Occurrence of Sea Lice *Caligus epinepheli* Yamaguti, 1936 (Copepoda: Siphonostomatoida) on Gills of *Nemipterus japonicus* (Bloch, 1791) from North West of the Arabian Gulf

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Abstract. A total of 188 fish samples of *Nemipterus japonicus* (Bloch, 1791) were collected from north west of the Arabian Gulf (latitudes 48° 44′ to 48° 46′; longitude 29° 46′ to 29° 47′) during the period from January 2011 till January 2012. The copepod *Caligus epinepheli* Yamaguti, 1936 was recorded from the gills during most months of the year. Descriptions of adult parasites and chalimi (larval stages of the parasites) were included. Females body length range was 1.38-2.55 (2.16) mm. Egg sac length 0.99-1.80 (1.31) mm, the number of eggs ranged from 13-22 (17) in each egg sac. The range of the males body length was 1.45-1.73 (1.59) mm. Statistical analysis showed no significant differences in the infestations of both sexes of the host (except in fish group with body length 18-21cm.).The highest incidence of infestation was recorded during March and June (57.1%), while the lower level of infestation was recorded during December (7.6%). The high intensity of infestation was recorded during April (10), while the lowest intensity of infestation was recorded in December (1).

Key words: Copepoda, Caligidae, Chalimi, *Nemipterus japonicus.*

Introduction

The Arabian Gulf is an unique arm of the sea with its entrance to the gulf of Oman, and of limited circulation to the open sea (27). Many important commercial fishes are dominant in the gulf (22). Although there are critical fluctuations in the temperature and salinity during the year (27), there are many threats, facing both fish capture and culture, from which the parasites are the most significant. Parasitic copepods are very common on cultured and wild marine fishes (15). When there is a development of aquaculture, the importance of parasitic copepods as disease causing agents has become more evident. Caligiform copepods (also known as sea lice) are economically important parasites in aquaculture (20). Such parasites infesting a wide range of fish species in the coastal and estuarine zones (17). Purivirojkul and Arcechon (26), stated that the family Caligidae currently accommodate 33 genera, of which 75% are members of *Caligus* (239 spp.). 40% of the major groups of parasitic copepods reported from fish culture in brackish and marine waters around the world, were species of *Caligus* (15).

Sea lice are regarded as having the most damaging effect on cultured fish; they affect fish in a variety of ways, by reducing growth, causing loss of scales that leaves the fish open to secondary infection, and damaging the fish that reduce its marketability (23). Only few

studies were carried on the parasitic copepods of the Arabian Gulf (18; 29; 19; 1; 11; 3; 4; 5; 16). *C. epinepheli* was poorly reported from *Nemipterus tolu* (Valenciennes, 1830) and *N. delagoae* Smith, 1941 in the region (11). This parasite was firstly reported by Yamaguti from the gills of *Epinephelus septemfasciatus* (Thunberg, 1793) in Japan (7). Recently *C. epinepheli* was recorded from different localities and hosts around the world (24).The adult *C. epinepheli* may cause minor tissue damaged, but this infestation lead to development of secondary infections and great fish losses in sea and estuarine fish cages (14).

Material and Methods

The fish were collected monthly from the north west of the Arabian Gulf about 26 km south of the mouth of Shatt Al-Arab River, during the period from January 2011 to January 2012. The collection region is a part from the Gulf between latitudes 48° 44′ to 48° 46′ and longitudes 29° 46′ to 29° 47′ (Fig. 1). A total of 188 fish specimens *Nemipterus japonicus* (Bloch, 1791), were caught by a trawl net, kept in plastic bags with a small amount of water on ice in icebox (25; 8).

Fish were transferred to the laboratory, where the fish examinations were carried out as soon as possible. Fish were weighted (gm), measured for total length (cm). Large parasites were collected prior to the microscopically examination. Fish specimens were examined microscopically for the presence of small parasites, the gills were separated in a petri dishes with a small amount of water and examined under dissecting microscope, then the fishes were opened to detect the sex.

The copepod parasites were preserved in 70% ethanol, washed in 5% sodium hypochlorite to remove host tissue, and cleared in 85% lactic acid for 1 to 2 h. Parasite were dissected in a drop of lactic acid on a modified glass slide instead of the wooden slide which was conducted by Humes and Gooding (12). The dissected parasites and appendages were examined, measured in mm (otherwise mentioned) and drew using camera lucida fixed on compound microscope. Parasitological terms were used according to (21).

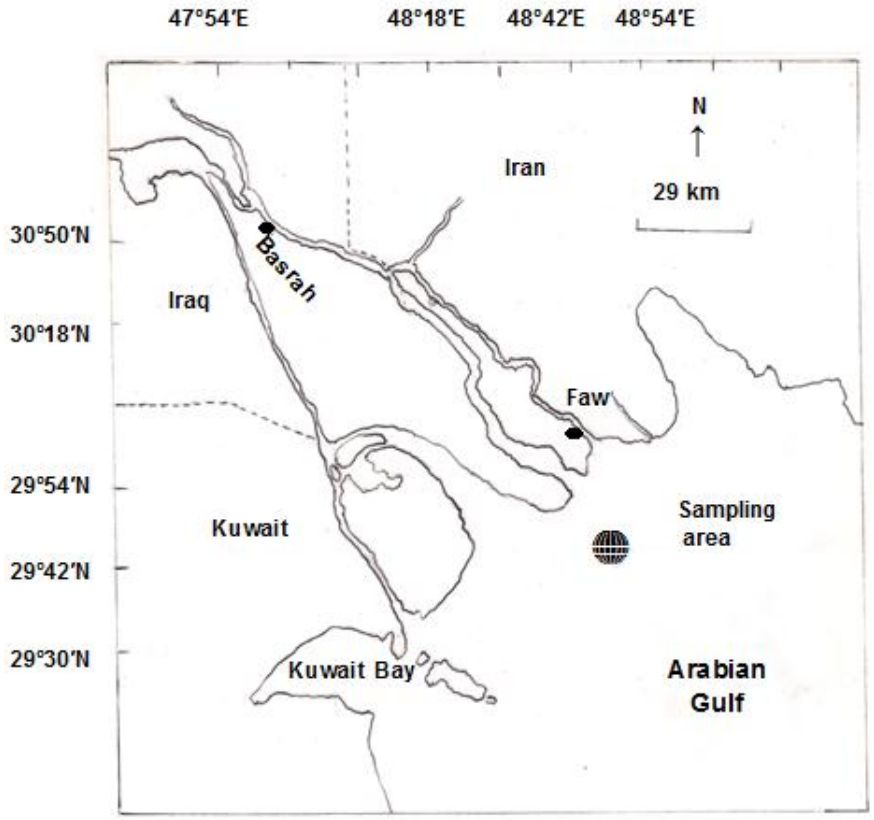

Fig. 1: A map showing sampling area.

Results and discussion

Descriptions of *C. epinepheli* Yamaguti, 1936

Female (Based on 10 ovigerous females): Body (Fig. 2 A) 1.38-2.55 (2.16) long, from the tip of the head to the base of the caudal rami. Cephalothorax shield 1.0 (0.90 - 1.11) long and 0.80-0.99 (0.90) wide excluding lateral hyaline membranes. Genital complex 0.68-0.86 (0.76) mm. long and 0.50-0.74 (0.59) wide. Abdomen 0.37-0.57 (0.47) long and 0.18-0.24 (0.19) wide. Caudal ramous longer than wide (81 x 54µ), armed with three short and three long seta. Egg sac 0.99-1.8 (1.31) long with 13-22 (17) egg/ sac. Antennule (Fig. 2 G) two segmented, proximal segment with 27 plumose setae, distal segment rod-shape, with one sub terminal setae and 11 setae plus aesthetics on distal margin. Antenna (Fig. 2 B) three segmented, proximal segment with posteromedial spine bearing a serrated membrane, middle segment sub rectangular, distal segment curved claw, bearing one basal and marginal setae. Antennule (Fig. 2 C) two segmented, proximal segment with 27 plumose setae, distal segment rod-shape, with one subterminal seta and 11 setae plus aesthetics on distal margin. Postantennal process (Fig. 2 D) hook like, carrying two basal papillae with setules. Another four setules bearing papillae located nearly on sternum. Mandible (Fig. 2 E) elongated, four segmented, with teethed distal blade. Maxillule (Fig. 2 F) pointed with serrated membrane, and a basal papilla with three setae. Maxilla (Fig. 2 G) two

segmented, proximal segment large unarmed, distal segment slender in shape with sub terminal hyaline membrane on outer edge and two elements at terminal end. Maxilliped (Fig. 2 H) three segmented proximal segment stout broad and unarmed, middle and distal segments fused to form a strong claw, with 1 medial setae. Sternal furca (Fig. 2 I) curved horseshoe like, hyaline membrane on outer margin extending around tip distal portion of medial margin.

Armature on rami of legs 1-4 as follows (Roman numerals indicating spines and Arabic numerals indicating setae:

	Exopod	Endopod
Leg 1	1-0; III,1	(rudimentary)
Leg 2	I-1; I-1; I,I,I,5	0-1; 0-2; 6
Leg 3	I-0; 1-I; 3,4	0-1; 6
Leg 4	I-0; I,III	(missing)

Leg 1 (Fig. 2 J) Basis with patch of spinules, one long outer plumose setae, one short inner plumose setae and outer papilla with two setules. Endopod a small knob. Exopod two segmented. First segment with inner row of setules and one small setae. First exo-distal segment with four terminal elements, the two in the middle are shorter, both with an accessory process, Pectin at base of three outer terminal elements. Leg 2 (Fig. 2 K) Biramous, coxa small with one dorsal long plumose setae and one ventral setule. Basis with one small simple setae and a setule by the base marginal membrane. Both exopod and endopod are three segmented. Each outer segment bears one spine, the first is the longer, and with pectin at its base. Both first and second endopod segments with row of setules on outer margin.

Leg 3 (Fig. 2 L) is a fused, expanded protopod (apron), with patches of spinules and marginal hyaline membrane. Leg 4 (Fig. 2 M), small protopod with single, short plumose outer setae, basis of all elements on both segments of leg 4 are pectinized. Leg 5 (Fig. 2 N), on the posterolateral corner of genital segment, with two papillae, the first one bears one plumose setae, while the second bears two plumose setae.

Male (Based on Six adult males): Body (Fig. 3 A) 1.45-1.73 (1.59) long from the tip of the head to the base of the caudal rami. Cephalothorax shield 0.81-0.99 (0.86) long and 0.66 - 0.88 (0.76) wide excluding lateral hyaline membrane. Genital complex (Fig. 3 B) 0.32-0.38 (0.36) long and 0.21-0.25 (0.23) wide. Abdomen 0.22-0.36 (0.26) long and 0.13-0.24 (0.61) wide. Caudal ramous same as in the females, Sternal furca (Fig. 3 C) curved horseshoe like. Antennule same as in the females. Antenna (Fig. 3 D) three segmented, proximal segment small and unarmed, middle segment largest, with three corrugated pads, terminal segment smallest, with two setae and four pointed lamellae. Postantennal process (Fig. 3 E) strongly curved. Maxilliped (Fig. 3 F) three segmented, proximal segment (corpus) very large, with conical projection on medial inner surface, middle segment (shaft) and terminal segment (claw) united to form a hook with one inner spiniform setae on the inner surface. Leg 5 (Fig. 3 G) located on posterolateral corner of the genital complex, with three small plumose setae. Leg 6 one small seta on

the posterior ventral surface of the genital segment.

Larval stages: Chalimi (Fig. 4) the larval stages of *C. epinepheli* recorded on gill filaments. No nauplii nor copepodids were observed. **Chalimus I** (Fig. 4 A, B; Based on three specimens). Body length 0.87-1.16 (1.05), elongated with cephalothorax equal in length with the free posterior somites combined. Free segments (pedigers 2, 3 and 4) tapering posteriorly. Fifth segment longer than wide. anal somite bearing wide caudal rami armed with six unequal naked setae.

Chalimus II (Fig. 4 C, D; Based on four specimens). Body length 1.41-1.43 (1.42), Cephalothorax rectangular shorter than the free posterior somites combined. Analogs of frontal filament were observed, the filaments were missed. Frontal plates were visible and big. Free pedigers, thoracic segments 3 and 4. Fifth segment cylinder shaped, longer than wide. Caudal ramous slightly wider than long, with six unequal setae.

Chalimus III: (Fig.4), males(Fig. 4 E, F; Based on single male) and females (Fig. 4 I, H; Based on three females), were easily distinguished in this stage. Males antenna blunt (Fig. 4 G) while females antenna sharp tipped (Fig. 4 J). Body length (including the male) 1.55-1.58 (1.56). Female Cephalothorax rectangular equal to the combined urosome. Male cephalothorax oval shorter than the combined urosome. Frontal plate, big and protruded anteriolateraly, with frontal filament in the middle. Postantennary process with small basal papillae and small sharp distal knob. Genital complex obviously longer in the males and more cylindrical than in females. Caudal ramous slightly wider than long with six unequal setae.

Chalimus IV Male: (Fig. 4 K, L; Based on two males), body length 1.61-1.67 (1.64). Cephalothorax short and wide. Frontal filament with two lateral annuli, and basal portion of frontal filaments in the middle. The marginal hyaline membrane is full developed in this stage. the H - shape was obvious on the dorsal surface of the cephalothorax. Genital complex slightly longer than wide, expanded posterolateral with analogs of both leg 5 and 6 in the same corner. Abdomen, two segmented, the first segment shorter than wide, while the second abdominal segment are about twice longer than wide. Caudal ramous longer than wide bearing six unequal setae.

Some ecological aspects of the infestation of *N. japonicus* with *C. epinepheli*:

Table 1: show the results of the infestation. The total number of the inspected fish was 188 of which 115 were females, 69 males and four Immature. The total prevalence was 33.5% (42.6 % females; 20.3 % males and 0 % Immature). The total intensity of infestation was 2.7 (2.87 females; 2.07 males). Monthly changes (Table 1) illustrate that the highest prevalence were during March and June (57.1%) while highest intensity was during April (10). Minimum levels of infestation were recorded during December (prevalence 7.6; intensity 1). The

changes of the infestation according to the length of infested fish (Table 2), generally shows that the infestation higher in medium size fish (18 - 21), while the infestation were lower in small hosts.

The intensity of infestation in this group is significant than others for males and females, while the prevalence of infestation was unsignificant between males and females (28).

Caligus epinepheli was firstly recorded by Yamaguti from the gills of *Epinephelus septemfasiatus* and some other hosts from marine waters of Japan during the year 1936 (7). Latterly *C. epinepheli* was recorded from *E. merra* Bloch, 1793 in Australia (17), and from some marine fishes in India and Australia (7). *C. epinepheli* specimens of the present study are clearly identifiable with that of Ho and Lin (10).Tareen (29) recorded this parasite from the gills of *N. japonicus* which he collected from the coastal waters of Kuwait. From the same region two additional hosts were added by Ho and Sey (11) viz., *N. tolu* and *N. delagoae*. Nothing was mentioned in all the above studies about the chalimus stages of *N. japonicus*, which is the most dangerous to the fish and may cause harmful diseases to it (14). Boxshall and El-Rashidy (6) accommodated *C. epinepheli* in a group of 15 species, named the productus-group (related to *C. productus*), all those species are characterized by the loss of two setae and the reduction or loss of the third setae carried on the exopodal segment of the first leg. This character isolate all the 15 species from the remaining of sea lice. Ho and Lin (10) considered *C. epinepheli* as a synonym to *C. cossakii* Rangnekar and Murti, 1959 and they rejected Byrnes (7) proposal to consider *C. epinepheli* a synonym to *C. pagrosomi*. Moreover they consider Cressey's (9) report of *C.epinepheli* on fishes of the Caribbean sea was misidentification. According to Johnson et al. (15) all members of the genus *Caligus* may cause heavy losses in the mariculture fish cages. There are many attempts in the Arabian Gulf to rear and raise commercially fishes in marine cages (2).

The present study illustrate that *C. epinepheli* (females, males and chalimus) occurred on *N. japonicus* during the most months of the year, that will increase the hazard of the parasites especially when hosts are cultured in cages that cause significant pathological lesions leading to mortality of heavy infested fish.The damage caused by the frontal filament, which is lost in the adult. Jakson et al. (13) studied the variations in caligid infestations on farmed salmonids in the west coasts of Ireland, they found the highest levels of infestations were during autumn.

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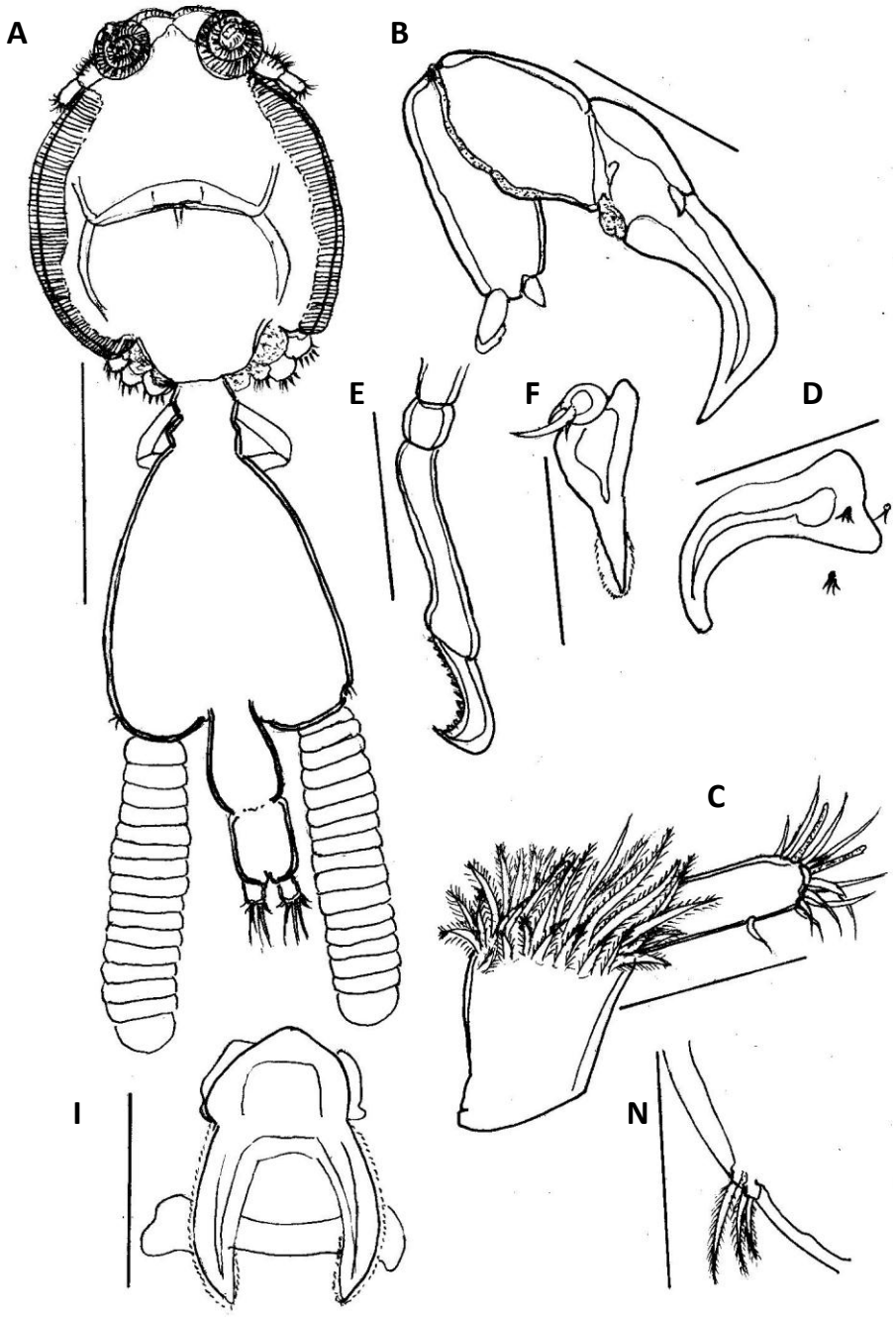

Fig. (2): *Caligus epinepheli* Yamaguti, 1936 (Female)

A habitus, dorsal; B antenna; C antennule; D postantennal process; E mandible; F maxillule; I sternal furca; N leg 5 (Scale bars 0.5 in A; 0.1 in B, C, E, F, I; 0.05 in N).

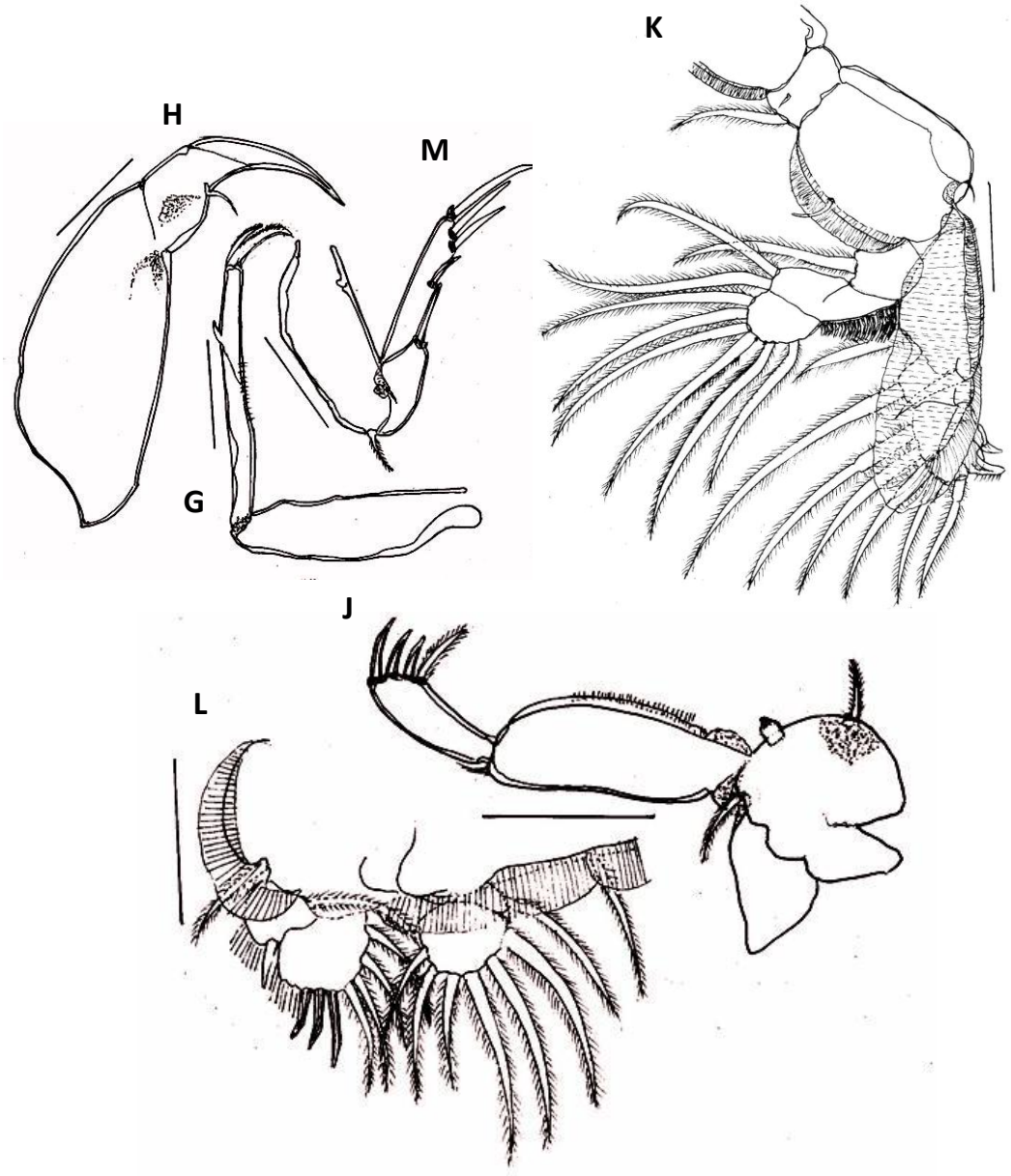

Fig. (2): *Caligus epinepheli* (cont.)

G maxilla; H maxilliped; J leg 1; K leg 2; L leg 3; M leg 4 (Scale bars 0.1 in G, H, J, K, L, M).

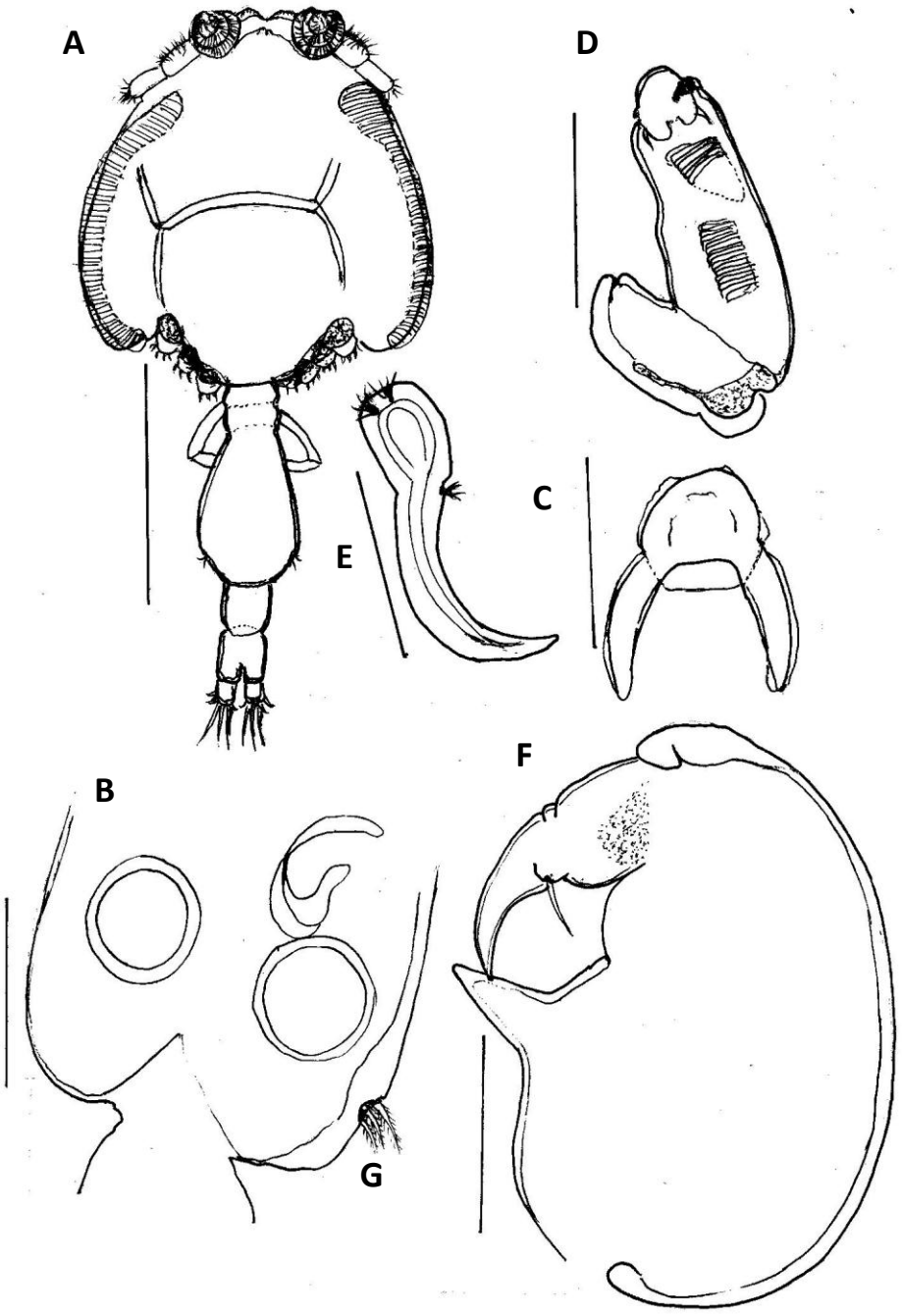

Fig. (3): *Caligus epinepheli* (Male)

A habitus, dorsal; B genital segment; C sternal furca; D antenna; E postantennal process; F maxilliped; G leg 5 (Scale bars 0.5 in A; 0.1 in B, C, D, E, G).

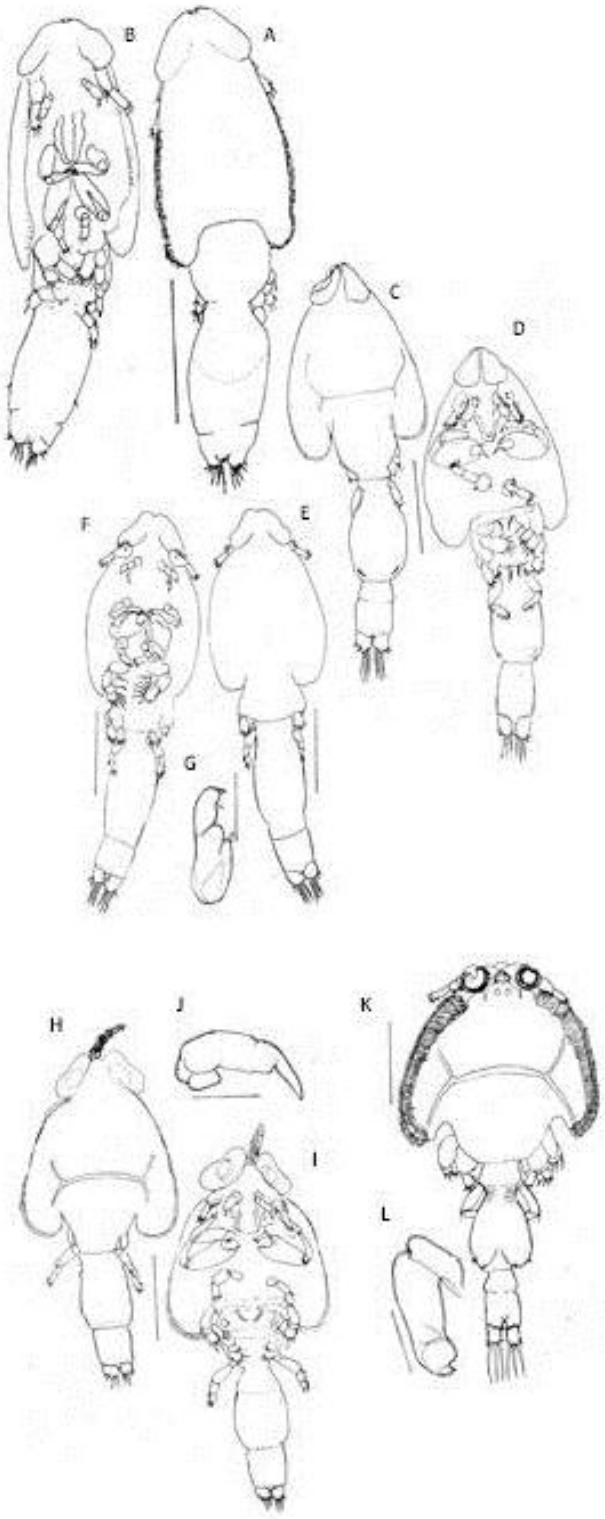

Fig. (4): *Caligus epineheli* (Chalimi stages I- IV)
Chalimus I: A habitus, dorsal; B habitus, ventral; Chalimus II: C habitus, dorsal; D habitus, ventral; Chalimus III Male: E habitus, dorsal; F habitus, ventral; G antenna; Chalimus III, Female: H habitus, dorsal; I habitus, ventral; J antenna; Chalimus IV, Male: K habitus, dorsal; L antenna (Scale bars 0.5 in A, B, C, D, E, F; 0.1 in G).

Table 1: Monthly infestation of *N. japonicus* with *C. epinepheli.*

Month*	No. fish examined			No. fish infested			No. parasites			Prevalence of inf.%			Intensity of inf.			Fish exam	Fish inf.	Inc. %	Int.
	♂	♀	Imm	♂	♀	Imm	♂	♀	Imm	♂	♀	Imm	♂	♀	Imm				
January2011	1	4	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-
February	7	10	1	3	3	-	4	8	-	42.8	30	-	1.33	2.6	-	18	6	33.3	2
March	3	4	-	1	3	-	5	10	-	33.3	75	-	5	3.3	-	7	4	57.1	3.7
April	3	6	-	-	5	-	-	50	-	-	83.3	-	-	10	-	9	5	55.5	10
June	4	10	-	3	5	-	7	10	-	75	50	-	2.33	2	-	14	8	57.1	2.21
July	2	-	1	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-
September	7	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
October	7	6	-	-	-	-	-	-	-	-	-	-	-	-	-	13	-	-	-
November	12	15	-	2	5	-	6	6	-	16.6	33.3	-	-	3	1.2	27	7	25	1.7
December	6	14	-	-	3	-	-	5	-	-	21.4	-	-	1.6	-	13	1	7.6	1
Janury2012	17	40	2	4	25	-	6	52	-	23.5	62.5	-	1.5	2	-	20	3	15	1.6
Total	69	115	4	14	49	-	29	141	-	20.3	42.6	0	2.07	2.87	0	59	29	49.1	2
	188			63			170			33.5			2.7			188	63		

Table 2: Infestation of length groups of *N. japonicus* with *C. epinepheli.*

Groups length	No. fish examined			No. fish infested			No. parasites			Incidence of inf.			Intensity of inf.			Fish exam	Fish inf.	Total Inc.	Total Int.
	♂	♀	Imm	♂	♀	Imm	♂	♀	Imm	♂	♀	Imm	♂	♀	Imm				
15 -18	7	2	3	2	2	0	2	3	0	28.5	100	0	1	1.5	0	12	4	44.4	1.2
18.1-21	39	58	1	8	23	0	32	59	0	20.5	39.6	0	4	2.5	0	98	31	31.6	2.9
21.1-24	19	36	-	3	14	-	5	40	-	15.7	38.8	-	1.6	2.8	-	55	17	30.9	2.6
>24	4	19	-	2	9	-	5	24	-	50	47.3	-	2.5	2.6	0	23	11	47.8	2.6
Total	69	115	4	15	48	0	44	126	0	21.7	41.7	0	2.9	2.6	0				
	188			63			170			33.5			2.6			188	63		

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ظهور قمل البحر *Caligus epinepheli* Yamaguti, 1936 (Copepoda: Siphonostomatoida) على غلاصم أسماك *Nemipterus japonicus* (Bloch, 1791)، شمال غرب الخليج العربي

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الخلاصة. جمع 188 نموذج من اسماك *Nemipterus japonicus* (Bloch, 1791) من شمال غرب الخليج العربي (خطوط العرض′44 °48 إلى ′46 °48، خطوط الطول ′46 °29 إلى′47 °29) خلال الفترة الممتدة من كانون الثاني 2011 حتى كانون الثاني 2012. سجل مجذافي الأقدام *Caligus epinepheli* Yamaguti, 1936 على غلاصم الأسماك. ظهر هذا الطفيلي خلال معظم أشهر السنة. تضمنت الدراسة وصف لبالغات الطفيلي هذا فضلا عن وصف المراحل اليرقية. كان الطول الكلي للإناث 1.38 – (2.16) 2.55 ملم، طول أكياس البيوض 0.99 – 1.80 (1.31) ملم، وتراوح عدد البيوض بين 13– 22 (17) بيضة/ كيس. طول ذكور الطفيلي 1.45 – 1.73 (1.59) ملم. أظهرت نتائج التحليل الإحصائي عدم وجود فروق معنوية في اصابة جنسي السمكة (عدا الأسماك ضمن مجموعة الطول 18–21 سم). سجلت أعلى نسبة اصابة خلال شهر آذار وحزيران (57.1%)، بينما كان أدنى مستوى لها خلال شهر كانون الأول (% 7.6). كانت أعلى شدة اصابة في شهر نيسان (10) وسجلت أدنى شدة اصابة في تشرين الثاني (1).