The orchid flora of Cocos Island National Park, Puntarenas, Costa Rica

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The orchid flora of Cocos Island National Park, Costa Rica is described based on field collections and herbarium sampling. Cocos Island is an oceanic island situated 550 km south-west of Puntarenas (the main Costa Rican port on the Pacific coast) and 680 km north-east of the Galápagos Islands. Five species of orchids were recorded in this small area of 24 km²: Camaridium micranthum and Ornithidium adendrobium (both formerly included in Maxillaria) and three endemic species of Epidendrum (E. cocoense, E. insulanum and E. jimenezii). The species are described and analytical illustrations are provided for each. A key to the species for field identification based on morphology is presented. Biogeography, ecology, taxonomy, evolution and conservation status of the species are also discussed. © 2011 The Linnean Society of London, Botanical Journal of the Linnean Society, 2011, 166, 20–39.


INTRODUCTION

Isla del Coco, also known as Cocos Island, is an oceanic island in the south-eastern tropical Pacific Ocean (5°31′39″N, 87°03′32″W), situated 550 km south-west of Puntarenas, the main port of Costa Rica on the Pacific coast (Fig. 1). The nearest continental point is Cabo Blanco on the Península de Nicoya, Costa Rica, 532 km from the island. Other oceanic islands relatively near Cocos Island are Isla Pinta of the Galápagos archipelago (Ecuador) at 681 km, Isla Malpelo (Colombia) at 630 km, Isla Coiba (Panama) at 632 km and Clipperton Island (Île de Clipperton or Île de la Passion, France) at 2375 km.

Cocos Island became part of Costa Rica in 1869, when President Jesús Jiménez decreed it as national territory. At that time, the island was uninhabited and had never been claimed by any other country. Its name was probably a mistranscription from the original map by the French cartographer Nicolas Desliens in 1541, in which the island appeared (for first time) as ‘Ye Coques’ (Hogue & Miller, 1981; Trusty, 2004). In French, the word ‘coque’ means eggshell or nutshell and the name could have been a reference to the common fruit of the abundant endemic tree Sacoglottis holdridgei Cuatrec. (Humiriaceae).

In 1978, under the government of President Rodrigo Carazo, the island was decreed a National Park and a zone of absolute protection. Administratively, the area belongs to the Área de Conservación Marina Isla del Coco (ACMIC) of the Costa Rican Ministry of Environment, Energy and Telecommunications (MINAET) and its National System of Conservation Areas (SINAC). Later, in 1997 the island became a UNESCO-designated World Natural Heritage Site in recognition of its exceptional biodiversity. In 2002, the World Natural Heritage Site designation was extended to include an expanded marine zone of 1997 km², thus protecting marine ecosystems, populations of sharks, rays, dolphins and other large marine species. In addition, in 1998 the island was
Figure 1. Map of Cocos Island showing collecting sites. Scale 1 : 25 000.
included in the list of Wetlands of International Importance under the RAMSAR Convention.

**Topography**
The total land area is 24.85 km² (c. 7.6 × 4.4 km) with the following limits: to the north Punta Agujas, to the south Cabo Dampier, to the west Cabo Lionel and to the east Cabo Atrevido (Fig. 1). The topography is abrupt with high slopes and cliffs. The highest point is Cerro Iglesias, observable as a cloudy mountain rising 575 m above sea level. Other important hills are Cerro Pelón at 530 m and Cerro Jesús Jiménez at 430 m of elevation. Some flat areas are observed in the region called Llanos Palo de Hierro at 300 m elevation (Fig. 1). The island has four bays: Iglesias, Weston, Chatham and Wafer. The later two are the most important for boats and crafts and have the main ranger stations. The most important rivers are: the Genio to the north-east that flows into Wafer Bay, the Chatham River that flows into Chatham Bay and the Iglesias to the south, which terminates in Iglesias Bay. The irregular topography produces many waterfalls because of the vertical cliffs and high water availability in the soil.

**Geology**
Cocos Island emerged from the ocean through volcanic activity of the submarine mountain range called the Cocos Ridge. The ridge was formed in the Miocene by tectonic movements of the Cocos and Nazca plates and volcanic action of the Galápagos hotspot. These geological events occurred along the Pacific Ocean near South America. Then, the island moved to the north as a result of the action of the Cocos and Nazca plates. Geologists have estimated the age of the island to be 1.9–2.4 million years (Bellon, Sáenz & Tournon, 1984). The soils are composed of basaltic and pyroclastic alkaline rocks, the remains of ancient volcanic activity. However, the acidic condition is caused by the degradation of organic material under high humidity and the consequent action of bacteria and fungi (Trusty, 2004).

**Climate**
The island is under the influence of the Intertropical Convergence Zone (ITCZ) and receives other climatic influences such as the El Niño-Southern Oscillation (ENSO). The climate of the island was discussed by Alfaro (2008) and Lizano (2008). A complex system of marine currents originating in America and the Indo-Pacific region flows around the island, thus influencing its climate (Lizano, 2008). The island experiences high rainfall, which can reach 7000 mm per year. Cocos is the only island in the tropical eastern Pacific with a tropical humid forest. According to Tosi (1969), the life zone is the premontane belt forest, basal belt transition. The period of high rainfall is between May and October. There is no true dry season but rainfall is slightly lower from November to March (Alfaro, 2008). The average temperature is approximately 27–28 °C. These climatic factors allow the establishment of plants such as bromeliads, ferns and epiphytic orchids.

**Biodiversity**
The biodiversity of Cocos Island includes both marine and terrestrial ecosystems. Marine biodiversity is the main attraction for touristic and scientific activities. This place is an important breeding site for many species. The migration and reproduction of sharks is one of the most spectacular marine attractions for divers. It is possible to observe the rare and endangered whale shark (Rhincodon typus) and large populations of hammerhead sharks (Sphyrna lewini), the marine emblem of the island. The history of marine research at Cocos Island was reviewed recently by Cortés (2008). Terrestrial biodiversity is also important. According to the most recent botanical treatment of the island by Trusty, Kesler & Haug Delgado (2006), there are 262 species of plants, of which 37 (approximately 14%) are endemic. Among the terrestrial fauna, there are 382 species of insects, five species of reptiles, one scorpion and 12 species of birds, including the endemic Coco finch, Pinaroloxias inornata. There is a low elevation rainforest formed mainly by the endemic tree Sacoglottis holdridgei. At the highest points (i.e. Cerro Iglesias), there is a high elevation cloud forest. Other important plant communities are the riparian habitats, estuarine habitats, coastal cliff communities, shore vegetation, landslides and rocky islets that have sparse grassy vegetation and scattered trees of Clusia rosea Jacq. These plant associations were defined and characterized by Trusty (2004). Detailed information on climate, geology, human impacts and introduced animals and plants can be found in Trusty (2004) and Trusty et al. (2006).
have kept his treasure in an unknown place on the island (Hogue & Miller, 1981; Trusty, 2004) and, secondly, the ‘treasure of Lima’ of Captain Thompson of the Mary Dear may be on Cocos, including priceless gold and jewels from Peru. Following these tales, people looking for treasures made > 400 expeditions to the island and Cocos is therefore also well known as the ‘treasure island’.

In spite of these hundreds of expeditions, plant collections only started in 1836 when the English collector George W. Barclay visited Cocos Island as part of an exploration of the Pacific coast aboard H.M.S. Sulphur, commanded by Captain Sir Edward Belcher (Bentham, 1844–1846). However, in their botanical treatment they did not report or describe any orchid species. After Barclay’s expedition, the marine zoologist and oceanographer Alexander Agassiz collected plants during the late 19th century (1888 and 1891). Aboard the Albatross, he visited Cocos Island on his way to the Galápagos. He collected Epidendrum insulanum Schltr. (then undescribed), the first orchid specimen collected in the island (Agassiz s.n., GH).

In 1898, the government of President Rafael Yglesias sponsored the first Costa Rican expedition. He assigned to the scientist Anastasio Alfaro and Henry Pittier the task of assessing the island in order for it to be reopened as a penal center (Pittier, 1898). They went aboard the Poás and collected plants and animals. Four years later, on a second trip in 1902, together with Paul Bioley, aboard the Turrialba, Pittier collected two specimens of Epidendrum L. One was the first orchid species described from the island, published by R. Schlechter as E. insulanum in Beihefte zum Botanischen Centralblatt in 1918. Unfortunately, the specimen studied by Schlechter was destroyed in the Dahlem-Berlin Herbarium during the Second World War and there is no indication that Schlechter received more than one specimen from Pittier. However, Pittier prepared at least five duplicates; two are kept at the herbarium of the Museo Nacional de Costa Rica (CR) and another specimen of E. cocoense was collected in his second trip.

Witold L. Klawe, a fishery researcher, collected plants as part of the Inter-American Tropical Tuna Commission aboard the Costa Rica Dome Cruise in 1959. He collected E. cocoense, wrongly identified as E. ramulosum Jacq. var. imbricatum Ames, F.T.Hubb. & C.Schweinf. Later, President Cruise of the USA made other expeditions from 1935 to 1940.

The Costa Rican botanist and ex-director of the Museo Nacional de Costa Rica, Juvenal Valerio Rodríguez, went to the island on two expeditions during 1939 and 1940. He collected C. micranthum (misidentified as Maxillaria variabilis Bateman ex Lindl) and another specimen of E. cocoense was collected in his second trip.

Hágsater (1999b) described the last species known from the island under the name E. jimenezii. The species honours Alfonso Jiménez, ex-director of the Museo Nacional de Costa Rica, who collected the type specimen in 1965 (A. Jiménez 3178, CR). He stated that the plant had white flowers and it is apparently a common epiphyte along the Genio River, near its mouth into Wafer Bay.
In 1967, the botanists Ira L. Wiggins and Duncan M. Porter, who worked on the Flora of the Galápagos Islands, collected specimens of *E. insulanum* (Hágsater, 2007). Luis D. Gómez went to the island in 1970 and made another collection of *E. cocoense* from the forest of Wafer Bay.

After many expeditions, the number of species of the island remained unclear. In 1973, in a trip organized by the Smithsonian Tropical Research Institute, Robert L. Dressler collected an *Epidendrum*, identified by Hágsater as *E. jimenezii* (Dressler 4468, PMA-36761), but a duplicate kept at CR (Dressler 4468, CR) could be an *E. insulanum* as noted by Trusty & Blanco (2006). A mixed collection was probably made under the same number, demonstrating the difficulties in identifying those species without flowers as their vegetative features are highly variable. Another sample of *E. cocoense* was collected and a new record, *Ornithidium adendrobium* (Rchb.f.) M.A.Blanco & Ojeda (formerly known as *Maxillaria adendrobium* Rchb.f.) Dressler was found near Wafer Bay. This widespread species ranges in both continental and insular lands around the Neotropics. In 1865, Heinrich G. Reichenbach described it as *Ponera adendrobium* Rchb.f. based on a collection of Charles Wright in Cuba.

In 1979, Robin Foster collected an interesting *Epidendrum* in the floodplain of Genio River. It seems to be an example of *E. insulanum*, but Hágsater cited it as *E. jimenezii* (Hágsater, 1999b). In 1980, Pablo Sánchez-Vindas collected *E. cocoense* and in 1981 Jorge Gómez-Laurito collected *E. jimenezii* (wrongly identified as *Epidendrum imbricatum* Lam.) and another *E. insulanum*. He also collected *E. cocoense*, and Luis D. Gómez collected *M. parviflora* in the same year. In 1989, R. Soto collected *E. cocoense*, *O. adendrobium* and other two specimens of *C. micranthum*. Other collections were made in 1994 by the researchers of Instituto Nacional de Biodiversidad (INBio). However, they reported the same five species. With the description of *E. cocoense* and *E. jimenezii* by Hágsater (1999b), the orchid flora of Cocos Island is made up of three endemic species of *Epidendrum* (*E. cocoense*, *E. insulanum* and *E. jimenezii*), one species of *Camaridium*, *C. micranthum*, and one species of *Ornithidium*, *O. adendrobium* (Dressler, 2003). The two former species are also found in continental parts of the Neotropics.

Recently, Trusty and co-workers (Trusty, 2004; Trusty & Blanco, 2005, 2006; Trusty et al., 2006) finished their floristic treatment of the Cocos Island National Park. They reported the same five species for the island. However, they were unable to locate material of *E. jimenezii*, and consequently they could not distinguish this species from *E. insulanum* (Trusty & Blanco, 2006).

The aim of this paper is to present detailed information for identifying the orchids of Cocos Island, to provide illustrations of the five species based on living plants (two of them are illustrated for a first time) and to discuss the identity of the rare *E. jimenezii*. This work is part of a series of floristic studies intended to clarify the diversity and taxonomy of Orchidaceae in Costa Rica (e.g. Pupulin, 2010) and its national parks and protected areas (Pupulin, 1998; Bogarín & Pupulin, 2007).

**MATERIAL AND METHODS**

This work was conducted mainly in the Cocos Island National Park, Puntarenas, Costa Rica and the Lankester Botanical Garden (LBG), University of Costa Rica. Living specimens were collected, cultivated and documented between 2006 and 2009. Data from all specimens cited have been recorded in a computerized database at LBG. They are also available on the website at http://www.epidendra.org (Pupulin, 2007; Pupulin, 2009). Georeferences for specimens were obtained using a Garmin eTrex Vista GPS and maps. Ecological zones were estimated by using the Holdridge Life Zone System (Holdridge, 1967, 1987) and the ecological map of Costa Rica (Tosi, 1969).

Phenology data were recorded both in the field and in cultivated specimens or herbarium labels. Individual plants were photographed, illustrated and preserved as herbarium specimens and preserved specimens in formaldehyde: acetic acid: ethanol [FAA (53% ethanol, 37% water, 5% formaldehyde and 5% glycerol)] (including flowers, portions of the stems or entire plants) for future reference. Newly collected herbarium specimens were deposited at CR, JBL and USJ herbaria. Whenever possible, the herbarium specimens were complemented with sketches, photographs and FAA material. The material preserved in FAA was deposited at JBL and indicated in the treatment as ‘JBL-spirit’. Herbarium and spirit material may consist of wild collected specimens or material collected entirely from cultivated plants.

Sketches of specimens were made with a Leica MZ7.5 stereomicroscope with drawing tube and conserved in the reference collections at JBL. All taxa were illustrated by composite line drawings from living specimens. Illustrations include a typical plant habit, inflorescences or part of the inflorescences, the flower and a dissection of perianth. Plate composition was as consistent as possible to facilitate species comparison.

Descriptions were prepared from both living specimens and herbarium material. Materials from the following herbaria were studied: AMES, BM, CAS, CR, INB, JBL, K, PMA and USJ.
**KEY TO THE ORCHIDs OF THE COCOS ISLAND NATIONAL PARK**

1. Plants with pseudobulbs, each with one apical leaf. .......................... *Camaridium micranthum*
2. Inflorescence lateral, lip adnate to the column foot ................................................ *Ornithidium adendrobium*
3. Inflorescence with one green–yellow flower < 1 cm in length, apex of column erose, lateral lobes of lip not covering the column apex. ................................................ *Epodendrum insulare*
4. Leaves 1.5–2.7 cm wide, floral bracts 1.3–1.6 cm wide, broadly ovate, larger than the scurfy ovary... *Epodendrum cocoense jimenezii*

**LIST OF SPECIES**

1. **Camaridium Lindl.**


**Type species:** *Camaridium ochroleucum* Lindl., Bot. Reg. 10: 844. 1824.

PLANT epiphytic, caespitose or straggling plants, small to large in size, variable in habit. **Pseudobulbs** unifolate, separated by an elongate rhizome, caespitose or lacking pseudobulbs with erect, monopodial leafy shoots. Rarely with dimorphic growth. **Leaves** conduplicate, thin or coriaceous to subcoriaceous, conduplicate. **Inflorescences** produced from a leafy new growth. From several to many. **Floral bracts** small and inconspicuous to medium sized and showy. **Sepals and petals** subsimilar, spreading. **Lip** often shorter than the other perianth parts and floral segments, lacking fibres, simple or three-lobed, articulated with or adnate to the column, usually provided at the base with a fleshy callus. **Column** erect, terete. **Capsules** have apical dehiscence. **Camaridium** is a Neotropical genus with wide distribution and approximately 80 species. The highest diversity is found in Central America.


**Description:** PLANT epiphytic, pendent or suberect, to 25 cm long. **Roots** flexuous, < 1.5 mm in diameter, white to greenish, with green or orange–yellowish tips. **Pseudobulbs** unifolate, ovoid, pyriform, separated by an elongate rhizome, 2.5–6 × 0.8–1.3 cm, internodes up to 3 cm long, covered by scarious, imbricate papyraceous sheaths. **Leaves** apical on each pseudobulb, petiolate, oblong–linear, acute, emarginate, unequally two-lobed at the apex, conduplicate, subcoriaceous, to approximately 10–20 × 1.0–1.4 cm. **Inflorescences** a single-flowered raceme, produced in clusters along the stem, at the base of each pseudobulb, covered by several scarious, imbricate, acute, papyraceous sheaths. **Pedicels** inconspicuous. **Floral bracts** triangular, ovate, scarious. **Ovary** cylindrical, < 4 mm long. **Flowers** small, inconspicuous, white with a yellow dot in the lip callus, approximately 5 mm in length. **Dorsal sepal** oblong, acute, conduplicate, concave towards the apex, 5 × 2 mm. **Lateral sepals** narrowly ovate, acute, slightly conduplicate, concave, 4.5 × 2.5 mm. **Petals** narrowly oblong, acute, 3.8 × 0.8 mm. **Lip** simple, spatulate, oblong, obtuse, attached to the column foot, conduplicate, callus laminar, 3.0 × 1.5 mm. **Column** short, terete, to 1 mm long, anther apical, stigma ventral, rectangular. **Pollinia** four, ovoid, with a short stipe, viscidium elliptic. **Anter cap** subquadrate–cucullate.

**Other vouchers examined:** COSTA RICA. Puntarenas: Puntarenas, Isla del Coco, cumbre del Cerro Iglesias, 575 m, 5°31′45.8N, 87°04′50.5W, bosque pluvial premontano, transición a basal, epífitas en *Sacoglottis holdridgei*, 15 Abril 2006, D. Bogarin 2766; G. Blanco, G. Gigot, V. Savolainen & J. Warner (JBL-Spirit); Puntarenas: Puntarenas, Isla del Coco, camino entre Bahía Wafer y Bahía Chatham, orillas del sendero, 210 m, 5°32′44.07″, N 87°03′00.18″W, bosque pluvial premontano, transición a basal, epífitas en *Sacoglottis holdridgei*, 14 Abril 2006, D. Bogarin 2766; G. Gigot, V. Savolainen & J. Warner (JBL-Spirit); Puntarenas: Puntarenas, Isla del Coco, camino al Cerro Iglesias, ascenso en el primer mirador, 275 m, 5°32′14.09″N, 87°03′36.8″W, bosque pluvial premontano, transición a basal, epífitas en *Sacoglottis holdridgei*, 15 Abril 2006, D. Bogarin 2746; G. Blanco, G. Gigot, V. Savolainen & J. Warner (JBL-Spirit). Pun-
Figure 3. Floral morphology of: (A, B) Camaridium micranthum; (C) Epidendrum cocoense; (D) Epidendrum insulanum; (E) Epidendrum jimenezii; (F) Ornithidium adendrobium.
Camaridium parviflorum

Conservation status: This species is not rare and has a wide distribution range throughout Neotropics. In the island it is a common epiphyte. This species should not be regarded as endangered and may well fit the IUCN Least Concern (LC) category for widespread and abundant taxa.

2. Epidendrum L.


PLANT epiphytic or rarely terrestrial herbs to subshrubs, small to large, variable in size and habit, caespitose, creeping, erect to pendent, occasionally with pseudobulbs. LEAVES distichously arranged along the stem, occasionally one apical leaf or several apical leaves distributed throughout the stem or aggregate at the apex of the stem or pseudobulb, conduplicate, subcoriaceous to fleshy, not petiolate. INFLORESCENCE apical, rarely lateral, a one- to many-flowered raceme, spike, panicle or umbel. FLOWERS resupinate or not, small to large and showy. SEPALS AND PETALS subsimilar, free, usually spreading; the lip simple or lobed, mostly united to the ventral portion of the column, usually with fleshy calli at the base. COLUMN mostly totally fused with the lip, but sometimes totally free or half fused with the lip just to the apex, often provided with a hooded clinandrium. POLLINIA two, four or rarely eight, waxy. Epidendrum is one of the largest genera of Neotropical orchids with more than 1500 species. The genus is widely distributed throughout the Neotropics, from North Carolina to northern Argentina including the Antilles.


Description: PLANT a large epiphyte, pendent, with terete, leafy stem up to 2.5 m long. Roots thick, up to 1–2 mm in diameter, white to greenish, with green tips, produced basally. STEM terete, branching, cane-like, with lateral, secondary stems shorter than the main stems, each stems ending in apical inflorescences. LEAF SHEATHS tubular, enclosing the stem, laterally flattened, to 3 cm long. LEAVES many (to 30), distichous, distributed throughout the stem, laterally twisted, lanceolate, elliptic–oblong, acute, with a bilobed apex, conduplicate, subcoriaceous, articulate with the sheath involving the stem, to approximately 5–14 ¥ 1.5–2.7 cm. INFLORESCENCE apical, racemose, distichous, two- to four-flowered, shorter than the leaves, flowering once, to 6 cm long, covered by
imbricate sheaths, foliaceous, becoming papyraceous with age. PEDICEL inconspicuous, <0.5 mm long, floral bracts widely ovate, longer than the ovary, scarious, condisculate, acute to subacute, 2.5–3.3 × 1.5–2.0 cm. OVARY cylindrical, to 2 × 3 mm, scurfy. FLOWERS white–cream, approximately 1.7 cm in length. DORSAL SEPAL subequal to the lateral sepals, rectangular–ovate to elliptic, acute, 12 × 5 mm. LATERAL SEPALS ovate, elliptic, acute, slightly mucronate, 10 × 5 mm. PETALS rectangular–oblong, subacute, margins revolute, 10 × 2.5 mm. Lip triangular to slightly cordate, with basal rounded lobes covering the column apex, subacute, callus basal, rectangular with erose apex touching the column apex and a central keel running to the lip apex, adnate to the column, 1.0 × 0.7 cm. COLUMN short, slightly acute, with sinuose thick wings, widely dilated towards the apical half in lateral position, with an minutely acute, triangular tooth on each side, 5 × 4 mm, anther apical, stigma ventral. CLINANDRIUM reduced, erose, sinuose. NECTARY prominent, penetrating the ovary. POLLINIA scurfy. FLOWERS white–cream, approximately slightly mucronate, 10 mm.


Discussion: Among the orchids of the island, E. cocoense can be distinguished by the large pendant plants up to 2.5 m long. It can be distinguished from E. insulanum and E. jimenezii by the larger main stems, its conspicuous broad floral bracts to 1.3–2.0 cm wide (vs. less than 0.5–0.6 cm wide in E. insulanum and E. jimenezii) and the scurfy ovary 5 mm in diameter (vs. a glabrescent ovary < 2 mm in diameter). The leaves are wider and longer, up to 2.7 cm wide and 12.5 cm long (vs. < 1.5 cm wide and 8 cm long in the other Epidendrum spp.). Also, it differs from E. insulanum in the inflorescence having three or four white flowers, rarely two (vs. one yellow flower), the column with two apical teeth in each side (vs. erose column apex) and the lateral lobes of lip covering the column apex in lateral position (vs. lateral lobes of lip not covering the column apex). It differs from E. jimenezii by the less conspicuous teeth at the apex of the column, the subacute lip apex and the wider floral bracts completely covering the ovary.
Conservation status: The first IUCN Red List Assessment of *E. cocoense* by Trusty (2004) estimated an extent of occurrence (EOO) of 22.3 km². Based on fieldwork collections during a trip in 2006, the EOO was calculated as 4.5 km² and the area of occupancy (AOO) in 7 km². However, as *E. cocoense* is a common epiphyte in the island, its distribution in the whole territory is expected, with the exception of few disturbed areas and cliffs along the coast. If threats are identified in the future, then a rating of Vulnerable (VU) under criterion D2 may be appropriate. In 2004, Trusty suggested classifying this species either as Critically Endangered (CR) or as VU because of criterion B and D. The current conservation status by IUCN is Near Threatened (NT).


Description: Plant epiphytic, pendent, erect or suberect, with terete, leafy stem to 30 cm long. Roots thin, < 1.5 mm in diameter, white to greenish, with green tips, produced basally. Stem terete, branching, cane-like, with lateral, secondary stems shorter than the main stems, each stems ending in apical inflorescences. Leaf sheaths tubular, enclosing the stem, laterally flattened, to 1 cm long. Leaves many (to 18), distichous, distributed throughout the stem, laterally twisted, lanceolate, elliptic-oblong, acute, with a bilobed apex, conduplicate, coriaceous, articulate with the sheath involving the stem, greenish to yellowish, to c. 5–6 × 2.5–1.3 cm. Inflorescence apical, racemose, distichous, one-flowered, shorter than the leaves, flowering once, to 5 cm long, covered by imbricate sheaths, foliaceous, papyraceous with age; pedicel inconspicuous, < 0.5 mm long. Floral bracts tubular, slightly larger than the ovary, scarious, acute to subacute, to 6 mm long. Ovary cylindrical, to 5 cm long. Flowers yellowish to lemon, approximately 6 mm in length. Dorsal sepal subequal to the lateral sepals, ovate to elliptic, subacute, 7.5 × 2.3 mm. Lateral sepals ovate to elliptic, acute, 7.5 × 2.5 mm. Petals anguste-oblong to lanceolate, acute, margins slightly revolute, 7.0 × 1.2 mm. Lip subulate, with short basal rounded lobes not covering the column apex and produced just after the apex of the column, acute, callus basal, triangular with touching the column apex and a central keel running to the lip apex, adnate to the column, 6.0 × 2.5 mm. Column very short, straight, almost tubular, without teeth, 5.0 × 3.3 mm, anther apical, stigma ventral. Clinandrium reduced, erose, sinuose. Nectary prominent, penetrating the ovary. Pollinia four, ovoid in pairs, with caudicles. Anther cap cucullate, four-celled.


Distribution: known only from Cocos Island, Costa Rica.

Etymology: From the Latin insula, ‘island’, in allusion to Cocos Island, to which this species is endemic.

Phenology: Apparently they flower throughout the year. However, plants collected and cultivated for this study flowered from March to July.

Habitat and ecology: A common endemic epiphyte in premontane rainforest, basal belt transition. The habitat is mostly the same as for *E. cocoense* and sometimes they grow intermixed. They are pendent or suberect, growing on exposed or shady conditions in both shrubs and trees. Most of the plants are found between sea level and 300 m of elevation; however, they can reach 575 m on Cerro Iglesias. Pollinators are unknown. The three *Epidendrum* spp. have similar floral architecture. As in *E. cocoense* and *E. jimenezii*, plants could be pollinated by Lepidoptera.
Discussion: Epidendrum insulanum is easily distinguished by the inflorescences having only one, green-yellow flower (vs. whitish to white, and two or four in E. jimenezii and E. cocoense, respectively). The apex of column is erose, lacking the two peaks present in the other species. The lateral lobes of lip do not cover the apex of column in lateral view. The lip is smaller, up to 6 mm long. Sepals and petals are smaller, < 1 cm in length. Vegetatively, plants are smaller than those of E. cocoense, reaching up to 30 cm long with leaves < 1.5 cm wide. Some larger plants can be confused with E. jimenezii because of the similar size.

Conservation status: In 2004, Trusty suggested classifying this species either as Critically Endangered CR or as VU because of criterion B and D. Based on herbarium specimens and field collections, she estimated an EOO of 18.2 km². Based on field collections performed in 2006, the EOO was calculated as 3 km² and the AOO as 7 km². Although restricted in range and variation in EOO and AOO values, based on field observations it is highly probable that plants of this species are found on the whole island. They are not restricted to a particular place. The current conservation status by IUCN is Near Threatened (NT).


Description: Plant epiphytic, pendent, with terete, leafy stem to 35 cm long. Roots thin, < 1.5 mm in diameter, white to greenish, with green tips, produced basally. STEM terete, branching, cane-like, with lateral, secondary stems shorter than the main stems, each stem ending in apical inflorescences. LEAF SHEATHS tubular, enclosing the stem, laterally flattened, to 2 cm long. LEAVES many (to 20), distichous, distributed throughout the stem, laterally twisted, lanceolate, elliptic–oblong, acute, with a bilobed apex, conduplicate, coriaceous to subcoriaceous, articulate with the sheath involving the stem, to approximately 6–8 × 1.0–1.3 cm. INFLORESCENCE apical, racemose, distichous, two-flowered, shorter than the leaves, flowering once, to 3.1 cm long, covered by imbricate sheaths, foliaceous, becoming papyraceous with age. PEDICEL inconspicuous, < 0.5 mm long. FLORAL BRACTS tubular, as long as the ovary, scarious, acute to subacute, 0.5–0.6 cm long. OVARY cylindric, to 1.5 cm long. FLOWERS whitish, about 1.3 cm in length. DORSAL SEPAL subequal to the lateral sepals, ovate to elliptic, acute, 9.5 × 3.0 mm. LATERAL SEPALS ovate to elliptic, acute, 9.5 × 3.0 mm. PETALS rectangular–oblong to lanceolate, acute to subacute, margins revolute, 8 × 2 mm. LIP cordate, with basal rounded lobes covering the column apex, acute, callus basal, rectangular with erose apex touching the column apex and a central keel running to the lip apex, adnate to the column, 7 × 4 mm. COLUMN short, straight, slightly alate, with sinuose wings, widely dilated towards the apical half in lateral position, with an acute, triangular tooth on each side, 5.0 × 2.2 mm, anther apical, stigma ventral. CLINANDRIUM reduced, sinuose. NECTARY prominent, penetrating the ovary. POLLINIA four, ovoid in pairs, with caudicles. ANTER CAP cucullate, four-celled.


Distribution: Known only from Cocos Island, Costa Rica. It is restricted to the Genio River and Wafer Bay areas.

Eponymy: Named in honour of Ing. Alfonso Jiménez Muñoz, ex-profesor of Agronomy and Biology at Universidad Nacional de Costa Rica and ex-director of the Museo Nacional de Costa Rica, who collected the type specimen.

Phenology: December to January.

Habitat and ecology: a very rare endemic epiphytic orchid in premontane rainforest, basal belt transition. Only five specimens are known from the island and their ecology is poorly understood. As noted for the other Epidendrum spp., the floral architecture is similar and their pollinators could share the same characteristics. The only plant found in this study was growing along the path to the Genio River waterfall, in shady humid conditions.

Discussion: Plants of this species are distinguished by the inflorescence producing two whitish flowers, the corollas, acute lip and the column with two acute teeth at apex. Compared with E. cocoense, it can be distinguished by its smaller habit, up to 35 cm long, the leaves 1.0–1.2 wide, the less conspicuous tubular floral bracts 0.5–0.6 cm wide and as long as the glabrescent ovary. Vegetatively it is similar to some larger plants of E. jimenezii. Large plants of E. insulanum are often indistinguishable from those of E. jimenezii. However, plants of E. jimenezii can be
distinguished by the inflorescences having two whitish flowers, >1 cm in length, the column apex with two teeth in each side and the lateral lobes of lip covering the column apex.

The floral features of the three Epidendrum spp. are similar. The only specimen collected for this study seems to be intermediate between E. cocoense and E. insulanum. Basically, the lip shape is similar to E. cocoense, with the same callus structure, but having rounded basal lobes and acute apex as in E. insulanum. The sepals and petals are as long as those of E. cocoense, but the shape is more similar to E. insulanum. Plant size is intermediate between the two species. The column shape also shares intermediate characteristics. The column is oblong as in E. insulanum but with two teeth at apex as in E. cocoense.

Trusty (2006) was unable to distinguish this species from E. insulanum. They suggested the possibility that this species could be a hybrid between E. cocoense and E. insulanum and observations of floral morphology support their hypothesis. However, more evidence is needed to complement the morphological data, especially at population genetics and reproductive biology levels.

Conservation status: Trusty (2004) suggested classifying this species as CR because of criterion B and D. The estimation of the EOO is < 1 km². This species is very rare and restricted to the Wafer Bay areas around the Genio River where it is known from less than five collections. This species has not been evaluated yet under IUCN criteria; however, it should be classified as CR as suggested by Trusty (2004).

The endemic Epidendrum species: The three Epidendrum spp. are similar in their vegetative morphology. All the species have a pendent branching habit. The inflorescence is terminal and new branches are produced beneath the apex after they have flowered. The new branches flower again. Flowers are superficially similar. The lip is cordate or subcordate with the callus always Y-shaped. The column has a reduced clinandrium and shows little variation between species. The perianth segments show some variation in size and their shape varies from oblong to ovate–elliptic.

Relationships with other members of the genus Epidendrum: According to Hågsater (2007), they are members of the Epidendrum ramosum Jacq. group, which is characterized by the monopodial branching stems, the spike-like distichous inflorescence and the lip with a single callus and the flexicaule subgroup, which has a straggling habit, the main stem not very evident and the dorsal keel present in the sepals, which is generally prominent.

Epidendrum insulanum is closely related to E. flexicaule Schltr., E. stevensii Hágsater, E. modestiflorum Schltr and E. veraguasense Hágsater (Hågsater, 2007), but they can be distinguished: E. flexicaule has longer leaves (up to 8.2 cm long) and two or three larger flowers, E. stevensii has two or three smaller flowers, E. modestiflorum shorter wider leaves (5 × 15 cm) and two or three flowers and E. veraguasense has two or three white, larger flowers. Epidendrum jimenezii is perhaps closely allied to E. insulanum and E. cocoense. Being sympatric and having similar plant size, E. jimenezii and E. insulanum are sometimes confused.

Epidendrum cocoense is vegetatively similar to E. rafael-lucasii Hágsater, E. santaclaarense Ames and E. acuanae Dressler. They are found in Central America and Panama, with the exception of the Costa Rican endemic E. rafael-lucasii. According to Hågsater (1999a), E. rafael-lucasii has larger yellow flowers (vs. white), sepals 16–20 mm long (vs. 12 mm in E. cocoense) and the column is blunt at the apex (vs. with two teeth at each side of apex). Epidendrum santaclaarense has deep green flowers (vs. white) and E. acuanae has shorter stems and very short flowering stems.

Pollination of endemic species of Epidendrum: The pollination biology is unknown. Epidendrum spp. have a deep tube inside the ovary, sometimes with free nectar. The lip and column made up a simple horizontal tube, with the free part of the lip used as an appendage for pollinator attraction. Some species of Lepidoptera, mainly moths, are important pollinators of members of subtribe Laeliinae Benth., including Epidendrum (van der Pijl & Dodson, 1966). The white to whitish flowers of E. cocoense produce a perceptible sweet smell and they could attract some species of moths or butterflies. Nearly 100 species of Lepidoptera are recorded from Cocos Island and moths are the largest group (Brown, Donahue & Miller, 1991; Brown & Miller, 1999). As there are no bees in the island, it is highly probable that the Epidendrum spp. are pollinated by Lepidoptera. Self-pollination was not observed and plants in cultivation flowered without producing fruits.

3. Ornithidium Salisb. ex R.Br.


Epiphytic, sympodial (caespitose to rhizomatous) or monopodial plants; rarely with dimorphic growth.
The thick roots with an orangish coloration. Stems cane-like with distichous leaves or with pseudobulbs bearing basal and apical leaves. The stems and leaves of most species have an olive green coloration. Leaves conduplicate, coriaceous to subcoriaceous. Inflorescences usually fascicled, pedicel and ovary longer than the floral bract. Flowers usually small, fleshy, campanulate or subglobose, the perianth lacks fibres; many species have yellow, orange, red, tan, green or pink flowers. Sepals and petals subisimilar, spreading. Lip simple or three- to four-lobed, articulated with or adnate to the column, usually provided at the base with a fleshy callus and often producing nectar at the base of the labellum. Column erect, terete. Base with a fleshy callus and often producing nectar with or adnate to the column, usually provided at the base with a fleshy callus and often producing nectar at the base of the labellum. Column short, terete, sinuose, retuse, margin erose, callous laminar in the centre, with two parallel keels running to the apex, attached to the column foot. This species was previously treated in Maxillaria; however, nomenclatural changes in Maxillariinae suggest its inclusion in Ornithidium (Blanco et al., 2007; Whitten et al., 2009).

**Distribution:** This is a widespread species ranging from Mexico and the Antilles throughout Central and South America.

**Etymology:** Made up by the Latin prefix 'a', 'away from' and the name of the genus *Dendrobium*. According to Reichenbach (1865), the specimen he studied 'has all characteristics of *Dendrobium*, therefore the name'.

**Phenology:** The plants have been recorded in flower throughout the year, mostly between September and April.

**Habitat and ecology:** Plants are frequent in the island. They are mostly found from 250 to 585 m of elevation, up to the top of Cerro Iglesias. It is rarely found at sea level. Some plants are probably self-pollinated because they form capsules quickly and regularly in almost all flowers. In the field, small ants were observed around the flowers but without pollinia. Capsules are seen throughout the year.

**Discussion:** Plants have distichously arranged leaves without pseudobulbs. Compared with *Epidendrum* spp., it is easily recognized by the lateral single-flowered inflorescences and the footed column. It is distinguished from *C. micranthum* by its larger habit, without pseudobulbs and the stem with distichously arranged leaves. The small flowers do not have the lip adnate to the column foot. This species was previously treated in *Maxillaria*; however, nomenclatural changes in *Maxillariinae* suggest its inclusion in *Ornithidium* (Blanco et al., 2007; Whitten et al., 2009).


Conservation status: This species has a wide distribution range throughout the Neotropics. It is common in the island. It should not be regarded as endangered and may well fit the LC category for widespread and abundant taxa.

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