

Three New *Ramaria* species from central Mexican oak forests

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Tres nuevas especies de *Ramaria* de los bosques de encino del centro de México

Resumen. Las especies de *Ramaria* son ecológica y económicamente importantes, sin embargo, los estudios sobre este género son muy escasos en México. Debido a esto, se llevó a cabo un estudio taxonómico sobre este género. Se describen tres nuevas especies de *Ramaria* del subgénero *Laeticolora* de los bosques de encino del centro de México. *R. persicina* es reconocida por su color rosa a rosa anaranjado, contexto inamiloide y ornamentación verrucosa lobada y dispersa. *R. suaveolens* es reconocida por su color amarillo pálido, hifas dendrofitoides en el contexto del estípite, con esporas lisas y en asociación con *Quercus*, y *R. radicans* es reconocida por su color amarillo pálido, estípite radicante, esporas largas y lisas, e hifas dendrofitoides en el contexto del estípite.

Palabras clave: hongos coraloides, hongos micorrícicos, *Quercus*.

Abstract. The species of *Ramaria* are ecologically and economically important, however, studies on this genus are very scarce in México. Due to this, a taxonomic study on this taxon was performed. Three new *Ramaria* spp. in the subgenus *Laeticolora* are described from oak dominated forests of central Mexico: *R. persicina* is recognized by its pinkish orange color, nonamyloid context and spore ornamentation of scattered, lobed warts. *R. suaveolens* is recognized by its pale yellow color, sweet odor, dendrophysoid hyphae in the stipe context, mostly smooth spores, and association with *Quercus*, and *R. radicans* is recognized by its pale yellow color, rooting stipe, long smooth spores and dendrophysoid hyphae in the stipe context.

Key words: coral fungi, mycorrhizal fungi, *Quercus*.

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Introduction

Ramaria was initially treated as a subgenus within *Clavaria* until Corner (1970) elevated it to genus rank. The genus *Ramaria* along with *Clavariadelphus*, *Gautieria*, *Gomphus* and *Kavinia* belong to the family Clavariaceae within Order Gomphales. About 500 species are known in the world, and the wet, temperate rain forest of western North America is

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considered the global center of species diversity (Exeter *et al.*, 2006). Very little is known about the ecology of *Ramaria*, however, most species are associated with conifer forest and few with hardwood and tropical forest. In Mexico, few taxonomic and ecological studies have been performed. The species of *Ramaria* known from México and its reference can be seen in Table 1. Recent exploration to central Mexican oak forest has yield three new species. This research is a contribution to the knowledge of the North American mycoflora.

Materials and methods

Methods of collecting and macroscopic and microscopic study were generally those of Exeter *et al.* (2006). Colors of fresh specimens are in general terms. Hand-cut sections of dried material were mounted in 5% KOH (Potassium hydroxide) and cotton blue for standard microscopy. Measurements of structures are from mature specimens. Twenty spores were measured to estimate range and average size. Whenever length/height and width measurements are given, length/height comes first. Photomicrographs are from material mounted in 5% KOH. We also examined specimens of similar species for comparisons. All specimens are deposited in the Mycological Herbaria of (TLXM) and Oregon State University (OSC).

Ramariapercicina Cázares sp. nov.

Figures 1-2.

Basidiomata 4-10 x 5-10 cm. *Stipes singularis vel compositus, basi albidus, supra basin persicinus; contextus albus, nonamyloideus. Rami superi et apices ramorum juventute rosei, maturitate persicini. juventute laete rosei, maturitate persicini. Basidiosporae* 9-13 x 4-5 µm, *subcylindricae, verrucis dispersis, parvis, lobatis ornatae. Fibulae absentes. Typus hic designatus: Trappe 32456 (TLXM, isotypus OSC).*

Basidiomata 4-10 x 5-10 cm. Stipe single to compound with abortive branchlets, whitish at base, pinkish orange above; context white, solid, fleshy-fibrous when fresh but soft and brittle when dried; context chemical reactions: Ferric sulfate and Melzer's reagent negative. Upper branches and branch apices bright pink when young to pinkish orange when mature; context white, solid and fleshy-fibrous when fresh but soft and brittle when dried.

Basidia 40-60 x 5-10 µm, hyaline, clavate, 4-spored, bases lacking clamp connections. Context and tramal hyphae hyaline, 3-15 µm broad, lacking clamp connections.

Basidiospores 9-13 x 4-5 µm, subcylindrical, hyaline, ornamented with scattered, small, lobed warts, noncyanophilous.

Habitat: Terrestrial in *Quercus* forests (*Quercus rugosa*, *Q. crassifolia* and others) at elev. 2600 m.

Etymology: Latin *persicina* (peach colored) in reference to the color of the basidiomata.

Collections examined: HOLOTYPE: MEXICO: Tlaxcala, Municipality Panotla, 1 km E of San Francisco, Temezontla, lat. N 19°20'76", long. W 98°16'42" E. Cázares, Trappe 32456, 20 Sep 2007 (TLXM, isotype OSC). PARATYPE: As above, Trappe 32457 (TLXM, isotype OSC).

Discussion: *R. persicina* is recognized by its pink to pinkish orange color, nonamyloid context and spore ornamentation of scattered, lobed warts. In color it resembles *R. araiospora*, *R. cyaneigranosa* and *R. stuntzii* (Marr and Stuntz, 1973). However, the spore width of up to 5 µm and ornamentation distinguished it from *R. araiospora* and *R. cyaneigranosa*, and the nonamyloid context and long spores of up to 13 µm separate it from *R. stuntzii*. The *Quercus* forest habitat separates *R. persicina* from other pink species. The similar pink *Ramaria* species mentioned above are associated with temperate rain forests of western north America. *Ramaria rosella* is a similar pink species described from North Carolina and Tennessee, USA. However, this species is characterized by its gracile stature when mature and rich pink pigmentation is lacking when young (Petersen 1985).

Ramaria suaveolens Cázares sp. nov.

Figures 3-4.

Basidiomata 5-15 x 5-12 cm. *Stipites singulares sed basi caespitosis, 2-5 cm lati, basi albi, supra basin albid, contusis brunneolentescentes, mycelio albo basali; contextus albus, nonamyloideus. Rami superi et apices maturitate luteoli vel cremei. Hyphae dendrophysioideae praesentes. Basidia sine fibulis, hyphae contextae fibulis. Odor suaveolens.*

Table 1. Species of *Ramaria* known from México

<i>Ramaria abietina</i> (Pers.) Gray	Villarruel-Ordaz & Cifuentes, 2007
<i>R. acris</i> (Pk.) Corner	Villegas & Cifuentes, (1988)
<i>R. apiculata</i> (Fr.) Donk	Villegas & Cifuentes, (1988)
<i>R. araiospora</i> var. <i>rubella</i> Marr & Stunts	Bandala-Muñoz <i>et al.</i> (1987b)
<i>R. aurea</i> Shæff. Fr.	García, <i>et al.</i> (1970); Chio, <i>et al.</i> (1988)
<i>R. bonii</i> Estrada	Estrada-Torres (1995)
<i>R. botrytis</i> (Atk.) Corner	García, <i>et al.</i> (1970); Bandala-Muñoz <i>et al.</i> (1987b); Chio, <i>et al.</i> (1988)
<i>R. concolor</i> f. <i>tsugina</i> (Pk.) Petersen	Villegas & Cifuentes, (1988)
<i>R. concolor</i> (Corner) Petersen	Villegas & Cifuentes, (1988)
<i>R. cyanocephala</i> (B. & C.) Corner	Bandala-Muñoz <i>et al.</i> (1987b)
<i>Ramaria cystidiophora</i> var. <i>fabiolens</i> Marr & Stuntz	Montoya <i>et al.</i> 2004
<i>R. flava</i> (Fr.) Quel.	García, <i>et al.</i> (1970); Chio, <i>et al.</i> (1988); Landeros <i>et al.</i> 2006
<i>R. flavobrunnescens</i> (Atk.) Comer	Bandala-Muñoz <i>et al.</i> (1987a & b)
<i>R. flavula</i> (Atk.) Petersen	Villegas & Cifuentes, (1988)
<i>R. formosa</i> Fr.	García, <i>et al.</i> (1970); Chio, <i>et al.</i> (1988); Landeros <i>et al.</i> 2006
<i>R. fumigata</i> (Pk.) Comer	Bandala-Muñoz <i>et al.</i> (1987b)
<i>R. gracilis</i> (Pers.:Fr.) Quél.	Villegas & Cifuentes, (1988); Valenzuela, <i>et al.</i> (2004)
<i>R. sp. aff. guayanensis</i>	Bandala-Muñoz <i>et al.</i> (1987b)
<i>R. molleriana</i> (Bres. & Roum.) Corner	Villegas & Cifuentes, (1988)
<i>R. persicina</i> Cázares	This paper
<i>R. pseudogracilis</i> Petersen	Villegas & Cifuentes, (1988)
<i>R. radicans</i> Cázares & G. Guevara	This paper
<i>R. rainieriensis</i> Marr & Stuntz	Villegas & Cifuentes, (1988)
<i>Ramaria rasilispora</i> var. <i>scatesiana</i> Marr & Stuntz	Montoya <i>et al.</i> 2004
<i>R. rubiginosa</i> Marr & Stuntz	Bandala-Muñoz <i>et al.</i> (1987b)
<i>Ramaria rubricarnata</i> (Pers.) Quél.	Montoya <i>et al.</i> 2004
<i>Ramaria rubripermanens</i> Marr & Stuntz	Montoya <i>et al.</i> 2004
<i>R. stricta</i> var. <i>concolor</i> Corner	García, <i>et al.</i> (1970); Bandala-Muñoz <i>et al.</i> (1987b); Chio, <i>et al.</i> (1988); Villegas & Cifuentes, (1988)
<i>R. suaveolens</i> Cázares	This paper
<i>R. suecica</i> (Fr.) Donk	Villegas & Cifuentes, (1988)
<i>R. subbotrytis</i> (Coker) Comer	Bandala-Muñoz <i>et al.</i> (1987b)
<i>R. subbotrytis</i> var. <i>intermedia</i> Comer	Bandala-Muñoz <i>et al.</i> (1987 a & b)
<i>Ramaria cf. testaceoflava</i> (Bres.) Comer	Montoya <i>et al.</i> 2004
<i>Ramaria versatilis</i> Quél.	Montoya <i>et al.</i> 2004
<i>R. xanthosperma</i> Peck	Bandala-Muñoz <i>et al.</i> (1987 a & b)

Basidiosporae 11-13 x 4-5 µm, *subcylindricae, laeves vel aliquotus subtiliter verruculosae. Typus hic designatus: Trappe 32458 (TLXM, isotypus OSC).*

Basidiomata 5-15 x 5-12 cm. Stipe single but fused at the base, with few abortive branchlets, 2-5 cm broad, rooting to a depth of 2 cm, white at base, whitish above, with

white basal mycelium; bruises brownish; context white, solid, fleshy-fibrous when fresh but soft and brittle when dried; context chemical reactions: FSW and Melzer's reagent negative. Upper branches and branch apices pale yellow to cream colored at maturity, bruising brownish; context white, solid and fleshy-fibrous when fresh but soft and brittle when

dried. Odor fragrant, sweet.

Basidia 40-60 x 5-8 μm , hyaline, clavate, 4-spored, bases lacking clamp connections. Context and tramal hyphae hyaline, 3-15 μm broad, with clamp connections; dendrophysoid hyphae present in the outer layer of stipe context.

Basidiospores 11-13 x 4-5 μm , subcylindrical, smooth or a few finely warted, hyaline, noncyanophilous.

Habitat: Terrestrial in *Quercus rugosa* forest at elev. 2500 m.

Etymology: Latin *suaveolens*, smelling sweet.

Collections examined: HOLOTYPE: MEXICO: Tlaxcala, Municipality Huexoyucan. lat. N 19° 23' 9", long. W 98° 18' 19", E. Cázares, Trappe 32458, 20 September 2007. (TLXM, isotype OSC).

Discussion: *R. suaveolens* is recognized by its pale yellow color, sweet odor, dendrophysoid hyphae in the stipe context, mostly smooth spores, and association with *Quercus*. In color it closely resembles *R. cystidiophora* and its varieties, but that species has a fabaceous odor, its spores are distinctly warty, and it is associated with Pinaceae. *R. flavobrunnescens* var. *aromatica* and *R. rasilispora* and its varieties are also yellow but lack dendrophysoid hyphae in the stipe context (Marr and Stuntz, 1973). *R. radicans* (see below) is yellow with perfumy odor but has much longer spores than *R. suaveolens*.

***Ramaria radicans* Cázares & G. Guevara sp. nov.**

Figures 5-7.

Basidiomata 12-17 x 10-15 cm. Stipes singularis vel compositus, basin versus decrescens, in profunditatem 7 cm radicans, basi albidus vel cremeus, supra basin cremeus, contusis brunneolescentes, mycelio albo basali; contextus albus, nonamyloideus. Rami superi maturitate luteoli, creme vel erubescetes. Apices ramorum lutioli. Hyphae glepterae, dendrophysioideae praesentes. Basidia et hyphae

contextae fibulatis. Odor valde fragrans. Basidiosporae 13-20 x 3-5 μm , subcylindricae, laeves vel obscure rugulosae. Typus hic designatus: G. Guevara 920 (ITCV, isotypus OSC).

Basidiomata 12-17 x 10-15 cm. Stipe single to compound, tapering toward the base, with abortive branchlets, rooting to a depth of 7 cm, whitish to cream colored at base, cream colored above, with white basal mycelium; bruises brownish; context white, solid, fleshy-fibrous when fresh but hard when dried; context chemical reactions: FSW and Melzer's reagent negative. Upper branches cream colored to pale yellow with pale pink tones at maturity, bruising brownish; context white, solid and fleshy-fibrous when fresh but hard when dried. Branch apices pale yellow at maturity. Odor strong, perfumy.

Basidia 30-60 x 5-10 μm , hyaline, cyanophilous, clavate, 4-spored, bases with clamp connections. Context and tramal hyphae hyaline, thin-walled, 3-15 μm broad, with clamp connections; glepterae hyphae present; dendrophysoid hyphae present in the outer layer of stipe context, cyanophilous.

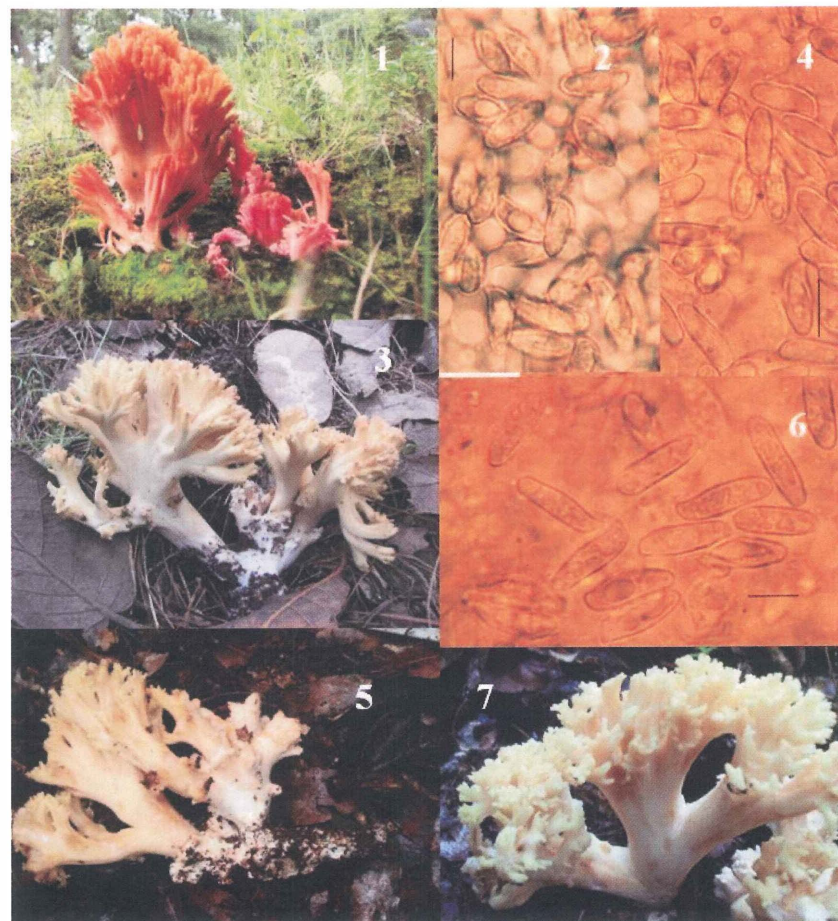
Basidiospores 13-20 x 3-5 μm (= 16.6 x 4.0 μm), subcylindrical, smooth to obscurely wrinkled, hyaline, with amorphous inclusions and guttules, noncyanophilous.

Habitat: Terrestrial in mixed *Quercus-Pinus* forest at elev. 2500 m.

Etymology: *radicans*, in reference to the deeply rooting stipe.

Collection examined: HOLOTYPE: MEXICO, México State, Municipality de Villa del Carbón, Cerro El Rincón, Monte de Peña, G. Guevara 920, 25 Jul 2007 (ITCV, isotype OSC).

Discussion: *R. radicans* is recognized by its pale yellow color, rooting stipe, long smooth spores and dendrophysoid hyphae in the stipe context. In color it closely resembles *R. fragrans*, *R. flavobrunnescens* var. *aromatica*, *R. rasilispora* var. *rasilispora*, and *R. cystidiophora* and its



Figures 1-7. *Ramaria* species. 1. *R. persicina*, basidiomata. 2. *R. persicina*, basidiospores (Bar = 10 μm). 3. *R. suaveolens*, basidiomata. 4. *R. suaveolens*, basidiospores (Bar = 10 μm). 5. *R. radicans*, basidiomata. 6. *R. radicans*, basidiospores (Bar = 10 μm). 7. *R. radicans*, basidiomata.

varieties (Marr and Stuntz, 1973). *R. fragrans* has smaller basidiomata and smooth to slightly warted spores = 13 µm long. *R. flavobrunnescens* var. *aromatica* lacks dendrophysoid hyphae in its stipe. *R. rasilispora* and its varieties have smooth spores = 12 µm long and lack dendrophysoid hyphae in the stipe. The presence of dendrophysoid hyphae in the peripheral context of the stipe unites *R. radicans* with *R. cystidiophora* and its varieties. *R. cystidiophora* var. *cystidiophora* has small spores, range 7-9 x 3-4 µm. *R. cystidiophora* var. *citronella* its bright yellow and spores range 9-13 x 3.5-5 µm. *R. cystidiophora* var. *fabiolens* has small spores, range 8-11 x 3.5-5 µm and fabaceous odor. *R. cystidiophora* var. *maculans* has spores 10-14 x 3.5-5 µm and its stipe stains reddish brown. *R. cystidiophora* var. *anisata* has small spores, 7.7-8.6 x 3.2-3.9 µm. Except for *R. fragrans*, these other species are known only from forests of *Pinaceae* in temperate rain forest of western North America. (Marr and Stuntz, 1973).

Ramaria radicans is known as "patitas de pájaro", commonly eaten and sold in markets of the region.

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