Taxonomy and systematicsA new species of Maxillaria (Orchidaceae: Maxillariinae) from Southwestern EcuadorBosco Javier Zambrano-Romeroa,⁎y Rodolfo Solano-GómezbaCentro de Tenencia Orquiecuador y Gloxinias, El Oro, EcuadorbCentro Interdisciplinario de Investigaciónparael Desarrollo Integral Regional, Unidad Oaxaca, Instituto PolitécNational Clinic, Oaxaca, MexicoReceivedMay 22, 2015; accepted September 25, 2015Available online February 18, 2016AbstractA new species of orchid, Maxillaria pinasensis, from the piedmontane and semi-deciduous montane evergreen forests of southwestern Ecuador, is described and illustrated. Information on their distribution, habitat, phenology, and conservation status is provided. The new species is compared with Maxillaria estradae from Ecuador, M. flava, M. lankesteri, M. microphyton and M. wercklei from Costa Rica and Panama, to which it resembles morphologically. Keywords: Piedmont evergreen forest; Semi-deciduous forest; Maxillaria estradae; Maxillaria flava; Maxillaria lankesteri; Maxillaria microphyton; Maxillaria wercklei; Maxillaria pinasensis; EcuadorAbstractMaxillaria pinasensis, a new orchid species from evergreen premontane and semi-deciduous montane forests from Southwestern Ecuador, is herein described and illustrated. Information about its distribution, habitat, phenology and conservation status is provided. The new speciesis compared with Maxillaria estradae from Ecuador, M. flava, M. lankesteri, M. microphyton and M. wercklei from Costa Rica and Panama, morphologically similar species. Keywords: Evergreen premontane forest; Semi-deciduous montane forest; Maxillaria estradae; Maxillaria flava; Maxillaria lankesteri; Maxillaria microphyton; Maxillaria wercklei; Maxillaria pinasensis; EcuadorIntroductionThe genus Maxillaria Ruiz et. Pav. it includes approximately 660 taxa (Govaerts, 2014) and is considered to be the largest group of the subtribe Maxillariinae. It is distributed from Mexico to Peru and Bolivia, including the Antilles, where most species grow as epiphytes in forests⁎Corresponding author. E-mail: bosco escorpion@hotmail.com(B.J. Zambrano-Romero). Peer reviewis the responsibility of the National Autonomous University of Mexico. In its wider circumscription(Chase et al., 2015; Schuiteman & Chase, 2015), Maxillaria differs from other generaof its subtribe because its members, in many cases, have leaves with unplicate development, usually conduplicated, uniflorous inflorescences that arise from the base of the pseudobulb and an articulated labellum at the foot of the column (Chaseet al., 2015; Schuiteman & Chase, 2015). The phylogenetic relationships of the subtribe Maxillariinae, or some of its groups, have been evaluated from DNA sequence analysis (Dathe and Dietrich, 2006; Ojeda, Carnevali, Williams, & Whitten, 2003; Singer & Koehler, 2003; Szlachetko, Sitko, Tukallo, & Mytnik-

Ejsmont, 2012; Whitten et al., 2007). These studies revealed that Maxillaria was a polyphyletic group within a highly supported clade that included other genera preliminarily recognized in the subtribe, such as Anthosip-hon Schltr., Chrysocycnis Linden et. Rchb. f., Cryptocentrum Benth., Cyrtidiorchis Rauschert, Mormolyca Fenzl, Pityphy-llum Schltr., and Trigonidium Lindl (Chase, Cameron, Barrett, & Freudenstein, 2003). In their study of Maxillaria's phylogenetic relationships, Whitten et al. (2007) revealed that Maxillaria's representatives and the aforementioned groups were divided into 17 clades. Based on these results, Blanco et al. (2007) redefined Maxillaria with a strict delimitation and elevated to a generic level the other monophilic groups recognized in the analysis of Whitten et al. (2007). Thus, these authors considered as genres Brasilior-chis R.B. Singer, S. Koehler et. Carnevali, Camaridium Lindl.,Christensonella Szlach., Mytnik, Górniak et. Smiszek, Hetero-taxis Lindl., Hylaeorchis Carnevali et. G.A. Romero, Inti M.A.Blanco, Mapinguari Carnevali et. R.B. Singer, CyrtidiorchisRauschert, Cryptocentrum Benth., Pityphyllum Schltr., Maxilla-riella M.A. Blanco et. Carnevali, Nitidobulbon Ojeda, Carnevaliet. G.A. Romero, Rhetinantha M.A. Blanco and Sauvetrea Szlach.This classification of Maxillaria and related groups was adopted by Pridgeon, Cribb, Chase and Rasmussen (2009). Despite having a narrower delimitation, Maxillaria continued to be the most numerous genus in its subtribe. On the other hand, Szlachetko et al. (2012) also evaluated the phylogenetic relationships of Maxillariinae and proposed a new, even more fragmented classification for the subtribe, and raised to a generic level several of the clades recognized within the most diverse genera considered by Pridgeon et al. (2009), such as Camaridium, Maxillaria and Ornithidium Salisb.ex R. Br. In this way, Szlachetko et al. (2012) conclude by recognizing a total of 36 genera within the subtribe. Recently, Schuiteman and Chase (2015) proposed a classification of Maxillaria based on the expanded delimitation for the genus, which not only includes the groups previously segregated by Blanco et al. (2007), but was extended to also include Mormolyca, Ornithidium and Trigonidium. With this delimitation, Maxillaria turns out to be a megagenus that, in addition to the characteristics mentioned above, can be recognized because its members, in general, have sclerotized fibers in the flowers, the floral bract longer than the pedicellate ovarium and fruits with lateral dehiscence. On the other hand, the 17 monophyletic groups determined in the analysis of Whittenet al. (2007) are considered as sections of Maxillaria by Schuiteman and Chase (2015): Maxillaria sect. Camaridium(Lindl.) Christenson, M. sect. Cryptocentrum (Benth.) Schuit.et. M.W. Chase, M. sect. Cyrtidiorchis (Rauschert) Schuit. et.M.W. Chase, M. sect. Digammae Christenson, M. sect. Erec-tae Pfitzer, M. sect. Iridifoliae Pfitzer, M. sect. PolyphyllaeChristenson, M. sect. Mapinguari (Carnevali et. R.B. Singer)Schuit. et. M.W. Chase, M. sect. Maxillaria Ruiz et. Pav., M.sect. Nitidobulbon (Ojeda, Carnevali et. G.A. Romero) Schuit.et. M.W. Chase, M. sect. Ornithidium (Salisb. ex R.Br.) Chris-tenson, M. sect. Pityphyllum (Schltr.) Schuit. et.

M.W. Chase, M. sect. Repentes Pfitzer, M. sect. Rufescens Christenson, M.sect. Trigonae Christenson, M. sect. Trigonidium (Lindl.) Schuit.et. M.W. Chase and M. sect. Urceolatae Christenson. In this work, Maxillaria's classification is followed, because although it is now a more diverse and morphologically heterogeneous group, it is also monophyletic, has a high support value and, additionally, the proliferation of generic names that would only create confusion for the understanding of the genus would be avoided (Bennett & Christenson, 2009; Chase et al., 2015; Schuiteman & Chase, 2015). In Ecuador, the presence of more than 200 taxa of Maxillaria has been recorded so far (Dodson, 2002), which represents almost 30% of the diversity of the genus. About 50 of these species are endemic to Ecuador (Jørgensen and León-Yánez, 1999). However, except for Dodson (2002) and Dodson and Dodson (1980), taxonomic studies for Maxillaria are scarce in the country. Recently, in the Orquiecuador and Gloxinias collection, specimens that superficially resemble Maxillaria estradae Dodson —endemic to Ecuador—, Maxillaria flava Ames, Hubbard et. C. Schweinf., Maxillaria lankesteri Ames, Maxi-llaria microphyton Schltr. and Maxillaria wercklei (Schltr.) L. O. Williams —species from Costa Rica and Panama—. However, when examining and comparing the material grown with these taxa, it was found that it corresponded to a different and unknown plant, which is described and illustrated here from living and herborized material. Materials and methodsThe description and illustration of the new taxon were elaborated from specimens grown in the Orquiecuador and Gloxinias holding center (Pi'nas-El Oro, Ecuador). On the other hand, photographs were taken of the flowering individuals using a Nikon 8700 camera. A line drawing of one of the specimens was made, using a USB 50-500x microscope on a millimeter sheet and a Nikon D7100 camera. The drawing included the habit of the plant, the flower, and the floral dissection; The fresh flowers were examined and dissected under a microscope. Supporting samples were prepared and deposited in the Ecuadorian Herbarium of Natural Sciences (QCNE) and in the private collection of Orquiecuador and Gloxi-nias (J. Zambrano). DescriptionMaxillaria pinasensis Zambrano et. Solano sp. Nov. (Figs. 1 and 2)Type. Ecuador. El Oro Province: Pi ñas, Curi-tejo mountain range, 1,200 m above sea level, cultivated in Orquiecuador and Gloxinias, 20/XI/2007, J. Zambrano B. 432 (holotype in QCNE; isotype in J. Zambrano Herbarium [flowers preserved in alcohol]). Herba epiphytica, pseudobulbis ovoideis, striatis, unifolia-tis. Folia oblongo-elliptica. Sepalum intermedium oblongo-lanceolatum; Sepala Lateralia ovato-lanceolata. Ovato-elliptic petal. Labellum 3-lobum, lobis lateralibus orbicularibus, leviter erectis, lobo intermediate orbiculari-obovate, apex rotun-dato. Leviter curved column. Epiphytic plant, 25-30 cm long, rhizomatous, algopendulous, 3-5 cm high; rhizome cylindrical, 2-4.5 cm long between adjacent pseudobulbs, covered by several acute, scarious, overlapping sheaths. Whitish, thin roots. Ovoid pseudobulbs, longitudinally striated, 10-20 mm long and 8-9 mm thick, formed by an internode, unifoliate at the apex and surrounded at the base by 2-3 foliaceous sheaths,

conduplicated, overlapping. Leaves elliptical to oblong-elliptic, slightly leathery, oblique, sessile, articulated at the apex of the pseudobulb, 15-30 × 8-12 mm, mucronate-emarginate apex. Inflorescence small, uniflora, from the base of the mature pseudobulb, 2-3 per pseudobulb; an erect, cylindrical peduncle, 7 mm long and 1 mm in diameter, surrounded by 3-4 acute, scary, overlapping bracts, 5-6 × 2 mm (4 mm when extended). Floral bract longer than the pedicellate ovary, covering the base of the flower, conduplicate, obtuse, carnada, 7-8 mm long. Flowers open to semi-open, star-shaped; yellow-amber sepals and petals, with red-purple markings along the veins, pink labellum with purple spots, whitish column, cream anther with a slight purple spot on the cap. The ovary is pediclate, slightly arched, cylindrical, widened towards the apex, 6 mm long and 1 mm in diameter. Dorsal sepal 9 × 3 mm, slightly concave, oblong-lanceolate, obtuse, 5-nerve; lateral sepals 9 × 3.5 mm, extended, ovate-lanceolate, slightly oblique, acute, 5-ribbed. Petals 7.5 × 3 mm, slightly concave, elliptical to ovate-elliptical, acute, 3-4-ribbed. 3-lobed labellum, 5.5 × 3.5 mm, articulated at the foot of the spine, 7-ribbed, basal lateral lobes, orbicular, slightly erect, with a callus slightly ligulated in the middle of the labellum, which connects the lateral lobes, medial orbicular-obovate lobe, with rounded apex. A short, slightly arched column, 2 mm long and 1 mm in diameter, with a prominent foot almost as long as the body of the column. Anther subapical, ovoid, tiny papillose; Polynyas 4, ovoid. Additional copies. Ecuador. Pi ñas, Panupali sector, via Machala, 458 m above sea level. 3/VIII/2013. Cultivated in Orquiecuador and Gloxinias, Zambrano B. 1060 (J. Zambrano Herbarium); El Pla-cer, km 12 via Machala, 567 m above sea level. 30/VI/2014. Cultivated in Orquiecuador and Gloxinias, Zambrano B. 1473 (Herbarium J. Zam-brano); Pi ñas Grande sector, 1,100 m above sea level. 5/VII2014. Cultivated in Orquiecuador and Gloxinias, Zambrano B. 1597 (J.Zambrano Herbarium). Distribution and habitat. So far this species is endemic to Ecuador, where it has only been recorded in the mountains of the southwest of the province of El Oro, between 400 and 1,100 m above sea level (fig. 3). It grows as an epiphyte in the middle of the canopy, on layers of mosses and organic matter accumulated on the trunks and branches of shrubs (Citrus sp.) and trees (Carapasp., Ficus sp., Clusia sp. and Miconia sp.). The taxon inhabits the evergreen piedmontane and semi-deciduous montane forests located between 400 and 1,500 m above sea level, where mists are frequent throughout the year, but especially in the dry season. Phenology. It blooms between June and November. Etymology. The name of the species is in allusion to the canton Pi ñas, the town where it was discovered. State of conservation. This species has a very restricted geographical distribution. So far it has been located in forest remnants disturbed by human activity, where its populations are very limited, have low densities (2-11 individuals/tree) and, in addition, seem to be subject to frequent extinction-recolonization events. Due to the fragmentation of their habitat, the populations known to date —Curitejo, Panupali, El Placer, Pi ñas Grande— seem to be isolated and poorly

connected with each other, so that it could be expected that a genetic structure would occur between them. The only population whose conservation could be guaranteed is the one found in the areas of influence of the Buenaventura-El Placer Reserve; the other populations are located in non-protected areas. Taxonomic comments. The most similar species from Ecuador is the endemic M. estradae, which is different because of its more robust, and evidently pendulum habit, bifoliate pseudobulbs, wider leaves (15 vs. 8-12 mm), yellow-pink flowers (vs. yellow-amber), larger perianth segments and evidently arched column (Dodson, 1980). Other morphologically related taxa are M. flava, M. lankesteri, M. microphyton and M. wercklei, native to Costa Rica and Panama; however, the former is different because of its conical and somewhat truncated pseudobulbs, longer leaves (up to 70 vs. 15-30 mm), shorter peduncle (5-8 vs. 13-15 mm, including the ovariopedicellate) and ovate labellum of 3-4.5 × 2 mm (vs. orbicular-ovate of 5.5 × 3.5 mm). On the other hand, M. lankesteri is distinguished by its long rhizomatous plants (8 cm rhizome segment between adjacent pseudobulbs vs. 2-4.5 cm), oscillindrical pseudobulbs, shorter peduncle (7 vs. 13-15 mm, including the pedicellate ovary) and elliptic-ovate labellum (vs. orbicular-ovate). On the other hand, M. microphyton has suborbicular conical pseudobulbs, regularly not furrowed in dry specimens (vs. striated ovoids), elliptic-lanceolate, 3-ribbed petals (vs. elliptical to ovate-elliptic, 3-4-nervated). Finally, M. wercklei is different because of its cylindrical to slightly conical pseudobulbs (vs. striated ovoids), shorter peduncle (3.5-4.5 vs. 13-15 mm, including the pedicellate ovary), elliptical-lanceolate petals (vs. elliptical to ovate-elliptic), labeloemarginate at the apex (vs. rounded) with highly recurved (vs. slightly erect) lateral lobes (Atwood and Mora de Retana, 1999). Table 1 presents a summary of the main differences between the species already mentioned. The Central American taxa mentioned above are morphologically more similar to M. pinasensis than the Ecuadorian M. But the great geographical disjunction between their populations and the different ecosystems in which they grow in Ecuador, Panama and Costa Rica are criteria for considering Ecuadorian specimens as a different species. On the other hand, so far it is not known that the plant described here as new, or any very similar, has been recorded in adjacent areas of Colombia and Peru. It should be noted that the species described here has only been found in the southwest of Ecuador, in a very restricted area of humid forests surrounded mostly by dry forests. Maxillaria pinasensis belongs to M. sect. Camaridium(Lindl.) Christenson, which is distinguished by its small labellum and enlarged perianth, with a floral bract that extends to overlap the base of the dorsal sepal. It has petals similar in size and shape to the sepals, the column short and arched, a 3-lobed labellum, with a prominent callus directed towards the base of the labellum, concave, non-shiny (Blanco et al., 2007; Schuiteman & Chase, 2015; Szlachetko et al., 2012; Whitten et al., 2007). AcknowledgementsWe thank the anonymous reviewers for the comments and suggestions that improved the quality of the manuscript, Dr.

Fernando Chiang for his valuable observations and correction of the Latin description, as well as the Ecuadorian Ministry of the Environment (MAE) for the authorization of scientific research N.◦006-IC-FLO-DPAEO-MAE.ReferencesAtwood, J. T. and Mora de Retana, D. E. (1999). Flora Costaricensis family #39Orchidaceae: Tribe Maxillarieae: Subtribes Maxillariinae and Oncidiinae.Fieldiana. Botany (new series), 40, 1–182.Bennett, D. E., & Christenson, E. A. (2009). Nine new species and one new namein Maxillaria (Orchidaceae). Phytotaxa, 1, 21–36.White, M., Carnevali, G., Whitten, M., Singer, R., Koehler, S., Williams, N.,et al. (2007). Generic realignments in Maxillariinae (Orchidaceae). Lankes-teriana, 7, 515–537.Chase, M. W., Cameron, K. M., Barrett, R. L., & Freudenstein, J. V. (2003). DNAdata and Orchidaceae systematics: a new phylogenetic classification. In K.M. Dixon, S. P. Kell, R. L. Barrett, and P. J. Cribb (Eds.), Orchid conservation (pp. 69–89). Kota Kinabalu, Malaysia: Natural History Publications.Chase, M. W., Cameron, K. M., Freudenstein, J., Pridgeon, A. M., Salazar, G., van den Berg, C., & Schuiteman, A. (2015). An updated classification ofOrchidaceae. Botanical Journal of the Linnean Society, 177, 151–174.Dathe, S., & Dietrich, H. (2006). Comparative molecular and morphologicalstudies in selected Maxillariinae orchids. Willdenowia, 36, 89–102.Dodson, C. (2002). Maxillaria. In C. Dodson (Ed.), Native Ecuadorian orchids.Vol. III: Lepanthopsis-Oliveriana. (pp. 544–573). Quito: Imprenta Mariscal.Dodson, C. & Dodson, P. M. (1980). Icones plantarum tropicarum 2. Orchids ofEcuador. Sarasota, Florida: Mary Selby Botanical Garden.Govaerts, R. (2014). World checklist of Orchidaceae. Retrieved May 1, 2015. Available in: http://apps.kew.org/wcsp/.J ørgensen, P. M. & León-Yánez, S. (1999). Catalogue of the vascular plants ofEcuador. Monographs in systematic botany from Missouri Botanical Garden,75, 1–1182.Ojeda, I., Carnevali, G., Williams, N., & Whitten, M. (2003). Phylogeny of theHeterotaxis Lindley complex (Maxillariinae): evolution of the vegetativearchitecture and pollination syndromes. Lankesteriana, 7, 45–47.Pridgeon, A. M., Cribb, P. J., Chase, M. W., & Rasmussen, F. N. (2009). GeneraOrchidacearum 5. Epidendroideae (Part two). Oxford: Oxford University Press.Schuiteman, A. & Chase, M. (2015). A reappraisal of Maxillaria (Orchidaceae). Phytotaxa, 225, 1–78.Singer, R., & Koehler, S. (2003). Toward a phylogeny of Maxillariinae orchids:Multidisciplinary studies with emphasis on Brazilian species. Lankesteriana,7,