

## Systematic Revision of the Indian Species of *Ilisha* Richardson, 1846 (Pisces : Clupeiformes)\*

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The systematics of Indian species of *Ilisha* has been dealt with in the present study on the basis of re-examination of the types of various nominal species deposited in the three European Museums. All the species have been redescribed based on comparative morphology, anatomy, morphometrics and meristics. An attempt has also been made to study the electrophoretic patterns of muscle proteins of three species of *Ilisha* to reinforce the conclusions arrived at from the morphological studies. A key to Indian species of *Ilisha* modified from that of Ramaiyan and Whitehead (1975) is presented herewith.

**Key Words:** Revision, comparative morphology, Electrophoresis, Key to species, Redescription

### Introduction

The clupeoid fishes are of considerable commercial importance, forming nearly 20-30% of total catches of fishes in India. Of all the Clupeoids, the genus *Ilisha* is more confusing and the identification of the species by different authors based on different criteria has often led to conflicting views. (Nerman 1923, Fowler 1941, Misra 1952, Nair 1953, Munro 1955, Dutt 1967, Whitehead 1965, '66, '67, '69, '70, '72, Whitehead et al. 1966, Talwar & Whitehead 1971, Seshagiri Rao 1972, '73, '74a, '75a, Ramaiyan & Whitehead 1975, Ramaiyan & Natarajan 1977)

Recently, Whitehead (1972) listed three species of *Ilisha* (*I. melastoma*, *I. megaloptera* and *I. elongata*) as valid from India

and proposed a key for identification of all the Indo-Pacific species of *Ilisha*, based on fin position, scutes, gillrakers and body depth, all of which are not completely reliable, and emphasized the urgent need for revision of species of this genus.

The position of fins, body-form and other meristic characters were emphasized by earlier authors for identifying *Ilisha* spp. These studies were limited due to apparent convergence and overlapping of the morphological characters between species of the same genus. Unfortunately characters like the nature of the air bladder or otolith, which are now considered dependable, were not taken into account by these workers. The present comprehensive study,

\*Formed part of a thesis submitted by the first author to the Annamalai University for the award of the Ph.D. degree.

provides an integrated approach to clarify the systematics and the interrelationships between species of *Ilisha* in Indian waters.

### Materials and Methods

Specimens were collected as under (i) *Ilisha melastoma* from Waltair, Madras, Porto Novo, Nagapattinam, Mandapam and Tuticorin (east coast), Mangalore and Vizhin-gam (west coast) and from Ceylon; (ii) *Ilisha megaloptera* from Masulipatnam, Madras, Pondicherry, Porto Novo, Tranque-bar, Adirampattinam, Point Calimere and Mandapam (east coast) and Bombay (west coast); and (iii) *Ilisha kampeni* from Porto Novo only. The only Indian record of *Ilisha elongata* seems to be the type *Pellona leschenaulti* and there is no subsequent report about the occurrence of this species in India. The description of *I. elongata* in the present study, is therefore based (i) on the description of the type *Pellona leschenaulti* by Whitehead (1967), and (ii) on 29 specimens from Leiden Museum (RMNH) examined by the first author. All the collections of *Ilisha* studied in the British Museum (N.H.) London, the Museum National d' Histoire Naturelle, Paris and the Rijksmuseum van Natuurlijke Historie, Leiden are cited in the text as BMNH, MNHN and RMNH respectively.

The details of the localities and the sizes of the sample examined for each species are given under 'material examined'. Part of the material employed in the present study is deposited in Reference Museum of the Marine Biological Station of Annamalai University, Porto Novo, India (cited in the text as BSRM.)

Seven morphometric characters in addition to standard length and six meristic characters, which could be accurately measured and counted, were considered. The vertebral counts were made by X-ray

photographs of 110 specimens of *I. melastoma* (Porto Novo) and 46 specimens of *I. megaloptera* (Point Calimere). For 12 specimens of *I. kampeni* (Porto Novo), the counts were made from skeletal preparations.

The studies were supplemented with the findings on variations in the nature of the air bladder, striae on head, scale and otoliths, and the electrophoretic analyse of muscle myogens.

### Comparative Morphology

**Colour:** It is one of the useful characters for distinguishing very closely related species of fish. In *Ilisha melastoma*, the back is uniformly brown in live specimens and the lower flanks are silvery white. The dorsal profile is dark grey in live specimens of *I. megaloptera*, and the upper flanks are light brown. In *I. kampeni* the upper part is greenish dark and the flanks are silvery in fresh specimens. In *I. elongata* (not collected by us) colour description given by Whitehead (1967) for the type *P. leschenaulti* is included here. The upper 1/9th of body is brown and the remainder of flanks are silvery and the fins are hyaline in preserved specimens.

**Scales:** The scales are cycloid—those on the body just below the dorsal fin, are relatively large and rounded. The only report on the striation pattern of scales (in *I. megaloptera* and *I. melastoma*) was by Seshagiri Rao (1973). The present study includes the striation pattern of scales in *Ilisha kampeni* also.

Our findings of a single unbroken horizontal striation with 6-8 and 4 interrupted vertical striae on the exposed portion in *I. melastoma* (figure 1c) and *I. megaloptera* (figure 2c) respectively, are in agreement with the observations of Seshagiri Rao (1973).

*Ilisha kampeni* differs considerably from the other two species in that there are only two interrupted vertical striae on the unexposed portion of the scale (figure 3c).

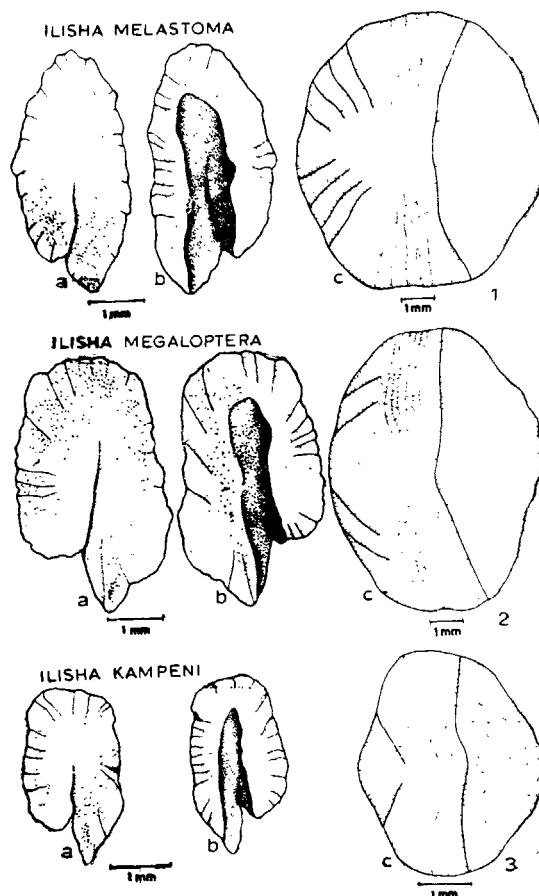
**Otoliths:** The proportions of the sagitta expressed as percentage of (i) otolith (Sagitta) length (OL)/standard length, and (ii) greatest height (H)/Length of Sagitta, are given below :

	OL/SL (%)	H/OL (%)
<i>I. melastoma</i> —152 mm SL	3.28	600.0
<i>I. megaloptera</i> —172 mm SL	3.20	54.50
<i>I. kampeni</i> —105 mm SL	3.80	62.50

The sagitta of *I. kampeni* is the largest followed by *I. melastoma* and *I. megaloptera*. *I. kampeni* is distinct in having a longer and thinner rostrum and a less distinctive sulcus on the inner side of the sagitta (figures 3a, b). The rostrum is relatively thin in *I. melastoma* (figures 1a, b). While it is short and wide with relatively broad and deep sulcus on the inner side of the sagitta in *I. megaloptera* (figures 2a, b).

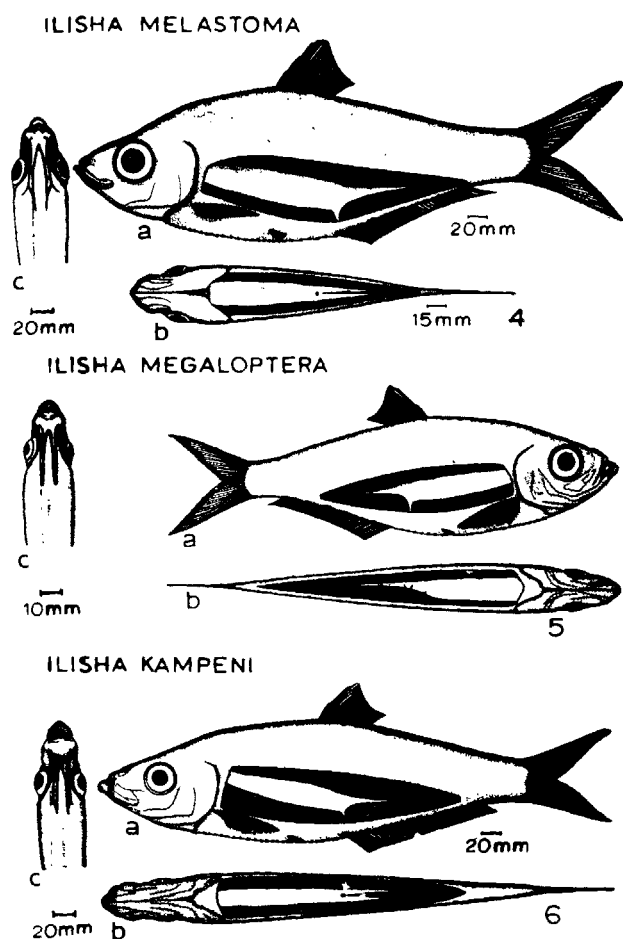
**Air bladder:** The form of swimbladder and its importance as a diagnostic character in distinguishing closely related species of fish has been reported by Ridewood (1892), Tracy (1920), Dehadrai (1960), Talwar and Whitehead (1971), Seshagiri Rao (1975a) and Ramaiyan and Whitehead (1975).

The nature of the air bladder in *I. melastoma*, *I. megaloptera* and *I. kampeni* has already been given by Ramaiyan and Whitehead (1975). Though the air bladder is bifid both in *I. melastoma* (figures 4a, b) and *I. kampeni* (figures 6a, b), examination of further material suggested that the posterior extension of air bladder was beyond the 30th anal ray in the former, while it stopped short of the 20th anal ray in the latter. The bifid nature of the air bladder, as observed by Seshagiri Rao (1974b) in *I. whiteheadi* (= *I. kampeni*), is confirmed by the present study.



Figures 1-3 a, Outer view of the sagitta, *I. megaloptera*. b, Inner view of the sagitta; c, Striations on dorsal surface of scale and *I. kampeni* respectively.

In *I. megaloptera* (figures 5a, b) and in *I. elongata* there is a single post-coelomic extension on the right side. This type of air bladder is seen in the West African *I. africana* (Talwar & Whitehead 1971). Ramaiyan and Whitehead (1975) briefly described 7 anomalous specimens (4 fishes from Mangalore 150.0–167.8 mm SL, BMNH 1975.3.20, 823–826, 2 fishes from Bombay 58.3–67.8 mm SL, BMNH 1975.3.20, 820–821 and 1 fish from Tuticorin 156.8 mm SL, BMNH 1975.3.20, 822) with no post-coelomic extension of the air



Figures 4-6 a, Lateral view of the swimbladder; b, Ventral view of the swimbladder showing the post-coelomic extension; c, Striations on dorsal surface of head

bladder, a condition otherwise known only in *I. sladeni* amongst the Indo-Pacific species of *Ilisha* (Talwar & Whitehead 1971). Seshagiri Rao (1975c) while reporting a new species *I. sirishai* from Visakhapatnam, described this condition of the air bladder as a new species character.

**Striae on head:** The frontal ridges are also one of the useful characters for distin-

guishing *Ilisha indica* (= *I. melastoma*) from *I. megaloptera* (Seshagiri Rao 1972). In all the specimens of *I. melastoma* examined by us, the frontals had 'indica' pattern of striae (figure 4c). In all the specimens of *I. megaloptera* the frontals had 'megaloptera' pattern of striae (figure 5c) as already indicated by Seshagiri Rao (1972). Specimens of *I. kampeni* examined by us had the 'megaloptera' pattern of striae (figure 6c).

**Meristic characters:** Six meristic characters (dorsal fin rays, pectoral fin rays, anal fin rays, gillrakers, pre- and post-pelvic scutes and vertebrae), which could be accurately counted were studied. The range of dorsal and pectoral fin rays of the four species obtained from various localities overlap, indicating their unsuitability in distinguishing the species. The anal fin rays overlap between *I. melastoma* and *I. kampeni* and similarly between *I. megaloptera* and *I. elongata*.

*I. melastoma* differs strikingly from other species by the presence of more number of gillrakers. Though the gillrakers overlap between *I. elongata* and *I. kampeni*, the former could be easily identified by numerous pre- and post-pelvic scutes. *I. melastoma* and *I. megaloptera* could also be separated on the basis of scutes. *I. megaloptera* differs markedly from other species by possessing more number of vertebrae. Though the vertebrae overlap between *I. melastoma* and *I. kampeni* the latter could be separated by its narrow body. The vertebrae could not be counted in *I. elongata* as no specimen could be collected in the present study.

**Morphometric characters:** Eight morphometric characters were selected for the present study namely (i) standard length, (ii) head length, (iii) body depth, (iv) eye-diameter, (v) snout length, (vi) pre-dorsal distance, (vii) pre-pelvic distance and, (viii) pre-anal distance. There is no

consistency in the values of various morphometric characters of the four species of *Ilisha* obtained from various localities. It is evident from the above analyses that there is much overlapping in all the characters between the four species, indicating thereby that based on morphometric characters alone, these four species could not be distinguished from each other.

**Electrophoretic studies in three species of *Ilisha***

The aim of the present study was to find out the possibility of using the protein specificity pattern for purposes of taxonomy and as an aid in the identification of the species of *Ilisha*, to reinforce our conclu-

sions arrived at through classical methods. For electrophoretic analysis specimens of *I. melastoma* and *I. kampeni* were obtained from Vellar estuary and specimens of *I. megaloptera* were collected from commercial catch at Porto Novo. Three layer polyacrylamide disc electrophoresis (Davis 1964) was adapted with the chemical formulations described in Canalco Bulletin (Anon. 1968).

Proteins were stained with Coomassie brilliant blue, after fixing the gels in 10% TCA solution. The excess stain was removed by repeated washing in 7% acetic acid. The position of each fraction from the origin was measured and its relative mobility was calculated.

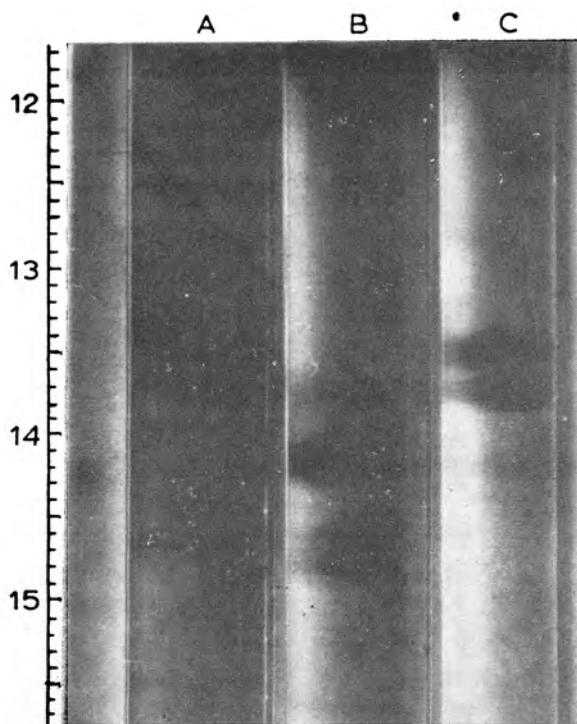


Figure 7 The muscle myogen patterns of the three species of *Ilisha*; A, *I. melastoma*; B, *I. megaloptera*; and C, *I. kampeni*

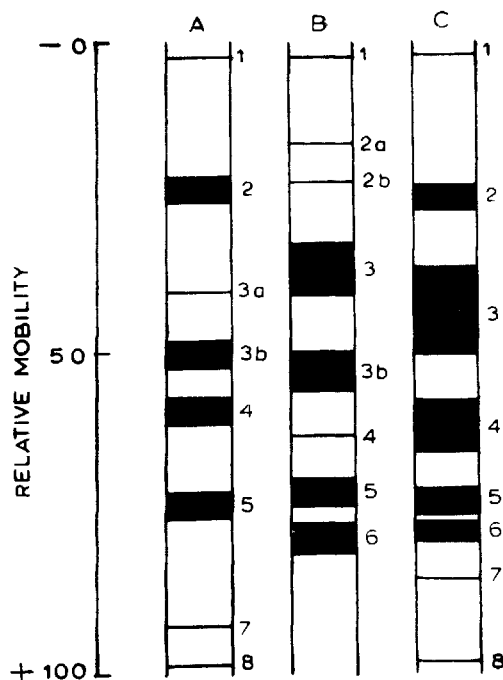


Figure 8 Diagrammatic representation of muscle myogens of the three species of *Ilisha*; A, *I. melastoma*; B, *I. megaloptera*; and C, *I. kampeni*

Seven to eight protein fractions were discernible from the muscle myogens of three species of *Ilisha*. All the three species of the genus *Ilisha* investigated presently show muscle myogen patterns which are specific to each. Figure 7 shows the muscle myogen patterns in three species of *Ilisha* and figure 8 is a diagrammatic representation of the protein fractions along with intensity of staining of certain protein fractions and their relative mobility.

Of the two slow-moving fractions, the first is uniformly weak with more or less similar relative mobility in all the three species but the second fraction is very dense both in *I. melastoma* and *I. kampeni* with the same relative mobility. It is divided into two (2a & 2b) in *I. megaloptera*.

Among the intermediate fractions (3 & 4) 3 is significantly dense in *I. kampeni*, whereas it is divided into two (3a and 3b) both in *I. melastoma* and *I. megaloptera* indicating perhaps their closeness.

Among the fast moving fractions (5, 6, 7 & 8) 5 is common, with respect to relative mobility, to all the three species of *Ilisha* and thus appears to be characteristic for the genus *Ilisha*. The Rm value of fraction 6 is different in *I. kampeni* and *I. megaloptera* and is missing in *I. melastoma*. Similarly, though the relative mobilities of fractions 7 and 8 are different, they are present both in *I. melastoma* and *I. kampeni*, but missing in *I. megaloptera*. These variations in the fast moving fractions may be taken as indicative of differences between the three species, thereby confirming that the three are valid species as shown already by a study of meristics and morphometrics.

A key to the valid Indian species of *Ilisha* and detailed descriptions of all species are also given.

### General Discussion

Based on results of the present study on a large number of specimens from various localities, only four species of *Ilisha* (*I. melastoma*, *I. megaloptera*, *I. kampeni* and *I. elongata*) are to be considered valid from India.

Out of 29 nominal species referable to *Ilisha* (Whitehead 1970), Whitehead (1972) listed only three species of *Ilisha* (*I. melastoma*, *I. megaloptera* and *I. elongata*) as valid from India. This was confirmed later by Fischer and Whitehead (1974) who recognised only 6 species of *Ilisha* as valid from the entire Indo-Pacific region. In the present study one more species, *I. kampeni* is added since we have found that *Pellona kampeni* Weber and de Beaufort (1913) actually belongs to *Ilisha* because of the distinct nature of hypomaxilla as a ligament (*Ilisha*) and not as a toothed bone (*Pellona*). Whitehead (1972) briefly described 13 Indian specimens (BMNH collections, 12 fishes from Porto Novo and 1 from Madras) which resembled *I. elongata* but had fewer ventral scutes. Seshagiri Rao (1974b) included these in his new species *I. whiteheadi*. However, Ramaiyan and Whitehead (1975) who proposed a key for the identification of Indian species of *Ilisha* emphasising the nature of the air bladder as a diagnostic character, found that the syntypes of *Pellona kampeni*, Weber and de Beaufort (ZMA 112-595 1ex, ZMA 112-594 3ex) had bifid swimbladder extension which is a species character. They therefore stated that Seshagiri Rao's *I. whiteheadi* must be considered as a junior synonym of *I. kampeni* which was later accepted by Seshagiri Rao (1975b) himself. It is therefore clear now that *I. kampeni* is not only a valid species but also it does not belong to *Pellona* as originally described. This is therefore included here as the fourth valid species from Indian waters.

Whitehead (1969a: 270) examined Schneider's type specimen of *Clupea melastoma* (ZMB 3842) and referred it to *I. melastoma*. In spite of Article 79(b)iii of the International code of Zoological nomenclature, the name *melastoma* is not a 'nomen oblitum', since it has never been rejected as such in the literature and it should therefore replace the name *indica* of authors. The nature of the air bladder had been examined in the type specimens of *micropus*, *ditchoa* and *brachysoma* and they were all referred to *I. melastoma* by Ramaiyan and Whitehead (1975). They further described seven anomalous specimens (as referred to already on page 6) which resembled *I. melastoma* in all features, except for the absence of post-coelomic extension of the air bladder a condition otherwise known only in *I. sladeni* amongst Indo-Pacific species of *Ilisha* (Talwar & Whitehead 1971). Seshagiri Rao (1975c) described another new species *I. sirishai* in which he pointed out the above as a species character. A more detailed study of those anomalous specimens (Ramaiyan & Whitehead 1975) revealed the presence of a bulge on the lower edge of maxilla opposing the tip of the pre-maxilla (figures 9a, b). This bulge was very striking in the juveniles than in the adults. No such bulge was indicated in the description of *I. sirishai* by Seshagiri Rao (1975c). However, removal of the bulge revealed the underlying hypomaxilla in these specimens as in *Pellona*. In all species of *Ilisha* only a ligament is present in its place. The presence of hypomaxilla is thus characteristic of *Pellona* and aids in separating it from *Ilisha*. It is therefore suggested that *I. sirishai* is actually a species of *Pellona* rather than of *Ilisha*.

The nature of the air bladder has been examined in type specimens of *dussumieri*, *fligera*, *zanthoptera* and *russelli* and they all had only a single post-coelomic exten-

sion on the right side, characteristic of *I. megaloptera* to which they had all already been referred to by Ramaiyan & Whitehead (1975).

The nature of the air bladder in the type specimens of *elongata*, *abnormis*, *leschenaulti*, *vimbella*, *novacula*, *schlagelli* and *sinensis* have been examined and they all showed single post-coelomic extension, characteristic of *I. elongata*, to which therefore, all of them must be referred to as suggested by Ramaiyan & Whitehead (1975).

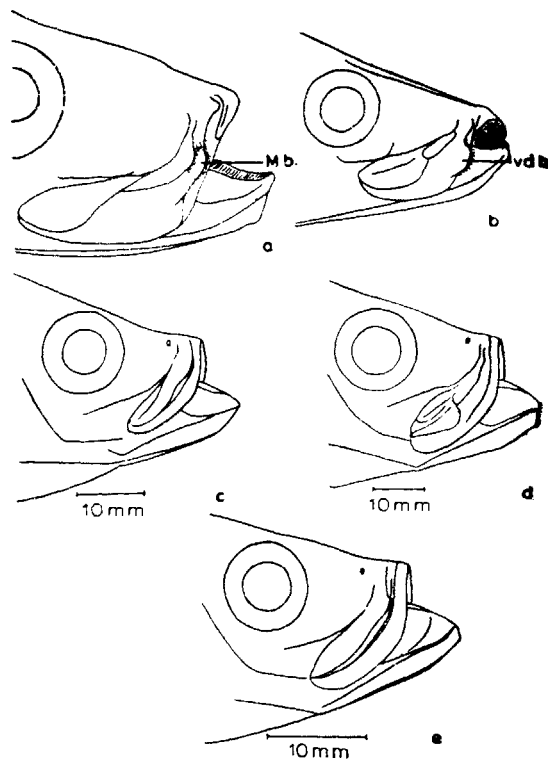


Figure 9 a, *Ilisha sirishai* (adult 156.8 mm SL BMNH 1975.3.20 822 ex Tuticorin) with bulge in the maxilla; b, *I. sirishai* (juvenile 67.8 mm SL BMNH 1975. 3. 20. 820-821 ex Bombay) with distinct plate of bone in the maxilla; c, d & e, *I. melastoma*, *I. megaloptera*, *I. kampeni* respectively without either bulge or plate of bone in the maxilla

The types of *novacula* and *sinensis* were in poor condition and the form of the swimbladder could not be checked in them. However, the meristic and morphometric characters of the two specimens are found to be the same as found here for *I. elongata*. On this basis they are also presently referable to *I. elongata*. With regard to *Clupea affinis* Gray, Whitehead (1967: 119) reproduced Gray's plate, gave measurements of the same, compared it with the measurements of various type specimens of *I. elongata* and reported that the body depth of *C. affinis* was more than the body depth of various type specimens of *I. elongata* (depth 31.7% SL Cf 24.2-28.75). The scute count was unusual (20-11 to total 31) compared to the figures given by Whitehead (1972) for *I. elongata* (23-26 + 10-14 total 35-39). *C. affinis* differs from *I. kampeni* in having more number of scutes (cf 18-21+7-9, total 27-30 in the types of *I. kampeni* and in Porto Novo specimens). The anal count in Gray's *affinis* was 49. This high count was found only in *I. elongata* (e.g. 48-50 in the types of Valenciennes *novacula*) whereas in the types of *kampeni* and in Porto Novo specimens the count was only 37-41. Since the form of the swimbladder in Gray's *affinis* is not known and information based on the drawing alone is not sufficient, at present this may be treated as a synonym of *I. elongata* rather than resurrecting a name which is rarely used (Ramaiyan & Whitehead 1975).

Further, of the 15 fishes from East Indies (Indonesia) labelled as *I. elongata* (RMNH 7086) which Whitehead et al. (1966) included under *I. elongata*, two fishes (108.2-137.9 mm SL) were found presently to belong to *I. kampeni* since they had bifid swimbladder extensions. The rest 13 fishes belonged to *I. elongata* as they had only a single post-coelomic extension and more number of pre-pelvic (22-25) and post-pelvic scutes (11-13).

In the light of above facts and as a result of present detailed taxonomical study, only four species of *Ilisha* (*I. melastoma*, *I. megaloptera*, *I. kampeni* and *I. elongata*) must be considered as valid from Indian waters at present. Of the four, only three (*I. melastoma*, *I. megaloptera* and *I. kampeni*) are very common. The paucity of occurrence of *I. elongata* is rather puzzling and needs further study.

#### Key to the Indian Species of *Ilisha*

The following key is modified from that of Ramaiyan & Whitehead (1975) but emphasis is here given to the form of the swimbladder, vertebrae and body depth as major characters.

- I. Swimbladder without post-coelomic extensions
  - A. Body slender, its depth less than 30% of SL.
    - ... *I. sladeni* (Day) (Burma)
  - \*B. Body deeper, its depth more than 30% of SL.
    - ... *I. sirishai* Seshagiri Rao
- II. Swimbladder with tubular post-coelomic extensions.
  - A. Single swimbladder extension on right side.
    1. Body slender, its depth 24-31% SL: scutes 23-26+10-14 (Total 35-39)
      - a) Anal origin below or in advance of middle of dorsal base
        - ... *I. pristigastroides* (Bleeker) (Java, Burma)
      - b) Anal origin below posterior half of dorsal base
        - ... *I. elongata* (Bennett)

\*Possibly belongs to the genus *Pellona*.



2. Body deeper, its depth more than 30% of SL; scutes 19-25+(7) 8-11 (Total 27-36).
- a) Body deep, its depth 37% of SL. ... *I. macrogaster* Bleeker (Borneo)
- b) Body moderate, its depth 29-35% of SL; Vertebrae 46-52 ... *I. megaloptera* (Swainson)
- B. Bifid tubular swimbladder extensions.**
1. Body deep, its depth 35-42% of SL, frontal ridges of 'indica' pattern, pseudobranch exposed, vertebrae 42-44 ... *I. melastoma* (Schneider)
2. Body slender, its depth 26-30% of SL; frontal ridges of modified 'megaloptera' pattern basal part of pseudobranch covered, vertebrae 41-42 ... *I. kampeni* (Weber & de Beaufort)
- (i) *A redescription of I. melastoma* (Schneider 1801)
- Ilisha melastoma* (Schneider 1801)
- Clupea melastoma* Schneider 1801, *Syst. Ichthyol. Bloch.*: 427 (Indian Ocean near Coromandel)
- Clupea motius* Hamilton—Buchanan, 1822, *Fishes of the Ganges*: 251, 383 (Brahmaputra)
- Platygaster verticalis* Swainson, 1838, *Nat. Hist. Anim.*, 1: 278 (on Ditchoe of Russell, 1803, *Fishes of Coromandel*, 2: 74, pl. 192)
- Platygaster indicus* Swainson, 1839, *Nat. Hist. Anim.*, 2: 294 (on Gray, 1834, *Illustr. Ind. Zool. Hardwicke*, 2: pl. 109(3) —*Clupea motius*)
- Pellona micropus* Valenciennes, 1847, *Hist. Nat. Poiss.*, 20: 320 (Coromandel coast, Bengal)
- Pellona ditchoa* Valenciennes, 1847, *Hist. Nat. Poiss.*, 20: 313 (on Ditchoe)
- Pellona brachysoma* Bleeker, 1852, *Verh. batav. Genoot. Kunst. Wet.*, 24: 22 (Batavia)
- Material examined*: (610)\* 29.1-184.5 mm SL, Porto Novo; (7) 137.0-155.3 mm SL, Waltair; (25) 93.4-171.1 mm SL, Madras; (194) 85.0-126.0 mm SL, Nagapattinam; (213) 83.0-131.0 mm SL, Mandapam; (10) 110.0-140.3 mm SL, Tuticorin, (2) 98.5 & 121.8 mm SL, Malabar; (15) 97.9-124.9 mm SL, Vizhingam; (33) 98.5-134.1 mm SL, Mangalore; (2) 41.1 & 46.9 mm SL, Ganges; (1) 112.1 mm SL, Andaman; (45) 90.1-120.2 mm SL, Sri Lanka; (23) 77.3-112.4 mm SL, Indonesia; (4) 55.9-97.2 mm SL, Hong Kong; (2) 66.5 & 101.7 mm SL, Singapore; (2) 117.3 & 137.1 mm SL, Pakistan; (1) 63.4 mm SL, Sumatra.
- Description*: Based on 610 specimens (29.1-184.5 mm SL) from Porto Novo.
- Br. St. 6 D i-ii 15-17, P i 14-17, V i 6, A ii 34-46, G.R. 10-14+19-25, Scutes 18-22 +8-10, Scales in lateral series 42-44, vertebrae 42-44.
- In percentages of standard length; body depth 30.3-42.3, head length 24.1-33.3, snout length 6.1-10.3, eye-diameter 8.1-12.8, pre-dorsal distance 44.3-56.1, pre-pelvic distance 39.2-54.9 and pre-anal distance 55.2-69.5.
- Body strongly compressed, its depth greater than head length, belly sharply keeled. Snout a little shorter than eye-diameter. Lower jaw strongly projecting, small granular teeth present on tongue. Pre-maxilla with a single row of small

\*The numbers in parentheses indicate the samples examined.

teeth, no hypomaxilla, two supra-maxillae, the first (anterior) slender, the second (posterior) expanded posteriorly and tapering to a slender shaft anteriorly.

Frontals with prominent ridges of the 'indica' pattern (Seshagiri Rao 1972) i.e. a pair of ridges arising on median line before anterior border of eye passing posteriorly, diverging at first but then running parallel to each other or converging slightly with posteriorly a second pair of ridges parallel to the first, the two pairs sometimes meeting each other on each side at the hind end of the skull. Pseudobranch present, exposed, greater than  $\frac{1}{2}$  eye diameter, with 16-20 filaments.

Dorsal fin origin a little nearer to snout tip than to caudal base. Pectoral fin reaching to pelvic base, axillary scale present, half length of pectoral fin. Pelvic fins small, no pelvic axillary scale present. Anal origin just behind vertical from 2nd dorsal ray.

The range and mean of the meristic characters of *I. melastoma* obtained from various localities are as follows:

*Dorsal fin rays:* 16 (Ganges and Sumatra) 17 (Andaman and Singapore), 18 (Malabar) 16-17 (Pakistan  $\bar{X}$ : 16.50), 16-18 (Waltair  $\bar{X}$ : 16.85, Madras  $\bar{X}$ : 17.00, Nagapattinam  $\bar{X}$ : 16.70, Mandapam  $\bar{X}$ : 16.30, Tuticorin  $\bar{X}$ : 16.90, Vizhingam  $\bar{X}$  16.40, East Indies  $\bar{X}$ : 16.95), 17-18 (Ceylon  $\bar{X}$ : 17.02, Hong Kong  $\bar{X}$ : 17.25), 17-19 (Mangalore  $\bar{X}$ : 18), 16-19 (Porto Novo  $\bar{X}$ : 17.20).

*Pectoral fin rays:* 15-16 (Ganges  $\bar{X}$ : 15.50, Ceylon  $\bar{X}$ : 15.82), 15-17 (Waltair  $\bar{X}$ : 16.43, Nagapattinam  $\bar{X}$ : 15.86, Mandapam  $\bar{X}$ : 16.04, Tuticorin  $\bar{X}$ : 16.30), 15-18 (Madras  $\bar{X}$ : 15.68, Porto Novo  $\bar{X}$ : 16.09), 16-17 (Malabar  $\bar{X}$ : 16.50, Vizhingam  $\bar{X}$ : 16.60, Hong Kong  $\bar{X}$ : 16.50, Pakistan  $\bar{X}$ : 16.50, Mangalore  $\bar{X}$ : 16.25), 16-18 (East Indies  $\bar{X}$ : 16.95), 17 (Singapore) 18 (Sumatra).

*Anal fin rays:* 36-48 (Porto Novo  $\bar{X}$ : 41.65, Mandapam  $\bar{X}$ : 42.66), 37-44 (Madras  $\bar{X}$ : 41.54), 38-46 (Nagapattinam  $\bar{X}$ : 40.66), 37-47 (Vizhingam  $\bar{X}$ : 42.53), 39-45 (Mangalore  $\bar{X}$ : 41.03), 38-41 (Ganges  $\bar{X}$ : 39.50), 39 (Andaman  $\bar{X}$ : 39.00), 39-44 (Ceylon  $\bar{X}$ : 40.88), 38-41 (East Indies  $\bar{X}$ : 39.82), 39-42 (Hong Kong  $\bar{X}$ : 39.95), (Singapore  $\bar{X}$ : 40.50), 40-48 (Tuticorin  $\bar{X}$ : 43.90), 41-48 (Malabar  $\bar{X}$ : 44.50), 46 (Pakistan), 42-47 (Waltair  $\bar{X}$ : 44.28).

*Gillrakers:* 32-33 (Waltair  $\bar{X}$ : 32.20), 32-37 (Madras  $\bar{X}$ : 34.70), 29-39 (Porto Novo  $\bar{X}$ : 34.60), 31-38 (Nagapattinam  $\bar{X}$ : 34.24), 30-38 (Mandapam  $\bar{X}$ : 33.25), 32-35 (Tuticorin  $\bar{X}$ : 33.77), 36 (Malabar and Andaman  $\bar{X}$ : 36.00), 31-36 (Vizhingam  $\bar{X}$ : 33.85), 33-39 (Mangalore  $\bar{X}$ : 34.75), 31-33 (Ganges  $\bar{X}$ : 32.00), 34-37 (Ceylon  $\bar{X}$ : 35.11), 33-37 (East Indies  $\bar{X}$ : 34.69), 34-36 (Hong Kong  $\bar{X}$ : 34.75), 33 (Singapore), 33-35 (Pakistan  $\bar{X}$ : 34.00).

*Abdominal scutes:* 25-28 (Waltair  $\bar{X}$ : 26.85), 27-32 (Madras  $\bar{X}$ : 28.40), 26-31 (Porto Novo  $\bar{X}$ : 28.31, Nagapattinam  $\bar{X}$ : 28.24, Mandapam  $\bar{X}$ : 27.96), 27-29 (Tuticorin  $\bar{X}$ : 28.20, Malabar  $\bar{X}$ : 28.00), 26-29 (Vizhingam  $\bar{X}$ : 27.86), 26-27 (Ganges  $\bar{X}$ : 26.50), 29 (Andaman), 27-30 (Ceylon  $\bar{X}$ : 28.42, East Indies  $\bar{X}$ : 28.30), 27-29 (Hong Kong  $\bar{X}$ : 28.25), 27-30 (Singapore  $\bar{X}$ : 28.50), 27 (Pakistan and Sumatra).

*Vertebrae:* 42-44 (Porto Novo  $\bar{X}$ : 42.84).

*Distribution:* This species has a widely recorded distribution from the Persian gulf to Hong Kong (Whitehead 1972). It is also known to occur in Ceylon, Andaman, Singapore, Sumatra, Pakistan, based on the collections listed here. In India, *I. melastoma* is known from both the west coast (Vizhingam, Mangalore) and east coast (Waltair, Madras, Porto Novo, Nagapattinam & Tuticorin) based on the collections listed here and the reports of Whitehead (1972) and Seshagiri Rao (1973).

(ii) *A redescription of I. megaloptera*  
(Swainson 1839)

*Ilisha megaloptera* (Swainson 1839)  
*Platygaster macrophthalmia* Swainson, 1838,  
*Nat. Hist. Anim.*, 1 278 (on Jangarloo  
of Russell 1803, *Fishes of Coromandel*, 2  
73, pl. 191) (nomen oblitum)

*Platygaster megalopterus* Swainson, 1839,  
*Nat. Hist. Anim.*, 2 294 (on Jangarloo)

*Pellona dussumieri* Valenciennes, 1847, *Hist.*  
*Nat. Poiss.*, 20 316, pl. 516 (Bombay,  
Malabar, Coromandel)

*Pellona filigera* Valenciennes, 1847, *Hist.*  
*Nat. Poiss.*, 20 322 (Bombay, also Coro-  
mandel coast)

*Pellona zanthoptera* Bleeker, 1851, *Natuurk.*  
*Tijdschr. Ned-Indie*, 2 439 (Sambar,  
Borneo)

*Pellona russelli* Bleeker, 1852, *Natuurk.*  
*Tijdschr. Ned-Indie* 3 72 (Java, Madura,  
Pasuruan, Singapore)

*Material examined* : (10) 87.9–161.0 mm  
SL, Calcutta; (11) 196.0–266.0 mm SL,  
Masulipatnam; (12) 74.5–223.1 mm SL,  
Madras; (13) 161.0–189.0 mm SL, Pondi-  
cherry; (24) 117.0–223.0 mm SL, Porto  
Novo; (1) 136.6 mm SL, Thirumullivasal;  
(5) 160.0–186.0 mm SL, Tranquebar; (67)  
114.0–435.0 mm SL, Point Calimere; (3)  
163.0–196.0 mm SL, Adirampattinam; (37)  
134.0–275.0 mm SL, Mandapam; (26)  
73.0–180.9 mm SL, Bombay; (7) 165.7–  
221.3 mm SL, Sri Lanka; (2) 128.4 & 156.0 mm  
SL, Singapore; (1) 158.2 mm SL, Java,  
(4) 127.6–193.6 mm SL, Indonesia.

*Description*: Based on 67 specimens  
(114.0–435.0 mm SL) from Point Calimere.

Br. St. 6 D iii 13–15, p i 14–17, A ii  
42–50, G.R. 9–12+17–20, Scutes 21–24+  
10–13, Scales in lateral series 47–50, Verte-  
brae 46–52 (for Porto Novo specimens).

In percentages of standard length: body  
depth 29.4–34.0, head length 20.8–28.0,  
snout length 5.3–8.7, eye-diameter 5.5–10.0,  
pre-dorsal distance 48.3–52.0, pre-pelvic  
distance 40.7–46.8, and pre-anal distance  
53.7–64.4.

Body much compressed, its width less  
than depth and deepest under dorsal  
origin. Belly strongly keeled, scutes begin-  
ning at isthmus, a few scutes being hidden by  
the branchiostegal membrane. Head length  
less than body depth. Snout smaller than  
eye. Lower edge of maxilla with fine serrae,  
the maxilla tip reaching to below middle of  
eye. No hypomaxilla. Two supra-maxillae,  
the first slender and the second expanded  
posteriorly and tapering to a slender shaft  
anteriorly, single series of teeth in both  
jaws. Pseudobranch present and exposed.  
Gillrakers slender, as long as longest gillfila-  
ment and slightly less than eye diameter.

Dorsal fin origin equidistant between  
snout tip and caudal fin base. Pelvic fin base  
nearer to anal fin origin than to pectoral fin  
base; no pelvic axillary scale; origin of anal  
fin below vertical from 10 to 12th branched  
dorsal ray. Frontals with two prominent  
ridges; all the specimens examined here had  
the so-called '*megaloptera*' pattern of striae  
described by Seshagiri Rao (1972).

The range and mean of the meristic  
characters of *I. megaloptera* obtained from  
various localities are as follows :

*Dorsal fin rays*: 16–19 (Mandapam  $\bar{X}$ :  
16.00), 16–18 (Madras  $\bar{X}$ : 17.08, Pondi-  
cherry  $\bar{X}$ : 17.23, Porto Novo  $\bar{X}$ : 17.16,  
Point Calimere  $\bar{X}$ : 16.88), 16–17 (Masuli-  
patnam  $\bar{X}$ : 16.60, Adirampattinam  $\bar{X}$ :  
16.33), 17–19 (Calcutta  $\bar{X}$ : 17.40), 17–18  
(Tranquebar  $\bar{X}$ : 17.20, Bombay  $\bar{X}$ : 17.84,  
East Indies  $\bar{X}$ : 17.50), 17 (Thirumullivasal,  
Ceylon, Singapore and Java).

*Pectoral fin rays*: 15–18 (Pondicherry  $\bar{X}$ :  
16.84, Point Calimere  $\bar{X}$ : 16.31), 16–18

(Porto Novo  $\bar{X}$ : 17.16, Bombay  $\bar{X}$ : 16.88), 17-18 (Calcutta  $\bar{X}$ : 17.50, Madras  $\bar{X}$ : 17.25, Ceylon  $\bar{X}$ : 17.14, East Indies  $\bar{X}$ : 17.25), 17 (Masulipatnam and Singapore), 16-17 (Tranquebar  $\bar{X}$ : 16.80, Adirampattinam  $\bar{X}$ : 16.33, Mandapam  $\bar{X}$ : 16.52), 18 (Thirumullivasal and Java).

*Anal fin rays*: 45-52 (Calcutta  $\bar{X}$ : 48.40), 44-52 (Point Calimere  $\bar{X}$ : 47.72), 43-48 (Pondicherry  $\bar{X}$ : 45.23), 43-51 (Porto Novo  $\bar{X}$ : 45.70), 43-49 (Mandapam  $\bar{X}$ : 45.55), 46-52 (Masulipatnam  $\bar{X}$ : 48.60), 45-50 (Madras  $\bar{X}$ : 46.63), 44-48 (Tranquebar  $\bar{X}$ : 45.00), 43-46 (Adirampattinam  $\bar{X}$ : 45.00), 48-54 (Bombay  $\bar{X}$ : 51.53), 46-48 (Ceylon  $\bar{X}$ : 47.00), 43-45 (Singapore  $\bar{X}$ : 44.00), 44 (Java), 39-44 (East Indies  $\bar{X}$ : 40.75), 48 (Thirumullivasal).

*Gillrakers*: 26-32 (Masulipatnam  $\bar{X}$ : 28.54, Point Calimere  $\bar{X}$ : 29.31), 27-33 (Madras  $\bar{X}$ : 30.00), 27-32 (Porto Novo  $\bar{X}$ : 29.45), 28-31 (Calcutta  $\bar{X}$ : 29.40, Bombay  $\bar{X}$ : 29.53), 27-30 (Adirampattinam  $\bar{X}$ : 28.33), 29-31 (Tranquebar  $\bar{X}$ : 30.00), 29-30 (Pondicherry  $\bar{X}$ : 29.50), 29-34 (Mandapam  $\bar{X}$ : 30.97), 30-31 (Ceylon  $\bar{X}$ : 30.14), 31-32 (Singapore  $\bar{X}$ : 31.50), (East Indies  $\bar{X}$ : 31.75), 30 (Thirumullivasal), 31 (Java).

*Abdominal scutes*: 29-33 (Calcutta  $\bar{X}$ : 31.60), 29-32 (Madras  $\bar{X}$ : 31.25, Pondicherry  $\bar{X}$ : 30.76), 30-37 (Porto Novo  $\bar{X}$ : 31.45), 30-33 (Tranquebar  $\bar{X}$ : 31.40, Adirampattinam  $\bar{X}$ : 32.00), 29-33 (Mandapam  $\bar{X}$ : 31.25), 30-36 (Bombay  $\bar{X}$ : 33.53), 31-37 (Point Calimere  $\bar{X}$ : 33.52), 32-37 (Masulipatnam  $\bar{X}$ : 33.45), 30-32 (Ceylon  $\bar{X}$ : 30.99), 31-32 (Singapore  $\bar{X}$ : 31.50), 30-31 (East Indies  $\bar{X}$ : 30.50), 32 (Java) 30, (Thirumullivasal).

*Vertebrae*: 46-52 (Porto Novo  $\bar{X}$ : 48.21).

*Distribution*: This species has a widely recorded distribution, having been recorded from Pakistan (BMNH Specimens). It is

also recorded from Java, Singapore and Ceylon, based on the material listed here. In India, *I. megaloptera* is known from Calcutta, Masulipatnam, Madras, Pondicherry, Porto Novo, Thirumullivasal, Tranquebar, Adirampattinam, Point Calimere, Mandapam (east coast) and Bombay (west coast) based on the material listed here and the reports of Whitehead (1972) and Seshagiri Rao (1973).

(iii) *A redescription of I. kampeni* (Weber and de Beaufort, 1973)

*Ilisha kampeni* (Weber & Beaufort 1913)  
*Pellona kampeni* Weber & de Beaufort, 1913, *Fishes. Indo. Austr. Arch.*, 2: 87 (Java, Bornea)

*Ilisha whiteheadi* Seshagiri Rao, 1974, *Copeia*, No. 4: 861

*Ilisha elongata* (part) Whitehead, 1972. *J. mar. biol. Ass. India*, 14 (1): 212 (Porto Novo, not the Madras specimen)

*Material examined*: (147) 68.0-136.0 mm SL, Porto Novo; (3) 76.6-126.2 mm SL, Batavia; (2) 108.2 & 137.9 mm SL, East Indies; (4) 98.7-114.7 mm SL, Borneo

*Description*: Based on 147 specimens (68.0-136.0 mm SL) from Porto Novo

D ii 14-16, A ii 34-44, P i 13-16, V i 6, G.R. 7-9+19-25, scutes 18-21+7-9, scales in lateral series 42-43, vertebrae 41-42

In percentages of standard length: body depth 25.3-30.8, head length 26.3-32.3, snout length 6.5-10.4, eye-diameter 6.7-10.4, pre-dorsal distance 41.1-53.4, pre-pelvic distance 39.2-51.7, and pre-anal distance 57.7-66.2.

Body oblong, compressed, ventral profile a little more convex than dorsal. Maxilla reaching to below middle of eye, its length

twice in head. No hypo-maxilla; two supra-maxillae, the 2nd expanded posteriorly. Chin very prominent; two pairs of diverging ridges on the dorsal surface of the head; all specimens have the so-called 'megaloptera' pattern of striae as described by Seshagiri Rao (1972).

Origin of dorsal fin a little nearer to snout tip than to caudal fin base. Pelvic fins very short; anal fin base almost three times in SL, its origin below posterior half of dorsal fin, caudal deeply forked.

The range and mean of meristic characters examined from various localities are as follows:

*Dorsal fin rays:* 16-18 (Porto Novo  $\bar{X}$ : 16-98), 17-18 (Batavia  $\bar{X}$ : 17.66), 17 (East Indies), 18 (Borneo).

*Pectoral fin rays:* 14-17 (Porto Novo  $\bar{X}$ : 15.19), 16-17 (Batavia  $\bar{X}$ : 16.66, East Indies  $\bar{X}$ : 16.50, Borneo  $\bar{X}$ : 16.25).

*Anal fin rays:* 36-46 (Porto Novo  $\bar{X}$ : 40.86), 42-43 (Batavia  $\bar{X}$ : 42.50, East Indies  $\bar{X}$ : 43.00), 39-43 (Borneo  $\bar{X}$ : 41.00).

*Gillrakers:* 26-35 (Porto Novo  $\bar{X}$ : 30.68), 30 (Batavia and East Indies), 26-30 (Borneo  $\bar{X}$ : 28.00).

*Abdominal scutes:* 26-31 (Porto Novo  $\bar{X}$ : 27.70), 26-29 (Batavia  $\bar{X}$ : 27.33), 27-29 (Borneo  $\bar{X}$ : 28.25), 28-29 (East Indies  $\bar{X}$ : 28.50).

*Vertebrae:* 41-42 (Porto Novo  $\bar{X}$ : 41.91).

*Distribution:* Weber and de Beaufort (1913) recorded *I. kampeni* from Java (Batavia) and Borneo (Balikappan). It is also known from East Indies, based on the material listed here. It is here recorded from Kakinada, Bay of Bengal (as *I. whiteheadi*) by Seshagiri Rao (1974) and from Porto Novo, based on the material listed here.

(iv) *A redescription of I. elongata* (Bennett 1830)

*Illosha elongata* (Bennett 1830)

*Alosha elongata* Bennett, 1830 (Feb.) *Mem. Life of Rafles*. 691 (Sumatra)

*Clupea affinis* Gray, 1830 (July), *Illustr. Ind. Zool. Hordwicke*, 1: pl. 96 (2) (Penang, on Hardwicke drawing)

*Illosha abnormis* Richardson, 1846. *Rapt. Ichthyol. Seas China Japan*: 306 (China seas)

*Pellona grayana* Valenciennes, 1847, *Hist. Nat. Poiss.*, 20: 315 (on *affinis* Gray)

*Pellona leschenaulti* Valenciennes, 1847, *Hist. Nat. Poiss.*, 20: 311 (Pondicherry)

*Pellona vimbella* Valenciennes, 1847, *Hist. Nat. Poiss.*, 20: 317 (Macao)

*Pellona novacula*, Valenciennes, 1847, *Hist. Nat. Poiss.*, 20: 319 (Rangoon)

*Pellona schlegelii* Bleeker, 1854, *Natuurk. Tijdschr. Ned-Indie*, 6: 418 (Nagasaki)

*Pristigaster chinensis* Basilewsky, 1855, *Nouv., Mem. Soc. Nat. Moscow*, 10: 243 (Gulf of Tschiliensis, China)

*Pristigaster (Pristigaster) sinensis* Sauvage, 1881, *Bull. Soc. Philomath. Paris*, (7) 5: 107 (Swatow)

*Material examined:* (6) 126.7-242.8 mm SL, China, (3) 185.2-218.3 mm SL, Indonesia, (2) 113.9 & 134.7 mm SL, Batavia; (13) 181.6-310.3 mm SL Indonesia.

*Description:* Based on the description of Whitehead (1967). D iii 14, P i 15, vi 6, A iii 46, G.R. 10+20, Scutes 25+12.

In percentages of standard length, body depth 27.8, head length 23.2, snout length 6.6, eye-diameter 5.9, length of upper jaw 12.2, length of lower jaw 12.3, pectoral fin length 15.7 (tip broken) pelvic fin length 4.0, length of anal fin base 32.7, pre-dorsal distance 54.0, pre-pelvic distance 45.7, and pre-anal distance 65.0.

Body compressed, its depth only slightly greater than head length. Lower jaw without a median notch, but this area edentulous. Few small teeth present along remainder of pre-maxillae. Lower jaw prominent, about 7 small teeth on each side of dentary symphysis. No hypo-maxilla, two supra maxillae present. Belly sharply keeled. Pectoral axillary scale present. Pelvic fin base equidistant between pectoral base and anal origin. Dorsal fin origin nearer to caudal base than to snout tip.

The range and mean of the meristic characters of *I. elongata* examined from various localities are as follows:

*Dorsal fin rays:* 17-19 (China  $\bar{X}$ : 16.16), 17-18 (East Indies  $\bar{X}$ : 17.66), 17 (Batavia).

*Pectoral fin rays:* 16-17 (China  $\bar{X}$ : 16.83), 17-18 (Batavia  $\bar{X}$ : 17.50), 15-18 (East Indies  $\bar{X}$ : 16.76).

*Anal fin rays:* 47-52 (China  $\bar{X}$ : 49.00), 42-43 (Batavia  $\bar{X}$ : 43.50), 45-49 (East Indies  $\bar{X}$ : 47.16).

*Gillrakers:* 33-37 (China  $\bar{X}$ : 35.33), 31-32 (Batavia  $\bar{X}$ : 31.50), 31-33 (East Indies  $\bar{X}$ : 32.30).

*Abdominal scutes:* 37-39 (China  $\bar{X}$ :

38.33), 36-37 (Batavia  $\bar{X}$ : 36.50), 34-37 (East Indies  $\bar{X}$ : 35.69).

*Distribution:* This species recorded from China and Japan westwards to the Indo-Malayan Archipelago and Burma (Whitehead 1972). It is also recorded from Batavia, based on the material listed here. The paucity of records from India is curious, but this is evidently the western boundary of its range and it is perhaps generally replaced by *I. kampeni* along Indian coasts.

#### Acknowledgements

The first author (V R) wishes to record his sincere thanks to Dr P J P Whitehead, British Museum (Natural History) London for his valuable suggestions and helpful criticisms. Thanks are due to Dr Charles Roux, Museum, National d' Histoire Naturelle, Paris and Dr Boeseman, Curator, Rijksmuseum van Natuurlijke Historie, Leiden for providing facilities for study of the *Ilisha* material and to the University Grants Commission, to the authorities of Annamalai University and the British Council India and London for deputing me as a Visiting Scientist to England and other places. Their financial support is also gratefully acknowledged.

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