A new cryptic species of lizard (Sauria: Teiidae: *Gymnophthalmus*) from Venezuela

M.S. Hoogmoed, C.J. Cole & J. Ayarzaguena

Hoogmoed, M.S., C.J. Cole & J. Ayarzaguena. A new cryptic species of lizard (Sauria: Teiidae: *Gymnophthalmus*) from Venezuela.

Zool. Med. Leiden 66 (1), 31.vii. 1992: 1-18, figs. 1-7, tables 1-2.— ISSN 0024-0672.

Key words: *Gymnophthalmus*; Teiidae; biogeography; Guianan Region; Venezuela.

Gymnophthalmus cryptus spec. nov. is described and illustrated on the basis of males and females collected in the Territorio Federal Amazonas, southern Venezuela. Some details on ecology and distribution are also presented. The females of *G. cryptus* are very similar to the unisexual *Gymnophthalmus underwoodi*, which also occurs in the Guianan Region. In fact, *G. cryptus* is one of the best candidates for future genetic research to determine whether it is the missing ancestor of *G. underwoodi*, a parthenogenetic species of hybrid origin (*G. speciosus* × *G.* spec.?). Two other series of previously unreported species of *Gymnophthalmus* from Venezuela are also discussed.

Marinus S. Hoogmoed, Department of Vertebrates, Nationaal Natuurhistorisch Museum, Postbus 9517, 2300 RA Leiden, The Netherlands.

Charles J. Cole, Department of Herpetology and Ichthyology, American Museum of Natural History, Central Park West at 79th Street, New York, New York 10024-5192, U.S.A.

José Ayarzaguena, Asociación Amigos de Doñana, Fundación La Salle, Apartado 1930, Caracas, Venezuela.

Introduction

In the course of conducting field work in the southern part of Venezuela at the invitation of the Ministerio del Ambiente y de los Recursos Naturales Renovables (MARNR-CODESUR), MSH collected a series of 34 *Gymnophthalmus* in the vicinity of Canaripó, Territorio Federal Amazonas, Venezuela. The trip was made in the company of the zoologist J. Cerda and the botanist O. Huber (both of MARNR-CODESUR) and was meant to provide a comparison of the fauna and flora of the Territorio Federal Amazonas in the dry and in the wet season. On separate expeditions, a series of nine similar specimens was collected by JA and W. Villalobos in the Serranía de Pijiguaos, State of Bolívar, Venezuela, and three similar specimens were collected by Charles W. Myers and John W. Daly at Santa Barbara, Territorio Federal Amazonas, Venezuela (fig. 1). All of these collectors recognized that their specimens were similar to *Gymnophthalmus underwoodi* Grant, 1958, but the presence of males was not in accordance with that identification and *G. underwoodi* was unknown for Venezuela. Moreover, colour differences were observed in live specimens as compared to live *G. underwoodi*.

At the time that these specimens were collected and initially examined, *G. underwoodi* was thought to be a unisexual species (Thomas, 1965; Hoogmoed, 1973), although a few males had been reported from a few localities (Vanzolini, 1976) (but Vanzolini's identifications become questionable in the light of newly described species [Vanzolini & Morato de Carvalho, 1991; present paper]). CJC and collaborators had begun investigating parthenogenesis and the possible hybrid origin of *G.*

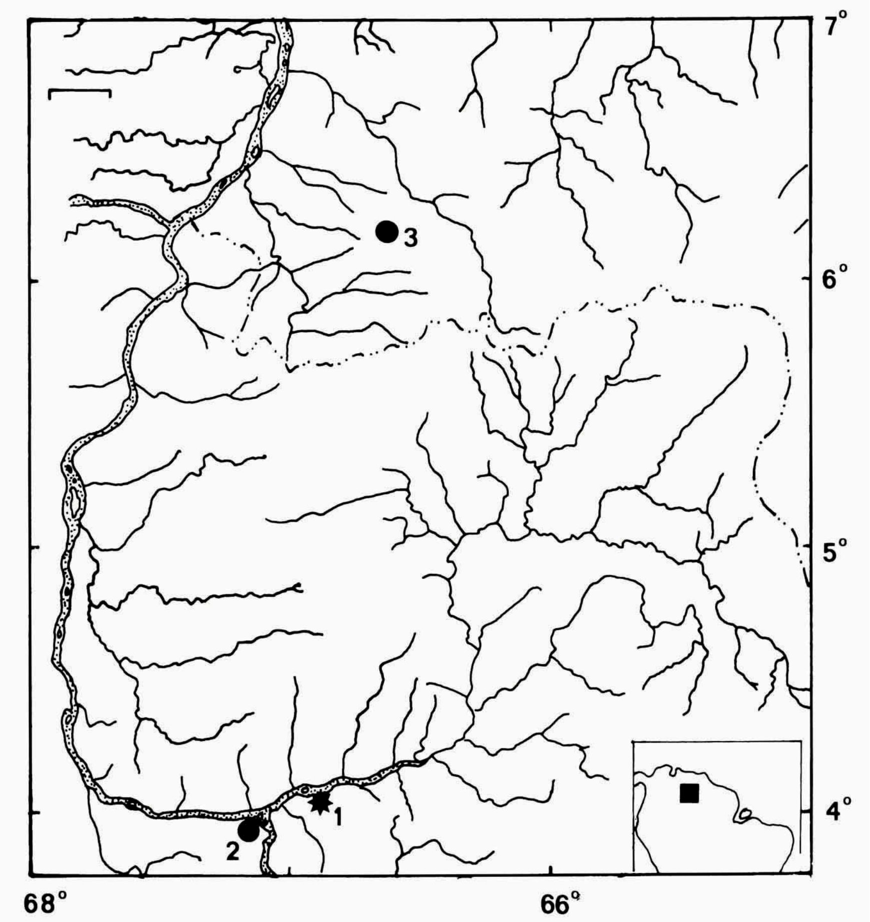

Fig. 1. Map of part of western Venezuela showing the three localities for the specimens of *Gymnophthalmus* reported here for the first time. 1, type locality of *G. cryptus*, vicinity of Canaripó, Departamento Atabapo. 2, Santa Barbara, Departamento Atabapo. 3, Serranía de Pijiguaos, Distrito Cedeño. The inset shows the location of the area in northern South America. The line of dots and dashes indicates the border between the Territorio Federal Amazonas (south of the line) and the Distrito Cedeño of the Estado Bolívar (north of line). Scale bar in upper left corner represents 25 km.

underwoodi, which involved examining all available specimens of *Gymnophthalmus* from the Guianan Region (eastern Venezuela, northern Brazil, Guyana, Suriname, and French Guiana). Thus, we awaited completion of those studies in order to describe this new species in the context of the new information. Those studies have been completed now and indicate a. o. that: (1) *G. underwoodi* is indeed a unisexual taxon that reproduces by means of parthenogenesis (Hardy et al., 1989); (2) *G. underwoodi* is a diploid clone of hybrid origin of which the two bisexual ancestors are cryptic species, including *G. speciosus* (Hallowell, 1861) and another as yet unrecognized species (Cole et al., 1989, 1990); and (3) the males previously identified as *G. underwoodi* are actually specimens of one (or more) different cryptic species (probably *G. speciosus* or the recently described *G. leucomystax*), for which males do exist (Cole et al., 1990; Vanzolini & Morato de Carvalho, 1991).

Systematic part

We now describe and name another cryptic species of *Gymnophthalmus* from the Guianan Region and discuss its possible significance. Morphological characters were determined as described by Hoogmoed (1973), with determination of sex, number of infralabial scales to posterior edge of eye, number of gular scales, number of ventral scales, and number of subdigital lamellae as described by Cole et al. (1990). Condensed data are presented as the mean plus or minus one standard error of the mean (observed range), sample size.

Specimens reported for the first time here were all fixed in formaline and subsequently preserved in alcohol 70%, and no karyotypic or electrophoretic data are available for them. Most of the morphological characters are consistent with treating these specimens as one species, but *G. underwoodi* and its closest relatives are a complex of cryptic species, so the lack of genetic data suggests we should proceed with caution. We begin by describing and naming the new bisexual species from the RMNH material, confident that the type series includes only one taxon. This is:

Gymnophthalmus cryptus spec. nov.
(figs. 1-4)

Holotype.— RMNH 22166 (field number 2249; one of 10 specimens), adult ♂, Venezuela: Territorio Federal Amazonas, Departamento Atabapo, Canaripó, riverine forest 1.5 km SE of camp, 91 m elevation. This locality is along the Río Ventuari, approximately 33 km ENE (upriver) from Santa Barbara, which is on the Río Orinoco W (downriver) of the confluence with the Río Ventuari, 30.v.1978, 11:45 - 12:30 hrs, leg. M.S. Hoogmoed and J. Cerda.
Paratypes.— RMNH 22155-22165, 5 ♂♂, 6 ♀♀, Canaripó, 29.v.1978, 15:00 - 16:00 hrs, leg. M.S. Hoogmoed. RMNH 22167-22175, 6 ♂♂, 3 ♀♀, same data as the holotype. RMNH 22176-22188, 7 ♂♂, 6 ♀♀, Canaripó, E of camp, 31.v.1978, 11:00 - 14:00 hrs, leg. M.S. Hoogmoed and J. Cerda.

Etymology.— The Latin adjective *cryptus* is derived from the Greek *kryptos*, which means secret or hidden.

Diagnosis.— This species differs from all other known species of *Gymnophthalmus* by the following combination of characters: colour of unregenerated tail in life blue; dorsal body brown with pale yellow dorsolateral stripe either fading near midbody or continuing to waist; sides very dark brown or black; dorsal scales of body and base of unregenerated tail all smooth; frontal usually separated from internasals by median contact of prefrontals (79.4% of specimens); one supraocular on each side; usually eight supralabials on each side, five to the posterior edge of the eye; usually four infralabials on each side counted to the posterior edge of the eye; two pairs of enlarged chinshields; 8 to 10 gulars; ventrals in males 20 to 22, in females 21 to 24; dorsals in males 30 to 32, in females 32 to 34; usually 15 scales around midbody (five of which are dorsals, four of which are ventrals, and three on each side); and four or fewer very inconspicuous femoral pores on each side in adult males (pores absent in females).

Differentiation.— *Gymnophthalmus cryptus* differs from both *G. rubricauda* Boulenger, 1902, and *G. multiscutatus* Amaral, 1933, by not having more than four (total) bold light stripes on a dark ground color (8-10 conspicuous stripes present in *G. rubricauda* and *G. multiscutatus*), by having one supraocular on each side (two in *G. rubricauda* and *G. multiscutatus*), by having two pairs of enlarged genials (3-4 in *G. rubricauda* and *G. multiscutatus*), and by having four or fewer inconspicuous femoral pores on each side in adult males (five or more conspicuous ones in *G. rubricauda* and *G. multiscutatus*); differs further from *G. rubricauda* by having the frontal separated from the internasals by median contact of the prefrontals (frontal in contact with internasals in *G. rubricauda*).

Gymnophthalmus cryptus differs from *G. pleei* Bocourt, 1881, by having the dorsal scales of the body and base of unregenerated tail smooth (keeled in *G. pleei*), by usually having eight supralabials on each side, five to the posterior edge of the eye (*G. pleei* usually has seven on each side, four to the posterior edge of the eye), by usually having four infralabials on each side counted to the posterior edge of the eye (six in *G. pleei*), by having fewer gulars (8-10 in *G. cryptus*; 10-13 in *G. pleei*), by having fewer ventrals in males (20-22 in *G. cryptus*; 23-27 in *G. pleei*), by having usually 15 scales around midbody (16-19 in *G. pleei*), and by having four or fewer very inconspicuous femoral pores on each side in adult males (five or more conspicuous ones in *G. pleei*).

Gymnophthalmus cryptus differs from *G. lineatus* (Linnaeus, 1758) by having only one stripe (often incomplete) on each side of the body (two distinct and complete in *G. lineatus*). In addition males tend to have fewer ventrals (20-22 in *G. cryptus*; 22 or more in *G. lineatus*), and inconspicuous femoral pores (conspicuous in *G. lineatus*).

Gymnophthalmus cryptus differs from the recently described bisexual species *G. leucomystax* by having indistinct femoral pores in males (very distinct, with plugs, in *G. leucomystax*), in having 15 (rarely 14) scales around midbody (13 in *G. leucomystax*), and in having a dark upper lip (white in *G. leucomystax*).

Gymnophthalmus cryptus is most similar to *G. speciosus* and *G. underwoodi*, differing from the former in having very inconspicuous femoral pores in adult males (conspicuous in *G. speciosus*), differing from the latter in being a bisexual species (*G. underwoodi* is unisexual), and differing from both in having usually 15 (rarely 14) scales around midbody (13 in *G. underwoodi*; usually 13 or 14 in *G. speciosus*). The laterals in *G. cryptus* are arranged in three longitudinal rows, in *G. underwoodi* they are arranged in three rows in the axil, reduced to two after a short distance. Other differences that can be observed in preserved specimens involve statistically significant differences in the means of scale counts that have overlapping ranges of variation. Thus, *G. cryptus* has a mean of fewer ventrals and fewer dorsals than *G. speciosus* (allowing for sexual dimorphism), although the females of *G. cryptus* are similar to *G. underwoodi* in both of these characters.

Description of the holotype and variation in the type series (data within parentheses apply to paratypes) (figs. 2-4).— Snout-vent length 32 mm (18-32 mm). Head small, pyramidal; 1.5 times as long as wide, slightly depressed, as wide as the neck, which is as wide as the body; snout obtuse.

Rostral hexagonal, visible from above, twice as wide as deep. A large, heptagonal frontonasal separating the nasals. A pair of irregularly hexagonal prefrontals, forming a short median suture (27 out of 34 specimens). Frontal rhomboidal, about the same size as a prefrontal. Contact of prefrontal with loreal separates frontonasal from anterior supraciliary (33 out of 34 specimens). Frontoparietals absent. An enormous,

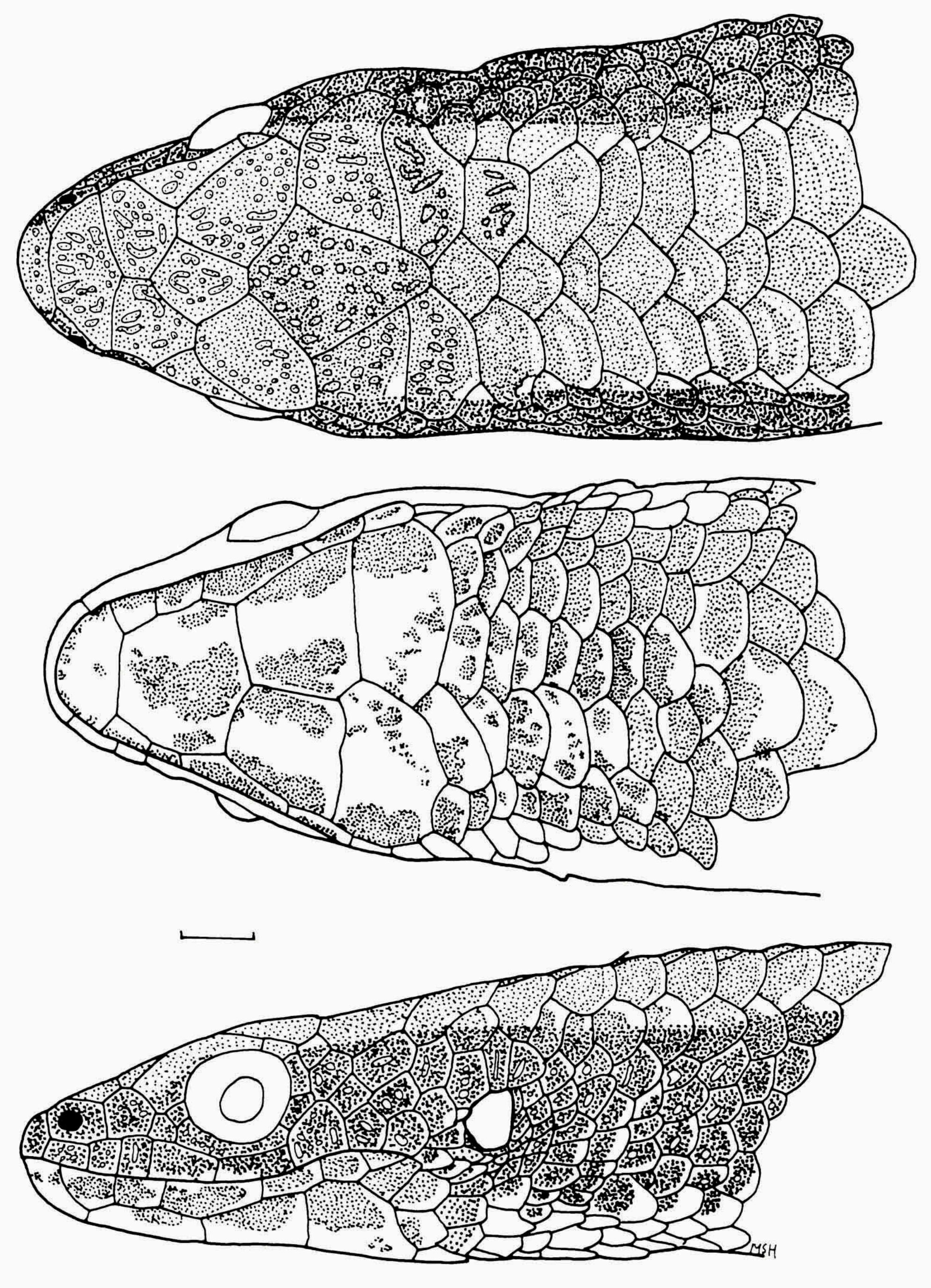

Fig. 2. Scutellation of holotype of *Gymnophthalmus cryptus*, RMNH 22166, male: dorsal, ventral, and lateral views of the head. The bar represents 1 mm.

elongate interparietal. Parietals irregularly pentagonal, slightly wider than long, smaller than interparietal. A row of three occipitals; the central one small, rhomboidal; the lateral ones heptagonal, transversely enlarged. One large supraocular, in contact with the supraciliaries. Nostril low in an undivided nasal (but nasal grooved below nostril on at least one side in 10 out of 34 specimens). Loreal hexagonal. A small frenocular (but fused with the subocular on one side in three out of 34 specimens), deeper than long. One small preocular (two on one side in one specimen). One large subocular. Three postoculars (two on one side in two specimens), the lowest one largest. Two supraciliaries, the anterior one very large, posterior one minute. Temporal region with large imbricate scales. Three anterior temporals (two on one or both sides in four specimens), two posterior temporals (one on both sides in two specimens). Ear opening small, nearly oval, with long axis vertical, surrounded dorsally and anteriorly by large scales, the other two sides by small scales, forming a smooth margin. External auditory meatus short; tympanum visible. Supralabials eight (seven in three specimens, six in one), the fifth below the eye (third in one, fourth in two, sixth in one), the sixth extending higher than the rest. Lower eyelid transparent, grown over the eye and immovable. Pupil round.

Mental trapezoid with a convex anterior margin. A large pentagonal postmental. Two pairs of large imbricate chinshields forming median sutures, the second pair about as long as first but wider, in contact with the infralabials. Six infralabials, the third longest, the fourth below the posterior edge of the eye (third in six specimens).

Head scales with a row of small pits along their margins and scattered pits elsewhere, mostly on the anterior dorsal, the lateral, and the anterior ventral head scales. All scales of head, body, and limbs smooth, excepting ventral surfaces of hands and feet.

Nine rows of transversely enlarged, imbricate gulars from the chinshields to the pectorals (eight in seven specimens, ten in one). No collar. Scales on the nape indistinguishable from the dorsals. Scales on the side of the neck small, rounded, imbricate, in longitudinal and oblique rows.

Dorsals imbricate, in oblique and in five longitudinal rows, one vertebral row of small, rhomboidal scales and one lateral (paravertebral) row of transversely enlarged, hexagonal scales, and one row of more or less rhomboidal dorsolateral scales on each side (fig. 3d); 32 vertebral scales (range 30-32 in males; 32-34 in females) between the interparietal and the posterior surfaces of the thighs. Laterals imbricate, as large as the dorsals, hexagonal to rounded, in oblique and in three longitudinal rows. Two central rows of ventrals imbricate, as large as the transversely enlarged dorsals, hexagonal, and two lateral rows of ventrals which are distinctly smaller, in oblique and in four longitudinal rows, 22 transverse rows (range 20-22 in males; 21-24 in females) between the pectorals (not included) and the preanals. Hoogmoed (1973) did include the pectoral in the ventral count, so actually his counts are one higher than when counted according to Cole et al. (1990). Fifteen scales around midbody (14 in three specimens). One large central preanal scale, three posterior preanals bordering the cloaca, and three very small laterals on each side (fig. 3a).

Femoral pores (absent in females) are very inconspicuous, so much so that they appear to be absent at first glance in young males; three on each side; total six (range of total 5-8) (fig. 3b).

Scales on and under the tail smaller than the dorsal body scales (fig. 3c), imbri-

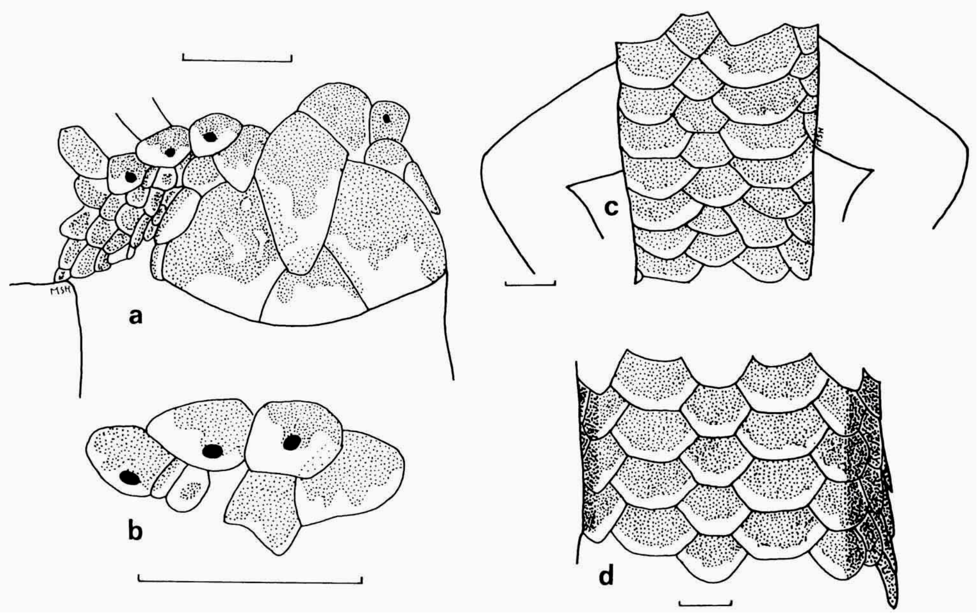

Fig. 3. Scutellation of para- and holotype of *Gymnopthalmus cryptus*, RMNH 22166 and 22176, males: a, anal region, b, enlargement of right row of femoral pores (both of RMNH 22176); c, dorsal scales at midbody, d, dorsal surface of base of tail (both of RMNH 22166). The bars represent 1 mm.

cate, rounded, in longitudinal and in oblique rows, smooth in the anterior third, with low, sharp keels forming longitudinal ridges on the posterior two thirds. (In specimens with the tail regenerated, scales on and under the regenerated part are elongate, hexagonal, keeled, in transverse and in longitudinal rows.)

Forelimbs covered with imbricate, rounded scales, larger on the anterior surface of the lower arm than elsewhere. Anterior and ventral surfaces of the hind limbs (upper and lower limbs) with large, rounded, imbricate scales; posterior and upper surfaces of the hind limbs with small, slightly imbricate scales. Four fingers (the ancestral first -inner- finger absent); 13 single, obtusely keeled lamellae (range 12-15) forming a serrated keel under the right (left finger missing) third finger (phylogenetically the fourth, except that the first is typically missing in this genus); 16 lamellae (range 14-17) under each fourth toe. Palms and soles with small, juxtaposed, tubercular (conical), granular scales, except for a row of enlarged keeled scales along the interior margin of the sole.

The type series shows no variation in the following characters: one supraocular; no frontoparietals; nare below center of or low in nasal; one loreal; one subocular; two supraciliaries (posterior one very small); cephalic scales smooth; one postmental; two pairs of enlarged genials; dorsal body scales smooth; dorsal caudal scales smooth at base of unregenerated tail, keeled posterior to first one third to two thirds; regenerated caudal scales keeled.

Colour in life (based on notes in the field and on colour slides): back bronze, anteriorly with golden dorsolateral stripes, that disappear posteriorly, accompanied medially by a row of narrow, dark brown spots continuing on the tail. Flanks black. Anterior third of tail as back, posterior two thirds blue, the row of dark brown spots

Fig. 4. *Gymnophthalmus cryptus*, photographed in life by MSH, 29 May 1991, Venezuela, Canaripó, RMNH 22155 (field number MSH 2234), snout-vent length 29 mm, male.

still recognisable (fig. 4). Iris dark brown.

In preserved specimens (as seen in several lizards in addition to the holotype) the back is light to dark brown. Scales on top of head greyish blue with small, bluish spots; those on the side very dark brown or black, sometimes with indistinct, lighter spots. Dorsal scales dark greyish blue with a lighter transverse bluish line or series of spots. The edges of the scales are lighter. The dorsolateral stripe is silver or creamy, extending from the snout over the eye to the back, where it usually fades out about half way between the forelimbs and the hind limbs. Paravertebral scales with black spots that form a longitudinal row, nearly continuous anteriorly, more spaced posteriorly; due to fixation in formaline not very evident. The flanks are black. Scales on the underside of the body have dark brown centers and white rims; scales on underside of tail as on underside of body, but total impression lighter. RMNH 22176 has the upperside of the tail very light brown, demarcated sharply from the very dark bluish brown back; the cloaca is followed by two transverse rows of scales with dark centres and lighter rims, and the rest of the underside of the incomplete tail is immaculately white. Probably the entire tail of this live specimen was bright blue, but this cannot be deduced from the fieldnotes.

A small, elongate lizard with a maximum snout-vent length of 32 mm in males (holotype is 32 mm), and of 28 mm in females. Hind limb 1.5 times as long as forelimb. When the limbs are laid along the body the toes and fingers are widely separated. The tail of the holotype is incomplete and partly broken (43 mm remaining). In males with the tail complete, it is 57-64% of the total length; in females, 55-61%.

Habitat and natural history.— Specimens were collected on the ground between leaf litter in open, sunny areas in riverine forest. RMNH 22155-22165 were collected at the edge of a bare slab of granite (locally called "laja") surrounded by riverine forest, RMNH 22166-22175 at the edge of a road through a forest island in a sandy savanna, and RMNH 22176-22188 in sunny spots in a closed area of riverine forest. All specimens were active in daytime between 11:00 and 16:00 hrs.

Disclaimer.— The above description is based only on material from Canaripó, because we feel confident that this series definitely only contains a single species. We have intentionally excluded the material from Santa Barbara and Serranía de Pijiguaos from the type series, because we observed slight morphological differences that could indicate that we are dealing with other taxa, although very similar. Only the material from Santa Barbara was used in the principal components analysis (PCA), which indicates that identification of these specimens remains problematical. For logistic reasons the Serranía de Pijiguaos material was not included in the PCA.

Discussion

Comparisons.— Cole et al. (1990) used principal components analyses to effectively distinguish species of *Gymnophthalmus* from the Guianan Region and the West Indies. We repeated their analyses, using precisely the same characters, all of the same data sets, and the same computer programs and statistical procedures, with the addition of the new data from *G. cryptus* and three other unreported specimens of *Gymnophthalmus* (AMNH 117888-117890) that were collected by C.W. Myers and J.W. Daly approximately 33 km WSW (downriver) from the type locality of *G. cryptus*, at the following locality: Venezuela, Territorio Federal Amazonas, Departamento Atabapo, Santa Barbara, 100 m elev. (confluence of Río Ventuari and Río Orinoco).

Following Cole et al. (1990), ten characters were used for PCA: snout-vent length; number of femoral pores (total for both sides, except in analyses of females, which always lacked pores); and the number of the following epidermal scales: supralabials (total for both sides); infralabials (counted from the mental posteriad to the posterior edge of the eye; total for both sides); gulars; ventrals; dorsals; scales around midbody; subdigital lamellae on the fourth toe; and subdigital lamellae on the fourth (= functional third) finger (the longest, as the ancestral "first finger" is absent in this genus). For finger and toe lamellae, only the right hand and foot were used in PCA, but if the specified right finger or toe was missing, the left hand or foot was used. Given the number and combination of toes and fingers missing on certain specimens, this maximized the number of specimens available for the analyses (individuals with blank cells in the data matrix were excluded from the analyses). This violated no assumptions, as Student's *t*-tests indicated no left-right asymmetry in counts of lamellae.

Our present PCA's (figs. 5-7) include both the full data set for 23 samples of *Gymnophthalmus* presented by Cole et al. (1990, table 3) and the new data for two additional population samples presented here (table 1), including the type series of *G. cryptus* (sample Y). The PCA's were performed separately on males and females because of significant sexual dimorphism in number of ventrals, dorsals, and femoral pores. Several different PCA's were performed for various reasons based on the 10 characters in table 1 (nine characters for females as they all lack femoral pores), and these analyses are discussed separately below.

PCA 1: The 66 males of *G. cryptus* (N= 11; sample Y), *G. speciosus*, *G. lineatus*, *G. pleei*, and the sample from Santa Barbara (N= 2; sample X) with complete data were analyzed to see whether clustering would be consistent with recognizing *G. cryptus* as a separate taxon among the bisexual taxa occurring in the Guianan Region and the West Indies. Assuming that the specimens of *G. pleei* from the island of Martinique represent clustering of one species, would PCA show the *G. speciosus* and *cryptus* from Venezuela to show a similar form of clustering, perhaps even in different space? The analysis revealed three distinct groups consistent with the taxa *G. pleei*, *G. speciosus*, and *G. cryptus* (fig. 5, largest three polygons), although one specimen of *G. speciosus* (an individual of sample U, UIMNH 63577, with locality data specific only to "Venezuela") was separated from the other specimens of *G. speciosus* on the first principal component (PC1). The specimens of *G. pleei* (W) completely separated from the other taxa on PC1; the form of clustering in *G. pleei*, *G. speciosus* (P-U), and *G. cryptus* (Y) was similar; *G. speciosus* and *G. cryptus* overlapped slightly on PC2; *G. lineatus* (V) overlapped with *G. speciosus*; and the two males from Santa Barbara (X) occuppied separate space. Particularly informative larger samples are R (*G. speciosus* from Colonia Coronel Mota, Brazil), T (*G. speciosus* from Chacachacare Island, Republic of Trinidad and Tobago), and Y (type series of *G. cryptus*), as each represents a deme; R and T cluster together and show only slight overlap with Y (fig. 5). The correlation matrix showed significant correlation among most of the scale counts for this comparison, but only five scale counts appeared correlated with body length. The first two principal components jointly accounted for 74% of the total variation in the data set (PC1= 56%; PC2= 18%), and no other principal components explained as much as 10%. The loadings on the first two principal components are listed in table 2, and the scores are shown in figure 5.

PCA 2: The 269 females of *G. cryptus* (N= 13), *G. speciosus*, *G. lineatus*, *G. pleei*, *G. underwoodi*, and some individuals of uncertain identity but all with complete morphological data were analyzed to see whether clustering would be consistent with recognizing *G. cryptus* as a separate taxon among those occurring in the Guianan Region and the West Indies; do the females cluster similarly to the males, and how does the unisexual *G. underwoodi* cluster in comparison? The analysis (fig. 6) revealed the following: *G. pleei* (W) completely separated from all the others on PC1; most specimens of *G. speciosus* (R-U) clustered reasonably well together (but one individual of U, FMNH 176692, from Puerto Ayacucho, Amazonas, Venezuela, was clearly distinct on PC2); *G. lineatus* (V) was separated from *G. speciosus* on PC1, although there may have been overlap if there had been a larger sample of *G. lineatus*; the positively identified *G. underwoodi* (HEDJNO polygon, reading counter clockwise) tended to separate from the positively identified *G. speciosus*, with some overlap of their polygons; the female *G. cryptus* (Y) occupied essentially the same space as the unisexual *G. underwoodi*; and the one female from Santa Barbara (X) occurs within the polygon of *G. speciosus* but adjacent to the *G. underwoodi*. Present samples show no overlap between the females of the bisexual *G. cryptus* and *G. speciosus*. All 11 individuals of Q and M with complete data clustered together and separate from the other lizards, indicating that these Brazilian populations need additional study (also see the recent publication by Vanzolini & Morato de Carvalho, 1991). These and other individuals of interest (F, K, Z) were discussed by Cole et al. (1990, PCA 2 and

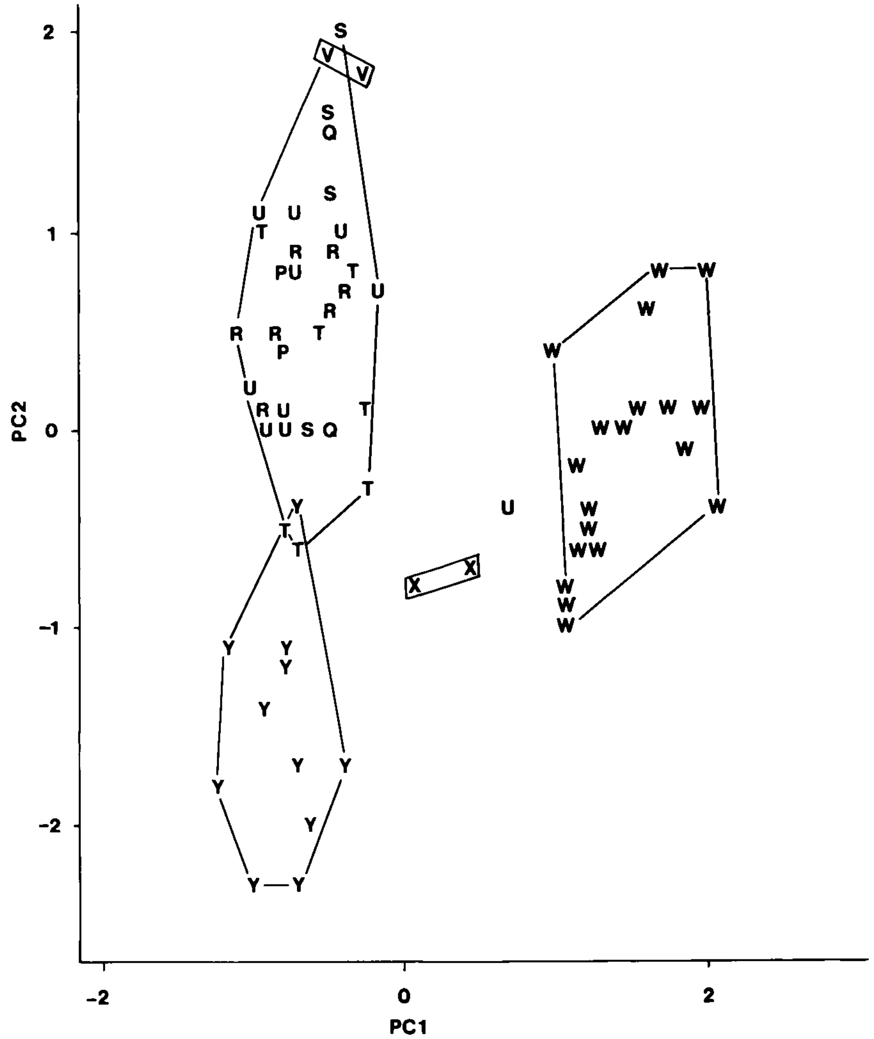

Fig. 5. Polygons and letters indicating scores of 66 males of *Gymnophthalmus* (*G. cryptus*, *G. speciosus*, *G. lineatus*, *G. pleei*, sample X) on the first two principal components extracted from the correlation matrix of 10 morphological characters (tables 1, 2; and table 3 of Cole et al., 1990). Each letter represents an individual, from samples listed with corresponding letters in the tables cited. The distinctive *G. speciosus* (individual U) is UIMNH 63577 from "Venezuela".

PCA 3). The correlation matrix showed significant correlation among most of the scale counts for this comparison (including number of ventrals with number of dorsals), but only one scale count (number of toe lamellae) appeared correlated with body length. The first two principal components jointly accounted for 61% of the total variation in the data set (PC1= 40%; PC2= 21%), PC3 accounted for 12%, and no other principal component explained as much as 10%. The loadings on the first two principal components are listed in table 2, and the scores are shown in figure 6.

PCA 3: The sample of *G. pleei* was included in the previous analyses in order to compare patterns of clustering within samples of bisexual species from limited geo-

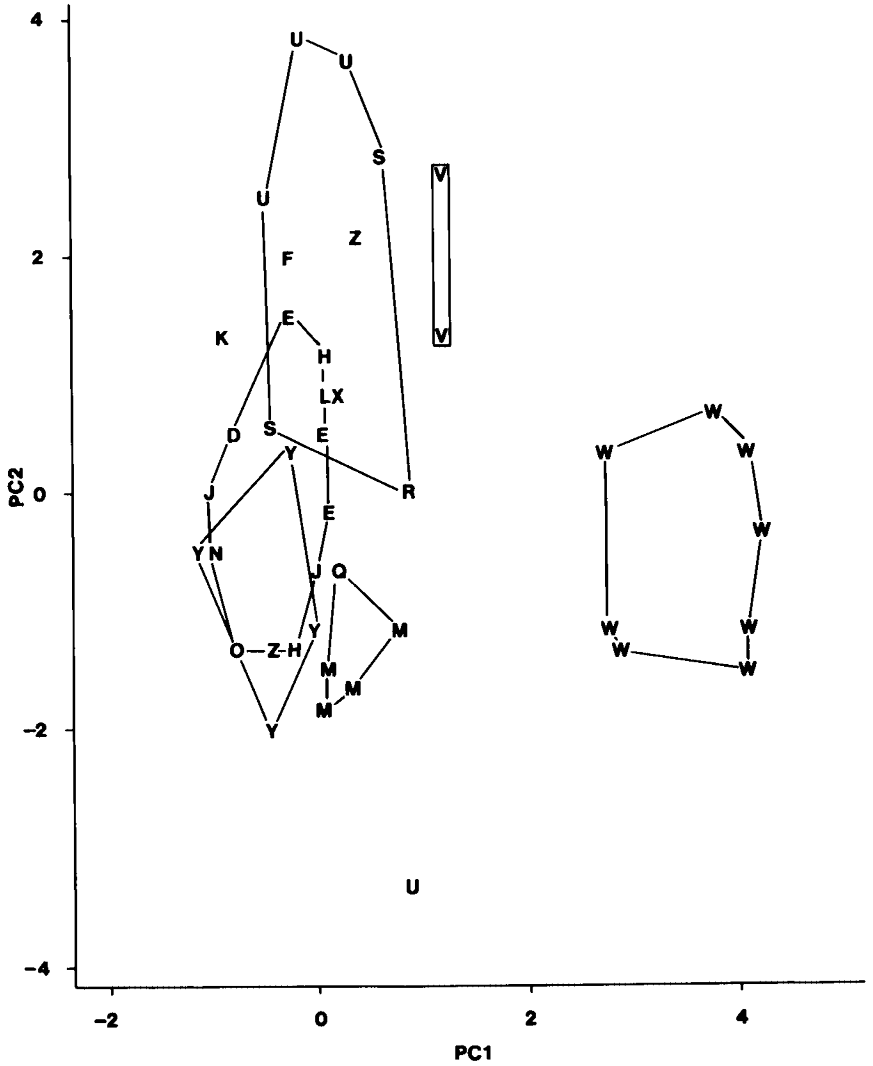

Fig. 6. Polygons and letters indicating scores of 269 females of *Gymnophthalmus* (*G. cryptus*, *G. speciosus*, *G. lineatus*, *G. pleei*, *G. underwoodi*, and sample X) on the first two principal components extracted from the correlation matrix of nine morphological characters (tables 1, 2; and table 3 of Cole et al., 1990). Only letters for individuals on the periphery of each polygon are shown (due to crowding), correlated with letters designating samples in the tables cited. Sample sizes are as follows: *G. cryptus* (Y), 13; Santa Barbara (X), 1; *G. lineatus* (V), 2; *G. pleei* (W), 17; *G. speciosus* (USR polygon), 29, including 3 from sample T, 11 from R; Q and M polygon, 11; and *G. underwoodi* (HEDJNO polygon), 196, including 32 for sample A (type locality, Barbados) and 40 for D (Trinidad). The distinctive individual of *G. speciosus* indicated (U) is FMNH 176692 from Puerto Ayacucho, Amazonas, Venezuela.

graphic areas. Our purpose now, however, is to compare clustering among the unisexual *G. underwoodi* and bisexual taxa that may be the ancestors of *G. underwoodi*, which had a hybrid origin in or near the Guianan Region. On the basis of genetic evidence (karyotype and protein electrophoresis), *G. pleei* was clearly ruled out as a pos-

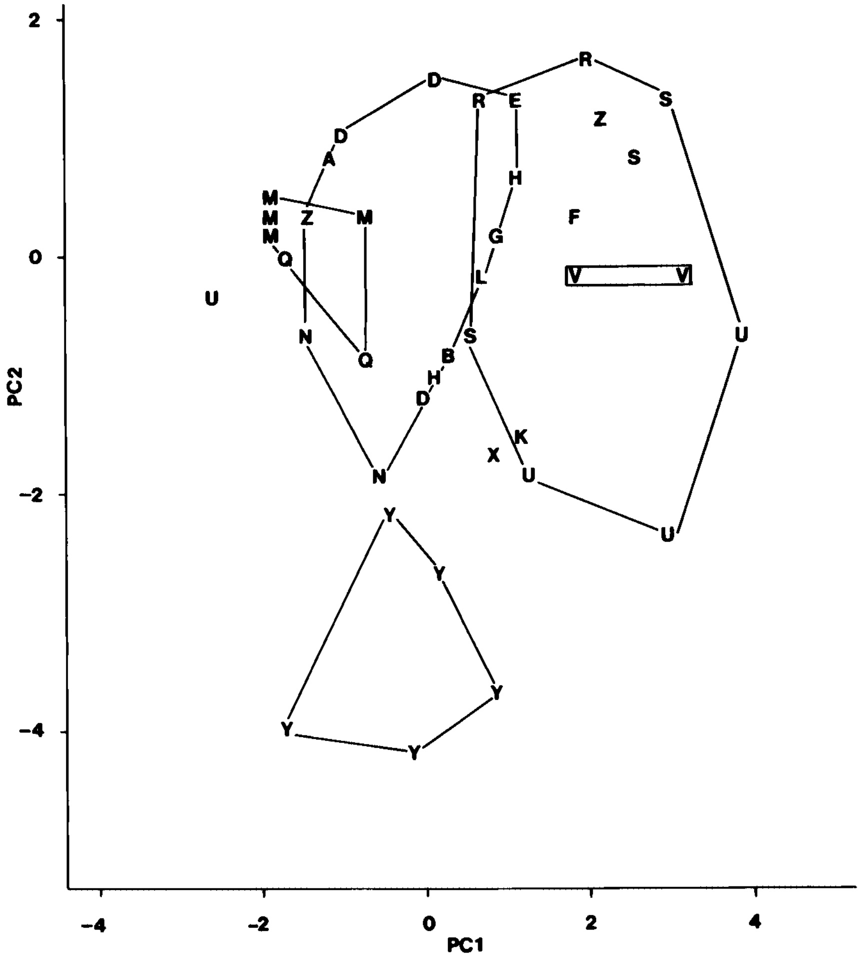

Fig. 7. Polygons and letters indicating scores of 252 females of *Gymnophthalmus* (*G. cryptus*, *G. speciosus*, *G. lineatus*, *G. underwoodi*, and sample X) on the first two principal components extracted from the correlation matrix of nine morphological characters (tables 1, 2; and table 3 of Cole et al., 1990). Individuals analyzed and included in the respective polygons are the same ones as in figure 6, except the specimens of *G. pleei* (W) were excluded. The distinctive individual of *G. speciosus* indicated (U) is FMNH 176692 from Puerto Ayacucho, Amazonas, Venezuela.

sible ancestor of *G. underwoodi*, *G. speciosus* was concluded to be one of the ancestors, and the second ancestor remained to be found (Cole et al., 1990). Might *G. cryptus* be the missing ancestor of *G. underwoodi*? Removing *G. pleei* from this analysis prevents its characters from distorting the spatial arrangements among the specimens most pertinent to this question. Thus, the 252 females of *G. cryptus*, *G. speciosus*, *G. lineatus*, *G. underwoodi*, and some individuals of uncertain identity but with complete data were analyzed (same analysis as PCA 2 but with *G. pleei* removed). The analysis (fig. 7) revealed the following: *G. cryptus* and *G. speciosus* differ on both PC1 and PC2, with no overlap; *G. underwoodi* and *G. speciosus* differ on PC1, but with some overlap, and they do not differ on PC2; *G. underwoodi* and *G. cryptus* do not differ on PC1 but they separate completely on PC2; the Q and M polygon overlaps broadly with *G.*

underwoodi; and the female from Santa Barbara (X) is closest to *G. speciosus.* Again, an individual of U, FMNH 176692 from Puerto Ayacucho, Venezuela, was distinct, as discussed by Cole et al. (1990) along with other interesting individuals (F, K, Z). Considering the result of this analysis (fig. 7) together with PCA 3 of Cole et al. (1990), both *G. cryptus* and FMNH 176692 (if it is not aberrant) are viable candidates for representing the missing ancestor of *G. underwoodi.* The correlation matrix showed some correlation among scale counts (including number of ventrals with number of dorsals), but only two scale counts (scales around midbody; toe lamellae) appeared correlated with body length. The first two principal components jointly accounted for only 43% of the total variation in the data set (PC1= 26%; PC2= 17%), PC3 accounted for 15%, PC4 accounted for 11%, and no other principal component explained as much as 10%. The loadings on the first two principal components are listed in table 2, and the scores are shown in figure 7.

Identity of the specimens from Santa Barbara (sample X, AMNH 117888-117890).— We recorded data from these specimens for all of the same characters as described and discussed above for *G. cryptus.* These specimens are so similar to *G. cryptus* that it is most efficient to simply discuss the few differences that do exist, along with diagnostic similarities, rather than list all of the similarities.

Body length and colour of tail and ventral surfaces in life.— C. W. Myers' field notes record colours in life as follows: AMNH 117888 (a female with body length of 34 mm; the largest female of *G. cryptus* is 28 mm in body length) and AMNH 117889 (a male with body length of 27 mm), "...are dorsally brown onto the basal one-half of the tail— the distal half being grayish blue. Ventral surfaces are whitish [female]...or pale gray [male]..." However, AMNH 117890 (a male with body length of 38 mm; the largest male of *G. cryptus* is 32 mm in body length) had "all but the very base of the tail dull *red;* all ventral surfaces...somewhat brighter red."

Supralabials.— AMNH 117889 has seven supralabials on each side (four to the posterior edge of the eye), AMNH 117890 has 8-7 (5-4 to the posterior edge of the eye), and AMNH 117888 has eight on each side (five to the posterior edge of the eye). This fits in with the variation observed in *G. cryptus.*

Dorsals.— The number of dorsals (32) of two of the specimens fits the diagnosis of *G. cryptus,* but AMNH 117889 has 33 dorsals. This would add one scale to the range of variation observed in *G. cryptus.*

Femoral pores.— Two of the specimens fit the diagnosis of *G. cryptus,* but AMNH 117890 has conspicuous, rather than inconspicuous, pores (four on each side).

Infralabials to the posterior edge of the eye.— AMNH 117888 has four infralabials on each side reaching to the posterior edge of the eye, AMNH 117889 has 3-4, and AMNH 117890 has three on each side. This fits in with the variation observed in *G. cryptus.*

Toe lamellae.— The number of toe lamellae (17-17) of two of the specimens fit the range of variation for *G. cryptus,* but AMNH 117888 (18-17) would add one scale (on one side) to the range of variation observed in *G. cryptus.*

Reviewing the important characters and figures 5-7, what species is (or are) represented by the three specimens described above? Judging from the PCA plots, the males appear to be distinctive (fig. 5, sample X; an unnamed species?), and the female clusters with (fig. 6, sample X) or is adjacent to *G. speciosus* (fig. 7, sample X).

Judging from tail colour (blue, inconsistent with *G. speciosus*), scales around midbody, and other diagnostic characters, the female is not *G. speciosus*, but possibly *G. cryptus* (adding to its range of variation in adult female body size and number of toe lamellae). The males, judging from tail colour, size, and condition of femoral pores (very inconspicuous versus conspicuous) could represent two species (the smaller of which could be *G. cryptus* and the larger could be *G. speciosus*), or immature and adult of one species. From a physiological and genetical point of view this is unlikely: it would indeed seem very difficult to change a blue tail into a red one. Given the morphologically cryptic nature of species of *Gymnophthalmus* in the Guianan Region, we conclude that firm identification of these specimens will have to await the availability of a larger series of specimens from Santa Barbara with data on their karyotypes and biochemical genetics to compare with other species, including *G. cryptus* from the vicinity of Canaripó. It is particularly intriguing that there might be two species of *Gymnophthalmus* at Santa Barbara, and if so, that there also could be, or could have been, hybridization there. As is known from previous work (Cole et al., 1989, Cole et al., 1990, Hardy et al., 1989), the unisexual *G. underwoodi* is of hybrid origin, one of the parents being *G. speciosus* and the other possibly *G. cryptus*. Further research at the Santa Barbara site might provide more insight in these matters, if not the answer to the above mentioned questions. The three AMNH specimens were found "under scrap metal by isolated tree in grassy area...savanna-forest edge" (field notes of C. W. Myers, 26-27 February 1978).

Additional specimens possibly referable to *G. cryptus*.— Here we discuss the series of nine specimens of *Gymnophthalmus* collected on 19-21 June 1987 by JA and W. Villalobos at the following locality: Venezuela, Estado Bolívar, Distrito Cedeño, Serranía de Pijiguaos, area of BAUXIVEN (Bauxitas de Venezuela, Cia.), 100 to 500 m elevation (6°10'N, 66°50'W). The specimens all have JA's fieldnumbers, being AY 687, AY 688, AY 695, AY 696, and AY 699 to AY 703. Of these, two have been donated to the Museo de Historia Natural La Salle, Caracas, Venezuela (MHNLS) as follows: AY 699 (MHNLS 11573) and AY 703 (MHNLS 11574). Others are in the process of being deposited and catalogued in the herpetological collections at Rancho Grande, Venezuela and Estación Biológica de Doñana, Spain, but catalogue numbers are not yet available. Except for these nine specimens, all data for all specimens reported and compared in this paper were recorded personally by CJC and most specimens were examined also by MSH, so all observations are internally consistent in all details. The data for the AY specimens were recorded by JA, following the same procedures as for the other specimens. In addition, CJC had an opportunity to spot-check specific characters on these nine specimens. The nine specimens from Serrania de Piijiguaos are morphologically so similar to *G. cryptus* that it is most efficient to simply discuss the differences, along with diagnostic similarities, rather than list all of the similarities. These specimens are identical to *G. cryptus* except as specified below.

Sex.— On first inspection, all specimens were thought to lack femoral pores and therefore were treated as probably female. Dissection of the base of the tail of all nine specimens, however, revealed two males (AY 687 and AY 695), with very inconspicuous femoral pores similar to those of *G. cryptus*.

Body length and colour of tail in life.— The range of body length (25-31 mm) and the blue tail fit *G. cryptus*.

Medial contact of prefrontals.— The frontal usually is separated from the internasals by median contact of the prefrontals (88.9% of the specimens), as in *G. cryptus*, which shows similar variation in this character.

Supralabials.— Eight of the specimens have five supralabials on each side to the posterior edge of the eye, as in *G. cryptus*, and the total count on each side was 8-8 in eight specimens but 9-8 in one, the last of which would add one scale to the range observed in *G. cryptus*.

Ventrals.— The range of the number of ventrals in females is 20-23, which would add one scale to the lower end of the range observed in *G. cryptus*. The range in males is 21-22, which fits in with *G. cryptus*.

Dorsals.— The range of the number of dorsals in females is 29-33, which would extend by three scales the lower end of the range observed in *G. cryptus*. Males have 31 dorsals, like *G. cryptus*.

Scales around midbody.— The number of scales around midbody usually is 15 (14 in AY 695), as in *G. cryptus*.

Toe lamellae.— These usually range from 16 to 18, which would add one scale to the range observed in *G. cryptus*, but one specimen had 19-18, adding another scale.

Reviewing the important characters, what species is represented by the nine specimens described above? Judging from tail colour, scales around midbody, and other diagnostic characters, these appear to be *G. cryptus* (adding slightly to the range of variation in some scale counts). We assign these to *G. cryptus* and hope that a larger series with comparative karyotypic and electrophoretic data will become available in the near future, as discussed above for the specimens from Santa Barbara. The present series of nine specimens was collected in an area of forest with clearings, from the base to the summit of the Serranía.

Comments.— JA suggests that in May and June in Venezuela the most conspicuous *Gymnophthalmus* are young of the year, and therefore our sample of *G. cryptus* may not include a full-grown male. In addition, he suggests that it may be useful to count the number of scales around the base of the tail (in rows 4-6 posterior to the cloaca) in future comparisons of population samples from Venezuela, because there seem to be differences between populations in this character.

Summary and conclusions

Gymnophthalmus cryptus spec. nov. is named and described on the basis of 34 specimens (including males and females) from the vicinity of Canaripó, Territorio Federal Amazonas, Venezuela. The new species is very similar to the unisexual *G. underwoodi*, which occurs east of this area in the Guianan Region. *Gymnophthalmus cryptus* is one of the best candidates for future genetic research to identify the missing ancestor of *G. underwoodi*, a parthenogenetic species of hybrid origin (*G. speciosus* × *G.* ?).

Two other series of previously unreported *Gymnophthalmus* are also described (fig. 1). Nine specimens from the Serranía de Pijiguaos are rather similar to, and may actually represent, *G. cryptus*. Three specimens from Santa Barbara, however, are more puzzling and may include more than one taxon, one of which may be *G. cryptus*. Morphologically, the species of *Gymnophthalmus* in Venezuela are cryptic species. The details of identity and relationships of these and other samples from the Guianan Region can be clarified only after future collecting provides fresh samples for comparing karyotypes and biochemical genetics of these lizards.

Acknowledgements

The report by Cole et al. (1990) lists the individuals and institutions that provided comparative material, and the hundreds of specimens examined are also listed in that paper. We have benefited once again from the assistance of the individuals mentioned by Cole et al. (1990), particularly for the specimens used in the principal components analyses.

Abbreviations referring to individual specimens mentioned here are: AMNH, American Museum of Natural History, New York, USA; AY, field series of Jose Ayarzaguena, Caracas, Venezuela; FMNH, Field Museum of Natural History, Chicago, USA; MHNLS, Museo de Historia Natural La Salle, Caracas, Venezuela; RMNH, Nationaal Natuurhistorisch Museum (formerly Rijksmuseum van Natuurlijke Historie), Leiden, The Netherlands; and UIMNH, University of Illinois Museum of Natural History, Urbana, Illinois, USA.

For assistance in collecting the specimens reported in the present paper we thank John W. Daly, Charles W. Myers, and W. Villalobos. MSH wants to thank Julio Cerda and Otto Huber of MARNR (CODESUR), who took care of the logistics of the trip to Canaripó, and Stefan Gorzula who made the initial contacts between MSH and MARNR. MSH's trip to Venezuela was funded by grants from the Treub Society and the Treub Fund. Margaret G. Arnold executed the principal components analyses, and George F. Barrowclough provided important guidance with the computer work.

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Received: 30.xii.1991
Accepted: 26.ii.1992
Edited: J.C. den Hartog

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* Note added in proof.— While the present article was in proof we received this paper. We only could make short comments to it and not incorporate its data and conclusions completely in our discussion.

Table 1. External morphological data [mean ± 1 standard error of the mean (range) and sample size] for two population samples of *Gymnophthalmus* from Venezuela. X denotes *Gymnophthalmus* spec. from Santa Barbara (AMNH 117888-117890); Y denotes the type series of *G. cryptus*.

Species or locality	Sample	Sex	Body length l	Supra-labials	Infra-labials	Gulars	Ventrals	Dorsals	Scales around midbody	Left toe lamellae	Right toe lamellae	Left finger lamellae	Right finger lamellae	Femoral pores
Santa	X	♀	34	16	8	9	24	34	15	18	17	12	13	0
Barbara			(-)1	(-)1	(-)1	(-)1	(-)1	(-)1	(-)1	(-)1	(-)1	(-)1	(-)1	(-)1
Santa	X	♂	32.5	14.5	6.5	10.0	22.0	32.0	15.0	17.0	17.0	14.0	13.5	8.0
Barbara			(27-38)2	(14-15)2	(6-7)2	(10-10)2	(22-22)2	(31-33)2	(15-15)2	(17-17)2	(17-17)2	(14-14)2	(13-14)2	(8-8)2
G. cryptus	Y	♀	21.3±0.66	16.0±0.00	7.7±0.12	8.8±0.14	22.2±0.30	32.7±0.19	14.9±0.09	15.8±0.24	16.0±0.23	13.1±0.13	13.0±0.21	0.0
			(18-28)15	(16-16)15	(7-8)15	(8-10)14	(21-24)15	(32-34)15	(14-15)15	(15-17)14	(15-17)14	(12-14)14	(12-15)14	(0-0)7
G. cryptus	Y	♂	23.5±1.05	15.7±0.15	7.9±0.07	8.8±0.10	20.6±0.16	31.0±0.16	14.9±0.05	15.7±0.22	15.9±0.21	12.8±0.10	12.8±0.10	5.8±0.26
			(18-32)19	(14-16)19	(7-8)19	(8-9)19	(20-22)19	(30-32)19	(14-15)19	(14-17)19	(14-17)19	(12-13)18	(12-13)19	(5-8)11

Table 2. Character loadings of first two axes for three Principal Components Analyses of *Gymnophthalmus* morphology. Based on data summarized in table 1 here together with those summarized in table 3 of Cole et al. (1990).

	PCA 1		PCA 2		PCA 3	
Character	PC 1	PC 2	PC 1	PC 2	PC 1	PC 2
Body length	0.486	0.592	0.194	0.024	-0.016	0.770
Supralabials	-0.832	0.270	-0.923	0.083	-0.122	-0.013
Infralabials	-0.907	0.170	-0.753	0.248	0.230	0.159
Gulars	0.851	0.312	0.708	0.041	0.188	0.464
Ventrals	0.734	0.562	0.724	0.530	0.813	0.060
Dorsals	-0.358	0.789	0.086	0.822	0.791	0.150
Around body	0.838	-0.326	0.889	-0.067	0.148	-0.724
Toe lamellae	0.833	-0.039	0.579	-0.493	-0.541	0.420
Finger lamellae	0.555	-0.363	-0.149	-0.808	-0.804	-0.068
Pores	0.898	0.226	—	—	—	—
Variation expl.	56%	18%	40%	21%	26%	17%