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Morpho-species of common Silverbellies (Family: Leiognathidae) found in East Java's Coastal Sea, Indonesia

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Abstract

All leiognathid's species within catch of Indonesia's fisheries are grouped into single category, locally name peperek. Separating them into genus or even species category is important in terms of fisheries management. A fishery-based data were collected from seven different fish landing centers in East Java, from January 2012 to January 2014. All species of family Leiognathidae were identified based on morpho-characters and named to the newest and valid nomenclature. The results showed there at least 15 different species found in the catches, but two species were still nomen dubium (not confirmed). All the nine genera of Leiognathidae were found in East Java as represented in the catches, being: *Aurigequula*, *Devexim*entum, *Equulites*, *Eubleekeria*, *Gazza*, *Leiognathus*, *Karalla*, *Nuchequula*, and *Photopectoralis*. Genus *Aurigequula*, *Devexim*entum, and *Nuchequula*, although found in Indonesia, the name have never been up dated. Each genus was clearly identifiable and distinguishable one to the others. With the help of a practical (pictorial) guide, short training, and some field experience, field fishery enumerators would be able to identify most species of family Leiognathidae from fresh sample. Body-shape, body coloration and color pattern, and specific marking are three main characters applicable to separate most of the species.

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Introduction

The first publication on fish fauna of Indonesia was dated back in 1842 when Peter Bleeker arrived in Batavia (currently Jakarta), and spent 18 years of his best life to study the surrounding marine-waters (Weber and de Beaufort, 1964a; Peristiwady, 2012). He visited or received fish specimens from at least 89 fishing bases (some names misspelled) all over the Indonesia's archipelago and succeeded in describing species of 155 fish families. Bleeker included *Gerres* and *Pentaprion* into leiognathid's group (Family: Leiognathidae) although its resemblance with other genera within the family seems to be superficial. Ichthyologists after Bleeker took out both genera and developed a new family of Gerridae that covers both. To avoid homonym with water strider's group of insect, Nelson (1984) changed the family name into Gerreidae.

Leiognathidae initially composed of two genera (as *Gerres* and *Pentarion* were sent out), *Leiognathus* and *Gazza*. Starting from the evolvement or retrieval of genus *Secutor*, the family currently covers at least nine different genera (Larson *et al.*, 2013; Kottelat, 2013) and as many as 50 valid species. Many of the species name are either synonyms or named differently, leaving controversy in the nomenclature. Hence, the family of Leiognathidae is in real need of taxonomic revision (Jones, 1985; Chakrabarty and Sparks, 2007), although it falls outside the scope of this study.

Our literature review included peer review articles, books, reports, and non-online sources, resulted in a record of 39 nominal species of Family Leiognathidae found from Indonesia's marine water. Many of the species are dubious, due to lack of descriptive information or later were found as synonym. Genus *Secutor* for instance, a name introduced by Gistel (Jordan, 1918), was meant for a genus that has been described and named previously. Instead, all *Secutor* that described from Indonesia's marine waters should be renamed with *Deveximentum* (Kottelat, 2013), a name provided by Fowler (1904). The study is intended to provide distinctive characters of leiognathid's species found in Java Sea and scientifically name it based on the latest and valid nomenclature. The study area is considered to be the most over-exploited fishing ground with leiognathid's group is still the predominant species in the catch of demersal fisheries (DJPT, 2013). In terms of both scientific and fishery management, documenting the descriptive information of the species and hence, separate catch statistics per genus or even species are worth as over-fishing will lead to species scarcity or even extinction. All leiognathid's species in the catch were treated as a single commercial name in Indonesia's fishery statistics, peperek, and well known to be the most dominant and popular species group for demersal fisheries in the region (DJPT, 2013). The study will help Indonesian fishery enumerators and administrators to separate species under catch based on recognizable characters from the field (fresh samples). Before any detail fishery-related biological studies are made, revision of species name those found in Indonesia's marine waters need to be corrected.

Materials and methods

Samples for the study were collected from seven Fish Landing Centers (FLC) in East Java (Fig. 1), from January 2012 to January 2014. An attempt was initially designed to include FLC(s) from other sides of the island. However, it was not applicable in the field as no chance to maintain fresh samples prior it reach FLC, and no record was available on the area the fish being caught. All samples were collected from two main gears, mini-trawls and beach seines, both are operating near-shores with an average fishing trip (setting and hauling) of less than 6 hours. Total catch of one fishing trip varies from around 2 to 120 kg, estimated from the percentage of a fish basket that filled with fish. Samples were selected by purchasing all the leiognathid's catch from boat owner before it sold at auction. Samples for identification and further analysis were separated and selected based on completeness and freshness of body structure. The best specimen of each species was photograph, and

quickly identified based on distinctive characters such as body coloration, anatomical parts that can be counted, and the appearance and position of body structures. All samples were stored in fish-box with ice and transferred to laboratory for detail identification and morphometric measurements.

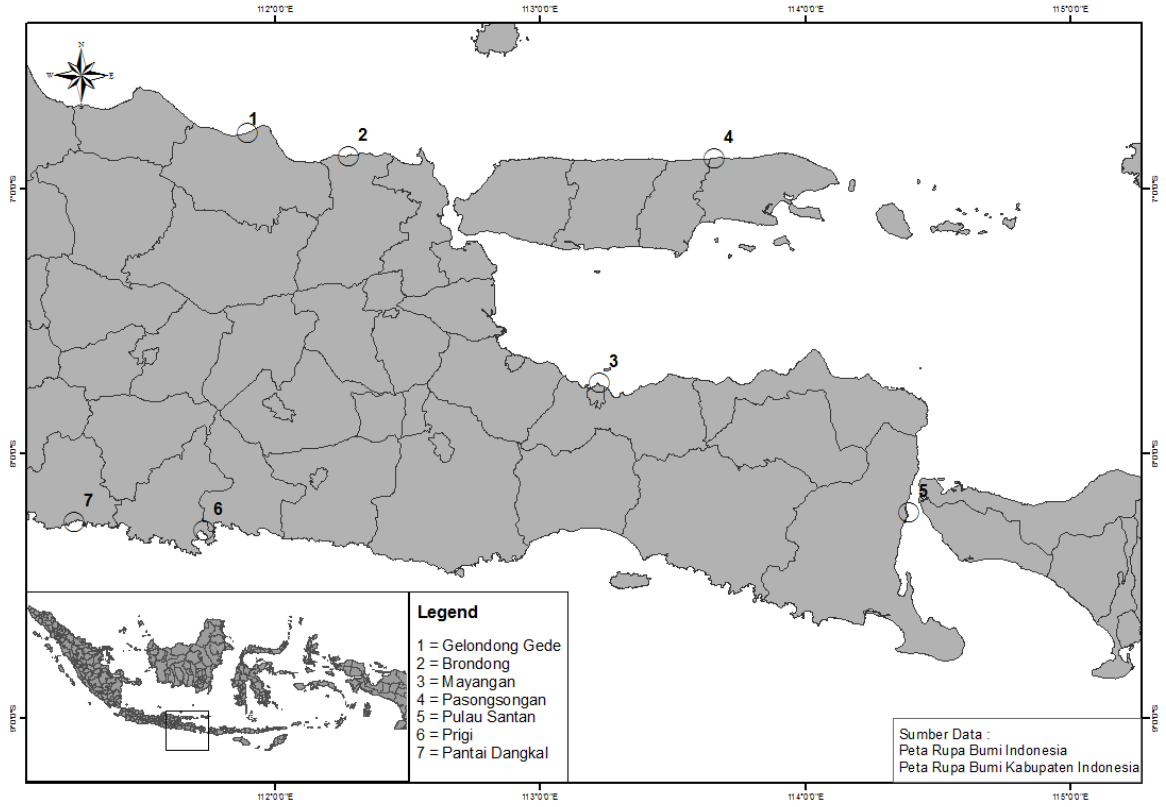

Fig. 1. Map of sampling sites (sites 1 and 2 represent Java Sea, shallow and muddy bottom; site 3 represents Madura Strait, semi-enclosed and turbid coastal sea; site 4 represents Madura Islands, coral reefs dominant area; site 5 represents Bali Strait, narrow and high current; sites 6 and 7 are typical for open sea, directly connected to Indian Ocean).

Species identification

Key identification at family level was based on Carpenter and Niem (2001), continued with separation into three main genus – *Gazza*, *Leiognathus*, and *Secutor*. Further examination into four additional genera and species of each genus used more updated references (Table 1). Cross-references for Leiognathid's species formerly found in Indonesia was based on Fowler (1904), Weber and de Beaufort (1964b), Pauly (1977), Praseno *et al.* (1983), Gloerfelt-Tarp and Kailola (1984), Kottelat *et al.* (1993), Iwatsuki *et al.* (2000), Kuiter and Tonozuka (2001), Kimura *et al.* (2003), and Kimura *et al.* (2005). Finally, naming of the identified species was based on revision notes provided by Larson *et al.* (2013), Kottelat (2013), and combined with catalog of fishes (www.research.calacademy.org, version 19 May 2014)

Table 1. List of main references used for species identification within each genus prior to application of new and valid scientific names.

No	Species under Genus	Main references used for identification
1	*Eubleekria*	Fowler, 1904; James, 1969; Kimura *et al.*, 2005; Chakrabarty and Sparks, 2008; Kimura *et al.*, 2008;
2	*Gazza*	Yamashita *et al.*, 1998; Kimura *et al.*, 2000; Yamashita and Kimura, 2001; Jawad and Al-Mamry, 2013;
3	*Leiognathus*	James and Badrudeen, 1990; Kimura *et al.*, 2003; Sparks, 2006;
4	*Nuchequula*	Wongratana, 1988; Chakrabarty and Sparks, 2007; Kimura et al., 2008; Renxie *et al.*, 2010;
5	*Photopectoralis*	Balan, 1963; Abraham *et al.*, 2011;
6	*Photoplagios*	James, 1967; Dunlap and McFall-Ngai, 1984; Kimura *et al.*, 2008; Chakrabarty *et al.*, 2010; Golani *et al.*, 2011; Sparks and Chakrabarty, 2007;
7	*Secutor*	Monkolprasit, 1973; Carpenter and Niem, 2001; Baldwin and Sparks, 2011

Morphometry

Prior to morphometric measurement, all samples were preserved in formaldehyde 4% for 48 hours, diluted with running water for another 48 hours, and permanently stored in saturated alcohol (96%). Representative specimen for each species was deposited in Museum Zoologicum Bogoriense (MZB), Bogor Indonesia. Morphometric measurements (a straight distance between two anatomical landmarks) were based on Lagler *et al.* (1977), recorded to the nearest 0.01 mm using dial caliper (Fig. 2). It consisted of 20 measurements for each individual sample: standard length (SL), fork length (FL), dorsal body depth (DBD), anal body depth (ABD), maximum body depth (MBD), pre-dorsal length (PDL), pre-anal length (PAL), pre-pelvic length (PVL), pre-pectoral length (PPL), upper caudal peduncle length (UpCL), lower caudal peduncle length (LoCL), dorsal fin base (DFB), anal fin base (AFB), head length (HL), nuchal length (NL), snout length (SNL), orbit diameter (OBD), Upper maxilla length (UpML), lower maxilla length (LoML), and post-orbital length (POL).

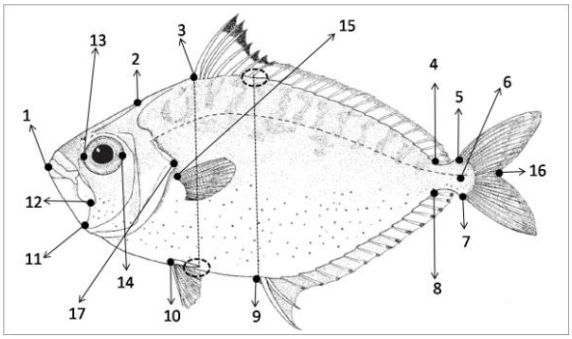

Fig. 2. Point of anatomical landmarks used as bases for morphometric measurements (figure was redrawn from Carpenter & Niem, 2001); SL = straight distance between 1-6; FL = 1-16; DBD = 3 to abdomen; ABD = 9 to dorsal; MBD = usually lays between DBD and ABD; PDL = 1-3; PAL = 1-9; PVL = 1-10; PPL = 1-15; UpCL=4-5; LoCL = 7-8; DFB = 3-4; AFB = 8-9; HL = 1-17; NL = 1-2; SNL = 1-13; OBD = 13-14; UpML = 1-12; LoML = 1-11; POL = 14-17.

Analyses

Naming of the identified species is based on most up dated reference (Larson *et al.*, 2013; Kottelat, 2013; and research.calacademy.org, version 19 May, 2014), but also, stating the current name used in Indonesia.

Preserved type specimens, completed with photographs and morphometric data, were deposited in MZB and provided with code for each species. Truss-morphometries were constructed (Sparks and Chakrabarty, 2007; Chakrabarty *et al*., 2010) based on SL, except for NL, SNL, OBD, UpML, LoML, and POL that used HL throughout. For geometric morphometric analysis, Principal Component Analysis (PCA) was performed to show the axes on which species groups are best distinguished by shape. The calculation was supported with computer-based software of SPSS ver.16.0, and graph construction based on Excel program.

Results and discussions

Based on a two-year fisheries sampling, there were 15 different Leiognathid's species found from the catches of coastal-demersal fisheries in East Java; two species are still nomen dubium (dubious) and not confirmed – *Gazza sp*. (possibly *G. dentex*) and *Nuchequula sp*. (most likely of *N. longicornis*). All the genera within family are represented. Representative specimen for each species has been deposited (with retrieval code) at Museum Zoologicum Bogoriense (Table 2).

Table 2. List of leiognathid's species found in East Java with corrected names based on Kottelat (2013), Larson *et al*. (2013), and www.research.calacademy.org, accessed on 19 May 2014.

No	Species Name	Specimen Code	Density	Distribution
1	*Aurigequula longispina*	MZB.FISH 22111	low	limited
2	*Devexímentum insidiator*	MZB.FISH 22112	abundant	wide
3	*Devexímentum interruptum*	MZB.FISH 22113	abundant	wide
4	*Equulites elongatus*	MZB.FISH 22114	low	very limited
5	*Equulites laterofenestra*	MZB.FISH 22115	low	limited
6	*Equulites leuciscus*	MZB.FISH 22116	medium	wide
7	*Eubleekeria jonesi*	MZB.FISH 22117	abundant	wide
8	*Eubleekeria splendens*	MZB.FISH 22118	abundant	wide
9	*Gazza minuta*	MZB.FISH 22119	abundant	wide
10	*Gazza sp*.	MZB.FISH 22120	abundant	wide
11	*Karalla daura*	MZB.FISH 22121	low	very limited
12	*Leiognathus equula*	MZB.FISH 22122	abundant	very limited
13	*Nuchequula flavaxilla*	MZB.FISH 22123	low	limited
14	*Nuchequula sp*	MZB.FISH 22124	low	limited
15	*Photopectoralis bindus*	MZB.FISH 22125	abundant	wide

Nomenclature

Analysis on historical nomenclature resulted in family Leiognathidae that is currently divided into nine, from formerly three different genera (Carpenter and Niem, 2001): *Gazza*, *Leiognathus*, and *Secutor*. Genus *Secutor*, that introduced by Johannes Gistel in 1848 (Jordan, 1918), was meant to replace *Equula*. However, *Equula*, which is synonym of *Leiognathus*, is clearly different. Gistel's book seems to have been widely noted by ichthyologists and applied in many fields, so genus *Secutor* is maintained up to now. Fowler (1904), initially proposed genus *Devexímentum* (type species: *Zeus insidiator*, Bloch) that is different from *Leiognathus* in having nearly vertical mandible. This name considered more appropriate and hence, Kottelat (2013) declared

genus *Deveximentum* as a replacer to *Secutor*. For those arguments, in this text, *Deveximentum* is applied, instead of *Secutor*.

Genus *Leiognathus* evolved and broken down into seven different genera: *Aurigequula*, *Equulites*, *Eubleekeria*, *Leiognathus*, *Karalla*, *Nuchequula*, and *Photopectoralis*. Fowler (1918) indicated *Aurigequula* (type species: *Clupea fasciata*) as sub-genus of *Leiognathus*, characterized by elongated second dorsal and anal spines, and complete lateral line. Chakrabarty *et al.* (2008) lifted it into new genus with two species: *A. fasciatus*, and *A. longispinis*. Considering plural meaning of longispinis, and the existence of *Equula longispina* (De Vis, 1884) that also described by Weber and De Beaufort (1964b), Kottelat (2013) stated *A. fasciata* and *A. longispina*, both as new valid names for the former. Fowler (1904), also created a new sub-genus of *Leiognathus*, *Eubleekeria* (type species: *Equula splendens*), a name dedicated to Pieter van Bleeker, famous ichthyologist in that era. The species was characterized by having black color at spinous dorsal fin membrane, deep head, and with short and blunt snout. Kimura *et al.* (2005) analyzed and described *Leiognathus splendens complex*, composed *L. jonesi*, *L. rapsoni*, *L. kupanensis*, and *L. splendens*. This new name was first lifted as new genus in 2008 and declared as valid since then (Larson *et al.*, 2013). *Equulites* (type species: *Leiognathus vermiculatus*), initially submitted as sub-genus of *Leiognathus* by Fowler (1904), described as having downward direction of mouth when protracted, breast and chest being entirely scaled, and incomplete lateral line. It used to be considered as senior synonym of *Photoplagios* in Sparks *et al.* (2005), and supported by Kimura *et al.* (2008). However, at the same time, Chakrabarty and Sparks (2008) elevated *Equulites* into new genus and supported by Kottelat (2013). Chakrabarty and Sparks (2008) described genus *Karalla* (type species: *K. daura* and *K. dussumieri*) as a sister group of *Nuchequula* and separated it from *Leiognathus*, based on phylogenetic tree. Genus *Gazza* is remained constant with valid species: *G. achlamys*, *G. dentex*, *G. minuta*, *G. rhombea*, and *G. squamiventralis* (Yamashita *et al.*, 1998; Yamashita and Kimura, 2001). *Equula bindus* or *E. bindoo*, was first described in Cuvier and Valenciennes (1835) with specific character of membrane of spinous dorsal in its upper third was orange and lined inferiorly with black color. Fowler (1904) named the species as *Leiognathus virgatus* and later as *L. bindus* by Weber and De Beaufort (1964b). Sparks *et al.* (2005) established new genus, *Photopectoralis* (type species: *P. bindus*), based on light organ system (LOS) and currently maintained as valid new name (Larson *et al.*, 2013).

Species descriptions

Based on nomenclature analyses, list of leiognathid's species found in the catches of demersal fisheries of East Java, and believed to be valid, is shown in Table 2. Genus *Aurigequula* is represented by *A. longispina* (Valenciennes, 1835), with synonyms currently still in use in Indonesia are: *Leiognathus smithursti* (in Weber and de Beaufort, 1964b; Pauly, 1977; Gloerfelt-Tarp and Kailola, 1984), and *L. longispinis* (in Jones, 1985; Sparks, 2006). In the field, the species is identifiable from very long second dorsal and anal fin spine, typical character of this species (Fig. 3D). However, both spines are easily broken down during capture process. If so, the following characters (with some field experience) are useful: deep body; blunt snout, clear concavity appearance in the occipital region, lower mandible profile clearly concave; cleft of mouth positioned a bit below lower edge of eye; three to five dusky-yellow blotches along the lateral part of the body (below lateral line); membrane of dorsal fin is yellow (from anterior part of 6th spine to 5th soft ray); membrane of anal fin is yellow (from anterior part of 3rd spine up to 9th or 11th soft ray); and yellow pectoral axil that forms a semi-circular area. Although considered commonly found in the commercial catch (James, 1975), this research showed otherwise. It was rarely found in the catch of coastal-demersal fisheries. If so, the percentage number would be very small (less than 1% of all leiognathid's in the catch). The species was found in three, out of total seven landing

sites; most likely due to low density of the species and over-fishing. The closest resemblance to *A. longispina*, *A. fasciata* (Lacepède 1803), did not find in the sampling areas. Three principal differences between both species are (Abraham *et al.*, 2011): second anal fin elongate but not as long as that on *A. longispina*; 10-15 gray-brown vertical bands on dorso-lateral part of *A. fasciata*, extending up to little below lateral line; and inner side of pectoral fin dotted black on *A. fasciata* (pectoral axil on *A. longispina* is yellow, forming a semi-circular area).

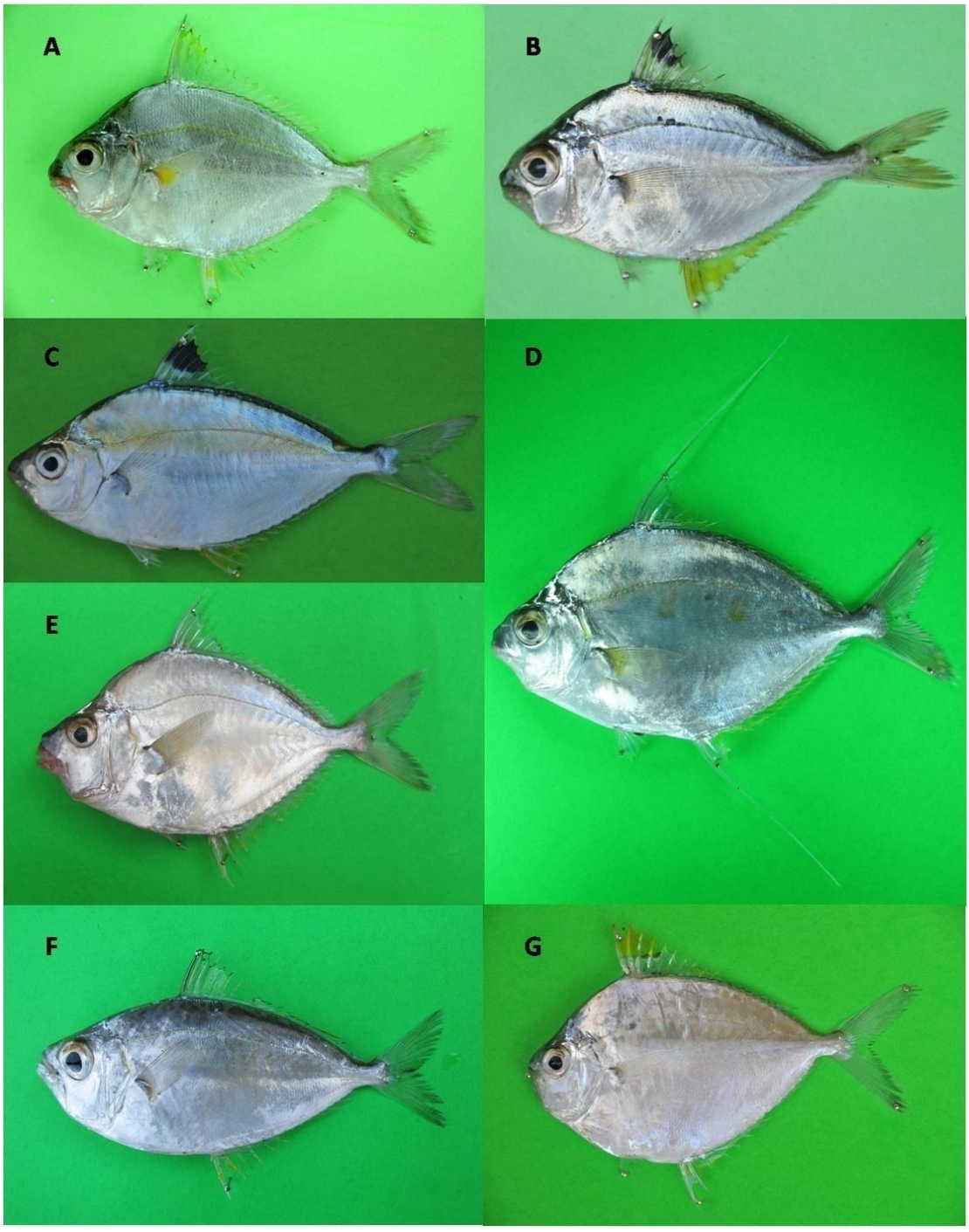

Fig. 3. (A) *Eubleekeria jonesi* (James, 1971); (B) *Eubleekeria splendens* (Cuvier 1929); (C) *Karalla daura* (Cuvier, 1829); (D) *Aurigequula longispina* (Valenciennes, 1835); (E) *Leiognathus equula* (Forsskål, 1775); (F) *Gazza minuta* (Bloch, 1795); (G) *Photopectoralis bindus* (Valenciennes, 1835). All samples used for species identification were deposited to Museum Zoologicum Bogoriense (MZB), Indonesia.

Genus *Deveximentum*, is represented by *D. insidiator* (Bloch, 1787) and *D. interruptum* (Valenciennes, 1835). Names currently in use for *D. interruptum* are: *Secutor ruconius* (in Weber and De Beaufort, 1964b; Pauly, 1977; Praseno *et al*., 1983; Gloerfelt-Tarp and Kailola, 1984), *Leiognathus ruconius* (in Weber and De Beaufort, 1964b), and *S. interruptus* (in Kottelat *et al*., 1993). *S. ruconius* is the most widely used scientific name for the species in Indonesia. In the field, all species of *Deveximentum* posses two characters distinguishable from other genera (identifiable from naked eye): upward mouth direction when protracted, and lower maxilla profile that is almost vertical. *D. insidiator* (Fig. 4F) is clearly different from *D. interruptum* (Fig. 4G) in having more elongated body-shape (ratio body depth to standard length less than that in *D. interruptum*), 15-17 dark and vertical-broken bands along dorsal part of the body (from just behind the head to the end of dorsal soft ray), and upper one-third portion of the membrane of dorsal fin (between second to sixth spine) is black. *D. interruptum* has much deeper body-shape, anterior-ventral profile clearly convex, more than dorsal-lateral part; lateral line fade and indistinct from the middle of dorsal fin ray, and about 10 dark and broken vertical bands (big blotches) on back and extending below lateral line (Fig. 4G). Both species always found together in almost every catch of demersal gears.

All species under genus *Eubleekeria* are found in Indonesia's marine waters (Kimura *et al*., 2005; Kimura *et al*., 2008), but only two species were caught in East Java, *E. jonesi* (James, 1971), and *E. splendens* (Cuvier, 1829). The genus is clearly differentiable in the field in having very deep body-shape, blunt snout, third and fourth dorsal spines serrated, and black color on tip of dorsal fin membrane. *E. jonesi* (Fig. 3A) was characterized by having asquamate light-brown color forming nearly semicircular area on nape; lateral line scales prominent yellow; pectoral axil prominent yellow, forming a half-circular area; pale-dark line color on distal (edge) part of dorsal fin, between the second and eighth spine; and half (distal) part of dorsal fin membrane, between second and fourth spine are yellow. On the contrary, *E. splendens* (Fig. 3B) has no clear semi-circular area on nape compared to that on *E. jonesi*; lateral line scales with faint grey color; pectoral axil light grey; very clear black color of dorsal fin membrane half distally, between posterior of second up to fifth of dorsal spine (the clearest character to differentiate both species). *E. jonesi* found only in north coast of East Java, whereas *E. splendens* seems to be widely spread in north coast of East Java (Pauly, 1977), with medium percentage in the catch.

The most distinctive character for *Equulites* is elongated body shape compared to other genera. Species found in the area are: *E. elongatus* (Fig. 4A), *E. laterofenestra* (Fig. 4B), and *E. leuciscus* (Fig. 4C). *E. elongatus* is the most elongated body shape under family Leiognathidae, with maximum body depth <35% of standard length. Other typical characters include: black blotch on snout blunt, not pointed like that of *E. strecorarius*; posterior margin of adipose eyelid not sharp; a clear dark-lateral strip, starting from posterior of opercle toward posterior part up to the end of caudal peduncle; dorsal fin membrane golden yellow, starting from posterior of second spine, forms a triangle and tapers to the end of seventh spine; distal edge of anterior dorsal fin membrane forms a black line; anterior part of anal fin golden yellow; zigzag black color along the dorsal lateral part of the body. *E. laterofenestra* is having body-shape a bit deeper than *E. elongatus* (body depth may reach 45% of standard length); black blotch on tip of snout pointed; posterior margin of adipose eyelid not sharp; long second dorsal and anal fin spines, the length nearly equal to body depth; anterior margin of dorsal and anal fin faintly yellow; distal edge of caudal fin faintly yellow; three faint-yellow blotches at lateral surface of the body. *E. leuciscus* was found in all samples of all landing sites, *E. laterofenestra* was found in two landing sites of southern part of East Java, and *E. elongatus* was only caught in Pulau Santan (Bali Strait). Both species of

E. laterofenestra and *E. elongatus* are considered to be more offshore and deeper species, compared to *E. leuciscus* (Pauly, 1977; Kuiter and Tonozuka, 2001).

Genus *Gazza* was easily identified in the field with naked eye based on the presence of canine teeth, forward direction of mouth when protracted, and with oval and slender body-shape (Carpenter and Niem, 2001). Species found in the catch are *Gazza minuta* (Bloch, 1795), and one species was still nomen dubium (dubious). Distinctive features of *G. minuta* (Fig. 3F) are: the presence of a long but narrow anterodorsal extension of sub-ocular (below eye) silvery region in contact with orbit proximally and distally; scaled area of anterior dorsolateral surface of body extending beyond a vertical through posterior tip of sensory canal on temporal; some vertical irregular dark broad-wavy bands above lateral line (Yamashita *et al*., 1998; Yamashita and Kimura, 2001); dark spots on lateral line (sometimes indistinct or absent); and five to seven dark blotches below lateral lines from around below the first dorsal fin spine toward the end of dorsal fin rays. Some of these features can only be recognized with the help of digital photograph of fresh specimen. The other specimen (MZB.FISH 22120), suspected to be *G. dentex*, is having broad anterodorsal extension of sub-ocular silvery region in contact with orbit; scaled area of anterior dorsolateral surface of body not beyond a vertical through posterior tip of sensory canal on temporal; and no blotch below lateral line. Both species were found in all sampling sites with medium density.

Karalla daura (Cuvier 1829) was found in very low density and caught only at fishing ground with low fishing pressure (Fig. 1: southern coast of East Java). The only synonym currently used in Indonesia is *Leiognathus daura* (in Weber and De Beaufort, 1964b; Pauly, 1977). The species is practically easy to identify from three main characters (Fig. 3C): (1) color of upper-half membrane of dorsal fin is deep black, extending from posterior margin of second to the anterior part of seventh spines; (2) a broad golden-yellow horizontal band extending from the orbit (including dorsal half of the eye), across the lateral line, and terminating on the caudal peduncle; and (3) color of membrane of anal fin is dark yellow, extending from the first to the anterior part the 10th ray; toward the posterior part, this yellow color moves to the distal part of the body. Other characters used to distinguish the species (Abraham *et al*., 2011) include: body between oval and elongated with antero-dorsal and antero-ventral equally convex; shallow head with straight profile; snout pointed or sharp with black color on tip; inferior margin of lower jaw concave; a black band on upper part of caudal peduncle; and black color of head, at dorsal part of the eye.

Leiognathus equula (Forsskål 1775) is the only representative of genus *Leiognathus* found in the catch. The species used to be found in almost fish landing centers and fish market in Indonesia (Froese and Pauly, 2011). Together with *E. splendens*, *L. equula* was considered to be the most common leiognathid's species in north coast of Java (Pauly, 1977). However, in this study, the species was only found in one sampling site with medium density in the catch. The synonym still in use is *Leiognathus equulus* (in Weber and De Beaufort, 1964b; Pauly, 1977; Praseno *et al*., 1983; Gloerfelt-Tarp and Kailola, 1984; Kottelat *et al*., 1993). Important characters identified from fresh samples are (Fig. 3E): body oblong, deep and compressed with maximum body depth >50% of standard length; dorsal profile more convex than the ventral profile; gently elevated from the occipital region, head forms a strongly humped back; snout short and blunt; mouth with thick lips, and pointing downwards when protracted; commencement of gape of mouth below lower border of eye when mouth closed; lower margin of lower jaw strongly concave; caudal fin not deeply forked, and with slightly rounded lobes; color of body mostly silvery, back grayish; grayish vertical zigzag bands descent from back to about mid height (this can only be seen in fresh sample); membrane between anal spines and anterior fin rays yellowish; snout dotted black.

Based on morpho-characters, there were two different groups for genus *Nuchequula* found in the area, one was identifiable as *N. flavaxilla* (Kimura *et al.*, 2008), and one group was still not confirmed (Table 2: MZB.FISH 22124). Distinctive characters for *N. flavaxilla* from field examinations (Fig. 4D) are: oval, and compressed body-shape with body depth varies between 45–55% of standard length; anterior dorsal and ventral profiles equally convex, and occipital region slightly concave; lower jaw profile strongly concave; second dorsal fin spine elongated, reaching or extending beyond base of fifth soft ray; second anal fin spine elongated, extending beyond base of fifth soft ray; snout somewhat blunt (not really pointed), tip of snout black; tip of posterior limb of maxilla extending beyond vertical through anterior margin of the eye; a dark blotch on nape; lateral line faint yellow (not very prominent yellow); pectoral axil yellow and forms a semi-circular area; yellow band running from median part of dorsal and anal fin membranes between the second and third spines to margin of soft-rayed portions; posterior caudal fin dark yellow, particularly clear on margin of lower lobe; a prominent yellow blotch on ventral part, between pectoral and anal fin (Chakrabarty and Sparks, 2007). The second group did not show elongate second dorsal and anal spine (not as long as in *N. flavaxilla*), and no yellow blotch on ventral part.

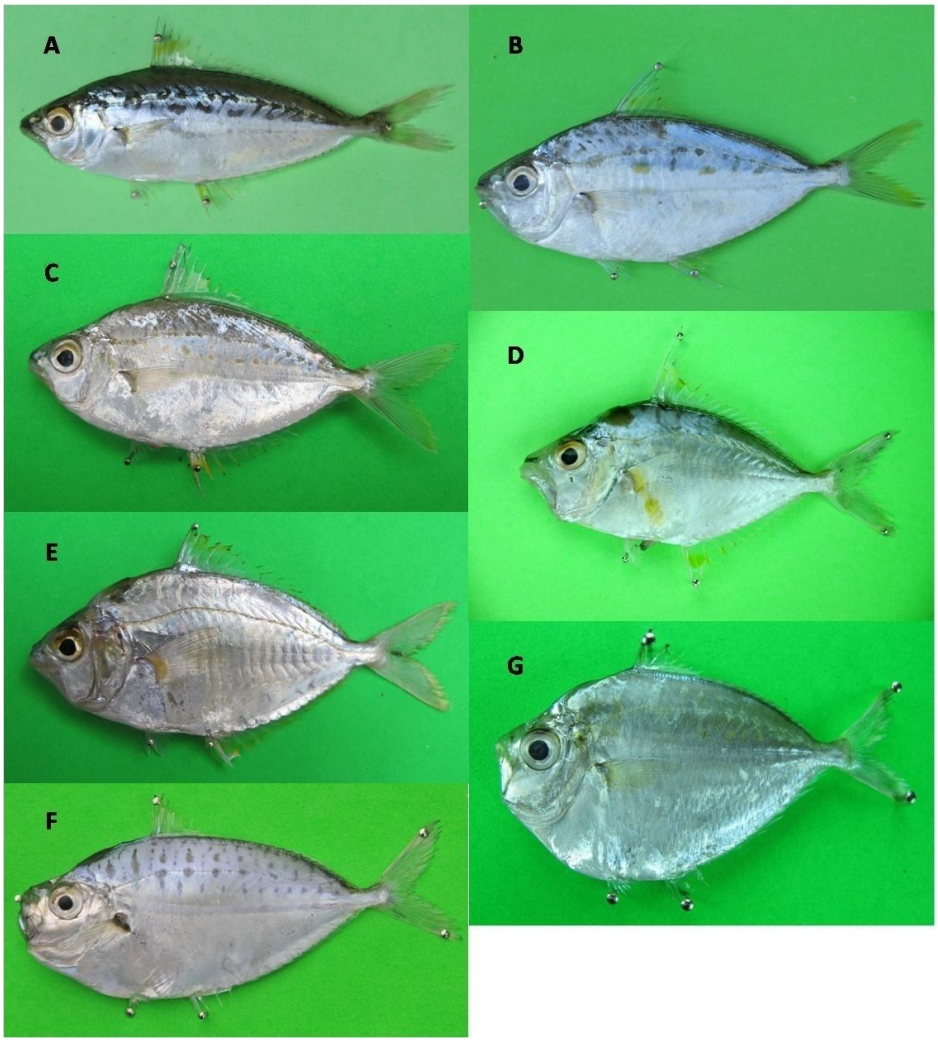

Fig. 4. (A) *Equulites elongatus* (Günther, 1874); (B) *E. laterofenestra* (Sparks and Chakrabarty, 2007); (C) *E. leuciscus* (Günther 1860); (D) *Nuchequula flavaxilla* (Kimura, Kimura and Ikejima 2008); (E) *Nuchequula sp.*; (F) *Devexim*entum *insidiator* (Bloch 1787); (G) *D. interruptum* (Valenciennes 1835). All samples used for species identification were deposited to Museum Zoologicum Bogoriense (MZB), Indonesia.

Photopectoralis bindus (Valenciennes 1835) is the most dominant species and found in all catch samplings. Synonym still in use in Indonesia is *Leiognathus bindus* (in Weber and De Beaufort, 1964b; Pauly, 1977; Gloerfelt-Tarp and Kailola, 1984; Praseno *et al*., 1983; Iwatsuki *et al*., 2000). Important characters identified from the field include (Fig. 3G): body shape very deep, maximum body depth may reach or exceed 60% of standard length; ventral profile of the body more convex than the dorsal profile; abdomen before anal more strongly convex; commencement of the gape of mouth above level of lower border of eye; lower maxilla a bit concave or straight; lateral line anteriorly prominent, but posteriorly becoming obsolete; caudal fin deeply forked; dark irregular, somewhat vermiculate or semicircular markings in a zigzag pattern, commencing immediately behind head and extending to the end of the soft dorsal, laterally extending down to less than half height; spinous part of dorsal fin forms a black line at half height, above which the membrane between the second and fifth spines bears a bright yellow-orange color; tip of snout and ventral half of body with grey dots; pectoral axil dotted black; faint-yellow color on basal part of spinous anal fin membrane.

Morphometry

In total, 158 selected data of 13 different species was used for Principal Component Analysis (PCA). Results of PCA showed that the 13 species form many discrete groups on the plot of Principal Component (PC) 1 versus PC 2 (Fig. 5). PC1 explains 32.6% of the variations among species, whereas PC2 explains 15.6% and PC3 explains 10.0%. The total six components together explain 77.6% of the variations. PC1 describes variations related to body depth, head length, and length of fin base. *Aurigequula longispina* and *Eubleekeria jonesi* are both highly variable with respect to these shape components, followed by *Deveximentum interruptum* (with negative values of PC1). *Equulites elongatus* is so elongated in body-shape and does not overlap with any other species, except for one data from *E. leuciscus*. In terms of body-shape, *E. leuciscus*, *K. daura*, *G. minuta*, and *E. splendens* are overlaps (Fig. 5).

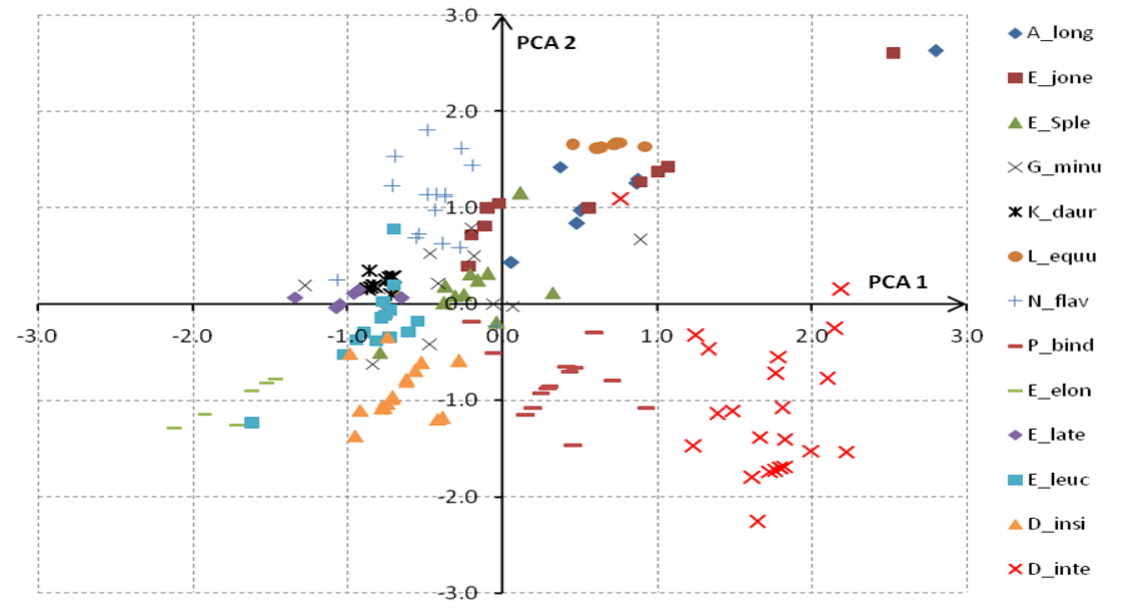

Fig. 5. PCA for 13 confirmed species of family Leiognathidae (plot of PCA1 versus PCA 2). Legend: A-long = *Aurigequula longispina*; E_jone = *Eubleekeria jonesi*; E_sple = *E. splendens*; G_minu = *Gazza minuta*; K_daur = *Karalla daura*; L_equu = *Leiognathus equula*; N_flav = *Nuchequula flavaxilla*; P_bind = *Photopectoralis bindus*; E_elon = *Equulites elongatus*; E_late = *E. laterofenestra*; E_leuc = *E. leuciscus*; D_ins = *Deveximentum insidiator*; D_int = *D. interruptum*.

PC2 largely explains variations in ratio connected to head length, such as snout length, nuchal length, and upper maxilla length. *K. daura* and *L. equula* both have relatively longer snout length. On the contrary, *P. bindus, D. interruptum*, together with *D. insidiator* all are having short snout length. Measurement of anatomical landmark is not very practical for most of field fisheries enumerators. Principal Component Analysis (PCA), graph presentation and interpretation of the results are also very technical for them. Considering these technical and precision in the measurement, PCA might not be a reliable method in recognizing species of family Leiognathidae.

Based on field findings, body shape, color patterns, and specific marking are three important categories that can be used by field fishery enumerators to quickly identifying leiognathid's species from fresh sample. All *Equulites* are elongated, in contrast with *Aurigequula*, *Eubleekeria*, *Leiognathus*, and *Photopectoralis*. Genus *Devexiмentum* (except for *D. interruptum*), *Gazza*, *Karalla*, and *Nuchequula* are with oval body-shape. *Equulites elongatus* is the most elongated body-shape among species within genus *Equulites* and also family Leiognathidae. *Devexiмentum* is very clear in having upward mouth direction when protracted and lower maxilla that almost vertical when mouth closed. Curved-canine teeth and anterior mouth direction when protracted are identifiable characters for *Gazza*. Other than *Devexiмentum* and *Gazza*, all genus and species are having downward mouth direction. Genus *Nuchequula* is also very clear in having black (or dark) blotch on nape. *Photopectoralis* can be distinguished from the presence of a bright yellow-orange color of spinous dorsal membrane. *Eubleekeria splendens* is typical in having black color of dorsal fin membrane and anterior of third and fourth fin spine clearly serrated. Once *E. splendens* can be identified, *E. jonesi* is having similar body shape but without clear black color of dorsal fin membrane. *K. daura* is different from *E. splendens* (although both are having black color of dorsal fin membrane) in having more oval body shape and a broad horizontal golden-yellow band running from the head, across lateral line, and terminating on the caudal peduncle. So, with the help of at least 10 M pixel of digital camera, a practical-pictorial guide, and some field experience, fisheries workers would be able to identify most species of Family Leiognathidae directly in the field.

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