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SYSTEMATIC REVISION OF THE BALITORID LOACH GENUS *SEWELLIA* OF VIETNAM AND LAOS, WITH DIAGNOSES OF FOUR NEW SPECIES

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ABSTRACT. - The highly specialized rheophilic loach genus *Sewellia* Hora, 1932 and its only previously known species, the Vietnamese *S. lineolata* (Valenciennes, 1849), are redescribed based on recently collected material. Four new species are described: *S. pterolineata* from Vietnam and *S. speciosa* from Laos in the nominal subgenus *Sewellia*, and *S. diardi* and *S. elongata* from Laos in the new subgenus *Diardichthys*. All species from Laos are from hill streams in the Se Kong watershed (Mekong basin). The species differ in size, scale counts, coloration, sexual dimorphism, and vertebral counts. Scanning electron micrographic observations are presented on tubercles and on unculiferous and non-unculiferous epidermal structures of the mouth and fins.

KEYWORDS. - *Sewellia*, Vietnam, Laos, loach, new species.

INTRODUCTION

The only previously known species of the highly specialized hillstream loach genus *Sewellia* was collected in central Vietnam around 1821 and named *Balitora lineolata* by Valenciennes (1849). The distinctiveness of this species was emphasized when it was made type species of the new genus *Sewellia* by Hora (1932). The genus and the species *Sewellia lineolata* were redescribed by Kottelat (1994).

New species from Laos reported in this paper were collected in April-May 1995, when the author did an ichthyological survey of the Bolovens plateau and adjacent parts of southern Laos as part of the environmental impact assessment of the Xe Nam Noi-Xe Pian hydropower project. All of the Laotian material comes from mountain streams in the Se Kong watershed, the southern-most large tributary of the Mekong in Laos.

The type material of *Sewellia lineolata* and the material redescribed by Kottelat (1994) have been re-examined. One of the Vietnamese specimens reported by Kottelat is *S. lineolata* but

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the other belongs to a new species, here described as *S. pterolineata*. Three additional specimens of *S. lineolata* recently collected from central Vietnam are also reported upon.

Unculi - hard unicellular projections of varied shape arising from epidermal cells - are an adaptive feature of major importance to balitorid loaches. The surface of the velvety pads on the ventral surface of the expanded paired fins consist solely of thousands of unculi. The unculiferous pads evidently serve as friction pads. Without unculi, such expanded paired fins presumably would not have evolved, nor would have the rows or patches of tubercular contact organs on the dorsal surface of the pectoral fins. Unculi also cover the entire surface of the upper and lower horny jaw sheaths of balitorids. And finally, in many balitorids, the large tubercles or breeding tubercles on the body, head, and fins are often themselves unculiferous. In all of these respects *Sewellia* are typical unculiferous balitorids. See Roberts (1982a) for a detailed discussion of unculi and their adaptive significance in Cypriniformes and other Ostariophysan fishes.

Material examined is deposited at the Zoological Reference Collection of the Department of Biological Sciences, National University of Singapore, Singapore (ZRC); The Smithsonian Institution, Washington, D. C., U.S.A. (USNM); Nationaal Museum van Natuurlijke Historie, Leiden, The Netherlands (RMNH); Museum National d'Histoire Naturelle, Paris, France (MNHN); and California Academy of Sciences, San Francisco (CAS).

Sewellia Hora, 1932

(Figs. 1-8)

Sewellia Hora, 1932: 315. Type species *Balitora lineolata* Valenciennes, 1849, by original designation and monotypy. Gender feminine.

Diagnosis. - Body depressed and laterally expanded. Paired fins with a single simple ray and numerous branched rays. Pectoral fin rays i19-26, pelvic fin rays i18-21. Posteriormost 2-3 pectoral fin rays not exposed ventrally, but reflexed dorsally and adpressed to side of body. Pelvic fins widely separated and not joined posteriorly. Mouth very small, strongly curved. Two pairs of rostral and a single pair of maxillary barbels. Rostral barbels with medially expanded papilliferous bases overlying or adjacent to concavities on ventral surface of head. Gill opening very small, its depth about equal to eye diameter, somewhat lower than eye and well above pectoral fin base, covered by a vertically oblique, biconvex membranous flap or gill cover. No groove leading from ventral end of gill opening to ventral surface of body. Dorsal fin rays iii8. Anal fin rays ii4 (first simple ray very short, tightly adpressed to second; second ray very large, stout, and laterally expanded). Scales in lateral line series about 50-75 (scale rows just behind gill opening are difficult to count). Caudal fin rays 9-10+8/8+4. Vertebrae 22-27+8-11=31-37.

Viewed from above or below, the head of *Sewellia* may appear to be either oblong (almost rectangular) or broadly ovate. This depends on whether the oropectoral membrane is folded in or folded out. The oropectoral fold of *Sewellia* is located in the same place and presumably has the same function as the "lateral oral fold" in the Bornean balitorid genus *Gastromyzon* (Roberts, 1982b: 498-499, fig. 1b). In *Gastromyzon*, however, the morphology of the oral structures including rostral cap, barbels, lips, and horny jaw sheaths differs radically from that in *Sewellia*. The lateral oral fold extends from the rostral cap, rather than from the corner of the mouth (or rictus of the jaws) to the pectoral fin origin.

Ventral disc. - The entire ventral surface of the paired fins, head and body to the end of the pelvic fins forms an adhesive disc, probably suctorial as well as frictional. Friction is provided by the tubercles on the anteroventral surface of the head and by dense pads of fine unculi on the ventral surface of the anteriormost 10-14 rays of the paired fins. Suction may be provided when the paired fins are depressed, lifting the body slightly off the substrate, and by evacuation of water by orobranchial pumping action. The integrity or seal of the ventral adhesive surface or disc evidently is maintained by a number of devices: 1) oropectoral fold, a folded tuberculate membrane extending from corner of mouth to pectoral fin origin; 2) greatly expanded and overlapping paired fins with their unculiferous surface which can be applied tightly to the substrate; and 3) a valve at the posterior part of the pelvic fins.

The posterior pelvic valve is a complex structure in *Sewellia*, possibly quite unlike that in other rheophilic loaches. It involves overlapping of the penultimate few ventrally exposed rays by the upturned ultimate few rays which are not ventrally exposed, but directed dorsally and adpressed to the side of the body, and a thick fleshy flap on the posteriorlateral part of the pelvic fin where it attaches to the side of the body. The pair of ribs on the 13 vertebra

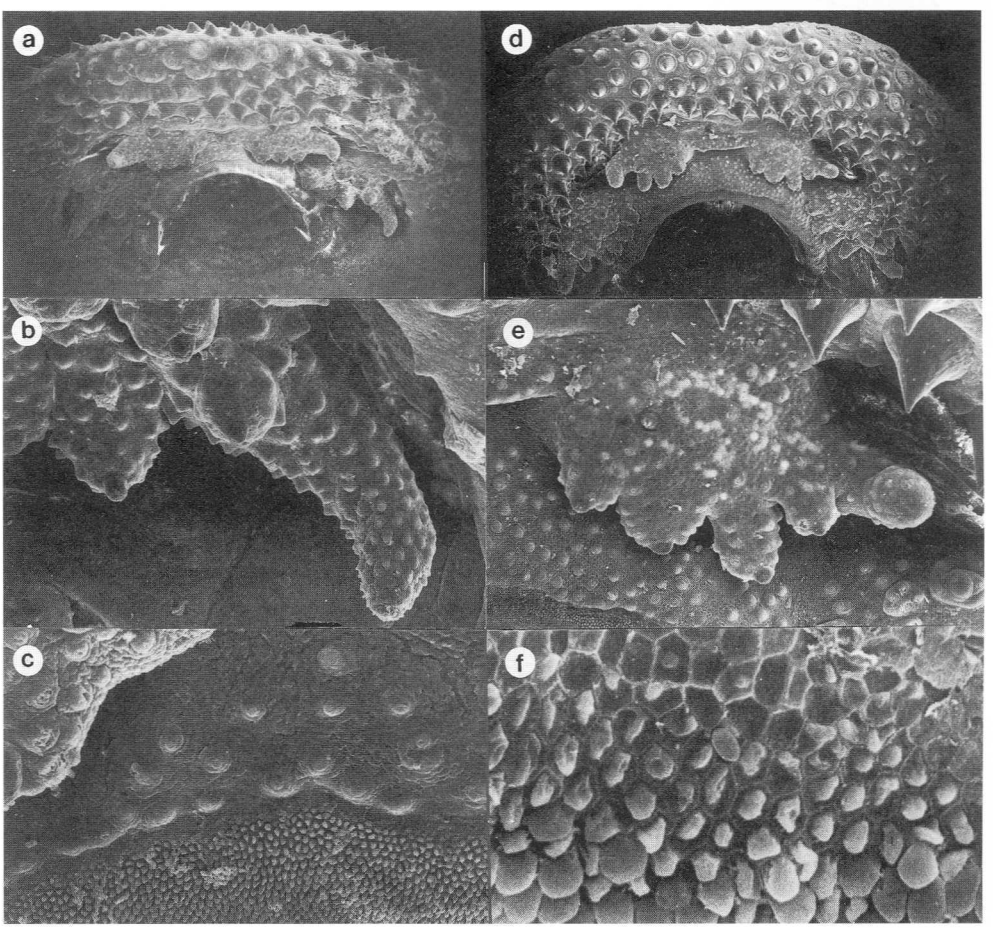

Fig. 1. *Sewellia* mouth parts. a-c, *Sewellia (Sewellia) speciosa*, 49.0 mm male, Huai Sai; d-f, *Sewellia (Diardichthys) elongata*, 57.5 mm male, Xe Nam Noi. Note tubercles on rostral cap, taste buds on barbels and lips, and unculi on lower jaw sheath. Horizontal frame widths: a, 3.15 mm; b, 1.5 mm; c, 720 micra; d, 3.15 mm; e, 260 micra; f, 195 micra.

(9th rib-bearing vertebra) are greatly enlarged compared to those on preceding and succeeding vertebrae, and are attached to the medially expanded posteriormost part of the pelvic girdle. They are presumably involved with enlarged muscles opening and/or close the valve.

Sexual dimorphism. - Sexual dimorphism involves the distribution and degree of development of tubercles on the dorsal surface of the head and pectoral fins. The tubercles have three developmental stages: 1) small; 2) large; 3) shed, leaving behind the so-called pores or "mucus pores", better called tubercle dehision scars. Not all small tubercles become large, but all tubercles start out small. Tubercles on the dorsal surface of the head generally are large in presumed males, small in females. Tubercles on the pectoral fin confined to the noticeably convex dorsal surface of anteriormost five or six rays (absent or weakly developed in presumed females). Tubercles on head small in females, large in males.

The sexually dimorphic nature of the observed differences in tuberculation were confirmed by examination of gonads in a sexual ripening population sample of *Sewellia speciosa*. The

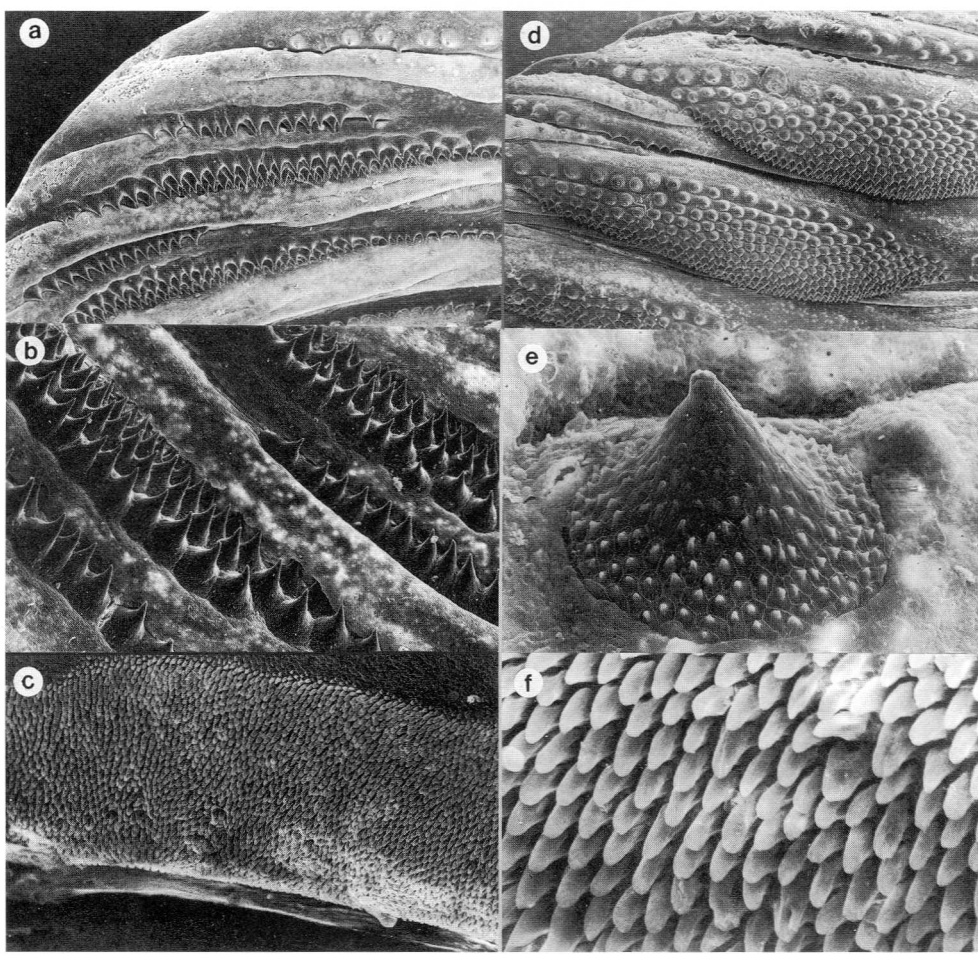

Fig. 2. *Sewellia* pectoral fin. a-c, *Sewellia (Sewellia) speciosa*, 49.0 mm male; d-f, *Sewellia (Diardichthys) elongata*, 57.5 mm male. a-b and d-e, tubercles on dorsal surface of anteriormost pectoral fin rays; c and f, unculi on ventral surface of anteriormost pectoral fin. Horizontal frame widths: a, 6.3 mm; b, 1.2 mm; c, 540 micra; d, 6.3 mm; e, 1.2 mm; f, 120 micra.

expanded convex patches of small tubercles on the anterior part of the pectoral fin in male *Sewellia* are born on expanded convex plate-like extensions of hypertrophied lepidotrichia on the posterior edges of the first unbranched ray and on the posterior edges of the second branch of the first through second, third, or fourth branched rays. Both sexes have dorsoposteriorly projecting processes from hypertrophied lepidotrichia on the pelvic fins, usually fully erupted but sometimes covered with skin. These plate-like extensions or lamellae are similar to those bearing tubercles on the anterior part of the pectoral fin in male *Sewellia (Sewellia)*, but they are non-tuberculate, equally or nearly equally well developed in both sexes, and their posterior margins tend to be exposed and strongly serrate (individual serrae representing individual lepidotrichia). Similar serrated lepidotrichial lamellae occur on the pelvic fin in both sexes of *Gastromyzon.*

Species of *Sewellia* fall into two clear-cut groups, recognized here as subgenera. The new subgenus *Diardichthys*, type species *Sewellia (Diardichthys) diardi*, new species, is defined in the key. *Sewellia (Sewellia)* comprises the generic type species, *S. lineolata* and two new species, *S. pterolineata* and *S. speciosa. Sewellia (Diardichthys)* comprises the two new species *S. diardi* and *S. elongata.*

Key to the subgenera and species of *Sewellia*

1. Ornate species with strongly contrasting dark and light coloration on body and fins; body relatively short and broad, tips of pelvic fins reaching to or slightly overlapping anal fin origin; males with greatly expanded tuberculate patches with many rows of tubercles of decreasing size on anterior part of pectoral fin; scales in lateral line series about 50-60; maximum size less than 60 mm; vertebrae 31-34 (subgenus *Sewellia*) 2
- Relatively dark, inconspicuous or cryptically colored species; body stout or elongate, but narrower, with tips of pelvic fins noticeably failing to reach anal fin origin; males with 1-3 long rows of tubercles on anterior rays of pectoral fin; scales in lateral line series about 60-75; maximum size over 70 mm; vertebrae 33-37 (subgenus *Diardichthys*) 4

2. Body and/or paired fins with conspicuously lined or banded pattern 3
- Body and paired fins with conspicuously spotted pattern ..... *S. speciosa*

3. Side of body with four parallel longitudinal stripes, including one centered on lateral line canal; pectoral fin with single submarginal band or stripe; dorsal surface of head and body with reticulated pattern consisting of dark outlines and pale centers; vertebrae 31-32 ..... *S. lineolata*
- Side of body with blotches only; pectoral fin with four conspicuous parallel bands; dorsal surface of head and body with reticulated pattern consisting of pale outlines and dark centers; vertebrae 34 ..... *S. pterolineata*

4. Body relatively robust and broad, caudal peduncle stout; vertebrae 33-35 ..... *S. diardi*
- Body relatively slender, caudal peduncle slender; vertebrae 35-37 ..... *S. elongata*

Sewellia lineolata (Valenciennes, 1849)

(Fig. 3)

Balitora lineolata Valenciennes in Cuvier & Valenciennes, 1849:99 (type locality Cochinchine).
Sewellia lineolata, Hora, 1932.
Sewellia lineolata, Kottelat, 1994 (partim).

Material examined. - MNHN 2906, syntypes, 2:32.5-45.2 mm, Cochinchine, Diard; 1821?, RMNH 2011, syntype, 36.8 mm, Cochinchine, Diard; 1821?, RMNH 31832, 48.8 mm, Trac Khuc River,

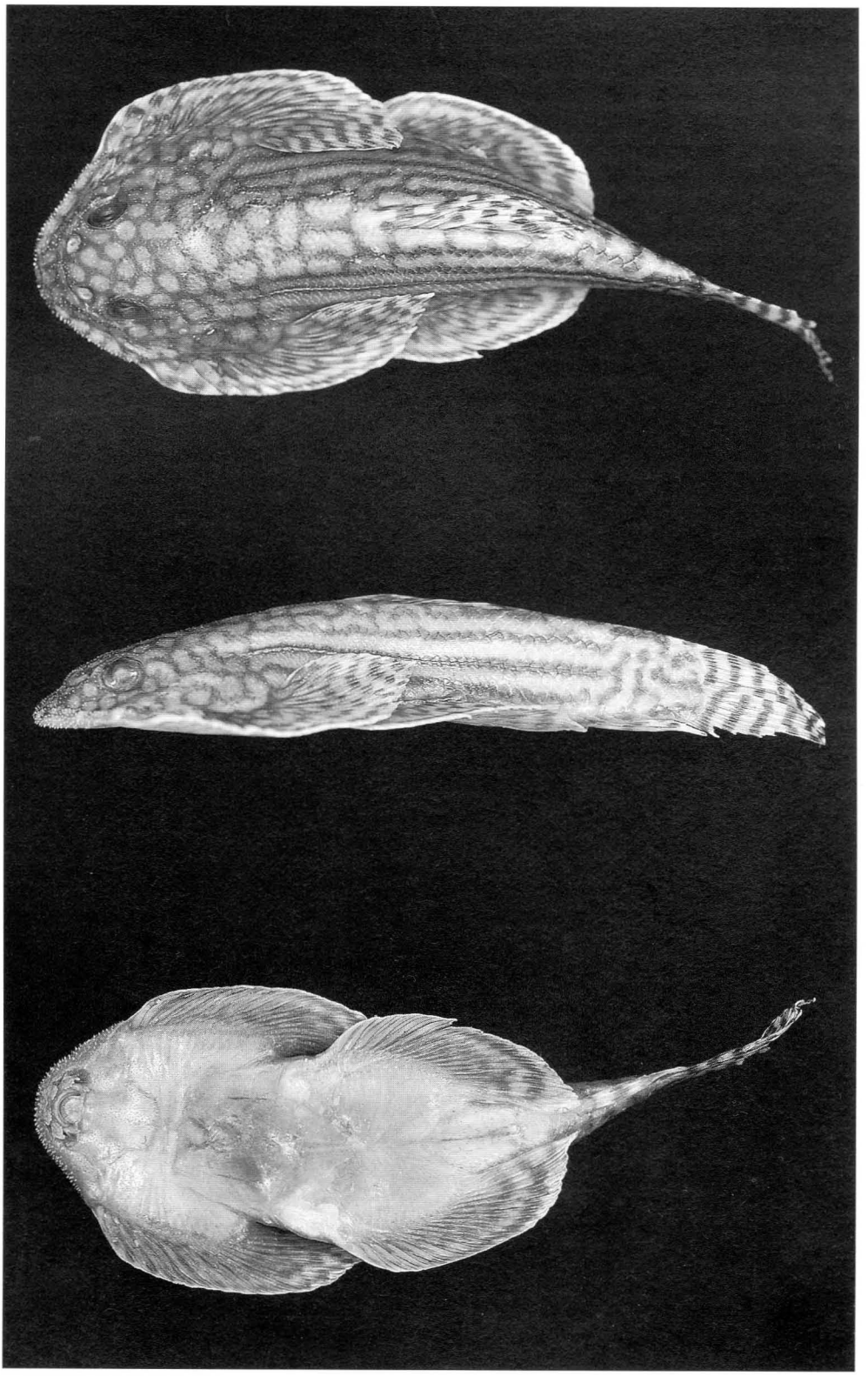

Fig. 3. *Sewellia (Sewellia) lineolata*, USNM 340036, 44.9 mm (dorsal, lateral and ventral views).

Nghia Bin province, Vietnam, Nguyen Huu Duc, 3 Jul.1986; USNM 340036, 3:44.9-48.4 mm, Quang Nan province, about 20 km N of Danang, NW of Namo Bridge, Vietnam, B. W. Miller, 12 Jun.1968.

Diagnosis. - Differs from all other *Sewellia* in having sides of body with 4 bold longitudinal stripes. Pectoral fin with bold submarginal stripe, otherwise with reticulated marks. Pelvic fin with 3 bold stripes. Dorsal surface of head, body and paired fins otherwise with bold, connected polygonal markings or reticulations with dark outlines and pale centers. Pectoral fin branched rays 19(1), 20(4) or 21(2). Pelvic fin branched rays 19(7). Scales in lateral line series about 50-55. Vertebrae 22-23+8-9=31(3) or 32(4) [23+9=32 (MNHN syntypes), 22?+9=31? (RMNH syntype), 23+8-9=31(1) or 32(2) (USNM), 22+9=31 (RMNH 31832)].

Sexual dimorphism. - As in other members of the subgenus *Sewellia*, male *S. lineolata* have very strongly developed patches of numerous rows of small tubercles on expanded posterior lamellae of the first 4-5 pectoral fin rays. Within each patch, the tubercles are aligned in rows, those of each successive row slightly smaller. In addition to these patches confined to the anteriormost few rays, all of the rays tend to have single rows of tubercles. In the three USNM specimens nearly all scales on dorsal and lateral surfaces of body have about 6-10 small tubercles on their posterior margin. All known specimens of this species are male.

Comments. - Despite their age, the MNHN syntypes of *Sewellia lineolata* retain very well the distinctive lines and other coloration of the species. The USNM specimens, compared directly with these syntypes, agree perfectly with them, as does the faded 48.8 mm RMNH specimen supposedly from Nghia Bin (see discussion of this specimen under *S. pterolineata*).

Diard travelled widely in Vietnam. The type locality "Cochinchine" could be anywhere in southern Vietnam. The USNM specimens are the only *S. lineolata* with precise locality data.

Sewellia pterolineata, new species
(Fig. 4)

Sewellia lineolata, Kottelat, 1994 (partim: RMNH 31832, 44.1 mm, fig. 1, dorsal and lateral views).

Material examined. - Holotype, RMNH 31832, 44.1 mm male?, Nghia Bin province, Trac Khuc River, Vietnam, Nguyen Huu Duc, 3 Jul.1986.

Diagnosis. - Differs from all other *Sewellia* in having pectoral fin with 5 bold stripes parallel to fin margins. Pelvic fin with 3 stripes (as in *S. lineolata*). Dorsum and sides of body with mottling or reticulations (no stripes). Reticulated marks on dorsum of head and body with pale outlines and dark centers. Scales in lateral series about 55. Pectoral fin branched rays 22. Pelvic fin branched rays 21. Vertebrae 25+9=34.

Sexual dimorphism. - The holotype is tentatively identified as a male because of the tuberculation on the anterior rays of the pectoral fin. But the tubercles are not so well developed as in males of other members of the subgenus *Sewellia*. The lepidotrichial lamellae supporting the expanded tubercle patches are weakly developed. Many of the tubercles have been shed. The scales on the dorsum and sides of the body are non-tuberculate.

Etymology. - From the Latin *pteryx*, wing (hence paired fin) and *lineatus*, lined (adj.).

Comment. - Apart from the striking differences in coloration, *Sewellia pterolineata* differs from *S. lineolata* (the only other species of the genus known from Vietnam) in having more vertebrae and more rays in both of the paired fins. This meristic comparison is based on all known specimens of both species.

The 44.1 mm holotype of *Sewellia pterolineata* and a 48.8 mm specimen supposedly collected with it were compared with the RMNH type material of *S. lineolata* by Kottelat (1994) and were used for his redescription of *S. lineolata.* The RMNH syntypes of *S. lineolata* are somewhat faded. In the MNHN syntypes of *S. lineolata*, not examined by Kottelat, the color pattern is well preserved, and just like that in the recently collected USNM specimens. The most obvious significant difference observed between *S. pterolineata* and *S. lineolata* are those involving coloration. The only known specimen of *S. pterolineata* also has more vertebrae than any of the specimens of *S. lineolata* (34 vs. 31-32).

The 48.8 mm specimen supposedly collected with the holotype of *S. pterolineata* is here identified as *S. lineolata.* It has been compared directly with the Paris syntypes and recently collected USNM specimens of *S. lineolata.* Although somewhat faded, its coloration agree closely with them and not with the holotype of *S. pterolineata.* If the two specimens were really collected together, it could indicate that *S. pterolineata* is a color variety of *S. lineolata.* But against this hypothesis is the appearance of the two specimens. The 44.1 and 48.8 mm

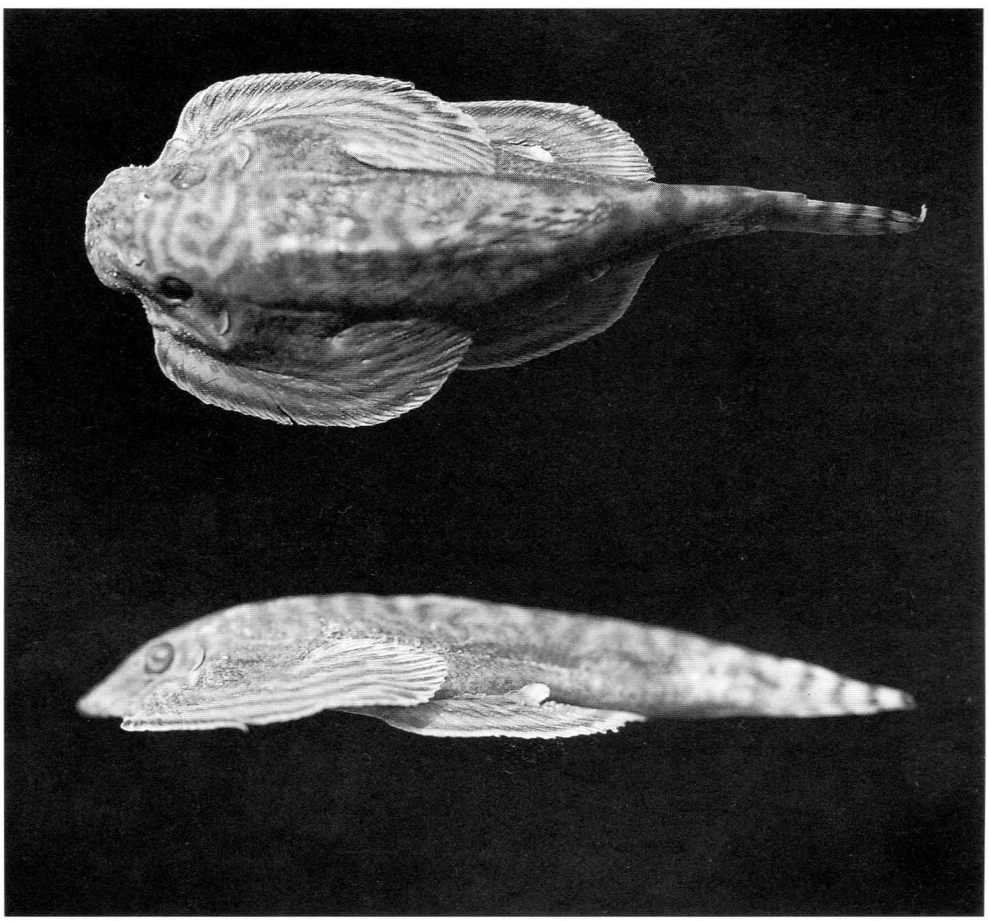

Fig. 4. *Sewellia (Sewellia) pterolineata*, 44.1 mm holotype(dorsal, and lateral views).

specimens are very different in appearance, the larger specimen being much more faded and somewhat shrunken, with a discolored abdomen. This indicates either that the specimens were in quite different condition when preserved, or that they had a different collection history. I am inclined to believe that they were not collected at the same time and place. This raises the possibility that the collection locality data for *S. pterolineata* may not be correct.

Sewellia speciosa, new species
(Fig. 5)

Material examined. - Holotype, ZRC 40368, 53.7 mm male, lower Xe Nam Noi 1.5 km downstream from bridge on route 232 to Attapeu, 26 km from Ban Nam Tang (elevation 270 m), Laos, T. R. Roberts, 25 Mar.1995.

Paratypes - ZRC 40369, 49:33.5-51.9 mm, CAS 91779, 22:25.1-52.0mm, MNHN 1997-003, 21:22.6-52.5 mm, and USNM 344490, 21:18.3-48.7 mm, collected with holotype; ZRC 40370, 148:15.3-43.8 mm, lower Xe Nam Noi about 3 km downstream from ferry crossing on Attapeu-Saravan road, 54 km by road from Ban Nam Tang (elevation about 130 m), T. R. Roberts, 27 March 1995; ZRC 40371, 10:33.7-40.4 mm, small stream where it flows into right side of Se Kaman mainstream just upstream from Se Kaman 1 dam site, T. R. Roberts, 14 April 1995; ZRC 40372, 8:16.5-50.4 mm, Houai Sai, tributary of Se Kong, Kaleum district, Se Kong province, I. G. Baird. All specimens from Laos.

Diagnosis. - Differs from other *Sewellia* known from Laos (subgenus *Diardichthys*) in its showy and very contrasting coloration, pelvic fins reaching or overlapping anal fin origin, and pectoral fin of males with large, elevated patches of very fine tubercles, and usually fewer vertebrae. From the two closely related Vietnamese species (subgenus *Sewellia*) with pelvic fins reaching or overlapping anal fin origin and very fine tubercles on pectoral fin of males and similar vertebral counts it has an entirely different coloration on body and paired fins, very small dark spots on an otherwise very pale background (no bands on body or pectoral fins). Pectoral fin branched rays 20-22. Pelvic fin branched rays 19. Scales in lateral line series about 50-60. Vertebrae 22-23+8-10=31(5) or 32(11). Similarly low vertebral counts occur only in the Vietnamese species *S. lineolata*. Other species with 33 or more vertebrae.

Sexual dimorphism. - In the paratype series of 148 specimens, 56:28.3-43.8 mm (38%) appear to be males and 82:15.3-42.3 mm either females or immature. Thus in this large population sample the sex ratio approaches 1:1, but may still be skewed in favor of females. With the exception of one 15.3 mm juvenile, the rest of the females and immatures were 27 mm or bigger. At 28 mm, males exhibit clear sexual dimorphism.

The Laotian *Sewellia speciosa* has sexually dimorphic pectoral fin tuberculation comparable to its two Vietnamese congeners of the subgenus *Sewellia*, and quite different from other Laotian species of *Sewellia* (subgenus *Diardichthys*). Some of the largest specimens from the population sample collected in the lower Xe Nam Noi on 25 March 1995 were divided into two lots of 7 specimens each, based on tubercle development. The presumed males, 49.6-51.9 mm, had relatively large tubercles on head and pectoral fin with well-defined dense patches of numerous small tubercles projecting dorsally from posterior part of first 2-3 branched rays. The presumed females, 41.7-50.3 mm, had smaller tubercles on head, and either no tubercles on pectoral fins, or tubercles on pectoral fins weakly developed, not at all in dense patches. None of the presumed males had eggs. All had whitish paired organs that appeared to be testes. What appeared to be testes were relatively small in some, but in

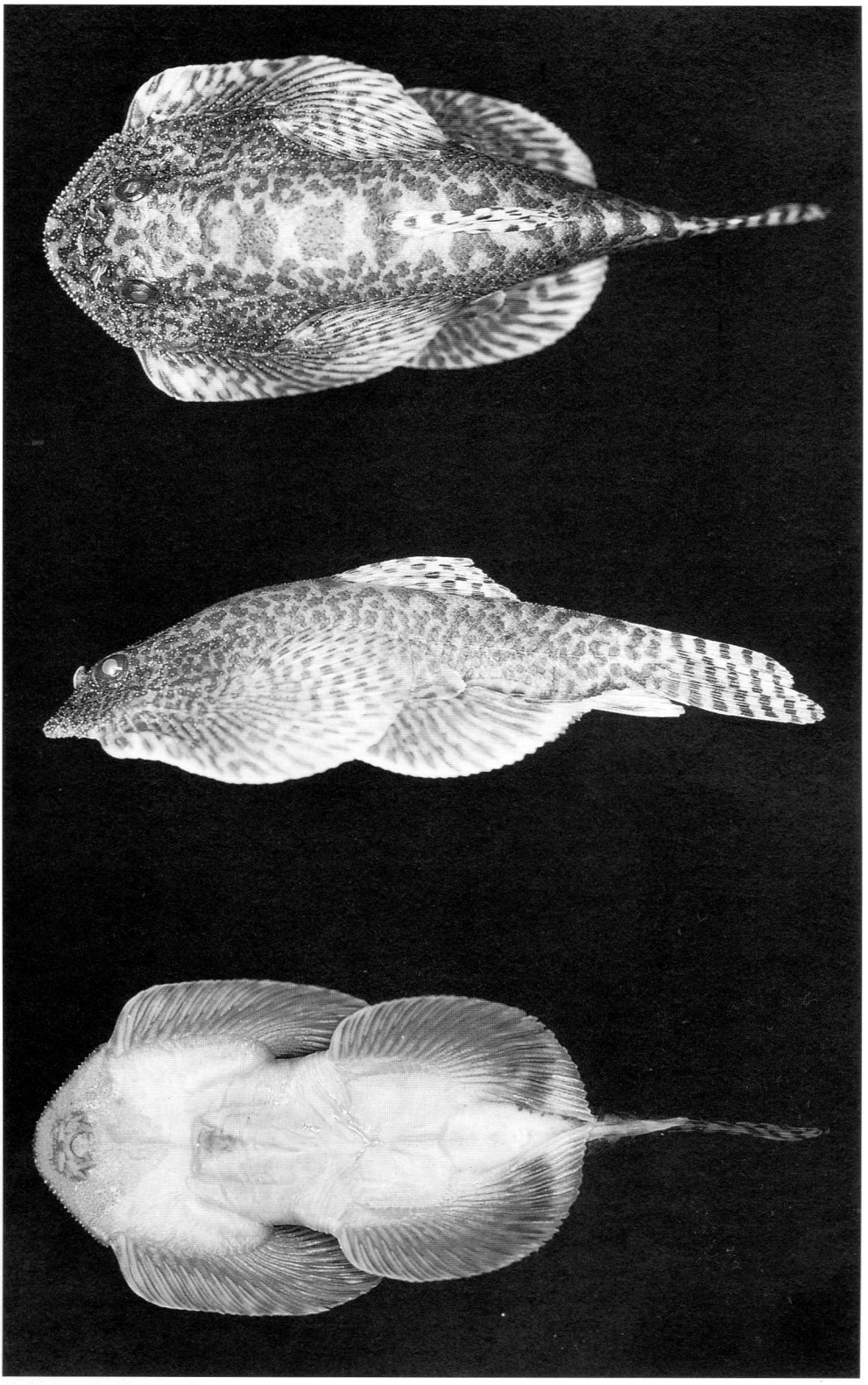

Fig. 5. *Sewellia (Sewellia) speciosa*, 53.7 mm holotype (dorsal, lateral, and ventral views).

3 specimens were enlarged and divided into about 8 broad-based triangular lobes. 6 of the 7 specimens presumed to be females on the basis of external morphology have well-developed ovaries with hundreds of eggs to 0.7 mm diameter.

One of the presumed females turned out to have ovaries much less well developed. Eggs were present, but the ovaries were relatively very small. The pectoral fin of this specimen had tubercles better developed than the other presumed females. Tubercles on dorsal surface of anteriormost branched pectoral fin rays were small and in straight single rows, quite unlike those in males.

Habitat and species associations. - *Sewellia speciosa* occurs in the lower Xe Nam Noi and lower Se Kaman where these rivers have rocky bottom, with gravel and stone, and sometimes large boulders. Current is moderate to swift, but the gradient is moderate. In the lower Xe Nam Noi it was collected together with 28 other fish species comprising Cyprinidae (10), Gyrinocheilidae (1), Cobitidae (4), Balitoridae (5), Bagridae (2), Sisoridae (2), Belonidae (1), Mastacembelidae (1), Gobiidae (1), and Tetraodontidae (1). At least 14 of the species are rheophilic. Other balitorids found with it include *Annamia* sp., *Balitora* sp., *Homaloptera smithi*, and *Sewellia diardi*. It was not collected or observed in the Xe Pian.

Etymology. - From the Latin *speciosus*, beautiful, showy (adj.).

Sewellia diardi new species
(Fig. 6)

Material examined. - Holotype, ZRC 40364, 71.1 mm male, lower Xe Nam Noi 1.5 km downstream from bridge on route 232 to Attapeu, 26 km by road from Ban Nam Tang (elevation 270 m), Laos, T. R. Roberts, 25 Mar.1995.

Paratypes - ZRC 40365, 21:21.1-71.8 mm, CAS 91780, 5:23.4-51.6 mm, MNHN 1997-001, 5:42.8-55.4 mm, and USNM 344488, 5:42.0-57.2 mm, collected with holotype; ZRC 40366, 12:33.5-54.9 mm and CAS 91778, 5:23.4-51.6 mm, middle Xe Pian, about 2.5 km down gorge from top of Bolovens plateau at Ban Houai Chot (elevation 540 m), Laos, T. R. Roberts, 1 Apr.1995.

Other material - ZRC 40367, 3:50.3-68.5 mm, Houai Sai, Kaleum district, Se Kong province, Laos, I. G. Baird, 1996.

Diagnosis. - *Sewellia diardi*, type species of the subgenus *Diardichthys*, differs from members of the subgenus *Sewellia* in its more somber coloration, larger size, less pronounced pectoral fin tuberculation in males, pelvic fin failing to extend posteriorly to anal fin origin, and more vertebrae (35-36 vs. 31-34). Pectoral fin rays i23-26, pelvic fin rays i18-20. From *S. elongata*, the only other member of *Diardichthys*, it differs in its much more robust body, deeper caudal peduncle, color marks on body usually more finely divided (without exception in the type series), and usually fewer vertebrae. Scales in lateral line series about 60-70. Vertebrae 24-25+10-11=35(8) or 36(2).

Comments. - In its finely divided color pattern, especially on the body, *S. diardi* resembles *S. speciosa*. As the two species do occur sympatrically (e.g. at the Xe Nam Noi type locality), and both have departed in coloration from other species of their respective subgenera, their similarity in coloration might involve mimicry. The contrast between dark and light areas is not nearly so great in *S. diardi* as in *S. speciosa*. *Sewellia diardi* further differs from *S. speciosa* in attaining a larger size, having relatively large pectoral fin tubercles in few straight

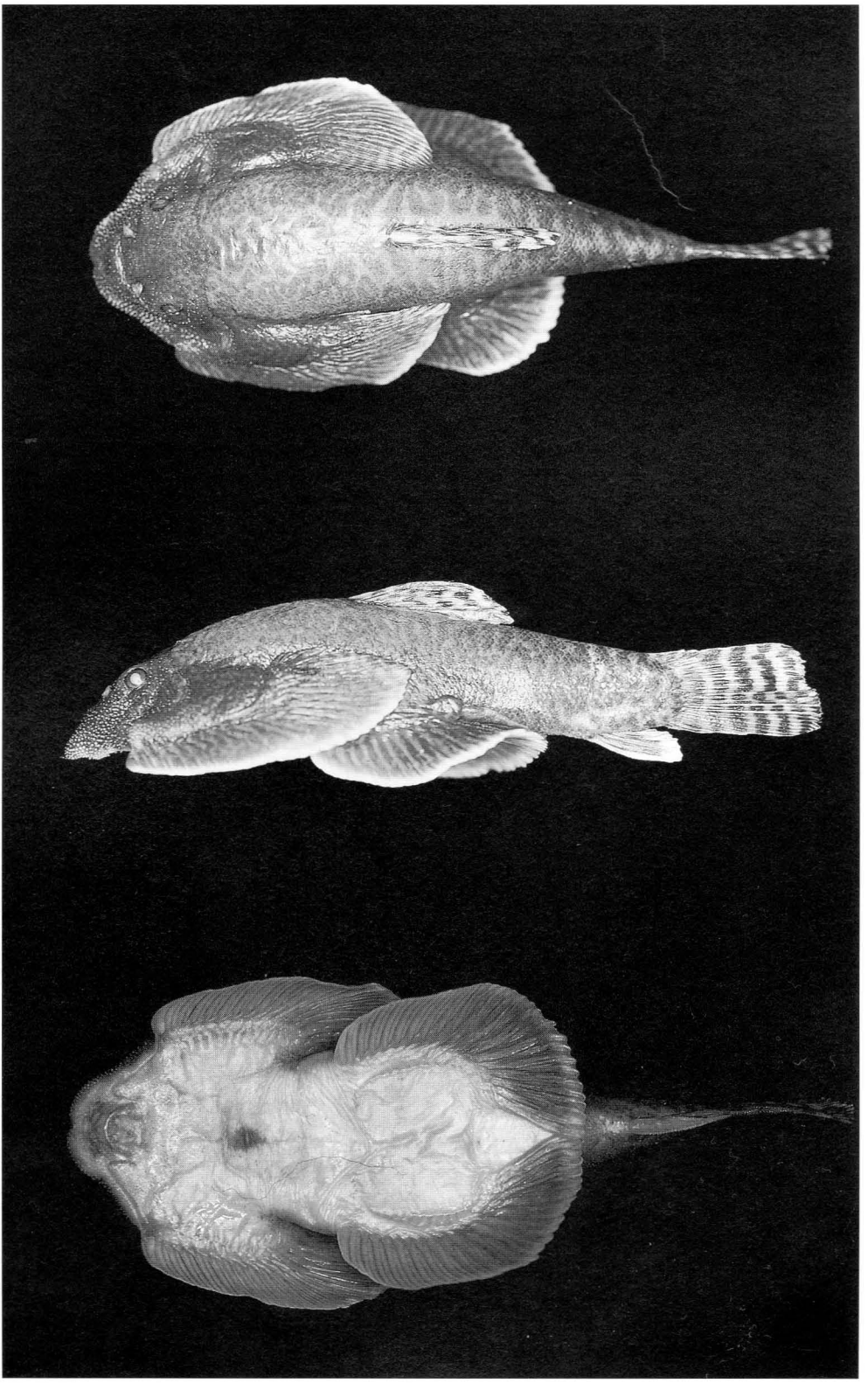

Fig. 6. *Sewellia (Diardichthys) diardi*, 71.1 mm holotype (dorsal, lateral and ventral views).

rows in males, pelvic fin falling far short of anal fin, and more numerous vertebrae.

The Houai Sai sample of three specimens is identified as *Sewellia diardi* but is not included in the type material mainly because of slightly more elongate, less robust body and minor differences in coloration. The mottling or color marks on the head and body tend to be less finely divided and the pectoral fin coloration less distinctive in the Houai Sai samples. Ian Baird, collector of the Houai Sai sample, observed that the specimens had red margins, a color not present in any other samples when they were collected alive (several of which were also photographed in fresh condition). Scales in lateral line series about 65-75. Pectoral fin rays i22-24, pelvic fin rays i18. Vertebral counts 34(1) and 35(2). Further study may show that the Houai Sai sample represents a distinct species, or that *S. diardi* is more variable in coloration than observed in the type series. The specimens somewhat resemble *S. elongata*, but are less elongate and have fewer vertebrae.

Etymology. - Named for Diard, naturalist-explorer of Indo-China and Indonesia, perhaps the first person to collect freshwater fish specimens in what is now known as Vietnam. He also collected mammals, birds, reptiles, and amphibians. His best known discovery is the Malaysian tapir. *Sewellia lineolata*, collected by Diard around 1821, is one of the earliest freshwater fishes to be collected and scientifically described from Vietnam.

Sewellia elongata, new species
(Fig. 7)

Material examined. - Holotype, ZRC 40361, 65.9 mm (strongly tuberculate, presumed sexually mature male), Xe Nam Noi at proposed dam site for Xe Nam Noi-Xe Pian hydropower dam, 16 km SE of Ban Nam Tang, Bolovens plateau (elevation 730 m), southern Laos, T. R. Roberts, 24 Mar.1995.

Paratypes - ZRC 40362, 158:30.1-73.0 mm, CAS 91777, 160:28.8-70.7 mm, MNHN 1997-002, 159:29.9-68.7 mm, and USNM 344489, 162:27.6-70.0 mm, collected with holotype; ZRC 40363, 68.0 mm (presumed senescent male), Xe Pian just after leaving Bolovens plateau, about 4 km down Xe Pian gorge from Huay Chot (elevation about 400 m), southern Laos, T. R. Roberts, 1 Apr.1995.

Diagnosis. - Longest known species of *Sewellia*, to 73 mm, but head and body much more slender and less robust than in *S. diardi*. Coloration relatively darkish and plain, nondescript compared to other *Sewellia*. Paired fins with a thin pale border, otherwise indistinctly mottled. Scales in lateral series about 65-70. Pectoral fin branched rays 22-24. Pelvic fin branched rays 20. Postanal portion of body relatively elongate or slender, its depth about 8-9 times into standard length (vs. 6-7 in other species). Vertebrae usually more numerous than in any other species, 25-27+9-10=35(3), 36(31) or 37(9) (vs. 35 or fewer).

Coloration. - Nearly all of the specimens were very dark, almost black when alive. After preservation a dorsomedian series of large dark blotches surrounded by pale areas became evident, with smaller mottlings on the sides and paired fins. Dorsal and caudal fins with dark bars, as in other *Sewellia*. Overall coloration, including the dorsomedian blotches, is like that in many or most species of *Balitora* and *Homaloptera*, and not like that of the more showy species of *Sewellia*. As in many *Balitora* and *Homaloptera*, a large proportion of the specimens have very pale areas dorsally. In the large sample of *S. elongata* these turned out to be nearly all females (or presumed females, see below). A peculiar feature is that the ventral surface of the paired fin rays is more or less extensively covered with fine melanophores in nearly all of the specimens. Such coloration occurs in *S. diardi* but not in

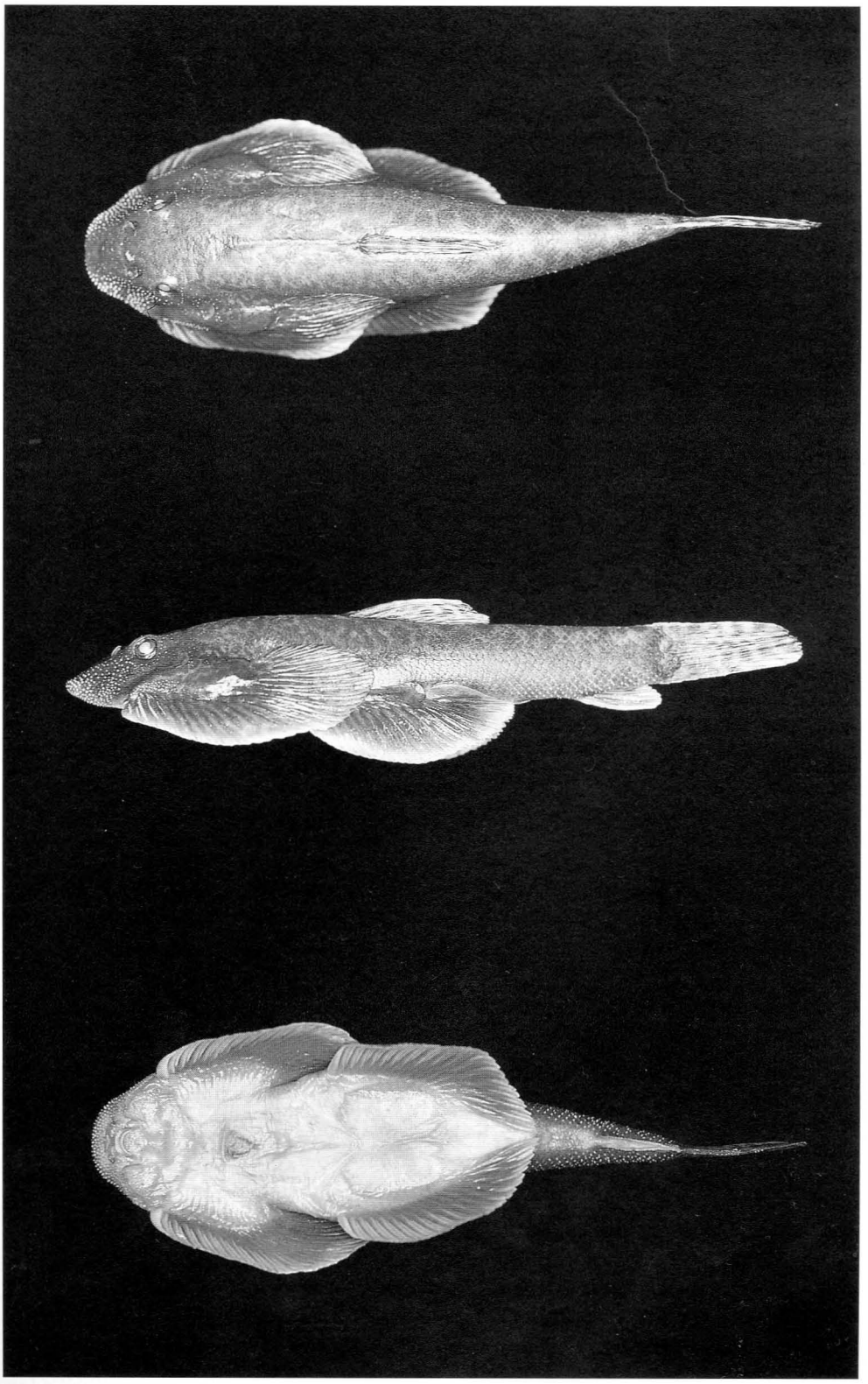

Fig. 7. *Sewellia (Diardichthys) elongata*, 65.9 mm holotype (dorsal, lateral and ventral views).

other *Sewellia*. Usually the entire ventral surface of the body and paired fins is devoid of melanophores in Balitoridae.

Sexual dimorphism, sex ratio. - As in other *Sewellia*, secondary sexual dimorphism in *S. elongata* seems to be limited to size and distribution of tubercles. Presumed males have larger tubercles on the head and pectoral fin than immature and presumed females, and the tubercles on the pectoral fin are more numerous and arranged in straight rows. Sexual dimorphism of the pectoral fin tubercles is less pronounced in *S. elongata* than in its congeners. This species does not have tubercles on all of the body scales. Larger males, however, including the holotype (Fig. 7) may have 1-5 erect, sharp conical tubercles on the posterior margin of each scale on the lowermost third of the body extending from end of pelvic fins to base of caudal fin. Similarly placed tubercles occur in some large male *S. diardi*. They also are present in large males of *Gastromyzon borneensis*, in which, however, each scale bears only a single tubercle (Roberts, 1982b: fig. 5).

Only 32 of 162 specimens collected in the Xe Nam Noi are identified as male (20% of the sample). In the size range with the largest numbers of males and of females, 50-60 mm, females outnumber males by almost 5 to 1. Such skewed sex ratios, probably unusual in Balitoridae generally, have not been observed in other *Sewellia*. The relatively large size of the smallest individual collected, 27.6 mm, probably indicates that this population had not reproduced since the beginning or middle of the last rainy season, around May or June 1994. As might be expected in specimens collected near the end of the dry season, several large females dissected showed no evident development of eggs. This is in marked contrast to *S. speciosa* in which young as small as 15 mm and ripe females were collected only a few weeks later, still before the end of the dry season.

Habitat, species association. - *Sewellia elongata* is the only species of *Sewellia* known from the top of the Bolovens plateau. The Xe Nam Noi where the large series was collected is a moderately high gradient forested montane stream with large boulders, a coarse gravel or sandy bottom, and some logs. A total of 10 fish species was collected at the site, including Cyprinidae (3), Cobitidae (2), Balitoridae (2), Sisoridae (2), and Channidae (1). The dominant species in number of individuals and biomass was an apparently polymorphic species of the cyprinid genus *Poropuntius*, with three distinct feeding or trophic morphs. *Sewellia* were second in number of individuals and biomass. Other rheophilic species were a *Cyprinion*, an *Annamia* and two *Glyptothorax*. It was also observed (but not collected) in the Xe Pian on top of the plateau, in association with nearly the same species as in the Xe Nam Noi except that a *Garra* and a *Clarias* were also present. The entire known fish fauna on the top of the Bolovens plateau consists of only 16 or 17 native species. *Cyprinus carpio* and *Tilapia nilotica* have been introduced. *Channa striata* may be native or introduced. The only other Bolovens fish species likely to prey on *S. elongata* is *Clarias batrachus*.

The only other locality where *Sewellia elongata* was observed (and collected), the middle Xe Pian about 3-4 km after it flows down through a gorge from the top of the plateau, is an extremely high gradient, tumultous mountain stream with huge boulders and coarse gravel bottom. Nine fish species were collected at this site: Cyprinidae (4), Cobitidae (1), Balitoridae (3), and Sisoridae (1), all but one or two restricted to swift flowing stream habitats. Other balitorids at the site were *Annamia* and *S. diardi*.

Distribution. - *Sewellia elongata* is known only from the upper reaches of the Xe Nam Noi and adjacent Xe Pian on the Bolovens plateau in southern Laos. After flowing off the plateau

in different directions, these streams join the Se Kong. The main type series (including holotype) were collected in the Xe Nam Noi on top of the Bolaven plateau about one kilometer below the proposed dam site for the Xe Nam Noi-Xe Pian hydropower project (Fig. 8). At this place the left bank of the Xe Nam Noi is formed by a concave wall of lava about 10 m high, which keeps the site well shaded for almost half of the day time. The fish were observed continuously distributed in rocky areas from there upstream to or beyond the dam site. Specimens were observed (but not preserved) in the Xe Pian on top of the plateau. At this

Fig. 8. Xe Nam Noi at Xe Nam Noi-Xe Pian hydropower dam site, type locality of *S. elongata*. a) looking upstream past the dam site; b) looking downstream (actual collection site).

site the Xe Pian is a forested montane stream of about the same size and characteristics and with a similar fish fauna as the Xe Nam Noi site. No other *Sewellia* species was collected or observed on top of the plateau.

A single *Sewellia elongata* was taken in the Xe Pian where it has left the plateau, but none in several Xe Pian collections below 400 m elevation. A number of sheer waterfalls 10-20 m high separate the middle Xe Pian from the lower Xe Pian. The last (farthest downstream) of these waterfalls, 4-5 km upstream from the village of Ban Hin Lat, is the 20 m high Se Pa waterfall (Roberts, 1995: fig. 4). This particular specimen, apparently a senescent male, differed from all other *S. elongata* observed in that it had shed all of its tubercles.

Sewellia elongata may be endemic to the Bolovens plateau, but so little collecting has been done elsewhere in the Se Kong watershed and other places where it might occur that this can not be asserted. It should be noted, however, that the upper Xe Nam Noi and the upper Xe Pian are both separated from the middle and lower portions by one or more high waterfalls which undoubtedly represent an absolute upstream barrier to *Sewellia.* The polymorphic *Poropuntius* and two or three other species found on the Bolaven plateau also have not been collected elsewhere and may be endemic.

Etymology. **-** From the Latin *elongatus*, elongate (adj.).

DISCUSSION

Observations of external morphology reveal a number of epidermal modifications that all species of the genus probably share in common, and also some features that are probably characteristic of the subgenera. Light microscopic observations were made of all of the species, and scanning electron microscopic observations of a 46.6 mm male *Sewellia (Sewellia) speciosa* and a 57.5 mm male *Sewellia (Diardichthys) elongata* (see Figs. 1, 2).

Features probably common to all *Sewellia* include the following:

1. unculiferous pads on ventral surface of first 10-14 pectoral and pelvic fin rays;
2. unculiferous upper and lower horny jaw sheaths;
3. tuberculate rostral sheaths;
4. two pairs of heavily papillose but non-tuberculate and non-unculiferous rostral barbels with medially expanded bases bearing numerous non-tuberculate and non-unculiferous papillae;
5. one pair of maxillary barbels morphologically similar to rostral barbels but without expanded bases;
6. broad-based conical tubercles more or less extensively developed (usually larger and more numerous in males) on head, rostral cap, oral-pectoral fold, base of pectoral fin, dorsal surface of pectoral fin, ventral surface of pectoral fin, and side of body, and anal fin (especially on lateral margins of enlarged simple anal fin ray).

Features possibly common to all members of the subgenus *Sewellia* include:

1. many tubercles have unculiferous basal portions;
2. males without patch of tubercles immediately medial to pectoral fin origin.

Features probably common to all members of the subgenus *Diardichthys* include:

1. tubercles on head body and fins non-unculiferous;
2. males with patch of numerous conical tubercles lying in shallow depression on abdomen immediately medial to pectoral fin origin.

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