Herpetological Review, 2004, 35(2), 128–130.

First Description of a Clutch and Nest Site for the Genus *Caecilia* (Gymnophiona: Caeciliidae)

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Caecilians are tropical, limbless, primarily fossorial amphibians (Duellman and Trueb 1986). Although they may be fairly abundant in certain areas (Péfaur et al. 1987), their subterranean habits make them difficult to find and as a result, life histories are unknown for most of the 167 described species (for examples of studies that have documented caecilian life histories, see Gans 1961; Parker 1936, 1958; Sanderson 1937; Sarasin and Sarasin 1887–90; Taylor 1968; Wake 1980). Information on caecilian life histories is important not only for improving understanding of amphibian life history evolution, but also for developing management strategies for conservation. For example, life history data can be used to conduct ecological sensitivity analyses to infer which human activities are most likely to negatively impact caecilian populations (Biek et al. 2002).

Even such general information as reproductive mode remains unknown for many caecilian species (Wake 1992). Caecilians have a variety of reproductive modes including oviparity with aquatic larvae, oviparity with direct development, and viviparity (Wake 1977, 1992; Wilkinson and Nussbaum 1998). A large percentage of caecilians are viviparous, although the exact percentage of viviparous species remains controversial because of differences in opinion on which criteria are acceptable for inferring reproductive mode (Wake 1977; Wilkinson and Nussbaum 1998).

The family Caeciliidae, the largest family of caecilians, contains both oviparous and viviparous species (Gans 1961; Peters 1874, 1875; Sanderson 1937; Wake 1977, 1992; Wilkinson and Nussbaum 1998). However, reproductive mode has not been reported for any of the 33 described species in the genus *Caecilia*, the most speciose genus in the family Caeciliidae and one of the two largest genera in the entire order (AmphibiaWeb 2003). To date, evidence suggests that *Caecilia* species are oviparous or that some are oviparous and others are viviparous (Taylor 1968; Tschudi 1839; Wake 1977). Wilkinson and Nussbaum (1998) reported observing an unspecified *Caecilia* species lay eggs in captivity. Observations of large ova and larvae with gill slits have also been used to infer that some *Caecilia* species are oviparous (Tschudi 1839; Wake 1977, 1992). The presence of fetal teeth in other *Caecilia* species suggest that these species may be viviparous (Taylor 1968). However, the only conclusive evidence for reproductive mode is documentation of parturition, laid eggs, aquatic larvae, or oviductal fetuses for specific species.

In January 2001, we began an inventory of the amphibians of Yanayacu Biological Station, Ecuador, located at approximately 2100 m on the east side of the Cordillera Oriental of the Andes in Provincia Napo at 00°35'S 77°53'W. Yanayacu is surrounded by cloud forest with a 20–25 m high canopy as well as some pasture. On 16 January 2001, we found a clutch of *Caecilia orientalis* (Taylor 1968) eggs (Fig. 1), an adult female, two adult males, and one

FIG. 1. Clutch of *Caecilia orientalis* eggs found at Yanayacu Biological Station near Cosanga, Provincia Napo, Ecuador (2100 m elev.).

TABLE 1. Body measurements and primary and secondary annular counts of adult *Caecilia orientalis* and number and length of ovarian ova found in dissected females. One female (QCAZ 21417) and the two males (QCAZ 21418–21419) were found with the clutch of eggs reported in this article at Yanayacu Biological Station near Cosanga, Provincia Napo, Ecuador (2100 m). Baeza is also located in Provincia Napo at an elevation of 1990 m.

				Body measurements (mm)				Ova	
QCAZ	Sampling location	Month collected	Sex	Total length	Head length	Width at mid-body	Annuli (prim / sec)	Number	Length (mm)
2311	Baeza	August	F	400	10.7	10.5	116 / 139	120	< 1.5
6987	Cosanga	November	F	363	9.9	9.4	118 / 96	30	1.5–2.5
								110	< 1.5
6988	Cosanga	November	F	310	9.3	8.9	114 / 98	22	1.5–2.5
								115	< 1.5
21417	Yanayacu	January	F	625	13.5	15.2	122 / 208	7	3.5–5.7
								110	< 1.5
21418	Yanayacu	January	M	406	10.0	11.8	114 / 119	NA	NA
21419	Yanayacu	January	M	427	10.0	12.0	112 / 123	NA	NA

other individual that escaped capture underneath a large, highly decomposed log in pasture bordered by secondary cloud forest (Fig. 2). The clutch was almost certainly a *C. orientalis* clutch because no other caecilians have been documented at the site after two years of inventory work. All three captured adults were preserved as vouchers and stored at the Museo de Zoología of the Pontificia Universidad Católica del Ecuador in Quito, Ecuador (QCAZ; Table 1). The female (QCAZ 21417) was much larger than the two males (QCAZ 21418–21419) and the individual that escaped appeared to be a male based on its small size. The nest site was very wet and was several meters from a small 1 m wide creek. The female was found approximately 5 cm from the clutch and one of the males was approximately 5 cm from the female. The second male and the individual that escaped were found approximately 30 cm and 150 cm, respectively, from the other two adults.

The *C. orientalis* clutch had a total of seven eggs (Fig. 1). The eggs were connected to each other by cords attached to both ends of each egg. The eggs were transparent so that embryos could be seen inside. Embryos had distinct dark eyes, feathery external gills, and creamy yellow yolk sacs and moved when the eggs were touched. The lengths and diameters of three of the eggs were measured. The lengths of these eggs were 10.6 mm, 10.3 mm, and 10.2 mm (mean ± SE = 10.4 ± 0.1 mm) and the diameters in the same order were 8.8 mm, 8.3 mm, and 8.1 mm (mean ± SE = 8.4 ± 0.2 mm). Two of the seven eggs were preserved as vouchers on January 21, 2001 (QCAZ 21420). The remaining five eggs were given to Oscar Pérez and Eugenia M. del Pino in the Departamento de Ciencias Biológicas at the Pontificia Universidad Católica del Ecuador for study of the development of the embryos.

The observation of a clutch of *C. orientalis* eggs clearly demonstrates that this species is oviparous. Wilkinson and Nussbaum (1998) also report egg laying in a *Caecilia* species in captivity, but they do not specify which species was observed. Nonetheless, their observation and ours suggest that oviparity may be the predominant reproductive mode in the genus. Wake (1992) hypothesized that *C. pressula* and *C. subnigricans* are viviparous based on observation of fetal teeth. However, it has been suggested that fetal teeth are not a reliable character for inferring reproductive mode because some *Siphonops* possess what have been called fetal teeth, yet are known to be oviparous (Wilkinson and Nussbaum 1998).

The observation that the clutch was found several meters from a small stream also suggests that *C. orientalis* has direct develop-

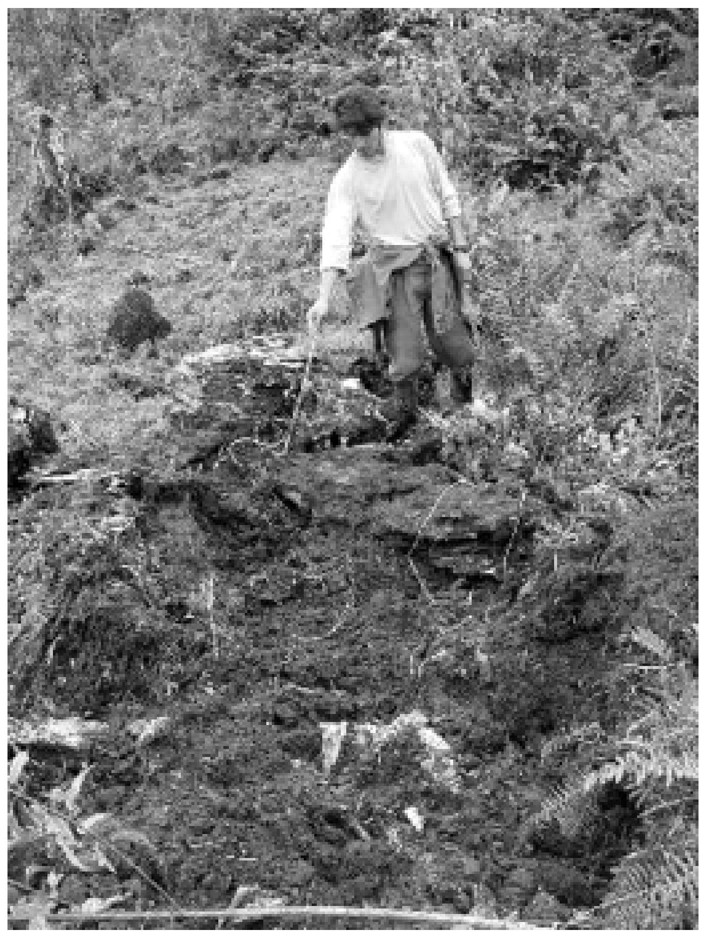

FIG. 2. Site where *Caecilia orientalis* clutch, adult female, two adult males, and one other individual were found underneath a large, highly decomposed log at Yanayacu Biological Station.

ment with no aquatic larval stage. If *C. orientalis* had an aquatic larval stage, it seems more likely that the female would have laid the clutch directly adjacent to the stream to provide easy access to the water for recently hatched larvae as is the case in *Ichthyophis glutinosus* (Sarasin and Sarasin 1887–90).

Our observation of a female *C. orientalis* by the clutch suggests that she was attending her eggs as has been documented for other oviparous species of caecilians (Breckenridge and Jayasinghe 1979; Sanderson 1937; Sarasin and Sarasin 1887–90). However, we are unaware of any previous reports of male caecilians at nest sites. One possible explanation for why males were found at the nest site is that they were simply sharing a preferred microhabitat with the female. Another possibility is that the males were attempting to mate with the female. Finally, the male found closest to the female and closest to the eggs may have been the father of the eggs and may have also been attending them. This would be the first known case of biparental care in caecilians.

We also dissected the female *C. orientalis* found with the clutch and three additional females previously collected as vouchers from Provincia Napo, Ecuador, to count and measure ovarian ova (Table 1). All four females had large numbers of ova (mean ± SE = 129 ± 6 ova). Most ova were small (< 1.5 mm), although the female found with the clutch (QCAZ 21417) contained seven ova ranging from 3.5–5.7 mm long and two of the other females (QCAZ 6987–6988) had 30 and 22 medium-sized ova, respectively, ranging from 1.5–2.5 mm long. The different sizes of ova likely represent different stages of development as documented in *Gymnopis multiplicata* (Wake 1968) and *Dermophis mexicanus* (Wake 1980).

The temporal sequence of ova maturation in the dissected females suggests that reproduction is seasonal in *C. orientalis* (Table 1). The observation of female QCAZ 21417 with a laid clutch of eggs on January 16 shows that ovulation starts by January, the beginning of the rainy season at Yanayacu Biological Station (Harold Greeney, owner and Station Manager of Yanayacu, pers. comm.). The female found in August had only very small ova, suggesting reproductive quiescence during this dry period of the year. The two females found in November have medium-sized ova indicating that by this point, vitellogenesis is occurring. This seasonal reproductive pattern matches that reported for *Dermophis mexicanus* in which birth occurs at the beginning of the rainy season (Wake 1980).

The observation that female QCAZ 21417 had mature ovarian ova at the same time she was guarding the reported clutch also suggests that *C. orientalis* is able to produce two clutches per rainy season. This conclusion is supported by the observation that *C. orientalis* females found after the rainy season (QCAZ 2311, 6987–6988) do not have mature ova. Thus, female QCAZ 21417 likely would have laid her mature ovarian ova later during the same rainy season in which she was caught. This frequency of parturition is four times greater than that observed in *Dermophis mexicanus* which only gives birth once every other year (Wake 1980). The slower rate of parturition in *D. mexicanus* is likely due to the long gestation period observed in this viviparous species (Wake 1980).

Acknowledgments.—We thank Luis A. Coloma, P. Stephen Corn, Bryce Maxell, Andrew Sheldon, and Marvalee H. Wake for reviewing drafts of this paper. Specimens from sites other than Yanayacu were collected by Giovanni Onore (QCAZ 2311), Felipe Campos, and Marisol Ayala (QCAZ 6987–6988). Funding for this project was provided by a Conservation, Food & Health Foundation grant awarded to the Population Biology Foundation and a National Science Foundation Graduate Research Traineeship awarded to WCF (DGE 9553611). We would also like to thank Harold Greeney for providing accommodations at Yanayacu Biological Station. Research permits for this project were obtained from the Ministerio del Ambiente (number 029-IC-FAU-DFP). This project was approved by the University of Montana Institutional Animal Care and Use Committee (number ACC 034-00). This is publication number 71 of the Yanayacu Natural History Research Group.

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