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Taxonomic Note on *Ellochelon vaigiensis* (Quoy & Gaimard, 1825) (Mugilidae: Mugiliformes) from West New Guinea, Indonesia

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Abstract

Ellochelon vaigiensis is a monotypic, catadromous, and widespread species throughout Indo-Pacific region. Taxonomy of the species is ancient and somewhat confused by morphological resemblance. Here, we present and compare the morphological characteristics of *E. vaigiensis* from 3 distinct areas, respectively from the type locality (Waigeo Island, Raja Ampat), from Cendrawasih Bay (Biak Island), and Kaimana (Venu and Aiduma Islands). All the samples belong to *E. vaigiensis* following the species diagnosis given by Harrison and Senou (1999). No significant differentiation is found for all meristic and morphological characters between specimens caught from the type locality and Biak Island. Nevertheless, specimens from Kaimana have a slender body width compared to specimens from Waigeo Island (type locality) and Biak Island. Specimens from Kaimana also display a longer head and a larger eye diameter than specimens from Biak Island. A canonical discriminant analysis made on all morphometric data confirms the morphological differentiation of Kaimana's specimens compared to the type locality and Biak Island. These results suggest the possibility of the presence of cryptic species in *E. vaigiensis* and emphasize the necessity to conduct molecular taxonomy to definitely solve the taxonomic status of Kaimana specimens.

Keywords: *Ellochelon vaigiensis,* Morphometric, Meristics, New Guinea

Introduction

The family Mugilidae is a marine dweller origin, a wide spread group throughout tropical, subtropical, and temperate regions [1-3]. They are found in the Indian, Pacific and Atlantic Oceans [4-6]. So far, there are 20 valid genera and 75 species [7].

Ellochelon vaigiensis belongs to the family of Mugilidae, classified as monospecific in the genus of *Ellochelon*. The species is widely distributed throughout the Indo-Pacific region from the eastern coast of Africa to New Caledonia [9-11], from very southern latitudes such as Tasmania or the Cape in South Africa to latitudes as far north as the Persian Gulf or Japan [11,12]. Taxonomy of *E. vaigiensis* is ancient, originally described from specimens collected in Waigeo Island, Raja Ampat, Indonesia [13,14]. Chronologically, the species had long taxonomic status and somewhat confused due to their morphology overlap with many other species belonging to the family [11]. The species was previously placed under several generic names such as *Mugil vaigiensis*, Quoy and Gaimard, 1825, *Ellochelon* [14], *Chelon* [15], *Ellochelon* [16], *Liza* [17], and presently replaced to the genus *Ellochelon* [18-20].

As a widespread marine species throughout the range of Indo-Pacific region, this species is commonly found in the coastal ecosystem including estuaries, mangroves, coral reefs, and lagoons. *Ellochelon vaigiensis* enters into the freshwater ecosystems during the rainfall season [8,21,10,22]. Juveniles may be found in rice fields and mangroves and may be used as baitfish [9]. Similar to another member of the family, the squaretail mullet is an important food and income resources for coastal and island communities in the region of Indo-Pacific countries [9,23,24,22].

Since its formal description in 1825, research on the species remain scarce. Most recently, molecular investigation on few juvenile specimens belonging to this species from the western part of Indonesia suggested a cryptic diversity with potential occurrence of unknown taxa [25]. To fill this knowledge gap, the present study aims to provide a more detailed morphological study based on additional specimens collected at the type of locality of Waigeo and additional samples caught from adjacent islands in the western part of New Guinea.

Materials and methods

Samples were collected during the Lengguru expedition 2017 [26] and additional surveys were conducted by several members of Diversity Aquatic Indonesia Network (DIVA Indonesia Network). Specimens will be respectively deposited at the Museum Zoologicum Bogoriense (MZB) and the Tanah Papua Collection (TPC) housed at the Campus of Politeknik Kelautan dan Perikanan Sorong, West Papua.

The material includes specimens from the type locality (Waigeo, Raja Ampat) and additional specimens collected near the type locality (Salawati, Raja Ampat), and from the north-eastern (Biak, Cendrawasih) and southern (Kaimana) parts of West New Guinea. Taxonomic assignation of the material to the species *Ellochelon vaigiensis* was done according to the species key of mullet proposed [9]. Their geographic locations are presented in **Figure 1**.

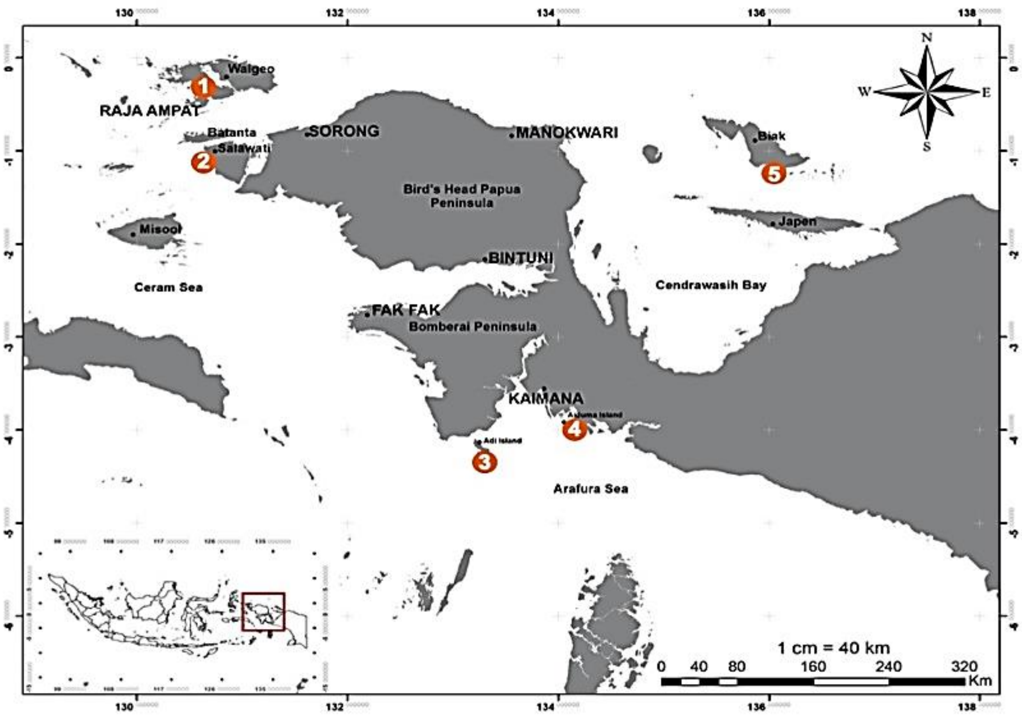

Figure 1 Sampling localities of *Ellochelon vaigiensis* on the western part of New Guinea: (1) Waigeo, Raja Ampat (type locality); (2) Salawati, Raja Ampat; (3) Venu Island (Kaimana); (4) Aiduma Island (Kaimana); (5) Biak (Cendrawasih Bay).

Raja Ampat: MZB 26053-54, 2 specimens (284.46-294.68 mm SL), and TPC 2309:1, 10 specimens (219.60-276.57 mm SL), collected by Ahmad Darun, 24 January 2020, southwest Waigeo Island, type locality, Raja Ampat, West Papua, Indonesia (*Site 1*: -0.381209 - 130.681445); TPC 2309:2, 1 specimen (302.44 mm SL), collected by Amir Suruwaky, 4 April 2020, Salawati Island, Raja Ampat, West Papua, Indonesia (*Site 2*: -0.953356-130.669216).

Kaimana: TPC 2309:3, 11 specimens (107.89-201.86 mm SL), collected by Abraham Apono, 29 October 2017, Venu Island, Kaimana, West Papua, Indonesia (*Site 3*: -4.325069 - 133.504848); TPC 2309:4, 1 specimen (258.71 mm SL), collected by Abraham Apono, 7 November 2017, Aiduma Island, Kaimana, West Papua, Indonesia (*Site 4*: -3.914767 - 134.090433).

Biak: TPC 2309:5, 7 specimens (214.09 - 326.37 mm SL), collected by Yosep, 27 January 2020, Biak Timur, Biak, Papua, Indonesia (*Site 5*: -1.207356 - 136.18723).

The methods of counting (10 meristic characters) and measuring (23 morphological characters) are derived [27] with some modifications and additions (**Figure 2**). Measurements were taken with a digital caliper measuring tool under a lightening monocular lens (2×) and partial counts were made under lightening binocular lens (4×). Measurements were taken on the left side and expressed to the nearest 0.1 mm. All proportions are expressed as a percentage of the standard length (%SL). Counts are as follow, **A**: Number of unbranched spinous rays (in roman numerals) and soft branched rays (in Arabic numerals) in second dorsal fin; **D1**: Number of spinous rays (in roman numerals) in first dorsal fin; **D2**: Number of segmented rays in second dorsal fin (the first ray is a small segmented spine and is indicated by lower case roman numerals; the remaining, branched rays are indicated by Arabic numerals); **P**: Number of rays in pectoral fin [the first (i.e. dorsal) ray is reduced to a very short spur that is closely opposed to the second ray and, although not a true spine, appears spinous and is therefore listed in italicized roman numerals, all remaining rays are segmented and listed in Arabic numerals]; **CPs**: Number of scales in circumpeduncular series on half of caudal peduncle, just anterior to point of caudal flexure (the circumpeduncular series start at the scale row on the ventral surface of the caudal peduncle and is taken vertically up the scale rows on one flank, over the dorsum, zigzagging between adjacent, overlapping scale rows so that all rows are included in the count); **D2s**: Number of scales in longitudinal series anterior to origin of second dorsal fin and posterior to end of first dorsal fin base; **LL**: Number of scales in longitudinal series on midline, counted from just behind opercula, above pectoral fin, to point of caudal flexure (i.e. not including scales on caudal fin); **Ps**: Number of scales in longitudinal series anterior to tip of pectoral fin; **TR**: Number of scales in transverse series, counted from origin of pelvic fin to origin of first dorsal fin; **GR**: Number of gill rakers in the anterolateral row on the lower part (ceratobranchial) of the first gill arch.

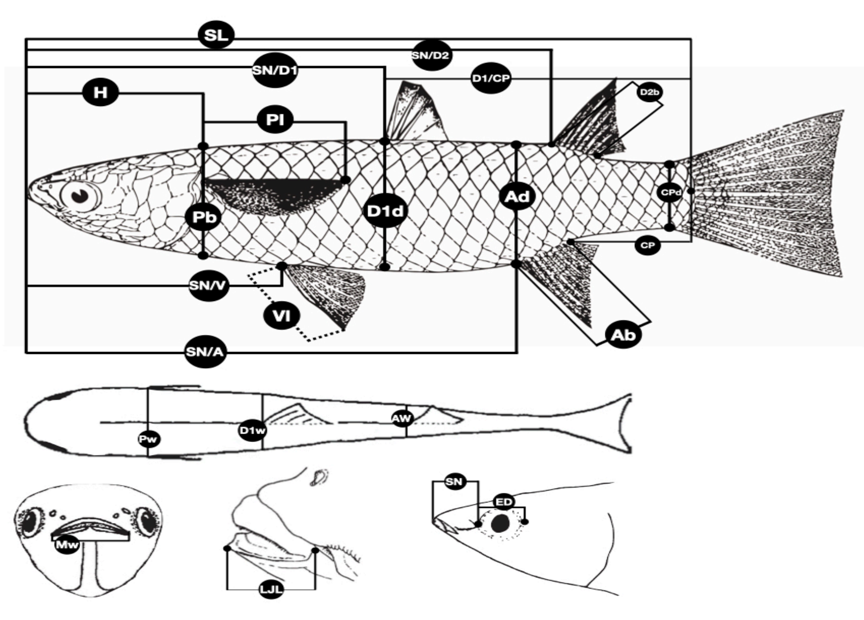

Figure 2 Morphometric characters of *Ellochelon vaigiensis*, sketch adapted from senou (1988) in FAO (1999), characters determination derived from Harrison *et al*. [9] (2007).

Measurements are as follow, **Ab**: Length of base of anal fin; **Ad**: Depth of body at origin of anal fin; **Aw**: Width of body at origin of anal fin; **CP**: Length of caudal peduncle from posterior end of base of anal fin to point of caudal flexure; **CPd**: Minimum depth of caudal peduncle; **D2b**: Length of base of second dorsal fin; **D1d**: Depth of body at origin of first dorsal fin; **D1w**: Width of body at origin of first dorsal fin; **D1/CP**: Length from origin of first dorsal fin to caudal peduncle at point of caudal flexure; **H**: Length of head from snout to posterior of opercula; **LJL**: Length of lower jaw measured from dentary symphysis to corner of mouth; **Mw**: Width between corners of mouth; **Pb**: Dorsoventral depth of origin of pectoral fin; **PI**: Length of pectoral fin from axilla to tip of longest ray; **Pw**: Width of body at origin of pectoral fin; **SL**: Standard body length; **SN**: Length of snout from tip to anterior margin of eye; **SN/A**: Horizontal distance from tip of snout to origin of anal fin; **SN/D1**: Horizontal distance from tip of snout to origin of first dorsal fin; **SN/D2**: Horizontal distance from tip of snout to origin of second dorsal fin; **SN/V**: Horizontal distance from tip of snout to origin of pelvic fin; **VI**: Length of pelvic fin from base of spine to tip of longest ray; **ED**: Eye diameter. SPSS version 22 and XLSTAT 2021 were used for statistical analysis. One Way ANOVA and Bivariate Scatter Plot option were performed for 22 morphometric characters (excluding standard length) to estimate morphological differentiation among sampled localities.

Results and discussion

Meristic data show no significant differences among the 3 localities (**Table 1**). Morphometric characters measured at the 3 localities are given below (**Table 2**). The morphometric data show also no differences between the type locality (Raja Ampat) and Biak Island in Cendrawasih Bay. Nevertheless, specimens from Kaimana show significant differentiation for 3 characters with Biak and with the type locality. Specimens from Kaimana have a slender body width at the origin of the first dorsal fin (D1w) compared to specimens from the type locality and Biak Island (11.92 - 15.99 vs. 16.35 - 20.44 %SL). Specimens from Kaimana also display a longer head (27.03-28.14 vs. 26.24 - 26.69 %SL) and a larger eye diameter (6.07 - 7.13 vs. 5.30 - 5.91 %SL) than specimens from Biak Island. However, specimens from Kaimana have overlap of head length and the eye diameter with the specimens from Raja Ampat. Scatterplots representing these morphological differences are respectively given in **Figure 3**. The width of the body at the origin of the anal fin (Aw) has also a tendency to be slender for Kaimana specimens compared to other localities even overlap of the values is observed (8.90 - 11.78 vs. 10.79 - 14.75 %SL).

Table 1 Meristic characters of *Ellochelon vaigiensis.*

Meristic characters	Raja ampat type locality	Kaimana	Biak
	N = 13	N = 12	N = 7
D1	IV	IV	IV
D2	I-(6-8)	I-(6-7)	I-(6-8)
P	I-(13-14)	I-(13-14)	I-(13-14)
CPs	(6-7)	7	(6-7)
D2s	8	8	(7-8)
LL	(24-26)	26	(25-26)
A	III-(7-8)	III-8	III-(7-8)
Ps	(6-7)	(7-8)	(6-8)
TR	8	8	8
GR	48-68	46-66	54-67

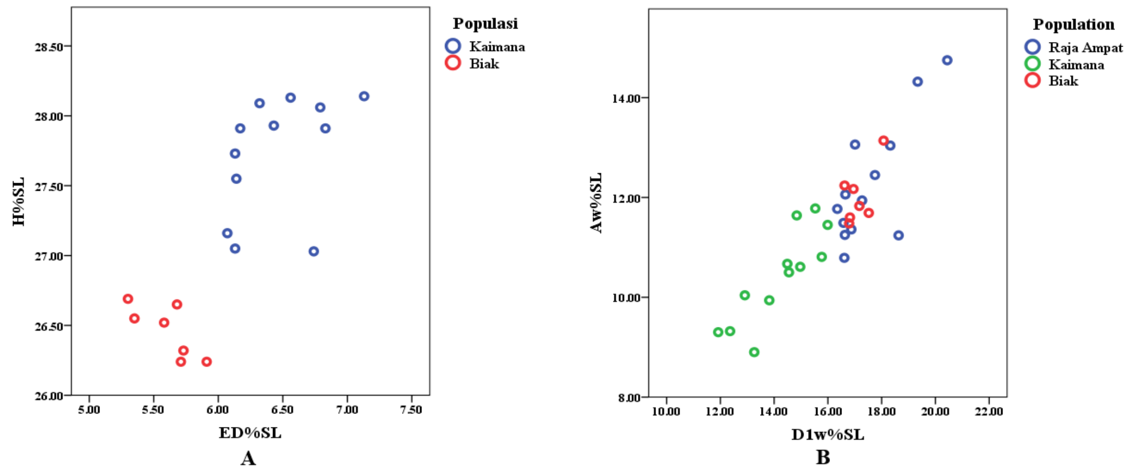

Figure 3 Plot between A. head length (H) and eye diameter (ED); B. Plot between the width of the body at first dorsal fin origin (D1w) and width of the body at anal fin origin (Aw).

Table 2 Morphometric characters of *E. vaigiensis* from Raja Ampat (type locality), Kaimana dan Biak.

Characters	**Raja ampat**					**Kaimana**					**Biak**				
SL (mm)	**219.60 - 302.44**					**107.89 - 258.71**					**214.09 - 326.37**				
in % Standard length (SL)	**n**	**min**	**max**	**mean**	**SD**	**n**	**min**	**max**	**mean**	**SD**	**n**	**min**	**max**	**mean**	**SD**
Length of base of anal fin (Ab)	13	8.26	10.56	9.58	0.73	12	8.05	10.92	9.45	0.89	7	8.87	10.18	9.47	0.53
Depth of body at origin of anal fin (Ad)	13	23.85	25.67	24.74	0.63	12	24.51	26.51	25.46	0.67	7	23.35	25.95	24.53	0.95
Width of body at origin of anal fin (Aw)	13	10.79	14.75	12.27	1.21	12	8.90	11.78	10.41	0.94	7	11.48	13.14	12.02	0.57
Length of caudal peduncle (CP)	13	17.20	20.21	18.64	0.92	12	17.94	21.48	19.92	1.02	7	17.72	21.65	19.32	1.42
Minimum depth of caudal peduncle (CPd)	13	13.60	14.42	14.00	0.27	12	13.63	14.76	14.26	0.35	7	13.47	14.27	13.89	0.33
Length of base of second dorsal fin (D2b)	13	7.01	8.13	7.71	0.43	12	6.92	8.31	7.61	0.44	7	7.42	7.97	7.64	0.18
Depth of body at origin of first dorsal fin (D1d)	13	25.97	29.16	27.77	0.79	12	25.37	29.54	27.44	1.39	7	25.65	30.48	28.10	1.84
Width of body at origin of first dorsal fin (D1w)	13	16.35	20.44	17.57	1.26	12	11.92	15.99	14.20	1.35	7	16.62	18.07	17.13	0.51
Length of half body at first dorsal fin base to caudal flexure (D1/CP)	13	46.21	49.10	47.56	0.93	12	45.74	48.59	46.74	0.91	7	46.34	48.56	47.51	0.90
Length of head (H)	13	26.14	27.70	26.93	0.46	12	27.03	28.14	27.72	0.43	7	26.24	26.69	26.46	0.19
Length of lower jaw (LJL)	13	6.33	7.20	6.76	0.30	12	6.42	7.09	6.87	0.22	7	6.52	7.06	6.75	0.20
Width between corners of mouth (Mw)	13	11.26	12.37	11.78	0.35	12	11.41	12.57	12.01	0.40	7	11.21	11.89	11.50	0.23
Dorsoventral depth of origin of pectoral fin (Pb)	13	19.82	22.73	21.11	0.88	12	20.45	22.10	21.10	0.59	7	19.33	22.34	21.13	0.97
Length of pectoral fin (PI)	13	20.79	23.45	22.30	0.93	12	21.33	24.51	22.80	0.94	7	21.33	22.77	22.22	0.51
Width of body at origin of pectoral fin (Pw)	13	19.77	21.69	20.68	0.60	12	19.52	21.56	20.59	0.70	7	19.89	21.61	20.58	0.74
Length of snout (SN)	13	7.36	9.22	8.39	0.61	12	8.24	9.52	9.03	0.42	7	7.45	8.95	8.29	0.56
Length of snout to origin second anal fin base (SN/A)	13	74.10	80.52	77.50	2.13	12	73.64	79.19	76.63	1.44	7	75.95	81.06	77.47	1.78
Length of snout to origin of first dorsal fin (SN/D1)	13	53.56	55.69	55.00	0.58	12	53.84	58.28	56.13	1.39	7	53.36	55.95	54.62	0.98
Length of snout to origin of second dorsal fin (SN/D2	13	79.55	82.19	80.72	0.69	12	79.29	81.95	80.36	0.86	7	80.19	80.81	80.47	0.24
Length of snout to origin of pelvic fin (SN/V)	13	39.82	43.98	42.03	1.15	12	41.48	45.62	43.53	1.45	7	39.73	43.27	41.60	1.47
Length of pelvic fin (VI)	13	16.80	19.32	17.97	0.72	12	17.38	19.32	18.64	0.60	7	16.76	19.74	18.26	0.98
Eye diameter (ED)	13	5.20	6.66	6.07	0.39	12	6.07	7.13	6.45	0.35	7	5.30	5.91	5.61	0.22

An ANOVA analysis (**Table 3**) made on all samples and all morphometric characters confirm the above results by considering head length (H), body width at the origin of anal fin (Aw), body width at the origin of first dorsal fin (D1w), and eye diameter (ED) as the most discriminant characters among the 3 localities.

Table 3 Descriptive statistics from ANOVA made an all samples and all morphometric characters.

Characters	Min.	Max.	Mean ± SE	SD	F value	*p*-value
SND2%SL	79,29	82,19	80.53 ± 0.12	0,695	0,855	0,435
D1CP%SL	45,74	49,10	47.24 ± 0.17	0,972	2,888	0,071
SND1%SL	53,36	58,28	55.34 ± 0.21	1,188	5,899	0.007
H%SL	26,14	28,14	27.13 ± 0.11	0,639	23,944	0.000*
D2b%SL	6,92	8,31	7.66 ± 0.07	0,385	0,19	0,828
SNA%SL	73,64	81,06	77.17 ± 0.32	1,814	0,833	0,445
SNV%SL	39,73	45,62	42.50 ± 0.27	1,535	5,94	0.007
Ab%SL	8,05	10,92	9.51 ± 0.13	0,739	0,108	0,898
CP%SL	17,20	21,65	19.27 ± 0.21	1,192	4,361	0.022
CPd%SL	13,47	14,76	14.08 ± 0.06	0,343	3,646	0.039
Ad%SL	23,35	26,51	24.96 ± 0.14	0,805	4,794	0.016
D1d%SL	25,37	30,48	27.72 ± 0.23	1,282	0,592	0,56
Pb%SL	19,33	22,73	21.11 ± 0.14	0,775	0,002	0,998
PI%SL	20,79	24,51	22.47 ± 0.15	0,874	1,414	0,259
VI%SL	16,76	19,74	18.28 ± 0.14	0,779	2,608	0,091
Aw%SL	8,90	14,75	11.52±0.23	1,311	11,7	0.000*
D1w%SL	11,92	20,44	16.21 ± 0.35	1,960	28,086	0.000*
Pw%SL	19,52	21,69	20.62 ± 0.11	0,649	0,069	0,934
ED%SL	5,20	7,13	6.11 ± 0.08	0,464	13,289	0.000*
SN%SL	7,36	9,52	8.61 ± 0.11	0,617	6,038	0.006
LJL%SL	6,33	7,20	6.80 ± 0.04	0,254	0,742	0,485
Mw%SL	11,21	12,57	11.81 ± 0.07	0,390	4,777	0.016

*Note significance level $p < 0.001$

The plot of functions 1 (96.5 %) and 2 (3.5 %) computed from a canonical discriminant analysis for all morphometric data confirms the distinctiveness of Kaimana samples compared to Biak and type locality (**Figure 4**).

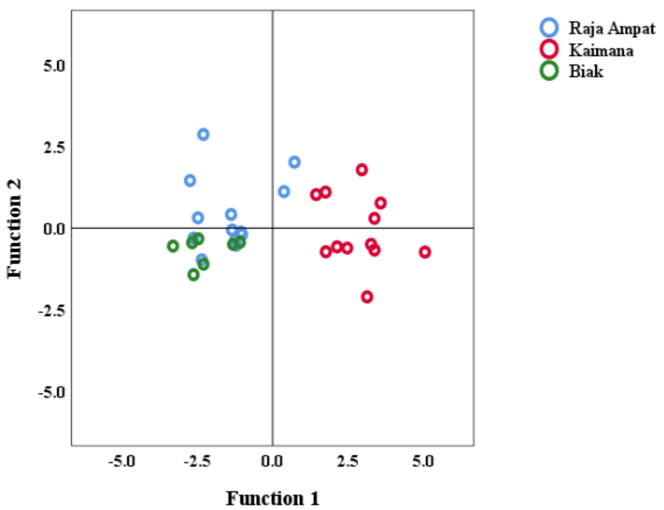

Figure 4 Plot of function 1 and 2 from canonical discriminant analysis based on all morphometric characters for the 3 localities of *E. vaigiensis*.

According to the diagnosis of *Ellochelon vaigiensis* [9], the material from the type locality and Biak Island display the same fresh body colouration. The specimens are olive-brown dorsally with flanks silvery and abdomen white or pale yellow. About 6 grey longitudinal stripes on flanks are visible. Iris have yellow patches. Dorsal fins are dusky and yellowish and pectoral fins are black. Pelvic fins are white and anal fin is grey (adult specimens) or yellowish (immature specimens). The caudal fin is distinctly yellow. In contrast, specimens from Kaimana are light silver dorsally with the absence of longitudinal stripes on flanks. All other parts of the body have a similar colouration to specimens from Biak and type locality (**Figure 5**).

1 2 3

Figure 5 Fresh specimens of *Ellochelon vaigiensis* West New Guinea, Indonesia, from (1) Waigeo Island (type locality), Raja Ampat: (A) Upper photo, adult female 301.56 mm SL. (B) Middle, adult male, 213.95 mm SL. (C) Lower, juvenile male 149.44 mm SL; (2) Biak Island, Cendrawasih Bay: (A) Upper photo, adult female 308.92 mm SL. (B) Middle, adult male, 214.09 mm SL. (C) Lower, 214.95 mm SL; (3) Kaimana: (A) Upper photo, male 258.71 mm SL. (B) Middle, male, 142.23 mm SL. (C) Lower, 119.04 mm SL.

A detailed morphometric species description of *Ellochelon vaigiensis* based on specimens from the type locality and Biak Island is given below following [9] (Values in brackets refer to specimens from Biak if different from specimens from the type locality): Body robust; depth at origin of first dorsal fin 25.97 - 29.16 (25.65 - 30.48) %SL; depth at origin of anal fin 23.85 - 25.67 (23.35 - 25.95) %SL; depth at origin of pectoral fins 19.82 - 22.73 (19.33 - 22.34) %SL; width at origin of first dorsal fin 16.35 - 20.44 %SL; width at origin of anal fin 10.79 - 14.75 %SL; width at origin of pectoral fin 19.77 - 21.69 %SL. Caudal peduncle deep; minimum depth 13.60 - 14.42 (13.47 - 14.27) %SL; length 17.20 - 20.21 (17.72 - 21.65) %SL. Head broad, wider than deep and dorsally flattened; length of head 26.14 - 27.70 %SL; length of lower jaw 6.33 - 7.20 %SL; width between corners of mouth 11.26 - 12.37 (11.21 - 11.89) %SL. Eyes large; diameter 5.20 - 6.66 %SL. Adipose eyefold poorly developed as a rim around eye. Snout longer than eye diameter; length 7.36 - 9.22 %SL. Gill rakers on lower limb of first gill arch 48 - 68. Origin of first dorsal fin distinctly closer to the base of caudal fin than the tip of snout; length from the origin of first dorsal fin to caudal peduncle at point of caudal flexure 46.21 - 49.10 %SL; length from tip of snout to origin of first dorsal fin 53.56 - 55.69 (53.36 - 55.95) %SL. Origin of fully erected second dorsal fin on vertical through anterior third to half of anal fin in advance of second dorsal fin; length from tip of snout to origin of second dorsal fin 79.55 - 82.19 %SL; length from tip of snout to origin of anal fin base 74.10 - 80.52 (75.95 - 81.06) %SL. Caudal fin square. First dorsal fin with IV spines. Second dorsal fin I-(6-8); length of base 7.01-8.13 %SL. Anal fin III-(7-8); length of base 8.26 - 10.56 %SL. Pectoral fin short, just reaching origin of first dorsal fin; I-(13-14); length of base 20.79 - 23.45. Pelvic fin short; length 16.80 - 19.32 (16.76 - 19.74) %SL; length from tip of snout to origin of pelvic fin 39.82 - 43.98 (39.73 - 43.27) %SL. Scales weakly ctenoid, 24-26 scales in longitudinal series on midline, 8 scales in transverse series from origin of pelvic fin to origin of first dorsal fin; 6-7 (6-8) scales in longitudinal series anterior to tip of pectoral fin; 8 (7-8) scales in longitudinal series anterior to origin of second dorsal fin and posterior to end of first dorsal fin base; 6-7 scales in transverse series around half of caudal peduncle.

The taxonomy of *E. vaigiensis* is ancient and was originally described from the type locality in Waigeo Island [11]. The type specimens were caught during the Voyage Autour du Monde of the French corvette of l'Uranie and La Physicienne [28]. Nearly 2 centuries after its discovery for Science, type locality was never revisited for taxonomic work. *Ellochelon vaigiensis* has a long history of systematic revision as summarized [29]. The species was placed under multiple generic names due to overlap of morphological traits and misidentifications. Initially, it was described as *Mugil vaigiensis* [13] and subsequently placed to the new genus and monotypic *Ellochelon vaigiensis* as proposed [14], then *Chelon vaigiensis* [15], placed again onto *Ellochelon vaigiensis* [16], moved to *Liza vaigiensis* by Thomson [17], and finally validated as *Ellochelon vaigiensis* [18-20].

The most evident diagnostic characters of *E. vaigiensis* are a squared caudal fin, a broad head (larger than deep), and a colouration pattern with 6 longitudinal stripes on flanks formed by longitudinal marks on scales.

Our results based on a morphometric approach confirm that the material collected in Waigeo and Biak Island belongs to the species *Ellochelon vaigiensis* according to the species diagnosis [9]. In contrast, the material collected in Kaimana in the southern part of West Papua is more problems concerning its taxonomic status. Part of the diagnostic characters of *E. vaigiensis* fit with this material such as the square caudal fin, the head characteristic, and most of the morphometric measurements. Nevertheless, other diagnostic characters as the head length, the eye diameter, the body width at first dorsal fin origin do not fit with *E. vaigiensis*. Specimens from Kaimana have a longer head, smaller eye diameter and a slender body than specimens from the type locality of *E. vaigiensis*. Because specimens from Kaimana are smaller than specimens from Waigeo (standard length 107.89-258.71 vs. 219.60-302.44 mm), we are aware that body width can be strongly influenced by sexual maturation [30]. But concerning the head length and the eye diameter, it seems that the distinctiveness observed for all specimens from Kaimana regarding to specimens from the type locality and Biak Island reflects significant morphological differences, which cannot be explained by allometric relationships. The present results probably emphasize the belonging of Kaimana specimens to a distinct population. The absence of longitudinal stripes on flanks (vs. present on *Ellochelon vaigiensis*) corroborates with these results.

The further molecular analysis we plan to assess on these specimens will validate if this new population observed in Kaimana belongs to a new cryptic species within the *Ellochelon* species group as previously suggested in other localities in Western Indonesia [25].

Conclusions

The present study contributes to an updated description of the species *E. vaigiensis* and emphasizes the possible existence of a distinct population in Kaimana compared to the type locality and Biak Island. The results presented here confirm that the taxonomy of Mugilidae is problematic when it is assessed only with morphometric especially in areas where researches remain scarce. This work underlines the need to perform molecular approaches as DNA barcoding for solving such crucial taxonomic gaps.

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References

[1] E Fraga, H Schneider, M Nirchio, E Santa-Brigida, LF Rodrigues-Filho and I Sampaio. Molecular phylogenetic analyses of mullets (Mugilidae, Mugiliformes) based on two mitochondrial genes. *J. Appl. Ichthyol*. 2007; **23**, 598-604.
[2] S Heras, MI Roldán and MG Castro. Molecular phylogeny of mugilidae fishes revised. *Rev. Fish Biol. Fish*. 2009; **19**, 217-31.
[3] E Pacheco-Almanzar, J Simons, H Espinosa-Pérez, X Chiappa-Carrara and AL Ibáñez. Can the name Mugil cephalus (Pisces: Mugilidae) be used for the species occurring in the north western Atlantic? *Zootaxa* 2016; **4109**, 381-90.
[4] W Fischer and G Bianchi. *FAO Species identification sheets for fishery purposes.* Vol 3. Western Indian Ocean Fishing Area 51, Food and Agriculture Organization of the United Nations, Rome, Italy, 1984.
[5] JS Nelson. *Fishes of the world*. Vol 4. John Wiley & Sons, New Jersey, 2006.
[6] MG Castro, JMDD Astarloa and MB Cousseau. First record of a tropical affinity mullet, *Mugil curema* (Mugilidae), in a temperate southwestern Atlantic coastal lagoon. *Cybium* 2006; **30**, 90-1.
[7] C Turan, M Gürlek, D Ergüden, D Yağlıoğlu and B Öztürk. Systematic status of nine mullet species (Mugilidae) in the Mediterranean Sea. *Turkish J. Fish. Aqua. Sci*. 2011; **11**, 315-21.
[8] JS Nelson, TC Grande and MVH Wilson. *Fishes of the world.* Vol 5. John Wiley & Sons, New Jersey, 2016.
[9] IJ Harrison and H Senou. *FAO Species identification guide for fishery purposes. In*: KE Carpenter and VH Niem (Eds.). Order Mugiliformes, Mugilidae. The Living Marine Resources of the Western Central Pacific. Food and Agriculture Organization of the United Nations, Rome, Italy, 1999.
[10] BW Coad. Review of the freshwater mullets of Iran (Family Mugilidae). *Iranian J. Ichthyol.* 2017; **4**, 75-130.
[11] A Teimori and MA Hesni. Morphological characteristics of squaretail mullet *Ellochelon vaigiensis* (Quoy and Gaimard 1825), a rare *Mugil* species collected from the Iranian waters of the Persian Gulf (Teleostei: Mugiliformes). *Int. J. Mar. Sci.* 2020; **36(2)**, 405-13.
[12] GBIF.org, Available at: https://doi.org/10.15468/dl.r93vfs, accessed March 2021.
[13] JRC Quoy and JP Gaimard. *Description des Poissons*. *In*: LCD Freycinet (Ed.). Voyage autour du monde: Entrepris par ordre du roi ... Exécuté sur les corvettes de S. M. l'Uranie et la Physicienne, pendant les années 1817, 1818, 1819 et 1820. Chez Pillet Aine, France, 1825.
[14] GP Whitley. Five new generic names for Australian fishes. *Aust. Zool.* 1930; **6**, 250-1.
[15] LP Schultz. A revision of the genera of mullets, fishes of the family Mugilidae, with descriptions of for new genera. *In*: Proceedings of the United States National Museum, Washington. 1946, p. 377-95.
[16] H Senou. 1988, Phylogenetic interrelationships of the mullets (Pisces: Mugilidae). Ph. D. Dissertation. Tokyo University, Tokyo, Japan.
[17] JM Thomson. The Mugilidae of the world. *Memoir. Queensl. Mus.* 1997; **41**, 457-562.
[18] J Ghasemzadeh. 1998, Phylogeny and systematics of Indo-Pacific mullets (Teleostei: Mugilidae) with special reference to the mullets of Australia. Ph. D. Dissertation. Macquarie University, Sydney, Australia.
[19] D Jean-Dominique, C Wei-Jen, S Kang-Ning, C Fu and P Borsa. Genus-level taxonomic changes implied by the mitochondrial phylogeny of grey mullets (Teleostei: Mugilidae). *Compt. Rendus Biologies* 2012; **335**, 687-97.
[20] R Fricke, W Eschmeyer and RVD Laan. *Eschmeyer's catalog of fishes: Genera, species, references. In*: WN Eschmeyer (Ed.). Eschmeyer's Catalog of Fishes online. California Academy of Sciences, California,
[21] V Salehi, MA Hesni, A Teimori and MR Lashkari. The sagittal otolith morphology of four selected mugilid species from Iranian waters of the Persian Gulf (Teleostei: Mugilidae). *Int. J. Aquat. Biol.* 2016 ; **4**, 318-24.
[22] JD Durand, N Hubert, KN Shen and P Borsa. DNA barcoding grey mullets. *Rev. Fish Biol. Fish*. 2017; **27**, 233-43.
[23] SK Mohanty, SS Mishra, M Khan, RK Mohanty, A Mohapatra and AK Pattnaik. Ichthyofaunal diversity of Chilika Lake, Odisha, India: An inventory, assessment of biodiversity status and comprehensive systematic checklist (1916-2014). *Check List* 2015; **11**, 1817.

[24] A Prosser. Capture methods and commercial fisheries for mugilidae. *In*: D Crosetti, SJM Blaber (Eds.). Biology, Ecology and Culture of Grey Mullets (Mugilidae). CRC Press Taylor & Francis, Florida. 2016, p. 451-66.

[25] E Delrieu-Trottin, D Jean-Dominique, G Limmon, T Sukmono, Kadarusman, HY Sugeha, C Wei-Jen, F Busson, P Borsa, H Dahruddin, S Sauri, Y Fitriana, MSA Zein, R Hocdé, L Pouyaud, P Keith, D Wowor, D Steinke, R Hanner and N Hubert. Biodiversity inventory of the grey mullets (Actinopterygii: Mugilidae) of the Indo-Australian Archipelago through the iterative use of DNA-based species delimitation and specimen assignment methods. *Evol. Appl.* 2020; **13**, 1451-67.

[26] R Hocdé, IB Vimono, AM Suruwaki, Y Tuti, RS Utama, A Mohammad, P Boli, H Ashari, H Wikanta, J Jean-Baptiste, C Cochet, C Thébaud, B Milá, G Abdul, J Leblond, E Bahuet, G Diraimondo, B Fromento, J Chevallard, S Sumanta, ..., L Pouyaud. *Mission report: LENGGURU 2017 expedition 'biodiversity assessment in reef twilight zone and cloud forests', R/V AIRAHA 2, 1st october 2017 - 30th november 2017, Kaimana Regency, West Papua, Indonesia*. HAL, Lyon, France, 2017.

[27] IJ Harrison, M Nirchio, C Oliveira, E Ron and JA Gaviria. A new species of mullet (Teleostei: Mugilidae) from Venezuela, with a discussion on the taxonomy of *Mugil gaimardianus*. *J. Fish Biol.* 2007; **71**, 76-97.

[28] M Blanc and JC Hureau. Catalogue critique des types de poissons du Muséum national d'Histoire naturelle. (Suite) (Mugiliformes et Polynémiformes). *Bull. Mus. Nati. Hist. Nat.* 1972 ; **15**, 673-735.

[29] M González-Castro and J Ghasemzadeh. *Morphology and morphometry based taxonomy of mugilidae. In*: D Crosetti and S Blaber (Eds.). Biology, Ecology and Culture of Grey Mullet (Mugilidae). CRC Press Taylor & Francis Group 6000 Broken Sound Parkway NW, Florida, 2016.

[30] AL Ibáñez-Aguirre, E Cabral-Solís, M Gallardo-Cabello and E Espino-Barr. Comparative morphometrics of two populations of *Mugil curema* (Pisces: Mugilidae) on the Atlantic and Mexican Pacific coasts. *Sci. Mar.* 2006; **70**, 139-45.