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A new species of *Philautus* Gistel (Amphibia: Anura: Rhacophoridae) from southern Western Ghats, India

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Abstract

A new species of the oriental shrub frog genus *Philautus* is described from Kakkayam Reserve Forest of Calicut district, Kerala state, in the southern Western Ghats. This species is distinguished from congeners by the combination of characters such as body small, elongate, squat and flat; head arched, wider than long; snout short rounded, equal or sub equal to diameter of eye; canthus rostralis rounded; tympanum indistinct but visible; eyes protruding, pupil with striking golden yellow dentition like marks; belly granular; vocal sac unpigmented; fleshy brown to cream yellow dorsum with two distinct golden yellow lateral bands bordered by dark brown from upper eyelid to the posterior part of flanks. A description of the advertisement calls and ecology and natural history notes are also provided for the new species which so far is only known from the type locality.

Key words: *Philautus ochlandrae* sp.nov., shrub frogs, Western Ghats, *Ochlandra setigera* Gamble, advertisement calls

Introduction

The shrub frog genus *Philautus* Gistel, characterized by endotrophic development, was revised in 2001 with 22 species in India, of which 11 species are from South India (Bossuyt & Dubois, 2001). Subsequently, ten new species of this genus were described from the Western Ghats (Bossuyt, 2002; Kuramoto & Joshy, 2003; Biju & Bossuyt, 2005a; Biju & Bossuyt, 2005b; Biju & Bossuyt, 2005c; Biju & Bossuyt, 2006; Gururaja *et al*. 2007). Amphibian taxonomy in general, and of the genus *Philautus* in particular has not been well studied in this region (Bossuyt, 2002; Biju & Bossuyt, 2005c). The Western Ghats being an amphibian diversity hotspot, many more new discoveries are awaiting. During our recent survey in the Western Ghats we came across an undescribed species of shrub frog of the genus *Philautus*, in Kakkayam Reserve Forest in the Waynaad hill ranges. We describe this species herein as *Philautus ochlandrae* sp.nov.

Materials and Methods

Measurements and terminology follow Bossuyt and Dubois (2001) as listed below, except for a few new characters (1-6, 10, 16, 19, 27, 34, 36 and 49). Morphological measurements were made using Mitutoyo Digimatic Caliper, taken to the nearest 0.1 mm and abbreviated as follows: 1. AG–axilla to groin distance; 2. BWBS–

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body width behind shoulders (region of axilla); 3. BWFL–body width in front of legs (region of groin); 4. DBDB–distance between dorsolateral bands; 5. DBL–dorsolateral band length; 6. DBW–dorsolateral band width at mid–dorsum; 7. EL–eye length (eye horizontal diameter); 8. EN–distance from front of eye to nostril; 9. $fd_{1,2,3,4}$–disk width of finger 1,2,3 and 4 respectively; 10. FFL–first finger length; 11. FFTF–distance from maximum incurvature of web between fourth and fifth toe to tip of fourth toe; 12. FL–femur length (from vent to knee); 13. FLL–forelimb length (from elbow to base of outer palmar tubercle); 14. FOL–foot length (from base of inner metatarsal tubercle to tip of fourth toe); 15. FrFL–length of fourth toe (from basal border of proximal subarticular tubercle to tip of fourth toe); 16. FW–femur width; 17. $fw_{1,2,3,4}$–width of finger 1,2,3 and 4; 18. HAL–hand length (from base of outer palmar tubercle to tip of third finger); 19. HD–head depth; 20. HL–head length (from back of mandible to tip of snout); 21. HW–head width; 22. IBE–distance between posterior corner of eyes; 23. IFE–distance between anterior corner of eyes; 24. IMT–length of inner metatarsal tubercle; 25. IN–internarial space; 26. IUE–minimum distance between upper eyelids; 27. LP–lingual papilla; 28. MBE–distance from back of mandible to back of eye; 29. MFE–distance from back of mandible to front of eye; 30. MN–distance from back of mandible to nostril; 31. MTFF–distance from distal edge of metatarsal tubercle to maximum incurvature of web between fourth and fifth toe; 32. MTTF–distance from distal edge of metatarsal tubercle to maximum incurvature of web between third and fourth toe; 33. NS–distance from nostril to tip of snout; 34. SFL–second finger length; 35. SL–distance from front of eye to tip of snout; 36. STF–supratympanic fold; 37. SVL–snout vent length; 38. $td_{1,2,3,4,5}$–disk width of toe 1,2,3,4 and 5; 39. TFL–length of third finger (from basal border of proximal subarticular tubercle); 40. TFOL–length of tarsus and foot (from base of tarsus to tip of fourth toe); 41. TFTF–distance from maximum incurvation of web between third and fourth toe to tip of fourth toe; 42. T_1L,T_2L,T_3L,T_4L,T_5L–length of toe 1,2,3,4 and 5; 43. TL–tibia length; 44. TW–tibia width; 45. $tw_{1,2,3,4,5}$–width of toe 1,2,3,4 and 5; 46. TYD–tympanum horizontal diameter; 47. TYE–tympanum to eye; 48. UEW–maximum width of upper eyelid; 49. WF–webbing in foot.

***Philautus ochlandrae* sp. nov.**
(Figure 1a–h; Table 1)

Holotype: Zoological Survey of India, WGFRS, Calicut (ZSI/WGFRS/V/A/632), an adult male from *Ochlandra setigera* reed was collected at Kakkayam Reserve Forest, Calicut District, Kerala State, by DKP, MdJP and KVG on 23rd April 2007 (11°33'16" N, 75°55'12" E, altitude ~745 m above mean sea level) between 17:30–22:00 h.

Paratypes: ZSI/WGFRS/V/A/633, 634, two males and ZSI/WGFRS/V/A/635, 636, a male and a female collected from the same locality on 24th April 2007 at 08:00 h by DKP, MdJP and KVG, collection data same as holotype. ZSI/WGFRS/V/A/637, a male collected by DKP and KVG on 27th April 2007 at 21:00 h from the same locality.

Diagnosis: A small-sized frog diagnosed as *Philautus* (Male: 22.1–25.6 mm; Female: 23.3 mm), having granular belly, all digits with well differentiated disks bearing circummarginal grooves, predominantly inhabiting shrubs (this species exclusively inhabits hollow tubular internodes of *O. setigera* reed brake) and having direct development as in *Philautus* cf. *leucorhinus* (Gururaja & Ramachandra, 2006). It is distinguished from all other congeners of Western Ghats by the following combination of characters: (i) body small, elongate (ii) habitus squat and flat; (iii) head arched, wider than long; (iv) snout short rounded, equal or sub equal to diameter of eye; (v) tympanum indistinct but visible; (vi) canthus rostralis rounded; (vii) eyes protruding, pupil with striking golden yellow dentition like marks; (viii) belly granular, under parts of forearm and thigh granular; (ix) vocal sac unpigmented and (x) fleshy brown to cream yellow dorsum with two distinct golden yellow lateral bands bordered by dark brown from upper eyelid to the posterior part of flanks.

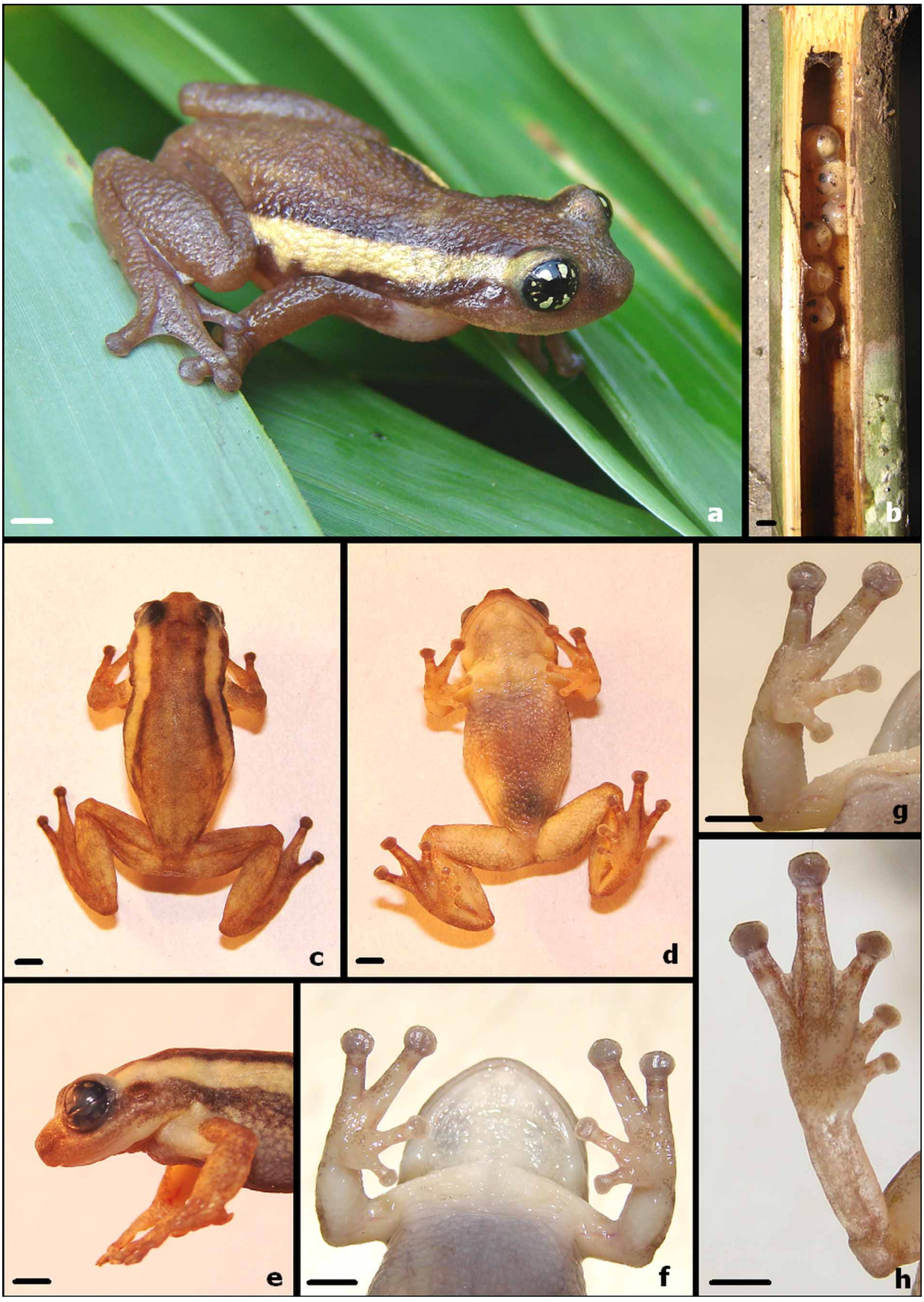

FIGURE 1. a. *Philautus ochlandrae* sp. nov. Holotype in life on *Ochlandra setigera* reeds (SVL = 25.6 mm); b. egg clutch within the hollow tube of *O. setigera* (culms cut open to show the eggs, diameter measured, eggs not collected); c. Dorsal view; d. Ventral view; e. Lateral view of the head; f. Ventral view of head; g. Ventral view of the hand and h. Ventral view of the foot. Scale bar is 2 mm.

Description of the holotype: A small sized shrub frog (SVL = 25.6 mm), width of head broader than head length (HW = 8.6 mm; HL = 6.4 mm), arched, flat dorsally; snout rounded in total profile, slightly protruding beyond mouth. Snout length is equal to diameter of eye (SL = 2.9 mm, EL = 2.9 mm). Canthus rostralis rounded, loreal region slightly concave. Interorbital space (IUE = 2.8 mm) flat and broader than upper eyelid (UEW = 1.9 mm), wider than internarial distance (IN = 1.7 mm). Internarial distance between posterior margins of the eyes 1.93 times that of anterior margins (IFE = 4.0, IBE = 7.7 mm). Nostrils oval, nearer to tip of snout (NS = 0.8 mm) and away from eye (EN = 1.9 mm). Pineal ocellus absent. Weak symphysial knob. Vomerine ridges absent. Eyes large, protruding, pupil horizontal, with golden yellow dentition like marks interspersed with black. Tympanum rather indistinct, rounded, barely visible behind the eye, 2.15 times in eye diameter (TYD = 1.4 mm). Tongue bifid, granular with a distinct retractile papilla. Supratympanic fold from behind eye to shoulder. Median subgular vocal sac with a pair of opening at the base of the lower jaw.

Fore arm (FLL = 4.4 mm) less than hand (HAL = 7.0 mm). Relative length of fingers I<II<IV<III. Finger tips with well developed disks (fd_1 = 0.8 mm, fd_2 = 1.1 mm, fd_3 = 1.4 mm, fd_4 = 1.4 mm; fw_1 = 0.5 mm, fw_2 = 0.6 mm, fw_3 = 0.9 mm, fw_4 = 0.8 mm) with distinct circum–marginal grooves, fingers with dermal fringes on both sides. Webbing on palm absent, subarticular tubercles indistinct, rounded and pre–pollex tubercle oval, distinct. Supernumerary tubercles absent.

Hind limb long, heels barely touch when folded at right angles to the body. Tibia 2.9 times longer than wide (TL = 10.1 mm, TW = 3.4 mm), subequal to femur (FL = 10.4 mm) and longer than foot (FOL = 9.5 mm). Heel to tip of fourth toe (TFOL = 14.9 mm) 2.76 times length of fourth toe (T_4L = 5.4 mm). Relative toe length I<II<III<V<IV. Toe disk width and toe width are td_1 = 0.8 mm, td_2 = 1.0 mm, td_3 = 1.3 mm, td_4 = 1.5 mm, td_5 = 1.5 mm; tw_1 = 0.7 mm, tw_2 = 0.7 mm, tw_3 = 0.8 mm, tw_4 = 0.9 mm, tw_5 = 0.9 mm. Webbing moderate and distinct (MTTF = 5.5 mm, MTFF = 5.5 mm, TFTF = 4.4 mm, FFTF = 3.9 mm); web formula, I 2–2 II 1–2 III 1–2 IV 2–1 V. Tibiotarsal articulation reaches tympanic region. First toe (T_1L = 1.5 mm) nearly 1.9 times the length of inner metatarsal tubercle (IMT = 0.8 mm). Outer metatarsal tubercle, supernumerary tubercles and tarsal tubercle absent.

Skin: Snout, between eyes, sides of head, dorsum smooth. Dorsal part of forelimb, femur, tibia and tarsus smooth to very finely granular. Venter granular, larger granulation on belly extending up to throat, flanks (mid part of dorsolateral band) and thigh. Dorso–lateral folds and macroglands absent.

Color in life: Dorsum fleshy brown with two lateral golden yellow bands bordered by dark brown from upper eyelid to the posterior part of the flanks (¾ of flank). Head, forelimbs and hind limbs brown dorsally. Hand ventrally cream, a few brown granulation along the dermal fringes of third and fourth finger. Upper lip and lower lip cream colored. Venter granular and uniform cream. Granulation on femur, tibia, tarsus and entire foot, brown ventrally. Webbing brown. Eyes with horizontal black pupil surrounded by golden yellow dentition like marks interspersed with black.

Color in preservative: Dorsum and lateral parts of body light sandy brown with two lateral golden yellow bands, bordered by dark brown color from upper eyelid to the region of groin. Dorsal and lateral parts of limbs uniform without any cross bars. Ventral parts of head, body and hand cream white, belly translucent, granular. Granulation on foot, toes, disks and webbing, brown dorso–ventrally.

Etymology: The species epithet refers to the generic name of *Ochlandra setigera*, the plant in which we observed this species (both male and female) as well as its eggs and advertisement calls.

Sexual dimorphism: Nuptial spines absent in male, possess a median subgular vocal sac with a pair of openings at the base of the lower jaw. Female larger than the paired male (SVL: 23.3 mm and 22.1 mm respectively). Ovary large, with creamy white eggs. Female paler than males, dorsum golden yellow and two lateral stripes slightly thinner than males.

Variation: Table 1 details the morphometric and meristic variations observed in six individuals. Color on the dorsum varied from dark brown to brown interspersed with yellow blotches to broad yellow bands (this is

apart from two lateral distinct golden yellow bands from upper eyelid to the posterior part of the flanks). In individuals with brown dorsum and yellow spots, the yellow spots were in four–six stripes, two stripes commencing at snout dividing in to four at interorbital space, and widening at mid dorsum to which two more stripes are added that coalesce near vent. In individuals with brown dorsum and yellow stripes, the yellow stripe starts singly at snout, bifurcating at dorsum and ending near vent. Dorsum of forelimb and hind limb brown with yellow blotches. A yellow stripe along the canthus rostralis was also noticed in an individual.

Additional information from paratypes: Morphometric data are given in Table 1. All the paratypes are in good condition, except for ZSI/WGFRS/V/A/636, which was incised ventrally to determine sex.

TABLE 1 Morphometric (in mm) and meristic data for the type series of *Philautus ochlandrae* sp. nov. Prefix ZSI/WGFRS/V/A/ for all Holotype and Paratypes. For abbreviations see text.

Parameters	Holotype 632	Paratype 633	Paratype 634	Paratype 635	Paratype 637	Average ± SD (Range)	Paratype 636
SEX	Male	Male	Male	Male	Male		Female
SVL	25.6	22.1	23.2	24.7	24.5	24.0±1.38 (22.1–25.6)	23.3
EL	2.9	2.8	3.0	3.1	3.3	3.0±0.18 (2.8–3.3)	3.1
EN	1.9	2.1	2.1	2.0	1.9	2.0±0.07 (1.9–2.1)	2.0
HL	6.4	6.0	5.9	6.1	6.3	6.2±0.23 (5.9–6.4)	6.1
HW	8.6	8.2	7.8	8.5	8.0	8.2±0.33 (7.8–8.6)	8.3
HD	3.9	3.3	3.3	3.1	2.8	3.3±0.38 (2.8–3.9)	3.8
IBE	7.7	7.2	7.3	7.6	7.6	7.5±0.20 (7.2–7.7)	7.7
IFE	4.0	3.5	3.6	4.2	4.1	3.9±0.30 (3.5–4.2)	4.5
IN	1.7	1.6	1.4	2.0	1.6	1.7±0.23 (1.4–2.0)	1.9
IUE	2.8	2.8	2.5	3.0	2.6	2.7±0.19 (2.5–3.0)	2.9
MBE	1.9	1.8	2.0	1.7	1.9	1.8±0.10 (1.7–2.0)	1.5
MFE	4.7	4.2	4.7	4.1	4.2	4.4±0.32 (4.1–4.7)	4.0
MN	6.5	5.5	5.9	6.4	5.8	6.0±0.39 (5.5–6.5)	5.8
NS	0.8	0.9	0.7	0.9	1.2	0.9±0.19 (0.7–1.2)	0.9
SL	2.9	2.6	2.8	3.0	3.0	2.8±0.15 (2.6–3.0)	3.1
TYD	1.4	1.0	1.2	1.2	0.9	1.1±0.17 (0.9–1.4)	1.0
TYE	0.6	0.8	0.6	0.6	0.6	0.6±0.09 (0.6–0.8)	0.8
UEW	1.9	1.6	1.8	1.8	1.9	1.8±0.14 (1.6–1.9)	1.7
fd_1	0.8	0.7	0.7	0.7	0.8	0.7±0.07 (0.7–0.8)	0.9
fd_2	1.1	0.9	1.1	1.0	1.1	1.0±0.10 (0.9–1.1)	1.1
fd_3	1.4	1.2	1.4	1.3	1.5	1.3±0.10 (1.2–1.5)	1.4
fd_4	1.4	1.2	1.2	1.2	1.3	1.3±0.11 (1.2–1.4)	1.3
fw_1	0.5	0.6	0.6	0.6	0.6	0.6±0.04 (0.5–0.6)	0.6
fw_2	0.6	0.9	0.8	0.7	0.7	0.8±0.11 (0.6–0.9)	0.9
fw_3	0.9	0.9	0.9	0.9	1.1	0.9±0.07 (0.9–1.1)	1.0
fw_4	0.8	1.0	0.8	1.0	0.8	0.9±0.12 (0.8–1.0)	0.9

.....continued

TABLE 1 (continued).

Parameters	Holotype 632	Paratype 633	Paratype 634	Paratype 635	Paratype 637	Average ± SD (Range)	Paratype 636
FFL	1.7	1.4	1.4	1.6	1.4	1.5±0.13 (1.4–1.7)	1.6
SFL	2.2	1.9	2.0	2.3	1.8	2.0±0.19 (1.8–2.3)	2.3
TFL	4.0	3.8	3.8	4.3	3.7	3.9±0.23 (3.7–4.3)	4.0
FrFL	3.4	2.8	2.9	3.3	3.1	3.1±0.25 (2.8–3.4)	2.9
HAL	7.0	6.0	7.0	7.1	6.1	6.6±0.54 (6.0–7.1)	7.4
FLL	4.4	4.9	4.8	4.9	5.3	4.8±0.33 (4.4–5.3)	5.4
AG	12.7	9.8	11.1	11.4	13.5	11.7±1.42 (9.8–13.5)	7.8
BWBS	8.2	7.6	7.1	5.9	7.8	7.3±0.89 (5.9–8.2)	7.9
BWFL	4.1	4.8	4.1	3.7	4.1	4.2±0.37 (3.7–4.8)	5.0
FL	10.4	9.5	9.7	11.1	9.9	10.1±0.61 (9.5–11.1)	10.4
FW	3.6	2.9	3.8	3.5	3.5	3.5±0.30 (2.9–3.8)	3.3
TL	10.1	10.1	10.1	11.3	11.3	10.6±0.63 (10.1–11.3)	11.4
TW	3.4	3.6	3.3	3.2	2.8	3.2±0.30 (2.8–3.6)	3.2
FOL	9.5	8.8	9.2	10.5	9.4	9.5±0.63 (8.8–10.5)	9.9
TFOL	14.9	14.8	15.0	16.3	14.6	15.1±0.69 (14.6–16.3)	16.4
T_1L	1.5	1.5	1.5	1.6	1.4	1.5±0.07 (1.4–1.6)	1.8
T_2L	2.0	2.0	1.9	2.3	1.8	2.0±0.18 (1.8–2.3)	2.4
T_3L	3.6	3.2	3.3	3.7	3.3	3.4±0.22 (3.2–3.7)	3.8
T_4L	5.4	5.3	5.0	6.0	5.6	5.5±0.39 (5.0–6.0)	5.5
T_5L	4.1	4.3	3.7	4.1	3.7	4.0±0.26 (3.7–4.3)	4.3
td_1	0.8	0.8	0.7	0.9	0.8	0.8±0.05 (0.7–0.9)	0.8
td_2	1.0	0.9	1.0	0.9	0.8	0.9±0.07 (0.8–1.0)	1.1
td_3	1.3	0.9	0.9	1.1	1.1	1.1±0.16 (0.9–1.3)	1.3
td_4	1.5	1.1	1.1	1.1	1.4	1.2±0.16 (1.1–1.5)	1.3
td_5	1.5	1.2	1.1	1.3	1.2	1.3±0.14 (1.1–1.5)	1.3
tw_1	0.7	0.6	0.5	0.7	0.6	0.6±0.09 (0.5–0.7)	0.7
tw_2	0.7	0.8	0.6	0.8	0.8	0.7±0.10 (0.6–0.8)	0.8
tw_3	0.8	0.8	0.9	0.8	0.8	0.8±0.05 (0.8–0.9)	0.9
tw_4	0.9	0.8	0.7	1.0	1.0	0.9±0.14 (0.7–1.0)	1.1
tw_5	0.9	0.8	0.8	0.9	0.7	0.8±0.08 (0.7–0.9)	1.1
IMT	0.8	0.8	0.9	0.8	0.7	0.8±0.06 (0.7–0.9)	0.9
FFTF	3.9	3.6	3.6	3.9	3.7	3.7±0.16 (3.6–3.9)	4.3
MTFF	5.5	6.1	5.8	7.1	5.4	6.0±0.68 (5.4–7.1)	6.7
MTTF	5.5	5.4	5.4	6.1	4.9	5.4±0.42 (4.9–6.1)	5.9
TFTF	4.4	3.9	3.1	4.3	3.7	3.9±0.52 (3.1–4.4)	4.1
DBL	16.2	15.2	13.9	14.6	15.0	15.0±0.85 (13.9–16.2)	13.8
DBW	2.3	2.0	2.1	1.7	2.2	2.1±0.23 (1.7–2.3)	2.1
DBDB	4.5	4.5	4.0	4.7	4.4	4.4±0.25 (4.0–4.7)	4.5

Ecology and natural history notes: This species was first noticed on a reed brake on 23rd April 2007 calling at 19:30 h while it was drizzling. Other species calling at that time were *Nyctibatrachus* cf. *aliciae* Inger, Shaffer, Koshy and Bakde, *Sylvirana aurantiaca* (Boulenger), *Philautus* cf. *wynaadensis*, and *P. ponmudi*. Two more individuals were collected during the same night from reed brakes. On 24th April 2007 at 8:00 h, two individuals were collected, of which one was female.

These frogs reside in the hollow tube of internodal region of *O. setigera* reed brake. On four occasions, calling males were noticed inside culms of *O. setigera*. Generally, this species remain within these culms throughout the day at a height of 2.42 ± 0.25 m (range: 2.25–2.7 m) above ground. These culms (girth: 81.5 ± 9.4 cm, range: 70–93 cm) had slit like openings (length: ~27.0 mm, width: ~5.0 mm) which the frogs used as portals. Males start calling early (around 16.00h) on rainy days, increase in number at dusk and subsequently last until around 22:00h. However, on two occasions, we heard them calling at 8:00 h in the morning. We observed that individuals reside only in live reeds. Specimens were found as pairs (a male and a female) in culms on two occasions, and solitarily in different culms and reed brakes at the type locality.

In subsequent field visits (29th May 2007) we observed an egg clutch with six developing embryos (Figure 1b) (diameter of eggs with jelly cover: 4.94 ± 0.06 mm, range: 4.87–5.01 mm) ensconced in jelly cover, attached to inner walls of hollow reeds, ~12 cm above the opening. Embryos were cream-white in color and had pigmented eyes with visible heart-beats and movements; which would eventually hatch into froglets as in other *Philautus* of the region (Gururaja & Ramachandra, 2006). This is similar to development mode 20 (Duellman & Trueb, 1994). Both males and females were in the same hollow reed, indicating the possible provisioning of parental care. However, this requires further field investigations to substantiate.

Advertisement call analysis: Calls were recorded using Olympus digital voice recorder (W–10, Olympus) within 10–20 cm from calling males. The air temperature and relative humidity were 93.75 ± 3.3 % (range: 90–98 %) and 21.76 ± 1.45°C (range: 20–23.6°C) respectively. Calls were recorded from four individuals, on two days. Six calls were analyzed using SIGVIEW32 Ver.1.9.3.2. Call terminology were based on Giacomo & Castellano (2001). Advertisement call had a short four pulse call (shriek '*shreaaw*' note) and a long 27–73 pulse call ('*tink tink tink tink*….' notes). Average dominant frequency was 2796.82 ± 125.49 Hz (range: 2691.23–2978.56 Hz), Call duration was 5.42 ± 1.90 sec (range: 3.04–8.23 sec), short call pulse duration 0.22 ± 0.05 sec (range: 0.17–0.27 sec), short pulse rate 19.37 ± 4.37 sec^{-1} (Range: 14.83–24.24 Sec^{-1}), long pulses were 48.33 ± 17.84 (range: 27–73), long call pulse duration 5.11 ± 1.92 sec (range: 2.74–7.94 sec), long pulse rate 9.47 ± 0.63 sec^{-1} (range: 8.52–10.21 sec^{-1}). Figure 2 illustrates call spectrum and amplitude of a single advertisement call of 8.22 sec duration.

Comparisons: We compared the new species with all 22 known species from south India listed in Appendix-I. Sri Lankan and South-east Asian *Philautus* are excluded from comparison as they form phylogenetically distinct clades (Bossuyt *et al*. 2004; Manamendra–Arachchi & Pethiyagoda, 2005). However, the phylogenetic status of *P.* cf. *leucorhinus* and *P.* cf. *variabilis* is not fully resolved, and they were therefore included in morphological comparison. Morphometric and meristic data of type specimens were taken from the original description of the respective species (Table 2), additional information is compiled from subsequent publications as cited in Appendix–I. *Philautus ochlandrae* sp.nov. differs from all other Indian species of *Philautus* in a number of characters. Appendix–I provides the opposing suites of characters of these congeners compared to *P. ochlandrae* sp.nov.

Considering the morphological information of 17 male type specimens of *Philautus*, we performed a cluster analysis using STATISTICA software (version 5.5). This analysis was used to compare the new species with other known congeners, based on unweighted pair group averages and squared Euclidian distance measure of 19 morphometric and three meristic characters. We included only male type specimens for cluster analysis, hence *P. tinniens* and *P. variabilis* (with female type specimens) were excluded from the analysis. We also excluded *P. beddomii*, *P. bombayensis*, *P. chalazodes*, and *P. travancoricus*, for lack of data. From the dendrogram generated (Figure 3), despite a minor branching among the individuals of *P. ochlandrae* sp. nov.,

overall clustering clearly indicates the species to be new. There is an overlap of *P. ochlandrae* sp. nov. with *P. griet*, however, *P. griet* differs from *P. ochlandrae* sp.nov., in the following characters: dorsum brown with large spines; tongue without papilla; supernumerary tubercles on both fingers and toes; webbing on toes rudimentary; webbing transparent with black spots; vocal sac and throat light gray; thighs cross barred.

TABLE 2. Morphometric and meristic characters of 18 *Philautus* species from the southern India (values in mm, except for meristic characters).

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
SVL	23.8	21.3	29	20.5	29.4	22.3	22.6	21.3	27	27.8	29.9	34	35.9	31.5	25	18.2	37.2	28.3
HAL	6.3	5.5	8.7	6.3	8.8	6.2	7	6.3	7.1	7.5	8.2	10.6	10	8.8	6.9	4.5	10.5	7
TFL	3.7	3	5.9	3.1	5.2	3.2	4.2	4.5	5.3	4.8	4.7	6.3	6.3	5.5	4.9	3.4	6.5	5.2
EL	3.1	3.5	3.7	2.8	3.9	3.8	4	2.6	4.4	3.8	4.1	4.4	4.4	4.1	2.8	2.3	5	4.1
EN	2.1	1.4	2.1	1.7	2.6	1.7	1.9	1.3	3.1	3.7	2.8	3.5	3	2.8	1.9	1.4	3	2.1
HW	9	9.3	10.7	8.6	11.8	9.4	9.6	7.6	9.9	10.2	10.8	13.7	14.7	12	9.3	6.6	14.9	9.6
HL	9.2	8.2	10	8.5	10.4	8.5	9.2	7	9.1	7.7	9	12.6	13.1	11.6	8.6	4.5	13.1	10.1
NS	1	1	1.3	1.4	0.8	1.2	1.4	0.9	1.4	2	1.4	1.6	1.8	1.5	0.9	1.1	1	1.1
IN	2.1	2.5	3.1	2	2.8	2.6	2.3	2.1	2.6	2.8	2.4	3.2	3.3	3.2	2.3	1.8	3.2	3
IUE	2.5	4	3.5	2.7	3.7	3.3	2.8	2.5	3.2	3.4	3.8	3.2	4	4	3	2.4	4.4	3.3
TYD	1	0.8	1.3	1.6	1.4	1.1	1.2	1	2.3	1.4	0	2	1.5	1.7	1.2	1	1	2.1
UEW	2.4	1.6	2.7	1.8	2.6	2	2.7	2	2.3	2.5	2.2	3.2	3.1	2.9	2	1.7	3.3	2.5
FL	10.8	12	13.3	9.4	13.5	11.1	12.8	9.2	14	13.2	15.1	17.1	18	14.2	10.2	9.3	17.2	12.9
TL	11.6	11.2	12.7	9	13.5	10.9	11.6	9.3	13.7	13.5	14.3	17.1	17.4	15	9.9	9	17.7	13.4
FOL	8.9	9.2	12.3	8	12.3	8.9	9.3	8.9	10.7	10.6	12	14.3	14.6	13.1	10.2	7.1	16.2	11.8
T_1L	1.7	1.8	2.7	1.9	3	2.1	2	2	2.4	2.	2	3.4	3.5	3	2.6	1.4	4	2.4
T_4L	4.4	4.3	6.3	3.8	5.8	4.5	5.1	5.4	6.5	6.7	7	8.8	7.7	6.3	5.6	4.1	8.3	6
TFOL	13.3	15.1	19.3	11.8	19.4	14.2	15.4	13.4	16.8	17.7	19.8	23.1	24	19.9	16.4	11.6	24.7	17.8
IMT	0.8	0.8	1.1	0.9	1.2	1	1.1	0.8	0.9	0.9	0.9	1.7	1.4	1.4	1	0.8	1.6	1.1
STF	1	0	1	1	1	1	1	1	1	1	0	1	1	0	1	1	1	1
LP	0	0	0	0	1	0	0	0	0	0	0	1	1	1	1	0	0	0
WF	0.3	0.8	0.5	0.3	0.5	0.5	0.3	0.2	0.5	0.3	0.5	1	0.5	0.5	0.3	0.2	0.5	0.5
SEX	Male	Male	Male	Male	Male	Male	Male	Male	Male	Male	Male	Male	Male	Male	Female	Male	Female	Male

Note: For abbreviations see text. Species 1. *P. anili*; 2. *P. bobingeri*; 3. *P. charius*; 4. *P. dubois*; 5. *P. flaviventris*; 6. *P. glandulosus*; 7. *P. graminirupes*; 8. *P. griet*; 9. *P.* cf. *leucorhinus*; 10. *P. luteolus*; 11. *P. neelanethrus*; 12. *P. nerostagona*; 13. *P. ponmudi*; 14. *P. signatus*; 15. *P. tinniens*; 16. *P. tuberohumerus*; 17. *P. variabilis*; 18. *P. wynaadensis*. STF : present = 1, absent = 0; LP: present = 1, absent = 0, WF: 0.2 = reduced, 0.3 = partial, 0.5 = medium, 0.8 = nearly full, 1.0 = full.

Discussion

In an era of mass extinctions (Dubois, 2003), new species descriptions are indicative of the yet undocumented biological wealth of the Western Ghats. Recent studies in the Western Ghats also have emphasized that amphibians are the best surrogates for conservation priority regions (Das *et al*. 2006) and *Philautus* is considered as an indicator of fragmented forests for its patchy distribution (Gururaja *et al*. 2007).

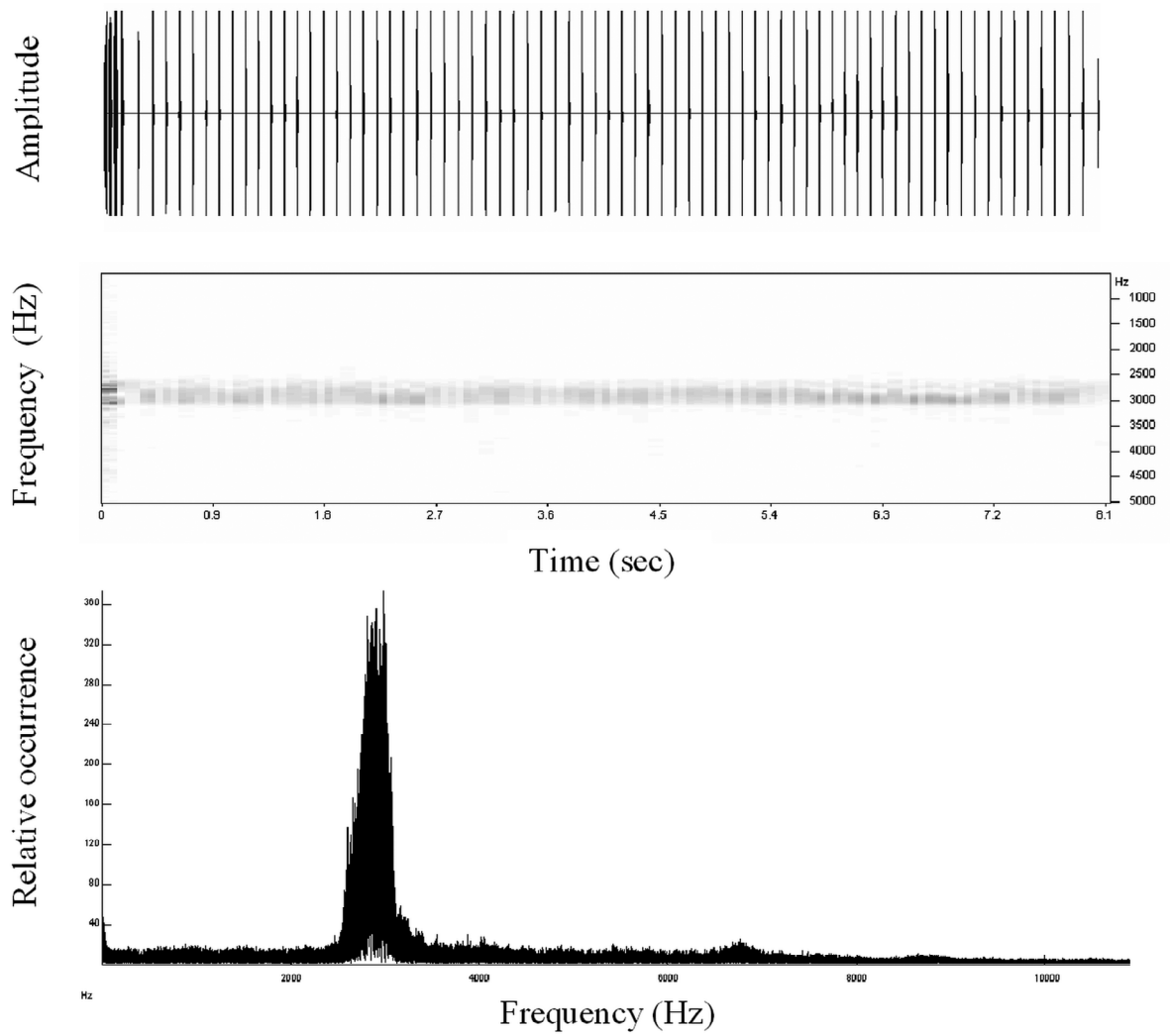

FIGURE 2. Spectrogram of *P. ochlandrae* sp. nov. advertisement call of 8.22 sec duration. Dominant frequency of this call 2969 Hz, short call pulse duration 0.17 sec, short pulses 4, short pulse rate 24.1 sec^{-1}, long pulses 73, long call pulse duration 7.94 sec, long pulse rate 9.2 sec^{-1}

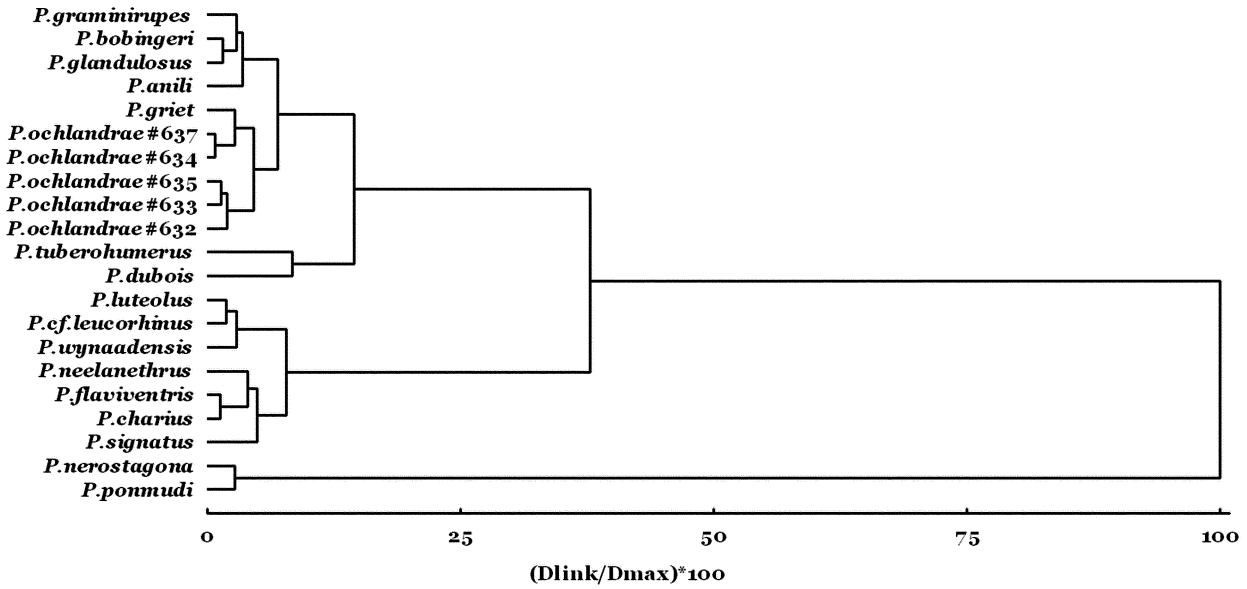

FIGURE 3. Cluster analysis of 17 *Philautus* species based on 19 morphometric and 3 meristic characters. Overall clustering clearly indicates *P. ochlandrae* sp.nov. to be new species, but shares a few characters with *P. griet*. Opposing suites of characters are discussed in text.

Type localities of 21 species of *Philautus* from the Southern India has marked differences in their distribution, both spatio-temporally. Sixteen species from southern (8°–12°N), five from central (12°–16°N) and none from northern Western Ghats (16–21°N) (Figure 4 and Table 3). Chronologically too, eight species between 1850-1900, two species between 1900-1950 and from 2000 onwards 11 species have been described. The spatial distribution trend of species discovery can be attributed to a) biogeography of the region (*viz*., southern Western Ghats bestowed with more evergreen forests, greater number of rainy days, higher altitudes [and hence more wet and cool habitats], more protective areas (nature reserves/parks/sanctuaries) than central or northern Western Ghats); b) higher per cent endemism (restricted geographical ranges) in amphibians of Western Ghats (Aravind *et al*. 2007); whereas temporal pattern is attributed to c) recent taxonomic revisions of the genus *Philautus* (Bossuyt & Dubois, 2001) d) considering Sri Lankan and Western Ghat *Philautus* as phylogenetically disjunct population (Bossuyt *et al*. 2004; Manamedra–Arachchi & Pethiyagoda, 2005) leading to more split in earlier combined *Philautus* group from the subcontinent (Chaitra *et al*. 2004); e) renewed interest in this genus as indicator species of diversity hotspots/fragmentation/decline, etc., leading to accidental new discoveries (Gururaja *et al*. 2007) and f) charismatic nature of these tiny frogs compelling researchers to look for them (Aravind *et al*. 2007). However, this spatio-temporal pattern necessitates further systematic research on the distribution and biogeography of this genus in particular and amphibians in general from the Western Ghats to acquire insights on distribution and diversity patterns.

TABLE 3. Type localities of 21 *Philautus* species from south India.

Species	Locality	Latitude (°N)	Longitude (°E)	Altitude (m)
P. beddomii	Athrimala	8.65	77.21	1219
P. bobingeri	Ponmudi hills	8.75	77.13	1030
P. graminirupes	Ponmudi hills	8.75	77.13	1020
P. ponmudi	Ponmudi hills	8.75	77.13	1000
P. travancoricus	Bodinayakanoor	10.02	77.35	350
P. griet	Munnar	10.08	77.05	1500
P. dubois	Kodaikanal	10.22	77.48	1900
P. chalazodes	Travancore	10.77	76.65	100
P. flaviventris	Palghat	10.77	76.65	180
P. signatus	Nilgiris	11.40	76.70	2240
P. tinniens	Nilgiris	11.40	76.70	2240
P. ochlandrae sp. nov.	Kakkayam	11.55	75.91	745
P. anili	Kalpatta	11.64	76.14	1000
P. nerostagona	Kalpatta	11.64	76.14	1000
P. wynaadensis	Sultan battery	11.67	76.28	1000
P. glandulosus	Mananthavadi	11.82	76.02	500
P. luteolus	Kodagu	12.40	75.70	920
P. tuberohumerus	Kudremukh	13.14	75.30	940
P. charius	Chickamagalure	13.34	75.77	692
P. neelanethrus	Aarodi	13.74	75.11	692
P. bombayensis	Castle rock	15.42	74.37	623

The issue of great concern is that many of the species will simply vanish even before they are formally detected and identified, as there is a tremendous pressure generated from ever increasing human population and human induced changes in the Western Ghats. This is evident in the present study as Kakkayam Reserve

Forest harbors some of the best remaining tropical wet evergreen forest (Nair, 1991), but due to dam construction and other related activities they are getting fragmented and reduced in area. *Philautus ochlandrae* sp. nov. being very restricted in these forest patches further highlights the need for conservation of this region.

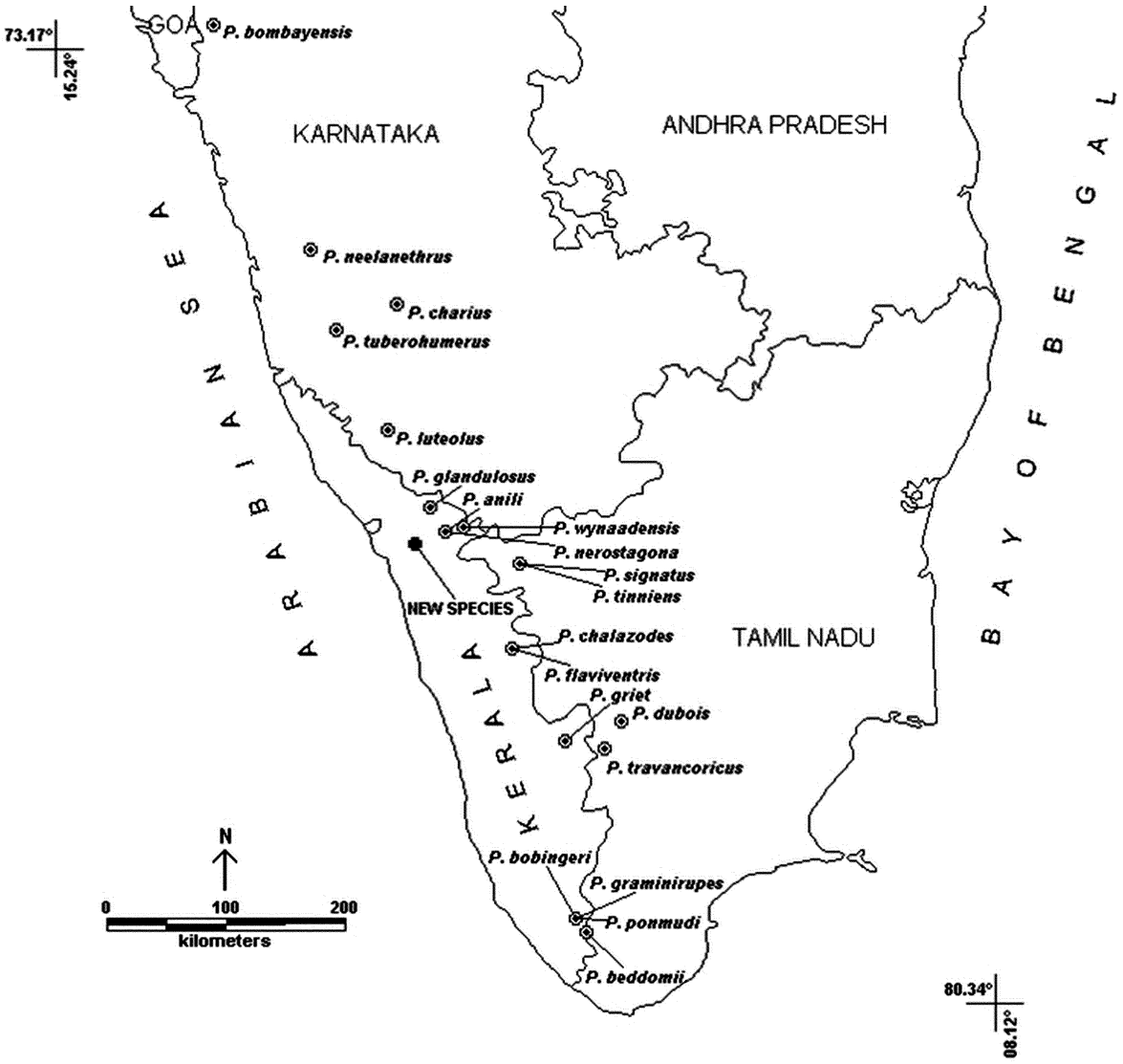

FIGURE 4. Map indicating the type localities of 21 *Philautus* species from southern India. There is spatial as well as temporal difference in discovery pattern of *Philautus* from this region.

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Appendix–I

List of congeners compared (22 species of *Philautus*) with the opposing suite of characters to *P. ochlandrae* sp.nov.

Species	Opposing suite of characters
P. anili Biju and Bossuyt	Snout pointed, longer than diameter of eye; canthus rostralis sharp; loreal region acutely concave; width of head and length of head equal; tongue without papilla; webbing in toes reduced; dorsum light brown with deep brown irregular patches; on dorsum a broad dark brown inverted 'V'; flanks and groin deep brown with light gray blotches; anterior and inner surface of thighs, and inner side of tibia with chocolate brown blotches; ventral side gray and dark brown vermiculation throughout.
P. beddomii (Günther)	Canthus rostralis sharp; tongue without papilla, tibiotarsal articulation reaches eye; dorsum green; thighs with a greenish stripe along upper surface (Chanda, 2002).
P. bobingeri Biju and Bossuyt	Snout shorter than diameter of eye; loreal region vertical; interorbital slightly convex; tongue without papilla; oval finger tips; two palmar tubercle; supernumerary tubercles prominent on all fingers and toes; nuptial spine on first finger in male; fourth toe webbing reach beyond the distal subarticular tubercle on outer side; dorsum uniform leaf green; anterior and posterior surfaces of thighs light red to dark flesh red; uniform granular on snout, between eyes, upper eyelids, side of head, back and flanks.
P. bombayensis (Annandale)	Tongue without papilla; reduced webbing on toes; inner metatarsal tubercle large; tibiotarsal articulation reaches eye; dorsum with small scattered pointed warts and tubercles; dorsum dark brown to gray speckled with black; lateral sides spotted with yellow; limbs cross barred; ventral surface greenish yellow suffused with black (Chanda, 2002; Daniels, 2005).
P. leucorhinus (Lichtenstein, Weinland and Von Martens)	Tongue without papilla, rudimentary webbing on fingers; toes half webbed; yellowish brown or olive dorsum; a dark stripe below the canthus rostralis and on the temporal region; large triangular white spot on the snout; dark line between eyes; a light vertebral line or stripe on back; throat dotted with brown (Gururaja *et al*. 2007).
P. chalazodes (Günther)	Supratympanic fold indistinct; subarticular tubercles distinct; tibiotarsal articulation reaches between eye and tip of snout; dorsum uniform bluish green; a few round white tubercles on flanks, hind part of back and metatarsus (Chanda, 2002).
P. charius Rao	Medium size (SVL: 29 mm); interorbital convex; tongue without papilla; supernumerary tubercles on all fingers and toes; between eyes small folds forming a more or less oval figure; anterior and posterior part of back with small horny spinules; head with a light brown triangle from tip of snout to between eyes; interocular dark brown cross–bar; dorsum with a dark cross mark; flanks, forelimb and groin gray; groin with large pale yellow spots; loreal region dark brown; tympanic region and tympanum grayish; upper and lower lip gray with some white spots; dorsal part of thigh, tibia and foot with darker bands; throat and margin of throat marbled with gray; chest, belly, ventral part of thighs and webbing whitish (Bossuyt & Dubois, 2001).
P. dubois Biju and Bossuyt	Small size (male, SVL: 19.2–20.2 mm); snout nearly pointed, longer than diameter of eye; loreal region acutely concave; interorbital concave; tympanum distinct; tongue without papilla; webbing in toes reduced; inner metatarsal tubercle oval; supernumerary tubercles prominent on all fingers and toes; femur coffee brown with variable–sized light brown and yellowish brown blotches; tympanic region, back, thigh and tibia granular; loreal and temporal region brownish black, iris golden brown with a greenish brown outer ring, dorsum light grayish brown, black and gray spots throughout; inverted 'V' on back.

P. flaviventris (Boulenger)	Medium size (SVL: 29.4 mm); slightly convex above; tympanum distinct; vomerine ridge present; fingers without dermal fringe; rudimentary webbing on fingers; supernumerary tubercles on fingers; dorsal parts of head and dorsum, and flanks brown with cream/yellow dots; loreal region, tympanic region and tympanum brown; upper lip cream/yellow; forelimb, dorsal part of thigh, tibia and foot, and posterior part of thigh brown with cream/yellow dots; throat and chest dark brown; margin of throat cream/yellow; belly and ventral part of thigh brown marbled with cream/yellow; webbing dark brown (Bossuyt & Dubois, 2001).
P. glandulosus (Jerdon)	Snout longer than diameter of eye; interorbital space convex; vomerine ridge present; tongue without papilla; rudimentary webbing on fingers, supernumerary tubercles on fingers II, III and IV; heels do not overlap when folded at right angles to body; throat smooth; dorsal parts of head and dorsum purple; flanks white; loreal region, tympanic region and tympanum white with some brown spots; toes webbed at the base (Bossuyt & Dubois, 2001).
P. graminirupes Biju and Bossuyt	Snout pointed and shorter than diameter of eye; canthus rostralis sharp; body robust; loreal region acutely concave; interorbital slightly convex; tongue without papilla; supernumerary tubercles on fingers; webbing on toes reduced; weakly developed supernumerary tubercles on all toes; between eyes a horny ridge from snout to middle of body; upper eyelids granular; dorsum grayish brown with various amounts of irregular black patches; a brownish–black band between the eyes; loreal and tympanic regions dark brown; inguinal region vermiculated with brown–yellow; iris silvery–brown with dark brown horizontal bands; forelimbs and hind limbs light grayish–brown with brownish–black cross–bands; fingers and toes with dark cross–bands; anterior surface of thighs vermiculated with brown–yellow, tinted with bluish–green; posterior surface of thighs light chocolate brown, vermiculated with bluish green; ventrally light gray with dark brown specks of variable size; feet and hands light gray with dark brownish–black margins.
P. griet Bossuyt	Small size (SVL: 21.3 mm); dorsum brown with large spines; tongue without papilla; supernumerary tubercles on both fingers and toes; webbing on toes rudimentary; webbing transparent with black spots; vocal sac and throat light gray; thighs cross barred.
P. luteolus Kuramoto and Joshy	Snout pointed, longer than diameter of eye; tongue without papilla; canthus rostralis distinct; webbing on toes reduced; dorsum finely granular, dorsum yellow to yellowish brown; hind limbs with faint cross bars; iris pale gold encircled with black; venter and vocal sac uniformly light yellow; dominant frequency of advertisement call 2.7 kHz.
P. neelanethrus Gururaja, Aravind, Sameer Ali, Ramachandra, Velavan, Krishnakumar, and Aggarwal	Medium size (SVL: 29.9 mm); snout pointed; canthus rostralis angular; tongue without papilla; blue ring on iris; heels do not overlap when folded at right angles to the body; tibiotarsal articulation reaches anterior border of eye; dorsum yellow with brown fine granulations; weak cross bars on forelimb and hind limbs; circular brown patches on head and nearer to vent; dominant frequency of advertisement call 2.4 kHz.
P. nerostagona Biju and Bossuyt	Medium size (SVL: 30.1–34.0 mm); canthus rostralis sharp; webbing on fingers present; toes fully webbed; distinct dermal fringe along the outside of hind limb and forelimb; supernumerary tubercles on all fingers and toes; glandular with short spinular projections on side of head and between eyes, on upper eyelids, and on dorsum and flanks; dorsal parts of fore and hind limbs with some scattered granules; dorsally light brown with tan and dark brown patches; laterally light brown; loreal and tympanic region gray with irregular white, tan and dark gray patches; dorsal surface of fore– and hind limbs light gray with light brown cross–bands; disks of fingers and toes gray; ventrally gray with various amounts of irregular patches and spots; tibia with light brown to black markings; calls resembling the sound of a drop falling into water at 3–4 sec interval; 41 eggs in a clutch.

P. ponmudi Biju and Bossuyt	Large size (SVL: 35.9–38.9 mm); body robust; snout longer than diameter of eye; canthus rostralis sharp; tympanum distinct; supernumerary tubercles on finger III; small dermal fringe along toe V; supernumerary tubercles on toes III–V; snout, between eyes and dorsum light gray yellow with a few scattered white blotches and minute black spots; a pair of brown concave stripes running from behind eye to vent, uniting at the middle in a light brown color and forming an 'X' on the back; a light brown inverted triangular marking between eyes, extending on the upper eyelid; upper eyelid dark gray; groin light gray with numerous dark brown spots; iris golden brownish, encircled by gray ring; lips with brown bands; forelimbs light brown, with darker spots; hind limbs light brown with dark gray cross–bands; posterior surface of thigh light chocolate brown; vermiculated with gray patches of variable size; ventrally light gray; throat gray with dark brown specks of variable size; ventral side of feet light gray; tibia light chocolate brown vermiculated with grayish green patches; nuptial spines present in male.
P. signatus (Boulenger)	Medium size (SVL: 31.5 mm); head slightly convex above; snout longer than diameter of eye; loreal region concave; tympanum distinct; vomerine ridge present; dermal fringe on inside of all fingers; supernumerary tubercles on all fingers; anterior and posterior part of back with very small horny spinules; upper part and lower part of flanks granular; dorsal parts of head and dorsum, and upper part of flanks brownish, with small dark brown spots; a darker band between eyes; a dark cross–mark on the back; loreal region brownish with a few white spots; tympanic region and tympanum brownish; upper lip brown, with some white spots; forelimb and dorsal part of thigh light brown with darker bands; dorsal part of tibia, foot, and posterior part of thigh light brown; throat, chest, belly, ventral part of thigh and webbing uniformly light brown; males with small spines on back (Bossuyt & Dubois, 2001).
P. tinniens (Jerdon)	Loreal region concave; interorbital space convex; webbing at the base of the fingers; webbing on toes reduced; supernumerary tubercles on all toes; dorsal parts of head and dorsum dark brown; flanks yellowish with dark brown spots; loreal region, tympanic region and tympanum dark brown; upper and lower lip brown; forelimb, dorsal part of thigh, tibia and foot brown; posterior part of thighs and groin with large blackish spot; two inner fingers and toes yellowish; throat, margin of throat, chest, belly, ventral part of thighs and webbing yellowish, with some small darker spots (Bossuyt & Dubois, 2001).
P. travancoricus (Boulenger)	Medium frog (SVL: 31 mm), canthus rostralis obtusely pointed; dorsum cream; larger black dots scattered on back and on tibia; a blackish streak on each side of anterior half of back; a narrow band of pigment along the upper surface of femur (Chanda, 2002).
P. tuberohumerus Kuramoto and Joshy	Small size (SVL: 17.4–18.2 mm); snout pointed; tongue without papilla; dorsum brown to dark brown with conspicuous yellow spots on anterior surface of thigh; a bony projection on undersurface of humerus bone; dorsum granular; a pair of wide ridges from the posterior corner of the eye, obliquely running toward the body axis; large yellow or reddish yellow markings near groin; throat mottled with dark brown; dominant frequency of advertisement call ~ 4 kHz.
P. variabilis (Günther)	Medium size (SVL: 37.2 mm); snout smaller than diameter of eye; vomerine ridge present; tongue without papilla; supernumerary tubercles on all fingers and toes; heels strongly overlap when folded at right angles to the body; dorsal parts of head and dorsum, upper part of flanks, loreal region, tympanic region and tympanum brown and purple marbled; lower part of flanks marbled brown and whitish; forelimb, dorsal part of thigh and dorsal part of tibia purple with brown stripes; dorsal part of foot and posterior part of thighs purple marbled with brown; webbing whitish (Bossuyt & Dubois, 2001).

P. wynaadensis (Jerdon)	Snout subelliptical and shorter than diameter of eye; head slightly convex above; tongue without papilla; supernumerary tubercles on all toes and finger III and IV; limbs barred; inter-orbital space convex; anterior and posterior part of back with small horny spinules; dorsal parts of head and dorsum and upper part of flanks reddish brown; loreal region and tympanic region darker brown than on back; upper 2/3 of tympanum dark brown; upper lip brownish; lower lip white and brown; forelimb brown with some darker bands; dorsal part of thigh and tibia with three darker bands; dorsal part of foot brown; posterior part of thigh orange–brown; margin of throat and webbing whitish, speckled with brown; nuptial spines and small spines on the back in male (Bossuyt & Dubois, 2001).