First inland record of Bull shark *Carcharhinus leucas* (Müller & Henle, 1839) (*Carachariniformes*: *Carcharhinidae*) in Celebes, Indonesia

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**Abstract**

A single specimen (c. 86.2 cm) juvenile of Bull shark *Carcharhinus leucas* (Müller & Henle, 1839) was captured and photographed by local fisherman using a casting net on 13 February 2018 in Pangkajene River, about 16 km inland, Pangkajene District, South Celebes, Indonesia. This finding is considered as a first inland record of *C. leucas* in Celebes, and fourth inland records in Indonesia after Papua, Sumatra and Borneo. Monitoring is needed to assess the possibility of Celebes as a migration route and breeding ground of *C. leucas*.

**Key words:** Biogeography, distribution, elasmobranch, freshwaters, requiem sharks.

**Introduction**

The Bull shark *Carcharhinus leucas* (Müller & Henle, 1839) is one of the few sharks that are truly euryhaline and is a common species that occurs in marine and coastal riverine environments and is widespread along the continental coast of all tropical and subtropical seas as well as numerous rivers, lakes, and estuaries (Compagno *et al.* 2005; Werry *et al.* 2011; Gausmann 2018). Migrations of *C. leucas* may also be directly related to changes in water conditions, specifically salinity, to decrease energy expended for osmoregulation (Glaus *et al.* 2019; Reilly 2011). Ballantyne & Robinson (2010) mentioned that the high urea requirement of many proteins in marine elasmobranch might be one of the factors. The adaptation to freshwater environments have occurred independently many times in Chondrichthyes evolution (Pillans *et al.* 2005; Evans *et al.* 2004; Lucifora *et al.* 2015). However, the factors affecting the poor penetration of *C. leucas* into inland are currently unknown (Ortega *et al.* 2009; O’Connell *et al.* 2017; Hyatt *et al.* 2018).

*Carcharhinus leucas* are designated as Near Threatened (NT) by the IUCN Red List due to the close proximity of critical habitats to anthropogenic influences (Simpfendorfer & Burgess 2009). It has been
recorded in the Amazon River, Peru, South America (Myers 1952); Mississippi River, Illinois, North America (Thomerson et al. 1977); Zambezi River, Zimbabwe, South Africa (Bass et al. 1973), Nicaragua Lake, Nicaragua, Central America (Thorson 1971); Tigris River, Iraq, West Asia (Coad 2015); Ganges River, Bangladesh, South Asia (Martin 2005); and Perak River, Serawak Malaysia, Southeast Asia (Boeseman 1964). Although the knowledge about *C. leucas* and its distribution has increased over the past decades, the borders and the full range of it reach in some regions are unclear, especially in the inland waters (Campagno et al. 2002). *Carcharhinus leucas* is a large coastal apex predator that is globally distributed in warm temperate waters, including Indonesian freshwaters, and the only known inland records of this species were found in Sumatra (Tan & Lim 1998; Iqbal et al. 2019a; Hasan & Widodo 2020), Borneo (Iqbal et al. 2019b), and Papua (Boesman 1964; Compagno 1984, Keller 1987, Allen 1991). However, Celebes Island of Indonesia is not included in the distribution map of *C. leucas* in many major shark references (Campagno & Niem, 1998; Fahmi 2010; Last et al. 2010; Ebert et al. 2013). It is more likely that *C. leucas* had not been reported because shark of Celebes has not been explored enough. In this paper, we report the presence of *C. leucas* in the Pangkajene River, Pangkajene District, South Celebes Province, Indonesia.

**Material and Methods**

We captured a single specimen by local fisherman using a casting net on 13 February 2018 in Pangkajene River, about 16 km inland, Pangkajene District, South Celebes Province (4°46'26"S; 119°38'36"E) (Fig. 1). The fish was documented and photographed, although no voucher specimen was retained because the fish was too large to be stored and we did not have enough space in the laboratory. Diagnostic morphological characters of the single specimen were analyzed following Compagno (1998) and Ebert et al. (2013) method. The water quality parameters were determined directly after capture.

*Figure 1.* Location of known *C. leucas* collected in inland Indonesia. Green, blue, and yellow shows the previous record from Sumatra, Borneo, and Papua respectively; and red show recent record from Celebes.
Results and Discussions

A single specimen collected from Pangkajene River, South Celebes has features of Carcharhinidae family: short and broad snout; large, elongated, and arched mouth; small eyes on the side of the head; two dorsal fins: the first dorsal fin is moderately large, much shorter than the caudal fin, and its base is located over the interspace between pectoral and ventral fin bases; broad pectoral fins, with narrow pointed tips. This shark is identified as juvenile of *C. leucas* by the first dorsal fin triangular, rearward sloping, originating over or slightly behind pectoral insertion, snout much shorter than width of mouth and bluntly rounded. (Figs. 2 and 3). The coloration of specimen are fitted well to the juvenile *C. leucas*: white belly and greyish back, the black coloration on the tip of the second dorsal, and caudal fins. The characters above are fitted well to the features of juvenile *C. leucas* (Compagno *et al.* 2005; Ebert *et al.* 2013). Morphometric characters of a single specimen are given in Table 1.

Figure 2. The side view of *C. leucas* caught on the Pangkajene River, Pangkajene District, South Celebes Province, Indonesia. Photo Q. A. Mubaraq.

The discovery of *C. leucas* in Pangkajene River, Pangkajene District, South Celebes Province is the first inland record from Celebes, and the fourth inland records beyond its previous records in Indonesia (Papua, Borneo, and Sumatra). Among other biological topics, the new record of near-threatened shark is an important contribution to raise an understanding of species diversity and biogeography (Iqbal *et al.* 2019b; Hasan & Widodo 2020). As reported in this paper, the new record of *C. leucas* has helped to improve the knowledge of the species as it extends the distribution range of the species in Celebes.

The existence of juvenile of *C. leucas* in Celebes indicates that the inland habitat is a migration route for this species in the Wallace area. In the future, data collection using assisted by local fisherman is needed to assess the occurrence of *C. leucas* and evaluate the importance of Celebes as a habitat and distribution range.

Environmental factors may interact to define *C. leucas* movement patterns, including temperature, dissolved oxygen, and salinity (Smoothey *et al.* 2016; Hyatt *et al.* 2018; Galván-Magaña 2019). Water conditions in the Pangkajene River, namely salinity 2.1‰, temperature 28-31°C, dissolved oxygen 4.1-12.3 mg/l, are ideal for *A. leucas* habitat (Drymon *et al.* 2014; Hyatt *et al.* 2017). Besides that, the Pangkajene River is a natural habitat of several estuarine fishes such as mullet and milkfish which are the main food of juvenile *C. leucas* (Pillans *et al.* 2005).
Figure 3. The dorsal view of *C. leucas* caught on the Pangkajene River, Pangkajene District, South Celebes Province, Indonesia. Photo Q. A. Mubaraq.

*Carcharhinus leucas* is not the main commodity of fisheries in Celebes because the number of individuals entering into Celebes is very rare. There is no official record of how many *C. leucas* are caught because these fish are not a targeted species in Indonesia's commercial fisheries. Although *C. leucas* are not normally targeted but are commonly taken in commercial and recreational fisheries for their meat, oil, and fins (Dulvy *et al.* 2014; Davidson *et al.* 2016). The Indonesian government needs to strictly prohibit the practice of catching sharks, especially *C. leucas* (Booth *et al.* 2018).

| Character (cm)                  | Present study | (Purushottama *et al.* 2013) |
|--------------------------------|---------------|-------------------------------|
| Total length                   | 86.2          | 82                            |
| Fork length                    | 71.1          | 65                            |
| Pre anal length                | 52.4          | 42.4                          |
| Pre pelvic length              | 41            | 40.6                          |
| Pre pectoral length            | 15.3          | 16.1                          |
| Pre orbital length             | 5             | 4.8                           |
| Head length                    | 16.2          | 18.3                          |
| Pre first dorsal length        | 21.1          | 23.6                          |
| Pre second dorsal length       | 51.4          | 51                            |
| Pre caudal length              | 63            | 61                            |

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