

A striking new endemic species of *Galagete* Landry (Lepidoptera, Autostichidae) from the Galapagos Islands, Ecuador

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A striking new species of *Galagete* Landry (Lepidoptera, Autostichidae) from the Galapagos Islands, Ecuador. - *Galagete krameri* sp. n. is described and illustrated as an endemic from the island of San Cristobal, Galapagos Province, Ecuador. The species is unlike any other in the genus in having a striped forewing pattern, but otherwise it possesses all the morphological synapomorphies of adult *Galagete*. Its phylogenetic relationships are analysed on the basis of morphological characters and the species is found to be most closely related to *G. darwini* Landry, and *G. consimilis* Landry + *G. cinerea* Landry. *Galagete espanolaensis* Landry is transferred as a subspecies of *G. turritella* Landry.

Keywords: Autostichidae - *Galagete* - new species - phylogeny - *Galagete turritella* Landry - *Galagete espanolaensis* Landry.

INTRODUCTION

Galagete Landry (2002), now comprising 12 species and two subspecies, represents by far the most diverse endemic radiation of Lepidoptera in the Galapagos Islands. The moths of the 13 previously described taxa show forewing patterns of paler spots or fasciae on a dark background, or the reverse (see Landry, 2002), except for *G. griseonana* Schmitz & Landry (2005) for which the forewing is uniformly grey. The forewing pattern of the new species described here diverges markedly from that of the other species in being simply striated. Because of this singular feature of its appearance, the species remained unnoticed in undetermined material of Gelechiidae until a male was dissected in 2008. Thus, it was not included in the phylogenetic work conducted by the second author (PS) (Schmitz *et al.*, 2007).

The new species is described and illustrated and its phylogenetic affinities are analyzed on the basis of morphological characters. A discussion to transfer *Galagete espanolaensis* Landry as a subspecies of *G. turritella* Landry is also provided.

MATERIALS AND METHODS

The label data style for types is presented in Landry (2006) as are the methods used for specimen collecting. Paratypes of the new species are deposited in the Charles Darwin Research Station, Santa Cruz Islands, Galapagos (CDRS) and the Muséum d'histoire naturelle, Geneva (MHNG).

A cladistic analysis of all *Galagete* species was performed with PAUP* (Swofford, 2003) using the character matrix shown on Table 1. *Taygete sphecophila* (Meyrick) (Autostichidae) was used as the outgroup following results obtained by Schmitz *et al.* (2007). All characters were unordered and given equal weight. Character state descriptions and coding are given in Table 2.

TABLE 1. Matrix of character states and *Galagete* taxa used in the cladistic analysis (see Table 2 for character definitions). A question mark is used when the state of the character is unknown in the species (as for the first three characters in the unknown female of *G. griseonana* Landry).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Taxa																		
<i>T. sphecophila</i>	0	1	0	0	0	0	0	1	0	2	?	?	0	0	0	1	?	0
<i>G. seymourensis</i>	1	1	1	0	1	1	0	0	0	1	?	0	0	0	0	1	0	1
<i>G. protozona</i>	1	1	1	0	1	1	0	0	0	1	1	0	0	1	1	0	0	1
<i>G. gnathodoxa</i>	1	1	1	0	1	1	0	0	0	1	1	0	0	0	1	0	0	1
<i>G. t. turritella</i>	1	0	0	0	1	1	1	0	1	0	0	1	1	0	0	1	0	1
<i>G. turritella</i>																		
<i>espanolaensis</i>	1	?	?	?	1	1	1	0	1	0	0	1	1	0	0	?	0	1
<i>G. consimilis</i>	1	0	0	1	1	1	0	0	0	0	1	2	0	1	0	1	1	0
<i>G. darwini</i>	1	0	0	1	1	1	0	0	0	0	0	2	0	0	0	1	1	0
<i>G. levequei</i>	1	0	0	1	1	1	0	0	0	0	1	0	0	0	2	1	1	1
<i>G. cristobalensis</i>	1	0	0	0	1	1	0	0	0	0	0	1	0	0	2	1	1	0
<i>G. pecki</i>	1	0	0	0	1	1	0	0	0	0	0	0	0	1	0	1	1	0
<i>G. cinerea</i>	1	0	0	1	1	1	0	0	0	0	1	2	0	1	0	1	1	0
<i>G. griseonana</i>	1	?	?	?	1	1	0	0	0	0	1	0	0	1	3	?	1	0
<i>G. krameri</i>	1	0	0	1	1	1	0	0	0	0	1	2	0	0	4	1	1	0

TABLE 2. Characters used in cladistic analysis with scores attributed to character states.

1. Female sternum VIII simple (0); bilobed (1).
2. Apical margin of female tergum VIII simple (0); bilobed (1).
3. Corpus bursa with signum (0); without signum (1).
4. Dorsal base of papillae anales separated in the middle (0); joined by sclerotized band (1).
5. Transtilla absent (0); well developed and tripartite (1).
6. Uncus with pair of setose arms medially situated, barely separated, and pointing posteriorly (0); setose arms laterally situated, pointing anteriorly and downward (1).
7. Apical half of uncus not projected mediodorsally (0); projected mediodorsally (1).
8. Sacculus with a simple small projection (0); large and with two projections (1).
9. Vesica with small cornuti only (0); with large cornuti (1).
10. Phallus with at most a small crest medioventrally on coecum penis (0); with a large crest medioventrally on coecum penis (1); with a pair of small crests laterally on coecum penis (2). This character is unordered.
11. Median process of transtilla narrowly terminated (0); enlarged apically (1).
12. Lateral projections of transtilla short and rounded (0); rather short and narrow (1); long and narrow (2). This character is ordered.
13. Juxta a symmetric plate with a rounded, median concavity at apical margin (0); asymmetrical and forming sclerotized ring around phallus (1).
14. Valva simple on costal margin (0); costal margin with process(es) (1).
15. Colour of forewing of various shades of brown with darker markings (0); dark brown with white markings (1); whitish to cream coloured with dark brown markings (2); grey, without markings (3); brown, longitudinally striated (4).
16. Presence (1) or absence (0) of spicules on corpus bursae.
17. Scale-like setae on median process of transtilla small (0) or large (1).
18. Modified scales on abdomen present (1) or absent (0).

DESCRIPTION

Galagete krameri sp. n.

Figs 1-6

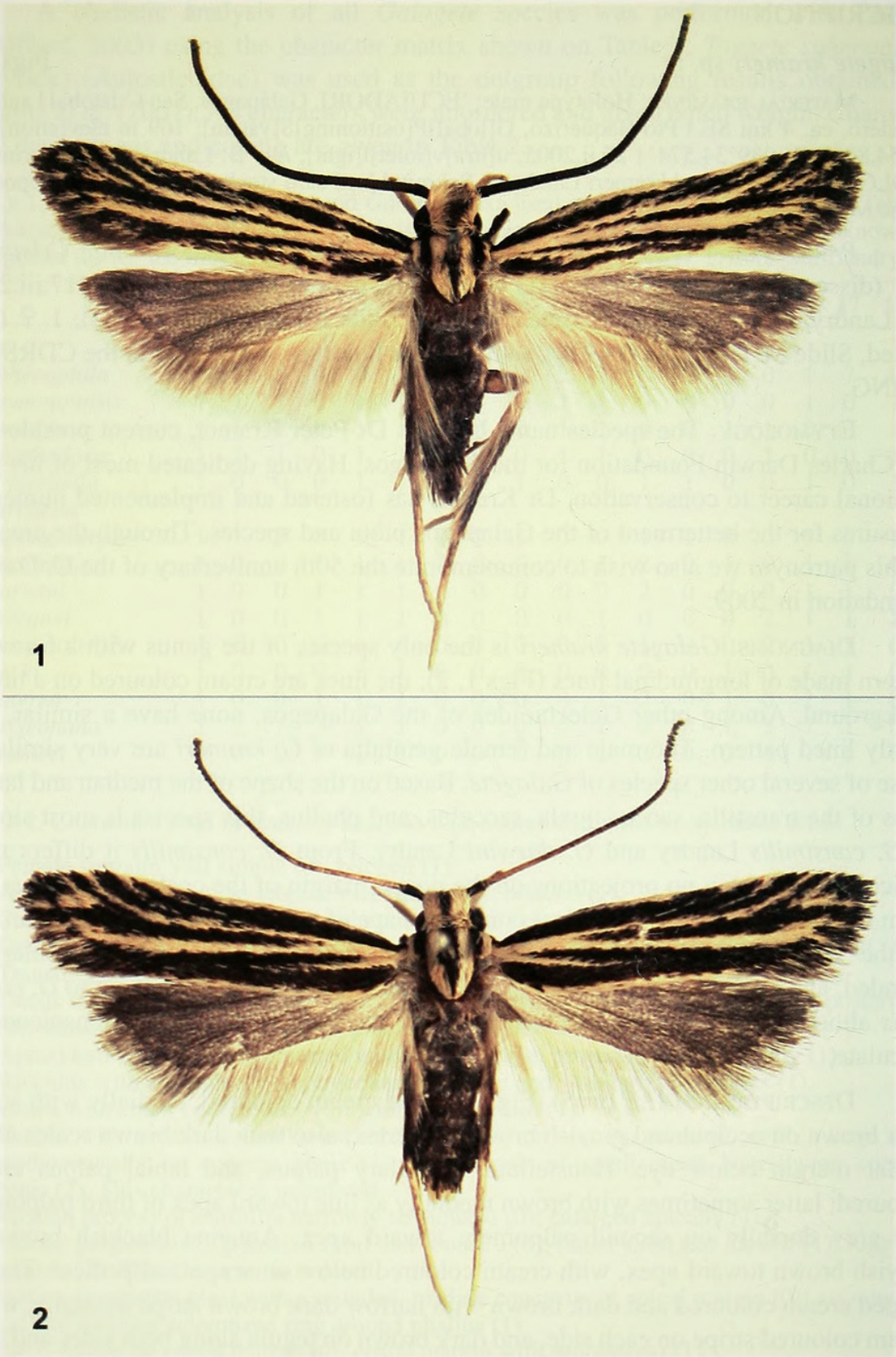
MATERIAL EXAMINED: Holotype male: 'ECU[ADOR], Galápagos, San Cristobal | antiguo botadero, ca. 4 km SE | Pto Baquerizo, G[lobal]P[ositioning]S[ystem]: 169 m elev[ation]. | S 00°54.800', W 089°34.574' | 25.ii.2005, u[ltra]v[iolet]l[ight], leg. B. Landry' [white, printed]; 'HOLOTYPE | Galagete | krameri Landry & Schmitz' [red card stock, hand written]. Deposited in the MHNG.

PARATYPES: 4 ♂, 2 ♀, from the Galapagos Islands, Ecuador: – *San Cristobal*: 1 ♀ (dissected, Slide MHNG ENTO 4932, same data as holotype except '17.iii.2004 (B. Landry, P. Schmitz)'; 4 ♂ (one dissected, Slide MHNG ENTO 4922), 1 ♀ (dissected, Slide MHNG ENTO 4928), same data as holotype. Deposited in the CDRS and MHNG.

ETYMOLOGY: The species name honours Dr Peter Kramer, current president of the Charles Darwin Foundation for the Galapagos. Having dedicated most of his professional career to conservation, Dr Kramer has fostered and implemented numerous measures for the betterment of the Galapagos biota and species. Through the creation of this patronym we also wish to commemorate the 50th anniversary of the C. Darwin Foundation in 2009.

DIAGNOSIS: *Galagete krameri* is the only species of the genus with a forewing pattern made of longitudinal lines (Figs 1, 2); the lines are cream coloured on a brown background. Among other Gelechioidea of the Galapagos, none have a similar, distinctly lined pattern. The male and female genitalia of *G. krameri* are very similar to those of several other species of *Galagete*. Based on the shape of the median and lateral arms of the transtilla, saccus, juxta, sacculus, and phallus, this species is most similar to *G. consimilis* Landry and *G. darwini* Landry. From *G. consimilis* it differs most noticeably in having no projections on the dorsal margin of the costa of the valva and from *G. darwini* it differs in the less compact shape of the uncus and in the median arm of the transtilla being apically modified, i.e. flattened dorsoventrally, enlarged, rounded, and slightly upturned. In female genitalia it is most similar again to *G. consimilis* although the latter has the basal third of the corpus bursae less conspicuously spiculate.

DESCRIPTION: MALE (n=5) (Fig. 1). Head cream coloured, medially with scales dark brown on occiput and greyish brown on vertex; also with dark brown scales along ocular margin below eye. Haustellum, maxillary palpus, and labial palpus cream coloured; latter sometimes with brown medially as line toward apex of third palpomere and grey dorsally on second palpomere toward apex. Antenna blackish brown to greyish brown toward apex, with cream coloured below on scape and pedicel. Thorax striped cream coloured and dark brown with narrow dark brown stripe medially, wider cream coloured stripe on each side, and dark brown on tegula along both sides and base with cream coloured in middle; metascutellum grey, shining. Foreleg blackish brown laterally, cream coloured medially. Midleg mostly cream coloured with white at base of coxa, black-brown on distal half of coxa, on trochanter, as lateral stripe on femur, and as traces at apex or dorsally on tibia and sometimes at bases of first four tarsomeres. Hindleg mostly cream coloured with greyish to blackish brown on coxa except



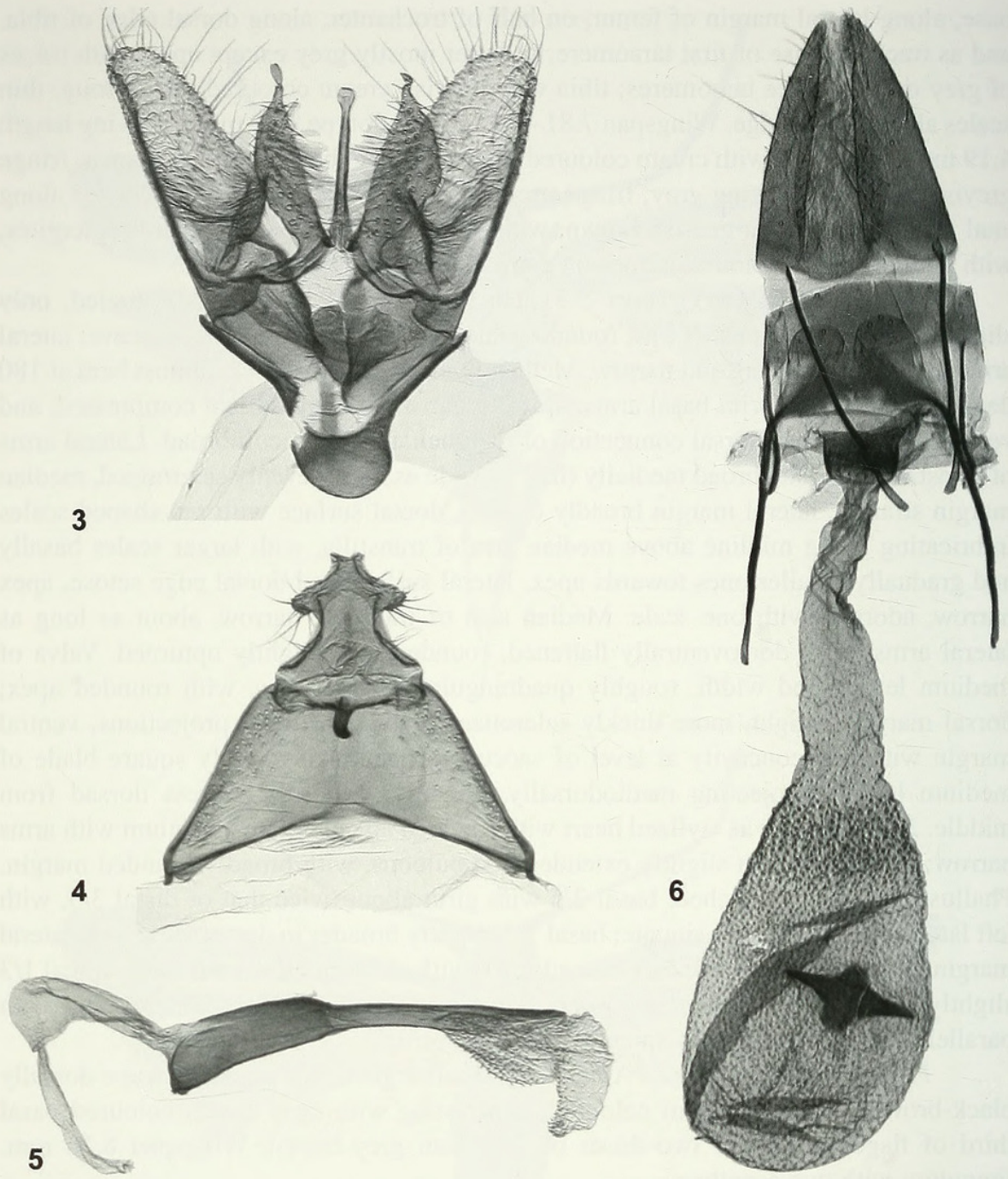
FIGS 1-2
Galagete krameri sp. n. 1. Holotype (MHNG); 2. Female paratype (MHNG).

base, along lateral margin of femur, on half of trochanter, along dorsal edge of tibia, and as traces at base of first tarsomere, or latter mostly grey except apex, with traces of grey on next three tarsomeres; tibia with greyish cream coloured tuft of long, thin scales along dorsal edge. Wingspan 7.81–9.46 mm (holotype 9.19 mm, forewing length 4.19 mm). Forewing with cream coloured lines on brown background as shown; fringe greyish brown. Hindwing grey; fringe greyish brown to mostly cream coloured along anal margin. Abdomen greyish brown, without modified spiny scales on first tergites, with whitish cream coloured scales on genitalia.

Male genitalia (n=1) (Figs 3-5). Uncus in lateral view weakly angled, only slightly convex, with pair of low, rounded, lateral crests; apex slightly concave; lateral arms flat, relatively long and narrow. Median hook of gnathos thick, almost bent at 180 degrees and parallel with basal arms, apically narrowly rounded, not compressed, and very shortly curved. Dorsal connection of tegumen and pedunculi broad. Lateral arms of transtilla elongate, broad medially (half as wide as long), evenly sclerotized, median margin straight, lateral margin broadly convex, dorsal surface with fan-shaped scales imbricating along midline above median arm of transtilla, with larger scales basally and gradually smaller ones towards apex, lateral surface and dorsal edge setose, apex narrow, adorned with one scale. Median arm of transtilla narrow, about as long as lateral arms, apex dorsoventrally flattened, rounded, and slightly upturned. Valva of medium length and width, roughly quadrangular in side view, with rounded apex; dorsal margin straight, more thickly sclerotized at base, without projections; ventral margin with low concavity at level of sacculus; sacculus a roughly square blade of medium length, projecting mediodorsally, dorsally with low buttress dorsad from middle. Juxta roughly as stylized heart with rounded apical notch. Vinculum with arms narrow; median section slightly extended and bulbous, with broadly rounded margin. Phallus long, slightly arched; basal 2/5 with girth about twice that of distal 3/5, with left lateral margin slightly sinuate; basal 1/5 slightly broader in dorsal view with lateral margins rounded; short coecum penis adorned with short medioventral crest; apical 1/3 slightly curved to left, ventrally open, with dorsal wall slightly enlarged and with parallel margins; vesica with spicules, without cornuti.

FEMALE (n=2) (Fig. 2). Antenna of smaller girth than in male; scape dorsally black-brown, ventrally cream coloured, contrasting with dirty cream coloured basal third of flagellum, distal two-thirds of flagellum grey-brown. Wingspan 8.78 mm. Frenulum with two acanthae.

Female genitalia (n=2) (Fig. 6). Papillae anales about 2.2 times longer than basal width in side view (in situ), narrowing towards apex to about one sixth of basal width in side view, apically rounded, dorsally at base with light sclerotized connection between papillae. Posterior apophyses narrow, about as long as papillae, slightly curved inward. Dorsal and free branches of anterior apophyses straight, together slightly longer than papillae; ventral branches widening and diffusing towards middle, not forming clear margin of sternite. Apical margin of sternum VIII with wide rounded lobes, with emargination about half as wide as lobes, reaching about 2/5 length of sternum medially. Apical margin of tergum VIII straight. Ostium bursae wide, about 2/5 width of base of sternum VIII; with ventral sclerotized plate about half as long as wide, with lateral margins slightly rounded, not forming sclerotized ring around base of



FIGS 3-6

Male genitalia of *Galagete krameri* sp. n. from genitalia slide MHNG ENTO 4922. 3. Valvae, transtilla, juxta, vinculum (broken); 4. Tegumen, uncus, gnathos; 5. Phallus in side view. 6. Female genitalia of *Galagete krameri* sp. n. from genitalia slide MHNG ENTO 4932.

ductus bursae. Ductus bursae slightly constricted at base, then gently widening to equal width of sclerotized plate of ostium; slightly spiculate on distal half. Corpus bursae elongate, about 1.7 times longer than wide; spiculate, more strongly so on basal third; with one large signum with 1-2 lateral spine-like projections from rounded to slightly elongate plate, projections and plate sometimes with small spines.

REMARKS: Despite its divergent forewing pattern, this species is clearly a member of *Galagete* as it possesses the two recognized synapomorphies for the genus, i.e. the tripartite male transtilla and the bilobed apical margin of the female's sternum VIII (Landry, 2002). The male also has the thickened antenna and the ventral corematal organ of the base of the abdomen found in all *Galagete* species, although these characters are also present in some other Autostichidae taxa.

The biology of *G. krameri* is unknown, except that the moth is attracted to light and flies in February and March at the type locality, which is an old garbage disposal site, at 169 m in elevation, close to the main road leading to the summit of the island of San Cristobal. This island, the oldest of the archipelago is the only one to harbour two single-island endemics of *Galagete*, *G. cristobalensis* Landry being the other one.

PHYLOGENETIC RESULTS AND TAXONOMIC STATUS OF *GALAGETE* *ESPANOLAENSIS* LANDRY

The maximum parsimony analysis produced 16 equally parsimonious trees of 31 steps (consistency index: 0.74; retention index: 0.79; rescaled consistency index: 0.59), one of which is presented as Fig. 7. The bootstrap analysis (nrep=2000) found more than 86% support for the clade made of the three larger species (*G. seymourensis* Landry, *G. protozona* (Meyrick), and *G. gnathodoxa* (Meyrick)) and 98% support for the pair formed by *G. t. turritella* Landry and *G. turritella espanolaensis*, but only 35.8% support for the relationship between *G. krameri* and its three most closely related taxa (*G. darwini* Landry, and *G. consimilis* Landry + *G. cinerea* Landry). The molecular phylogenetic work of Schmitz et al. (2007) showed the latter three taxa at the base of the tree of *Galagete* and the association of *G. krameri* with them is consistent with the evolution of the genus on the archipelago as *G. krameri* occurs only on the oldest island, i.e. San Cristobal.

The molecular work of Schmitz et al. (2007) also showed that *G. espanolaensis* (2002), described from two males collected on Española, was related most closely to *G. turritella*, a widespread species yet unknown on San Cristobal at the time of its description, in 2002. The data available currently are from three males identified as *G. espanolaensis* and collected on Española (one collected in 2005 was used in the molecular work of Schmitz et al. (2007)) and one female collected on San Cristobal in 2004 (identified as *G. turritella* by Schmitz & Landry (2005: 512), used in the above-mentioned molecular work, and identified as *G. turritella* in that work). Schmitz et al. (2007) showed that *G. espanolaensis* and the specimen of *G. turritella* from San Cristobal were most closely related, that these two specimens were most closely related to the rest of the *G. turritella* specimens, which came from other islands, and that these two clades were very well supported (bayesian posterior probability $\geq 95\%$, maximum likelihood bootstrap value $\geq 75\%$). The percentage of divergence for a 555 bp segment of the beginning of the mitochondrial cytochrome oxydase I gene between the pair from Española and San Cristobal and the clade of *G. turritella* from the other islands was 4.7% on average compared to 7.0% for the sister-species pair of *G. consimilis* Landry and *G. cinerea* Landry, for example, and to 3.2% for the two subspecies of *G. pecki* Landry. Schmitz et al. (2007: 188) mentioned that *G. espanolaensis* represented either a geographical variant of *G. turritella*, or a distinct species occurring on both the

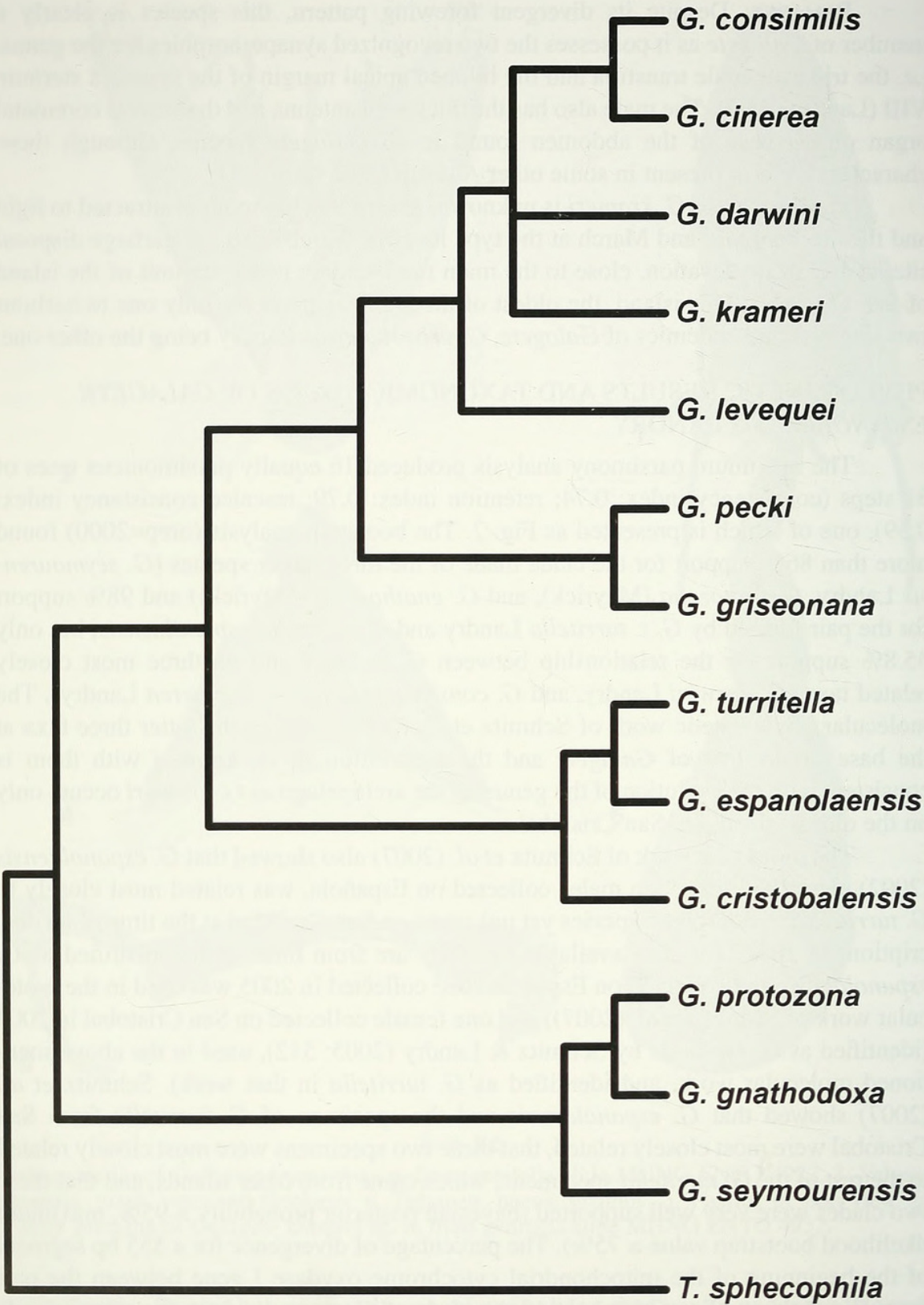


FIG. 7

One of 16 equally parsimonious trees resulting from the maximum parsimony analysis based on 18 morphological characters of *Galagete* (details are mentioned above in the Material and Methods and the Phylogenetic results chapter).

islands of Española and San Cristobal. The results of the present morphological phylogenetic analysis, those of the molecular phylogenetic analysis of Schmitz *et al.* (2007), the intermediate percentage of divergence of the above-mentioned 555 bp fragment, as well as similarities and differences in habitus and male genitalia as mentioned in the original descriptions lead us to propose to down-rank *G. espanolaensis* Landry as a subspecies of *G. turritella* Landry occurring on both San Cristobal and Española. The female of *G. turritella espanolaensis* remains undescribed and the female genitalia, based on a preparation of the unique San Cristobal specimen, are very similar to those of *G. t. turritella*. More specimens of *G. turritella espanolaensis* are needed to clarify morphological similarities and differences between it and the nominotypical subspecies, especially males from San Cristobal and females from Española.

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