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Islands, Revillagigedo Archipelago, Mexico.
Species and comparisons with the continental
and the Tres Marías Archipelago psocid faunas

Alfonso Nerl García Aldrete
Alex Cadena Carrión
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**PSOCOPTERA (INSECTA) OF SOCORRO AND CLARION
ISLANDS, REVILLAGIGEDO ARCHIPELAGO, MEXICO.
SPECIES AND COMPARISONS WITH THE CONTINENTAL
AND THE TRES MARIAS ARCHIPELAGO PSOCID FAUNAS**

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ABSTRACT

Nineteen species of psocids were found in Socorro Island, 704 km W of Manzanillo, Colima, Mexico, and six species of psocids were found in Clarión Island, 372 km. W of Socorro, and 1076 km W of Manzanillo. Socorro Island has an area of 167 km², and Clarión Island has an area of 25 km². All but two of the Clarión psocid species also occur in Socorro. Only two of the 21 species of both islands are endemic; one occurs in both islands and the other is present only in Clarión; they both belong in genus *Cerobasis*. Most of the nonendemic species are found on the Pacific coast of Mexico, east of the islands. Seven of the 21 species of psocids of the Revillagigedo Islands also occur in the Tres Marias Islands, and 13 species of the Revillagigedo Islands are also present in the Pacific coast of Mexico, to give an index of faunistic similarity of 0.19 with both areas. The psocid fauna of Socorro and Clarión islands constitute and impoverished

extension of the psocid fauna of the Pacific coast of Mexico, explainable by the distance from the coast, and the small area of the islands.

KEY WORDS: Psocoptera, Revillagigedo Islands, Fauna, Endemics.

RESUMEN

Diecinueve especies de psócidos fueron registrados en Isla Socorro, con una superficie de 167 km², y a 704 km al oeste de Manzanillo, Colima, México, y seis especies de psócidos fueron registrados en Isla Clarión, con una superficie de 25 km² y a 372 km al oeste de Isla Socorro y a 1076 km al oeste de Manzanillo. Todas las especies de Clarión, excepto dos, se encuentran también en Socorro. Sólo dos de las 21 especies de ambas islas son endémicas: una de ellas se encuentra en ambas islas y la otra se encuentra sólo en Clarión; ambas son del género *Cerobasis*. La mayoría de las especies no endémicas se han registrado en la costa del Pacífico de México, al este de las islas. Siete de las 21 especies de las Islas Revillagigedo se encuentran también en las Islas Marías, y 13 de ellas se encuentran también en la costa del Pacífico de México, para dar un índice de similitud faunística de 0.19 con ambas áreas. La fauna de psócidos de las Islas Revillagigedo, constituye una extensión empobrecida de la fauna de psócidos de la costa del Pacífico de México, explicable por la distancia de la costa a las islas, y por el área reducida de éstas.

PALABRAS CLAVE: Psocoptera, Islas Revillagigedo, Fauna, Especies endémicas.

INTRODUCTION

Socorro and Clarión islands are the largest and most complex of the four that constitute the Revillagigedo Archipelago, in the Mexican Pacific. They are found, respectively, at 704 and 1076 km west of Manzanillo, Colima. The islands are oceanic and volcanic, Clarión being the oldest, dating back from the early Pliocene (7 my BP), while Socorro dates back from the early Pleistocene (3 my BP) (Brattstrom, 1990). Socorro island is roughly oval in shape and measures approximately 16 km along its

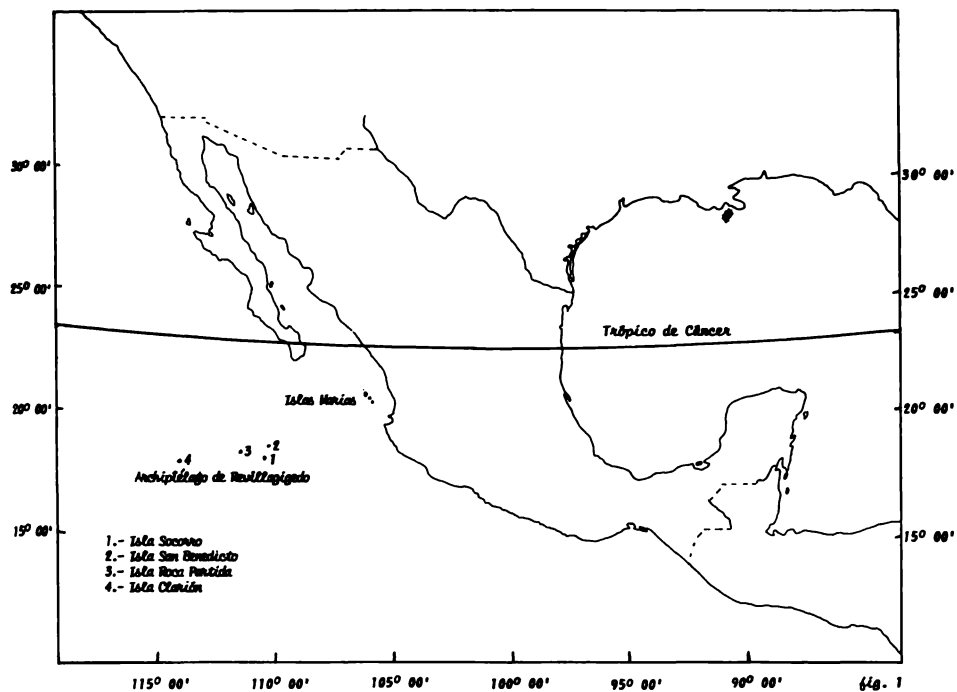


Figure 1
Geographic location of the Revillagigedo Archipelago.

longest axis, by 11 km along its greatest width, to give an approximate area of 167 km although Castellanos & Rodríguez Estrella (1992), give an area of 140 km², and Jiménez (1991), estimated an area of 150 km².

Socorro has a complex topography and seven types of vegetation have been recognized; the plants and the vegetation of the island have been studied by Johnston (1931), Miranda (1960), and Levin & Moran (1989). Clarión island is much smaller, with an approximate area of 25 km²; it is almost rectangular, with cliffs that descend to the sea from a slightly elevated plateau almost all around the island, except for a small area on the southern edge (Sulphur Bay and adjacent areas); the most prominent elevations on the plateau are Tent Peak, towards the east end, and Pico Gallegos, towards the west end of the island. There are extended grassy areas on the southern edge, and the plateau is dominated by low height shrubs and trees, mostly *Karwinskia* sp.; Contreras (1926) and Johnston (1931), mention the existence of dense *Opuntia* thickets on the plateau and on the south side of the island, which presently have considerably receded. In general, the botany of Clarión has been much less studied than that of Socorro. Brattstrom (1990), has summarized the information on flora and fauna of the four islands of the archipelago; according to him, the fauna of terrestrial arthropods is poorly known, and only a few papers on special groups have been published, in fact, the insects of the islands have been documented in 24 papers (see Richards & Brattstrom, 1959, Palacios Vargas *et al.* 1982, García Aldrete, 1988a, and unpublished manuscripts a and b), only three of which deal with insects of the order Psocoptera.

A survey of the insects of Socorro and Clarión islands was conducted during September-December of 1987, and during September-November of 1988, to increase the entomological knowledge about the islands, and to test the following hypotheses:

1. The insect fauna is related to that of the mainland and to that of the Tres Marías Archipelago.
2. The number of species is low as compared to that of the mainland and to that of the Tres Marías Archipelago.

3. The faunas of Socorro and Clarión are related, but the former is richer than the latter.

4. On account of the isolation, the level of endemism is high.

The preceding points are referred in this paper to the fauna of psocopteran insects.

MATERIALS AND METHODS

During 1987 and 1988 we accumulated 208 man hours of collecting in Socorro and 128 man hours of collecting in Clarión. In both islands we collected insects by beating branches and foliage, examining tree trunks and rock faces, searching underneath loose bark, sifting litter, and by means of light traps. The localities where insects were collected are indicated on Figures 2 and 3. We did not collect in the northern portion of Socorro due to difficulties of access. The psocids were taken from the beating cloth or the substrate with buccal aspirators, and then transferred directly to 80% ethyl alcohol. For identification purposes, the specimens were dissected in glycerol or in 80% alcohol, and their parts were mounted permanently in Euparal, or temporarily in glycerol, for examination under the optic microscope. The specimens collected and the slides made are deposited in the Insect Collection, Instituto de Biología, UNAM, Departamento de Zoología.

RESULTS

We collected 775 psocids in Socorro and 281 psocids in Clarión, in which 21 species are represented; 19 species occur in Socorro, and six species were recorded in Clarión, four of which are also present in Socorro (Table 1). The distribution of the psocids on the islands, and the habitats they occupy is presented in the Addendum. The distribution of the psocid species in Socorro is heterogeneous, some species being

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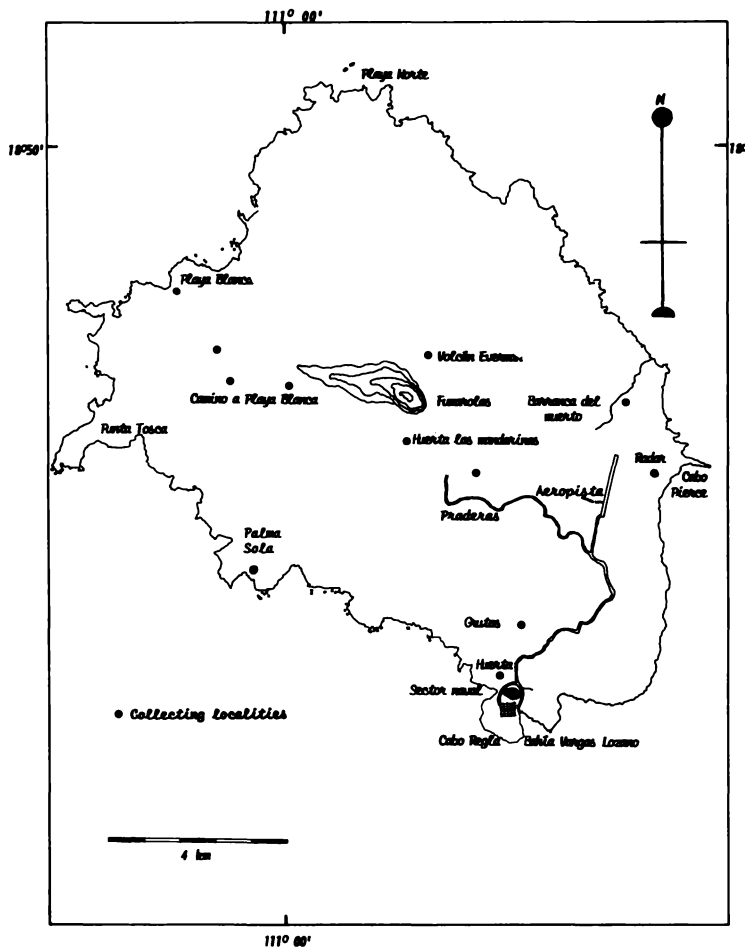


Figure 2
Collecting localities in Socorro Island.

present only in restricted areas, while others are found throughout the island; this is probably a consequence of inherent differences among the species, and/or a time factor, necessary for dispersal in the island after

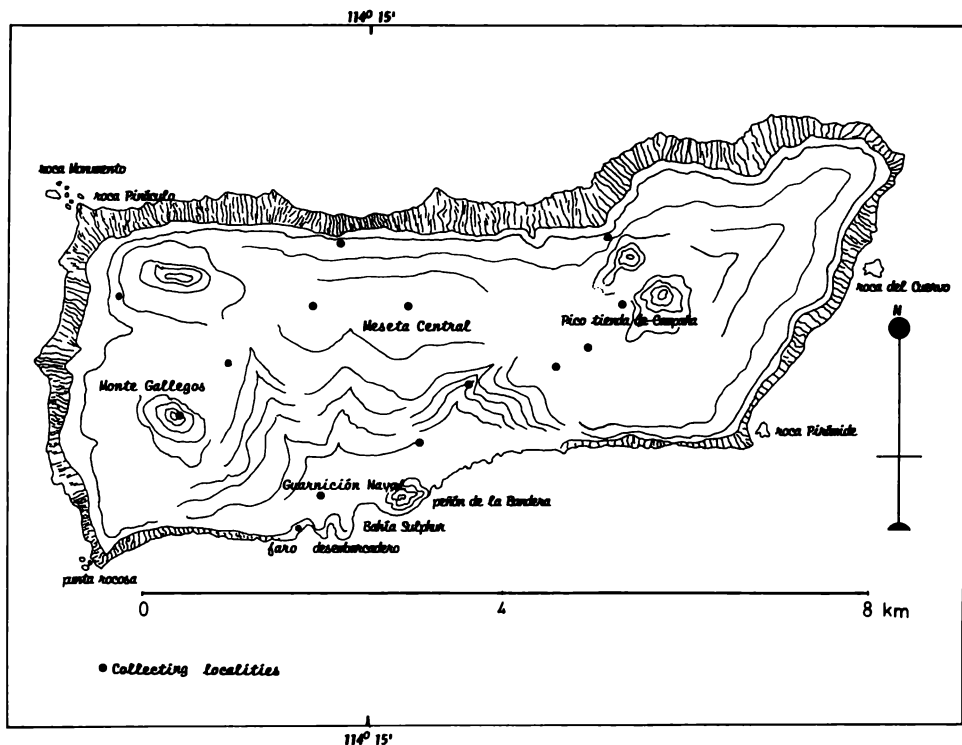


Figure 3
Collecting localities in Clarión Island.

a successful arrival and establishment; thus, of 19 species recorded in the whole island, 13 species were found in the southern end, near the Naval Sector (the village inhabited by the Navy personnel), including a small

Table 1
 Species of Psocoptera (Insecta) and number of individuals collected in Socorro and Clarión Islands, Revillagigedo Archipelago, Mexico. 1987-1988.

Species	Distribution on islands	
	Socorro	Clarión
TROGIOMORPHA, Group Atropetae		
Lepidopsocidae		
<i>Thylacella cubana</i> (Banks)	30 ♀, 29n.	
Trogiidae		
<i>Cerobasis clarionensis</i> García Aldrete		49 ♀, 30 ♂
<i>C. lapidicola</i> García Aldrete	20 ♀, 10 ♂	25 ♀, 12 ♂
<i>C. treptica</i> Thornton & Woo	25 ♀ 32 ♂, 52 n.	
Group Psocathropetae		
Psyllipsocidae		
<i>Psocathropos microps</i> Enderlein	1 ♀	
TROCTOMORPHA, Group Amphientometae		
Manicapsocidae		
<i>Nothoentomum tuxtlarum</i> (Mockford)	27 ♀, 23 ♂, 107n.	
Group Nanopsocetae		
Liposcelidae		
<i>Belaphotroctes alleni</i> Mockford	3 ♀	
<i>Liposcelis bostrychophilus</i> Badonnel	5 ♀	1 ♀
<i>L. ca. albothoracicus</i> Broadhead	16 ♀, 6♂	
Pachytroctidae		

<i>Tapinella olmeca</i> Mockford	11 ♀, 6 ♂, 7n.	
PSOCOMORPHA, Group Caecilietae		
Caeciliidae		
<i>Caecilius casarum</i> Badonnel	18 ♀, 2n.	
Group Homilopsocidea		
Lachesillidae		
<i>Lachesilla rena</i> Sommerman	15 ♀, 10 ♂, 18 n.	
<i>L. riegei</i> Sommerman	33 ♀ 6 ♂	
Ectopsocidae		
<i>Ectopsocus maindroni</i> Badonnel	64 ♀, 17 ♂	26 ♀, 14 ♂
<i>E. meridionalis</i> Ribaga	46 ♀, 16 n.	
Peripsocidae		
<i>Peripsocus stagnivagus</i> Chapman		52 ♀, 1n.
Pseudocaeciliidae		
<i>Pseudocaecilius citricola</i> (Ashmead)	5 ♀	
<i>P. tahitiensis</i> (Karny)	3 ♀	
Philotarsidae		
<i>Haplophallus iarevianus</i> García A.	18 ♀, 6 ♂	
Group Psocetae, Psocidae		
<i>Indiopsocus bisignatus</i> (Banks)	52 ♀, 31 ♂	40 ♀, 31 ♂
Myopsocidae		
<i>Lichenomima cervantesi</i> García A.	4 ♀, 2 ♂	

orchard of introduced trees; 12 species were recorded in Barranca del Muerto, while only five species were found around Playa Blanca, the

sampled locality most distant from the village, and four species were recorded in and around Mount Everman. In Clarión, being much smaller and simpler, the distribution of the psocid species is more homogeneous throughout the island; thus, of six species recorded on the island, all six were found around Sulphur Bay, five each were found on the central plateau and on the western end, around Pico Gallegos, and four species were found on the eastern end of the island, around Tent Peak.

ANALYSIS OF THE FAUNA

Composition and Origin. The three suborders of Psocoptera are represented in the 21 species found in Socorro and Clarión, as well as 14 families and 15 genera (Table 1). As it was to be expected, according to the tenets of the theory of island biogeography (Mac Arthur & Wilson, 1967), it is a poor fauna, and, since 15 of its 21 species (71%), occur in the immediate mainland, east and northeast of the archipelago, it seems evident that this area has been the source for the colonization of the islands. The presence of *Nothoentomum tuxtlarum*, previously known only from Los Tuxtlas, Veracruz, *Belaphotroctes alleni*, previously known only from Texas, and *Liposcelis ca. albothoracicus*, previously known only from Oaxaca, is puzzling, given the distribution of these species, but it gives a better picture of their distribution.

Psocids are small, light insects that are not particularly active fliers, but that can easily be taken by wind currents, and are frequent components of the aerial plankton; in open sea, living psocids have been taken at elevations above 4000 meters, and at distances of up to 320 km from the nearest land. Dead psocids, or parts of them have been found at distances of up to 1775 km from the nearest land (Freeman, 1945; Thornton, 1964; Thornton & Harrell, 1965). It is then feasible that aerial dispersal may have played some role in the colonization of the islands; also, the distribution of species in Socorro, where 68% of the species occur in the southern end, strongly suggests that some of the species may have been introduced by human activities. In 1957, the Mexican

government established a garrison on the southern tip, (a smaller garrison was established in Clarión in 1979), and since then there is a constant flow of ships to the islands to provide supplies for the personnel established there; as a result of this traffic, numerous plants have been introduced, including fruit trees and ornamentals, and it is not unconceivable that living psocids may have arrived with the plants. It is quite possible that the presence in Socorro of *Psocathropos microps*, *Tapinella olmeca*, *Caecilius casarum*, *Pseudocaecilius citricola*, *P. tahitiensis* and *Haplophallus iarevianus*, which are restricted to the southern tip of the island and are present in the coastal mainland, east of Socorro, may be explainable in this way. Examples of other introductions promoted by man in Socorro, are *Mus musculus* and *Periplaneta americana*, restricted to the inhabited area in the southern tip of the island.

Clarión island, dating back from the early Pliocene (7 my BP), has been available for colonization for 4 my more than Socorro island, which dates back from the early Pleistocene (3 my BP) (Brattstrom, 1990); this difference in age may account for the presence in Clarión of *Peripsocus stagnivagus* and *Cerobasis clarionensis*, both absent from Socorro; the former species occurs in the mainland, and *C. clarionensis* has close relatives in the mainland and in southern Baja California. Of the rest of shared species between Socorro and Clarión, only *Cerobasis lapidicola* is puzzling, since the others are either cosmopolitans (*Liposcelis bostrychophilus*), or tropical waifs (*E. amindroni*), or widely distributed species (*Indiopsocus bisignatus*). This indicates that the species present in Socorro have arrived posteriorly, and given the distance to Clarión, have not been able to successfully colonize it, notwithstanding the permanent traffic of ships from Socorro to Clarión.

The psocid fauna of Socorro and Clarión, composed of few species, most of which also occur in the mainland, and with only two species endemic, presents a picture very similar to that of the spider fauna of both islands (Jiménez, 1991; Palacios *et al.* 1982): Socorro has 26 species, and Clarión has 4 species, all but one of which occurs also in Socorro, and

only 2 species are known to be endemic, so both psocids and spiders conform well to the statements of Brattstrom (1990), that most of the arthropods of the islands are widespread forms and that most species are also found in or are related to species found in Baja California or in the Sonora-Sinaloa area of Mexico.

Faunal Comparisons. The psocid fauna of Chamela, Jalisco, consists of 115 species in 51 genera and 23 families (García Aldrete, 1988). For purposes of this work, this fauna is taken as representative of the psocid fauna in the Pacific coast of Mexico, east of the Revillagigedo archipelago, which, together with southern Baja California, we consider as the source area for the colonization of the archipelago. To the northwest of Chamela, and approximately 100 km from the coast (Fig. 4), is found the Tres Marías archipelago, whose psocids were studied by García Aldrete (1986); these islands are continental and, being close to the mainland, their species richness is quite high: San Juanito has an area of only 8 km², and harbors 16 species of psocids in 14 genera and 11 families; all but five of its species were also found in María Madre Island, from which it is separated by only 1.5 km. Also, all but two of its species occur in the mainland. María Madre Island has an area of 144 km², and a rich fauna of 47 species in 30 genera and 19 families, all but five of which occur in the mainland west of the island or in other continental localities; thus, the faunistic similarity of both islands with Chamela is quite high (Table 2, IFS= 0.42) On the other hand, and strongly contrasting with the above, the fauna of the Revillagigedo islands is poor: the number of psocid species in Socorro, an island only slightly larger than María Madre, drops to only 19 species, a reduction of 82% of that of the coastal fauna, and the further decrease to only six species in Clarión is accounted for both by the distance increase to and the small area of the island (only 25 km²). Thus, taking the coastal and the Marías and Revillagigedo faunas as a whole, there is a decrease in number of species of 55%, from the mainland to the Marías, 100 kilometers away, and a decrease of 83% to Socorro, 700 kilometers away in roughly the same direction (west from the coast). As a consequence, the IFS between the Revillagigedo and the Marías is of only 0.19, and, surprisingly, the same value was calculated for

Table 2

Number of species in common and indices of faunistic similarity (IFS)*, for the pairs of areas indicated.

	Species in common	IFS
Islas Marías-Chamela	35	0.42
Islas Revillagigedo-I. Marías	7	0.19
Islas Revillagigedo-Chamela	13	0.19

* $IFS = \frac{2A}{B + C}$ (A= number of species in common; B= number of species in area 1; C= number of species in area 2). To express in percentage, multiply by 100.

the similarity between The Revillagigedo and Chamela (Table 2). The Revillagigedo and the Marías islands have seven species in common, and 13 of the 21 species of the Revillagigedo islands are found in Chamela. It is then inescapable that the psocid faunas of the Marías and the Revillagigedo islands are as predicted by the tenets of the theory of island biogeography (Mac Arthur & Wilson, 1967): more species in islands close to the mainland, more species in large islands, and low densities, indicative of biotic fragility.

Biogeographic Categories. The following categories can be established for the psocids of Socorro and Clarión:

I. Endemics (two species).

Cerobasis clarionensis, *C. lapidicola*

II. Species occurring in the mainland.

A. Cosmopolitan species (two species).

Liposcelis bostrychophilus, *Ectopsocus meridionalis*.

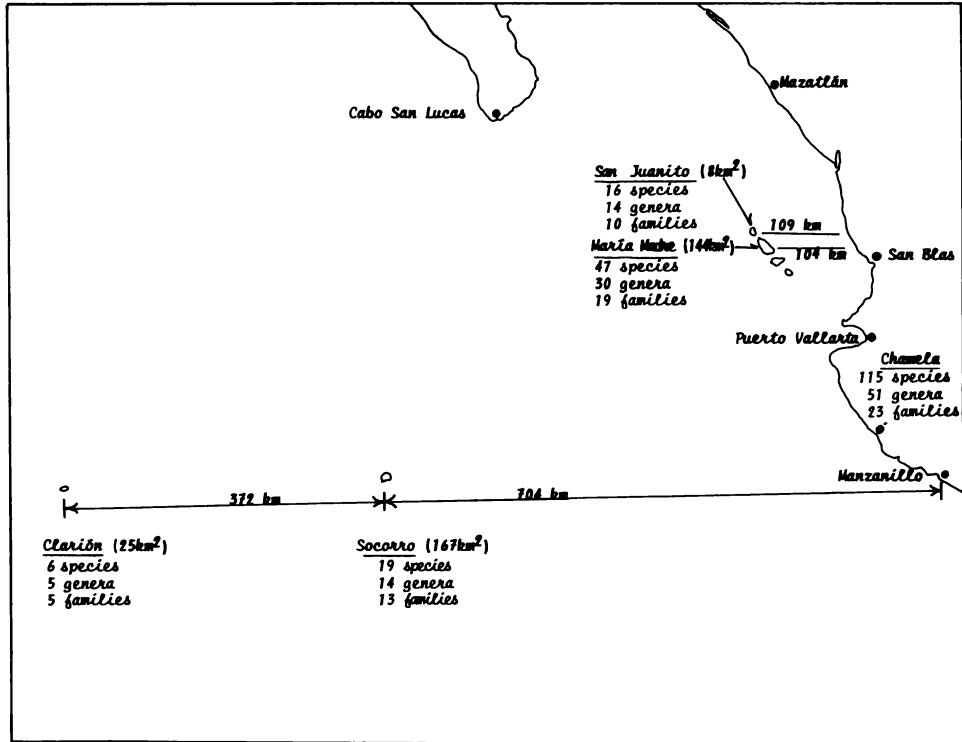


Figure 4

Number of species, genera and families of Psocoptera (Insecta), in Chamela, Jalisco, and San Juanito, María Madre, Socorro and Clarión Islands, area of each island, and distance of the islands from the continent.

B. Tropical waifs (three species).

Psocathropos microps, *Ectopsocus maindroni*, *Pseudocaecilius citricola*.

C. Species widespread in Tropical and Subtropical America (seven species).

Thylacella cubana, *Peripsocus stagnivagus*, *Lachesilla rena*, *L. riegeli*, *Caecilius casarum*, *Indiopsocus bisignatus*, *Tapinella olmeca*.

D. Species occurring in neighbouring coastal Pacific areas (five species).

Cerobasis treptica, *Liposcelis ca. albothoracicus*, *Pseudocaecilius tahitiensis*, *Haplophallus jarevianus*, *Lichenomina cervantesi*.

E. Species occurring on the Gulf coast of Mexico (one species).

Nothoentomum tuxtlarum.

F. Species occurring in southern U.S. (one species).

Belaphotroctes alleni

To summarize, the first three hypotheses to be tested proved correct (see Introduction), as the psocid fauna of Socorro and Clarión islands conform well with the basic tenets of the theory of island biogeography; the fourth hypothesis however, that, on account of the isolation a high level of endemism was to be expected, was not supported by our findings; it is likely that A): continuous arrivals from the continent, by natural means or aided by human activities, have helped to maintain the gene flow with the populations established in the islands, thus debilitating the effects of the isolation, or B): that not enough time has elapsed for the island populations to diverge from the source populations.

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ADDENDUM

Psocoptera of Socorro and Clarión Islands. Local distribution and habitats.

Thylacella cubana (Banks). SOCORRO. Towards mount Everman, 450-650m, ca. summit. Barranca del Muerto, 250 m Naval Sector, Huerta. Huerta Mandarininas. Habitats: branches, leaf litter, dead fern fronds, grass clumps, underneath loose bark of dead branches.

Cerobasis clarionensis García Aldrete. CLARION. Ca. Sulphur Bay, Central plateau, ca. Tent Peak, ca. Pico Gallegos. Habitats. Branches of trees, shrubs, dead leaves of grasses.

C. lapidicola García Aldrete. SOCORRO. Barranca del Muerto. CLARION. Ca. Tent Peak, northern edge of island, NW corner of island, near Roca Monumento, ca. Sulphur Bay, ca. Naval Garrison. Habitats: concavities of rocks, covered with lichens.

C. treptica Thornton & Woo. SOCORRO. Barranca del Muerto. Towards Mount Everman. Ca. Aeropista. Ca. Naval Sector. Huerta. Grutas. Playa Blanca. Habitats: *Croton* branches, *Ficus* adventitious roots, grass clumps, leaf litter, branches of trees and shrubs.

Psocathropos microps Enderlein. SOCORRO. Ca. Naval Sector. Habitat: grass clumps.

Nothoentomum tuxtларum (Mockford). SOCORRO. Towards Mount Everman (650 and 800 m), and ca. summit. Towards Playa Blanca, from summit of Mount Everman (800 and 900 m). Huerta Mandarininas. Barranca del Muerto. Habitats: on tree trunks and rocks with mosses and lichens, leaf litter.

Belaphotroctes alleni Mockford. SOCORRO. Barranca del Muerto (250 m). Ca. Praderas. Habitats: underneath loose bark of dead branches, *Ficus* leaf litter.

Liposcelis bostrychophilus Badonnel. SOCORRO. Playa Blanca. Huerta. CLARION. Ca. Sulphur Bay. Habitats: leaf litter, grass clumps and dead leaves of grasses, on nest of *Sceliphron jamaicense* (Hymenoptera: Sphecidae).

L. ca. albothoracicus Broadhead. SOCORRO. Barranca del Muerto (250 m). Huerta. Habitats: grass clumps, under loose bark of dead branches.

Tapinella olmeca Mockford. SOCORRO. Huerta. Habitat: grass clumps.

Caecilius casarum Badonnel. SOCORRO. Huerta. Habitats: branches of lemon and mango trees, dead leaves of banana and coconut trees.

Lachesilla rena Sommerman. SOCORRO. Road to Grutas. Huerta. Playa Blanca. Habitats: grass clumps, dead leaves of herbaceous plants, trees and shrubs.

L. riegei Sommerman. SOCORRO. Ca. Aeropista. Ca. Grutas. Barranca del Muerto. Huerta. Huerta Mandarinas. Habitats: grass clumps, dead fronds of ferns, dead leaves of herbaceous plants, trees and shrubs, *Ficus* trunks.

Ectopsocus maindroni Badonnel. SOCORRO. Barranca del Muerto. Aeropista. Huerta Mandarinas. Ca. Grutas. Naval Sector. Ca. Playa Blanca. CLARION. Ca. Sulphur Bay. Ca. Pico Gallegos. Central plateau. Ca. Naval garrison. Habitats: leaf litter, branches of *Croton*, *Karwinskia*, trees and shrubs, adventitious roots of *Ficus*, dead leaves of guava, lemon, orange, mango, coconut and banana trees, and dead fronds of ferns.

E. meridionalis Ribaga. SOCORRO. Towards mount Everman (550-650m), Huerta Mandarinas. Barranca del Muerto. Radar. Habitats: leaf litter, branches and tree trunks with lichens, dead fronds of ferns, under loose bark of dead branches.

Peripsocus stagnivagus Chapman. CLARION. Ca. Sulphur Bay. Ca. Naval Garrison. Ca. Pico Gallegos. Central plateau. Ca. Tent Peak. Habitats: leaf litter, dead fronds of coconut trees, dead leaves of grasses, branches and dead leaves of herbaceous plants, trees and shrubs, including *Karwinskia* and recumbent leguminous plants.

Pseudocaecilius citricola (Ashmead). SOCORRO. Huerta, ca. Naval Sector. Huerta Mandarinas. Habitats: branches with dead leaves of lemon, orange, mango, coconut, guava, and banana trees.

Pseudocaecilius tahitiensis (Karny). SOCORRO. Huerta, ca. Naval Sector. Grutas. Habitats: branches with dead leaves of lemon, orange, mango, coconut, and banana trees. Branches and adventitious roots of *Ficus*.

Haplophallus iarevianus García Aldrete. SOCORRO. Huerta, ca. Naval Sector. Radar. Barranca del Muerto. Habitats: branches of trees and shrubs, branches of lemon and orange trees.

Indiopsocus bisignatus (Banks). SOCORRO. Huerta, ca. Naval Sector. Praderas. Grutas. Radar. Aeropista. Barranca del Muerto. Huerta Mandarinas. Towards Mount Everman, 450, 550, 650, 850 m Ca. summit of Mount Everman. Palma Sola. Playa Blanca. CLARION. Ca. Sulphur Bay. Central plateau. ca. Monte Gallegos. Ca. Tent Peak. Ca. Naval Garrison. Habitats: leaf litter, dead fronds of ferns, grass clumps, tree trunks, adventitious roots of *Ficus*, branches of trees, shrubs, herbaceous plants, dead fronds of coconut palms.

Lichenomima cervantesi García Aldrete. SOCORRO. Barranca del Muerto. Habitat: concavities of rocks covered with lichens, near creek bed.