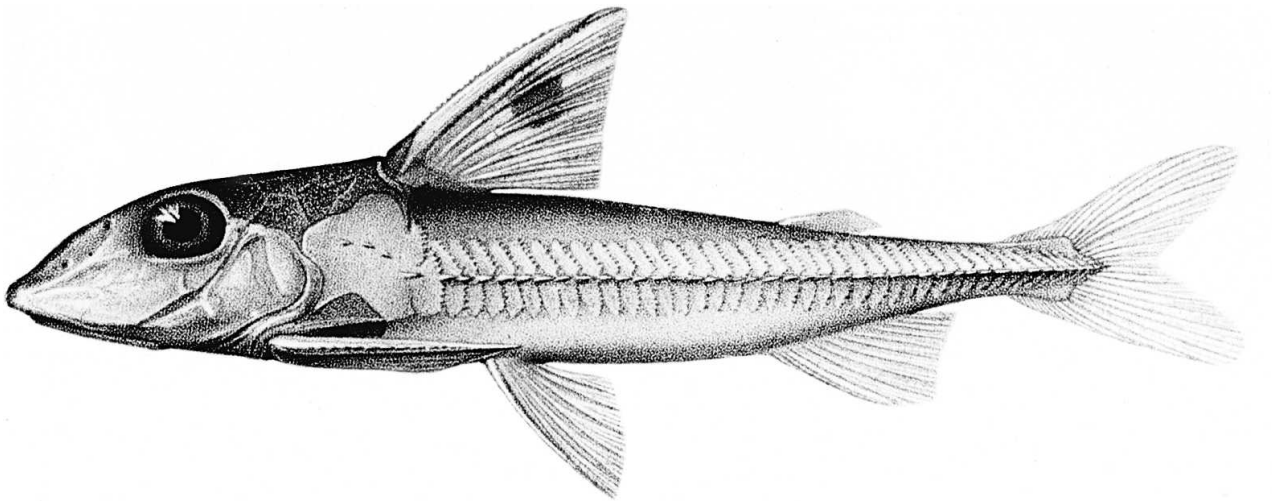

PHOTOGRAPHIC ATLAS OF FISHES OF THE GUIANA SHIELD

Mark H. Sabaj Pérez

Introduction

The last decade or so has witnessed a surge in expeditions to both ichthyologically familiar and virgin waters in southeastern Venezuela, Guyana, Suriname, and French Guiana. Included are surveys of the Iwokrama Forest in west-central Guyana (Watkins et al. 2005), retracing Carl Eigenmann's 1908 collecting route up the Essequibo to the Potaro River above Kaiteur Falls (Hardman et al. 2002), and rapid assessments targeting species-rich waters such as the upper Essequibo Basin, Guyana (Lasso et al. 2008), Coppename Basin, Suriname (Berrenstein 2005, Alonso & Berrenstein 2006, and references therein), and Venezuelan states of Amazonas (Lasso et al. 2006, and references therein), and Bolívar (Machado-Allison et al. 2003). Systematic fish inventories of French Guiana began over 50 years ago (see references in Vari & Ferraris, this volume), and have been recently expanded by French and Swiss ichthyologists to include ecological (e.g., Lord et al. 2007) and molecular data, the latter to investigate the origins of the Guianas' highly diversified fish fauna (Cardoso & Montoya-Burgos 2009). Explorations of remote Shield regions in search of undescribed catfishes (Sabaj Pérez et al. 2009) have assembled a parade of new taxa led by the sucker-mouth armored siluriforms in the family Loricariidae. Fifteen new loricariid species from Guyana, Suriname, and Amazonas, Venezuela, have been described in the last five years (e.g., Werneke et al. 2005, Armbruster et al. 2007, de Chambrier & Montoya-Burgos 2008, Lujan et al. 2009) with many more discoveries awaiting description.

This impressive amount of fieldwork has significantly advanced our taxonomic understanding of fishes in the Guianas; nevertheless, much must still be accomplished. Expeditions to remote, previously unsampled waters, particularly headwater systems above waterfalls or large cataracts, routinely yield new and sometimes enigmatic ichthyofaunas (Taphorn et al. 2008; Lujan, pers. comm.; pers. obs.). More comprehensive collecting efforts (e.g., night sampling) in relatively well-sampled waters have uncovered new species that escaped prior efforts (e.g., Armbruster et al. 2000; pers. obs.). Fieldwork aside, there exists in museums a wealth of specimens of Guianas fishes that require critical evaluation. The rich and complex diversity of fishes in the Guianas, and their systematic placement in the greater context of the Neotropical fauna, will remain a lodestone for ichthyological studies in decades to come.

Scope

The plates present 130 individuals representing 127 species of 46 families. Fishes were collected in Guyana (53 species), Suriname (36) and Amazonas State, Venezuela (38) from 1985 to 2008. Most of the species occur on or immediately peripheral to the Guiana Shield, with a few species restricted to lowland, coastal habitats in fresh and/or estuarine waters (i.e., *Rhinosardinia amazonica*, *Sciades parkeri*, *Tomeurus gracilis*, *Anableps anableps*, *Polycentrus schomburgkii*).

Fishes were imaged live or shortly after death (89 species), or from specimens purchased at market (2), preserved in formalin (2), or stored in alcohol (34). Each image is identified in the plate description by taxon, condition of specimen at time of photo, museum and catalog number, size and sex (if so determined), current status of voucher if other than preserved whole in alcohol, and complete locality data. Depositories are The Academy of Natural Sciences, Philadelphia (ANSP), Auburn University Natural History Museum (AUM), Field Museum of Natural History (FMNH), Illinois Natural History Survey (INHS), Museo de Ciencias Naturales de la UNELLEZ, Guanare (MCNG), National Zoological Collection of Suriname (NZCS), and University of Guyana, Center for the Study of Biological Diversity (UG/CSBD). Photos are by author unless credited otherwise. Abbreviations in the text are: LEA – length to end of anal fin; SL – standard length; and TL – total length. Scale bars are presented only for those species in which that indicator was included in the original photograph.

Fish Photography

There is a variety of techniques for capturing high-quality color images of fishes, all of which have been vastly simplified and in many ways improved by the advent of digital technology. Most of the images presented here are of live (or recently so) and alcohol preserved specimens immersed in water in a glass phototank. Materials and methods are largely the same whether taken streamside of live specimens (Figs. 3, 4) or in the lab of preserved specimens (Fig. 5), except for the light source: ambient sunlight in the field vs. incandescent light in-doors. Other photographers have used electronic flashes (e.g., Jenkins & Burkhead 1994:129, Planquette et al. 1996:17) to produce stunning photos of live fishes in phototanks. I have not tried such techniques, but consider a cooperative sun to be equally effective and in some ways less burdensome. In any event, phototank-immersion remains the gold standard for *ex-situ* fish photography.

Phototank-immersion Method

This method involves three stages: equipment set up, specimen preparation, and image capture and editing.

Figure 3. Author using phototank-immersion method to photograph fish streamside in Mongolia. Photo by C. Sabaj Pérez.

The techniques described below follow a minimalist approach with some advice limited to the specific cameras and conditions involved. For a more sophisticated system and additional tips on fish photography see Jenkins & Burkhead (1994:127–130).

Equipment set up.—The phototank is made of ordinary plate glass bonded together with clear silicone adhesive. Outside dimensions (in inches) of the tanks used for the photos in this section are: 13.5 length × 10.25 height × 2.75 width (field and lab) and 15.75 length × 12.25 height × 3.5 width (lab only). Both are made from one-quarter inch thick glass, except one-eighth inch glass is used for the front plate of smaller tank. These dimensions are well suited for lateral and often dorsal/ventral views of small to medium-sized fishes up to about 300 mm total length and 63 mm width for smaller tank, and 370 mm total length and 75 mm width for larger. Two important factors compromise field utility of larger phototanks: the volume of water necessary to fill it and size of carrying case (see below). Each tank requires a separate glass plate to immobilize the subject. The free plate can be one-eighth (smaller tank) or one-quarter (larger) inch thick and is slightly shorter and deeper than the inside dimensions of the tanks (e.g., 13 × 10.25 and 15 × 12 inches for smaller and larger tank, respectively). Having smooth edges of all plates is recommended.

The tank should be filled with clear bottled or filtered/deionized tap water to minimize formation of air bubbles on specimen and glass. Stream or lake water is unsuitable because it lacks the desired clarity and suspended debris is a significant distraction in an otherwise good photo. Any water will accumulate debris over an extended photo session, and an ample supply of clean photo water must accompany long forays to remote locations.

In the lab the phototank is stationed between two pairs of incandescent bulbs positioned to the side and slightly above the top of the tank (Fig. 5). Polarizing filters are useful for reducing glare or overexposed hot spots on the specimen, particularly on the snout. When using sunlight, the tank is oriented to maximize the even distribution of light and minimize glare and shadows on the subject.

Selection of a camera is important, but the rapid pace of digital technology soon outdistances specific recommendations on make or model. By current standards a digital camera with a good optical zoom (6X and higher) that records images at or above resolutions of 12 Megapixels (MP) is generally a safe

Figure 4. Author photographing fish streamside in Guyana. Photo by J.W. Armbruster.

choice. Most of the photos herein were taken with a Nikon Coolpix E8700 (8 MP); others with this model's predecessors, the E4500 (4 MP) and older E995 (3.1 MP). The most recent photos, all of alcohol preserved specimens, were taken in the lab with a Nikon D90 D-SLR (12.3 MP) fitted with a 60 mm f/2.8G micro lens. Images taken with the E8700 contain a high level of sharp detail that is slightly exceeded by the D90 (or other cameras offering greater MP), particularly for small specimens. The differences, however, are only visible at high magnification or extremely large print sizes. The greatest advantage of the D-SLR design and micro lens is the enhanced ability to reliably focus on very small specimens. Any camera and lens should be thoroughly vetted by comparing published reviews (many available on-line), and then personally tested with the phototank-immersion method. A few digital cameras apparently have difficulties rendering a sharp specimen image through glass and water.

Additional essentials for basic set up are a tripod (mini-tripods are handy in the field; Figs. 3–5), 4-ply mat board in several background colors (e.g., flat black, dull light blue) and $3/16^{th}$ inch foam board with flat black surface for camera blind (sizes of all boards ideally fitted to carrying case), glass cleaner, and paper towels or lint-free cloth, both long and small forceps, large metal binder clips, 12-inch plastic metal rulers, stiff wire, an assortment of needles and insect pins, calipers, a system for tagging individual specimens (e.g., dymo-tags in pre-punched number series tied to strong twine), extra camera batteries and charger, memory cards and reader, and laptop computer for image storage. These essentials are best stored with the phototank in a crushproof and watertight carrying case. The smaller tank is ideal for field use as it requires less water and allows for co-storage of accessories and laptop in a small case suitable for carry-on luggage (see Fig. 3). Cameras are better stored separately to facilitate other uses and avoid residual moisture in the phototank.

Specimen preparation.—The overarching strategy when photographing fishes for identification purposes is to maximize the content and accuracy of information in the image. This aim determines which among multiple specimens is photographed, how it is illuminated and arranged for display, and which color background is used. Most striking are photographs of the most impressive specimens (i.e., in peak coloration and with fins and scales intact), but even the image of an impressive fish may be rendered less informative if the photograph is poorly composed.

Once a live or alcohol specimen is selected it is carefully inspected and cleaned of foreign debris. Mucous-laden skin and fins often attract distracting grit or other suspended particles, and cheesecloth fibers may adhere to preserved specimens. An anesthetized fish (e.g., with a few drops of clove oil) is quickly euthanized in a container of strong (30–50%) formalin. This often causes the body to straighten and fins to become completely erect. Otherwise the anesthetized specimen may be

Figure 5. Kyle Luckenbill photographing small alcohol-preserved specimen (above ruler) while holding polarizing filter in lab. Photo by author.

removed to a tray of shallow formalin wherein small forceps are carefully used to hold the fins erect without damaging them. The most important consideration when photographing live specimens is time; bright colors and iridescences are soon lost in formalin. Fatty skin, as in pseudopimelodid catfishes, also becomes opaque in formalin, obscuring any underlying color.

Once the specimen is flat with fins erect, it is carefully wedged between the front plate of the phototank and free plate of glass, the latter set at an angle and braced against metal binder clips either attached to the sides of the tank or loosely set between the free plate and back of tank (Fig. 3). Positioning laterally compressed fishes in this manner is easy. Dorsoventrally depressed specimens, particularly those with pectoral spines, require more attention to achieve a vertical lateral view. Maintaining pectoral spines folded against the body as one wedges the specimen between the two glass plates requires practice and patience. Long forceps, a metal ruler and stiff wire are useful tools for fine-tuning a specimen's posture, arranging long delicate features such as barbels, and dislodging air bubbles that form on the fish. Information content of a fish photo is diminished when the specimen is tilted or otherwise poorly positioned.

Preserved specimens offer fewer options for achieving an ideal photo-friendly posture. Laterally contorted specimens often can be made to appear more linear when tightly wedged between the two plates of glass. Issues that are more difficult arise with partial or complete folding of fins. In some cases insect pins (carefully inserted in the body opposite the side to be imaged) may be used to prop up the anterior most portions of fins. This technique, however, may cause small tears in the fin membranes.

Next is selection of an appropriate background. Many specimens, particularly dark ones with opaque fins, often render best with more dramatic effect against flat black backgrounds. This may pose a serious drawback for specimens with relatively transparent fins. Black pigment in fin membranes or along distal fin margins disappears against dark backgrounds. In such cases, a light blue background provides better contrast and will highlight dark pigmentation in fins. Conversely, transparent fins lacking pigmentation and with clear margins, particularly in live specimens, are often lost against light backgrounds. This can be alleviated to a certain degree by adjusting the tank relative to light source to achieve a small measure of direct side or back lighting. While it is true that graphics editing software (e.g., Vertus Fluid Mask) can virtually affect any color background, specimens may not appear natural if the new background deviates sharply from the original (i.e., black to

white and vice versa). Choice of background color often involves trade-offs, and is ultimately a reflection of personal taste determined via trial and error.

The final step is placement of a scale bar. This is accomplished by cutting out a 10+ mm portion of a plastic ruler, dipping it in water and adhering it to the outside front of the phototank beneath the specimen and within the photographic field.

Image capture and editing.—The camera is mounted on a tripod, as most exposures are too long to permit hand-held use, and positioned behind a black foam board with central circular aperture fitted to lens. The blind prevents the phototank glass from reflecting the images of camera and photographer. Whether horizontal or angled the specimen should occupy about 90% of the length of the digital image recorded. To preserve detail in extremely long and slender fishes (e.g., belonids; Pl. 14, Fig. E) the specimen is imaged in two aligned and overlapping parts (anterior and posterior halves) that are digitally combined. The shutter is placed on a timer delay and white balance set appropriately (e.g., sunlight vs. incandescent).

Digital photography frees one from limits imposed by the amount of available film and developing costs. In the field, particularly while the sun is dodging clouds, it is advisable to take multiple photos for each of several combinations of exposures and apertures (f-stops). Full sunlight often highlights fine structures (e.g., odontodes in loricariids), but at the same time may wash out bright colors or result in overexposed hot spots on the snout or dorsum. The phototank should be carefully oriented with respect to the light source, and extra mat boards used to shadow harsh sunlight and maintain vibrant colors (Fig. 3).

For the Coolpix E8700 in manual mode, the shutter speed is set such that the target aperture (i.e., lower f-stops) lies between f-stops 5 and 7; larger apertures reduce depth of field, and smaller apertures tend to reduce resolution. The Nikon D90 D-SLR better accommodates smaller apertures (f-stop fixed at 16 with ISO set to 200), and the shutter speed is manually adjusted for the best exposure. Autofocus generally works fine as long as the active area of focus includes important features on the fish, not the scale bar or background. Digital cameras typically have a setting whereby the user determines the active area of autofocus. Depending on specimen size, the camera may need to be manually set to macro mode, and some cameras (e.g., Nikon CoolPix) also require one to slightly zoom in on subject for sharp autofocus. Nikon images presented here are of Fine quality (recorded as JPEGs with compression ratio of roughly 1:4) and maximum size (3264×2448 and 4288×2848 pixels for E8700 and D90, respectively). Higher quality settings record either uncompressed TIFF or RAW (NEF) images, the latter requiring extra software and computing time for conversion to TIFF files (Nikon D90 allows one to record NEF and Fine JPEG images concurrently). TIFF and RAW files retain the full quality of the image and the latter maximizes allowable post exposure processing, whereas JPEGs are compressed often with some visual quality permanently lost in the process (the loss, however, is barely perceptible). Larger image files (NEF, RAW, TIFF) do offer slightly higher resolution, but the improvement is often negligible, except at high magnification. For any camera, there is no substitute for testing a variety of settings and image qualities to optimize the desired effect and protocol.

While photographing a specimen it is difficult to know which image will optimize the desired effect; so, it is best to have ample images from which to choose. The number of images I generally take is directly proportional to the impressive and unique nature of the specimen added to the amount of time expended to pose it properly in the phototank. It is easy to accumulate many photos of numerous species, thus it is critical to have a system for later identification and management of images. Failure to do so guarantees extra time and often frustration when attempting to match images to specimens long after capture. The best field solution is to take a final photo of the specimen together with a uniquely numbered tag that is then secured to the fish. In the case of museum specimens, the jar label is photographed immediately after imaging the fish. A photo-log is useful for recording the standard length of the specimen. Such practices greatly facilitate subsequent annotation of images with catalog and measurement data. A new and much welcomed trend in digital cameras is a built in or accessory global positioning system (GPS) receiver that records and embeds latitude, longitude, altitude and universal time as image metadata.

The final step is image editing, all of which was performed on the photos in this section using Adobe Photoshop. This program offers a seemingly endless myriad of simple to advanced tools for graphics manipulation. Only a few of the more basic tools and techniques are mentioned briefly here.

Once an image is selected the background (original) layer is immediately duplicated and subsequent edits are made to the duplicate layer. A third blank layer is added to mask the specimen with a uniform background. Masking color (e.g., solid black or white, or a color shade taken from the original background using the eyedropper tool) is first added as a rough outline using a large diameter pencil tool, and then completed with a fine-tipped brush (1–10 pixels) under magnification (e.g., $\geq$300%) to carefully trace the specimen's precise contours. The magic wand and/or magnetic lasso are more expedient, yet less precise, tools for masking the specimen with a uniform background. Next, the duplicate layer is automatically and manually

adjusted for levels (tonal range and color balance), brightness/contrast, and hue/saturation. The auto options often render extreme values that are manually faded to desired opacity before additional manual fine-tuning. The cloning stamp tool is useful for removing small bubbles or debris on the specimen, while the dodge and burn tools help lighten or darken localized regions (brush size/shape and exposure/opacity of such tools are manually adjusted). Under the Filter menu 'Sharpen>Unsharp Mask' can sharpen an image with soft focus, and 'Noise>Despeckle' removes graininess, particularly for images scanned from 35 mm slides.

One final trick is to render a solid scale bar by: 1) rotating the entire image so the ruler piece in the photograph is horizontal, 2) using the rectangular marquee tool to select and copy a 5 or 10 mm long portion, 3) rotating the entire image back to its final intended position, 4) pasting the copied selection, thereby creating a new layer, and 5) adjusting the brightness/contrast of this layer to extreme values to render a black or white bar that is then labeled accordingly with the text tool.

The final edited version of the specimen image (i.e., duplicate layer) can be quickly compared to the original by using the layers window and clicking the 'eye' icon to hide or display the corresponding layer. Creation of additional layers requires the new image to be saved as an uncompressed TIFF file that is suitable for archiving and any additional post processing. A copy of the final edited image is flattened to a single layer and resaved as a TIFF for print publication (with Image>Mode set to Grayscale, RGB, or CMYK color based upon printer specifications) and separately as a JPEG (with Mode set to 8 bits/channel) for use in presentations or easy transmission and accession via the Internet.

In sum, a high-quality fish photo is the product of preparation, practice, and patience all committed with keen attention to detail. Additional factors in the field are perseverance under suboptimal conditions and a bit of luck with respect to weather and finding the ideal specimen. The amount and quality of the images presented herein had more to do with will than skill.

Acknowledgments

Numerous colleagues contributed valuable assistance both before and after the shutter click. For assistance in the field I wish to thank in particular: Mariangeles Arce, Jonathan Armbruster, Michael Hardman, Oscar J. León-Mata, Nathan Lujan, John Lundberg, Jan Mol, Matthew Thomas, David Werneke, and Philip Willink. For loans of specimens I thank Michael Retzer, and for help tracking down specimens and taking measurements I thank Osvaldo Oyakawa and especially Nathan Lujan. For help cleaning backgrounds I thank Kyle Luckenbill and Rebecca Meyer. Special thanks to Pierre-Yves le Bail, Raphaël Covain and Juan Montoya Burgos for comments on the introduction, and to Jonathan Armbruster, Hernán López-Fernández, Nathan Lujan, Donald Stewart, and Donald Taphorn for graciously contributing their images to this atlas. Finally I thank my ichthyological friends for years of help identifying many of the fishes presented here. Support for this project was received in part from the All Catfish Species Inventory (NSF DEB-0315963).

Literature Cited

Alonso, L. E., & H. J. Berrenstein (eds.). 2006. A rapid biological assessment of the aquatic ecosystems of the Coppename River Basin, Suriname. RAP Bulletin of Biological Assessment 39. Conservation International, Washington, D.C., 119 pp.

Armbruster, J. W., N. K. Lujan, & D. C. Taphorn. 2007. Four new *Hypancistrus* (Siluriformes: Loricariidae) from Amazonas, Venezuela.—Copeia 2007(1):62–79.

———, M. H. Sabaj, M. Hardman, L. M. Page, & J. H. Knouft. 2000. Catfish genus *Corymbophanes* (Loricariidae: Hypostominae) with description of one new species: *Corymbophanes kaiei*.—Copeia 2000(4):997–1006.

Berrenstein, H. J. 2005. Field guide to the freshwater fishes of the Central Suriname Nature Reserve (CSNR), (Coppename River Basin, Suriname). Conservation International Suriname, Paramaribo, 96 pp.

Cardoso, Y. P., & J. I. Montoya-Burgos. 2009. Unexpected diversity in the catfish *Pseudancistrus brevispinis* reveals dispersal routes in a Neotropical center of endemism: the Guyanas Region.—Molecular Ecology 18(5):947–964.

de Chambrier, S., & J. I. Montoya-Burgos. 2008. *Pseudancistrus corantijniensis*, a new species from the Guyana Shield (Siluriformes: Loricariidae) with a molecular and morphological description of the *Pseudancistrus barbatus* group.—Zootaxa 1918:45–58.

Hardman, M., L. M. Page, M. H. Sabaj, J. W. Armbruster, & J. H. Knouft. 2002. A comparison of fish surveys made in 1908 and 1998 of the Potaro, Essequibo, Demerara, and coastal river drainages of Guyana.—Ichthyological Exploration of Freshwaters 13:225–238.

Jenkins, R. E., & N. M. Burkhead. 1994. Freshwater fishes of Virginia. American Fisheries Society, Bethesda, Maryland, 1080 pp.

Lasso, C. A., J. C. Señaris, L. E. Alonso, & A. L. Flores (eds.). 2006. Evaluación rápida de la biodiversidad de los ecosistemas acuáticos en la confluencia de los ríos Orinoco y Ventuari, Estado Amazonas (Venezuela). Boletín RAP de Evaluación Biológica 30. Conservation International, Washington, D.C., 240 pp.

Lasso, C. A., J. Hernández-Acevedo, E. Alexander, J. C. Señaris, L. Mesa, H. Samudio, J. Mora-Day, C. Magalhaes, A. Shushu, E. Mauruwanaru, & R. Shoni. 2008. Aquatic biota: fishes, decapod crustaceans and mollusks of the upper Essequibo Basin (Konashen COCA), Southern Guyana. Pp. 43–54 *in* L. E. Alonso, J. McCullough, P. Naskrecki, E. Alexander, & H. E. Wright, eds., A rapid biological assessment of the Konashen Community-Owned Conservation Area, Southern Guyana. RAP Bulletin of Biological Assessment 51, Conservation International, Washington, D.C.

Lord, C., Y. Fermon, F. J. Meunier, M. Jégu, & P. Keith. 2007. Croissance et longévité du Watau yaike, *Tometes lebaili*

(Serrasalminae), dans le bassin du Haut Maroni (Guyane française). Résultats préliminaires.—Cybium, 31(3):359–367.

Lujan, N. K., M. Arce, & J. W. Armbruster. 2009. A new black *Baryancistrus* with blue sheen from the upper Orinoco (Siluriformes: Loricariidae).—Copeia 2009(1):50–56.

Machado-Allison, A., B. Chernoff, F. Provenzano, P. W. Willink, A. Marcano, P. Petry, B. Sidlauskas, & T. Jones. 2003. Inventory, relative abundance and importance of fishes in the Caura River basin, Bolívar State, Venezuela. Pp. 64–74 *in* B. Chernoff, A. Machado-Allison, K. Riseng, & J. R. Montambault, eds., A biological assessment of the aquatic Ecosystems of the Caura River Basin, Bolívar State, Venezuela. RAP Bulletin of Biological Assessment 28. Conservation International, Washington D.C. 284 pp.

Planquette, P., P. Keith, & P.-Y. Le Bail. 1996. Atlas des poissons d'eau douce de Guyane. Volume 1, Collection du Patrimoine Naturel, vol. 22. Institut d'Ecologie et de Gestion de la Biodiversité du Muséum National d'Histoire Naturelle, Institut national de la Recherche Agronomique, Conseil Supérior de la Pêche, Paris, 429 pp.

Sabaj Pérez, M. H, J. W. Armbruster, C. J. Ferraris, Jr., J. P. Friel, J. G. Lundberg, & L. M. Page (eds.). 2009. All Catfish Species Inventory. Internet address: http://silurus.acnatsci.org.

Taphorn, B. D. C, H. López-Fernández, & C. R. Bernard. 2008. *Apareiodon agmatos*, a new species from the upper Mazaruni river, Guyana (Teleostei: Characiformes: Parodontidae).—Zootaxa 1925:31–38.

Watkins, G., W. Saul, E. Holm, C. Watson, D. Arjoon, & J. Bicknell. 2005. The fish fauna of the Iwokrama Forest.—Proceedings of the Academy of Natural Sciences of Philadelphia 154(1):39–53.

Werneke, D. C., M. H. Sabaj, N. K. Lujan, & J. W. Armbruster. 2005. *Baryancistrus demantoides* and *Hemiancistrus subviridis*, two new uniquely colored species of catfishes from Venezuela (Siluriformes: Loricariidae).—Neotropical Ichthyology 3(4):533–542.

Plate 1

Potamotrygonidae

A. *Paratrygon aiereba* (live). AUM 43646 (154 mm maximum disk width). Venezuela, Amazonas, Río Negro (Amazonas drainage), left bank sandy beach and small adjacent backwater 7.2 km NW of San Carlos de Rio Negro, 01°58′11″N, 067°06′10″W, 19 Mar 2005, M. Sabaj, D. Werneke et al.

B. *Potamotrygon orbignyi* (live). AUM 43201 (171 mm maximum disk width). Venezuela, Amazonas, Río Orinoco ca. 60 km E of San Fernando de Atabapo, 03°58′26″N, 067°09′46″W, 3 Mar 2005, M. Sabaj, N. Lujan, D. Werneke et al.

C. *Potamotrygon marinae* (live). ANSP 187098 (400 mm maximum disk width). Suriname, Sipaliwini, Lawa River (Marowini drainage), ca. 8 km S-SW of Anapaike/Kawemhakan (airstrip), 03°19′31″N, 054°03′48″W, 18 Apr 2007, J. Lundberg, J. Mol, M. Sabaj, P. Willink, & K. Wan.

D. *Potamotrygon schroederi* (live). AUM 44507 (423 mm maximum disk width). Venezuela, Amazonas, Río Orinoco, island W of Puerto Venado, 4.5 km S of Samariapo, 56.5 km SW of Puerto Ayacucho, 05°12′25″N, 067°48′32″W, 28 Feb 2005, M. Sabaj, N. Lujan, D. Werneke et al.