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The Occurrence of *Pangasius polyuranodon* Bleeker, 1852 (Teleostei: Pangasiidae) in Peninsular Malaysia with Remarks on the Comparative Morphology with *Pseudolais micronemus* (Bleeker, 1847)

(Kehadiran *Pangasius polyuranodon* Bleeker, 1852 (Teleostei: Pangasiidae) di Semenanjung Malaysia dengan Ulasan tentang Morfologi Perbandingan *Pseudolais micronemus* (Bleeker, 1847))

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ABSTRACT

This paper presents the first reliable record on the occurrence of the pangasiid catfish, Pangasius polyuranodon, *in Peninsular Malaysia. It was previously unnoticed because of misidentification due to its close morphological appearance to* Pseudolais micronemus. Pangasius polyuranodon *can be positively distinguished from* P. micronemus *with a combination of characters: Distinctive palatal dentition with a large nearly squared vomerine tooth patch with small lateral palatine toothplates; longer maxillary and mandibular barbels; higher count of anal fin rays; higher counts of gill rakers on the first gill arch. Other characters are: longer caudal peduncle 19.84 ± 24.27% vs 18.35 ± 1.57% standard length* (SL)*; wider anterior snout 35.49-40.60% head length* (HL) *and wider mouth 45.15-59.65%* HL. *This finding has important implications for taxonomy and conservation of indigenous Pangasiid catfishes, due to its close morphological appearance to the more abundant* P. micronemus *but with different biology and ecological behavior, thus necessitating different management and conservation strategies.*

Keywords: Conservation; first record; palatal dentition; Pangasius polyuranodon*;* Pseudolais micronemus

ABSTRAK

Kertas ini mengesahkan kehadiran ikan berduri daripada keluarga pangasiid, Pangasius polyuranodon, *di Semenanjung Malaysia. Sebelum ini kehadirannya tidak disahkan kerana kesilapan mengenal pasti ikan ini yang morfologinya sangat menyerupai* Pseudolais micronemus. Pangasius polyuranodon *boleh dibezakan secara positif daripada* P. micronemus *dengan gabungan ciri: penggigian palatal jelas dengan tampalan gigi vomer yang besar berbentuk menghampiri segiempat dan gigi palatin kecil; sesungut maksila dan mandibel yang lebih panjang; bilangan ruji sirip anus yang lebih banyak serta bilangan sisir insang yang lebih banyak pada sisir insang yang pertama. Ciri lain adalah: pedunkel kauda yang lebih panjang 19.84 ± 24.27% daripada panjang piawai berbanding 18.35 ± 1.57% panjang piawai* (SL) P. micronemus*; muncung hadapan lebih lebar 35.49-40.60% panjang kepala* (HL) *dan mulut yang lebih lebar 45.15-59.65%* HL. *Keputusan ini memberikan satu implikasi penting untuk taksonomi dan pemuliharaan ikan patin asli di Malaysia, disebabkan rupa morfologi* P. polyuranodon *yang menyerupai* P. micronemus *yang lebih kerap ditemui, tetapi perlakuan biologi dan ekologi yang berbeza ini memerlukan pengurusan dan strategi pemuliharaan berlainan.*

Kata kunci: Pangasius polyuranodon*; pemuliharaan*; *penggigian palatal*; Pseudolais micronemus*; rekod pertama*

INTRODUCTION

Catfish species of the family Pangasiidae are recognized by a laterally compressed body, having two pair of barbels (maxillary and mandibular), long anal fin, short dorsal fin and small adipose fin with free posterior margin (Gustiano 2003; Roberts & Vidthayanon 1991). They are widely distributed throughout Asia, from Pakistan to Indochina and the Indo-Malayan Archipelago (Roberts & Vidthayanon 1991) and also recorded in China (Yang et al. 2007). A total of 28 valid Pangasiidae species have been reported throughout the Asian river systems (Eschmeyer & Fong 2013; Ferraris 2007; Froese & Pauly 2013; Nelson 2006), with 13 species occurring in Indo-China and 15 species found in the Indo-Malayan Archipelago (Gustiano 2003; Kottelat 2013; Ng & Kottelat 2000; Pouyaud & Teugels 2000; Pouyaud et al. 2002, 1999).

There are four genera in the catfish of the family Pangasiidae: *Helicophagus* Bleeker 1858; *Pangasianodon* Chevey 1930; *Pangasius* Valenciennes, in Cuvier & Valenciennes 1840 and *Pseudolais*, Vaillant 1902 (Kottelat 2013). While the earlier molecular phylogenetic studies using partial mitochondrial Cytochrome b gene (Pouyaud et al. 2000) could not resolve the groupings, later work by Pouyaud et al. (2004) using mitochondrial 12S rRNA and recent work by Karinthanyakit and Jondeung (2012) has supported the four groupings of the genera using complete mitochondrial cytochcrome b, 12S rRNA, tRNA-Val, 16S rRNA and partial nuclear recombination-activating gene

(*rag1)*. It should be noted that molecular evidence could be used to support morphological characteristics of such species, but each must be carefully used in conjunction with the others. External features such as morphological and meristic characters should be used in the first place to confirm the species identification before using any molecular work to support the study.

Members of the Pangasiids have very close morphological appearance to each other. Some may exhibit different morphological resemblance at different life stages (*P. bedado* Roberts 1999 was actually a junior synonym to *P. djambal* Bleeker 1846) (Gustiano et al. 2004), morphological variation of allopatric species that occur between the Asian Mainland and Indo-Malayan Archipelago (*Helicophagus leptorhyncus* Ng & Kottelat, 2000 vs *H. typus* Bleeker 1858; *P. bocourti* Sauvage 1880 vs *P. djambal* Bleeker 1846; *P. conchophilus* Robert & Vidthayanon 1991 vs *P. nasutus* Bleeker 1863; *P. elongatus* Pouyaud et al. 2002 vs *P. mahakamensis* Pouyaud et al. 2002). These reasons, together with living in various ecological habitats might create confusion as arouse in many of the previous classification. Further taxonomical clarification and supporting evidence is clearly required for proper management and conservation of such species as some species may be previously unknown or even unnoticed.

Pangasiids are known for their great economic importance. However, many Pangasiid populations are reported to be rare, under threat of extinction or least concerned under IUCN Red List of Threatened Species (IUCN 2013). Among them in the lists are *Pangasianodon gigas* (Hogan 2011), *H. leptorhyncus* (Vidthayanon 2013a), the wild populations of *Pangasianodon hypophthalmus* Sauvage, 1878 (Hogan & Vidthayanon 2011), *P. bocourti* (Vidthayanon 2013b), *P. conchophilus* (Vidthayanon 2013c), *P. elongatus* (Vidthayanon 2012d), *P. krempfi* Fang & Chaux, 1949 (Baird 2011), *P. larnaudii* Bocourt, 1866 (Baird 2012), *P. macronema* Bleeker, 1851 (Jenkins et al. 2009), *P. mekongensis* Gustiano et al. 2003 (Vidthayanon 2013e) and *P. myanmar* Roberts & Vidthayanon, 1991 (Chaudhry 2010). *P. pangasius* (Hamilton 1822) was listed as critically endangered (IUCN Bangladesh) (Hossain et al. 2009) but currently its status is least concern (Pal 2010). Populations of *P. sanitwongsei* Smith, 1931 is seriously declining; once, it was considered endangered in Thailand (Hogan et al. 2009; Humphrey & Bain, 1990; Roberts & Vidthayanon 1991) but then reviewed as critically endangered (Jenkins et al. 2009). IUCN's Red List database also has regarded *Pseudolais micronemus* (Bleeker 1947) as Data Deficient (Vidthayanon 2013f) while *P. pleurotaenia* (Sauvage, 1878) as Least Concern (Vidthayanon 2013g).

Peninsular Malaysia is the location where many Indonesian species have their northernmost distributional limit while a handful of Indian and Indochinese species have their southernmost distributional limit (Zakaria-Ismail 1994), resulting from the previous landmark change on the Sunda Shelf during the Pleistocene glacial maxima (McConnell 2011; Rainboth 1996; Voris 2000). In Peninsular Malaysia, three species of Pangasiidae have been recorded, namely *P. nasutus, P. micronemus* and *H. waandersii* (Herre & Myers 1937; Lim & Zakaria-Ismail 1995; Roberts & Vidthayanon 1991; Tweedie 1936). Fowler (1938) listed *P. polyuranodon* as having been found in Peninsular Malaysia, but its occurrence remains doubtful (Lim & Zakaria-Ismail 1995). In a recent study, all the four species of Pangasiids are listed as moderately threatened in Malaysia because of the combination factor of overharvesting and habitat degradation (Chong et al. 2010). Therefore, it is of utmost important to positively identify the species and understand its ecology to ensure proper management and conservation strategy can be taken to maintain a healthy and sustainable population, hence protecting the rich fish biodiversity and its genetic resources in the country.

The current study compares the morphological characters of *P. polyuranodon* with *P. micronemus*, and discussed its finding to the implications on the conservation of indigenous Pangasiid catfish species in Peninsular Malaysia.

Materials and Methods

While examining the pangasiid specimens housed at the Universiti Malaya Zoological Collections, the first author uncovered two specimens of *P. polyuranodon* which were first thought to be *P. micronemus*. Identification follows Roberts and Vidthayanon (1991) while morphometric measurements were taken using dial callipers and recorded to the nearest 0.1 mm, following Gustiano (2009, 2003) and Pouyaud et al. (1999). All measurements except standard length were expressed as proportional values of reference length. Measurements on the body including head length were conveyed as a percentage of the standard length (% SL). Other measurements on the head were articulated as a percentage of the head length (% HL).

Univariate analysis including sample size, mean and standard deviation, minimum and maximum values were analysed using Analysis of Variance (ANOVA). Variables with significant difference were selected as distinguishable characters.

Specimens were compared to *P. micronemus* collections from Peninsular Malaysia (n=82) located at the Universiti Malaya, Kuala Lumpur, Malaysia (BIRCUM and UMKL), Fisheries Research Institute (Freshwater Division), Glami Lemi, Jelebu, Malaysia (FRIGL), the Raffles Museum for Biodiversity Research, National University of Singapore (ZRC and NMS) and also collections of the first author (HB), fourth author (MZI) and Asian Wetland Bureau (AWB) (now known as Wetlands International). A specimen of *P. polyuranodon* and two other specimens of *P. micronemus* from Museum Zoologicum Bogoriense (MZB) were served as comparative specimens.

The present Malaysian specimens are now housed at the Fisheries Research Institute (Freshwater Division), Glami Lemi, (FRIGL), Jelebu, Negeri Sembilan, Malaysia.

RESULTS

DIAGNOSIS

Roberts and Vidthayanon (1991) stated that *P. polyuranodon* is an elongate species that could achieve 800 mm in standard length (Vidthayanon 1993), while maximum size observed by Gustiano (2003) was 602 mm SL. *Pangasius polyuranodon* can be distinguished from all congeners by the combination of a short predorsal length (25.2-29.2% SL) and a long caudal peduncle (17.2-21.8% SL) (Pouyaud et al. 2002). This species has a distinctive palatal dentition (Figures 1 and 2) which consists of a large nearly squared median vomerine tooth patch with small lateral palatine toothplates, while *P. micronemus* has smaller and separate palatal tooth patches (Figure 3). The number of gill rakers on first gill arch is 19-30. Anal fin rays are 33-42 (Gustiano 2003).

DESCRIPTION

Morphometric data of *P. polyuranodon* (Figure 1) specimens examined are shown in Table 1 in comparison with *P. micronemus*. Body is elongated, head short, flattened with snout slightly large and rounded. Mouth inferior with 'angulated' ventral outline of lower jaw. Anterior nostrils shorter than distance of posterior nostril and situated on the anterior margin of the upper lip. Large eye diameter is a shared characteristic between both species (Table 1). When mouth is closed, premaxillary toothplate is hardly visible (Figure 1(b)). Wide rectangular shape of vomerine teeth, with long and slender palatine toothplates (Figures 1(c) and 2). Maxillary barbels reaching the posterior border of operculum while mandibular barbels shorter and hardly reaching the mid eye level. Three chambers of swimbladder extending to above anal-fin base. Short predorsal, with long caudal peduncle. Anal fin long with high number of soft fin rays. Adipose fin minute.

From the external morphology, the two specimens recently discovered were first assumed to be *P. micronemus*, the more common and abundant indigenous pangasiid species in Peninsular Malaysia with the characteristic of large eye and elongate, slim body shape. However, closer examinations on the two specimens showed the clear and distinctive characters of *P. polyuranodon*.

The dentition having a large and nearly squared vomerine tooth plate with discrete palatal teeth (Figure 2) could distinguish *P. polyuranodon* from *P. micronemus* which has four small and widely separated vomerine and palatine tooth bands (Figure 3c). Longer barbels (maxillary barbel length (30.57, 32.97 and 35.34% HL) and mandibulary barbel length (23.29, 20.18 and 34.93 % HL)) is another character that distinguish this species from *P. micronemus* which has minute pair of barbels with mean maxillary 27.96±7.07 and mandibulary 13.24±5.67% HL (Table 1).

The number of gill rakers on the first gill arch is higher in *P. polyuranodon* (28, 25 and 22; mean 25) while the number of gill rakers in *P. micronemus* found in this study is lower (12-24), similar to the findings of Gustiano (2003) with 70% majority counts of 15-18.

Higher number of anal fin rays in the *P. polyuranodon* specimens observed (38 -40) could be another discriminating characteristic. However, small number of specimens could not draw a good conclusion as compared to Gustiano (2003) that observed a range count of 33-42. Anal fin ray counts of *P. micronemus* in Gustiano's observation were 26-40 but without frequency count distribution. In this current study, majority of *P. micronemus* specimens (67%) have anal fin ray count of 26-30 while only small number of samples (4%) have higher count (35-40). Therefore, this could be another promising character to discriminate both the species.

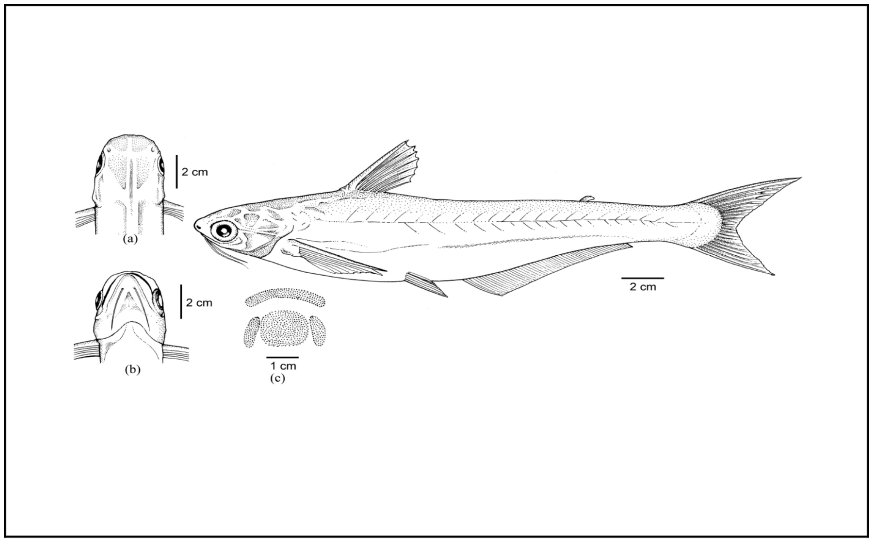

FIGURE 1. *Pangasius polyuranodon* (a) dorsal, (b) ventral head views and (c) maxillary and palatal dentition

TABLE 1. Morphometric and meristic data for *Pangasius polyuranodon* (*n*=3) with comparison to *Psedolais micronemus* from Peninsular Malaysia. All measurements are expressed as a percentage of standard length and percentage of head length. Data for *P. micronemus* is mean (mm) ± standard deviation, range (min-max) is in bracket, and * indicates significant at $p<0.05$

Characters	Comparative specimen (*P. polyuranodon*) MZB 3681	POLY 01	POLY 02	N	*P. micronemus* (*n*=82) 72.72-406 mm SL		F ratio	P*
in % standard length								
Head length	17.43	19.12	17.25	82	19.21 ± 1.80	(14.98-24.05)	1.47	0.23
Head depth	9.68	10.19	9.43	82	11.47±1.40	(7.67-15.33)	4.39*	0.04
Head width	13.25	13.72	13.14	81	13.94±1.10	(10.30-17.09)	0.78	0.38
Caudal peduncle length	24.27	19.84	21.13	82	18.35±1.57	(13.86-21.68)	13.15*	0.00
Caudal peduncle depth	8.15	7.61	7.80	82	7.69±0.54	(6.13-9.07)	0.27	0.60
Pectoral spine length	16.44	-	-	49	15.10±2.28	(7.05-18.18)	30.43*	0.00
Pectoral fin length	17.56	18.59	18.53	80	16.10±1.87	(10.45-20.21)	3.81	0.05
Dorsal spine length	16.89	15.70	14.94	47	14.85±1.69	(10.80-19.36)	1.01	0.32
Dorsal fin length	18.93	14.94	16.08	74	16.55±1.72	(11.87-22.16)	0.01	0.92
Pelvic fin length	11.60	9.13	10.34	82	10.70±0.92	(9.00-14.80)	0.38	0.54
Anal fin height	8.45	9.31	11.11	81	9.52±1.48	(6.56-16.60)	0.01	0.91
Anal fin length	31.94	32.64	31.83	82	27.77±2.85	(13.59-33.56)	6.93*	0.01
Adipose fin height	3.72	2.65	2.73	80	2.78±0.98	(0.42-6.41)	0.06	0.81
Adipose fin width	1.03	1.13	0.26	80	3.16±0.88	(0.42-4.92)	1.74	0.19
Interorbital distance	11.03	10.44	10.35	82	10.27±1.07	(7.38-14.02)	0.28	0.60
Body width	13.68	14.43	15.37	82	15.48±1.40	(11.23-18.88)	1.45	0.23
Predorsal length	28.00	27.25	26.00	82	30.77±4.27	(12.15-41.22)	2.21	0.14
Prepectoral length	16.95	18.29	19.17	82	17.29±3.88	(6.03-24.52)	0.14	0.71
Prepelvic length	37.69	37.63	36.45	82	42.66±5.24	(6.41-51.72)	3.15	0.08
in % head length								
Snout length	40.51	38.33	41.17	84	41.17±3.39	(29.25-49.45)	0.33	0.56
Anterior snout width	35.49	39.13	40.60	84	35.24±2.49	(27.55-41.04)	4.57*	0.04
Posterior snout width	49.41	50.66	48.06	84	46.53±3.81	(32.31-53.59)	1.62	0.21
Eye diameter	22.36	27.74	22.41	84	25.87±3.60	(14.81-35.90)	0.67	0.41
Mouth width	45.15	59.65	47.70	84	44.44±4.22	(32.18-54.84)	6.20*	0.01
Lower jaw length	31.58	26.10	32.23	84	28.10±5.12	(7.62-41.78)	0.39	0.53
Distance from snout to isthmus	53.92	59.28	61.34	84	59.34±3.61	(49.33-67.56)	0.39	0.53
Postocular length	32.16	35.03	49.30	84	40.72±9.87	(22.77-61.86)	0.09	0.76
Vomerine width	24.76	23.83	24.57	45	7.97±8.61	(0.22-29.63)	10.67*	0.00
Vomerine length	28.23	37.77	19.08	45	1.66±2.04	(0.21-8.87)	258.20*	0.00
Palatine length	18.15	25.87	13.47	41	3.24±4.13	(0.53-13.65)	39.15*	0.00
Palatine width	6.05	8.72	4.78	40	1.27±1.56	(0.22-5.45)	36.69*	0.00
Dorsal spine width	13.67	6.96	5.17	83	7.94±2.55	(4.71-16.29)	0.18	0.67
Maxillary barbel length	35.34	32.97	30.57	78	27.96±7.07	(18.25-49.97)	14.75*	0.00
Mandibulary barbel length	24.93	23.29	20.18	76	13.24±5.67	(5.63-35.33)	6.21*	0.01
meristic counts								
Anal fin rays	38	39	40	83	21-40		29.94*	0.00
Pelvic fin rays	6	6	6	83	6-7		0.41	0.52
Pectoral fin rays	13	13	13	84	10-16		0.10	0.76
Number of gill rakers on the first gill arch	22	28	25	81	12-24		33.85*	0.00

FIGURE 2. Closer look on the maxillary and palatal dentition of *P. polyuranodon*

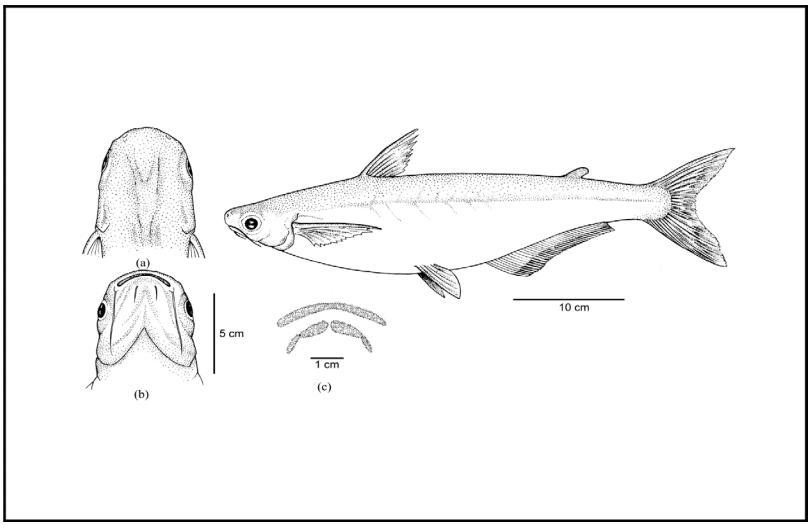

FIGURE 3. *Pseudolais micronemus* (a) dorsal, (b) ventral head view and (c) maxillary and palatal dentition

Longer caudal peduncle length (19.84, 21.13 and 24.27% HL vs 18.35 ± 1.57% HL of *P. micronemus*) and shorter predorsal length 26.00, 27.25 and 28.00% HL vs 30.77 ± 4.27% HL of *P. micronemus* resemble the morphological characters described in Gustiano (2003). Detailed comparison on the morphometric and meristic characters is presented in Table 1.

DISCUSSION

This study has confirmed the existence of *P. polyuranodon* in Peninsular Malaysia as previously cited by Fowler (1938) and Lim and Zakaria-Ismail (1995). The distribution of *P. polyuranodon* is now had extended further north to Peninsular Malaysia (Figure 4), of which previously only known from Indonesia and Borneo (Pouyaud et al. 2002; Gustiano 2003). In relation to the lost biogeographic connection between the freshwater species occurred in continental Asia and Indo-Malayan Archipelago, this finding therefore has filled up the gap on the map of aquatic faunal exchange across the high freshwater fish biodiversity of Sunda Shelf.

P. polyuranodon may have been previously misidentified as *P. micronemus* due to it close morphological appearance, with consequent confusion regarding respective distributions. Bleeker (1862) showed the synonymy of the specimens of *Pangasius juaro* Bleeker 1852: 136 type locality Palembang, Indonesia. However, the fish which is locally called 'Ikan Juara' (in Malay language (ikan = fish)) or 'Juaro' in Indonesia is actually *P. micronemus*. During earlier revisions, both the species were kept in the same lot [RMNH 6857 (4 ex: 136-299 mm) in Leiden Museum (Gustiano 2003: 138), before the designation of *P. polyuranodon* holotype RMNH 6855. A single *P. juaro* specimen (301 mm SL, RMNH 6857) was designated by Gustiano (2003) as the holotype based on meristic data described in the original description, not the 292 mm BMNH specimen suggested by Roberts and Vidthayanon (1991: 137).

Roberts and Vidthayanon (1991) also had the difficulty in distinguishing *P. polyuranodon* from *P. micronemus*. They reported *P. polyuranodon* as widely distributed throughout Vietnam, Thailand, Malaysia and Indonesia, thus they separated the two species based on geographical variation of the number of anal fin rays. Later, Pouyaud et al. (2002) resolved this problem by separating the *P. polyuranodon* complex into three species with the description of two new species that occur allopatrically: *P. mahakamensis* (endemic to Mahakam River, East Kalimantan, Indonesia) and *P. elongatus* (lower reaches of Chao Phraya, Bangpakong and Vietnam Mekong) (the former was mentioned as having 32-37 anal fin rays; while the latter have 32 rays (Roberts & Vidthayanon 1991: 137). This separation resulted in *P. polyuranodon* to be occurred in the Sumatra and Borneo Islands only (Figure 4).

The habitats used by both the species are also different. *Pseudolais micronemus* spends most of its life in freshwater habitats (upper and middle reaches) but the migratory pattern is poorly known (Vidthayanon 2012f) while *P. polyuranodon* inhabits estuaries and lower reaches but migrates upstream during the rainy season (Pouyaud et al. 2002). In Peninsular Malaysia, *P. polyuranodon* is thought to be endangered and in fact may be nearly extinct (personal observation) since it is rarely seen or partly due to specialised habitat preferences. On the other hand, *P. micronemus* is more abundant. These findings are contrary to the assessments of Vidthayanon (2012f) who reported the uncommonality of *P. micronemus* throughout its distribution range with no recent records from Chao Phraya drainage in Thailand. The 2012 IUCN Red List status for *P. micronemus* is Data Deficient, with declining population trend in Cambodia and Vietnam. Further extensive surveys are clearly needed to establish the distribution and abundance of both *P. polyuranodon* and *P. micronemus* (which can now be done definitively using the distinguishable characters outlined in this study). The status of the species must be identified by further specimen collection, ecological, migration patterns and spawning behaviour studies must also be conducted. If the status on risk of extinction or endangered have been confirmed, an appropriate fishery management plans must be developed for species protection. Stakeholders and public consultation could be enquired before gazetting any habitat or closing area or season. Once and while the population recovered, a long term program is required to create the awareness on the species and habitat protection. Not only for *P. polyuranodon*, could the same management plan also be applicable to any endangered or threatened fish species.

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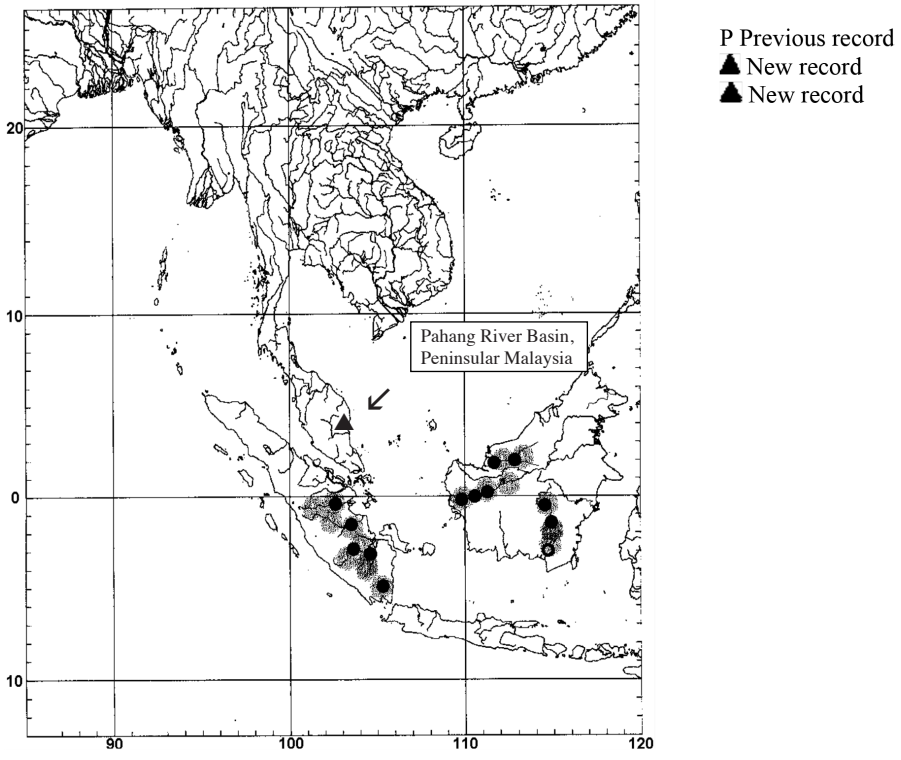

FIGURE 4. Geographic distribution of *P. polyuranodon* known to occur in Southeast Asia. Modified from Gustiano (2003)

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