

Distribution of Ant Species of Hawaii¹

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INTRODUCTION

The ant fauna of the Hawaiian Islands offers many unique opportunities for study. Among these are: (1) an excellent body of background resources dating from the 19th century, including many well preserved and labeled specimens; (2) isolated locations with well-defined ecological zones that exist in close proximity to one another on 6 islands of varying size and terrain and (3) a completely synthetic ant fauna made up of tramp species from many parts of the world, existing in artificial sympatric associations that are likely found in no other place in the world.

Specialized studies of the ants of Hawaii span the majority of the past century. Forel's (1899) paper on Formicidae in *Fauna Hawaiiensis* was based on extensive collections by Perkins. Of the 20 forms reported, 1 is now considered to have been incorrectly labeled as to locality (*Pogonomyrmex occidentalis* Cresson). 1 mis-identified (*Paratrechina obscura* Mayr), and 1 (*Aphaenogaster longiceps* F. Smith) an immigrant that apparently did not become established (Wheeler 1934). Gulek (1913) prepared a key and synopsis of the Hawaiian ants known at his time and added 6 new forms to those listed by Forel to give a total of 23 species.

In 1934, 2 highly significant papers that greatly increased the knowledge concerning Hawaiian ants were published. Wheeler (1934) added 9 new species to those known from the Hawaiian Islands; Phillips (1934), in a study of the ants in pineapple fields, presented a thorough ecological study of many of the species. The several new species that have been reported separately since 1934 have been summarized by Wilson and Taylor (1957) in "Ants of Polynesia". In their publication, 3 ponerine species recognized by Wheeler, (*Ponera kolakaana* Forel), *Ponera gleadowi decipiens* Forel and *Ponera punctatissima schauinslandi* Emery) have been synonymized with *Ponera punctatissima* and placed in the genus *Hypoponera*. A new ponerine species, *Amblyopone zwalzenbergi* (Williams) was added for a total of 6 species in the subfamily Ponerinae. Three new species of the subfamily Myrmicinae were added, *Strumigenys gulekii* Mayr, *Strumigenys rogeri* Emery, and *Cardenomyrma emeryi* Forel. One Dolichoderinae, *Indomyrma humilis*, and one Formicinae, *Auopolepis jagiper* (Jerdon) were also added. In addition, several changes were made in synonymy.

The isolated character of the Hawaiian Islands with its accessible land masses varying in size and topography offers an excellent opportunity for

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study. Two factors of great importance in ant ecology—rainfall and vegetation—have been carefully studied and mapped. Annual rainfall data are available for almost every accessible area of the main islands and have been developed into monthly and annual isohyet maps (Taliaferro, 1959). The vegetative zones of each island have been described and mapped in excellent detail by Ripperton and Hosaka (1942). These data, together with topographical maps make the Hawaiian Islands an ecologist's delight.

Due to extensive collecting in many areas bordering the Pacific, the concepts of the origin of the Hawaiian ant fauna have undergone a drastic revision since Wheeler's 1934 paper. At that time, 6 species were considered to be endemic. In addition, Wheeler recognized 9 subspecies or varieties as being endemic. Wilson and Taylor (1967) consider the Hawaiian Islands to be populated entirely with introduced species of ants, producing what is termed a "completely synthetic ant fauna." Except for a limited number of species, all Hawaiian ants have been found elsewhere under circumstances that deny their endemicity in Hawaii.

The study which is reported in this paper was undertaken to update the knowledge of the species of ants found in Hawaii and to determine the extent of their distribution on the 6 main accessible islands. In addition, data were obtained concerning some of the factors affecting species distribution on each island. While it is recognized that this study is far from complete, careful collections were made in each major ecological zone on each island. Because of the theory advanced by Wilson and Taylor (1967) that the species found in Hawaii appear to be approaching an equilibrial species density and that new species will probably be established as a result of competitive replacement, collection data from many areas are included to record present distribution for future studies (Appendix 1). These data include locality information in the usual manner and the Universal Transverse Mercator Grid designation of the collection site to the nearest 100 m for Oahu and the nearest 1000 m for the other islands.

AN ANNOTATED LIST OF THE ANTS OF HAWAII AND THEIR KNOWN DISTRIBUTION ON THE ISLANDS

This tabulation of the ants presently known from Hawaii has been edited to conform as closely as possible to the nomenclature used by Wilson and Taylor. Four species new to Hawaii, 3 of which may be species new to science, have been added to give a total of 42 species of ants presently recorded from Hawaii. It should be remembered that of these 42 species, 6 species which are designated as rare or not recently collected may now be extinct in Hawaii. These are:

- | | |
|---|---|
| 1. <i>Amblyopone zealandica</i> (Wilkinson) | 4. <i>Tetraspaena umbraeformis</i> Emery |
| = <i>Stigmatopona</i> (Fulakora) | = <i>Stenimyrmex zelandica</i> Emery |
| <i>zealandica</i> Williams | 5. <i>Phigadeuon cognatus</i> Forel |
| 2. <i>Monomorium luteolus</i> Mayr | 6. <i>Brachymyrmex obscurus</i> Forel |
| 3. <i>Strumigeres lewisii</i> Clarendon | = <i>Brachymyrmex lewisii</i> var. <i>apudocata</i> Forel |

References to the pertinent literature have been adequately reviewed by Wilson and Taylor (1967) and Wheeler (1934) and are not included. The abbreviated synonymy as shown is used to relate the nomenclature used by Wilson and Taylor (1967) to the nomenclature used by Wheeler (1934) and that used in the Proceedings of the Hawaiian Entomological Society. Species distribution records are furnished for the first published report of the species on each island.

A generalized description of each species is presented as an aid in identification. The average body length, excluding antenna, of a specimen in the normal walking position is given for each species. Under name headings, the numbers (1, 2, 3, etc.) designate references of collection surveys or studies. Number 14 is the number of the current study.

Ant Species Distribution

Oahu	Molokai	Kauai	Mau	Lanae	Hawaii
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Family Formicidae

Subfamily Cerapharthyinae

1. ***Syscia silvestrii*** Wheeler
 — *Cerapharhys (Syscia) silvestrii*
 Wheeler

2	3	14	2
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Description: A small, reddish-brown ant easily recognized by the short, stout antennal scapes and the extremely large nodes on the petiole and post petiole (2.2 mm).

Ecology: A hypogaeic ant most often collected under rocks. Apparently widespread on Oahu, although infrequently collected due to its cryptic habits. Found in areas of 20 to 70 inches of rainfall. Probably predacious. Colonies small, usually less than 30 individuals.

Subfamily Ponerinae

2. ***Amblyopone zwaluwenburgi*** (Williams)
 — *Stigmatomma (Fulakora)*
zwaluwenburgi Williams

6

Description: A very small (1.8 mm), rufescentaceous ponerine characterized by short, linear mandibles.

Ecology: The only reported collection of this cryptobiotic species was from soil in a cane field in Honolulu. This ant was not collected in the survey reported here.

3. ***Hypoponera punctatissima*** (Roger)
 = *Ponera glaberrima descripta* Forel
 — *Ponera kalakauae* (Forel)

1	2	1	2	3	2
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Description: A small ponerine recognized by short antennal scapes that fail to reach the median occipital border by a distance greater than their maximum diameter. Eyes small, but distinct, containing several facets. A highly variable species that may represent more than 1 species.

	Ant Species Distribution				
	Oahu	Molokai	Kauai	Maui	Hawaii

Specimens from dry areas are almost always yellowish to yellowish-red in color whereas those from wet areas are generally black to blackish-red. (2.5 mm)

Ecology—Widely distributed from sea level to over 4000 ft. Usually nesting under rocks in dry areas and in soil or rotting logs in wet areas. Predacious on other arthropods. Nests usually small, not over 100 individuals.

4. **Hypoponera opaciceps** (Mayr)

—*Ponera parkana* Forel

	2	1	1	1	1
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Description: A small ponerine with small but distinct eyes consisting of several facets. A slender, more or less parallel-sided petiolar node. Antennal scapes reach or surpass the median occipital border. (2.6-3.1 mm)

Ecology: Although occasionally found in areas of less than 40 inches of rainfall, most abundant in the higher rainfall areas of the mountains. Predacious, usually in colonies of less than 50 individuals nesting in decaying wood and soil, either near the base of trees or under rocks. Only on rare occasions in damp areas are workers seen on the surface of the litter or bare soil.

5. **Hypoponera zwaluwenborghi** (Wheeler)

—*Pseudocryptopone zwaluwenborghi*

Wheeler	2	2	14
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Description: A small (2.0 mm), yellowish brown ponerine easily recognized by the absence of eyes and the "comb-like" mandibular teeth on the posterior part of the mandible.

Ecology: A cryptobiotic species most readily collected under rocks in and around cane fields. Colonies apparently very small with nests in the soil or under rocks.

b. **Hypoponera sinensis** (Wheeler) 14

Description: A small (2.3 mm), yellowish species having very small, apparently 1-faceted eyes and a fine raised carina around the mesopisternum. Species and perhaps genus questionable.

Ecology: Commonly found in the soil under litter in moist habitats. Especially abundant on Mt. Tantalus and other similar areas. This species was found with many winged forms in late June on the edge of a pineapple field.

7. **Ponera swezeyi** (Wheeler)

—*Pseudocryptopone swezeyi* Wheeler

	2			14
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Description: A very small (1.7 mm) yellowish form recognized by the lack of eyes and the presence of an elliptical anterior fenestra and a pair of bilateral posteroventral denticles on the subpetiolar process.

Ant Species Distribution

	Oahu	Molokai	Kauai	Mani	Lanai	Hawaii
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Ecology: Collected only from soil and under rocks in cane fields; however, probably more widely distributed than is reported due to its small size and cryptobiotic habits.

8. *Leptogenys fulcigera* Roger

— *Leptogenys fulcigera insularis*

Wheeler

	i	2	1	1	1	14
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Description: A large (7 mm), blackish ponerine easily recognized by its size and curved, elongate mandibles. This is the largest ponerine known from Hawaii.

Ecology: Appears to be widely distributed over the lower elevations where rainfall is from less than 20 inches to more than 70 inches. Usually noticed as individual forms walking on the ground or tree trunks. Found nesting under rocks and in dead tree trunks in dry areas on Oahu, Molokai, and Maui, also under the bark of a paper bark tree in a wet area on Lanai.

Subfamily Myrmicinae

9. *Pheidole* (P.) *forvens* Fr. Smith 14 14

Description: Most easily recognized by dark brown color and large completely rugose head of the soldier cast. Waist with two nodes, short propodeal spines. (2.3 mm, soldiers 4.5 mm)

Ecology: Present known distribution on Oahu restricted to the higher elevations and rainfall areas of the Koolau range along the lower edge of the forest reserve. Widely distributed around Hilo, apparently occupying the same ecological niche that is occupied by *Pheidole megacephala* in other similar areas.

10. *Pheidole* (P.) *megacephala* (F.)

(Big-Headed Ant)

	1	1	1	1	1	1
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Description: Readily recognized by its dark brown color and the presence of big-headed soldiers in which the occipital region is smooth and shiny. Waist with 2 nodes, propodeum armed with spines. (2.2 mm, soldiers 3.4-3.8 mm)

Ecology: The dominant ant of the Hawaiian Islands, found in a great variety of habitats ranging from sea level to the top of Mt. Kaala (4000 ft), although usually restricted in areas of less than 3000 ft elevation. Food habits are extremely variable, including household food, tending honeydew-producing insects, and preying on small arthropods.

11. *Solenopsis geminata* (F.)

— *Solenopsis geminata* variety

rufa (Jerdon) (Fire Ant)

	1	10	14	5
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Description: Light to dark reddish-black ants with a smooth head; no propodeal spines. Sting on abdomen. Waist consists of 2 nodes.

Ant Species Distribution

	Oahu	Molokai	Kauai	Mau	Lanai	Hawaii
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There are major and minor worker castes with a wide size range. Ten-segmented antenna with a 2-segmented club. (3.1-8.3 mm, soldiers up to 8 mm)

Ecology: Most prevalent in drier areas where it replaced *Pheidole megacephala*. Found in wetter areas, especially around Hilo. Range overlaps that of *Pheidole megacephala* and *P. feroces* in several areas. Appears to tend honeydew-producing insects and to feed on other arthropods. Nests most often found under rocks or in the soil.

12. *Solenopsis "a"* 14 14

Description: A small, reddish-black ant similar to *Monomorium minimum* but distinguished by the 2-segmented club on the 10-segmented antenna. A distinct species at present unnamed because of the taxonomic confusion in the genus. Specimens on deposit in Bishop Museum and University of Hawaii collections. (1.6 mm)

Ecology: Widely distributed on Maui and the Mt. Tantalus region of Oahu. On large areas of Maui, this is the dominant and sometimes the sole ant species collected. Large nests with several queens found under rocks, in the soil near the base of trees, and in plant material.

13. *Solenopsis "b"* 14

Description: Similar to *Solenopsis "a"* but lighter in color (1.4 mm).

Ecology: Also found on Mt. Tantalus and near Waipio where it was nesting under the leaf sheath of a rice stalk. Taxonomic status uncertain.

14. *Monomorium floricola* (Jerdon) 1 1 14 1 1 14

Description: Small, monomorphic workers with the waist consisting of 2 nodes, entire body smooth and shining with no propodeal spines. A 3-segmented antennal club. Head and abdomen usually dark black. Thorax yellowish and distinctly lighter in color than head and abdomen. (1.5 mm)

Ecology: Widely distributed in uncultivated and cultivated land and in residential areas. Reported (Wilson and Taylor 1967) to be almost wholly arboreal; however, often collected on rocks and at the soil surface. Common household pest, probably omnivorous.

15. *Monomorium foveolatum* Emery

— *Monomorium foveolatum psychellense*

Emery 2 2 2 14 2

Description: A typical *Monomorium*, usually light reddish-yellow with a darker abdomen. Easily recognized by the very small (0.03 mm) eyes. (1.5 mm)

Ecology: A widely distributed, ground-dwelling species frequently taken in Berlese samples.

Ant Species Distribution

- | | Oahu | Molokai | Kauai | Mau | Lanai | Hawaii |
|---|------|---------|-------|-----|-------|--------|
| 16. Monomorium latinode Mayr | 2 | | | | | |
| Description: A distinctive polymorphic species having a wide, short postpetiolar node and a postpetiole that is larger than the petiole when seen in side view. | | | | | | |
| Ecology: Apparently collected only once in Nuuanu Valley in 1924. Extensive collecting in the same area has failed to reveal a single specimen. Perhaps this species has been completely replaced by other species. | | | | | | |
| 17. Monomorium minutum Mayr | | | | | | |
| = <i>Monomorium minutum</i> variety | | | | | | |
| <i>hawaiiense</i> Forel | | | | | | |
| | 1 | | 2 | | | 2 |
| Description: Small, blackish to dark brown, monomorphic workers distinguishable from <i>M. flavicola</i> by having the thorax, head and abdomen equal in color. The entire petiole is about as long as deep. (1.5 mm) | | | | | | |
| 18. Monomorium pharaonis (Lione) | | | | | | |
| (Pharaoh Ant) | | | | | | |
| | 2 | | | | | 2 |
| Description: A small, yellowish ant with body entirely shagreened and opaque, similar to other <i>Monomorium</i> species in size and general body outline. (2.0 mm) | | | | | | |
| Ecology: An occasional species collected from widely scattered locations. | | | | | | |
| 19. Monomorium destructor (Jerdon) | 1 | | 2 | | | |
| Description: A polymorphic species with the head width of the smaller workers greater than 0.4 mm. Yellowish-red in color with terminal segment of the antenna about as long as the next 2 together. Distinguished from <i>Solenopsis</i> by the 3-segmented antennal club. (2.3 mm) | | | | | | |
| Ecology: Primarily collected near sea level in dry sandy areas nesting under boards, cans, etc. Distribution appears to be quite limited. | | | | | | |
| 20. Cardiocondyla emeryi Forel | 14 | 14 | 14 | 14 | 14 | 14 |
| Description: A small (1.6 mm) yellowish-red ant with black abdomen and antennal clubs. Distinguished by fine but dense punctations on the head and thorax, short propodeal spines, a bilaterally compressed petiolar node, mesonotum gently sloping to the mesometanotal groove, and 2 nodes on the waist with the postpetiolar node much wider than the petiolar node. | | | | | | |
| Ecology: An active ant, abundant at lower elevations and in lower rainfall areas. Both ground-inhabiting and arboreal. Nests in soil, under rocks, and in plant cavities. | | | | | | |
| 21. Cardiocondyla nuda (Mayr) | | | | | | |
| = <i>Cardiocondyla nuda</i> variety | | | | | | |
| <i>minuta</i> Forel | | | | | | |
| | 1 | 1 | 2 | 2 | 2 | 2 |
| Description: A small, dark brownish-black ant with densely punctate | | | | | | |

Ant Species Distribution

	Oahu	Molokai	Kauai	Maui	Hawaii
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head and thorax, short propodeal spines, postpetiolar node wider than petiolar node which is semi-globular in outline when viewed from above, mesometanotal groove absent or very weak. (1.6 mm)

22. *Cardiocondyla wroughtoni* (Forel)

—*Cardiocondyla wroughtoni*

variety *hawaiiensis* Forel

2	1	2	2	3	2
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Description: Similar to *C. energyi* except that the propodeal spines are longer, the mesonotum declines abruptly to the mesometanotal groove, and the petiolar node is subglobular in outline when viewed from above. (1.9 mm)

Ecology: Although widely distributed, most abundant in higher and wetter areas than *C. energyi*.

23. *Cardiocondyla "a"*

14	14	14	14	14	14
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Description: Readily distinguishable by its dull punctate head, broad postpetiolar node and by being larger than other members of the genus in Hawaii. Propodeal spines are very short. Mesometanotal groove is distinct. Taxonomic status questionable. (2.2 mm)

Ecology: Widely distributed on all islands. In certain localities it appears to be the dominant ant species where neither *Pheidole megacephala* or *Hidomyrma humilis* are present.

24. *Tetramorium guineense* (F.)

1	1	2	2	1	
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Description: A large yellowish-red to reddish-black ant distinguished by the striated face, reticulated thorax and petiolar nodes, and long slightly curved propodeal spines. (3.1 mm)

Ecology: Widely distributed, extremely abundant in certain habitats, occasionally the dominant ant in restricted areas. Nests under rocks, in soil, and in decaying plant parts. Has been observed tending honeydew-producing insects.

25. *Tetramorium simillimum* (Fr.

Smith)

2	14	14	14		
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Description: Reddish-yellow head and thorax with black abdomen, striated head and thoracic notum, short propodeal spines, short, blunt hairs on body. Distinguished also by peduncle of the petiole being thick compared to *T. tonganum*. (2.0 mm)

Ecology: Extremely widely distributed and common to abundant over most of its range. Nests in many varied sites.

26. *Tetramorium tonganum* Mayr

2	14		14		
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Description: Intermediate in size between *T. simillimum* and *T. guineense*. Distinguished by reticulate thorax, long slender body hairs;

Ant Species Distribution

- | | Oahu | Molokai | Kauai | Mau | Tanai | Hawaii |
|---|------|---------|-------|-----|-------|--------|
| moderately long propodeal spines; long, thin peduncle of petiole. (2.5 mm) | | | | | | |
| Ecology: Seems to be scarce in its habitats, usually found in higher (over 800 inches) rainfall areas. Has been found nesting in hollow sugar cane stalks. | | | | | | |
| 27. <i>Strumigenys godeffroyi</i> Mayr | 13 | | 14 | | | 14 |
| Description: A small (2.0 mm) pale-yellow to dark-red ant with very long forceps-like mandibles, a 2-knobbed "waist" and 5-segmented antennae. Distinguished from other <i>Strumigenys</i> by having 1 preapical tooth, spongiform lamellae on rear face of propodeum and very abundant pilosity on pronotum. | | | | | | |
| Ecology: A hypogaeic ant usually found in wetter areas, in soil and especially under rocks. Probably feeds primarily on Collembola | | | | | | |
| 28. <i>Strumigenys lawisi</i> Cameron | | 2 | | | | |
| Description: Similar to <i>S. godeffroyi</i> except for very scant pilosity on the pronotum. (2.0 mm) | | | | | | |
| Ecology: A very rare cryptobiotic species that apparently has about the same habits as other members of the genus in Hawaii. Not collected in this study. | | | | | | |
| 29. <i>Strumigenys rogeri</i> Emery | 13 | 14 | 14 | 14 | | 14 |
| Description: Typical <i>Strumigenys</i> antennae and mandibles. Easily distinguished by the presence of 2 preapical teeth on mandible. (2.0 mm) | | | | | | |
| Ecology: Very abundant over most of its range, which extends from irrigated fields in low rainfall areas to over 3000 ft elevations. Found sympatrically with <i>S. godeffroyi</i> where it appears to have about the same habits. | | | | | | |
| 30. <i>Trichoscapa membranifera</i> Emery | | | | | | |
| - <i>Strumigenys membranifera</i> Emery | | | | | | 2 |
| Description: Very similar in size, shape, and color to <i>Strumigenys</i> , however, readily identified by the short triangular mandibles. | | | | | | |
| Ecology: Very rare, apparently only collected twice in the Hawaiian Islands. Concentrated collecting in the reported localities has failed to yield a single specimen. The USPA collection contains several specimens labeled "Honolulu." | | | | | | |
| 31. <i>Quadristrums emmae</i> (Emery) | | | | | | |
| - <i>Epitritus ischaeferi</i> Donistrophe | | 2 | | | | 14 |
| Description: A very small, yellowish ant easily recognized by the 4-segmented antennae. Characteristic short curved mandibles with a strong preapical tooth. (1.5 mm) | | | | | | |
| Ecology: Rare, collected from Bertese samples in areas of 40-60 inches of rainfall. The USPA collection contains specimens from the Island of Hawaii | | | | | | |

Ant Species Distribution

	Oahu	Molokai	Kauai	Maua	Lanai	Hawaii
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Subfamily Dolichoderinae

32. *Iridomyrmex humilis* (Mayr)

(Argentine Ant)

4 12 7 11 7

Description: A medium sized (2.5) reddish-black ant with a 1-segmented waist bearing a sharp pointed node. No standing hairs on the thorax.

Ecology: Found in a variety of habitats ranging from sea level to 6000 ft. Tends honeydew-producing insects. Usually very abundant in habitats where present. Predacious and highly antagonistic to *Phidole megacephala*. Nests are extremely numerous in infested areas. May be a pest in houses.

33. *Tapinoma melanocephalum* (F.) 1 5 3 1 2

Description: A very small, fast-moving ant with a dark brownish-black head and light antennae and abdomen. Single segmented waist. Thorax without standing pilosity (1.5 mm).

Ecology: A very abundant, ground inhabiting or arboreal ant that is widely distributed.

34. *Technomyrmex albipes* (Fr. Smith) 2 2 2 3 2

Description: A medium-sized blackish ant having a very dull, punctate thorax with only 2 to 4 standing hairs and a rudimentary petiole node. (2.4 mm)

Ecology: Nowhere very abundant, usually found in areas having more than 60 inches of rainfall. Often numerous in forested areas from 1000 to 5000 ft. elevation.

Subfamily Formicinae

35. *Plagiolepis exigua* Forel 2 2

Description: A small, robust yellowish ant with 11-segmented antennae, a cone-shaped defensive spray orifice on the 7th abdominal segment. Distinguished by the antennal scape exceeding the occipital corner by less than the length of the 1st funicular segment.

Ecology: Although reported from Hawaii, this species may well be confused with *P. niuauai* which is the only *Plagiolepis* collected in this study. Reported to have about the same ecological requirements as *P. niuauai*.

36. *Plagiolepis niuauai* Forel= *Plagiolepis maculicollis* Wheeler 2 2 2 3 3 14

Description: Similar to the description for *P. exigua* but separated by having antennal scapes exceeding the occipital corner by at least the length of the 1st 2 funicular segments combined. This is the smallest ant found in Hawaii.

Ant Species Distribution

Oahu	Molokai	Kauai	Mau	Lanai	Hawaii
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Ecology: Very abundant, widespread, and nesting in many varied habitats, both ground inhabiting and arboreal.

37. *Brachymyrmex obscurior* Forel

= *Brachymyrmex heeri* variety

aphidicola Forel

2

Description: A small, robust, brown ant, similar to *Pogonomyrmex* but having 9-segmented antennae.

Ecology: Collected only once by Lynn from nerbird baskets in Honolulu, probably never became established in the Hawaiian Islands.

38. *Camponotus variegatus* (Fr. Smith)

= *Camponotus maculatus mitchi* var. *hawaiiensis*

= *Camponotus variegatus hawaiiensis*

Forel (Carpenter: Ant.)

1 2 3 2 3 2

Description: A large, polymorphic, yellow to yellowish-red ant. Head and mesonoma yellowish, abdomen yellowish with subtriangular medium to dark areas on posterior edges of the dorsum of each abdominal segment. This is the largest ant found in the Hawaiian Islands. (7.5 mm, soldiers 11.0 mm).

Ecology: Mostly restricted to drier areas, although occasionally found in houses in areas of over 40 inches of rainfall. Nests under curbs, trash and in dead tree branches. Nocturnal; only an occasional specimen seen during daylight hours. Frequent household pest.

39. *Anoplolepis longipes* (Jordan)

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♀

Description: Medium large, monomorphic, yellow to reddish-yellow ant with a long slender body, long antennae and almost total lack of standing hairs on the dorsum of the thorax. Abdomen often darker than head and thorax. Extremely active and fast moving. (4.0 mm).

Ecology: A recent immigrant that appears to be extending its range on Oahu. Found very abundantly in dry areas, along edges of gullies in the central plateau and in one area on the windward side, mauka of Kaneohe.

40. *Paratrechina* (*P.*) *longicornis*

(Latreille)

1 1 2 2 14 1

Description: Robust, dark brown to black, fast moving ant, very small petiolar node. Seventh abdominal segment with cone shaped orifice. Antennal scapes with erect hair and shorter than 1.5 times the length of the head and closed mandibles. Thorax with numerous irregularly arranged standing hairs. Head width usually greater than 0.65 mm. (2.6 mm).

Ecology: Abundant to common in many different habitats. Nesting

Ant Species Distribution

	Oahu	Molokai	Kauai	Maui	Lana'i	Hawaii
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under rocks, in dead limbs and stalks, etc. Predaceous, also attending homopterous insects. Often observed feeding at extrafloral nectaries of many plants.

41. *Paratrechina* (Nylanderia;*bourbonica* (Forel)

1	1	2	2	14	1
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Description: Robust, dark brown to black, fast-moving ant, very small petiole node. 7th abdominal segment with cone-shaped orifice. Antennal scapes with erect hair and shorter than 1.5 times the length of the head and closed mandibles. Thorax with numerous irregularly arranged standing hairs. Head width usually greater than 0.65 mm. (2.6 mm).

Ecology: Abundant to common in many different habitats. Nesting under rocks, in dead limbs and stalks, etc. Predaceous, also attending homopterous insects. Often observed feeding at extra-floral nectaries of many plants.

42. *Paratrechina* (Nylanderia) *vaga*

(Forel) — *Paratrechina sharpi*

Wheeler

1	14	14	14	14
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Description: Very similar to *P. bourbonica* in certain habitats, usually distinguished by being lighter in color with abdomen darker than the thorax, smaller (head width 0.45–0.62 mm); and having fewer, more regularly placed standing hairs on the thorax. (2.2 mm).

Ecology: Occurs sympatrically with *P. bourbonica* in many habitats, almost as widely distributed with apparently favoring the same ecological conditions.

1. Forel 1699
2. Wheeler 1934
3. Phillips 1934
4. PHES XI (1): 130
5. PHES XII (2): 223
6. PHES XII (3): 189
7. PHES XIV (2): 222

8. PHES XV (1): 10
9. PHES XV (3): 387
10. PHES XVI (2): 103
11. PHES XVI (2): 185
12. PHES XVII (3): 329
13. Wilson & Taylor 1967
14. New records reported in this paper

SPECIES ASSOCIATIONS

Because of the possibility of many artificial sympatric associations being unique to the Hawaiian Islands, preliminary studies were conducted to enumerate these associations. Ant species were considered to be associated if both species were collected in a restricted area where their ranges could be clearly seen to overlap. The only species association that was clearly antagonistic was *Pheidole megacephala* and *Iridomyrmex humilis*, in which very

clear lines of demarcation were always present.

Collection areas were generally restricted to a radius of 10 yards or less. Data from all collection areas have been used, consisting of cultivated fields, uncultivated areas, residential areas, public parks and junctions between these areas. Time did not permit a careful study of the nature of the interaction; thus, only the presence of the two species is reported.

A total of 395 species associations are possible when the 6 species not collected and the 1 species of *Salceptra* that was collected only once are excluded. Of this number, 383 associations have been observed. This represents 54.4% of the maximum possible number. A large % of the associations not observed can be attributed to the cryptic habits of 1 or both of the species (145 or 24.4%). There is no doubt that more concentrated collecting, especially with the Berlese funnel or similar apparatus would reduce this number greatly. A few of the possible associations may not occur because of the restricted distribution of the species however, it appears that this factor will account for only a small percentage of the interactions. These data are presented in a complete matrix of 1190 interactions for ease in reading the chart (Table 2).

HABITAT PREFERENCE STUDIES

Rippon and Hosaka (1942) characterized the vegetative zones of Hawaii on the same 3 factors that appear to be of major importance in ant distributions: rainfall, altitude and vegetative species. The following 5 major vegetative zones are recognized:

1. Zone A. Sea level to 1,000 ft elevation. Rainfall 20 inches or less. Xerophytic shrub with coastal fringe of trees.
2. Zone B. Sea level to 3,000 ft elevation. Rainfall 20-40 inches. Xerophytic shrub with some trees in upper part.
3. Zone C. Sea level to 4,000 ft. Rainfall 40-60 inches. Mixed open forest to mixed open forest and shrub in lower part.
4. Zone D. Sea level to 7,000 ft. Rainfall 60 inches or more. Open forest to shrub and closed forest in lower part.
5. Zone E. 4,000 to over 10,000 ft. Rainfall 50 inches or less. Above tree line to open forest and shrub in lower part.

Data from more than 100 collection sites were analyzed to obtain information on the preference of each species for the 5 major zones. (Table 1 and Appendix 1). Although the many limitations of these data are recognized, it has been found that these data often can be used to predict the species most likely to be found in a given area.

Collection information from all of the islands was combined for this analysis of the data. The following 4 arbitrary categories of habitat preference were used:

1. Not collected (N). The species was not collected in a given zone. The probability of it being present in that zone varies in inverse proportion to the ease with which it can be collected, the probability remaining quite high for some of the rare, cryptobiotic species.
2. Low preference (L). The species was collected in a given zone from 1 to 16% of the total number of times that it was collected in all zones.

3. Moderate preference (M).—On the same basis as above, the species was present in a given zone from 17 to 33% of the times that it was collected.
4. High preference (H).—The species was present in a given zone in 34% or more of the collections in which it was taken.

The categories were selected on the hypothesis that a species found frequently in each of the 4 zones (A-D) preferred by the Hawaiian ants did not have a high preference for any 1 zone while a species found more

TABLE 1. *Vegetation zone preference and number of times collected for the ant species collected during the 1956-57 study period*

Species	Vegetation Zone					No. of Times Collected
	A	B	C	D	E	
<i>E. npaceps</i>	L	L	M	H	L	36
<i>E. punctatissima</i>	M	M	M	M		15
<i>E. sinuata</i>	N	N	H	H		6
<i>E. zwaluwerburgi</i>	H	N	N	H		2
<i>P. swamyi</i>	N	N	H	N		1
<i>L. flaccigera</i>	L	L	H	M		8
<i>S. silvestrii</i>	H	M	M	N		9
<i>P. fettersi</i>	N	N	N	H		6
<i>P. negacephala</i>	M	M	M	L		34
<i>S. geminata</i>	H	M	N	L		23
<i>S. "a"</i>	N	N	H	H		8
<i>S. "b"</i>	N	H	N	N		1
<i>M. fluensula</i>	H	M	M	M		20
<i>M. fessulatum</i>	M	M	M	M		19
<i>M. nanatum</i>	N	N	M	M		11
<i>M. pharacis</i>	N	H	H	N		1
<i>M. destructor</i>	M	M	N	N		4
<i>C. curvipes</i>	H	M	M	L		46
<i>C. nodi</i>	M	M	M	L		37
<i>C. "a"</i>	N	M	M	M	L	51
<i>C. scoullstoni</i>	L	N	L	H		13
<i>T. guineense</i>	M	M	M	H		28
<i>T. scutellatum</i>	N	M	M	M		36
<i>T. tonganum</i>	N	N	M	H		5
<i>S. godofroyi</i>	N	N	L	H		12
<i>S. rogeri</i>	L	N	M	H		24
<i>Q. erussia</i>	N	N	H	N		2
<i>L. humilis</i>	M	M	H	N	L	13
<i>T. meionocephalum</i>	M	L	M	M		25
<i>T. albipes</i>	N	N	M	H		11
<i>P. albaudis</i>	M	M	M	M		42
<i>C. variegatus</i>	H	M	L	N		12
<i>A. longipes</i>	H	M	L	N		13
<i>P. longicoxus</i>	H	L	L	L		18
<i>P. boerhoni</i>	M	N	H	M		33
<i>P. vaga</i>	M	L	H	M		28

APPENDIX 1 *Results of soil collections arranged by location, date, vegetation*

DATE	LOCATION	VEGETATIVE ZONE	UTM GRID	H. <i>spumosa</i>	H. <i>punctatissima</i>	H. <i>sinensis</i>	H. <i>twalshii</i>	P. <i>secreta</i>	A. <i>swallowtail</i>	L. <i>fabrigera</i>
<i>ISLAND OF OAHU</i>										
May 10	Ewa, 3000' W. of pump 15 jet RR	A	E J 91366681							
Mar. 26	Ewa, jet Oahu St. and B.P.N.A.S.	A	E J 90300844							
Mar. 26	Ewa, .58 mi S pump 15 & Malakole	A	E J 90856694							
Mar. 26	Ewa, 500' S Malakole & new rd 90	A	E J 91466074							
Oct. 6	Malakole, rd 90 at entrance	A	E J 91489094							
May 10	Rd 90 3000' W of Malakole Rd	A	E J 90546104							
May 10	500' S 1000' E. Kulaokas & pump 10	A	E J 91826918							
May 10	Ewa pump 13 makai across rd	A	E J 92307979							
May 10	Ewa, natural pump 10	A	E J 92305990							
May 10	Ewa gauge 72E across RR in gully	A	E J 90546031							
May 11	Ewa gauge 72C	A	E J 90546062							
Nov. 6	Diamond Head Rd E. of lighthouse	A	E J 23483132							
May 15	Ewa pump 10 rd near rd 90	A	E J 90546104							
May 15	Ewa pump 10 rd 126 mi. from rd 90	A	E J 90186104							
May 15	Ewa pump 10 rd 308 mi from rd 90	A	E J 90086034							
May 16	Ewa pump 10 rd 102 mi from rd 90	A	E J 90405085							
May 15	Ewa 200' off pump 10 rd gauge 72E	A	E J 90507078							
May 15	Ewa 1000' off pump 10 rd gauge 72E	A	E J 90606090							
May 15	Ewa Malakole & rd N of pump 10 rd	A	E J 91326046							+
June 19	Ewa jet pump 10 & Malakole Rd	A	E J 91075006	-						
June 25	Ewa. houses N of pump 10	A	E J 91216038							
May 15	Queen's Surf Beach Ewa of both houses	B	E J 27926272							
June 23	Pineapple field N of Greatview	B	E J 91096810							
June 23	Parakaahi Gulch .5 mi N Greatview	B	E J 91420687							
June 23	.3 mi makai Kama Hwy on Mahoe	B	E J 92846912		+					
June 23	Water tank Mahoe .3 mi N Waipahu	B	E J 92826702							
June 23	E. end of Waipahu St. W of jet	B	E J 91316653							
June 30	Dole field 4113, near old Key. 36	B	E J 93587954							
June 30	Dole field 4105, by mango tree	B	E J 93747118							
June 28	Foster Gardens	B	E J 92958000	+						+
June 28	Keawe & Haka St. Honolulu	B	E J 17585587							
Oct. 6	Waipahu	B	E J 93006800							
Oct. 27	Kalibi	B	E J 17026070							
Oct. 27	Small Island Keesi side	H	E J 15425623							
Oct. 6	Waipahu. Field 405 near rd	B	E J 93006650							
Oct. 23	Waialua	B	E J 92188600							
Oct. 30	Aua Hahaione, concrete water tank	B	E J 29005500							+

APPENDIX I.

Oct. 25 C. of H. campus	A	F	J	22303610			
May 12 Waiananali Exp. Sta. Rd.	C	F	J	33390020	+	+	
May 12 Waiananali W of Dairy Farm	C	T	J	39226100	+	+	
Nov. 2 Kahuku Camp B	C	F	J	05059744			+
Mar. 30 Haleiwa, Pupukoa Rd.	C	F	J	98925454			
June 30 Waianua, Cabl. & Hill track	C	F	J	0276			
June 30 Waianua, end of Lulelan St.	C	F	J	1279			
June 20 Waiananali water tank S Exp. Sta.	C	F	J	14065968	-		
June 20 Waiananali 41-740 Kaulukana St	C	F	J	31505980			
June 22 Kaneohe Kaulukana & Kahukou Hwy.	C	F	J	23226540			
June 22 Kaneohe Kaulukana & Kahukou Hwy.	C	F	J	23226924			
July 1 Waiananali, NW of Dairy by care	C	F	J	30528100	-	+	
Sept. 30 Mauna Kea trail	D	F	J	24025956			
Oct. 22 1300' Tanager	D	F	J	22766030			
Nov. 22 Mauna end of Mauna Kea trail	D	F	J	24015066			
Nov. 9 Puuoaia foot trail ca. 2000'	D	F	J	10338162			
Nov. 4 Summit of Mt. Kaala	D	F	J	88507968		+	
Nov. 4 Mt. Kaala 2800'	D	F	J	8979			
Nov. 4 Mt. Kaala 2000'	D	F	J	8979			
June 20 Waiananali edge of forest Calif St	D	F	J	03907921			
June 18 Mauna Kea trail	D	F	J	22225954		+	
June 15 Mauna end of Brundage Dr.	D	F	J	21958740		+	
June 20 Waiananali Akaka & Waikapuna	D	F	J	32175978	+		+
June 20 Waiananali W end Kaulukana St.	D	F	J	32185380	+	+	
June 20 Waiananali Bridge W Kaulukana St.	D	F	J	31607980	+		
June 22 Kaneohe Mauna end of Haiku Rd.	D	F	J	21766920			
June 20 Mt. Kaala summit	D	F	J	88607388		+	
June 25 Kolekole Pass	D	L	J	91387532	+		
<i>ISLAND OF LANAI</i>							
July 20 1.5 mi W of BM 1252 on R. 41	A	G	H	1167971			
July 20 1 mi W of BM 1252 on R. 41	A	G	H	1161952	-		
July 20 .5 mi W of BM 1252 on R. 41	A	G	H	1170982			
Jan. 29 Maunaloa	A	G	J	282036			
Jan. 28 East Lanai jeep trail above Naha	A	G	J	1954650	-		
Jan. 29 Kaunaloa Harbor	A	G	J	094902			
Jan. 29 Puuoaia	B	G	J	156079			
Jan. 29 Lanai City	C	G	J	102044			
Jan. 29 Cemetery area	C	G	J	106056	+		
July 20 Fallow field Mauna of Lanai City	C	G	J	1170341		+	
July 20 Munro trail	C	G	J	162060			
July 20 Munro trail	C	G	J	192060	+	-	
<i>ISLAND OF KAUAI</i>							
July 13 2 mi Mauna of Parking Sands	A	D	K	218389			
July 13 1.5 mi Mauna of Parking Sands	A	D	K	214388			
July 13 Palihale Beach	A	D	K	226446			
July 13 Rauhala Sta. 3-4 mi Mauna of Kekaha	A	D	K	252590			

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July 13	Pump E. of Kekaha	A	DK 274290	
July 13	Puola Point Rd. 343	A	DK 316220	
Jan. 17	Hanaopepe Lookout	B	DK 430340	
Jan. 17	Hanaopepe Town	B	DK 3394214	
Jan. 17	Waimea Canyon Lookout	B	DK 310424	
Jan. 17	Waimea Canyon & Kekoa Rd. jct.	B	DK 306424	*
Jan. 17	.5 mi W jct. 52 & 50	B	DK 508276	
Jan. 18	Kapaa Beach	B	DK 555426	
Jan. 18	Waialua River	C	DK 649386	
Jan. 17	Kokee Park Hwy.	C	DK 320480	
Jan. 17	Kokee Park Kawaikou	C	DK 335182	+
Jan. 17	Kokee Kamaoewa Lookout	C	DK 340500	
Jan. 18	Pahi 2.5 mi W	C	DK 572282	
Jan. 18	Waialua River mauka Exp. Sta. Paved	C	DK 573586	+
July 13	1.5 mi mauka of Waialua Falls	C	DK 595386	+
July 14	2 mi E of Kalaheo Rd. 50	C	DK 616558	+
July 14	Waipahoe Falls	C	DK 616478	+
July 13	4.3 mi W jct. 50 & 50H stream	D	DK 508278	
July 14	Hanalei Bay	D	DK 466556	+
July 14	Mauka of bridge E. of Hanalei	D	DK 400500	+
Jan. 18	Jeep trail mauka Waialua Exp. Sta	D	DK 582416	+
<i>ISLAND OF MAUI</i>				
Feb. 2	Maalae Bay	A	GJ 584040	
Feb. 2	2 mi N Lanaina	A	GJ 404132	+
Feb. 2	1 mi S end of paved Hwy. 31	A	GJ 663000	
Feb. 2	Maalae Bay jct 31 & 33	A	GJ 638008	
Feb. 2	Kalama Beach Park	A	GJ 650350	
Feb. 2	Honokohau	B	GJ 435240	
Feb. 4	11.3 mi Hana of Ulupalakua	B	GJ 666830	
Feb. 4	Between Makona & Ulupalakua	B	GJ 678854	?
Feb. 2	1 mi Waialua of Jao Needle	C	GJ 563116	
Feb. 2	Wailuku Heights	C	GJ 580104	
Feb. 2	Kahakulua	C	GJ 326258	
Feb. 2	3.5 mi Hana of Ulupalakua	C	GJ 4710852	
Feb. 2	Kaupo	C	GJ 1004850	
Feb. 2	Makawao	C	GJ 790082	-
Feb. 2	Halei	C	GJ 784155	
Feb. 2	Jao Needle Park	D	GJ 553114	+
Feb. 4	Rd. 36 mauka of airport	D	GJ 674122	
Feb. 2	Waialua Village	D	GJ 380080	+
Feb. 2	Honouliuli Grove	L	GH 848986	
Feb. 2	Haleakala Rd. ca. 2630'	L	GH 624382	+
<i>ISLAND OF HAWAII</i>				
June 5	Hapuna	A	KC 040134	
June 5	Hapuna ca. 200'	A	KC 050240	+
June 5	Puako	A	KC 024110	

APPENDIX I.

June 5 Rt. 26 2000'	B	K B 148170	+	
Dec. 29 Kalaheo Beach Park	B	J B 884684		
Dec. 29 Kailua Kona	B	J B 854750		
Dec. 29 U. of H. Exp. Sta. Kona	B	J B 934008		
Dec. 28 Pahala	B	K B 890244	+	
Dec. 28 City of Refuge	B	J B 946402		
June 7 Naula Picnic Area, Vol. Nat'l. Park	C	K B 766332		
Dec. 27 Akaka Falls	D	K B 744972		
Dec. 27 Kona Orchard	D	K B 864738		
Dec. 27 Meadowgold Plant. Hilo	D	K B 818822		
Dec. 27 Lava Tree State Park	D	K B 908590		
Dec. 27 Rainbow Falls	D	K B 770642		
Dec. 28 Eye of the Eel Crater	D	K B 690430		
June 8 Rainbow Falls	D	K B 770812		
June 7 1 mi SE of Kona on Rt. 11	D	K B 846700		
June 7 1.5 mi SE of Hilo on Rt. 11	D	K B 794046	-	
June 7 17 mi SE of Hilo on Rt. 11	D	K B 752550	-	++
June 7 18.5 mi SE of Hilo on Rt. 11	D	K B 746576	+	
June 7 23 mi SE of Hilo on Rt. 11	D	K B 702722	+	
June 6 2.5 mi on Kahakai off Rt. 13 N. Pahoa	D	K B 924652	+	
June 6 1 mi S Kona on Rt. 13	D	K B 868699		
June 6 1.5 mi S Kona on Rt. 13	D	K B 870537	+	
June 6 2 mi S of Kona on Rt. 13	D	K B 878692		
June 6 2 mi S of Pahoa on Rt. 13	D	K B 950568	+	
June 6 13 mi	D	K B 860710	+	
June 8 Kipuka ki Fire Cache Vol. Nat'l. Park	E	K B 874514		
June 8 Mauna Loa Strip Rd. 5000'	E	K B 950514	+	
June 8 Mauna Loa Strip Rd. 4100'	E	K B 534544		
<i>ISLAND OF MOLOKAI</i>				
July 18 Kaunakakai City Park	A	G J 054338		
Jan. 28 Koko Wharf	A	F J 880738		
Jan. 28 Moku	A	G J 133316		
Jan. 28 Waikele 4 mi Halawa Bay side	B	G J 324394		
July 18 Forest Camp Rd. approx. 1000'	B	G J 066384		
July 18 Beach Halawa Valley	C	G J 346422	+	
July 18 Old Chuzza Halawa Valley	C	G J 346422	+	+
July 18 1 mi up Halawa Valley	C	G J 336422	+	
July 18 Stream Halawa of Murphy Ranch	C	G J 336402	+	
Jan. 28 Waikele Sandy Beach	C	G J 326396		
Jan. 28 Halawa Bay	C	G J 340432	+	
Jan. 28 Smith and Briate Landing Site	C	G J 230300		
July 18 Mauna of Forest Camp	D	G J 090394		
July 18 Water Res. Mauna of Forest Camp	D	G J 116396	+	
Jan. 28 Pillar Rock area	D	G J 070432	+	
July 18 1.5 mi up Halawa Valley	C	G J 346422		

than 1/3rd of the time in a given zone could not have equal preference for zones A, B, C, and D, and thus did have a high preference for 1 or 2 of the zones. The validity of these data thus increases with the ease with which a species can be found. The total number of times the species was collected is given in the last column of Table 2. These data are based on the following number of collections from all of the 6 main accessible islands: (1) Zone A 44 collections; (2) Zone B 32 collections; (3) Zone C 34 collections; (4) Zone D 44 collections and (5) Zone E 2 collections.

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