two species in Oregon are partially sympatric (Maps 17-18). In areas of overlap, P. bicornis occurs at lower elevations, especially in southwestern Oregon (see Table II). Benedict and Malcolm (1978a) provide a detailed redescription of this genus.

Pseudogarypus bicornis (Banks) 1895

Geographical distribution. Arizona, California, Colorado, Idaho, Oregon (Map 18), Utah, Washington, Wyoming. This species occurs from

Figure 6. *Pseudogarypus bicornis* (Banks), a leaf litter and bark-inhabiting pseudogarypid species from Oregon. (Body length 2.2-3.3 mm).

Map 18. Distribution in Oregon: Pseudogarypus bicornis ● .

Map 19. Distribution in Oregon: Pseudogarypus hesperus ● .

the Rocky Mountains nearly to the Pacific coast at elevations from 300-3050 m (Benedict & Malcolm 1978a). Oregon specimens came from 28 localities in eight counties, where it occurred in eight vegetation zones at elevations from 305-2075 m (Table II).

Habitats. Leaf litter, bark, tree hollows, mosses, rock crevices. Although Benedict and Malcolm (1978a), reported P. bicornis from approximately 50 localities throughout its range, most specimens, except those from Oregon, lack habitat data. From other states, P. bicornis was recorded from rock crevices, bark of a cottonwood stump, litter beneath birch (Betula sp.) and maple trees, and from a swallow's nest.

Oregon specimens were collected from a total of 24 leaf litter samples of lodgepole pine, ponderosa pine, sugar pine, incense cedar, white-grand fir (Abies concolor-grandis), Douglas-fir, madrone, bigleaf maple, mountain alder, willow and sagebrush. The sagebrush (Artemisia tridentata Nutt.) sample, collected from one of the rarest habitats in western Oregon, also came from the highest elevation (2075 m) at which P. bicornis was collected in Oregon. P. bicornis was recovered from 11 samples of material from living trees: six bark samples from Douglas-fir, grand fir (Abies grandis (Dougl.) Lindl.), ponderosa pine, sugar pine, western yew (Taxus brevifolia Nutt.) and Engelmann spruce (Picea engelmannii Parry ex Engelm.); four tree hollow samples from Douglas-fir, grand fir, madrone and ponderosa pine; and one sample of moss-festoons from bigleaf maple. P. bicornis occurred in four samples of mosses-lichens growing on rocks, and was hand-collected from under a rock. In Harney County, it was collected exclusively from debris caught between multiple trunks of mountain alder and willows growing in riparian

TABLE II
COMPARISON OF ELEVATIONS AND VEGETATION ZONES IN OREGON
OF TWO SPECIES OF PSEUDOGARYPUS ELLINGSEN

WESTERN OREGON		
	<u>P. bicornis</u>	<u>P. hesperus</u>
Coast Range Mts.		620 m
(Lincoln, Polk Co.)		Western Hemlock Zone
Northern Cascade Mts.		1000 -- 1070 m
(Clackamas Co.)		Western Hemlock Zone
Middle Cascade Mts.	365 -- 1280 m	580 -- 1525 m
(Linn, Lane, Jefferson Co.)	Western Hemlock Zone	Western Hemlock Zone
		Pacific Silver Fir Zone
Southern Cascade Mts.	305 -- 1770 m	
(Douglas, Jackson Co.)	Mixed Conifer Zone	
	White Fir Zone	
	Shasta Red Fir Zone	
Eastern Siskiyou Mts.	915--- 2075 m	2075 -- 2290 m
(Josephine, Jackson Co.)	Mixed Conifer Zone	Mountain Hemlock Zone
	White Fir Zone	
EASTERN OREGON		
Ochoco Mts.	1525 m	
(Jefferson Co.)	Grand Fir Zone	
Blue Mts.		1540 m
(Umatilla Co.)		White Fir Zone
Steen Mt.	1280 -- 1675 m	
(Harney Co.)	Western Juniper Zone	

communities of the Blitzen River drainage. Otherwise P. bicornis appears to exhibit little habitat specificity except for non-coastal areas.

Seasonal distribution. The 39 Oregon collections were taken during every season of the year, often with both adults and nymphs of every stage. Banks (1895) noted that the type collection from Yellowstone Park contained many nymphs in molting cocoons of silk and earth.

Remarks. See Benedict and Malcolm (1978a) for a detailed redescription based on large series of specimens from throughout its range.

Pseudogarypus hesperus Chamberlin 1931

Geographical distribution. Oregon (Map 19), Washington. Known only from the Pacific Northwest (Chamberlin 1931; Benedict & Malcolm 1978a), P. hesperus is reported from four vegetation zones at elevations from near 0 m (southwestern Washington) to 1525 m (summit of Mt. Ashland).

Habitats. Twenty of the 23 collections of P. hesperus, including the only one from Washington, came from well-rotted bark of 0.6-2.5 m (dbh) old-growth Douglas-fir, mountain hemlock (Tsuga mertensiana (Dougl.) Forbes) and western red cedar. A litter sample was taken under each of these trees (in Oregon), but P. hesperus was not recovered. One specimen came from beneath a rock and one specimen from an outhouse in a forest camp.

Seasonal distribution. Oregon collections contained both adults and nymphs of every stage; collections were made in April, May, June, August and September.

Remarks. See Benedict and Malcolm (1978a) for a detailed

description of this species.

SUPERFAMILY CHEIRIDIOIDEA Chamberlin 1931

This superfamily is represented in the United States by two families, Cheiridiidae Chamberlin and Sternophoridae Chamberlin. Only species of the Cheiridiidae have been reported from Oregon (Benedict 1977).

FAMILY CHEIRIDIDAE Chamberlin 1931

Cheiridiids (Fig. 7), assigned to about 12 genera, occur in every zoogeographical region except Australasia (Chamberlin 1931). Of approximately 12 species known from the United States, five were recently reported from Oregon (Benedict 1977). Apocheiridium bulbifemorum Benedict, A. fergusoni Benedict and A. granochelum Benedict were described with Oregon type localities, while A. ferumoides Chamberlin and A. mormon Chamberlin were reported for the first time from Oregon.

Apocheiridium Chamberlin 1924

Five species of this genus are known to occur in Oregon (Benedict 1977). For a systematic study of western North American species, see Benedict (1977). Although a single "colony" of this genus may contain 30 to 40 individuals, the total number of collections reported for any species is very small. Thus, relatively little is known about these possibly rare pseudoscorpions.

Apocheiridium bulbifemorum Benedict 1977

Geographical distribution. Oregon (Map 20). This very distinctive species is known from a single adult collected at 800 m in the Mixed

Figure 7. Apocheiridium fergusonii Benedict, a bark-inhabiting cheiridiid species from eastern Oregon. (Body length 1.3 mm).

Map 20. Distribution in Oregon: *Apocheiridium bulbifemorum* ●, *A. fergusonii* ■, *A. ferumoides* ●.

Map 21. Distribution in Oregon: *Apocheiridium granocheilum* ●, *A. mormon* ○.

Conifer Zone of Douglas County (Benedict 1977).

Habitat. Bark of a living sugar pine tree.

Seasonal distribution. An Oregon adult was collected in September.

Remarks. See Benedict (1977) for a detailed description of this species.

Apocheiridium fergusonii Benedict 1977

Geographical distribution. Oregon (Map 20). This species is reported from four specimens collected in Harney and Deschutes Counties (Benedict 1977).

Habitat. Bark of living western juniper trees.

Seasonal distribution. Oregon adults were recovered in April, May and June, a nymph in April.

Remarks. See Benedict (1977) for a detailed description of this species.

Apocheiridium ferumoides Chamberlin 1924

Geographical distribution. Oregon (Map 20), California. This species is known from the coastal zone near sea level between Morro Bay and the Columbia River (Chamberlin 1924a, 1932; Benedict 1977). Oregon specimens were collected in the Sitka Spruce Zone between Douglas and Clatsop Counties.

Habitats. Bark. California specimens came from bark of eucalyptus (Eucalyptus sp.), oak, cypress (Cupressus sp.), pine and coast redwood (Sequoia sempervirens (D. Don) Endl.) trees. Six Oregon collections were taken from bark of living Sitka spruce, Douglas-fir and western red

cedar.

Seasonal distribution. Oregon adults and nymphs were collected in February and March, nymphs in February. See Essig (1958) for photographs of molting and egg webs of A. ferumoides. "Molting and egg webs are white silken disc-like, 2 mm in diameter; eggs white, irregular, somewhat globular, laid in groups of four within webs" (Essig 1958:11; Chamberlin 1924a).

Remarks. Published records suggest that A. ferumoides occurs in two widely separated geographical areas: the coastal zone of Oregon and California (Chamberlin 1924a, 1932; Benedict 1977) and the Great Salt Lake Desert of Utah (Gering 1956). Benedict (1977) questioned the Utah determination since species of this genus superficially resemble each other and are, therefore, easily confused (Chamberlin 1924a). Utah specimens were unavailable for examination. See Benedict (1977) for a revised diagnosis and for measurements.

Apocheiridium granocheum Benedict 1977

Geographical distribution. Oregon (Map 21). This species has been reported from three collections which were made during the 1930's from the Interior Valley Zones of Benton and Columbia Counties at elevations near 0 m.

Habitats. Bark. The species is known from two collections from oak bark and one collection from Oregon ash bark (Benedict 1977). More than 30 samples of oak and ash bark were taken on one trip, alone, in Benton County in an unsuccessful attempt to locate the habitats of A. granocheum before it was described (Benedict 1977). The species was not collected during the present investigation.

Seasonal distribution. Oregon adults were collected in February and March, nymphs in February.

Remarks. See Benedict (1977) for a detailed description of this species.

Apocheiridium mormon Chamberlin 1924

Geographical distribution. Idaho, Oregon (Map 21). Known for more than 50 years from a single specimen collected in Bear Lake County, Idaho, A. mormon was recently reported (Benedict 1977) from two collections made in the 1930's in Benton County, Oregon.

Habitats. Bark. The Idaho specimen came from bark of mountain mahogany (Cercocarpus ledifolius Nutt. in T & G.); Oregon specimens from under bark of oak and of an old fence post of an unknown species.

Seasonal distribution. Oregon adults were collected in February and March, nymphs in February. The fence post collection consisted of a colony of 37 adults and nymphs (Chamberlin Collection, unpubl. records).

Remarks. See Benedict (1977) for a revised diagnosis of this species, along with measurements.

SUPERFAMILY CHELIFEROIDEA Chamberlin 1931

This superfamily is represented in the United States by three families, Cheliferidae Hagen, Chernetidae Menge and Atemnidae Chamberlin. Species of both the Cheliferidae and Chernetidae occur in Oregon.

FAMILY CHERNETIDAE Menge 1855

Chernetids (Fig. 8) are currently assigned to approximately one-hundred poorly defined and confusing genera which Muchmore (1972b, 1974b, 1975b) is revising. Chernetids exhibit a nearly cosmopolitan distribu-

Figure 8. Illinichernes stephensi Benedict & Malcolm, a tree hollow-inhabiting chernetid pseudoscorpion from western Oregon. (Body length 2.5-3.3 mm).

tion (Chamberlin 1931) and are the most diverse in form and size "in the torrid and the warm temperate zones" (Hoff 1959:48), but also extend into cool temperate areas. Approximately 80 species have been reported from the United States, but none previously from Oregon. This is due to the perplexing systematic problems, not to a lack of chernetid specimens. Eight species are now being reported from Oregon:

Acuminochernes crassopalpus (Hoff), Dendrochernes crassus Hoff, Dinocheirus sicarius Chamberlin, D. validus (Banks), Illinichernes stephensi Benedict & Malcolm (1978c), Hesperochernes utahensis Hoff & Clawson, Lamprochernes sp. and Lustrochernes grossus (Banks). These species, and the specimens upon which they are based, probably represent only a small part of the Oregon chernetid fauna.

Acuminochernes Hoff 1949

The single known Oregon specimen keys to A. crassopalpus (Hoff 1949, 1958) and exhibits the characteristics described by Hoff (1949), even though the closest reported localities are in the Great Plains states (Hoff 1945).

Acuminochernes crassopalpus (Hoff) 1945

Geographical distribution. Arkansas, Illinois, Kansas, Michigan, Oregon (Map 22). A specimen was collected from Sauvie Island, Multnomah County, Oregon (elevation near 0 m).

Habitats. Rodent debris. The Oregon specimen came from debris collected from a tree hollow occupied by a California ground squirrel (Spermophilus beecheyi douglasii (Richardson)). In other states, this pseudoscorpion has been collected from the stomach of a red-bellied

Map 22. Distribution in Oregon: *Acuminochernes crassopalpus* ● , *Dendrochernes crassus* ● .

Map 23. Distribution in Oregon: *Dinocheirus sicarius* ● , *Dinocheirus validus* ○ .

woodpecker (Centurus carolinus (L)), a decayed log and from tree hollows (Hoff 1949; Nelson 1975).

Seasonal distribution. The Oregon adult was collected in October.

Remarks. See Hoff (1945, 1949) and Nelson (1975) for detailed descriptive data concerning this species.

Dendrochernes Beier 1931

One species of this genus is now being reported from Oregon. See Hoff (1956c) for descriptive details of the genus.

Dendrochernes crassus Hoff 1956

Geographical distribution. New Mexico, Oregon (Map 22). This species is now reported from Oregon where it was collected in western Oregon in the Interior Valley Zone at elevations from 150-610 m in Benton, Douglas, Linn and Washington Counties. In eastern Oregon, it was collected in ponderosa pine areas from 760-1370 m in Harney and Crook Counties.

Habitats. Bark. Oregon specimens came from under bark of "dead" ponderosa pine and Douglas-fir, and under bark of a relatively "freshly fallen" ponderosa pine log (Chamberlin Collection, unpubl. records). One collector recorded western pine beetles (Dendroctonus brevicornis Lec.) with D. crassus.

Seasonal distribution. Oregon adults were collected in March, April, May and July, nymphs are unknown.

Remarks. See Hoff (1956c, 1961) for descriptive details.

Dinocheirus Chamberlin 1929

Two species, D. sicarius and D. validus, are now reported from Oregon. See Muchmore (1974b) for a revision of the genus.

Dinocheirus sicarius Chamberlin 1952

Geographical distribution. California, Oregon (Map 23), Utah. This species has been reported previously from California (Chamberlin 1952) and Utah (Gering 1956). Oregon specimens were collected at elevations from 0-610 m in farm areas.

Habitats. Domestic animal shelters. California specimens were collected from a barn, from barn owl (Tyto alba (Scopoli)) pellets, Neotoma spp. nests and middens, and attached to the trochanter of a muscid fly (Chamberlin 1952). No habitat data were given for the Utah specimens (Gering 1956). Oregon specimens came from domestic animal shelters, either currently or once occupied by cows, horses, sheep, pigs or fowl. D. sicarius was recovered in high numbers from litter-dung samples from inside, under or within a meter of these shelters. This pseudoscorpion was present regardless of the condition of the building, the type of floor, or the moisture content of the debris. It was not, however, recovered from rain-weathered material removed from a former barn site, even though it occurred in samples taken from chicken house litter on the same farm.

Seasonal distribution. Oregon specimens were collected at all seasons of the year and many samples contained all life stages. Two of the May samples from Coos and Yamhill Counties each included four females with egg masses of approximately 20 eggs each.

Remarks. See Chamberlin (1952) for a detailed description of this species complete with excellent illustrations.

Dinocheirus validus (Banks) 1895

Geographical distribution. California, Colorado, New Mexico, Oregon (Map 23), Utah. This species has been reported previously from widely scattered localities between the Rocky Mountains and the Sierra Nevada Mountains (Banks 1895; Hoff 1947, 1956c, 1958, 1961; Knowlton 1972). Now it is reported from seven Oregon counties, where it occurs in the Interior Valley and Sitka Spruce Zones of western Oregon and in riparian communities of northeastern Oregon.

Habitats. Bark, tree hollows. California specimens came from bark near Lake Tahoe (Banks 1895), New Mexico specimens from bark of fir logs (Hoff 1956c, 1959), Colorado specimens from under bark of cottonwood logs and dead quaking aspen (Hoff 1961) and Utah specimens from under a 2 x 4 board in the sagebrush zone (Knowlton 1972). Western Oregon specimens came from samples of tree hollow debris (Oregon white oak, grand and white firs) and bark of a living tree (lodgepole pine). D. validus was also collected "on fly. In rotary flight trap. Upper net (5')" at Forest Grove, Washington County (Chamberlin Collection, unpubl. record). Eastern Oregon specimens came from bark of cottonwood.

Seasonal distribution. Oregon adults were collected in January, March, April, May, August and September, nymphs are unknown.

Remarks. See Hoff (1947, 1956c, 1961) for descriptive details of this species.

Hesperochnes Chamberlin 1924

One species of this genus is known from Oregon. See Muchmore (1974b) for a revised diagnosis.

Hesperochnes utahensis Hoff & Clawson 1952

Geographical distribution. Colorado, Idaho, New Mexico, Oregon (Map 24), Utah. This species was reported previously from the Rocky Mountain states (Hoff & Clawson 1952; Hoff 1958, 1961; Knowlton 1972). Now it is reported from Harney County, Oregon, from two localities at elevations of 1220 m and 1700 m on the western slope of Steens Mountain in the Western Juniper Zone.

Habitats. Leaf litter. Utah specimens came from wood rat nests (Hoff & Clawson 1952) and litter of juniper, rabbitbrush and sagebrush (Knowlton 1972), Idaho specimens from juniper litter (Knowlton 1972), Colorado specimens from litter, under rocks and wood in the pinyon-juniper zone (Hoff 1961) and New Mexico specimens from juniper litter (Hoff 1956c). One Oregon collection came from 6 cm deep mossy-big sagebrush litter in an area roughly 16 km from the nearest tree. The other Oregon collection was recovered from 8 cm deep mountain spray litter accumulated on a talus slope overgrown with deciduous shrubs within a few meters of juniper trees.

Seasonal distribution. Oregon adults were collected in July and September, nymphs are unknown.

Remarks. See Hoff and Clawson (1952) and Hoff (1956c, 1961) for descriptive details.

Map 24. Distribution in Oregon: *Hesperocharnes utahensis* ■ ,
Illinocharnes stephensi ● .

Map 25. Distribution in Oregon: *Lamprocharnes* sp. ◈ ,
Lustrorhynchus grossus ● .

Illinichernes Hoff 1949

One species of this genus is being described from Oregon (Benedict & Malcolm 1978c). See Hoff (1949) for descriptive details of this genus.

Illinichernes stephensi Benedict & Malcolm (in manuscript)

Geographical distribution. Oregon (Map 24). This species is common in lowlands (elevations 50-550 m) of the Interior Valley and Western Hemlock Zones of western Oregon; one collection came from an elevation of 1650 m at a locality 6 km north of the California-Oregon border.

Habitats. Tree hollows. All but two collections came from tree hollows (12 bigleaf maple, four grand fir, three California laurel, three tan oaks, two Oregon white oak, one red alder, one madrone). Samples were taken separately of material from the floor, walls and ceiling of hollows; I. stephensi occurred in all areas of a hollow. It inhabits both dry-rotted and wet-rotted wood, large and small hollows. It was recovered from two leaf litter samples (madrone, scrub white oak).

Seasonal distribution. Oregon adults and nymphs were collected during every month of the year. One June collection from Polk County contained a female with 13 external eggs, another female with 18 embryos, three males and several nymphs of various stages.

Remarks. This species is named after my father, Charles Lester Stephens. A detailed description is in manuscript (Benedict & Malcolm 1978c).

Lamprochernes Tömösváry 1882

At the present time this genus is known from Oregon from one specimen (Muchmore Collection) which has not been identified to species. See Hoff (1956c) for descriptive details of the genus.

Lamprochernes sp.

Geographical distribution. Oregon (Map 25), Douglas County, Dixonville. This community is located in the Umpqua River portion of the Interior Valley Zone.

Habitat. No data except the microslide is labeled "Host-housefly".

Seasonal distribution. This Oregon female was collected in September, nymphs are unknown.

Lustrochernes Beier 1932

One species of this genus is being reported from Oregon. See Hoff (1956c) for descriptive details of the genus.

Lustrochernes grossus (Banks) 1893

Geographical distribution. Arizona, Colorado, New Mexico, Oregon (Map 25). This species has been reported previously from three Rocky Mountain states (Banks, 1893; Hoff 1956c, 1958, 1961); now it is being reported from Oregon where it occurs at elevations from 0-1300 m in the Interior, Western Hemlock and Ponderosa Pine Zones.

Habitats. Bark. Hoff (1961) observed that this species in New Mexico and Colorado was usually collected in areas of ponderosa pine; no data are available on Arizona specimens. Oregon specimens came from bark of a Douglas-fir and a pine stump and a rotted log; two specimens

were phoretic on cerambycid beetles.

Seasonal distribution. Oregon adults were collected in March and April, nymphs are unknown.

Remarks. See Hoff (1947, 1956c, 1961) for descriptive details.

FAMILY CHELIFERIDAE Hagen 1878

Cheliferids (Fig. 9), practically cosmopolitan in distribution, (Chamberlin 1931) occur in drier areas (Beier 1932b; Weygoldt 1969), or in drier habitats of mesic areas. Apparently, cheliferids obtain their greatest diversity in size and form in "the torrid and the warm temperate zones" (Hoff 1959:48). Most Oregon cheliferids have been collected in the drier habitats of animal or human shelters, or in the drier southwestern and eastern portions of the state.

Approximately 40 species of cheliferids have been reported from the United States with eight species recorded from Oregon. Banks (1895) gave a record for Parachelifer scabriculus (Simon) from Hood River which was one of the first records of pseudoscorpions from Oregon. Over 50 years elapsed before the next two cheliferid species were reported: Hoff (1950) provided records for Chelifer cancroides (L.) from Tillamook and Jackson Counties, and Chamberlin (1952) reported Haplochelifer philipi (Chamberlin) from four southern counties. Another quarter-century passed before the next five species were reported (Benedict & Malcolm 1978b). Aspurochelifer littlefieldi Benedict and Malcolm, Dactylochelifer silvestris Hoff, Hysterochelifer fuscipes (Banks), H. proprius Hoff, and P. persimilis (Banks).

Figure 9. Aspurochelifer littlefieldi Benedict & Malcolm,
a leaf litter-inhabiting cheliferid species from southern
Oregon. (Body length 2-3 mm).

Aspurochelifer Benedict & Malcolm (in press)

One species of this genus is reported from Oregon. See Benedict and Malcolm (1978b) for a detailed description of the genus.

Aspurochelifer littlefieldi Benedict & Malcolm (in press)

Geographical distribution. California, Idaho, Oregon (Map 26), Nevada, Washington. This species was collected in Oregon at elevations from 360-1300 m in the Interior Valley Zone of Josephine and Jackson Counties, and at 1220 m in the riparian community along the Blitzen River in the Western Juniper Zone of Harney County.

Habitats. Leaf litter. Even though the species has been collected from five states, the only habitat data are for three of the four Oregon localities. This species was recovered from two samples of Oregon ash litter from riparian communities in Josephine and Jackson Counties, and from mountain alder litter in Harney County. Specimens occurred in both ground litter and in litter trapped between the multiple trunks of ash and alder trees.

Seasonal distribution. Oregon adults were collected in March, July, September and December. Females with an average of 16 embryos, non-gravid females, males, protonymphs and deutonymphs were collected at the Harney County site (Page Springs) in both July of 1971 and 1972.

Remarks. See Benedict and Malcolm (1978b) for a detailed description of this species.

Chelifer Geofroy 1762

Chamberlin (1952) and Hoff (1956d) have characterized this monotypic genus in modern terms.

Map 26. Distribution in Oregon: Aspurochelifer littlefieldi ○ , Chelifer cancroides ● .

Map 27. Distribution in Oregon: Dactylochelifer silvestris ○ , Haplochelifer philipi ● .

Chelifer cancroides (Linnaeus) 1758

Geographical distribution. World-wide including Oregon (Map 26). This pseudoscorpion is the species typically seen by the non-specialist because it inhabits human and domestic animal shelters (Hoff 1949, 1964; Weygoldt 1969). Hoff (1950) reported the first specimens from Oregon from Tillamook and Jackson Counties.

Habitats. Human habitations and domestic animal shelters. Several Oregon collectors first became aware of pseudoscorpions by noticing a specimen of C. cancroides in a bed or bathtub. Oregon specimens are recorded from houses on beds, bathtubs, books, dishes, and even on humans; from barns and sheds in the litter-dung layer and in grain; from out-of-doors in grass clippings, under garage shingles, and in a swallow's nest (Hoff 1950; Benedict & Malcolm 1978b). C. cancroides occurred in eight of my litter-dung samples, sometimes with the chernetid species, Dinocheirus sicarius.

Seasonal distribution. Weygoldt (1969) has cultured C. cancroides and provided developmental and life history data. Oregon adults and nymphs were collected during every season from the litter-dung layer, as well as from the other Oregon habitats from which this species is known.

Remarks. Unlike Hoff (1949) in Illinois, and Ressler and Beier (1958) in Austria, I did not recover specimens of C. cancroides from bark or leaf litter in other than domestic situations. It is possible that the earlier records from non-domestic bark and leaf litter habitats pertain to another closely related genus such as Parachelifer Chamberlin.

Dactylochelifer Beier 1932

One species of this genus is reported from Oregon (Benedict & Malcolm 1978b). See Hoff (1956d, 1964) for descriptive details of the genus.

Dactylochelifer silvestris Hoff 1956

Geographical distribution. Colorado, Idaho, New Mexico, Oregon (Map 27), Utah. Oregon specimens are recorded from five scattered localities east of the Cascade Mountains at elevations from 1185-1375 m in the Ponderosa Pine, Sagebrush-Grassland and Western Juniper Zones.

Habitats. Leaf litter. Specimens from Colorado and New Mexico occurred in debris and litter of various conifers and broad-leaf trees (Hoff 1956d, 1961); from Utah and Idaho, in litter of Rocky Mountain juniper (Juniperus scopulorum Sarg.), sagebrush, greasewood (Sarcobatus vermiculatus (Hook.) Torr.), and rabbitbrush (Chrysothamnus spp.) (Knowlton 1972); and from Oregon, in litter of big sagebrush, willow, green manzanita and ponderosa pine (Benedict & Malcolm 1978b). Knowlton (1972:1) observed that D. silvestris was "by far the most common species in Curlew Valley" of Utah and Idaho.

Seasonal distribution. Oregon adults and nymphs were recovered in March, May, July and December, with an adult only in January. One female, collected in July from Harney County, bore 12 embryos.

Remarks. See Hoff (1956d, 1961) for descriptive details of this species.

Haplochelifer Chamberlin 1932

Chamberlin (1952) characterized this monotypic genus in modern terms, complete with detailed illustrations of Haplochelifer philipi.

Haplochelifer philipi (Chamberlin) 1923

Geographical distribution. Arizona, California, Colorado, Idaho, Nevada, New Mexico, Oregon (Map 27), Utah. Chamberlin (1952) reported the first Oregon specimens from five localities in Josephine, Jackson, Klamath and Malheur Counties; it is now known from 24 additional localities in these and six other counties (Benedict & Malcolm 1978b).

Habitats. Leaf litter. Throughout its range, it has been collected chiefly from litter beneath pines, oaks, madrone and juniper; and from beneath rocks (Chamberlin 1952; Hoff 1956d, 1961; Benedict & Malcolm 1978b). Oregon specimens occurred in 38 collections of leaf litter, one hand-collection from under a board and two from under rocks. In western Oregon, it appears to be the most common cheliferid inhabiting leaf litter, where it occurs at elevations from 0-1465 m in the interior Valley Zone between Benton County and the California-Oregon border. Here, it has been recovered mostly from the relatively dry, shallow litter of the oak-madrone-manzanita woodlands. In eastern Oregon, it was generally recovered from juniper and ponderosa pine litter at elevations from 900-1375 m in the Western Juniper and Ponderosa Pine Zones.

Seasonal distribution. Oregon adults and nymphs were collected during all seasons, often from the same collection.

Remarks. See Chamberlin (1952) for a detailed redescription

including excellent illustrations.

Hysterochelifer Chamberlin 1932

Two species, H. fuscipes and H. proprius, occur in Oregon. A revision of the western North American species of this genus is currently in progress (Benedict & Malcolm 1978d).

Hysterochelifer fuscipes (Banks) 1909

Geographical distribution. California, Oregon (Map 28), Washington. The three Oregon collections were taken in 1936, 1940 and 1961 in the Interior Valley Zone of Benton County. Although "likely habitats" were sampled for this species, it was not recovered in any of the 2220 Berlese samples taken in this study.

Habitats. Records from a number of localities in the three Pacific states will be reported which indicate that H. fuscipes occurs chiefly in relatively dry, chaparral type communities, where it has been collected from surfaces associated with living and dead shrubs and trees, including bark, mosses-lichens, leaf litter and the interior of cynipid galls (Benedict & Malcolm 1978d). The Oregon specimens were collected from a newly fallen log, moss on a silver popular tree (Populus sp.), and from "sweeping" undesignated material.

Seasonal distribution. Oregon adults were found in May, August and September.

Remarks. A detailed redescription of this species is in manuscript, based on a restudy of Banks' types (1969) and a number of specimens from various localities in the western United States (Benedict & Malcolm 1978d).

Map 28. Distribution in Oregon: *Hysterochelifer fuscipes* ○ ,
H. proprius ● .

Map 29. Distribution in Oregon: *Parachelifer persimilis* ○ ,
P. scabriculus ● .

Hysterochelifer proprius Hoff 1950

Geographical distribution. Arizona, California, Colorado, Idaho, New Mexico, Oregon (Map 28), Utah, Washington. Prior to the recent study by Benedict and Malcolm (1978b) H. proprius was considered as rare (Hoff 1961) since it had been reported only from a total of 11 specimens from Arizona, New Mexico and Colorado (Hoff 1950, 1956d, 1961). Now it is known to be widely distributed between the Rocky Mountain and Pacific states (Benedict & Malcolm 1978b, 1978d). Oregon specimens have been recorded from 22 localities, chiefly east of the Cascade Mountains.

Habitats. Throughout its range, H. proprius was collected most frequently from bark of juniper (Figs. 10, 11) and ponderosa pine, and more rarely from bark of mountain mahogany and birch. It was also collected from a soaptree yucca, the surface of a rock, "clothes drying on a line" (Hoff 1956d:12), and the stomach of a sagebrush lizard (Sceloporus graciosus (Baird & Girard)). Oregon specimens are known from 15 samples of bark from living western juniper and ponderosa pine trees, one hand-collection from the top of a rock under a juniper tree, and a "beaten" collection from a birch and from a pine. H. proprius is easily found by peeling exfoliating bark from trunks or branches of western juniper trees. The single western Oregon specimen came from a sample of ponderosa pine bark from the Interior Valley Zone of Benton County.

Seasonal distribution. Oregon adults were collected every month between January and July and in October; nymphs were collected in April, May, September and October. A female (Jefferson County, Camp Sherman,

Figure 10. Exfoliating bark of Juniperus occidentalis Hook.

Figure 11. A laboratory specimen (male) of Hysterochelifer proprius Hoff feeding on a collembolan.

14 May 1966, collected from a freshly fallen ponderosa pine log) survived in my laboratory for three months. On August 1st she produced four pale, green nymphs that escaped three days later. The male of the same collection died two weeks after capture.

Remarks. A detailed redescription of this species is in manuscript based on restudy of Hoff's types and an extensive series of specimens from widely-distributed localities of the western United States (Benedict & Malcolm 1978d).

Parachelifer Chamberlin 1932

Further study may reveal that Oregon specimens of this genus actually belong to a single highly variable species instead of the two species, P. persimilis and P. scabriculus, to which they have been assigned (Banks 1895; Benedict & Malcolm 1978b). See Chamberlin (1952) for a detailed redescription of this genus, complete with illustrations of P. scabriculus. Hoff (1956d, 1964) added further details.

Parachelifer persimilis (Banks) 1909

Geographical distribution. Arizona, Colorado, Montana, Nebraska, Nevada, New Mexico, Oregon (Map 29), South Dakota, Utah. Oregon specimens came from 15 "chance" collections from eight widely scattered localities at elevations from 0-2150 m in six counties.

Habitats. Bark. From states other than Oregon, this species has been collected most frequently from under bark of ponderosa pine stumps, logs, living and dead trees and less frequently from similar habitats of firs, spruce, pinyon and limber pines and aspen. It was also reported from the bark-debris at the base of a few trees, snags and stumps, in

rock crevices, and on a cerambycid beetle. Oregon specimens were collected most frequently without adequate data concerning their habitats. Of the 15 collections, two lack any habitat data, four are recorded just "from bark", three from "bark of a ponderosa pine tree", one from "bark slab of ponderosa pine" and five phoretic on "cerambycid beetle". The three specimens from Crater Lake National Park were transported on separate nights (8, 10, 17 August 1960) to ultraviolet light by cerambycids. The Clatsop County specimen was on the body of a cerambycid (31 August 1963). Interestingly, the Lake County specimens came from an isolated relict ponderosa pine forest on Hart Mountain, a basin range block fault mountain, and were hand-collected from under ponderosa pine bark of a living tree, and from a flying cerambycid beetle. Twelve of the other collections also came from ponderosa pine areas. Thus, despite limited data, it appears that Oregon specimens of P. persimilis exhibit a similar preference for ponderosa pine habitats as postulated for the species elsewhere (Hoff 1961).

Seasonal distribution. Oregon adults were collected in February, April, May, August and October; nymphs and adults in October.

Remarks. This species needs to be redescribed in detail based on a restudy of Banks' types and large series of specimens throughout its reported range.

Parachelifer scabriculus (Simon) 1878

Geographical distribution. Arizona, California, New Mexico, Oregon (Map 29), South Dakota, Utah. Historically, P. scabriculus was one of the first pseudoscorpion species with a published record from Oregon, "Hood's River, Oreg., one specimen (Hubbard)" (Banks 1895:4).

It is now known from three additional widely scattered localities in Oregon at elevations from 150-1525 m in the Interior Valley, Western Hemlock and Mixed Conifer Zones.

Habitats. Bark. Throughout its range, P. scabriculus has been reported chiefly from bark of deciduous and coniferous trees (Hoff 1963). Although habitat data are mostly lacking, this species has been reported from Utah under stones (Banks 1895), from California, under bark of dead pine, oak logs, and apple, eucalyptus and sycamore trees (Chamberlin 1952), and from South Dakota, from ponderosa pine infested with bark beetles (Hoff 1963). Oregon specimens are known from bark of a conifer snag, a living sugar pine and a Douglas-fir tree.

Seasonal distribution. Oregon adults were recovered in April and August, nymphs are unknown for the state.

Remarks. See Chamberlin (1952) for a detailed redescription of this species based on a number of specimens from California.

DISTRIBUTION AREAS AND DISPERSAL OF OREGON SPECIES

The individual species accounts provide the names of states from which species occurring in Oregon have been reported. Such a listing leads to speculation about mechanisms by which these small (body length, 1-7 mm), flightless animals have spread over large geographical areas. It appears that pseudoscorpion species must be either very ancient, or have very efficient means of dispersal, or both. Therefore, known dispersal mechanisms, including examples of phoresy, are discussed below which may explain the observed distributional areas.

DISTRIBUTIONAL AREAS

According to Udvardy (1969:153) the term "distributional area" is preferred to "range" when "something less than the entire area of a species is under discussion." Such is the case for most western North American pseudoscorpion species as few localities have been thoroughly sampled. As collection data become available, interesting patterns emerge.

A case in point is the apparent distribution of Pseudo-tyrannochthonius incognitus and P. gracilis in southwestern Washington, western Oregon and northwestern California (Map 30). P. incognitus, recovered in nearly 160 samples (Benedict & Malcolm 1970; Benedict Collection unpubl.), occurs in a nearly continuous area west of the Cascade Mountains except in two disjunct areas inhabited by

Map 30. Distribution in western Washington, western Oregon and northern California: *Pseudotyrannochthonius incognitus* ○ , *P. gracilis* ●

P. gracilis. P. gracilis, known from only seven collections (Benedict & Malcolm 1970; unpubl. records, Benedict Collection), occurs in the lower Puget Sound area of Washington and in the Klamath-Siskiyou area along the Oregon-California border. Additional collections may, of course, provide intermediate records for both species. True disjunct distributions result from either relict populations or from recent colonizations (Nelson 1971; Udvardy 1969).

Conclusions based on the current knowledge of pseudoscorpion distributions are only tentative as several major problems exist. For example, several species are probably invalid taxonomically due to too broad or too narrow species definitions. Even when species are adequately defined, one or more specimens may have been misidentified and are now unavailable for reexamination. Species may be reported from too few localities and/or from specimens collected in a "hit-or-miss fashion" without accurate locality or habitat data. Range maps and lists may suggest that a species occurs statewide when it actually inhabits a very limited area. Any of these problems can distort the apparent distributional area or range of a species.

With these limitations in mind, the following Oregon species are grouped according to distributional areas somewhat similar to the ones devised by Nelson (1971) for Michigan species.

- a. World wide: Chelifer cancroides.
- b. Midwestern through Pacific states: Acuminochernes crassopalpus.
- c. Western edge of Great Plains through Pacific States: Lechytia hoffi, Parachelifer persimilis, P. scabriculus.

- d. Rocky Mountains through Pacific states: Apochthonius occidentalis, Archeolarca rotunda, Larca notha, Pseudogarypus bicornis, Dendrochernes crassus, Dinocheirus sicarius, Dactylochelifer silvestris, Haplochelifer philipi, Hysterochelifer proprius.
- e. Pacific slope: Apocheiridium ferumoides.
- f. Pacific coastline: Halobisium occidentale.
- g. Pacific Northwest: Pseudogarypus hesperus.
- h. Southwestern Oregon and northern California: Neochthonius amplius, Malcolmochthonius malcolmi.
- i. Two disjunct areas (Pugest Sound area, Washington; Klamath Mountains of Oregon and California): Pseudotyranochthonius gracilis.
- j. One locality (possible endemic species) Redmond Cave: Parobisium charlotteae; Malheur Cave: Apochthonius malheuri; sink of Charcoal Cave No. 1: Apochthonius forbesi.

Other Oregon species probably exhibit similar patterns but are known from too few localities or collections to categorize at this time.

DISPERSAL OF PSEUDOSCORPIONS

Although the distributional areas outlined may not reflect the actual ranges of the species involved, it is useful to discuss dispersal mechanisms which could account for such distributions. Mechanisms include phoresy, human activities and air currents (Nelson 1971).

Phoresy, defined as a "nonparasitic association of one kind of

animal with another which results in the transportation of the smaller by the larger" (Muchmore 1971:95), is the usual means postulated by which pseudoscorpions disperse. According to Muchmore, phoresy is the accidental by-product of predation. The pseudoscorpion in search of food attaches to a larger animal ("host") and is accidentally carried to another locality.

Oregon species observed in some part of their range attached to or on other animals are:

Chelifer cancroides, one male and one female on a human,

Benton County, Oregon, reported by Benedict & Malcolm (1978b).

Dinocheirus sicarius, one female clinging to trochanter of third leg of a muscid fly, Monterey County, California (Chamberlin 1952).

Dinocheirus validus, one female on a fly, Washington County, Oregon (unpubl. record, Chamberlin Collection).

Hysterochelifer fuscipes, one female attached by right chela to left second leg of a bostrichid beetle (Psoa quadrisignata Horn), Marin County, California (Benedict & Malcolm 1978d).

Lamprochernes sp., one female on a housefly (Musca domestica L.), Douglas County, Oregon (unpubl. record, Muchmore Collection).

Larca chamberlini, one male on a mosquito, Yuba County, California (Benedict & Malcolm 1977); one female on abdomen of a hibernating mosquito, Benton County, Oregon (unpubl. record, Chamberlin Collection).

Lechytia hoffi, one male and one female clinging to hind tarsus of a small beetle (Prostomis mandibularis Fabr.), Santa Cruz County, California (Muchmore 1975a).

Lustrochernes grossus, two females clinging to dorsal abdominal setae of a male giant crab spider (Olios fasciculatus Simon), Gila County, Arizona (Hoff & Jennings 1974); two females under elytra of a cerambycid beetle, "Oregon" (unpubl. record, Chamberlin Collection); five adults "ex." cerambycid beetles (Ergates spiculatus spiculatus LeConte), Benton County, Oregon (unpubl. record, Benedict Collection); nine males, ten females on E. spiculatus, Coconino County, Arizona (Muchmore 1971).

Mundochthonius sp., one male attached by the right chelicera to fourth left leg of a small centipede, Tillamook County, Oregon (unpubl. record, Benedict Collection).

Parachelifer persimilis, five males, seven females on cerambycid beetles (E. spiculatus), Coconino County, Arizona (Muchmore 1971); two males, two females under elytra of a prionine cerambycid (Tragosoma depsarium (L.)), Sandoval County, New Mexico (Muchmore 1971); one male, two females on separate cerambycids (Ortholeptura valida LeConte), Crater Lake National Park, Oregon (Benedict & Malcolm 1978b); one female on a cerambycid, Clatsop County, Oregon (Benedict & Malcolm 1978b); one male, one female attached to a leg of a cerambycid (Brachyleptura canadensis Kirby), Hart Mountain, Lake County, Oregon (Benedict & Malcolm

1978b).

Thus, specimens of ten pseudoscorpion species reported from Oregon have been collected in some part of their range either on or attached to another animal. It may be questioned whether the specimen of C. cancroides on a human is a case of phoresy, but it fits Muchmore's definition of being on a larger animal and could have been transported. The pseudoscorpion (Mundochthonius sp.) attached to the centipede may have been feeding since the fingers of the chelicera had penetrated the exoskeleton of the centipede's leg and disrupted the tissues. Pseudoscorpions of five species have been recorded as phoretic on insects in Oregon: Lustrochernes grossus and Parachelifer persimilis on cerambycid beetles, Dinocheirus validus and Lamprochernes sp. on flies, and Larca chamberlini on mosquitoes. The beetles carrying P. persimilis were collected in flight.

Phoresy, according to Weygoldt (1969) and Muchmore (1971), is observed mostly among the chernetids and cheliferids, less often among species of other families, and almost never among neobisiids and chthoniids. This may relate to the fact that many chthoniids and neobisiids inhabit moist woody plant litter and do not come into contact with suitable "host" animals (Beier 1948; Muchmore 1971). Another interpretation is that these pseudoscorpions would desiccate if flown through the air, thus, phoresy would be disadvantageous. The only chthoniid reported as phoretic by Muchmore was Lechytia hoffi. It inhabits bark and relatively dry litter, and consequently, would not desiccate as easily as pseudoscorpions from other habitats. The heavily-sclerotized chernetids and cheliferids also typically occur

in the drier habitats. See Müller (1960) and Weygoldt (1969) for photographs of a chernetid attached to a braconid hymenopteran embedded in amber of Oligocene age.

Humans apparently serve as indirect transporters of pseudoscorpions during movement of domestic animals and plant materials throughout the world (Muchmore 1963, 1969b, 1972a; Weygoldt 1969). Chamberlin (1938) reported instances of interception of pseudoscorpions at quarantine stations. One specimen of the European species, Allochernes peregrinus Lohmander, was recovered from New Hampshire and is considered an import by Muchmore (1972a). Two European species, C. cancroides and Cheiridium museorum (Leach), appear established in the United States through the transport of domestic animals (Muchmore 1973). Two other European species, Chthonius tetrachelatus (Preyssler) and Roncus lubricus L. Koch, occur in and around Rochester, New York, and may have been imported with nursery stock (Muchmore 1963). Nelson (1971:45), however, reported C. tetrachelatus as "widely distributed in the eastern part of the United States from Georgia to Maine, and as far west as Illinois." Possibly C. tetrachelatus is a relict of the time approximately 100 million years ago when the North American and Eurasian plates were joined (Kürtén 1969) and not a recent import at all. The other three European species were not reported from the southeastern states (Lawson 1968) nor from Michigan (Nelson 1971). They probably represent recent introductions.

Little is known of the dispersal of leaf litter-inhabiting chthoniids and neobisiids. A fast-moving arthropod, i.e., the centi-

pede (5.6 mm body length) to which the specimen of Mundochthonius sp. (1.2 mm body length) was attached, certainly could disperse pseudoscorpions through leaf litter. Nelson (1971) suggested that chthoniids and neobisiids are dispersed by air currents, but Lawson (1968:214) cast doubt on this idea since "their secluded habitat would protect them from high winds." I have seen leaf litter blown from hilltops. This sight suggests that wind dispersal could be a factor. Whatever the means, these tiny pseudoscorpions are certainly widely distributed.

ANCIENT ORIGIN OF PSEUDOSCORPIONS

According to Savory (1968) conditions in cryptozoic habitats probably have not changed appreciably for millions of years and thus have not produced much selective pressure for change. If true, then the distributional areas observed for pseudoscorpion species can be explained by the long passage of time during which a species could disperse. Udvardy (1969) noted that species of other taxa with broad distributions or with disjunct distributions were ancient, spreading initially from very small centers to their present areas. Hoff (1959) presented an interesting discussion of the adaptive radiation of pseudoscorpion families. Savory (1964:107) noted that pseudoscorpions "are found everywhere except in the frigid regions of the Arctic and Antarctic."

Normally, if one wishes to suggest an ancient origin for a species, evidence is gathered from fossils. However, pseudoscorpion fossils are rare, even though modern genera, including Pseudogarypus (Beier 1937; Roewer 1940; Savory 1964), were preserved in Oligocene

age ambers. Other closely-related arachnids were preserved among the earliest land invertebrates. Scorpions occur in formations of Silurian age and mites (Acari) in formations of Devonian age (Savory 1964). It is reasonable to think that pseudoscorpions are equally ancient but generally were not fossilized due to their habitats.

HABITATS OF OREGON PSEUDOSCORPIONS

This is the second major work from the United States with a detailed analysis of pseudoscorpions and their habitats. As background, the following information about Oregon biotic provinces is provided.

BIOTIC PROVINCES OF OREGON

Five major biotic provinces merge in Oregon, producing one of the more diverse states of North America in terms of environment and vegetation (Franklin & Dyrness 1973) and hence biotic communities. Three of these provinces intergrade in western Oregon--the mesic temperate coniferous forests typical of Washington and northwestern Oregon, the sclerophyllous forests of the Coast Ranges of California and southwestern Oregon, and the mixed coniferous forests of the Sierra Nevada and the interior of southwestern Oregon. The forests of eastern Oregon are primarily of the Rocky Mountain type, dominated by ponderosa pine and white fir, with western juniper on drier sites. Shrub-grass communities of the Great Basin occur in central and southeastern Oregon. This biotic diversity is difficult to classify ecologically because indefinite boundaries exist between communities, and because natural vegetation has been disrupted by logging, clearing, burning and grazing (Franklin & Dyrness 1973).

HABITAT RELATIONSHIPS OF OREGON SPECIES ACCORDING TO SUBORDERS

Heterosphyronid and diplosphyronid pseudoscorpions typically occur in soil-leaf litter and deep subterranean habitats, while monosphyronids are more typical of bark, rotted wood, animal nests and debris, domestic animal shelters and human habitations (Hoff 1959; Chamberlin & Malcolm 1960; Lawson 1968; Nelson 1971; Muchmore 1973). Tables III to V include the 50 identified Oregon species listed by habitats using the format of Nelson (1971). Habitat relationships of species to higher taxonomic categories shown in these tables will be more evident once the remaining Oregon specimens are identified to species, since most unidentified specimens are diplosphyronids from leaf litter habitats.

In the meantime, 27 Oregon species have been identified from woody plant litter, 20 from bark, seven from tree hollows, four from rotted wood, nine from epiphytes, six from under or on rocks, three from under boards, five from a cave or a well, five from animal nests, two from domestic animal shelters, two from human habitations, and one from an outhouse. Seven species were collected phoretically in Oregon.

HABITAT SPECIFICITY OF OREGON PSEUDOSCORPION SPECIES

Pseudoscorpion species from Oregon are difficult to classify ecologically as a number of the species occur in several vegetational zones (Appendix II) and in a variety of habitats (Tables III-V) in these zones. Even though it is premature to list species according to particular sites, given the current systematic problems and lack

TABLE III
OREGON HABITATS OF HETEROSPHYRONID PSEUDOSCORPIONS

	<u>Apocthonius forbesi</u>	<u>A. malheuri</u>	<u>A. minimus</u>	<u>A. occidentalis</u>	<u>Chthonius oregonicus</u>	<u>Kleptochthonius geophilus</u>	<u>K. oregonus</u>	<u>Lechytia hoffi</u>	<u>Malcolmochthonius malcolmi</u>	<u>M. oregonus</u>	<u>Mundochthonius erosidens</u>	<u>M. magnus</u>	<u>M. pacificus</u>	<u>Neochthonius amplius</u>	<u>Pseudovrannochthonius gracilis</u>	<u>P. incognitus</u>
Woody plant litter	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X
Bark			X	X				X					X			
Tree hollows				X				X			X		X			
Rotted wood				X				X			X					
Epiphytes			X	X							X		X			X
Under or on rocks																
Under boards			X													
Caves or wells		X													X	
High tide zone																
Animal nests				X									X			
Animal shelters																
Human habitations																

TABLE IV
OREGON HABITATS OF DIPLOSPHYRONID PSEUDOSCORPIONS

	<u>Halobisium occidentale</u>	<u>Microcreagris cingara</u>	<u>M. columbiana</u>	<u>M. theveneti</u>	<u>Parobisium charlotteae</u>	<u>P. hesperum</u>	<u>Svarinus spp.</u>	<u>Archeolarca rotunda</u>	<u>Larca chameralini</u>	<u>L. notha</u>	<u>Oreolpium nymphum</u>	<u>Pseudogarypinus frontalis</u>
Woody plant litter		X		X			X			X	X	X
Bark							X				X	X
Tree hollows												
Rotted wood				X								
Epiphytes				X					X			
Under or on rocks						X						
Under boards												
Caves or wells			X		X							
High tide zone	X											
Animal nests								X				
Animal shelters												
Human habitations									X			

TABLE V
OREGON HABITATS OF MONOPHYRIONID PSEUDOSCORPIONS

	<u>Pseudozarypus bicornis</u>	<u>P. hesperus</u>	<u>Apocheilidium bulbifemorum</u>	<u>A. fergusoni</u>	<u>A. ferumoides</u>	<u>A. granochelum</u>	<u>A. mormon</u>	<u>Acuminochernes crassopalpus</u>	<u>Dendrochernes crassus</u>	<u>Dinocheirus sicarius</u>	<u>D. validus</u>	<u>Hesperochernes utahensis</u>	<u>Illinoichernes stephensi</u>	<u>Lamprochernes sp.</u>	<u>Lustrochernes grossus</u>	<u>Aspurocheilifer littlefieldi</u>	<u>Cheilifer cancriformis</u>	<u>Dactylocheilifer silvestris</u>	<u>Haplocheilifer philipi</u>	<u>Hysterocheilifer fuscipes</u>	<u>H. propius</u>	<u>Paracheilifer persimilis</u>	<u>P. scabriculum</u>
Woody plant litter	X											X	X			X		X					
Bark	X	X	X	X	X	X	X		X		X				X						X	X	X
Tree hollows	X										X		X										
Rotted wood															X								
Epiphytes	X																			X			
Under or on rocks	X	X																	X		X		
Under boards																			X				
Caves or wells																							
High tide zone																							
Animal nests								X										X					
Animal shelters										X								X					
Human habitations																		X					

of intensive sampling, a few generalizations are possible. For example, chthoniids and neobisioids are more common in northwestern Oregon, while cheliferids, chernetids and pseudogarypids are more typical of southeastern Oregon.

It is informative to compare these two sections of the state in terms of pseudoscorpion habitat specificity. Superficially, at least, it appears that most species considered in this study exhibit specificity for a habitat type (e.g., bark, leaf litter, litter-dung) rather than for microhabitats provided by particular plant species. However, the diversity of pseudoscorpion species at any given locality appears partially to reflect the diversity of the vegetation at a particular site. For example, in mesic northwestern Oregon where the litter layer is nearly continuous and composed of debris from several plant species, five to seven pseudoscorpion species were often recovered from a sample. In contrast, in semi-arid southeastern Oregon, where the litter layer is in discrete patches, and each patch is composed of debris from only one or two plant species, only one or two pseudoscorpion species were recovered in a sample. At such sites, pseudoscorpion species appeared to be relatively specific to a particular microhabitat. In fact, at Page Springs (Harney County), I can predict with reasonable accuracy the pseudoscorpion species by just knowing the microhabitat--e.g., Lechytia hoffi and Haplochelifer philipi in western juniper litter. Hysterochelifer proprius under juniper bark, Pseudogarypus bicornis, Dactylochelifer silvestris and Aspurochelifer littlefieldi in debris of mountain alder and willow, and Apochthonius occidentalis in chokecherry litter.

Hoff (1959) noted a similar type of specificity exhibited by the pseudoscorpion species of New Mexico. Leaf litter species of Michigan (Nelson 1971) and of the southeastern states (Lawson 1968) appear not to exhibit any particular specificity for a microhabitat, which is the situation with mesic litter species of northwestern Oregon.

The comparison between northwestern and southeastern Oregon can be carried further. A sample from a northwestern site might contain up to 800 pseudoscorpions, but 0-100 were more usual. A sample from a southeastern site might have up to 40 pseudoscorpions, but 0-10 were more typical. The success rate of recovery from samples from "likely" habitats in northwestern Oregon was about 90%, while this rate was about 30% for southeastern Oregon samples. Naturally, the rate was higher at resampled sites which explains differences in these percentages and the number of successful collections mentioned under Methods and Materials.

The following nine categories appear to reflect the known ecological types of the currently identified Oregon pseudoscorpion species.

1. Mesic Litter-Epiphyte-Inhabiting Forms. Mixed deciduous-broad-leaf and coniferous-needle-leaf trees and shrubs occur in dense forests and woodlands in the humid rain forest and semi-rain forest environments of the northern two-thirds of western Oregon. Masses of well-rotted debris accumulate in layers roughly 2-15 cm deep which cover not only the ground, rocks and logs, but adhere to bark of

stumps, snags, tree trunks, branches and crotches. Most of these surfaces support abundant epiphytes, generally mosses and lichens, and often vascular plants such as ferns, huckleberry, salal, and seedlings of western hemlock and Douglas-fir.

Several species of chthoniid and neobisioid pseudoscorpions inhabit both the ground and epiphyte layers. Thus, for practical purposes, it appears that the ground and epiphyte layers are ecologically nearly continuous with each other, enabling certain pseudoscorpions to move between the horizontal and vertical layers.

Species which typically inhabit these mesic litter-epiphyte habitats in Oregon are:

Apochthonius minimus. Identified from 15 western Oregon and 1 eastern Oregon county (Map 7); over 70 collections from woody plant litter (mixed deciduous, sclerophyllous, coniferous), 1 from moss, 1 from bark (pine stump), 1 from under board; elevations 0-1675 m.

Apochthonius occidentalis. From all 18 western Oregon and from 2 eastern Oregon counties (Map 8); over 150 collections from woody plant litter (mixed deciduous, sclerophyllous, coniferous), 3 from mosses-lichens (forest floor, rock surfaces, log), 3 from bark (living tree, drift log), 2 from well-rotted wood (Sitka spruce stump, rotted log), 1 from tree hollow debris (bigleaf maple), 2 from packrat nest debris (in old shed, on forest floor); elevations 0-1700 m.

Chthonius oregonicus. From 1 southwestern Oregon county (Map

9); 1 collection from coniferous-deciduous leaf-litter; elevation near 0 m.

Microcreagris spp. Species of this genus are represented in numerous western Oregon collections from these habitats, but specimens have not been identified to species due to complex systematic problems. Two leaf litter species, M. theveneti (Banks 1895, 1900) and M. cingara (Chamberlin 1930), were reported by other workers.

Mundochthonius erosidens. From 5 western Oregon counties (Map 11); 10 collections from woody plant litter (mixed deciduous, sclerophyllous, coniferous), 4 from tree hollows, 2 from rotted wood (stump, snag); elevations 60-2285 m.

Mundochthonius pacificus. From 6 western Oregon counties (Map 12); 5 collections from woody plant litter (Douglas-fir, California laurel), 3 from mosses-lichens, 3 from tree hollows, 2 from bark (tree, snag), 1 from shrew's nest; elevations 0-1000 m.

Parobisium spp. Species of this genus are represented in numerous western Oregon collections, but specimens have not been identified to species due to complex systematic problems. Parobisium hesperum was reported by Chamberlin (1930) from rubble beneath a log above high tide at Cannon Beach (Map 5); it is probable that many of the western Oregon specimens will be assignable to this species.

Pseudotyrannochthonius incognitus. From 16 western Oregon counties (Map 14); over 100 collections from woody plant

and fern litter (mostly deciduous, coniferous), at least 15 from mosses-lichens (forest floor, rock surfaces, logs, tree surfaces), and 5 from rotted wood; elevation 0-1220 m.

2. Semi-Xeric Litter-Inhabiting Forms. Widely diverse forest, woodland, and grass-shrub communities occur in southwestern, north-eastern and southeastern Oregon, all characterized by basically dry to semi-dry tree or shrub litter, sometimes less than 1-2 cm deep. Although the litter layer is nearly continuous in some forests, in other areas, it is in discrete patches due to widely scattered trees or shrubs. A pseudoscorpion species inhabiting these discrete patches appears to exhibit greater specificity for the litter of one or two plant species than it does in an area where the litter is continuous.

Species typical of semi-xeric litter habitats in Oregon are:

Apochthonius forbesi. From 1 eastern Oregon county (Map 7);

1 collection from mossy-leaf litter (mountain spray) in Charcoal Cave No. 1 Sink; elevation 1385 m.

Aspurochelifer littlefieldi. From 3 southern Oregon counties

(Map 26); 6 collections from woody plant litter (mountain alder, Oregon ash); elevations 360-1300 m.

Dactylochelififer silvestris. From 3 eastern Oregon counties

(Map 27); 5 collections from woody plant litter (green manzanita, willow, ponderosa pine, big sagebrush); elevation 1185-1375 m.

Haplochelififer philipi. From 10 southern Oregon counties (Map

27); 39 collections from woody plant litter (oak, madrone, manzanita, juniper, ponderosa pine), 2 from under rocks, 1 from under board; elevations 0-1465 m.

Hesperochnes utahensis. From 1 southeastern Oregon county (Map 24); 2 collections from woody plant litter (mountain spray, big sagebrush); elevations 1220-1700 m.

Kleptochthonius geophilis. From 1 southwestern Oregon County (Map 9); 1 collection from woody plant litter (red alder); elevation near 0 m.

Kleptochthonius oregonus. From 4 southwestern Oregon counties (Map 9); 33 collections from woody plant litter (deciduous, coniferous, sclerophyllous); elevations 120-1460 m.

Larca notha. From 1 southeastern Oregon county (Map 16); 1 collection from woody plant litter (mountain alder); elevation 1220 m.

Malcolmochthonius malcolmi. From 1 southwestern Oregon county (Map 10); 9 collections from woody plant litter (manzanita, live oak, oak, madrone, tan oak, sugar pine, knobcone pine, Sitka spruce); elevations 60-915 m.

Malcolmochthonius oregonus. From 1 southwestern Oregon county (Map 10); 1 collection from woody plant litter (tan oak and Douglas-fir); elevation 250 m.

Mundochthonius magnus. From 2 southwestern Oregon counties (Map 11); from 13 collections from woody plant litter (live oak, tan oak, bigleaf maple, red alder, Douglas-fir, western white pine); elevations 0-1220 m.

Neochthonius amplus. From 6 western Oregon counties (Map 13);

12 collections from woody plant litter (Douglas-fir, bigleaf maple, oak, live oak, madrone, manzanita); elevations 0-450 m.

Pseudotyrannochthonius gracilis. From 2 southwestern Oregon

counties (Map 14); 1 collection from woody plant litter (Douglas-fir), 1 from lower crawlway in Oregon Cave; elevations 0-1220 m.

3. Semi-Xeric Litter and Bark-Inhabiting Forms. These pseudoscorpions occur in bark and in the semi-xeric to dry litter discussed in the last category. Bark of certain trees (e.g., madrone, firs, pines, spruces, Douglas-fir, juniper) tends to exfoliate and accumulate at the base of the trunk; pseudoscorpions commonly inhabit this debris. Certain species (e.g., Pseudogarypus bicornis) inhabit semi-xeric litter and bark in mesic areas and the more mesic leaf litter in semi-arid areas. In Harney County, P. bicornis was collected only from litter removed from tree crotches of willow and mountain alder but not from western juniper, even at the same localities (Page Springs and Big Indian Creek on Steens Mountain). In western Oregon, P. bicornis was collected from litter and bark of a wide variety of trees and thus is assigned to this category.

Species which typically inhabit semi-xeric litter and bark habitats in Oregon are:

Lechytia hoffi. From 5 western Oregon and 2 eastern Oregon

counties (Map 10); 11 collections from bark (living trees,

stumps, logs), 6 from tree hollows (Douglas-fir, red alder, oak, madrone), 2 from rotted wood (stump, snag), 6 from litter of woody plants (juniper, ponderosa pine, madrone, manzanita), 2 from harvester ant debris; elevations 150-1525 m.

Hysterochelifer fuscipes. From 1 western Oregon county (Map 28); 1 collection from under bark (log), 1 from moss (tree), 1 from "sweeping"; elevation near 0 m.

Pseudogarypinus frontalis. From 2 southwestern Oregon counties (Map 17); 4 collections from woody plant litter (sugar pine, Jeffrey pine, California black oak, canyon live oak), 2 from bark of living trees (Douglas-fir, madrone); elevations 150-1465 m.

Pseudogarypus bicornis. From 8 counties in southern third of Oregon (Map 18); 24 collections from woody plant litter (deciduous, coniferous), 6 from bark of living trees (coniferous), 4 from tree hollows (Douglas-fir, grand fir, ponderosa pine, madrone), 5 from mosses-lichens (surface of rocks, tree trunks), 1 from under rock; elevations 305-2075 m.

4. Bark-Inhabiting Forms. Bark of living trees provides three potential zones for pseudoscorpion habitation which I will term epicortical, cortical and subcortical after Chamberlin's (1952) use of "subcortical" for species of Parachelifer.

The epicortical zone (outer surface), if inhabited by

pseudoscorpions, is typically covered with epiphytes. Generally chthoniids and neobisioids were collected from this zone and not true bark species.

The cortical zone (spaces between bark scales) develops more or less as a tree ages, depending upon its condition and species and the climatic conditions (e.g., temperature, humidity). Young trees, with their rather solid bark, apparently lack suitable crevices for pseudoscorpions or their prey. In contrast, old Douglas-firs and western hemlocks with large diameters (dbh 1.2-2.5 m) contain numerous crevices between the well-rotted, thin (1-2 mm) bark layers. These spaces are inhabited by Pseudogarypus hesperus and Oreolpium nymphi. Several species occur between the slightly thicker, more rigid scales of ponderosa pine (e.g., Parachelifer persimilis, P. scabriculus) and of sugar pine, Sitka and Engelmann spruces (e.g., Apocheiridium spp.). H. proprius inhabits bark and branches of western juniper (Figs. 10, 11) and is easily seen in the tiny moist spaces where the exfoliating bark shreds away from the firmly attached bark. Although these examples pertain to coniferous trees, pseudoscorpions typically live in the bark of non-coniferous trees and shrubs also. By far the greater number of the bark-inhabiting specimens was obtained by Berlese extraction rather than by visual inspection of bark in the field. The latter method was relatively unsuccessful except for juniper bark.

The subcortical zone (spaces between bark and wood) develops as cambium tissue dies and the bark and wood separate. Thus, pseudoscorpions of this zone are more prevalent in dying trees, snags or

logs. Such is the case with Dendrochernes crassus in Oregon, and possibly P. persimilis, both species collected by Hoff (1959) from dead trees or logs in New Mexico. In Oregon, true bark species appear more common in semi-xeric areas, while litter-epiphyte-inhabiting forms (chthoniids and neobisioids) appear more typical of the very humid areas.

Several species listed below are known from only one or two Oregon collections. They are included, either because the species is corticolous (or subcorticolous) throughout most of its distributional area, or the genus to which it belongs is bark-inhabiting (e.g., Apocheiridium). In fact, specimens of species such as Oreolpium nymphum, Hysterochelifer proprius (Fig. 11) and Apocheiridium spp. (Fig. 7) exhibit flattened bodies, relatively short legs, and flattened chelae which enable them to move between bark flakes. Species typical of bark habitats in Oregon are:

Apocheiridium bulbifemorum. From 1 southwestern Oregon county (Map 20); 1 collection from bark of living trees (sugar pine); elevation 800 m.

Apocheiridium fergusonii. From 2 eastern Oregon counties (Map 20); 3 collections from bark of living trees (western juniper); elevations 915-1220 m.

Apocheiridium ferumoides. From 4 western Oregon counties (Map 20); 6 collections from bark of living trees (Sitka spruce, Douglas-fir, western red cedar); elevation near 0 m.

Apocheiridium granochelum. From 2 western Oregon counties (Map 21); 3 collections from bark of living trees (oak,

Oregon ash); elevation near 0 m.

Apocheiridium mormon. From 1 western Oregon county (Map 21);

1 collection from bark of living tree (oak), 1 from old fence post; elevation near 0 m.

Dendrochernes crassus. From 4 western Oregon and 3 eastern

Oregon counties (Map 22); 4 collections from bark of snags (ponderosa pine, Douglas-fir), 1 from bark of log (ponderosa pine); elevations 150-1370 m.

Dinocheirus validus. From 5 western Oregon and 2 eastern Oregon

Counties (Map 23); 5 collections from tree hollows (white fir, grand fir, Oregon white oak), 3 from bark of living trees (lodgepole pine, cottonwood), 1 phoretic on fly; elevations 0-?1000 m.

Hysterochelifer proprius. From 1 western Oregon and 8 eastern

Oregon counties (Map 28); 10 collections from bark of living western juniper trees, 1 from bark of living ponderosa pine tree, 4 from ponderosa pine (source unknown), 1 from rock surface, 2 from "beating" (birch, pine); elevations 0-1525 m.

Lustrochernes grossus. From 3 western and 1 eastern Oregon

counties (Map 25); 3 collections from bark (rotted log, pine stump, Douglas-fir stump), 2 phoretic on cerambycid beetles; elevations 0-1300 m.

Oreolpium nympha. From 5 western Oregon counties (Map 17);

10 collections from bark of living trees (Douglas-fir, western hemlock, sugar pine, ponderosa pine), 1 from woody plant litter (Douglas-fir and maple); elevations 305-1675 m.

Parachelifer persimilis. From 1 western Oregon and 5 eastern Oregon counties (Map 29); 4 collections from "bark", 3 from bark of living trees (ponderosa pine), 1 from log (ponderosa pine), 5 phoretic on cerambycid beetles; elevations 0-2150 m.

Parachelifer scabriculus. From 4 western Oregon counties (Map 29); 2 collections from bark of living trees (sugar pine, Douglas-fir), 1 from bark of snag (conifer); elevations 150-1525 m.

Pseudogarypus hesperus. From 6 western Oregon and 2 eastern Oregon counties (Map 19); 19 collections from bark of living trees (Douglas-fir, mountain and western hemlock, Engelmann spruce, Pacific silver fir, western red cedar), 1 from under rock, 1 from outhouse; elevations 0-1525 m.

5. Tree Hollow-Inhabiting Forms. Hollows of living trees nearly always contain rotted wood, unless recently flooded. Less often they contain soil and mammal, bird or insect debris. More rarely, they contain leaf litter and debris of the forest floor which has washed in. Regardless of the origin of the debris or the size of the hollow, these cavities provide suitable conditions for a wide variety of pseudoscorpions and their prey.

Several types of pseudoscorpions are found in tree hollows. Certain chthoniids, which typically occur in other habitats, are frequently present in the damp, rapidly-decomposing wood of hollows in red alder (e.g. Apochthonius occidentalis). Bark-inhabiting forms

are in hollows, suggesting either migration between cortical and sub-cortical spaces and the hollows, or a mixed sample. Phoretic "hosts" may carry pseudoscorpions such as Dinocheirus validus and Acuminochernes crassopalpus into hollows. Illinichernes stephensi appears to be a "true" cavity-dweller. It is common in the decomposing wood and debris of the walls, floor and ceilings of hollows of both soft-woods and hardwoods, especially in old bigleaf maples.

A typical tree hollow-inhabiting pseudoscorpion from Oregon is: Illinichernes stephensi. From 8 western Oregon counties (Map 24); 28 collections from tree hollows (14 bigleaf maple, 3 tan oak, 3 grand fir, 3 California laurel, 2 Oregon white oak, 1 red alder, 1 white fir, 1 madrone), 2 from woody plant litter; elevations 50-1650 m.

6. Animal Nest and Debris-Inhabiting Forms. Animal nests and debris provide habitats for a number of pseudoscorpion species, several of which apparently exhibit a high degree of specificity for these habitats (Hoff & Clawson 1952; Weygoldt 1969). However, prior to the present investigation, the only Oregon record reported from bird, small mammal or insect nests was Hoff's (1950) report of Chelifer cancroides from a swallow's nest from Tillamook County. Only mesic litter-epiphyte-inhabiting forms were recovered from the abandoned bird nests collected during the current study. Although few samples contained material clearly identifiable as rodent debris, C. cancroides and Archeolarca rotunda were extracted from debris of pack rats and Acuminochernes crassopalpus from debris of a California

ground squirrel. A huge pack rat nest in an incense cedar tree contained litter-inhabiting chthoniids, as did a shrew's nest constructed of mosses. Debris from harvester ant nests in Harney and Deschutes Counties contained Lechytia hoffi, otherwise collected in Oregon from semi-xeric litter, bark and rotted wood. It is evident from this data that the pseudoscorpion fauna associated with animal nest debris is virtually unknown for Oregon.

Although insufficient Oregon collections exist to justify including the following species in this category, they are so placed from their records from other states. Oregon species which appear to inhabit animal nests and debris are:

Acuminochernes crassopalpus. From 1 northwestern Oregon county

(Map 22); 1 collection from tree hollow debris from

California ground squirrel "nest"; elevation near 0 m.

Archeolarca rotunda. From 1 eastern Oregon county (Map 16);

1 collection from debris of pack rat (Unnamed Cave, Arnold Lavatube System); elevation 1100 m.

7. Human and Domestic Animal Shelter-Inhabiting Forms.

Pseudoscorpions are occasionally seen which are not surrounded by litter or debris but instead are in or near human dwellings, under boards or attached to insects. Chelifer cancroides apparently has migrated all over the world with humans and appears to be the only Oregon species typically encountered in or near homes. Other species collected near houses in Oregon are accidentals. For example, Haplochelifer philipi was collected from under a board in Klamath

County and Hysterochelifer fuscipes from mosses growing on an ornamental tree in Benton County, but both are typically associated with native vegetation throughout their ranges (see species accounts).

Pseudoscorpions flourish world-wide in the litter-dung layers of domestic animal shelters. Chelifer cancroides and Cheiridium museorum (Leach) are common around homes and farms in Europe, and both are nearly cosmopolitan in distribution (Beier 1932b; Weygoldt 1969). Collidge (1908) listed C. cancroides as wide-spread and common throughout Europe and the United States, but C. museorum was only recently reported from North America (Muchmore 1972a). Dinocheirus horricus Nelson and Manley occurs in barns in Michigan (Nelson 1975) and D. sicarius in barns in California (Chamberlin 1952). Samples of debris from domestic animal shelters in Oregon contained both C. cancroides and D. sicarius, occasionally together. Generally, C. cancroides was recovered from somewhat drier materials (hay, grain debris) while D. sicarius was taken from the damper, dung-coated bedding straw. Larca chamberlini was collected on and near mosquitoes in old buildings and Lamprochernes sp. was phoretic on a housefly; both species are included tentatively in this category for lack of other habitat data.

Oregon species associated with human and domestic animal shelters are:

Chelifer cancroides. From 13 Oregon counties (Map 26); 10

collections from inside and 4 from outside human dwellings,

8 from litter-dung layer in barns and sheds, 1 from Neotoma

sp. debris in old shed, 1 from swallow's nest; elevation

0-1250 m.

Dinocheirus sicarius. From 9 western Oregon counties (Map 23); 13 collections from litter-dung layer of cow, horse, sheep and pig barns and sheds, 4 from litter of chicken houses; elevation 0-610 m.

Lamprochernes sp. From 1 western Oregon county (Map 25); 1 collection from housefly; elevation ? .

Larca chamberlini. From 2 northwestern Oregon counties (Map 16); 3 collections on or in association with mosquitoes in old buildings, 1 from moss festoons on Sitka spruce tree; elevation 0-220 m.

8. Subterranean-Inhabiting Forms. According to certain views, caves are cavities large enough for human exploration which exist in whole networks of underground cracks and crevices (Barr 1968; Howarth 1973). These networks lie just beneath the litter layer and may reach considerable depths in limestone areas such as in Josephine County where Oregon Cave is located. A specialized fauna may inhabit such a network and come in contact with humans in caves, wells and mine shafts. Approximately one-sixth of the nearly 2000 described species and subspecies of pseudoscorpions are reported from caves and many exhibit morphological specializations, such as loss of phoroceptors, reduction of pigment and/or thinning of cuticle, attenuation of appendages and giantism or dwarfism (Chamberlin & Malcolm 1960; Benedict & Malcolm 1973; Muchmore 1976).

Of the 206 caves reported from Oregon (Larson & Larson 1976;

Larson 1977), pseudoscorpions are known from only four caves. There are several reasons for this paucity of specimens from caves of Oregon. Cave forms may not have evolved due to the lack of pre-adapted ancestors, insufficient time lapse since cave formation, inadequate barriers between epigean and hypogean habitats, or inhospitable microclimate conditions within a cave. Or, if evolved, cavernicoles may be undiscovered due to the small amount of biospeleological research in Oregon (Senger 1977).

Pseudoscorpions of five species have been collected in caves or deep wells in Oregon. Archeolarca rotunda from Unnamed Cave was probably an accidental occurring in the cave in association with rodents, and not cave adapted. Pseudotyranochthonius gracilis, collected both in the lower crawlway in Oregon Cave and from leaf litter, might be able to survive in either habitat. If so, it would be a troglaxene or troglophile (Barr 1960). The other three species, listed below, seem to exhibit troglobitic tendencies and would be, therefore, troglophiles or troglobites. Interestingly, Microcreagris columbiana, discovered originally in a well in Clatsop County, Oregon (Chamberlin 1962), was later collected in Pillar of Fire Cave, Klickitat County, Washington (Muchmore 1969c).

Species which appear to be restricted to subterranean habitats in Oregon are:

Apochthonius malheuri. From 1 southeastern Oregon county

(Map 7); 4 collections of rotted wood chips from Malheur Cave; elevation 1280 m.

Microcreagris columbiana. From 1 northwestern Oregon county

(Map 5); 1 collection from a well; elevation near 0 m.

Parobisium charlotteae. From 1 eastern Oregon county (Map 5);

1 collection from Redmond Cave; elevation 1100 m.

9. High Tide Zone-Inhabiting Forms. Several pseudoscorpion species occur along coastlines of the world and thus are exposed to sea water (Weygoldt 1969); Halobisium occidentale inhabits this zone along the Pacific coast of North America. In my attempts to obtain specimens of H. occidentale and other possible littoral species, I collected samples of tideline debris (algae, driftwood, bark) but pseudoscorpions were not recovered. Apochthonius occidentalis, Mundochthonius spp. and Microcreagris spp. occurred in the sand-filled litter from beneath salt-pruned lodgepole pines and Sitka spruce growing on outer dunes. These pseudoscorpion species also inhabit litter of willow and shrubs growing on deflation plains.

The species from Oregon which typically inhabits the High Tide Zone is:

Halobisium occidentale. From 2 coastal Oregon counties (Map 15); 2 collections from under boards and debris of Salicornia-saltgrass tidal flats, 1 from teredo-eaten log in high intertidal zone, 1 from gribble-eaten wood in slough, 1 from under estuary-water soaked bark of Sitka spruce tree root; elevation near 0 m.

ECOLOGICAL FACTORS

Chelonethologists attempting to explain distribution and habitat preferences of species generally refer to temperature and humidity

tolerances, the need for adequate crevices and other "factors" (Hoff 1959; Weygoldt 1969; Nelson 1971). The only experimental data on this subject are Weygoldt's (1969) observations that the European species Neobisium muscorum (Leach) reproduces in culture only at temperatures between 15-18°C. Hoff (1959) used indirect evidence of temperature and moisture relationships to explain distribution of species of New Mexico. Thus, it appears that so little is actually known about ecological physiology of pseudoscorpions that any attempt to explain why they occur where they do is pure speculation and a subject for future research.

CONCLUSIONS

1. Fifty pseudoscorpion species from nine families are now known from Oregon; only 13 species from three families were recorded prior to the initiation of the study in 1971.

2. Oregon's pseudoscorpion fauna is still incompletely known, especially east of the Cascade Mountain crest. At least 12 neobisioid species from both eastern and western Oregon are still to be identified by name, as are several species from other superfamilies.

3. Many pseudoscorpion species reported from Oregon are widely distributed over large geographical areas.

4. Known dispersal mechanisms are adequate to explain the broad distributional patterns observed in this study.

5. Most western Oregon species considered in this study exhibit specificity for a habitat type (e.g., bark, leaf litter, litter-dung) rather than for a microhabitat provided by a particular plant species. Most pseudoscorpion species in semi-arid southeastern Oregon habitats appear relatively restricted in habitat type selection.

6. Western Oregon samples often contained as many as seven species per sample. Eastern Oregon samples of a similar size generally contained only one or two species when pseudoscorpions were even recovered.

7. Data available on seasonal distribution are inadequate to draw conclusions about the occurrence of various life stages.

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APPENDIX I

MAP OF OREGON COUNTIES

Generalized Climax Vegetation Types of Oregon

MAP OF OREGON VEGETATION ZONES

APPENDIX II

Source: Franklin, J. F. and C. T. Dyrness. 1969. Vegetation of Oregon and Washington. USDA Forest Service Research Paper, PNW-80:38-39. Redrawn by L. W. Price. Biogeography field guide to Cascade Mountains, transect along U. S. Highway in Oregon. Occasional Papers in Geography. Portland State Univ. 1:1-36.

APPENDIX III

GENERALIZED DIAGRAM OF A DIPLOSPHYRONID PSEUDOSCORPION
(From Chamberlin 1931)

APPENDIX IV

IDENTIFICATION KEY TO OREGON PSEUDOSCORPIONS

Although only the presently identified Oregon species and genera are included, this key should be useful for many of the specimens from adjacent states as well as Oregon. The key is modified, in part, from Hoff 1958, 1959; Lawson 1968; Nelson 1975; Benedict & Malcolm 1970, 1973, 1978a; Benedict 1977, 1978a. For details of morphological terms, see Chamberlin 1931, Hoff 1949, and Nelson 1975. For generalized view of a pseudoscorpion, see Appendix III. Illustrations in the key are from the following sources: Figs. 1-5, 25-36, 44-47, 51-58, 67 from Chamberlin 1931; Figs. 6, 12-13 from Malcolm & Chamberlin 1961; Figs. 7-11 from Benedict & Malcolm 1970; Figs. 14-15, 18 Benedict & Malcolm 1973; Fig. 16 from Chamberlin 1929a; Fig. 21 from Chamberlin 1962; Figs. 22, 24 from Benedict 1978a; Figs. 37, 40-43 from Benedict & Malcolm 1978a; Figs. 38, 48-50 from Benedict 1977; Fig. 39 from Benedict & Malcolm 1978c; Figs. 48-50 from Benedict 1977; Figs. 61-64, 66-69, 71, 74-75 from Chamberlin 1962; Figs. 77-78 from Benedict & Malcolm 1978d. Fig. 23 was redrawn from Schuster 1968, Fig. 65 from Hoff 1949, and Fig. 63 from Hoff 1956c. The other figures are original.

KEY TO ADULTS

1. Legs I and II with a single tarsal segment (Fig. 1), legs III and IV with 2 tarsal segments (Fig. 2) (suborder Heterosphyronida, family Chthoniidae)..... 2

Legs, all, with an equal number of segments (Figs. 3, 4)..... 18

2. Chelal hand with 4 tactile setae on dorsum (Fig. 5)..... *Lechytia hoffi*, p.

Chelal hand either with a transverse pair of tactile setae on dorsum (Fig. 6), or with tactile setae absent on dorsum (Fig. 7)..... 3

3. Chelal hand without a transverse pair of setae).... (genus *Pseudotyranochthonius*) 4

Chelal hand with a transverse pair of tactile setae..... 5

4. Coxal spines arise individually from a lightly sclerotized or translucent hillock (Fig. 8); chelal length of male 0.98-1.10 mm, of female 1.12-1.40 mm; palpal femur length of male 0.68-0.79 mm, of female 0.78-0.98 mm *P. gracilis*, p. 34

Coxal spines arise individually from a more heavily sclerotized bar, or from contiguous ball-shaped pedestals (Fig. 9-11), not a translucent hillock; chelal length of male 0.79-0.94 mm, of female 0.89-1.11 mm, femur length of male 0.49-0.66 mm, of female 0.59-0.76 mm..... *P. incognitus*, p. 36

5. Coxal spines present on coxae, I, acuminate and confined to mesal portion (Fig. 12)..... 6

Coxal spines absent from coxae I..... 10

6. Chelal fingers with marginal teeth well spaced (Fig. 13) distally (genus *Kleptochthonius*; *K. geophilus* cannot be separated from *K. oregonus*)..... *K. oregonus*, p. 26

Chelal fingers with teeth small and contiguous (Fig. 14) (genus *Apochthonius*)..... 7

7. Coxal spine with a well-developed anterior spur (Fig. 15)..... 8

Coxal spine, either lacking anterior spur (Fig. 16) or, at most, with a very tiny anterior projection (Fig. 17).....
..... *A. occidentalis*, p. 21

8. Palpal femur length greater than 0.50 mm, chela length greater than 0.75 mm..... 9

Palpal femur length less than 0.45 mm, chela length less than 0.70 mm; anterior spur of coxal spine highly variable in length (Figs. 18, 19)..... *A. minimus*, p. 20

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