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First Record of Two Species of *Eudactylina* (Copepoda: Siphonostomatoida) from Elasmobranch Fishes of the Arabian Gulf

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Abstract: Description and some ecological aspects of two species of *Eudactylina* (*E. rhinabati* and *E. turgipes*) were found parasitic on two specimens of *Glaucostegus granulatus* and seven of *Gymnura poecilura* during the period from January 2011 till June 2012 from the north west of the Arabian Gulf (Latitudes 48° 44′ to 48° 46′; longitude 29° 46′ to 29° 47′). The prevalence of infection and the mean intensity of infection of *E. rhinabati* and *E. turgipes* was 40 %, 4.5 and 28.5, 2 respectively. The present finding of *E. rhinobati* on the gills of *G. granulatus* represents its first record in fishes of the Arabian Gulf, and its second occurrence in the World, while the finding of *E. turgipes* on the gills of *G. poecilura* in the present study represents a new host record and a new geographical distribution .

Keywords: Copepoda, *Eudactylina*, Gills, *Glaucostegus granulatus*, *Gymnura poecilura*

Introduction

Granulated guitarfish *Glaucostegus granulatus* (Cuvier, 1829) is a member of Glaucostegidae which includes one genus and six species (Froese & Pauly, 2019). It is distributed in the Atlantic, Indian and Pacific oceans, but mostly in tropical coastal waters and rarely entering estuaries and freshwaters. Long-tailed butterfly ray *Gymnura poecilura* (Shaw, 1804) belongs to Gymnuridae which is a monotypic family with 14 species, mostly distributed in the Atlantic, Indian and Pacific oceans. They are marine but rarely enter estuaries (Froese & Pauly, 2019). These two fish species are common in the Arabian Gulf (Carpenter *et al*., 1997). *G. granulatus* occurs from the intertidal to offshore continental shelves down to 119 m. It is a carnivorous fish that feeds on large shellfishes, while *G. poecilura* occurs on sandy bottoms of shallow inshore and offshore waters and feeds mainly on crustaceans and clams (Carpenter *et al*., 1997).

Historically, the siphonostomatoid Eudactylinidae was mentioned for the first time

as a group taxon by Wilson in 1932 (Kabata, 1979). In his study of copepod parasites of India, Pillai (1985) mentioned five genera of this family with six species of *Eudactylina*. Now, this family comprises 12 genera, the *Eudactylina* comprises 38 species (Walter & Boxshall, 2019). The records of marine parasitic crustaceans represent a basic steps for further investigations on its threats to mariculture activities and to establish adequate efforts to prevent and treat affected hosts (Ho & Lin, 2003). Recently, Mhaisen *et al*. (2018) demonstrated a checklist of parasites of marine fishes of Iraq which included two species belong to *Eudactylina* which the same that recorded in the present study.

Materials and Methods

Five *G. granulatus* and seven *G. poecilura* were collected from the 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 June 2012. Sampling were conducted using a trawl net. Fish samples were isolated in a plastic sacs with little amount of sea water and kept in icebox (Plumb & Bowser, 1983). Samples were transported to the laboratory and examined as soon as possible. Gills were removed and examined in petri dishes with little amount of aged tap water under the dissecting microscope. Copepods were isolated, kept in watch glasses filled with 5% aqua- solution of sodium hypochlorite and washed to clean it up from mucus and debris (Khamees, 1996). Parasites were then preserved in 70% ethanol and cleared in 85% lactic acid. Microscopical examinations were conducted by using glass-slide method of Humes & Gooding (1964) as modified by Adday (2013) under magnifications up to 1000×. Copepods were dissected out in a drop of 85% lactic acid under dissecting microscope model Meij (Lin & Ho, 2006) and examined under a compound microscope (Olympus C X 21 FS1) with series of magnifications up to 1600×. Measurements and illustrations were made with the aid of a calibrated ocular micrometer and a camera Lucida.

Results

Two specimens of both *G. granulatus* and *G. poecilura* were found to be infected with (Table 1). Nine specimens of this copepod were found on the gills of *G. granulates*.

Table (1): Length and weight of infected hosts and their levels of infection.

Fish species	No. examined fishes	No. infected fishes	Fish length (cm)	Fish weight (gm)	No. uninfected fishes	Fish length (cm)	Fish weight (gm)	prevalence (%)	Intensity
G. granulatus	5	2	47.4-51.5	278.8-310.6	3	87.7-88.0	1328.5-1330	40	4.5
G. poecilura	7	2	24.6-51.0	175.3-180.3	5	12.0-25.2	175.3-180.3	28.5	2

The present description and measurements (all in mm.) were based on five females. Another two specimens of this parasite were deposited in the British Museum Natural History serial numbers NHMUK 2013.47 and 48. Body (Figs. 1 A, B) long and slender. Total length, excluding caudal rami being 0.99-1.15 (1.01). The body is divided into three regions, cephalothorax, trunk and urosome (genital complex and two segments of abdomen). Cephalothorax longer than wide, being 0.26-0.29 (0.27) long and 0.16-0.20 (0.17) wide, with anterior rostral margin, being sub truncated. Surface of cephalothorax covered with cuticular flaps. Trunk (pedigers 2-5) long, second and third thoracic segments wider than long, being wide as the same broad of preceding segment. The fourth pediger is the smallest and wider than long. Genital segment (Fig. 1 C) is slightly wider than long, genital pore large, opens on dorsolateral surface with spinules.

Abdomen (Fig. 1 C) 2-segmented, both somites with spinules on ventral surface. Caudal ramus (Fig. 1 C) much longer than wide, bearing two dorsal slender setae, two unequal lateral setae, and tipped with two stout setae. Ventral surface without denticles. Egg sac (Fig. 1 A) being 0.39-0.40 (0.395) long, contains four eggs. Antennule (Fig. 1 D) 5-segmented, basal segment is the largest bearing spiniform process on distal inner corner, second segment triangular, located on the same axel of preceding segment, the remaining segments forming right angle with the preceding segment, formula of antennule segments being: 1, 5+2 claw-like spines, 4+claw-like spines, 1, 10 + 1ae. Antenna (Fig. 1 E) long, slender, and 4-segmented, basal segment small and unarmed, second segment long and unarmed, third segment short bearing spiniform inner process accompanied by two basal setae, distal segment long and slender tipped with terminal curved claw bearing median auxiliary spine and two basal setae. Mandible (Fig. 1 F) 2-segmented, first segment short, second segment long, slender with apical blade carrying eight teeth on ventral surface. Maxillule (Fig. 1 G) biramous, exopod with one long and two short setae, endopod tipped with long setae. Maxilla (Fig. 1 H) 2-segmented, basal segment (lacertus) large and unarmed, distal segment (brachium) long, slender and tipped with calamus that fringed with membrane, patch of dorso-distal long setules and patches of ventro-distal denticles (Fig. 1 I). Maxilliped (Fig. 1 J) 3-segmented, chelate and powerful, basal segment small, middle segment (corpus) with mitt-like receptacle, terminal segment (sub-chela) long, slightly curved, shaft with two outer spines and one inner seta, and tipped with powerful claw in addition to terminal cup. Legs 1-4 biramous, their spines (Roman numerals) and setae (Arabic numerals) are shown below:

Leg	Coxa	Basis	Exopod	Endopod
1st	1-0	0-1	I-0; III, I	0-0; 2
2nd	0-0	1-0	I-0; I-0; III	0-0; 2
3rd	0-0	1-0	I-0; I-0; II, 1	0-0; 1
4th	0-0	1-0	I-0; I-0; II, 1	0-0; 2

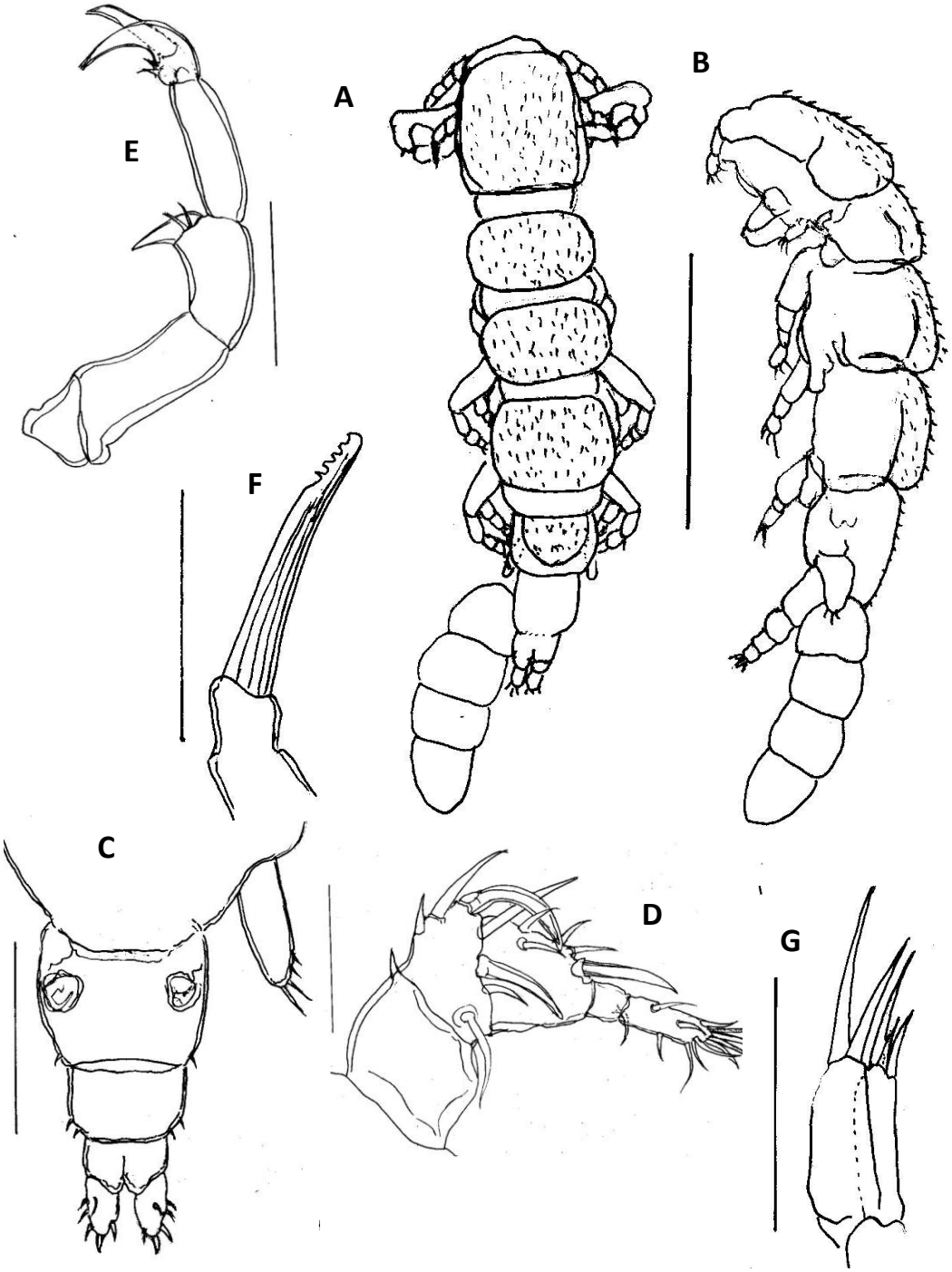

Fig. (1): ***Eudactylina rhinobati*****. Female.**

A: habitus, dorsal; B: habitus, lateral; C: urosome; D: antennule; E: antenna; F: mandible; G: maxilla. Scale bars 1.5 in A & B; 0.1 in C; 0.05 in D, E, F, G.

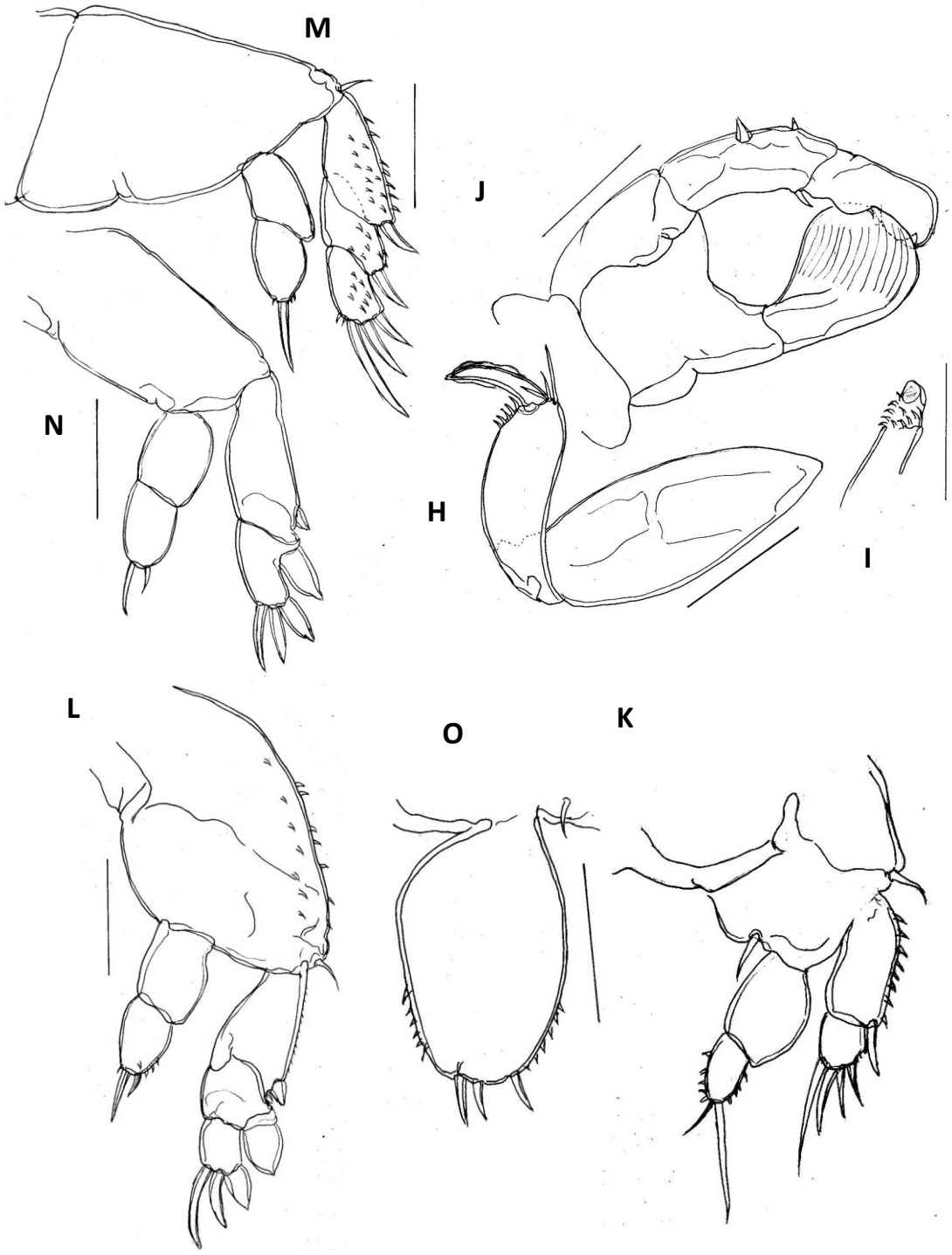

Fig. (1): *Eudactylina rhinobati* female (cont.)

H: maxilla; I: tip of maxilla, ventral; J: maxilliped; K: leg 1; L: leg 2; M: leg 3; N: leg 4 O: leg 5. Scale bars 0.05 in H, I, J, K, L, M, N, O.

Leg 1 (Fig. 1 K) with a row of denticles on outer margin of exopodal segment in addition to row of denticles on inner and outer margin of distal endopodal segment. Leg 2 (Fig. 1 L) with two rows of spinules on outer margins of protopod and exopodal segment, outer spines stout with projected bases, endopodal distal segment tipped with spinules. Leg 3 (Fig. 1 M) with rows of spinules on outer margin of exopod, terminal seta accompanied by basal spines. Leg 4 (Fig. 1 N) similar to the preceding leg but without spinules. Leg 5 (Fig. 1 O) 2-segmented, basal segment with one outer seta, distal segment truncate, bearing one sub terminal seta, two apical sub equal setae and rows of denticles on both outer and inner margins.

***Eudactylina turgipes* Bere, 1936 (Fig. 2)**

Four specimens were found on the gills of *G. poecilura* in April 2012. The description and measurement (all in mm.) of the present copepod were based on two females. The present identification of *E. turgipes* was confirmed by Dr. Susan Dippenaar of the University of Limpopo, South Africa (Pers. comm., 10. 10. 2012). Body (Figs. 2 A, B) is long and slender, being 1.37-1.60 (1.49) long (excluding caudal rami), devided into three regions: cephalothorax, trunk and urosome (Genital complex and two segmented abdomen). Cephalothorax is longer than wide, being 0.25-0.34 (0.29) long and 0.17-0.19 (0.18) wide, rostrum tapers distally with rounded ventral projection, entire surface covered with cuticular flaps. Trunk (pedigers 2-5) is long, all pedigers wider than cephalothorax and gradually increasing in size up to pediger 4, while pediger 5 is much smaller, forming intersegmental area. The fifth pediger distinctly longer than wide. Genital segment wider than long, genital opening on dorsolateral surface near anterior margin of the somite, ventral surface covered with spinules (Fig. 2 B). Abdomen (Fig. 2 A) 2-segmented, both somites. Caudal ramus (Fig. 2 C) is longer than wide bearing one outer seta, five apical setae and scattered denticles on ventral surface. Egg sac (Fig. 2, A, B) about 0.72 mm long, containing six eggs.

Antennule (Fig. 2 D) 4-segmented, basal segment largest, remaining segments tapering distally, both third and distal segments forming right angle with the second segment, formula on antennule segments being: 1, 5+ 2 claw- like spines, 4+2 claw- like spines, 12+ae + terminal claw- like spine. Antenna (Fig. 2 E) long, slender and four segmented, basal segment small and unarmed, second segment with spiniform inner process and row of denticles, third segment with spiniform inner process accompanied by two basal setae and rows of denticles, distal segment with terminal curved claw bearing medial auxiliary spine and two basal setae. Mandible (Fig. 2 F) 2-segmented, first segment short, second segment long, slender with apical blade carrying eight teeth on ventral surface. Maxillule (Fig. 2 G) biramous and represents small papilla-like, exopod carrying one long and two short setae, endopod tipped with two long setae. Maxilla (Fig. 2 H) 2-segmented, basal segment (lacertus) large and unarmed, distal segment (brachium) long, slender and tipped with calamus that fringed with membrane, patch of dorsodistal setules and patch of ventrodistal denticles. Maxilliped (Fig. 2 I) 3-segmented, chelate and powerful, basal segment small, middle segment (corpus) with mitt-like receptacle, terminal segment (subchela) long, shaft with sub terminal outer

spine, distal inner seta, and claw with enlarged base in addition to hollow terminal cup and spiniform process. Leg 1-4 biramous, with three-segmented rami (except for the first leg) their spines (Roman numerals) and setae (Arabic numerals) as shown below:

Leg	Coxa	Basis	Exopod	Endopod
1st	0-0	1-I	I-0; III, 1	0-0; 0-2
2nd	0-0	1-0	I-0; I-0; III	0-0; 0-0; 2
3rd	0-0	1-0	I-0; I-0; II, I	0-0; 0-0, 1
4th	0-0	1-0	I-0; I-0; II, 1	0-0; 0-0, 1

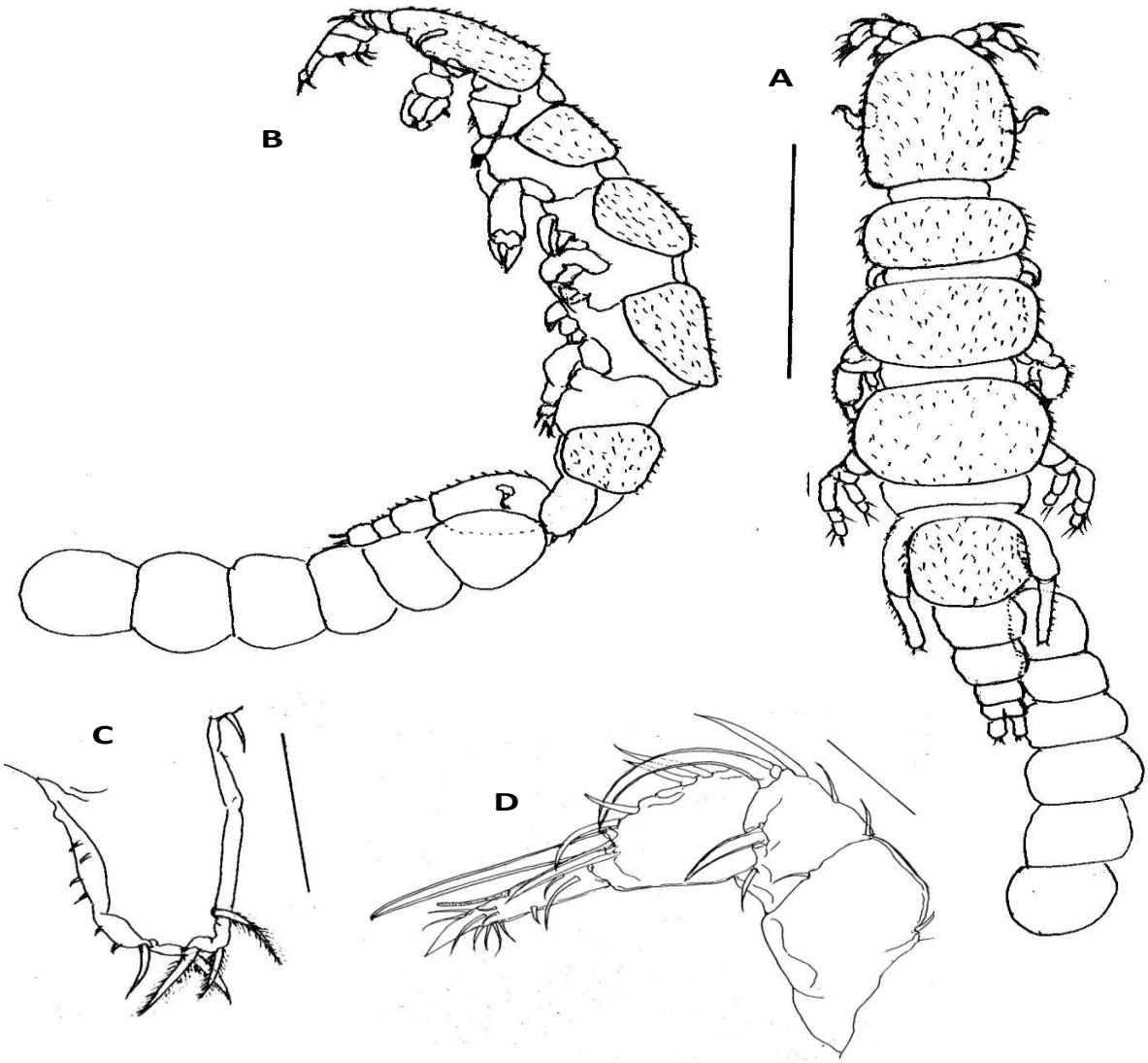

Fig. (2): *Eudactylina turgipes* Female

A: habitus, dorsal; B: habitus; C: caudal ramus lateral; D: antennule. Scale bars 0.5 in A, B; 0.05 in C, D.

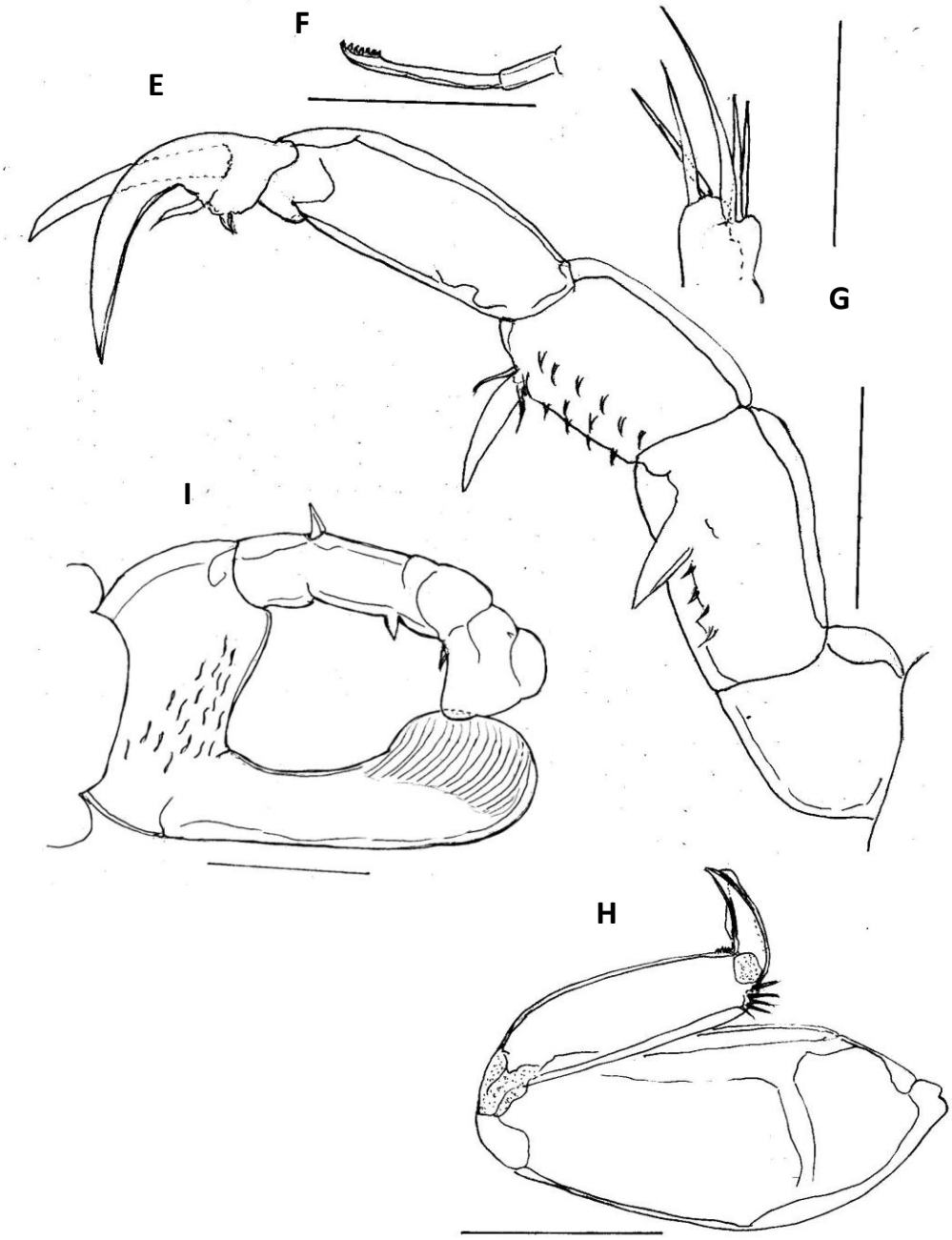

Fig. (2): *Eudactylina turgipes*, female (cont.)

E: antenna; F: mandible; G: maxillule; H: maxilla; I: maxilliped. Scale bars 0.05 in C, D, E, H, I.

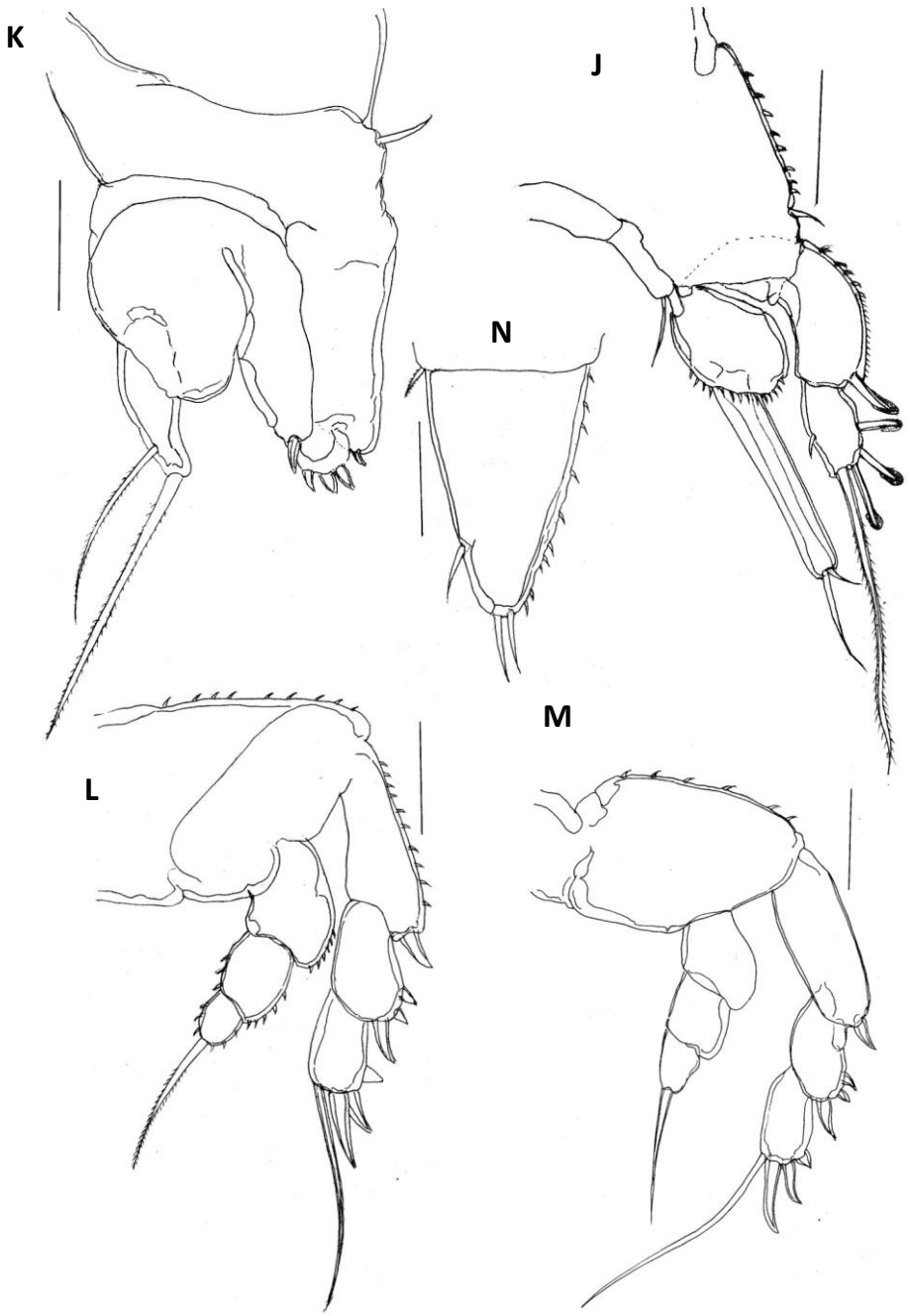

Fig. (2): *Eudactylina turgipes*, female (cont.)

J: leg 1; K: leg 2; L: leg 3; M: leg 4; N: leg 5. Scale bars 0.05 in J, K, L, M, N.

Leg 1 (Fig. 2 J) with outer row of denticles on basis, outer margin of first exopodal segment with row of denticles, first endopodal segment with row of denticles, distal endopodal segment very long. Leg 2 (Fig. 2 K) both rami with partly fused segments, exopod tapering distally, endopod with very large proximal segment. Leg 3 (Fig. 2 L) with slender rami, denticles on outer margin of exopod and on both margins of endopodal segments. Leg 4 (Fig.2 M) similar to the preceding leg, but without denticles. Leg 5 (Fig. 2 N) 2-segmented, basal segment with one outer pinnated seta, distal segment tapering distal wards bearing one sub terminal seta, two apical setae and row of outer denticles.

Discussion

The genus *Eudactylina* comprises 33 valid species with its oldest type taxon being *E. acuta* van Beneden, 1853 (Walter & Boxshall, 2019). The most recent species being *E. dasyati* Izawa, 2011; *E. gymnuri* Izawa, 2011; *E. musteli*, Izawa, 2011; *E. squatini* Izawa, 2011 and *E. taeniuri* Izawa, 2011 (Izawa, 2011). According to Deets & Ho (1988), *Eudactylina* van Beneden, 1853 is the largest genus of the eudactylinids and can be separated from other genera of the family by having first antenna with geniculate flexion between second and third segments (Kabata, 1979).

E. rhinobati was first described from two species of rays, viz *Rhinobatos rhinobatos* (Linnaeus, 1758) and *R. cemiculus* (Geoffroy, 1817) (= *Glaucostegus cemiculus*), both were collected from Tunisian waters of the Mediterranean Sea (Raibaut & Essafi, 1979). According to the same authors, *E. rhinobati* is closely resemble *E. acanthi* Scott, 1901. However, it can be distinguished from the latter by the spiniform process of the second segment of the first antenna, and the strong modification of the spines of the second exopodal rami. Moreover, the same authors referred to morphological resemblance between *E. rhinobati* and *E. longispina* Bere, 1936, as the latter species has second endopodal rami being single segmented, while in *E. rhinobati* the same rami being two segmented. The present report of *E. rhinobati* represents its first record in fishes of the Arabian Gulf. The identification of *E. rhinobati* here was confirmed by Dr. Susan Dippenaar (Pers, comm. 10. 10. 2012).

The crusracean *E. turgipes* was first described from gills of the butterfly ray *Pteroplatea maclura* (Bloch and Schneider, 1801) [now *Gymnura micrura* (Bloch & Schneider, 1801)] collected from the Gulf of Mexico. Subsequently, it was reported from the same host from the Mediterranean Sea during 1971 (Deets, 1994). Moreover, according to Dr. G. Boxshall (Pers. comm. 30. 4. 2012), the distribution of this species is limited in the European waters. It can be distinguished from its congeners by its swollen modified second leg. The closest species to *E. turgipes* is *E. gymnuri*. Both species have similar body shape and very close appendages structure and armature.

Izawa (2011) recorded *E. gymnuri* from *G. japonica* (Temminck & Schlegel, 1850) which was collect at Tanabe Bay, Japan. He referred to the resemblance between the two species. However, he mentioned many morphological differences, mainly including differences in the dimensions of the body segments of the two closely allied species. In the present study, another characters can be added to differentiate both species as the current specimens of *E.*

turgipes are more flattened, the cephalothorax is bullet-shape, while in *E. gymnuri*, it is more elongated with rounded frontal area. The tergum of the fifth somite being quadrate in *E. turgipes* while it is oval in *E. gymnuri*, and the maxilla bears setules on the dorsodistal end of the second segment of *E. turgipes*, which is absent in *E. gymnuri*. The present identification of *E. turgipes* was confirmed by Dr. Susan Dippenaar of the University of Limpopo, South Africa (Pers. comm., 10. October. 2012). So, the present record of this parasite represents a new host record (Dr. G. Boxshall, pers. comm. 30. April 2012) and a new geographical distribution.

Conclusion

Currently, 33 valid species of the genus *Eudactylina* are so far recorded in the World. This high number can give a wide distribution of these parasites and hence the ability to record other species of this genus. Hence, additional threat to fish culture activities will be expected.

Conflicts of interest

The authors-declare-that they-have-no-conflict of interests.

Ethical approval

All applicable institutional, national and international guidelines for the care and use of animals were followed.

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أول تسجيل لنوعين من الجنس *Eudactylina* (مجذافية الأقدام: سيفونية الفم) من اسماك صفائحية الغلاصم في الخليج العربي

ثامر قاطع عداي ونجم رجب خميس

فسم الأسماك والثروة البحرية، كلية الزراعة، جامعة البصرة، العراق

المستخلص: وصف وبعض القياسات البيئية لنوعي *Eudactylina* (*E. rhinabati* و *E. turgipes*) وجدت متطفلة على نموذجين من أسماك القيثار المحبب *Glaucostegus granulatus* وسبعة نماذج من أسماك الفراشة طويلة الذنب *Gymnura poecilura* خلال المدة من كانون الثاني 2011 حتى حزيران 2012 من جنوب غرب الخليج العربي (خطوط العرض °48 ′44 الى °48 ′46 وخطوط الطول °29 ′46 الى °29 ′47). كانت نسبة وشدة الاصابة الى *E. rhinabati* و *E. turgipes* 40%، 4.5 و 28.5 ، 2 على التوالي. يمثل ظهور *E. rhinabati* على غلاصم أسماك القيثار المحبب أول تسجيل في أسماك الخليج العربي وثاني ظهور لها في العالم، بينما ظهور *E. turgipes* على غلاصم أسماك الفراشة طويلة الذنب في الدراسة الحالية هو مضيف جديد وتوزيع جغرافي جديد لهذا للطفيلي.