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A new species of *Bedotia* (Teleostei: Atherinomorpha: Bedotiidae) from the Rianila drainage of Eastern Madagascar, with redescriptions of *Bedotia madagascariensis* and *Bedotia geayi*

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Abstract

Bedotia madagascariensis Regan 1903, type species of the genus and *B. geayi* Pellegrin 1907 are redescribed from recently collected topotypical material. The two species differ significantly with respect to their life colors, the lengths of the head, snout, caudal peduncle and bases of the second dorsal and anal fins as well as their second dorsal and anal fin ray counts. The aboriginal range of *B. madagascariensis* comprises eastward flowing streams from the Ivoloina River southward to Manambolo Creek inclusive of small streams flowing into the coastal lakes of the Pangalanes system situated between them, where it occurs up to an altitude of 30 m above sea level. A naturalized population is present in the westward-flowing Betsiboka drainage. *Bedotia geayi* is only known from the eastward-flowing Mananjary River, where it can be found in small streams between 300 m and 600 m above sea level. A second species of *Bedotia* from the Rianila basin is described. *Bedotia leucopteron sp. nov.* is found in shaded streams between 100 m and 850 m above sea level. The wide, iridescent white margins of the unpaired fins taken in combination with a melanophore pattern consisting of small, irregular black spots stochastically distributed over the flanks rather than a distinct midlateral band differentiate living individuals from all known congeners. Data on the natural history and conservation status of all three species are presented.

Résumé

Bedotia madagascariensis Regan 1903, espèce-type du genre et *B. geayi* Pellegrin 1907 sont ré-décrits de matière topotypique récemment collectioné. Les deux espèces diffèrent considérablement par rapport à leur coloris à l'état vivant, la longueur de la tête, du museau, du pédoncule caudal et de la base de la deuxième nageoire dorsale et de la naqeoire anale aussi bien que le nombre des rayons de ces deux nageoires. L'aire de repartition originelle de *B. madagascariensis* comprend des fleuves du versant oriental de l'Ivoloina jusqu'á la Rivière Manambolo, y compris les petits ruisseaux qui coulent dans les lacs côtiers du système des Pangalanes situés entre leurs embouchures, où il est présent jusqu'à une altitude de 30 m au-dessus du niveau de la mer. Une population naturalisée existe dans le bassin du Betsiboka, le fleuve le plus important du versant occidental. *Bedotia geayi* n'est connu que du bassin du fleuve Mananjary, où il habite les petits ruisseaux entre 300 m et 600 m au-dessus de niveau de la mer. Une nouvelle espèce de *Bedotia* est décrite de la cuvette de la Rianila. *Bedotia leucopteron* sp. nov. habite les ruisseaux ombragés entre 100 m et 850 m au-dessus de niveau de la mer. Les marges blanches larges et iridescents de ses nageoires depareillés pris avec un patron mélanique qui comprend des petits taches noires irrégulièrement distribuées sur les flancs plutôt que des bandes longitudinales distincts différencie des individus vivants de tout les autres espèces du genre connues. Des données sur l'histoire naturelle et statut de conservation de les trois espèces sont présentées.

Key words: *Bedotia*, Bedotiidae, biogeography, conservation, distribution, *B. geayi*, *B. leucopteron*, *B. madagascariensis*, Madagascar, natural history.

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Introduction

The atherinoid family Bedotiidae, endemic to Madagascar, comprises the genera *Bedotia* Regan 1903 and *Rheocles* Jordan and Hubbs 1919. Sixteen species of the genus *Bedotia* are presently recognized, of which only seven have been formally described. While descriptions published since the turn of the century (Stiassny and Harrison, 2000; Sparks, 2001; Sparks and Rush, 2005) are sufficiently detailed to permit unambiguous recognition of the species in question, this is not true of that of *Bedotia madagascariensis* Regan 1903, type species of the genus, or those of *B. geayi* Pellegrin 1907, *B. longianalis* Pellegrin 1914 and *B. tricolor* Pellegrin 1932. The material available to their authors was sparse and in several instances, in poor condition. Diagnostically important data on life coloration were likewise sparse, and in several instances, entirely lacking. The incomplete character of these descriptions complicates efforts to relate previously published species to more recently collected material. Given the magnitude of the threats to the survival of Madagascar's endemic fishes, this problem is of more than academic concern. Effective conservation planning for these fishes is impossible without either a clear understanding of the taxonomic status of the different populations of *Bedotia* or a precise picture of their geographic distribution.

We herein present a redescription of *B. madagascariensis* and *B. geayi* based upon recently collected material and describe a new species of *Bedotia* from the middle reaches of the Rianila drainage, together with data on the distribution and natural history of all three species.

Methods

Measurement of standard length, head length, snout length, eye diameter, and caudal peduncle length and depth follows Kottelat (1990) and Stiassny and Harrison (2000). Body depth is measured both at the origin of the pelvic fins and from the origin of the anal fin to that of the second dorsal fin. The distance from the snout to the first and second dorsal fin and to the anal fin is measured straight from the tip of the snout to a vertical through the base of the first ray of each fin. Anal and second dorsal fin length is measured from the base of the first ray to the base of the last. Morphometric data transformed to percent standard length were tested for overall intergroup differences using MANOVA (SPSS Version 11.5). Significant differences were found between all three data sets (Wilks' $\lambda = .032$, df: 34,48, $p < .05$). Comparisons of character means were undertaken using one-way ANOVA and Tucky's HSD to test *post-hoc* for significant (p. 05) between-species differences. Osteological characters were examined using radiographs. Vertebral counts exclude the ural centrum. Descriptions of life colors are based upon the first author's field notes and photographs of either wild-caught specimens or their captive-bred progeny held under aquarium conditions.

Institutional abbreviations follow Leviton *et al.* (1985). Place names follow contemporary usage, as indicated by the Foiben-Taosarintanin'i Madagasikara. First use of a place name is followed by the equivalent colonial-era name previously utilized in the literature within brackets. Altitudes are given in meters above sea level.

Bedotia madagascariensis Regan 1903

Bedotia madagascariensis Regan 1903: 416, pl. 14, fig. 2. Madagascar, eau douce. (Madagascar, fresh water). Holotype: MHNG 0665.007.

Diagnosis

Bedotia madagascariensis belongs to the group of species whose color pattern in life is based upon two dark lateral stripes clearly expressed in both sexes. This feature unambiguously distinguishes it from conge-

ners in which the lateral stripes are either replaced by a pattern of dark spots or are altogether lacking in one or both sexes. It is readily distinguished from its laterally stripped congeners by its caudal fin coloration, which consist of an extensive hyaline to iridescent yellow-white basal zone, a crescent-shaped black median band and broad red or white tips. Low second dorsal [10–12 (mode: 11)] and anal [14–17 (mode: 16)] fin ray counts are diagnostic for preserved specimens. Morphometric features that distinguish this species from *B. geayi* are presented in Table 3.

Description

Morphological measurements and meristic counts are given in Table 1. Although *Bedotia madagascariensis* can grow to 100 mm SL in captivity, largest specimen examined in this study is a 85.9 mm SL male. This is a robust, relatively long-bodied species somewhat deeper-bodied anteriorly and showing a moderately curved ventral outline. Dorsal outline of head and nape moderately curved to first dorsal fin. Head length divisible 3.1-4.4 times in the standard length. First dorsal origin is posterior to the vertical through the pelvic fin insertion, while that of the second dorsal is posterior to the vertical through the anal fin origin.

Snout is slightly indented behind the premaxillary pedicels. Snout length divisible 2.9–3.4 times in the head length. Lower jaw is moderately prognathous and angled at about 35°–40° to horizontal when mouth is closed. Premaxilla and maxilla reach the anterior margin of the orbit. Premaxilla with the distinct lateral "*Bedotia* notch" characteristic of the genus (Stiassny, 1990). Orbital diameter divisible 2.9–3.8 times in the head, 1.0–1.1 times in the snout length.

Teeth. Anteriorly both upper and lower jaws bear 4 to 6 rows of numerous small, strongly recurved unicuspid teeth. The outermost row of teeth is poorly differentiated from those of the inner band. The lower jaw and the premaxilla posterior to the *Bedotia* notch each have a single row of teeth. A single row of teeth is present along the anteroventral face of the vomer. Small patches of teeth are present on the endopterygoid. No ectopterygoid teeth present, at least in individuals of sizes available for examination.

TABLE 1. Morphometric data for *Bedotia madagascariensis* as % SL.

Character	N	Range	Mean	SD
Standard length [mm]	16	39.4–73.6		
Head length	16	27.2–31.8	30.0	1.1
Snout length	16	8.0–10.2	9.4	0.5
Lower jaw length	16	13.3–17.2	15.9	0.9
Orbital diameter	16	8.2–10.1	8.9	0.6
Interorbital distance	16	10.9–12.4	11.3	0.4
Pectoral fin length	16	15.6–21.6	18.3	1.5
$Dorsal_1$ – anal fin depth	15	21.2–25.0	23.2	1.3
$Dorsal_2$ – anal fin depth	15	20.7–25.5	23.2	1.5
Pre-$dorsal_1$ distance	16	53.4–56.0	54.7	0.7
Pre-$dorsal_2$ distance	16	65.0–69.2	67.0	1.1
Pre-pelvic distance	16	41.2–45.6	44.2	1.1
Base $dorsal_2$	16	15.9–18.7	17.6	0.9
Base anal	16	22.3–27.2	24.7	1.4
Length caudal peduncle	16	16.1–20.4	17.4	1.1
Depth caudal peduncle	16	9.2–10.5	10.0	0.4

Gill rakers. Two or three stout hypobranchial rakers and 9-13 (mode: 10) elongate ceratobranchial rakers are present on the lower limb of the first branchial arch. All rakers are strongly denticulate.

Scales. Body is fully covered with large, regularly imbricate, cycloid scales. Predorsal scales along the dorsal midline 15–16 (mode: 15). Scales along the midlateral axis from just behind the operculum, above the pectoral fin, to the end of the hypural plate: 33–35 (mode: 34). Scales in transverse series between the origins of the anal and the second dorsal fins (including a very small scale adjacent to each fin) 9–10 (mode: 9). Scales separating the first and second dorsal fins: 3–4. Circumpeduncular scales: 12. Dorsal, anal, and caudal scale sheaths and axillary pelvic scales are absent.

Fins. First dorsal fin with 4–5 (mode: 4) weak spines. Second dorsal fin rays: 10-12 (mode: 11), the first 4 or 5 unbranched. Anal fin rays: 14–17 (mode: 16), usually the first 3 or 4 unbranched. Pectoral fins short, high-set with 12 rays, the longest barely reaching the vertical from the pelvic fin insertion. Pelvic fins with one weak spine and five strongly bifurcate, branched rays. Caudal fin weakly emarginate.

Vertebrae. Total vertebral count taken from radiographs: 34–36 (mode: 35) and terminal, hypural-bearing half centrum. Precaudal vertebrae: 17–19 (mode: 19). Caudal vertebrae: 16-18 (mode: 16).

Viscera and Diet. Gut extremely short, intestinal length only about one-third body length. Examination of feces produced by newly caught specimens within two to four hours of capture revealed the remains of terrestrial insects, suggesting that this species exploits primarily allochthonous food sources.

Coloration

Living specimens: Figure 1 depicts a young pair of captive-bred *B. madagascariensis* descended from founders collected at Ambila-Lemaitso. The sexually dimorphic color pattern of the fins is clearly evident. All populations studied to date are characterized by male polymorphism with regard to the coloration of the unpaired fins. Their usual coloration is based upon discrete zones of red, yellow and black. First dorsal fin and ventral fins dusky distally, hyaline to metallic golden yellow basally. Second dorsal is metallic golden yellow basally, with a dark red margin and broad black submarginal band. Anal fin similarly colored, but a metallic golden yellow zone is sandwiched between a narrow black basal and a broader black submarginal band. The extension of the black midlateral band at the caudal base surrounded by an iridescent silvery white to metallic golden yellow halo, bordered in turn by a broad sooty black crescent-shaped band. Upper and lower distal caudal margins either dark red or iridescent white. However, the vertical fins of some males are uniformly red and black, or the yellow coloration is replaced by iridescent white. Within a given population, the representation of each color morph can vary from one year to the next.

FIGURE 1. Young pair of the aquarium strain of *Bedotia madagascariensis*, male top right. Not preserved.

In females, first dorsal fin dusky distally, clear yellow basally. Second dorsal whitish yellow basally, with an iridescent white margin and broad black submarginal band. Anal fin is similarly colored, but the lighter zone is sandwiched between narrow black basal and submarginal bands. The extension of the black midlateral band at the base of the caudal surrounded by a hyaline halo, bordered in turn by a broad sooty black crescent-shaped band. The upper and lower distal margins of the caudal clear yellow shading to iridescent white.

The pectorals of males are hyaline with a dark spot on their distal tip, those of females uniformly hyaline.

Preserved specimens: The holotype of *B. madagascariensis* retains little of the species-typical melanophore pattern (Figure 2.). Dorsum warm brown shading to pale beige on the flanks and white on the venter. Top of the head warm brown, shading to beige on the cheeks and operculum. A narrow dark stripe extends from the tip of the snout to the angle of the operculum. Here it becomes a midlateral stripe two scale rows deep that extends from the margin of the operculum to the caudal peduncle and is a more diffuse form, extends onto the caudal fin for about half its length. The midlateral stripe is sometimes interrupted along its posterior third. The lower dark lateral stripe is usually evident only in recently preserved material. In males, first dorsal and ventrals are uniform clear grey, second dorsal and anal clear grey basally, hyaline distally, with narrow black basal stripes and variably expressed black submarginal stripes. In females, dorsal and anal fins uniformly hyaline. Caudal hyaline in both sexes, marked with a black crescent-shaped marking medially that is narrower and less intense in females.

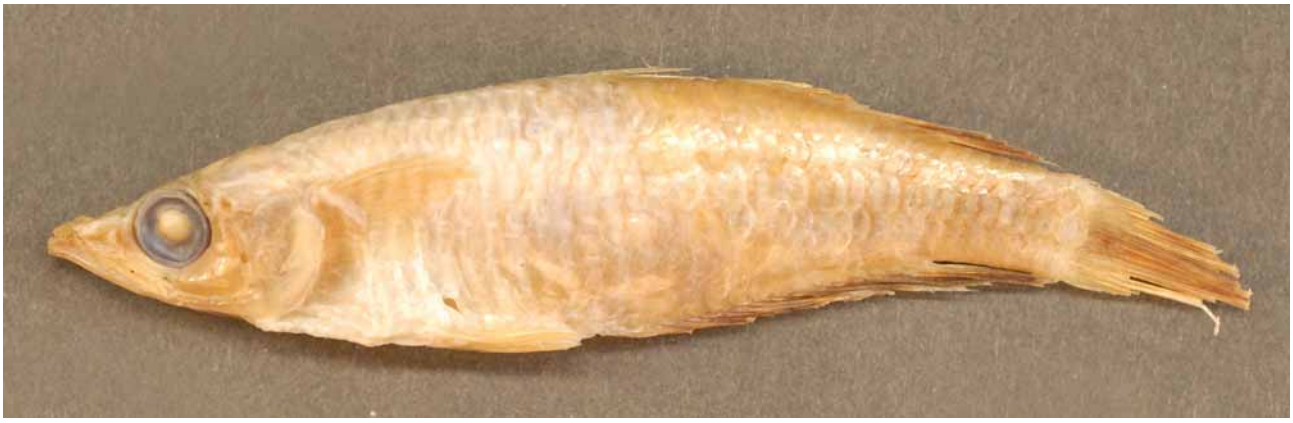

FIGURE 2. *Bedotia madagascariensis*, holotype, MHNG 0665.007.

Range

The type of *B. madagascariensis*, a single specimen 90.0 mm TL, was donated to the Museum of Natural History in Geneva by a Swiss visitor to Madagascar. In the original description (Regan, 1907), the type locality of this species is given only as "Madagascar; eau douce.". In a subsequent paper, Regan (1920) identified a series of specimens from Lac Rasoabe, next to the last lake of the series extending southward from Toamasina (Tamatave) to Andovoranto, at the mouth of the Rianila River, as *B. madagascariensis*. Prior to the completion of the railroad connecting Toamasina to Antananarivo, the initial stage of this journey entailed travelling by boat for several days along the Lakendrano Mpangalana (Pangalanes Canal) from Toamasina to the town of Andovoranto, thence up the Iaroka River to the head of navigation at Maromby. Such an itinerary would have afforded ample opportunity to secure specimens by either capture or purchase, for *Bedotia* remain abundant in this region of Madagascar and are still marketed for human consumption. As *B. madagascariensis* is replaced by the very differently colored *Bedotia leucopteron* sp. nov. in the middle reaches of the Iaroka-Rianila drainage, the type material of this species could only have come from one of the many small streams flowing into this interconnected series of large coastal lakes.

The present range of *B. madagascariensis* extends from the lower reaches of the Ivoloina River, the effective northern terminus of the Lakendrano Mpangalana, at least as far south as Manambolo Creek, which

drains into the Lakendrano Mpangalana 10 km south of the town of Vatomandry (Figure 3.). South of this point and in the middle and upper reaches of the Ivoloina River, *B. madagascariensis* is replaced by undescribed congeners. In the rivers to the north of the Ivoloina River, it is replaced by *Bedotia longianalis* Pellegrin, 1914.

In the 1950's, this species was translocated to marshes near the village of Mahitsy, just outside of Antananarivo in the upper reaches of the westward-draining Betsiboka River (Kiener, 1963). The exercise was successful and the translocated fish bred freely. The recent capture of juvenile *B. madagascariensis* in the rapids of the Ikopa River near the village of Antanimbary and of adult fish in Lanefitra Creek at Ankadibe Village, several hundred kilometers to the west, suggests that this species is now widely established in the Betsiboka basin.

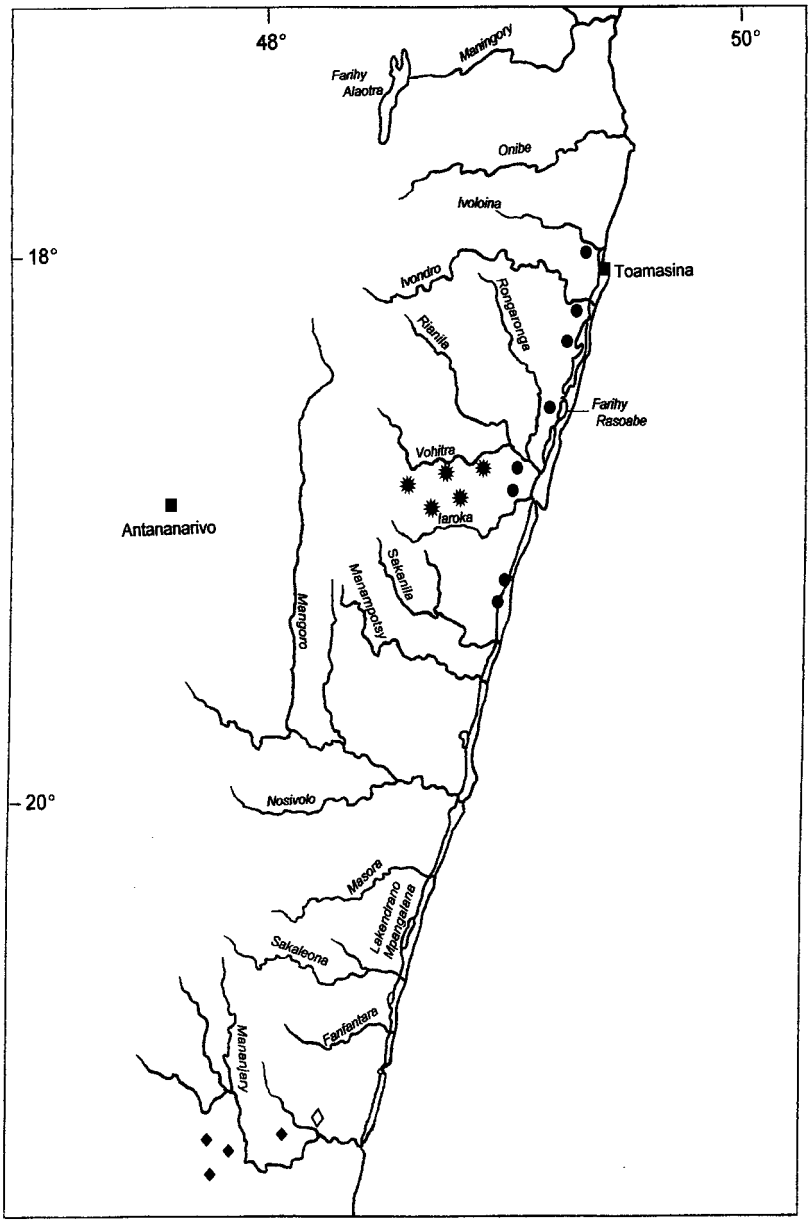

FIGURE 3. Distribution of *B. madagascariensis* (●), *B. geayi* (◇, type locality; ◆) and *B. leucopteron* sp. nov. (✹).

Natural History

Within its aboriginal range, *Bedotia madagascariensis* inhabits clear streams flowing under partial or complete forest cover at altitudes up to 30 meters above sea level. As long as the stream is shaded, this species

appears indifferent to the composition of the riparian vegetation, prospering even when it is comprised entirely of exotic species. Although capable of breasting a fairly strong current, *B. madagascariensis* prefers the quieter sections of well-shaded streams. Rivers draining the eastern versant of Madagascar are characterized by extremely soft water (General hardness [GH]:< 17.1 ppm, electrical conductivity 17.0–27.0 μmho/cm^2). It is thus not unusual to find this species inhabiting classic black water habitats such as *Dracaena/Pandanus* swamps, where pH values can be as low as 4.8. Although salinity levels up to 5.0 parts per thousand are tolerated in captivity, *B. madagascariensis* does not enter brackish water in nature. Water temperatures measured during the month of October in the habitats it frequents ranged from 23°-32° C.

Bedotia madagascariensis is typically observed in loose, size-graded associations of up to several dozen individuals. Juveniles are usually found in the shallows, while adults frequent deeper water away from the banks. There are no published data on the reproductive behavior of this species in nature. Collections made in October, towards the end of the dry season, include juvenile fishes as small as 2.0 cm TL. Taken with what is known of its growth rate in captivity, this suggests that *B. madagascariensis* enjoys a protracted breeding season in nature.

Prior to the introduction in the early 1970's of the spotted snakehead, *Channa maculata*, the only fish large enough to prey upon *B. madagascariensis* were cichlids of the genus *Paratilapia*, flagtails of the genus *Kuhlia*, the endemic grunter *Mesopristes elongatus*, *Glossogobius giuris*, and eels of the genus *Anguilla*. This species is also vulnerable to piscivorous wading birds and the Malagasy malachite kingfisher, *Corythornis vintsioides*. Despite its relatively small size, there is an active artisanal fishery for *B. madagascariensis* over most of its range. In captivity, individuals of this species can live for up to ten years. Predation pressure in all probability precludes comparable longevity in nature.

Conservation Status

A popular ornamental fish, *B. madagascariensis* is globally a low-risk species. Indeed, the number of individuals produced annually for the aquarium trade by commercial breeders in the Far East may well equal the number living in the wild. Although local informants consistently indicate that *B. madagascariensis* is less abundant than formerly, this species does not appear to be seriously endangered in nature. While *Bedotia* are usually considered to be forest-dependant fishes (Pellegrin, 1933; Arnoult, 1959; Kiener, 1963) *B. madagascariensis* has managed to cope well with the elimination of primary forest over much of its range. It is perhaps more accurate to describe this and other bedotiids as shade rather than forest dependant. This explains their persistence in streams where the riparian vegetation consists entirely of such exotic species as torch ginger, banana, lantana and Chinese bamboo. In unshaded or extremely turbid streams, this species is replaced by the naturalized poeciliids *Gambusia holbrooki* and *Xiphophorus maculatus*.

The chief threats to the survival of this species in the wild are the ongoing progressive degradation of its habitat, with concomitant risk of increased silt loading due to erosion and the inexorable spread of *C. maculata*. Unlike native piscivores, this exotic predator is not deterred by shallow water. Small streams thus afford *B. madagascariensis* no protection from its depredations, although the snakehead's dislike of rapidly flowing water affords those native fishes capable of coping with a pronounced current at least a partial refuge. Following the criteria established by the I.U.C.N., wild populations should be classified as vulnerable.

Discussion

In 1953, Arnoult shipped live *Bedotia* collected from the town of Ambila-Lemaitso to France. This town is located on the shore of Lake Anjanaborona, which lies immediately to the south of Lake Rasoabe. They were introduced to the aquarium hobby under the name *Bedotia geayi*, notwithstanding the fact that the type series of *B. geayi* was collected from the Mananjary basin, several hundred kilometers to the south of Lake Rasoabe. The color pattern of male *Bedotia* recently collected from the Mananjary drainage differs significantly from that of Arnoult's fish in lacking a black submarginal zone in the caudal fin and in the absence of

yellow pigmentation in the dorsal and anal fins. Nor do the Manajary *Bedotia* display the red/white color polymorphism characteristic of the unpaired fins in *B. madagascariensis*. The two also differ with respect to a number of morphometric and merisitic characteristics (Table 3). We thus recognize the two taxa as specifically distinct and *B. madagascariensis* as the correct name for the species long sold as *B. geayi* in the aquarium trade.

***Bedotia geayi* Pellegrin 1907**

Bedotia geayi Pellegrin 1907: 205. Morafeno, dans les placers, à une altitude de 300 m environs, aux sources des ruisseaux de la Haute-Maha, affluent du Bas-Mananjary. (Morafeno, at approximately 300 m altitude, over sand bottoms at the sources of the headwaters of the Upper Maha, a tributary of the Lower Mananjary). Syntypes: MNHN 1907 35-37 (11).

Diagnosis

Bedotia geayi of both sexes can be distinguished from laterally striped congeners by the presence of a discrete black basal spot on the caudal fin base in both living and preserved specimens. Living males have red dorsal and anal fin margins and a red caudal fin, as well as a large red spot on the chin, while a narrow, more or less well defined black margin is present in the caudal fin of preserved individuals. Elevated second dorsal [11–14 (mode: 12)] and anal [17–19 (mode: 18)] ray counts are likewise diagnostic for preserved material. Morphometric characters that set this species apart from *B. madagascariensis* are presented in Table 3.

Description

Morphological measurements and meristic counts are given in Table 2. The largest specimen examined is a 74.0 mm SL male. *Bedotia geayi* are gracile, relatively long-bodied fishes somewhat deeper-bodied anteriorly and showing a rather straight ventral outline. Dorsal outline of head and nape moderately curved to first dorsal fin. Head length divisible 3.3-4.5 times in the standard length. First dorsal fin origin is posterior to the vertical through pelvic-fin insertion, while that of second is posterior to the vertical through the anal fin origin.

Snout slightly indented behind premaxillary pedicels. Snout length divisible 2.9–4.1 times in the head length. Lower jaw is slightly prognathous and angled at about 40°–45° to horizontal when mouth is closed. Premaxilla and maxilla reach the anterior margin of the orbit. Premaxilla with a distinct lateral "*Bedotia* notch". Orbital diameter divisible 2.88–3.77 in the head, 0.93–1.01 in the snout length.

Teeth. Anteriorly both upper and lower jaws bear 4 to 6 rows of numerous small, strongly recurved unicuspid teeth. The outermost row of teeth is poorly differentiated from those of the inner band. The lower jaw and the premaxilla posterior to the *Bedotia* notch each have a single row of teeth. A single row of teeth is present along the anteroventral face of vomer. Small patches of endopterygoid teeth are also present. No ectopterygoid teeth present, at least in individuals of sizes available for examination.

Gill Rakers. Two or three stout hypobranchial rakers and 10-13 (mode: 11) elongate ceratobranchial rakers are present on the lower limb of the first branchial arch. All rakers are strongly denticulate.

Scales. Body is fully covered with large, regularly imbricate, cycloid scales. Predorsal scales along the dorsal midline: 13–14 (mode: 14). Scales along the midlateral axis from just behind the operculum, above the pectoral fin, to the end of the hypural plate: 31–35 (modes: 32, 33). Scales in transverse series between the origins of the anal and the second dorsal fin (including a very small scale adjacent to each fin): 9. Scales separating the first and second dorsal fins: 3. Circumpeduncular scales: 12. Dorsal, anal, and caudal scale sheaths and axillary pelvic scales are absent.

TABLE 2. Morphometric data for *Bedotia geayi* as % SL.

Character	N	Range	Mean	SD
Standard length [mm]	17	43.9–74.0		
Head length	17	22.0–29.8	27.8	2.0
Snout length	17	7.9–10.2	8.5	0.2
Lower jaw length	17	13.4–16.2	14.6	0.9
Orbital diameter	17	7.6–9.6	8.6	0.6
Interorbital distance	17	9.7–11.6	10.8	0.6
Pectoral fin length	17	10.4–20.3	15.9	3.4
$Dorsal_1$ – anal fin depth	14	18.4–25.4	23.0	2.6
$Dorsal_2$ – anal fin depth	14	19.9–32.2	24.5	3.2
Pre-$dorsal_1$ distance	17	52.4–58.7	54.5	1.7
Pre-$dorsal_2$ distance	17	64.7–69.2	66.9	1.7
Pre-pelvic distance	17	40.9–46.5	43.7	1.6
Base $dorsal_2$	17	16.9–21.4	19.4	1.3
Base anal	17	25.1–30.0	27.2	1.6
Length caudal peduncle	17	13.9–17.7	16.2	1.2
Depth caudal peduncle	17	9.0–15.1	10.8	1.4

Fins. First dorsal fin with 5 weak spines. Second dorsal fin rays: 11–14 (mode: 12), the first 4 or 5 unbranched. Anal fin rays 17–19 (mode: 18), usually the first 3 or 4 unbranched. Pectoral fins short, high-set with 12 rays, the longest barely reaching the vertical from the pelvic fin insertion. Pelvic fins with one weak spine and five strongly bifurcate, branched rays. Caudal fin weakly emarginate.

Vertebrae. Total vertebral count taken from radiographs: 34–37 (mode: 36), and a terminal, hypural-bearing half centrum. Pre-caudal vertebrae: 18–20 (mode: 19). Caudal vertebrae: 15–17 (mode: 17).

Viscera and Diet. Gut extremely short, intestinal length only about one-third body length. Examination of feces produced by newly caught specimens within two to four hours of capture revealed the remains of terrestrial insects, suggesting that this species relies primarily upon allochthonous food sources.

Coloration

Living specimens: Figure 4 depicts a sexually quiescent male *Bedotia geayi.* It does not show the diagnostic large red spot on the chin. The pectorals are hyaline in both sexes, but the color pattern of the unpaired fins and ventrals is sexually dimorphic. Figure 5 depicts an adult female. The clear yellow halo surrounding the black spot at the base of the caudal is diagnostic. None of the populations to date sampled is characterized by polymorphism with regard to male fin coloration.

Preserved specimens: Color pattern of the body as in *B. madagascariensis*, but the midlateral stripe terminates in a distinct black spot on the base of the caudal fin. Both dorsal fins and ventrals clear grey in males, hyaline in females. Anal in males clear grey, often with a narrow black edging along its posterior half, entirely hyaline in females. Caudal uniform clear grey with a variably present narrow black distal margin in males, hyaline basally, clear grey distally in females.

FIGURE 4. Sexually quiescent wild-caught male *Bedotia geayi*, Andranomaintso Creek. Not preserved.

FIGURE 5. Adult wild-caught female *Bedotia geayi*, Andranomaintso Creek. Not preserved.

Range

The eleven syntypes of *B. geayi*, measuring 48.0–74.0 mm SL, were collected from the Maha River, a north bank tributary of the Mananjary River near the town of Morafeno, at an altitude of c. 300 m. This species has also been collected from several south bank tributaries of the Mananjary (Figure 3).

Regrettably, neither preserved material of the *Bedotia* populations found between the Fanantara and Mangoro Rivers nor data on their life colors are available for analysis. This is unfortunate, as living individuals of *B. geayi* can be easily distinguished from *B. madagascariensis* by differences in the pigmentation of their unpaired fins noted in each species' diagnosis while meristic and morphometric characters presented in Table 3 permit differentiation of preserved material. Until further sampling corrects this deficiency, the northern range limit of *B. geayi* cannot be precisely determined. In the Namorona River, the basin immediately to the south of the Manajary, *B. geayi* is replaced by an undescribed congener.

Natural History

Bedotia geayi inhabits small streams flowing under partial or complete forest cover at altitudes of 300 to 650 meters above sea level (Pellegrin, 1907; Reinthal and Stiassny, 1991). This species has not been collected from low altitude habitats in the Mananjary basin. This is may be due to the fact that the immediate hinterland of the town of Mananjary has undergone extensive anthropogenic modification. This process favors exotic species, which are better adapted to deal with increased silt loads and higher water temperatures that follow deforestation than are the majority of Madagascar's native fishes.

Although the streams where it occurs frequently have a strong current, *B. geayi* prefers their well-shaded, quieter sections. Like the preceding species, it is indifferent to the composition of the riparian vegetation. This species has been observed swimming in loose, size-graded associations of up to a dozen individuals. Juveniles are usually found in the shallows, while adults frequent deeper water away from the banks. The scant information available on the natural history of *B. geayi* suggests that its dietary pattern, enemies and reproductive pattern are identical to those of *B. madagascariensis.*

TABLE 3. Summary of Distinguishing Characters for *Bedotia madagascariensis* **and** *B. geayi*.

Character	Species	
	B. madagascariensis	*B. geayi*
Head length [% SL]	27.2–31.8 (mean: 30.0 ± 1.1)	22.0–29.8 (mean 27.8 ± 2.0)
Snout length [% SL]	8.0–10.2 (mean: 9.4 ± 0.5)	7.1–10.1 (mean: 8.5 ± 0.2)
$Dorsal_2$ base [% SL]	15.9 - 18.7 (mean: 17.6 ± 0.9)	16.9–21.4 (mean 19.4 ± 1.3)
Anal fin base [% SL]	22.3–27.2 (mean: 24.7 ± 1.4)	25.1–30.0 (mean 27.2 ± 1.6)
Caudal peduncle length [% SL]	16.1–20.4 (mean: 17.4 ± 1.1)	13.9 - 17.7 (mean 16.2 ± 1.2)
Number of anal fin rays	14–17 (mode: 16)]	17–19 (mode: 18)

Conservation Status

Bedotia geayi remains abundant in those localities where it does occur. While *Channa maculata* is present in the immediately adjacent Namorona basin, it has not to date been reported from that of the Mananjary. The presence of exotic poeciliids, notably the highly predatory *Gambusia holbrooki*, in the Manajary basin is presently a greater cause for concern. However, if for the moment *B. geayi* appears to be in no immediate danger of extirpation, its apparently circumscribed distribution suggests particular vulnerability to both further degradation of its habitat and the probable future translocation of *C. maculata*. Following the criteria established by the I.U.C.N., it should be considered a species of special concern whose status needs to be regularly monitored.

***Bedotia leucopteron* sp. nov.** (Figure 6.)

Holotype: AMNH 231263. Sandrakatrana Stream at Ampasimbe Village, Toamasina Province, Madagascar (18° 56' 26S, 48° 41' 01 E). Altitude 126 m. Rianila drainage. Collected 21 October 2000 by villagers; single male specimen, 64.1 mm SL.

Paratypes: AMNH 231265. Same locality and collection data as holotype. Eleven specimens, 30.5-58.6 mm SL. MNHN 1942 0081. Beforona, Toamasina Province, Madagascar. Rianila drainage. Collected by R. Decary; 8 specimens, 56.5-71.9 mm SL.

Diagnosis

Living *Bedotia leucopteron* are readily distinguished from congeners by their metallic blue and gold base coloration, the presence of numerous small irregularly distributed black spots on the flanks rather than a pair of discrete black lateral stripes and the broad, iridescent white margins of the vertical fins in specimens > 25.0 mm SL. The distinctive melanophore pattern of the flanks, opaque white margins of the unpaired fins, deeper

body and markedly posterior insertion of the second dorsal fin, as reflected by a snout to D_2 distance of 66.2–71.9 (mean: 68.5 ± 1.3) % SL are likewise diagnostic in preserved specimens.

FIGURE 6. *Bedotia leucopteron* sp. nov., holotype, AMNH 231236.

Description

Morphological measurements and meristic counts are given in Table 4. *Bedotia leucopteron* can grow to 110.0 mm SL in captivity. The largest specimen examined in this study is a 64.1 mm SL male. *Bedotia leucopteron* is a robust fish somewhat deeper bodied than either of the two preceding species and showing a moderately curved ventral outline. Dorsal outline of head and nape moderately curved to first dorsal fin. Head length divisible 3.1–3.5 times in the standard length. First dorsal fin origin is posterior to the vertical through the pelvic fin insertion, while that of second is posterior to the vertical through the anal fin origin.

TABLE 4. Morphometric data for *Bedotia leucopteron* sp. nov. as % SL.

Character	N	Range	Mean	SD
Standard length [mm]	15	25.0–64.1		
Head length	15	21.6–33.1	29.8	2.7
Snout length	15	7.2–10.6	8.5	0.9
Lower jaw length	15	13.9–16.7	15.2	0.9
Orbital diameter	15	8.6–11.6	9.9	0.8
Interorbital distance	15	9.7–12.8	11.4	0.8
Pectoral fin length	15	13.9–20.7	17.5	2.2
$Dorsal_1$ – anal fin depth	15	22.9–26.7	24.4	1.1
$Dorsal_2$ – anal fin depth	15	23.3–27.5	25.8	1.2
Pre-$dorsal_1$ distance	15	53.8–59.3	57.1	1.6
Pre-$dorsal_2$ distance	15	66.2–71.9	68.5	1.8
Pre-pelvic distance	15	42.4–47.7	44.4	1.7
Base $dorsal_2$	15	14.7–20.2	18.4	1.5
Base anal	15	24.1–28.6	26.8	1.3
Length caudal peduncle	15	15.1–19.4	17.3	1.4
Depth caudal peduncle	15	10.3–12.3	11.3	0.6

Snout slightly indented behind the premaxillary pedicels. Snout length divisible 3.1–4.0 in the head length. Lower jaw is slightly prognathous and angled at about 40°–45° to horizontal when mouth is closed.

Premaxilla and maxilla extend posterior to the anterior margin of the orbit. Premaxilla with a distinct lateral "*Bedotia* notch". Orbital diameter divisible 2.8–3.4 times in the head, 0.7–1.1 times in the snout length.

Teeth. Anteriorly both upper and lower jaws bear 4 to 6 rows of numerous small, strongly recurved unicuspid teeth. The outermost row of teeth is poorly differentiated from those of the inner band. The lower jaw and the premaxilla posterior to the *Bedotia* notch each have a single row of teeth. A single row of teeth is present along the anteroventral face of vomer. A small patch of endopterygoid teeth is present. No palatine or ectopterygoid teeth are present, at least in individuals of sizes available for examination.

Gill Rakers. Two or three stout hypobranchial rakers and 11–12 (mode: 11) elongate ceratobranchial rakers are present on the lower limb of the first branchial arch. All rakers are strongly denticulate.

Scales. Body is fully covered with large, regularly imbricate, cycloid scales. Predorsal scales along the dorsal midline: 14 or 15 (modal value: 15). Scales along the midlateral axis from just behind the operculum, above the pectoral fin, to the end of the hypural plate: 32–35 (mode: 34). Scales in transverse series between the anal fin and the second dorsal fin (including a very small scale adjacent to each fin): 9. Scales between the first and second dorsal fins: 2. Circumpeduncular scales: 10–12 (mode: 10). Dorsal, anal, and caudal scale sheaths and axillary pelvic scales are absent.

Fins. First dorsal fin with 4 weak spines. Second dorsal fin rays: 10–12 (mode: 11), the first 4 or 5 unbranched. Anal fin rays: 15–17 (mode: 17), the first 4 or 5 unbranched. High-set pectoral fins with 12-13 (mode: 12) rays, the longest extending well beyond the vertical to the pelvic fin insertion. Pelvic fins with one weak spine and five strongly bifurcate, branched rays. Caudal fin weakly emarginate.

Vertebrae. Total vertebral count taken from radiographs: 34–36 (mode: 35) and a terminal, hypural-bearing half centrum. Pre-caudal vertebrae: 18–19 (mode: 18). Caudal vertebrae: 16–17 (mode: 17).

Viscera and Diet. Gut extremely short, intestinal length only about one-third body length. Examination of feces produced by newly caught specimens within two to four hours of capture revealed the remains of both aquatic insect larvae and terrestrial insect imagos, suggesting that this species opportunistically exploits both autochthonous and allochthonous food sources.

Coloration

Living specimens: Figure 7 depicts a male, Figure 8 a female and Figure 9 juvenile *B. leucopteron*. These photographs do not show the narrow salmon pink mid-dorsal line in specimens > 25 mm TL. This species is not characterized by color polymorphism with respect to fin coloration.

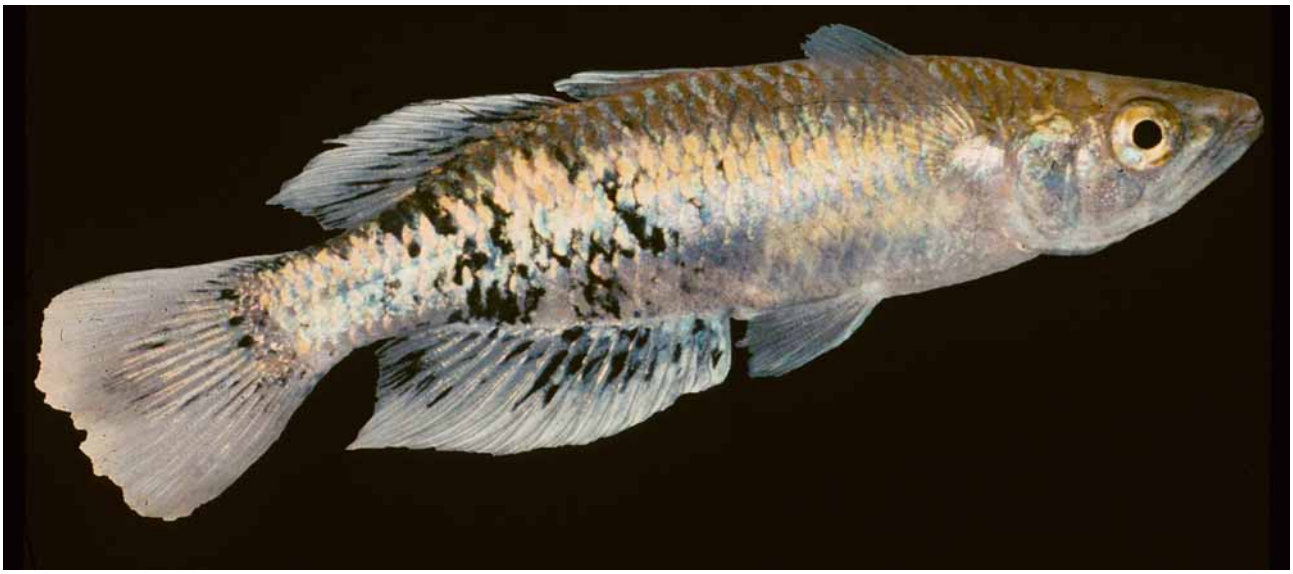

FIGURE 7. Sexually quiescent wild-caught male *Bedotia leucopteron* sp. nov. Lazana River. Not preserved.

Preserved specimens: Top of the head, dorsum and upper third of the flanks light brown, each scale with a darker brown margin. Flanks beige, shading to off-white on the venter. A grey band two scale rows wide extends along the midlateral line from the base of the caudal fin to a point just above the origin of the ventral fins. The posterior half of the flanks irregularly speckled with small black spots. The basal half of both dorsal fins and the anal fin clear grey, marked with black inter-radial streaks. Their distal half is opaque white. The median region of the caudal is clear grey marked with black inter-radial streaks, producing a triangular dark basal zone. The remainder of the caudal is opaque white. The ventral fins are opaque white, the pectorals hyaline.

Females differ from males in having clearer traces of the median and subpectoral lateral bands and fewer black dots on the posterior half of the flanks. The vertical fins are hyaline basally with dusky grey inter-radial streaks and narrower opaque white distal margins. Those of specimens > 50.0 mm SL may be irregularly sprinkled with small black dots. The ventrals and pectorals are hyaline.

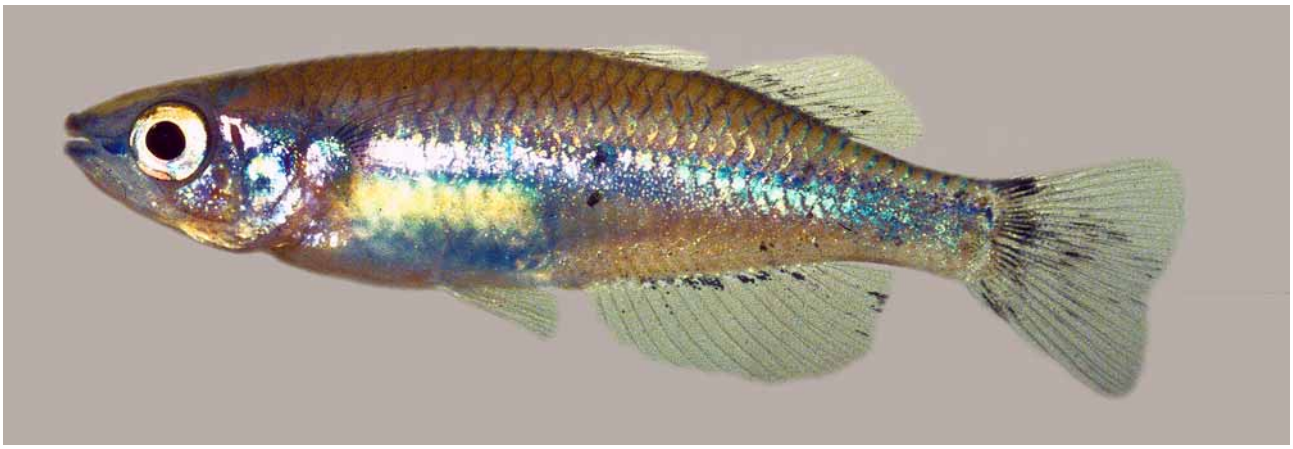

FIGURE 8. Adult wild-caught female *Bedotia leucopteron* sp. nov., Lazana River. Not preserved.

FIGURE 9. Juvenile captive-bred (F_1) *Bedotia leucopteron* sp. nov. Not preserved.

Etymology

The species name, derived from the Greek *leukos*, white and *pteron*, fin, refers to the iridescent white fin coloration particularly evident in adult males. It is to be treated as a noun in apposition.

Range

The type series of *Bedotia leucopteron* was collected from the middle reaches of the Iaroka-Rianila basin. Further material has been collected at localities within this drainage situated along Route Nationale 2 between 100 m and 843 m above sea level (Figure 3). Additional collecting is required to ascertain whether it is present in adjacent drainages.

Natural History

All the streams from which *B. leucopteron* has been collected flow under degraded forest cover. As is the case with the preceding species, its occurrence is not influenced by the composition of the riparian vegetation. The Lazana River at Beforona flows strongly even during the driest month of the year and according to local residents, becomes torrential during the rainy season. Recurrent flooding has undercut the banks and caused many trees to fall into the river. Size-graded schools of fifty to one hundred *B. leucopteron* can be observed from its banks swimming through these tangles of waterlogged wood.

While their waters are very low in dissolved solids (GH: < 17.1–35.0 ppm; electrical conductivity: 10.0–21.0 μmho/cm^2), pH values in these streams range from 6.0–7.0 and do not reach the extremes characteristic of coastal black water habitats. Water temperature in such habitats is strongly influenced by altitude. That of the Sahamamy River, the lowest altitude at which this species has been collected, measured 26° C, while values of 20° C. and 17° C respectively were measured in the Lazana River and in Amalabe Creek during the month of October. Residents of both Amalabe and Beforona stated that water temperatures of their respective streams did not vary noticeably on a seasonal basis. Nevertheless, October is early in the austral spring, so it is possible that summer temperatures in both streams are slightly warmer.

This species coexists with *Gambusia holbrooki* in Sandrakatrana Creek and *Xiphoporus maculatus* in the Sahamany River. According to local residents, *Channa maculata* also inhabits the quieter reaches of the latter stream. In the Lazana River, *B. leucopteron* shares its habitat with *X. maculatus*, an undescribed eleotrid of the genus *Ratsirakia*, the tadpoles of several frog species, diving beetles, a *Macrobrachium* species and a freshwater crab. The Amalabe Creek population occurs syntopically with two other bedotiids, *Rheocles alaotrensis* and an undescribed *Rheocles* species, the same *Ratsirakia* present in the Lazana River, and *X. maculatus*. According to local residents, eels are the only predatory fish present at these altitudes. *Bedotia leucopteron* is thus chiefly at risk from kingfishers and the skilfully wielded *tandroho* (woven reed baskets) of artisanal fisherfolk.

Conservation Status

Although Mantadia-Andasibe National Park affords the watershed of the of the Iaroka-Rianila basin a degree of protection, the middle reaches of this basin are characterized by much reduced and at best degraded forest cover. Nevertheless, *B. leucopteron* is quite abundant in those localities where it occurs. Like the preceding species, it does not appear at present to be seriously endangered, notwithstanding the presence of potentially competitive and/or predatory naturalized poeciliids throughout its altitudinal distribution and of the highly predatory *Channa maculata* at its lower end. It should be classified as vulnerable following the criteria established by the I.U.C.N.

Discussion

The lateral melanophore pattern of adult *B. leucopteron* somewhat resembles of that of *Bedotia masoala* Sparks 2001, *Bedotia marojejy* Stiassny and Harrison 2000 and three undescribed congeners restricted respec-

tively to the basins of the Sambava, Bemarivo and Mahanara du Nord Rivers in northeastern Madagascar. Its ontogeny in *B. leucopteron*, however, is quite different from that of the adult color pattern of this northern quintet of species, which for convenience sake we will refer to subsequently as the *karikary* group, from the Malagasy word for speckled. Juvenile *B. leucopteron* develop well-defined black lateral stripes within two weeks of hatching which become more intense until the young reach c. 30.0 mm SL. By this time, the stripes are more or less broadly edged in metallic gold. As the fish grow larger, the black lateral stripes begin to break up and the zone of metallic gold progressively expands while undergoing a comparable degree of fragmentation. The end result of this process is the distinctive adult color pattern seen in both sexes of *B. leucopteron*. In the three representatives of the *karikary* group bred to date, juveniles develop indistinct dusky lateral stripes shortly after hatching. In an attenuated form, these stripes persist into adulthood in females, but by the time males attain 3.0 cm SL, they have been replaced by a more or less well defined series of diffuse black spots, whose intensity and size decrease progressively as the fish grow larger.

The different fashion in which their superficially similar adult coloration develops in *B. leucopteron* and the species of the *karikary* group suggests that a spotted adult color pattern has evolved independently at least twice in the genus. This hypothesis is supported by the results of a recent genetic study of the Bedotiidae (Sparks and Smith, 2004), which recovers the *karikary* group as an assemblage of closely related species but places *B. madagascariensis* as the closest relative of *B. leucopteron*.

Material Examined

Bedotia madagascariensis

MHNG 0665.007. Madagascar, fresh water. Holotype, 73.6 mm SL. AMNH 215501. Small blackwater lake just inland of Ambila-Lemaitso and the Lakendrano Mpangalana, Toamasina [Tamatave] Province, Madagascar. Collected 21 November 1993 by P. deRham; 3 specimens 22.2–35.4 mm SL. AMNH 215505. Small stream on the road between Ranomafana-Nord and Vatomandry, Toamasina Province, Madagascar [Rianila drainage]. Collected 1 November 1993 by P. deRham; 6 specimens 35.1-43.1 mm SL. AMNH 229578. Residual pools in the rapids of the Ikopa River c. 3.0 km northwest of the town of Antanimbary, Mahajanga [Majunga] Province, Madagascar [17º 09' 95 S, 46º 49' 62 E]. Altitude 194 m. Betsiboka drainage. Collected 9 October 1997 by P. V. Loiselle, R. Haeffner and J. Davidson; 37 specimens,12.1–23.0 mm SL. AMNH 229592. Arola River c. 7.0 km west of Ampasimanolotra [Brickaville] on RN-2 at Km 109 marker, Toamasina Province, Madagascar [18º 49' 36S, 49º 01' 72 E]. Altitude 11 m. Rianila drainage. Collected 25 October 1997 by local fishermen; 8 specimens, 28.5–54.6 mm SL. AMNH 229594. Main channel of the Ivondro River at Fanandrana Village beneath the bridge on RN-2, Toamasina Province, Madagascar [18º 15' 55 S, 49º 16' 04 E]. Altitude 8 m. Ivondro drainage. Collected 25 October 1997 by villagers; 3 specimens, 46.5–79.4 mm SL. AMNH 231327. Sahameloka Creek, a south bank tributary of the Ivoloina River, at the village of the same name, Toamasina Province, Madagascar [18º 02' 26 S, 49º 19' 65 E]. Altitude 5 m. Collected 3 November 1999 by P. V. Loiselle and villagers; 27 specimens, 24.1–59.3 mm SL. AMNH 231418. Lanefitra Creek at Ankadibe Village, c. 25 km NE of Maevatanana, Mahajanga Province, Madagascar [16º 54' 90 S, 46º 58' 20 E]. Betsiboka drainage. Collected 16 October 2000 by P. Doukakis; 5 specimens, 36.4-85.9 mm SL. AMNH 233682. Sampindro Creek at Kadirano Village below bridge on RN-5, Toamasina Province, Madagascar [18º 19'24 S, 49º 13'87 E]. Rianila drainage. Collected 26 October 2003 by P. V. Loiselle and T. Ravelomanana; 102 specimens, 16.7-53.1 mm SL. AMNH 233683. Manambato Creek, affluent of Lake Rasoabe, on the road from RN-2 to Manambato Village, Toamasina Province, Madagascar [18º 45'59 S, 49º 08'17 E]. Altitude 3 m. Rasoabe drainage. Collected 26 October 2003 by P.V. Loiselle and T. Ravelomanana; 24 specimens, 17.0–53.9 mm SL.

Bedotia geayi

MNHN 1907: 35-37. Headwaters of the Upper Maha at Morafeno, Fianarantsoa Province, Madagascar. Altitude c. 300 m. Collected by F. Geay, 3 largest of 11 syntypes, 70.8–73.6 mm SL. AMNH 88014. Vintanona Creek at Andranomaintso Village, Fianarantsoa Province, Madagascar [20°21' S, 47°45' E]. Altitude c. 600 m. Mananjary drainage. Collected 30 June 1988 by M.L.J. Stiassny and P. Reinthal; 17 specimens, 16.5–68.4 mm SL. AMNH 88073. Fotobohitra Creek near the town of Kianjavato, Fianarantsoa Province, Madagascar [20°22' S, 47°52' E]. Altitude c. 400 m. Mananjary drainage. Collected 4 July 1988 by M.L.J. Stiassny and P. Reinthal; 9 specimens, 16.6–48.4 mm SL. AMNH 229533. Andranomaintso Creek several hm E. of Ambodirafia Village on RN-25, Fianarantsoa Province, Madagascar [21°20' 72 S ; 47°45' 13 E]. Altitude: 371 m. Mananjary drainage. Collected 28 October 1998 by P. V. Loiselle and R. Haeffner; 11 specimens, 20.0–45.1 mm SL. AMNH 231356. Ambatomainty Creek near Ambahaladara Village, Fianarantsoa Province, Madagascar [21°09' 66 S ; 48°06' 47 E]. Altitude: c. 380 m. Mananjary drainage. Collected 31 October 1999 by A. R. Saunders; 26 specimens 14.5–47.3 mm SL.

Bedotia leucopteron

AMNH 28133 Beforona River at Km 178 marker on RN-2, Toamasina Province, Madagascar. Rianila drainage. Collected 14 June 1961 by villagers; 4 specimens, 33.6–54.7 mm SL. AMNH 229580. Lazana River at Beforona below the bridge on RN-2, Toamasina Province, Madagascar [18°59' 06S, 48° 36' 75 E]. Altitude 402 m. Rianila drainage. Collected 22 October 1996 by villagers; 10 specimens 25.5–63.4 mm SL. AMNH 229583. Amalabe Creek at the village of the same name on RN-2 east of the turn-off to Andasibe-Mantadia National Park, Province of Toamasina, Madagascar [18°56' 68S, 48° 29' 08 E]. Altitude 843 m. Rianila drainage. Collected 19 October 1997 by P. V. Loiselle and villagers; 3 specimens, 52.0–56.9 mm SL. AMNH 229595. Sahamamy River west of Ampasimanolotra on RN-2 between Km 53 and Km 54 markers, Toamasina Province, Madagascar [18°59' 20S, 48° 46' 60 E]. Altitude 196 m. Rianila drainage. Collected 25 October 1997 by villagers; 5 specimens, 25.5–57.0 mm SL.

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Literature Cited

Arnoult, J. (1953) Un poisson d'ornement malgache: *Bedotia geayi*. *Naturaliste Malgache*, 5, 225–228

Arnoult, J. (1959) Poissons des eaux douces. *Faune de Madagascar*, ISRM, Tananarive, 10, 1–169.

Kiener, A. (1963) Poissons, pêche et pisciculture à Madagascar. *Publcation du Centre Technique Forestier Tropical* (24), 1–244.

Kottelat, M. (1990) Sailfin silversides (Pisces: Telmatherinidae) of Lakes Towuti, Mahalona and Wawotona (Sulawesi, Indonesia) with descriptions of two new genera and two new species. *Ichthyological Exploration of Freshwaters*, 1, 35–54.

Leviton, A.E., Gibbs R.H. Jr., Heal, E. & Dawson, C.E. (1985) Standards in herpetology and ichthyology: Part I. Standard symbolic codes for institutional resource collections in herpetology and ichthyology. *Copeia*, 1985(3), 802–832.

Pellegrin, J. (1907) Liste des poissons recueillis à Madagascar par M. F. Geay. Description d'une espèce nouvelle. *Bulletin du Musée Nationale d' Histoire Naturelle*, 30, 201–206.

Pellegrin, J. (1914) Sur une Athérinidé nouveau de Madagascar appartenant au genre *Bedotia*. *Bulletin de la Societé Zoologique de France*, 39, 178–180.

Pellegrin, J. (1932) Athérinidé nouveau de Madagascar appartenant au genre *Bedotia*. *Bulletin de la Societé Zoologique de France*, 57, 84–86.

Pellegrin, J. (1933) Les poissons des eaux douces de Madagascar et des îles voisins. *Mémoires de l'Académie Malgache* (Tananarive) 14, 1–224.

Regan, C.T. (1903) Descriptions de poissons nouveaux faisant partie de la collection du Musée d'Histoire naturelle de Genève. *Revue Suisse de Zoologie*, 11, 413–418.

Regan, C.T. (1920) Freshwater fishes from Madagascar. *Annals and Magazine of Natural History*, (9)5, 419–424.

Reinthal, P.N. & Stiassny, M.L.J. (1991) The freshwater fishes of Madagascar: a study of an endangered fauna with recommendations for a conservation strategy. *Conservation Biology*, 5, 231–243.

Sparks, J.S. (2001) *Bedotia masoala*, a new species of atherinoid rainbowfish (Teleostei: Atherinoidei) From the Masoala Peninsula, northeastern Madagascar. *Copeia*, (2), 482–489.

Sparks, J.S. & Rush, L.M.R. (2005) A new rainbowfish (Teleostei: Melanotaenioidei: Bedotiidae) from the southeastern highlands of Madagascar, with comments on the biogeography of *Bedotia*. *Zootaxa*, (1051), 39 - 45.

Sparks, J.S. & Smith, W.L. (2004) Phylogeny and biogeography of the Malagasy and Australasian rainbowfishes (Teleostei: Melanotaenioidei): Gondwanan vicariance and evolution in freshwater. *Molecular Phylogenetics and Evolution*, 33, 719–734.

Stiassny, M.L.J. (1990) Notes on the anatomy and relationships of the bedotiid fishes of Madagascar, with a taxonomic revision of the genus *Rheocles* (Atherinomorpha: Bedotiidae). *American Museum Novitas*, (2979), 1–33.

Stiassny, M.L.J. and I. J. Harrison. (2000) Notes on a small collection of fishes from the Parc National de Marojejy, northeastern Madagascar, with a description of a new species of the endemic genus *Bedotia* (Atherinomorpha: Bedotiidae). *In*: S. M. Goodman (Ed.) *A Floral and Faunal Inventory of the Parc National de Marojejy, Madagascar with Reference to Elevational Variation*. *Fieldiana (Zoology)*, (97), 143–156.