



Crustacean Fauna in Association with Common Algae of Karachi Coastal Waters

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ABSTRACT

Aspects of the structure (species composition and relative abundance, species associations and interactions, habitat preferences, species diversity and abundance relationships) of algal crustacean assemblages have been investigated from a range of algal types collected in clear Manora and Buleji waters. A total of 23 crustacean species were separated from algae at both the sites. Significant positive correlations between species were detected.

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Authors' Contribution

EE designed methodology of the study. QBK worked on ceptualization, writing and editing. FG finalized the manuscript. SQ collected the data.

Key words

Algae, Crustacean, Karachi coast, Amphipods, Isopods, Copepods, Ostracods, Crustaceans, Brachyurans, Cumaceans, Tanaidaceans

INTRODUCTION

Plant-animal relationships are attracting the attention of marine biologists for a long time. It is observed that food ingested by a grazer may affect the animal's growth and reproduction (Nicotri, 1977; Vadas, 1977) while the herbivores may affect the diversity, biomass and distribution of marine plants (Lubchenco, 1978; Raffaelli, 1979). Plants are also used by animals as refuge from predators and desiccation. The coastal areas of Karachi offer a variety of sandy beaches, rocky ledges, swampy wetlands and few islands. They are inhabited by a variety of marine benthic algae (Shameel and Tanaka, 1992; Shameel, 2001, 2002, 2008, 2012). Pakistan presents a unique opportunity for phycological studies of the various avenues of researches in this direction (Valeem, 2004; Valeem and Shameel, 2008), the most fascinating and useful investigation is the study of algal association with marine fauna (Warmke and Almodovar, 1963; Lewis, 1984). To date, some studies on plant-animal relationship

are found in Pakistan: Zehra *et al.* (1995a) conducted a study on molluscan epifauna on marine algae of Karachi. Zehra *et al.* (1995b) studied epifauna and monsoons on *Sargassum virgatum*. Biomass of animals and seaweeds was studied by Ahmed and Hameed (1999). Ghani and Nawaz (2000) investigated algal associated fauna of Manora mangroves. Barkati and Rahman (2005) likewise studied Sandspit, Clifton and Port Qasim mangroves for fauna including fauna of seaweeds found there. Baig and Zehra (1997, 2002, 2006) consecutively worked on seasonal variation of *Caulerpa* sp. and *Sargassum* sp. and associated faunas. Kazmi (2016) in a compendium on symbiotic crustaceans of Pakistan reported 270 symbiotic aquatic Crustacea from Pakistani area, of which at least 30 are algal associated. The present analysis was under taken based on the crustacean species associated with all the common algae found on the rocky shores of Manora and Buleji by Sadiq (1994). During this study of one year (June 1990 to May 1991), 22 algal species were studied from the two collection sites. Besides crustaceans, the remaining groups were molluscs, polychaete worms, foraminiferans, nematodes, pycnogonids, bryozoans, cnidarians, ticks and mites, brittle stars, and starfish.

The rocky shores of Manora and Buleji have a fairly rich algal growth confining to three main types: Chlorophycota (green algae), Phaeophycota (brown algae) and Rhodophycota (red algae). The most common algae seem to be *Padina pavonica* and *Stockeyia indica* at Manora, whereas *Ulva fasciata* and *Sargassum virgatum* are common

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at Buleji. *Sapathoglossum variabile*, *Hypnea musciformis*, *Laurencia obtusa*, *Gracilaria andersonii*, *Iyengaria stellata* and *Endarachne binghamiae* are less commonly found.

The material under study shows a predominance of crustaceans, which represents 70-80 % of the associated fauna in a given sample. The frequency of occurrence of crustacean groups is in the following descending order: Amphipoda, Isopoda, Copepoda, Tanaidacea, Ostracoda, Cumacea, Brachyura and Caridea. The same data with updated taxonomy and comparison is utilized here.

MATERIALS AND METHODS

During the study period from June 1990 to May 1991 monthly algal collections were obtained from Manora and Buleji at low tide. The non-random sampling was due to the patchy distribution of the plants. It was further noted that several species of algae grew side by side and that green and brown algae were mixed. Care was taken to obtain each species separately. During the study, salinity varied from 35 to 38‰ [T1]. At both collection sites, with a monthly mean at Buleji (35.5‰) [T2] somewhat lower than at Manora (36‰) [T3]. Water temperature at the two sites also varied from 22 to 30°C with a monthly mean at Buleji (24°C) slightly lower than at Manora (25°C). The pH was similar at both collection sites ranged from 5 in November 1990 to 7 in April 1991.

Algal assemblages at both sites were quantified by the quadrat (1 ft. sq) sampling technique with five samples per site per sampling date. Algal abundance varied seasonally at both the collection sites (Table 1). For each month, the crustacean occurrence and density of crustaceans is shown with the help of histograms. The relative abundance of epifaunal crustaceans to a particular alga was also studied. The known species are mostly illustrated and supported with brief note on each one.

RESULTS

COPEPODA

1. *Sacodiscus littoralis* (Sars, 1904) (Fig. 1a).

Material and measurements: Very abundantly found. Females: 1.0 - 1.3 mm, Males: 0.5 - 0.75 mm.

Colour: Golden yellow

Habitat: Lives on *Sargassums wartzii*, *Padina pavonica*, *Petalonia binghamiae*, *Stockeyia indica*, *Iyengaria stellata*, *Colpomenia sinousa*.

2. *Metamphiascopsis hirsutus* (Thompson and Scott, 1903)

(Fig. 1b)

Material and measurements: Large numbers of females only, measuring 1.0 - 1.3 mm.

Colour: Pale yellowish or bluish grey.

Habitat: This species is found on all types of the algae, more commonly on: *Padina pavonica*, *Iyengaria stellata*, *Colpomenia sinousa*, *Stockeyia indica*, *Laurencia obtusa*, and *Sargassums wartzii*.

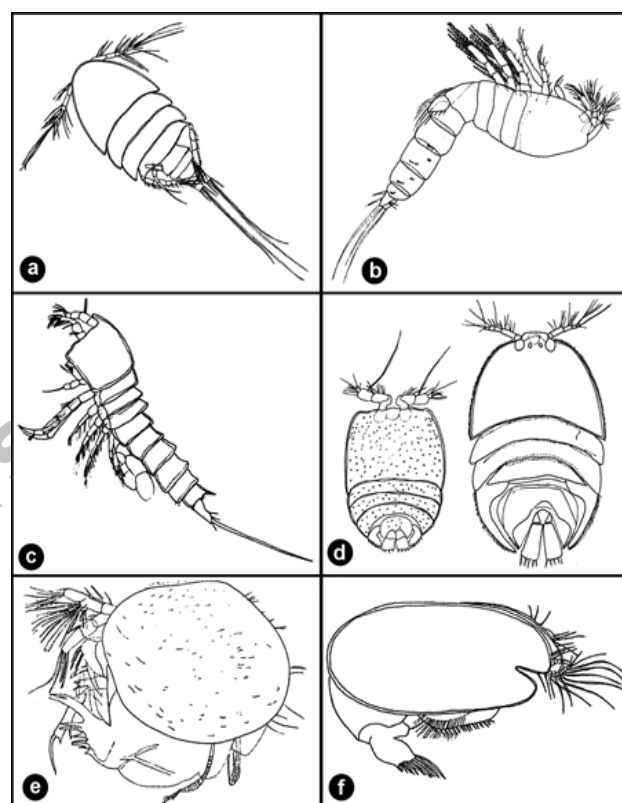


Fig. 1. a, *Sacodiscus littoralis* (Sars, 1904) Female 1.2 mm entire specimen, dorsal view; b, *Metamphiascopsis hirsutus* (Thompson and Scott, 1903). Female 1.3 mm. entire specimen, lateral view; c, *Laophonte cornuta* Philippi, 1840. Female 1mm entire specimen, lateral view; d, *Porcellidium fimbriatum fimbriatum* Claus, 1863. Male 0.5 mm. entire specimen, dorsal view; Female 0.7 mm entire specimen, dorsal view; e, *Ancohenia robusta* (Brady, 1890). Male length 1.5 mm, height 0.80 mm; f, *Cylindroleberis bacescui* Kornicker and Caraion, 1974. Female length, 4.0 mm, height, 1.7 mm.

3. *Laophonte cornuta* Philippi, 1840 (Fig. 1c)

Material and measurements: Not very common. Females: 0.8 mm - 1.0 mm, Males: 0.6 - 0.9 mm.

Habitat: Found on *Colpomenia sinoua*, *Sargassum virgatum*, *Ulva fasciata*, *Caulerpa taxifolia* *Iyengaria stellata* and *Padina pavonica*.

Remark: Since only males are known from *A. robusta* (Churchill *et al.*, 2014) the present females will be the first ever reported.

2. *Cylindroleberis bacescui* Kornicker and Caraion, 1974 (Fig. 1f)

Material and measurements: A large series of females only. Length, 2.5 - 4.0 mm, height, 0.55 - 1.7 mm.

Colour: Bluish purple.

Habitat: Lives on most of the algal species.

AMPHIPODA

1. *Protohyale (Boreohyale) rubra* (Thomson, 1879) (Fig. 2a)

Material and measurements: Large number of males only, measuring: 9.5 - 11mm.

Colour: Pale yellow.

Habitat: Lives on *Padina pavonica*, *Colpomenia sinoua*, *Stockeyia indica*, *Sargassum virgatum* and *Ulva fasciata*.

2. *Apothyale ayeli* (Barnard, 1955) (Fig. 2b)

Material and measurements: Very commonly found. Females: 9.5 -10.5 mm, Males: 7.2 -8.5 mm.

Colour: Brownish yellow.

Habitat: Lives on all types of algae, more commonly on *Stockeyia indica*.

3. *Cymadusa filosa* Savigny, 1816 (Fig. 2c)

Material and measurements: Extremely abundant. Females: 11.0 - 13.0 mm, Males: 10.5 - 12.5 mm.

Colour: Dark reddish brown.

Habitat: Found on all types of algae most common on brown algae: *Iyengaria stellata*, *Padina pavonica*, *Stockeyia indica*, *Colpomenia sinoua* and *Sargassum virgatum*, *Cymadusa filose* constructs open-ended, uniform diameter cylindrical tubes using amphipod silk, to bind together faecal pellets, detritus and fronds of *Sargassum*.

Remark: *Cymadusa filosa*, long been considered a polymorphic, pantropical species, is in fact a species complex, and this situation has confused the generic concept. *C. filosa* name has been misapplied to some other species (Peart, 2004).

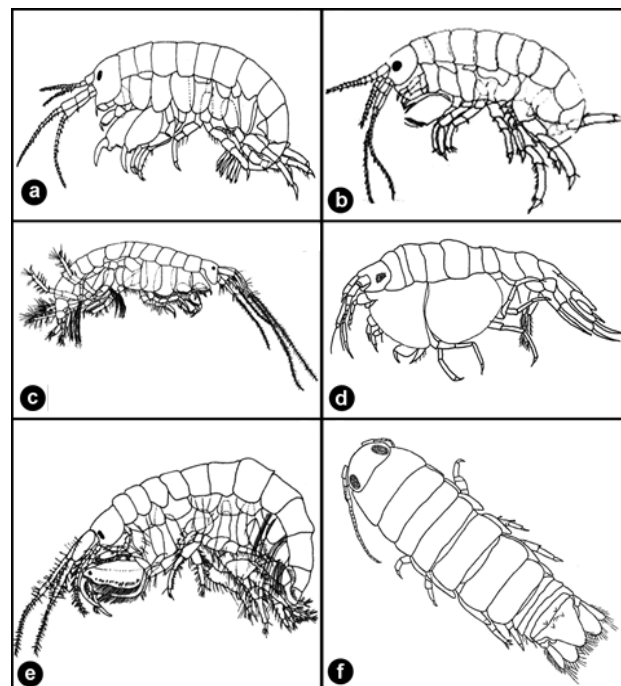


Fig. 2. a, *Atarbolana setosa* Javed and Yasmeen, 1989. Male 8.5 mm. entire specimen, dorsal view; b, *Paranthura latipes* Barnard, 1955. Male 7.0mm entire specimen, dorsal view; c, *Paracilicæa keijii* Javed, 1990. Male 11 mm. entire specimen, dorsal view; d, *Synidotea indicus* Javed and Yasmeen, 1994. Male 15mm. entire specimen, dorsal view; e, *Paraimene tuberculata* Javed and Roshan, 1988. Male 3.5 mm. entire specimen. dorsal view; f, *Bodotria arenosa* Goodsir, 1843. Male 3.2 mm, entire specimen, lateral view.

4. *Cyproidea ornata* Haswell, 1879 (Fig. 2d)

Material and measurements: Small number of males only measuring: 2.5 - 6.0 mm.

Colour: Brilliant yellow and black color.

Habitat: Found on *Stockeyia indica*, *Sargassum virgatum*, *Sargassum swartzii* and *Iyengaria stellata*.

5. *Elasmopus pecteniscrus* (Bate, 1862) (Fig. 2e)

Material and measurements: Numerous specimens. Females: 10 - 12.2 mm, Males: 7.5 - 10.5 mm.

Colour: Golden yellow.

Habitat: Lives on all types of algae, more commonly on *Caulerpa racemosa*, *Stockeyia indica*, *Ulva fasciata* and *Padina pavonica*.

6. *Hemiaegina minuta* Mayer, 1890

Material and measurements: Numerous specimens.
Females: 5.3 - 9.2 mm, Males: 6.1 - 10.5 mm.
Colour: Golden yellow.
Habitat: Lives on all types of algae.

7. *Pseudocaprellina pambanensis* Raj, 1927

Material and measurements: Numerous specimens.
Females: 4.4 - 5.7 mm, Males: 5.6 - 9.5 mm.
Colour: Pale cream.
Habitat: Lives on all types of algae.

ISOPODA

1. *Cirolana manorae* Bruce and Javed, 1987
(Fig. 2f)

Material and measurements: Not very abundant. Females:
7.5 - 10.0 mm, Males: 8.5 - 11.8 mm.
Colour: Pale tan.
Habitat: Lives on *Sargassum swartzii*, *Padina pavonica*,
Ulva fasciata, *Colpomenia sinousa*, *Stockeyia indica* and
Laurencia obtusa.

2. *Atarbolana setosa* Javed and Yasmeen, 1989
(Fig. 3a)

Material and measurements: Most abundant. Females: 4.9 -
5.3 mm, Males: 5 - 8.5 mm.
Colour: Pale cream.
Habitat: Found on all types of algae.

3. *Paranthura latipes* Barnard, 1955
(Fig. 3b)

Material and measurements: Rare, represented by males
only measuring: 5.0 - 7.2 mm
Colour: Pale cream.
Habitat: Lives on *Halimeda tuna*, *Stockeyia indica*,
Caulerpa taxifolia, *Chaetomorpha antenna* and *Bryopsis*
plumosa.

4. *Paracilicæa keijii* Javed, 1990
(Fig. 3c)

Material and measurements: A large series. Females: 5 - 8
mm, Males: 7.5 - 11.5 mm.
Colour: Reddish orange.
Habitat: Found on all types of algae.

5. *Synidotea indica* Javed and Yasmeen, 1994
(Fig. 3d)

Material and measurements: Extremely abundant.
Females: 8 - 14 mm, Males: 10 - 19 mm.
Colour: Brown with dark brown dots.
Habitat: Found on all types of algae; most commonly on
Stockeyia indica.

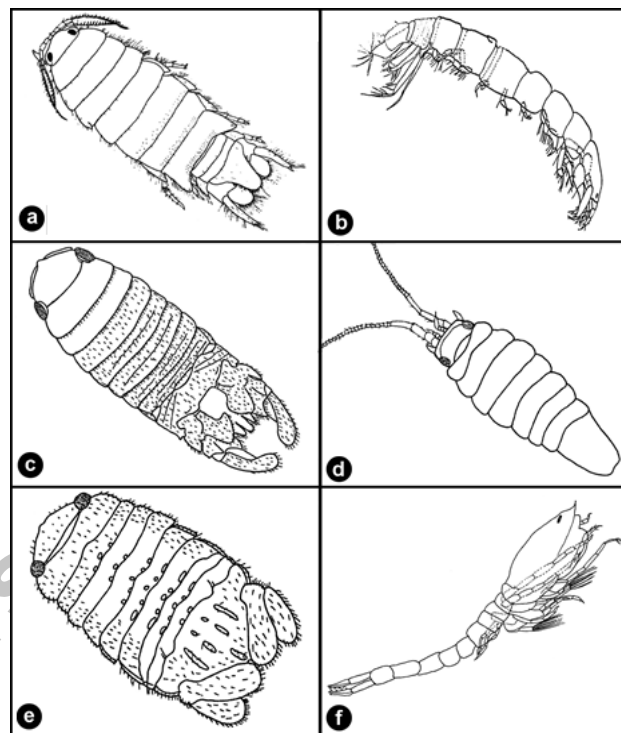


Fig. 3. a, *Protohyale (Boreohyale) rubra* (Thomson, 1879). Male 10.5 mm. entire specimen, lateral view; b, *Apohyale ayeli* (Barnard, 1955). Male 8mm, entire specimen, lateral view; c, *Cymadusa filosa* Savigny, 1816. Male 12.5mm, entire specimen, lateral view; d, *Cyproidea ornata* Haswell, 1879. Male 4.0 mm. entire specimen, lateral view; e, *Elasmopus pectinicus* (Bate, 1862). Male 8.5 mm. entire specimen, lateral view; f, *Cirolana manorae* Bruce and Javed, 1987. Male 11 mm. entire specimen, dorsal view.

6. *Paraimene tuberculata* Javed and Ahmed, 1988
(Fig. 3e)

Material and measurements: Found in large numbers.
Females: 2.5 - 3.2 mm, Males: 3 - 3.8 mm.
Colour: Pale cream.
Habitat: Found on *Ulva fasciata*, *Stockeyia indica*,
Sargassum swartzii, *Padina pavonica*, *Codium Iyengarii*
and *Colpomenia sinousa*.

CUMACEA

1. *Bodotria arenosa* Goodsir, 1843
(Fig. 3f)

Material and measurements: Most common. Females: 2.1 - 4.0 mm, Males: 3.0 - 5.2 mm.

Colour: Off white.

Habitat: Lives on all types of algae, more commonly on *Colpomenia sinoussa*, *Padina pavonica* and *Ulva fasciata*.

TANAIDACEA

1. Tanaid sp. undet. (Fig. 4a)

Material and measurements: Not very common.

Habitat: Lives on *Ulva* sp.

Remarks: Typical Tanaid, small and slender, with distinct black-pigmented eyes. To distinguish between species of Tanaid is notoriously difficult (Larsen, 2002; Larsen and Froufe, 2013). Polymorphic males and ontogenetic variation present the most serious problems as regards intra-specific variation, while females display a cryptic nature in almost all species.

BRACHYURA

1. *Acanthonyx inglei* Tirmizi and Kazmi, 1988 (Fig. 4b)

Material and measurements: Very abundant. Females: cl. 3.0 - 20 mm, cb. 1.8 - 15 mm, Males: cl. 5.0 - 25 mm, cb. 3.0 - 17 mm.

Colour: Colour matches to algae from brown to olive green; small specimen off white.

Habitat: Lives on *Ulva fasciata*, *Caulerpa taxifolia*, *Padina pavonica*, *Sargassum virgatum*, *Spathoglossum variabile*, *Gracilariopsis andersonii*.

2. *Acanthonyx limbatus* Milne-Edwards, 1862 (Fig. 4d)

Material and measurements: Found in small numbers. Females: cl. 4.5 - 9.0 mm, cb. 3.0 - 7.0 mm, Males: cl. 6.0 - 11 mm, cb. 4.2 - 9.5 mm.

Colour: According to colour of algae from brown to green.

Habitat: Lives on *Ulva fasciata*, *Sargassum virgatum*, *Padina pavonica*, *Sargassum swartzii*, *Stockeyia indica*, *Spathoglossum variabile* and *Colpomenia sinoussa*.

CARIDEA

1. *Hippolyte ventricosa* Milne-Edwards, 1837 (Fig. 4c)

Material and measurements: A small number of females

only measuring cl+r 4 - 5 mm.

Colour: Green or dark brown, according to the colour of algae.

Habitat: Lives on *Bryopsis plumosa*, *Padina pavonica*, *Stockeyia indica*, *Spathoglossum variabile* and *Sargassum swartzii*.

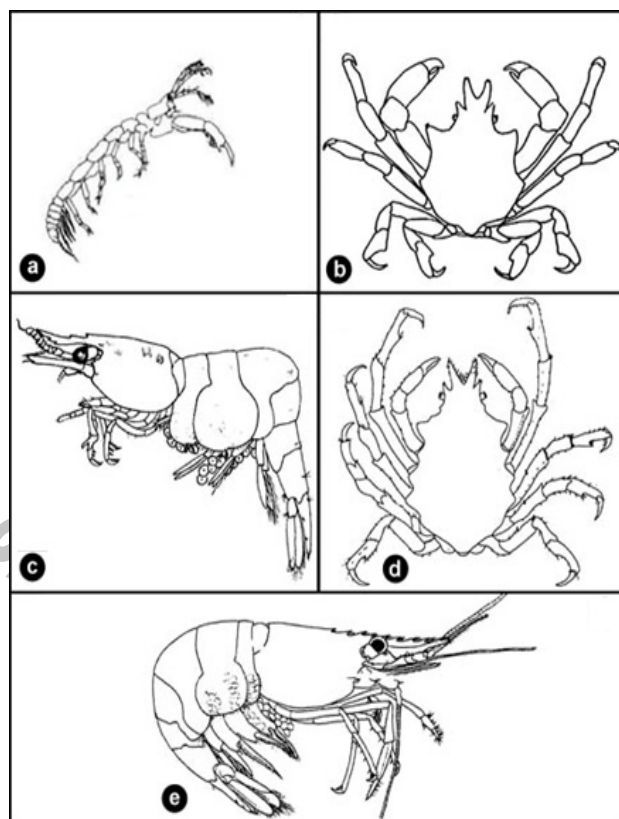


Fig. 4. a, Tanaid sp.; b, *Acanthonyx inglei* Tirmizi and Kazmi, 1988. Male cl. 20 mm, cb. 13 mm; c, *Hippolyte ventricosa* H. Milne Edwards, 1837. Ovipigerous female 5.3 mm in carapace length, lateral view; d, *Acanthonyx limbatus* A. Milne Edwards, 1862. Female el. 9.0 mm, cb. 7.0 mm; e, *Palaemon pacificus* (Stimpson, 1860). female 22mm in carapace length, lateral view.

2. *Palaemon pacificus* Stimpson, 1860 (Fig. 4e)

Material and measurements: Small numbers of females: cl+r. 3.2 - 4.5 mm.

Colour: Red colour with pinkish dots.

Habitat: Lives on *Codium iyengarii*, *Ulva fasciata*, *Padina pavonica* and *Sargassum virgatum*.

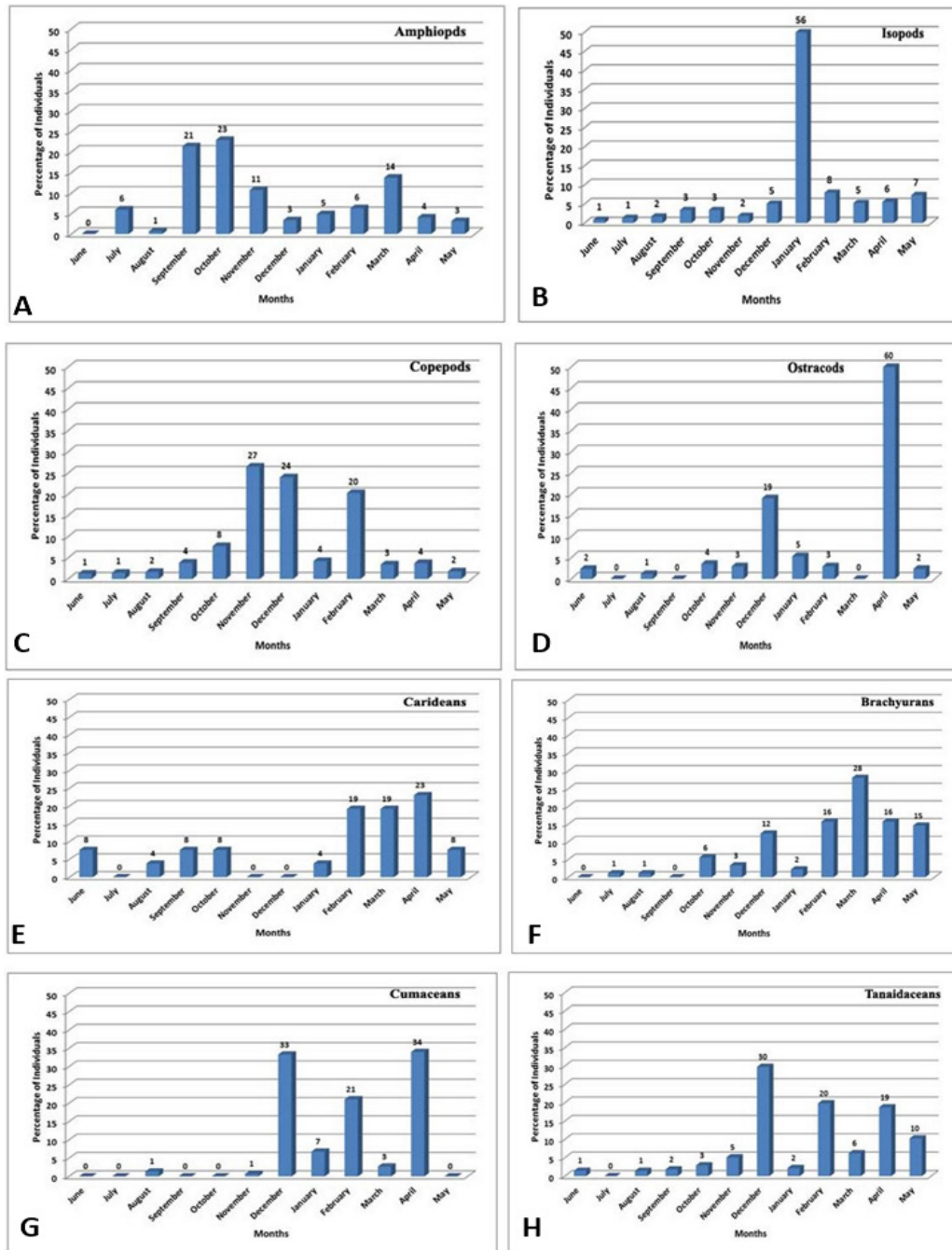


Fig. 5. Monthwise abundance of amphipods (A), isopods (B), copepods (C), ostracods (D), carideans (E), brachyurans (F), cumaceans (G), tanaidaceans (H) on algal species in Buleji.

DISCUSSION

Species composition and relative abundance of crustacean fauna differed in the various algae (Table II). It was noted that basically a similar suite of crustaceans occurred on all plant species, faunal differences seen

among algae were, however, due to the differences in the relative abundance of individual species on a particular organism.

The large size of seaweeds were collected during winter (present study), this may be one of the reason of abundant epifauna in winter found by Zehra *et al.* (1995).

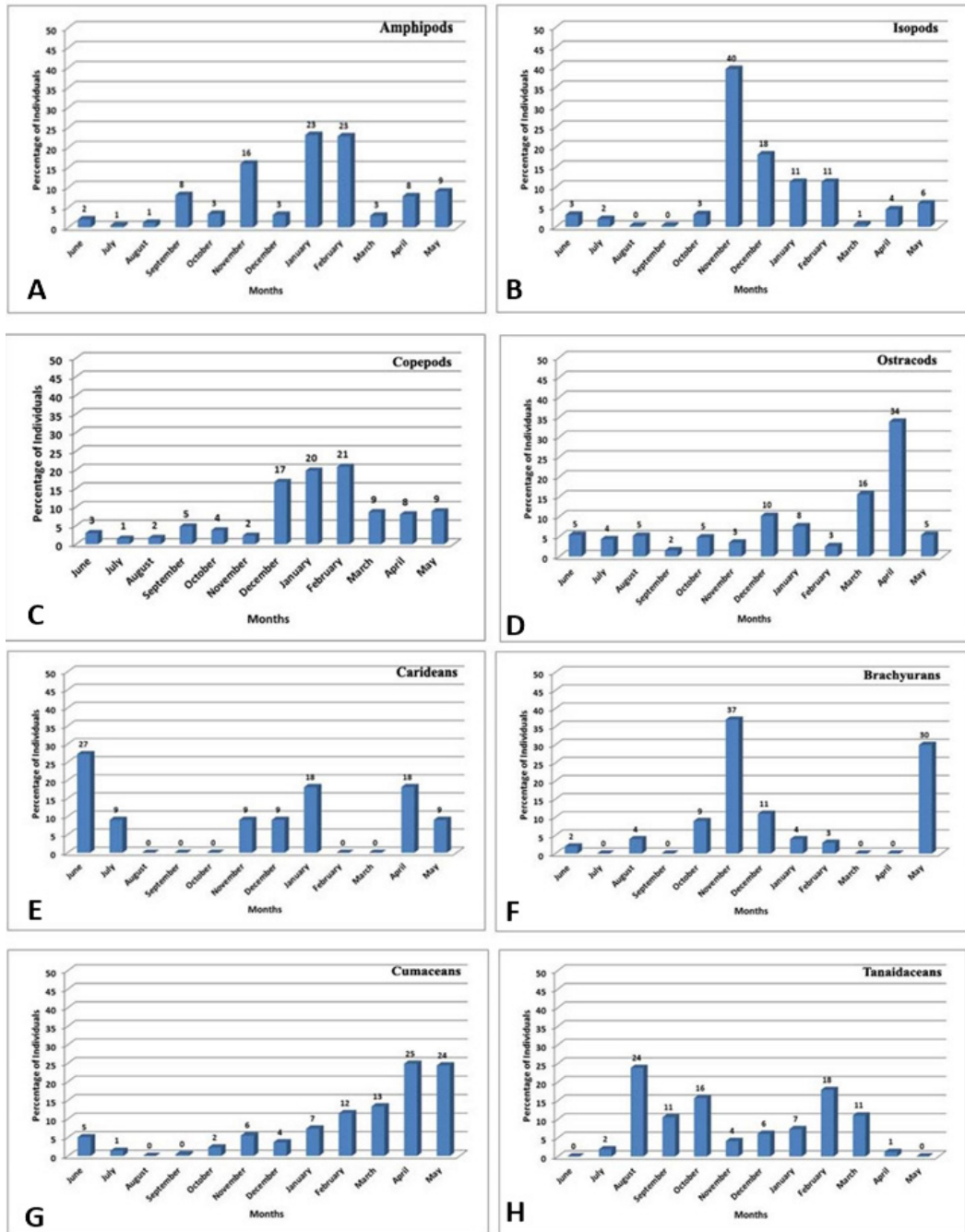


Fig. 6. Monthwise abundance of amphipods (A), isopods (B), copepods (C), ostracods (D), carideans (E), brachyurans (F), cumaceans (G), tanaidaceans (H) on algal species in Manora.

The present studies show that amphipods, which formed the major bulk of the algal fauna being 36 and 59% at Manora and Buleji, respectively, also exhibited the greatest differences in algae (Figs. 5, 6). A few crustacean sp. showed strong algal preference. Maximum number of amphipod species occurred on *Stockeyia indica* and

Odonthalia washingtonensis, eight species could be identified out of which six species at Manora and Buleji (Fig. 5a, 6a). *Cymadusa filosa*, *Elasmopus pectinicus*, *Pseudocaprellina pambensis* and *Hemiaegina minuta* were the most common on all types of algae, *Cyproidea ornata* was found mostly on *Sargassum virgatum* and *Stockeyia*

indica; *Hemiaengia minuta* occurred on *Halimeda tuna*, *Sargassum virgatum* and *Stockeyia indica*. For *C. filosa* the most common algal habitats were *Sargassum dentifolium* and *Cystosaira crinite* in the Red Sea (El-Sayed *et al.*, 2014).

The isopods showed striking differences of 42 and 5 % in algal fauna at Manora and Buleji respectively (Fig. 5b, 6b); four isopods: *Synidotea indicus*, *Atarbolana setosa*, *Cirolana manorae* and *Paraimen tuberculata* were common on all types of algae. *Paranthura latipes* was less frequently found on the algal samples. Relative abundance of isopods on *Stockeyia indica*, *Padina pavonica* and *Caulerpa taxifolia* were higher than found on other algal samples.

Copepods were the next most common group comprising 25 and 38% of the total algal fauna at Manora and Buleji, respectively (Fig. 5c, 6c). Four copepods *Sacodiscus littoralis*, *Laophonte cornuta*, *Porcellidium fimbriatum fimbriatum* and *Metamphiascopsis hirsutus* were most common and found abundantly on all types of algae.

Ostracods comprised 0.72 and 0.25 % of the algal fauna at Manora and Buleji, respectively (Fig. 5d, 6d), had the highest differences among plants. *Cylindroleberis bacescui* and *Ancohenia robusta* both were abundant on all the algae.

Carideans were found in abundance (60 %) in the month of April at Buleji, 27% in the month of June at Manora (Fig. 5e, 6e); brachyurans 28% in the month of march at Buleji, 37% in November at Manora (Fig. 5f, 6f); cumaceans 34% in the month of April at Buleji, 25% in the month of May at Manora (Fig. 5g, 6g); and tenaidaceans were found in abundance (30 %) in the month of December at Buleji while 24 % during the month of August were found at Manora respectively (Fig. 5h, 6h). Tanaidaceans had low relative abundance of 0.66 and 0.38% at the two collection sites.

Statement of conflict of interest

The authors have declared no conflict of interest.

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