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A new species of *Hyla* (Anura: Hylidae) from Cerro Las Flores, Oaxaca, Mexico

JESSE M. MEIK[1,3], LUIS CANSECO-MÁRQUEZ[2], ERIC N. SMITH[1] & JONATHAN A. CAMPBELL[1]

[1]*Department of Biology, The University of Texas at Arlington, Arlington, TX 76019, USA*
[2]*Museo de Zoología, Facultad de Ciencias, Universidad Nacional Autónoma de México, A.P. 70-399, c.p. 04510, México, DF, México*
[3] *e-mail, jmeik@uta.edu*

Abstract

Hyla ephemera, new species, is described from the cloud forests of Cerro Las Flores in south-central Oaxaca, Mexico. We tentatively place this species in the phenetic *H. bistincta* group. It is most similar to *H. calthula* in color pattern but differs in having a greater snout–vent length, a relatively shorter snout and tibia, a relatively wider head, and a larger tympanum. We also report an additional locality record for *H. calthula*, previously known only from the type locality.

Key words: Anura; *Hyla calthula*; *Hyla ephemera*, new species; Hylidae; Mexico; Oaxaca

Resumen

Se describe a *Hyla ephemera*, nueva especie, habitante del bosque mesofilo de montaña de Cerro Las Flores, en el centro-sur de Oaxaca, México. Tentativamente asignamos esta especie al grupo fenético de *H. bistincta*. Es mas similar a *H. calthula* en el patrón de coloración, pero difiere en tener una mayor longitud hocico-cloaca, hocico y tibia relativamente más cortos, la cabeza más ancha, y un tímpano más grande. Además registramos una localidad adicional para *Hyla calthula*, previamente conocida solo de la localidad tipo.

Introduction

In recent years, the rugged and diverse highlands of Oaxaca have continued to yield new species of hylid frogs (Campbell and Duellman 2000; Canseco-Márquez et al. 2002; Men-

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delson and Campbell 1994, 1999; Mendelson and Toal 1996; Toal 1994; Toal and Mendelson 1995; Ustach et al. 2000). Many of these species appear to be highly restricted in distribution, and some are known only from the type localities. During recent surveys of the Oaxacan herpetofauna, we acquired from an isolated patch of cloud forest an adult male specimen of a large hylid frog, superficially resembling *Hyla calthula* Ustach, Mendelson, McDiarmid & Campbell. Similar to *H. calthula*, this specimen appears to be associated with the phenetic *H. bistincta* species group. In addition, we collected a series of tadpoles at this same locality, and at nearby localities, that we tentatively associate with this species. The new material originates from Cerro Las Flores, a semi-isolated uplift that comprises part of the fragmented cordillera known as the Sierra Mixe, and is situated approximately 90 km (airline distance) southeast of Totontepec, the only previously reported locality for *H. calthula* (but see remarks). Members of the *H. bistincta* group have not been previously collected from Cerro Las Flores—thus the locality of origin for this specimen, together with its distinctive phenotype, has prompted us to evaluate its taxonomic status. Upon examination of comparative material, we have determined that this newly discovered specimen represents an undescribed species.

Materials and Methods

All measurements and terminology follow Duellman (1970); measurements (in millimeters) were rounded to the nearest 0.1 mm. Measurements greater than 10 mm were made using a digital caliper, those less than 10 mm were made using a stereo microscope with an ocular micrometer. Sex of specimens was determined by presence or absence of nuptial excresencences or by direct observation of gonads. Webbing formulae follow Myers and Duellman (1982). Format of the description for both the adult and tadpoles follows that of Ustach et al. (2000). Snout–vent length is abbreviated SVL throughout. Color pattern in life was obtained from color transparencies maintained in the UTA slide collection. Morphometric comparisons between the species described herein and adult male specimens referable to *Hyla calthula* (n = 16) were made using principal component analysis (PCA) applied to the correlation matrix obtained from $\log_{10}$-transformed measurements. Measurements used in PCA were as follows: SVL, tibia length (TL), foot length (FL), head length (HL), head width (HW), tympanum diameter (TYP), eye diameter (EYE), snout length (STL), and internarial (IN) distance.

Species Account

The results of PCA demonstrate that the sample of *Hyla calthula* forms a relatively cohesive group in multivariate space, and that this group is well separated from the specimen collected at Cerro Las Flores (Fig. 1). This separation is most evident along the second PC

axis. Examination of factor loadings indicates that in addition to its larger size, the specimen from Cerro Las Flores is morphologically differentiated from *H. calthula* in having a shorter snout and tibia, a relatively wider head, a larger tympanum, and a greater internarial distance (Table 1). We also noted aspects of color pattern and tympanum condition in the new specimen that differed consistently from those observed in *H. calthula*. Although to our knowledge only one adult specimen has been obtained from the population from Cerro Las Flores, we consider that at this time it is appropriate to describe it as a new species. An accurate assessment of the biological diversity of the Sierra Mixe requires expedient taxonomic work, as large expanses of forest have been, and continue to be, cleared from this region. Furthermore, many of the tadpoles collected from Cerro Las Flores possess deformed and/or missing mouthparts, which may be indicative of chytridiomycosis (see Berger et al., 1998). If this population is indeed infected with chytrid fungus, its continued persistence is doubtful.

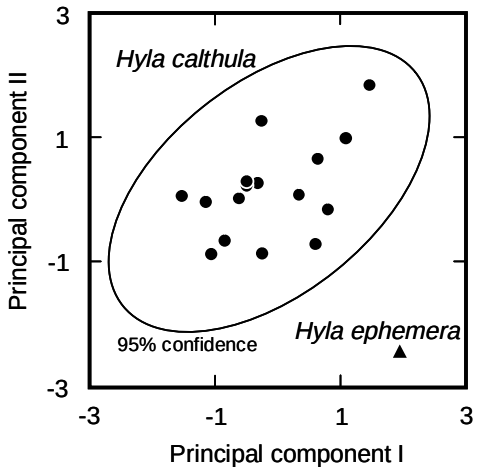

FIGURE 1. Scatterplot of factor scores from first two principal component axes for adult male specimens of *H. calthula* (circles) and the holotype of *H. ephemera* (triangle).

TABLE 1. Factor loadings, eigenvalues, and percentage of variation explained for the first two principal components based on $\log_{10}$-transformed measurements from adult male specimens of *Hyla calthula* and the new specimen from Cerro Las Flores (*H. ephemera*, new species).

Variable	PC 1	PC 2
SVL	0.874	-0.269
TL	0.722	0.589
FL	0.876	0.275
HL	0.940	0.043
HW	0.896	-0.320
TYP	0.800	-0.383
EYE	0.604	0.183
STL	0.579	0.668
IN	0.759	-0.494
Eigenvalues	5.653	1.469
% of variance explained	62.816	16.317

***Hyla ephemera*, new species**
(Figs. 2–4)

Holotype: MZFC 17049 (original field no. JAC 22944), an adult male obtained between Santa Maria Guienagati and Lachidola, 1100 m, (16.759° N 95.461° W), north slope of Cerro Las Flores, Oaxaca, Mexico; obtained by E. N. Smith and L. Canseco-Márquez on 7 April 2003.

Referred specimens: All tadpoles from Oaxaca, Mexico: road between Santa Maria Guinagati and Lachidola, 1156 m [16.759° N 95.461 W] (MZFC 17382; UTA A-56739, 56741–42, 56745); road between Santa Maria Guinagati and Lachidola [16.751° N 95.460° W] (MZFC 17384; UTA A-56744); road between Santa Maria Guinagati and Lachidola, 1095 m [16.749° N 95.457 W] (MZFC 17386; UTA A-56743); road between Santa Maria Guinagati and Santiago Lachiguiri, 1220 m [16.756 N 95.500 W] (MZFC 17383, 17385; UTA A-56738, 56740, 56746).

Diagnosis: A large, robust treefrog tentatively referred to the *Hyla bistincta* group (sensu Duellman, 1970; see also Toal and Mendelson, 1995). *Hyla ephemera* is most similar to the large yellowish tan to pale brown frogs of this group, particularly *H. pentheter* Adler and *H. calthula*. All three species can be distinguished from the similar *H. bistincta* Cope by the absence of vocal slits in males and by having long, slender fingers (fingers relatively short in *H. bistincta*). *Hyla ephemera* has a SVL of 59.2 mm, which exceeds the maximum size reported for males of *H. pentheter* (51.1 mm), *H. calthula* (56.0 mm), and *H. bistincta* (53.8 mm). *Hyla ephemera* differs from *H. pentheter* by having more webbing on the feet (**I**1–2**II**1–1½**III**1–2**IV**1½–1**V** in *H. ephemera* versus **I**2–2½**II**2–3**III**2–3**IV**3–2**V** in *H. pentheter*), by having uniform black markings with distinct borders on flanks and posterior surface of thighs (versus markings on flanks and posterior surface of thighs with yellow spots; also, in *H. pentheter* flank markings are bordered dorsally by a thin pale yellow line, and ventrally fade into yellow coloration), and by having the snout rounded in dorsal view rather than truncate.

In addition to its larger size, *Hyla ephemera* may be distinguished from *H. calthula* in aspects of form. The results of PCA demonstrated considerable morphometric differences between the specimen of *H. ephemera* and a series of adult male *H. calthula* (Fig. 1; Table 1). Values for *H. ephemera* exceeded the range of variation observed in adult male *H. calthula* (n = 16) for five out of eight standard measurement ratios: TL/SVL, 0.48 in *H. ephemera* versus 0.51–0.60 in *H. calthula*; FL/SVL, 0.44 in *H. ephemera* versus 0.45–0.50 in *H. calthula*; TYP/EYE, 0.51 in *H. ephemera* versus 0.32–0.44 in *H. calthula*; STL/HL, 0.24 in *H. ephemera* versus 0.25–0.31 in *H. calthula*; IN/STL, 0.89 in *H. ephemera* versus 0.65–0.84 in *H. calthula*. The lateral black markings are reduced in *H. ephemera* when compared to most of the known specimens of *H. calthula*. In *H. ephemera*, the tympanum is relatively large, round, and bordered by a uniformly distinct annulus, whereas in *H. calthula* the tympanum is small, black, and ovoid, with an annulus that is distinct on the anterior margin of the tympanum. There is, however, considerable variation in the condi-

tion of the tympanum and of the black lateral coloration in *H. calthula*, so an evaluation of the utility of these characters in distinguishing between the two species must await the collection of additional specimens of *H. ephemera*.

FIGURE 2. *Hyla ephemera* new species, holotype (MZFC 17049), in life.

FIGURE 3. *Hyla ephemera* tadpoles in life (A, UTA A-56745, Gosner stage 36; B, UTA A-56741, Gosner stage 31).

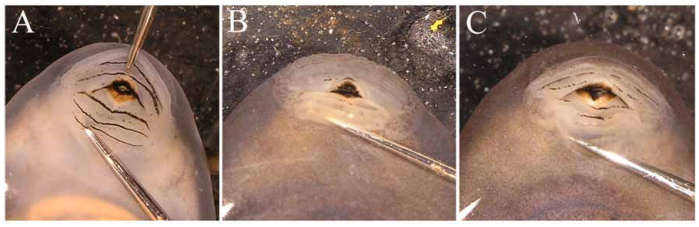

FIGURE 4. Preserved tadpoles of *Hyla ephemera* demonstrating complete (A, UTA A-56745) and missing (B, UTA A-56746; C, UTA A-56738) mouthparts.

Description of holotype: Adult male (Fig. 2), measurements (in mm): SVL 59.2; tibia length 28.7; foot length, 25.9; head length, 18.8; head width, 23.4; snout length 4.5; diameter of tympanum, 3.0; diameter of eye, 5.9; distance between medial borders of external nares, 4.0; distance between eye and tympanum, 3.3; body robust; head wider than long and also wider than body; head length 31.8% SVL; head width 39.5% SVL; snout abrupt, truncate in profile, bluntly rounded in dorsal view, without rostral keel; canthus rostralis distinct, rounded; loreal region slightly concave; lips not flared; nostrils ovoid, barely protuberant, directed posterodorsally; internarial region concave. Top of head flat; diameter of eye 25.2% head width. Supratympanic fold heavy, extending posteriorly from the edge of the orbit, obscuring upper edge of tympanum, becoming indistinct immediately above the insertion of the forelimb; tympanum distinct, round, slightly elevated above the surrounding skin; tympanic annulus uniformly distinct; diameter of tympanum 50.8% diameter of eye; diameter of tympanum 90.9% eye–tympanum distance.

Axillary membrane absent; thoracic fold and dermal fold on wrist absent; forearm robust; fingers long, slender, with moderate lateral fringe, bearing large discs; relative lengths of fingers: I < II < IV < III; relative widths of discs on fingers: I < IV < II < III; disc on Finger II as wide as tympanum; width of disc on Finger I approximately 65% diameter of tympanum; subarticular tubercles large, rounded, elevated, none bifid; supernumerary tubercles numerous, most on proximal half of digits, small, diameter about one third to two thirds that of subarticular tubercles, conical; prepollical tubercle large, distinct, elongately elliptical; palmar tubercle large, weakly defined; nuptial excrescences finely spinulate, brown, covering dorsal and medial surfaces of prepollex and medial surface of Finger II; ulnar tubercles absent; webbing on hands vestigial. Heels of adpressd hindlimbs barely overlap, tibiotarsal articulation extending to eye; tarsal fold distinct, extending entire length of tarsus on right leg and distal half of tarsus on left leg; tibia length 48.5% SVL; foot length 43.8% SVL; inner metatarsal tubercle distinct, large, ovoid; outer metatarsal tubercle small, low, weakly defined; subarticular tubercles distinct, large, rounded, elevated; supernumerary tubercles many, very small, round, some distinct and elevated, others diffuse and low; toes long, slender, with broad lateral fringe, bearing large terminal discs; relative lengths of toes: I < II < V < III < IV; relative widths of discs on toes: I < II < IV = V < III; webbing formula: **I**1–2**II**1–1½**III**1–2**IV**1½–1**V**.

Cloacal opening directed posteroventrally at midlevel of thigh; cloacal sheath long. Skin on all dorsal surfaces thick, glandular; skin on venter smooth to coarsely granular; skin on ventral surfaces of limbs smooth, coarsely granular on posterior surface of thigh; tongue large, round, barely free posteriorly; vocal slits absent; vomerine dentigerous processes with eight teeth on left side, eight on right side, dentigerous processes transverse, situated at midlevel of choanae, narrowly separated medially; choanae ovoid, widely separated.

Coloration of holotype: In preservative (ethanol after formalin), all dorsal surfaces brownish olive, becoming paler on lateral surfaces; all dorsal surfaces with numerous

minute white specks; few small, black markings on dorsum and flanks; distinct black stripe extending from anterior margin of upper lip, through narial and canthal regions to orbit, from posterior margin of orbit stripe follows supratympanic fold, continuing posteroventrally onto flank, terminating near insertion of hind limb on left side, at approximately midpoint along flank on right side; lateral and medial surface of forelimb and thigh with diffuse black markings, lateral and medial surface of shank and tarsus with distinct black stripe, transverse bars on limbs absent; faint, incomplete suborbital bar extending from margin of orbit to margin of upper lip. Ventral surfaces of body, forelimbs, hind limbs cream to sulphur yellow; ventral surfaces of hands, feet, and tarsus, dull gray; posteroventral surface of thigh with scattered gray spots.

Coloration in life: Dorsal and lateral surfaces of body, head, and limbs yellowish tan, becoming pale lemon-yellow in axillary and inguinal regions, and on throat; suborbital bar appears as a small black triangle immediately below orbit and as slight dark coloration on upper lip; black lateral markings distinct throughout body and limbs except on thigh and posterior portions of flank, which appear smeared; venter cream; iris bronze with black reticulations.

Distribution and Habitat: During 2003, the northern slopes of Cerro Las Flores were covered by a mosaic of cloud forest fragments and larger expanses of pine-oak forests. *Hyla ephemera* has only been collected from cloud forests on these slopes between elevations of 1100 and 1220 m. The only adult specimen was obtained approximately 2.5 km east of the town of Lachidola. It was found clinging to a palm frond about 1.8 m above a small stream at 2100 hrs. This streambed coursed through numerous large, jumbled boulders at the bottom of a deep ravine. At the time of our visit, the stream had very little water flow and many small plunge pools were present along the streambed. Tadpoles that we refer to *H. ephemera* were taken from these pools, from two other streams between 2.0–2.5 km east of Lachidola, and from an additional stream located approximately 2.5 km west of Lachidola. Other amphibians collected by us in the immediate vicinity of Lachidola include *Anotheca spinosa* Steindachner, *Ptychohyla zophodes* Campbell & Duellman, and *Eleutherodactylus pygmaeus* Taylor.

Tadpole: The following description is based on two tadpoles (UTA A-56745 and UTA A-56741) of a series collected from small pools in a stream at the type locality. We identified these tadpoles as belonging to the *H. bistincta* group on the basis of salient morphological features (continuous row of fringing papillae on the upper lip as well as submarginal papillae medial to the continuous row [Duellman and Campbell, 1992]), and tentatively assign them to *H. ephemera* as no other hylids of the *H. bistincta* group were collected from Cerro Las Flores. UTA A-56745 (Fig. 3A) was preserved in developmental stage 36 (Gosner, 1960), UTA A-56741 (Fig. 3B) was preserved in developmental stage 31.

Measurements (mm): total length 57.40–53.98; body length 18.47–17.23; tail length 39.03–36.75; interorbital distance 4.58–4.14; internarial distance 5.13–4.23; oral disc

diameter 5.94–5.56. Body ovoid in dorsal view; in lateral view higher posteriorly than anteriorly; snout rounded in dorsal and lateral view; eyes directed dorsolaterally; interorbital distance slightly less than internarial distance; nostrils small, ovoid; directed laterally. Spiracle sinistral; short, opening near midbody. Vent tube dextral. Caudal musculature robust, highest at junction with body, rounded at tip (pointed in UTA A-56741); dorsal fin slightly higher than ventral fin. Oral disc large, not emarginate, with a single row of conical marginal papillae above A_1 and two rows below P_3; a row of large rounded submarginal papillae above A_1 and below P_3. Numerous papillae present laterally. Labial tooth formula 2(2)/3, tooth row in A_1 slightly larger than A_2; A_2 gap present, narrow. Lower jaw wider than upper jaw; lateral processes taper abruptly posterolaterally, lower jaw shallowly V-shaped, more serrate than upper jaw.

In preservative, dorsal coloration dark brown; venter transparent, gut visible; caudal musculature cream with large brown blotches, small brown blotches on dorsal fin, three widely-spaced small blotches on ventral fin (small, faint spots near posterior end of ventral fin in UTA A-56741), brown dorsolateral stripe extending along caudal musculature over half the length of the tail (small, faint spots on caudal musculature and dorsal fin in UTA A-56741); caudal fins translucent.

Minor variation was observed in eleven additional tadpoles from stages 26—34: six specimens were missing all, or most, of the keratinized mouthparts (Fig. 4); two had bodies notably darker than remaining specimens; and the amount of blotching on the tail varied from few sparse, faint spots, to copious blotches of various sizes and pigment intensity. One tadpole (UTA A-56746) had two rows of marginal papillae above A_1, as opposed to one row in the remaining specimens. On comparing the tadpoles of *H. ephemera* with those of *H. calthula*, we noted that the presence and development of submarginal papillae on the anterior labium was variable in both species, and may be attributable to ontogenetic variation (for more detail on the ontogeny of *H. calthula* tadpoles see Ustach et al., 2000).

Etymology: The specific epithet is derived from the Greek *ephemeros*, meaning short-lived, and refers to the ominous observation that chytridiomycosis may be present in the only known population of this unique species.

Remarks: *Hyla calthula*, the likely sister species of *H. ephemera*, has previously been reported only from cloud forest in the immediate vicinity of Totontopec, Oaxaca. Ustach et al. (2000) commented that cloud forests were virtually gone from this area, and that the species probably no longer persists there. On 21 September, 2001, we secured a series of tadpoles and a metamorph frog that we identified as *H. calthula*, west of Zacatepec (17.190° N 95.987° W), at an elevation of 1360 m (MZFC 17381; UTA A-56736–37). Unlike the tadpoles collected from Cerro Los Flores, all of the tadpoles from near Zacatepec appeared to possess complete mouthparts. Although this collection represents an additional locality for *H. calthula* (Fig. 5), we noted that forests were highly fragmented in this region and we suspect that these patches will soon be gone, as they now are from the vicinity of Totontopec.

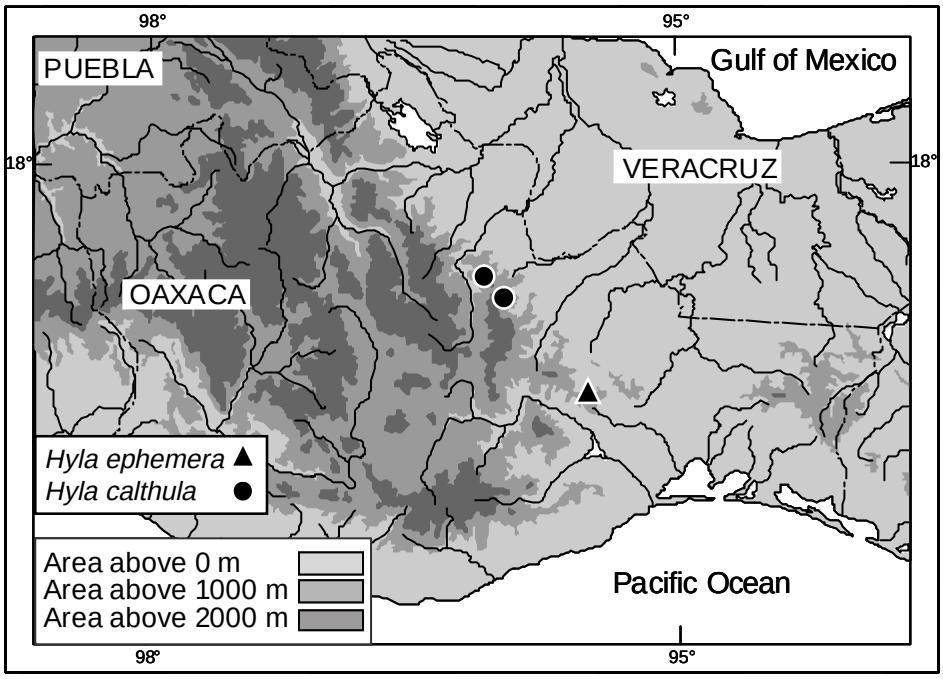

FIGURE 5. Map of Oaxaca and parts of surrounding states depicting the type locality of *Hyla ephemera* and the two known localities for *H. calthula*.

In general, the Sierra Mixe has suffered from greater habitat destruction than have the majority of other mountain ranges in central Oaxaca; however, many forested areas of the southeastern Sierra Mixe (including the type locality of *H. ephemera*) appeared to be relatively intact at the time of our visit. Owing to the more limited spatial extent of highlands in the southeastern Sierra Mixe, montane habitats such as cloud forests may naturally occur in disjunct fragments, predisposing populations that are dependent on these habitats to impacts of disturbance. Perhaps a more immediate threat to *H. ephemera* could be infection by chytrid fungus, which was indicated by the observation that nearly half of the tadpoles we examined were missing mouthparts. It is possible that the only known population of *H. ephemera* may already be extinct.

Duellman (2001) provided a hypothesis of relationships for species of the *H. bistincta* group based on morphology, and suggested that available data support the group's monophyly. Canseco-Márquez et al. (2002) considered this hypothesis preliminary and emphasized that relationships among species remain tenuous until additional data are obtained, and that the monophyly of the group has yet to be rigorously tested. Although Cerro Las Flores now represents the southeastern-most locality reported for members of the *H. bistincta* group, some of the smaller, isolated mountain ranges immediately west of the Isthmus of Tehuantepec remain poorly inventoried herpetologically, and it is possible that other species await description.

Comparative Material

Hyla bistincta: Mexico: Oaxaca: El Tejocote (UTA A-17133); 5.6 km WSW Tlaxiaco (UTA A-3652); 38.1 km E Teotitlan on road to Huautla, 2118 m (UTA A-13148).

Hyla calthula: Mexico: Oaxaca: Sierra Mixe, Totontepec, head waters of Rio de la Luna, 6000 ft. [1829 m] (UTA A-5788, 5876–86, 8508–9); Sierra Mixe, Totontepec, 6220 ft [1896 m] (UTA A-6929–32); Sierra Mixe, Totontepec, 1798 m (UTA A-13369); Sierra Mixe, E side Totontepec, 1780 m (UTA A-13370–71).

Hyla pentheter: 25.3 km N San Gabriel Mixtepec (UTA A-17165).

Acknowledgments

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