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Crowned jellyfish (Cnidaria: Scyphozoa: Rhizostomeae: Cepheidae) from waters off the coast of Pakistan, northern Arabian Sea

Shahnawaz Gul[1], **Mohammad Moazzam**[2] and **André C. Morandini**[3*]

1 Department of Zoology, Jamia Millia Government Degree College, Malir, Karachi, Pakistan
2 WWF-Pakistan, 46-K, Block 6, PECHS, Karachi 75400, Pakistan
3 Departamento de Zoologia, Instituto Biociências, Universidade de São Paulo, Rua do Matão, trav. 14, n. 101, Cidade Universitária, São Paulo, SP, 05508-090, Brazil
* Corresponding author. E-mail: acmorand@ib.usp.br

Abstract: This report presents the occurrence of two species of crowned jellyfish, *Cephea coerulea* and *Netrostoma setouchianum,* recorded for the first time from waters off the coast of Pakistan in the northern Arabian Sea. Diagnosis of the genera *Cephea* and *Netrostoma* are provided. We also provide simple keys for the identification of cepheid genera. We found that long filaments on mouth arms in *Cephea* easily distinguish it from *Netrostoma,* which has no such filaments.

Key words: scyphozoan, jellyfish, *Cephea, Netrostoma,* Pakistan, new records

In recent years there have been an increasing interest in jellyfish (Gibbons and Richardson 2013) due to their apparent more frequent population explosion events or blooms (Condon *et al.* 2012). Among the gelatinous zooplankton (Braconnot and Carré 1989) or gelata (Haddock 2004), jellyfish—meaning the free-swimming stage of some cnidarians (medusozoans)—seem to be the most conspicuous members that exhibit blooms. Many taxa are known by their beautiful morphology including members of the rhizostome family Cepheidae Agassiz (1862). Some genera of this family (*e.g.*, *Cephea* Péron & Lesueur, 1810 and *Netrostoma* Schultze, 1898) have a marked depression and several protuberances on the exumbrella and are commonly known as crowned jellyfish. These jellyfish are known to be distributed in the tropical waters of the Indo-West Pacific (Mayer 1910; Kramp 1970).

Our knowledge on the scyphomedusae from Pakistani waters is mainly from Stiasny (1937a). His work was based on material from John Murray's Expedition in 1933–34, reporting three scyphozoan jellyfish species [*Cephea* sp., *Pelagia noctiluca* (Forskål, 1775) and *Sanderia malayensis* Goette, 1886] from waters off Karachi Pakistan. Later information comprises records of *Catostylus perezi* Ranson, 1945 (as *Catostylus mosaicus*); *Pelagia* cf. *noctiluca* (Forskål, 1775) and *Marivagia stellata* Galil & Gershwin, 2010 (Tahera and Kazmi 2006; Gul and Morandini 2013; Gul *et al.* 2014). Our goal here is to add knowledge of scyphozoans from Pakistani waters; we provide the first records of two cepheid jellyfish, *Cephea coerulea* Vanhöffen, 1902 and *Netrostoma setouchianum* (Kishinouye, 1902), along the coast of Pakistan in the northern Arabian Sea.

While scuba diving on 19 December 2010 two specimens of crowned jellyfish (later referred to the genus *Netrostoma*) were photographed at Charna Island (24°53′56.422″ N, 066°36′15.297″ E), off the Pakistani coast (Figure 1). However, the specimens could not be collected and identification was based on examination of photographs. On 8 February 2014, during fishing activities off Pakistani coast (24°59.03′ N, 065°43.62′ E) (Figure 1), three specimens of another crowned jellyfish (later identified as belonging to the genus *Cephea*) were separated from the gill net and photographed in life. But as there were no technical facilities or preservatives, the specimens were kept in ice and brought to laboratory in

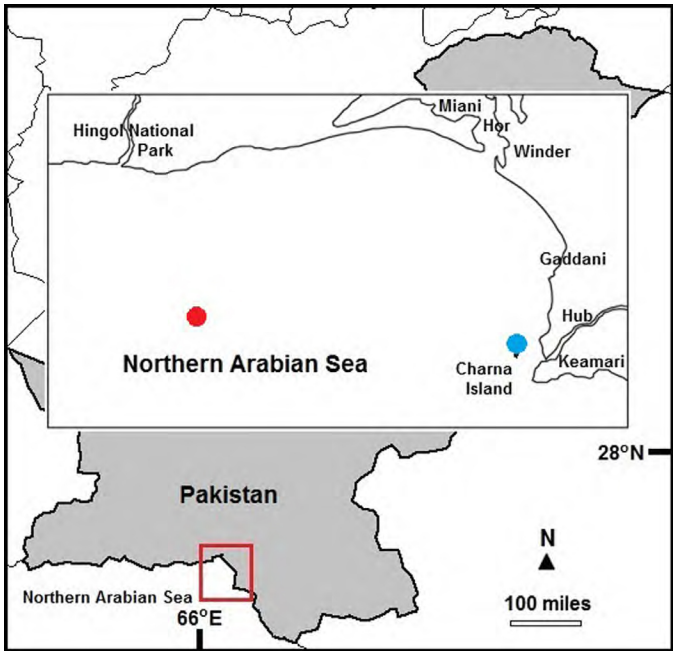

Figure 1. Map showing collection points of *Cephea coerulea* (24°59.03′ N, 065°43.62′ E) (red dot) and *Netrostoma setouchianum* (24°53′56.422″ N, 066°36′15.297″ E) (blue dot) off Pakistani coast, northern Arabian Sea.

mutilated condition. Unfortunately no voucher specimens could be deposited. The voucher photographs of both species (*Cephea coerulea*, CN 15P, and *Netrostoma setouchianum*, CN 16P) were archived in the Museum of Department of Zoology, Jamia Milla Government Degree College (JMGDC/MDZ), Malir, Karachi, Pakistan.

As we had no opportunity to study the canal system, thus the identification of the genera was made on the basis of exumbrellar morphology and subumbrellar appendages, in particular presence or absence of long filaments on the oral arms. We revise the diagnosis of the genus *Netrostoma* to include this feature (long filaments). We include keys that allow easy identification of cepheid genera and valid species of the genera *Cephea* and *Netrostoma*. Identification of the species was based upon their original descriptions (Kishinouye 1902; Vanhöffen 1902), Mayer (1910), and Kramp (1961).

Genus *Cephea* Péron & Lesueur, 1810

Diagnosis (after Kramp 1961): Cepheidae with a protuberances-bearing exumbrellar central dome; with numerous (more than 3) inter-rhopalar canals per octant; with long, pointed filaments on mouth arms.

Cephea coerulea Vanhöffen, 1902

(Figures 2 and 3a–b)

Material examined: 3 specimens, 8 February 2014, off Pakistani coast (24°59.03′ N, 065°43.62′ E), collected by gill netting, approximate bell width 250–300 mm, voucher photograph (JMGDC/MDZ/CN 15P).

Exumbrella with low central dome bearing 6 central, large and 25–30 small to tiny protuberances on the sides. Protuberances round to raised dome-shaped. Deep annular furrow on the exumbrella, *ca.* ¾ away from bell margin. Umbrella thin at the margin with slight indentations forming 7–8 indistinctly developed, greatly fused velar lappets per octant; sometimes markedly differ in width and, flat to oblique at the margins. Rhopalia and rhopalar lappets could not be identified. Oral arms short 1.5 × bell radius, stout, branched; each arm with 2–3 long, slender filaments of different sizes but lacking in some arms. Colour in life: umbrella and oral arms blue with brown ventral surfaces of arms, in good agreement with Vanhöffen's (1902) description.

Remarks: "No marginal lappets" were described for *C. coerulea* (Kramp 1961). Mayer (1910: 657) however, pointed out that "No marginal lappets, but 8 radial thickenings of the gelatinous substance at the margin in each octant".

Genus *Netrostoma* Schultze, 1898

Figure 2. *Cephea coerulea* Vanhöffen, 1902 captured by gill netting off Pakistani coast (24°59.03′ N, 065°43.62′ E), photographed in life (approximate bell width 250–300 mm).

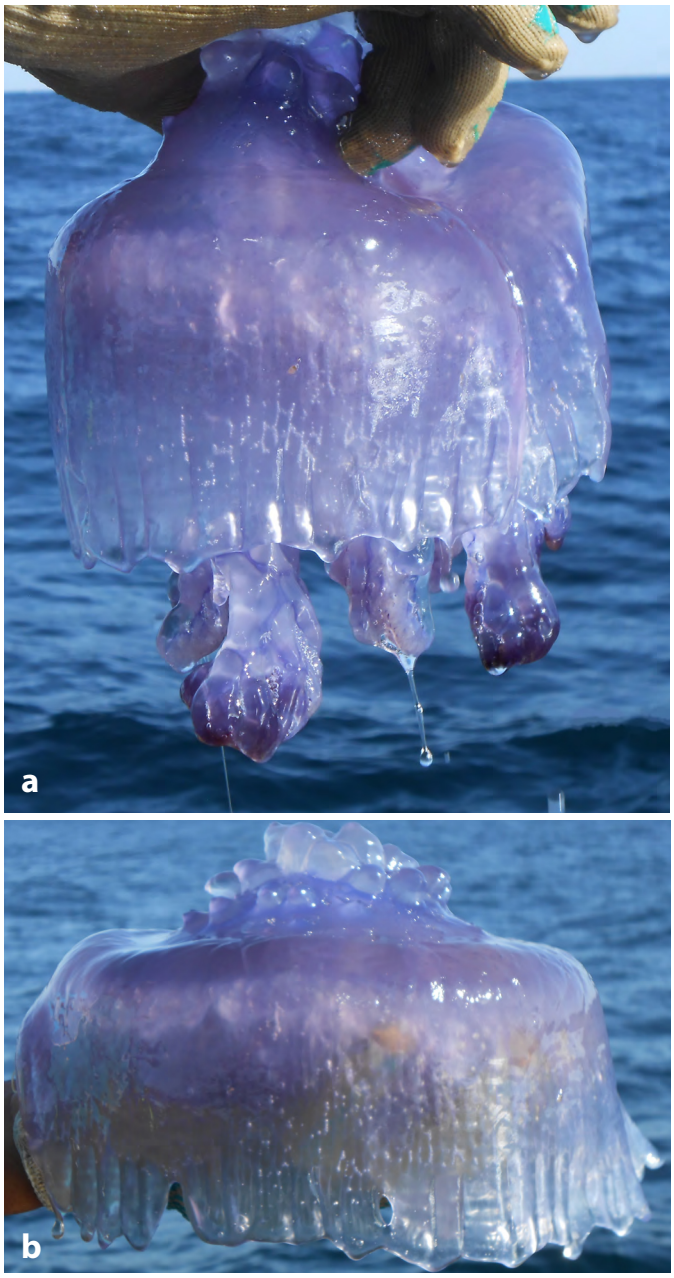

Figure 3. *Cephea coerulea* Vanhöffen, 1902 captured by gill netting off Pakistani coast (24°59.03′ N, 065°43.62′ E), photographed in life (approximate bell width 250–300 mm). **a**: the specimen was held by the exumbrella bell margin, mouth arms, and filaments. **b**: the specimen was held by the subumbrella, the velar lappets and the exumbrellar protuberances are highlighted.

Diagnosis (after Kramp 1961; Gershwin and Zeidler 2008): Cepheidae with a protuberances-bearing exumbrellar central dome or a large, smooth central knob on the exumbrella; with 3 inter-rhopalar canals per octant; mouth arms with or without short, stiff appendages, but no long filaments.

Netrostoma setouchianum (Kishinouye, 1902)
(Figures 4 and 5)

Material Examined: Photographs of 2 specimens (JMGDC/MDZ/CN 16P), 19 December 2010, Charna Island (24°53′56.422″ N, 066°36′15.297″ E), specimens not collected, approximate bell width 150–200 mm.

Exumbrella with low central dome bearing about 10–15 conical, pointed protuberances. Deep annular furrow on the exumbrella, *ca.* ¾ away from bell margin. Umbrella margin with 7 oblong-shaped, round velar lappets per octant. Rhopalia and rhopalar lappets could not be seen. Oral arms short 1.2 × bell radius, stout and branched. The oral arms bear frilled mouth openings with numerous tiny, pointed dark blue short appendages among them and are devoid of any form of long filaments. Colour in life: bright blue as also mentioned by Kishinouye (1902: 13).

Remarks: *N. setouchianum* can be easily distinguished from its congeners due its pointed protuberances on the exumbrellar central dome.

Figure 4. *Netrostoma setouchianum* (Kishinouye, 1902). Specimen observed at Charna Island, off Pakistani coast (24°53′56.422″ N, 066°36′15.297″ E) (photographed by "Divers Reef Karachi"). Note protuberances on exumbrella and absence of filaments on mouth arms, approximate bell width 150–200 mm.

There is no consensus in the literature regarding the validity of the genus *Netrostoma* and its species. The majority of authors consider *Netrostoma* a distinct and valid genus, but Mayer (1910: 651–652) regarded it as a junior synonym of *Cephea* (see also Tokioka 1964: 155). Kramp (1961), however, recognized these two genera distinct from each other based on the number of inter-rhopalar canals per octant and the characteristic subumbrellar appendages. The number of species of *Cephea* and *Netrostoma* is also a matter of dispute. For Stiasny (1937b: 114), *Netrostoma typhlodendrium* is identical to *N. coerulescens*. Based on the literature, we found that the different species of *Cephea* resemble each other more than the ones in the genus *Netrostoma*. The synonyms among *Cephea* species seem to be more established, being valid only two species: *Cephea cephea* and *C. coerulea* (see Stiasny, 1938: 23).

As cepheid medusae are not easy to distinguish, we provide keys to identify the genera of the family Cepheidae and species of *Cephea* and *Netrostoma* using easily recognizable characters.

Figure 5. *Netrostoma setouchianum* (Kishinouye, 1902), closer view of specimen observed at Charna Island, off Pakistani coast (24°53′56.422″ N, 066°36′15.297″ E) (photographed by "Divers Reef Karachi"), note the exumbrellar protuberances, bell margin of umbrella, and mouth arms; approximate bell width 150–200 mm.

Key to genera of Cepheidae (after Kramp 1961; Gershwin and Zeidler 2008; Galil *et al.* 2010):

1a Exumbrella lacking central dome ..... *Marivagia*
1b Exumbrella with a central dome 2
2a Dome smooth without protuberances; mouth arms with stalked suckers ..... *Cotylorhiza*
2b No stalked suckers 3
3a Dome with protuberances; more than three inter-rhopalar canals per octant; mouth arms with long filaments ..... *Cephea*
3b Dome with protuberances or a large, smooth central knob on the exumbrella; three inter-rhopalar canals per octant; mouth arms with or without short, stiff appendages but no long filaments ..... *Netrostoma*

Key to the species of *Cephea* (after Mayer 1910; Kramp 1961):

1a Exumbrella with a large central dome bearing about 30 large, conical, pointed protuberances; 8–9 large, oval velar lappets per octant; numerous (>100) long filaments on mouth arms; 5–6 inter-rhopalar canals per octant ..... *C. cephea*
1b Exumbrella with a dome-like apex bearing 6–8 large and about 30 small, round protuberances; 8 indistinct velar

lappets; 4 long filaments on each mouth arm; 7 interrhopalar canals per octant ..... *C. coerulea*

Key to the species of *Netrostoma* (after Kramp 1961; Gershwin and Zeidler 2008):

1a Exumbrella with a single, large, smooth central knob .....*N. nuda*

1b Exumbrella with a protuberances-bearing central dome 2

2a Two verticils of solid protuberances on the sides of central dome; marginal lappets scarcely distinguishable; no appendages on mouth arms and arm disc ...*N. dumokuroa*

2b Protuberances completely covering the central dome; mouth arms and arm disc with appendages; 6–8 velar lappets per octant 3

3a About 10 wart-like protuberances on the central dome *N. coerulescens*

3b Fifty or more pointed protuberances on the central dome .....*N. setouchianum*

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