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SESSILE BARNACLES (CIRRIPEDIA) FROM THE PAKISTAN COAST

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ABSTRACT: The taxonomy of sessile cirripeds from the Pakistan coast is described. Out of the 15 species, seven are reported for the first time from the area. Specific taxonomic characters of all the species are described and their previous records from adjacent areas are discussed.

KEY WORDS: Sessile barnacles, Cirripedia, Pakistan coast.

INTRODUCTION

The cirriped fauna of the Pakistan coast is not well known. Annandale (1906a, 1906b, 1906c, 1910) was probably the first to have shown the presence of barnacles in his collection from Pakistan. Stubbings (1936, 1940) mentioned some barnacles in his collection from the Arabian Sea. Moazzam and Rizvi (1978, 1982) described pedunculate barnacles from Pakistan, while rhizocephalan cirripeds are described by Moazzam and Moazzam (2004). Hassan (1963) described the distribution of *Balanus amphitrite amphitrite* along the Pakistan coast. Javed and Mustaquim (1992) and Mustaquim and Javed (1993) reported the occurrence of *Chelonibia patula* and *Chelonibia testidunaria* and Kazmi (2001) recorded *Conopea calceola* from the Pakistan coast. Barnacles have also been reported in a number of papers on the ecology and distribution of marine animals; noteworthy among them are Murray (1880), Haq *et al* (1978), Ahmed *et al* (1978) and Javed and Mustaquim (1995).

The cirriped fauna of the adjacent areas such as Persian Gulf was described by Stubbings (1936) and Utinomi (1969) and the Indian coast by Annandale (1906a, 1906b, 1906c, 1907a, 1907a, 1909, 1910, 1915), Daniel (1955, 1972), Karande and Palekar (1963, 1966) and Wagh and Ball (1974).

Barnacles are among the most prominent fouling organisms, thus constituting an important group economically. A number of barnacle species have been observed to foul artificial structures and coastal installations along the Karachi coast (Ahmed *et al*, 1978; Haq *et al*, 1978; Javed and Mustaquim, 1995; Rizvi *et al*, 1986). Such studies very much stress the need to determine the taxa of various barnacle species occurring along this coast. Considering these aspects, it was considered highly desirable to conduct studies with a view to determine the taxonomic status of various sessile barnacles occurring along the Pakistan coast.

MATERIALS AND METHODS

Most of the material was collected during 1974 and 1980 from the coast of Karachi. The samples of barnacles from the coasts of Balochistan were predominantly collected by the junior author, however, some samples from Ormara, Pasni, Gwadar and southern coast of Pakistan were available in the collection of the Centre of Excellence in Marine

Biology, University of Karachi. A few samples of barnacles were also collected during research cruises on board "R/V Dr. Fridtjof Nansen" in 1977 along the coast of Pakistan. The samples were preserved in 5 % formalin. The drawings of the mouth parts and other appendages were made with the aid of a camera lucida mounted on a SM-Lux microscope whereas drawings of the shell and opercular valves were made by Wild M5 stereomicroscope. Synonyms of barnacle species recorded during the present study are given in Newman and Ross (1976). The authorities of taxa are not explained in "References".

SYSTEMATIC ACCOUNT

BALNOMORPHA PILSBRY, 1916
Superfamily CHTHAMALOIDEA DARWIN, 1854
Family CHTHAMALIDAE DARWIN, 1854
Subfamily EURAPHINAE NEWMAN AND ROSS, 1976
Genus *Euraphia* Conard, 1837

1. *Euraphia withersi* (Pilsbry, 1916)
(Fig.1)

Description:

Shell much flattened, without distinct ribs, yellowish brown, compartments loosely articulated with simple sutures, rostro-lateral and lateral plates with internal pits (Fig. 1a). Basis membranous. Sutural line between scutum with occludent margin thickened, rolled inwards, articular ridge and furrow absent in mature specimens and represented by shallow wavy fold in young (Fig. 1b). Tergum with acutual and basal margins almost equal and longer than the carinal margin (Fig. 1c). Internal edge of the carinal and scutal margins become usually thickened and form 'V' shaped furrow along the tergal length. Crests for depressor muscle 3-4. Labrum flattened, semicircular, with a very shallow 'U' shaped groove bearing a row of 23-28 peg like teeth fringed with hairs (Fig. 1d), Maxilla I with two well marked notches dividing spines into three groups (Fig. 1e). Mandible with usually 3 large teeth and a pectinated lower angle, comb like group of spines absent (Fig. 1f). Cirrus I, II short and darker in colour than the rest. Distal segments of cirrus II carry many pinnate setae, lanceolate toothed spines absent. No caudal appendage. Pedicel of penis helmet shaped, shield and lateral processes almost equal in length, no horn (Fig. 1g).

Habitat:

Usually found growing attached to the stems and leaves of mangroves along the coastline.

Distribution Along Pakistan Coast:

Pipri, Gizri Creek, Karachi, Jiwani (Salt Pan Area), Miani Hor, Chandi, Kalmat Khor.

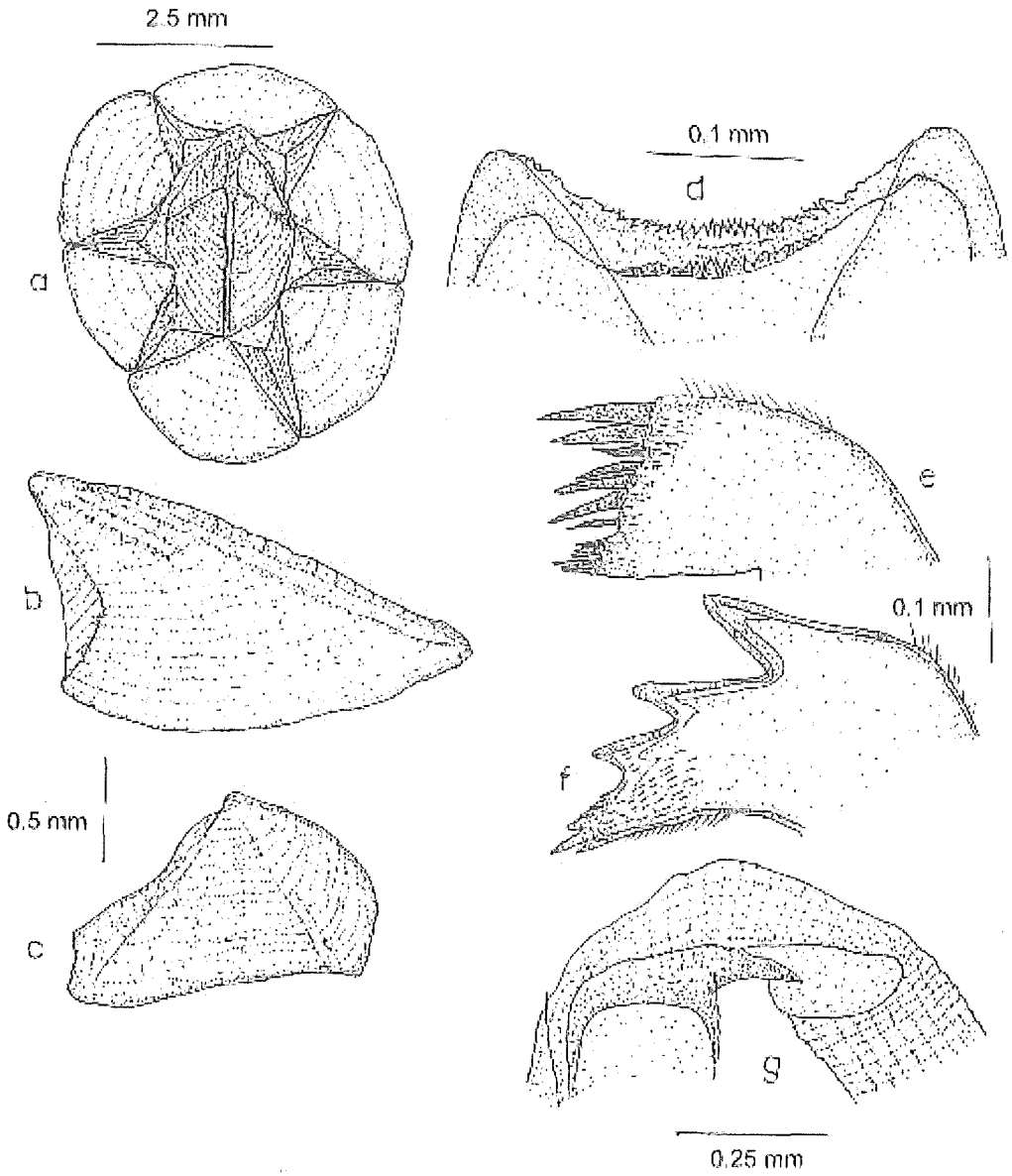

Fig. 1. *Euraphia withersii*: a, shell. b, scutum (internal view). c, tergum (external view). d, labrum. e, maxilla I. f, mandible. g, pedicel of penis.

Remarks:

This species inhabits the Indo-West Pacific and Australian coasts (Newman and Ross, 1976). It has been reported as *Chthamalus withersi* from the Bombay coast by Karande and Palekar (1966). The present survey records it for the first time from the Pakistan coast. It is abundant on the stems and leaves of mangroves along the coast of Pakistan.

Subfamily CHTHAMALINAE DARWIN, 1854
Genus *Chthamalus* Ranzani, 1817

2. ***Chthamalus* sp. (c.f. Southward and Newman, 2003)**
(Fig. 2)

Description:

Shape of the shell more stellate, smoother in young (Fig. 2b) and somewhat rectangular in older specimens (Fig. 2a). Shell with joint traces of ribs, generally flattened. Basis membranous; scutum with a deep narrow pit for lateral depressor muscles without any ridges (Fig. 2e). Tergum narrowing towards basi-scutal corner and folded along a line of deep pits along the axis drawn from apex to basi-scutal angle, with 3-4 crests for lateral depressor muscles (Fig. 2d). Labrum normal, bullate shape, broadly 'V' shaped, carrying a row of broadly triangular teeth with a row of close growing hairs above them (Fig. 2f). Maxilla I with a well marked upper notch devoid of spines and shaped like letter 'U' lying on its sides (Fig. 2g). mandible usually with 4 teeth, the 4th tooth double; below the 4th tooth a short comb like spinelets are present upto the spine at the tip of the lower jaw (Fig. 2h). Cirrus I and II bear peg like spines on basal segments; terminal segments of cirrus II armed with stout serrated spines with coarse sides (Fig. 2j), lanceolate spines with a double row of stout pointed side spines are present, the lower pair of these spines is separated from above spines by a slight gap. No caudal appendage. Pedicel of penis with upper part step like, girdle broad with carinal and somewhat triangular in shape at its upper margin (Fig. 2i).

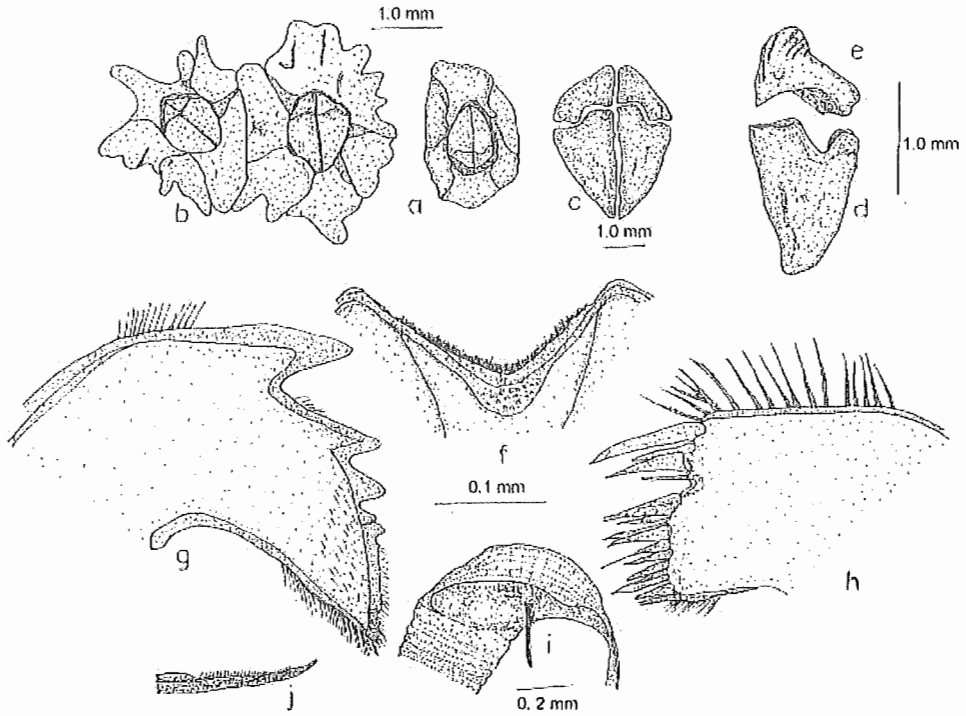

Fig. 2. *Chthamalus sp.*: a, adult. b, juvenile. C, opercular valves showing sutural arrangement between scutum and tergum (external view). d, tergum (internal view). E, tergum (external view). e, scutum (internal view). f, labrum. g, maxilla. h, mandible. i, pedicel of penis. j, hooked or pinnate spine at the apex of cirrus II.

Habitat:

This species grows abundantly on the rocks in the supra-littoral zone (Haq *et al*, 1978). It is also found growing attached to gastropods such as *Cellana karachiensis, Cellana radiata* and *Morula granulata* inhabiting the high water zone on rocky shores.

Distribution Along Pakistan Coast:

Manora, Buleji, Paradise Point, Cape Monz, Goth Mubbarak Gaddani, Hingol, Ormara, Pasni, Gwadar and Jiwani.

Remarks:

The rocky shores all along the Pakistan coast harbour this species. Similar observations from other parts of the Arabian Sea are reported by Utinomi (1969) and Wagh and Ball (1974). *Chthamalus malayensis* has already been known from the coast of Pakistan (Newman and Ross, 1976), however, Southward and Newman (2003) consider this to be an undescribed species of *Chthamalus challengeri* subgroup. Specimen observed during the present study comes close to this undescribed species as its mandible has a long pectin of about 20 small teeth and only has one teeth at the lower angle. It however, requires further study especially comparing the specimen from the area to verify its identification. The specimens reported from the Arabian Sea by Stubbings (1936) as *Chthamalus stellatus* and from India by Daniel (1955, 1972), Karande and Palekar (1963, 1966) and Nilsson-Cantell (1938) also seem to be similar to the undescribed species of *Chthamalus challengeri* subgroup. During the present study marked variations in the shell shape and structures of opercular valves were noted similar to those observed by Utinomi (1954) and Pope (1965).

Superfamily CORONULOIDEA LEACH, 1817
Family CORONULIDAE LEACH, 1817
Subfamily CHELONIBINAE PILSBRY, 1916
Genus *Chelonibia* Pilsbry, 1916

3. *Chelonibia caretta* (Spengler, 1790)

(Fig. 3)

Description:

Shell flattened, very strong, massive, dirty white, upper part usually with worn out surfaces, lower part rugged and slightly folded (Fig. 3a). Orifice oval with length slightly more than one third of basal diameter of shell. Radii poorly developed, narrow. Sutures between the shell plates plain. Compartments asymmetrical, rostrum usually not exactly facing carina. Parieties without cavities extending up between the interrupted radiating septa of variable thickness. Septa not continuous from circumference to sheath, irregularly divided into separate short points or portions. Sheath descending, extend down to the basal membrane; with loop-holes for the entrance of ribbon of corium only on the eight line of sutures. Basis membranous. Opercular valves reduced but elongated, do not fill the orifice. Scutum articulated with tergum by a horny projection. Crest for depressor muscles absent on tergum. Labrum with a long row of teeth on each side of notch, sometimes worn away (Fig. 3b). Maxilla I with a notch below the first pair of large spines; the lower end of cutting edge with a group of equal sized spinelets bearing setules

(Fig. 3c). Mandible with 5 teeth, all except the first are bifid (Fig. 3d). Pedicel of penis with broad and complete girdle, lateral processes short, no horn (Fig. 4c).

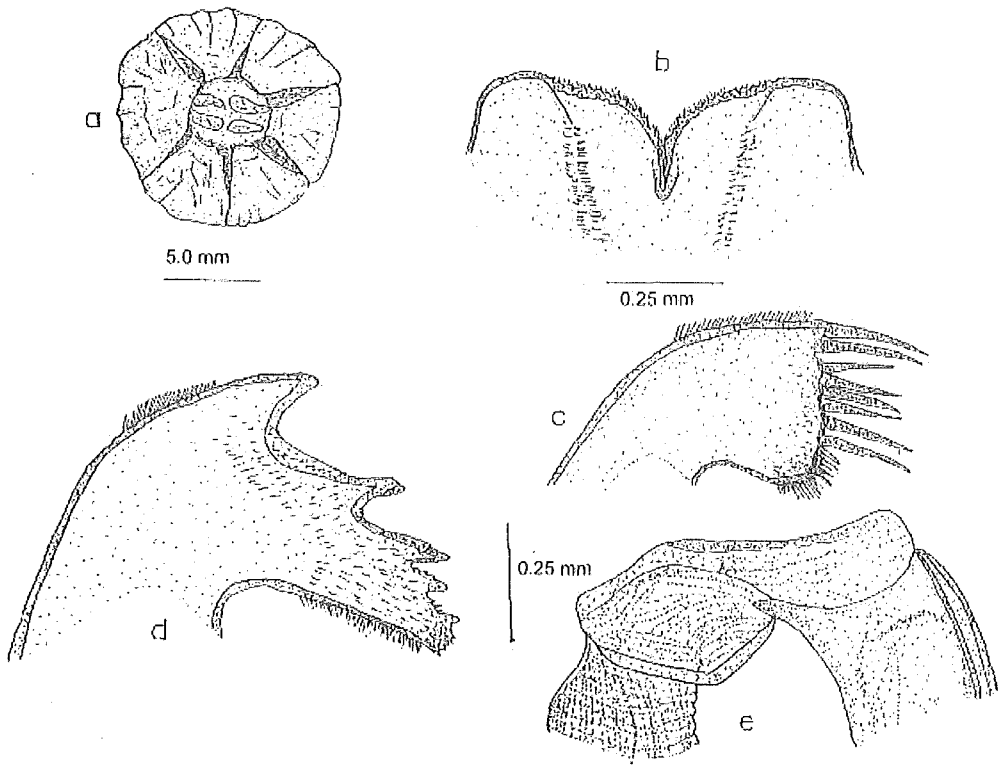

Fig. 3. *Chelonibia caretta*: a, shell. b, labrum. c, maxilla I. d, mandible. e, pedicel of penis.

Habitat:

This species is usually found attached to or imbedded in the carapace of marine turtles.

Distribution Along Pakistan Coast:

Paradise Point, Karachi and Gwadar (West Bay)

Remarks:

The species inhabit the external body surfaces of marine turtles and is well distributed in the Indo-Pacific and tropical Atlantic (Newman and Ross, 1976). It was already reported from India (Daniel, 1955; Nilsson-Cantell, 1938) and the Persian Gulf (Utinomi, 1969). This is the first record for the Pakistan coast.

4. *Chelonibia patula* (Ranzani, 1818)

(Fig. 4)

Description:

Shell conical, smooth and light yellowish white in colour. Orifice large, polygonal, slightly toothed. Parietes thin, with interspaces between septa (tubes) almost all along the

length, externally with fine longitudinal striae; radiating septa thin and dentated near basal edges (Fig. 4a). Sheath thin. Radiae broad with summits slightly oblique. Alae oblique. Basis membranous. Opecular valves elongated, tergum with spur more prominent. Labrum with a row of teeth on each side notch, fringed with hairs (Fig. 4b). Maxilla I and mandible similar to *C. caretta* (Fig. 4c-d). Pedicel of penis with girdle complete, lower margin somewhat crenulate, lateral processes short and broad, horn (basi-dorsal point) is absent, lateral areas rounded (Fig. 4e).

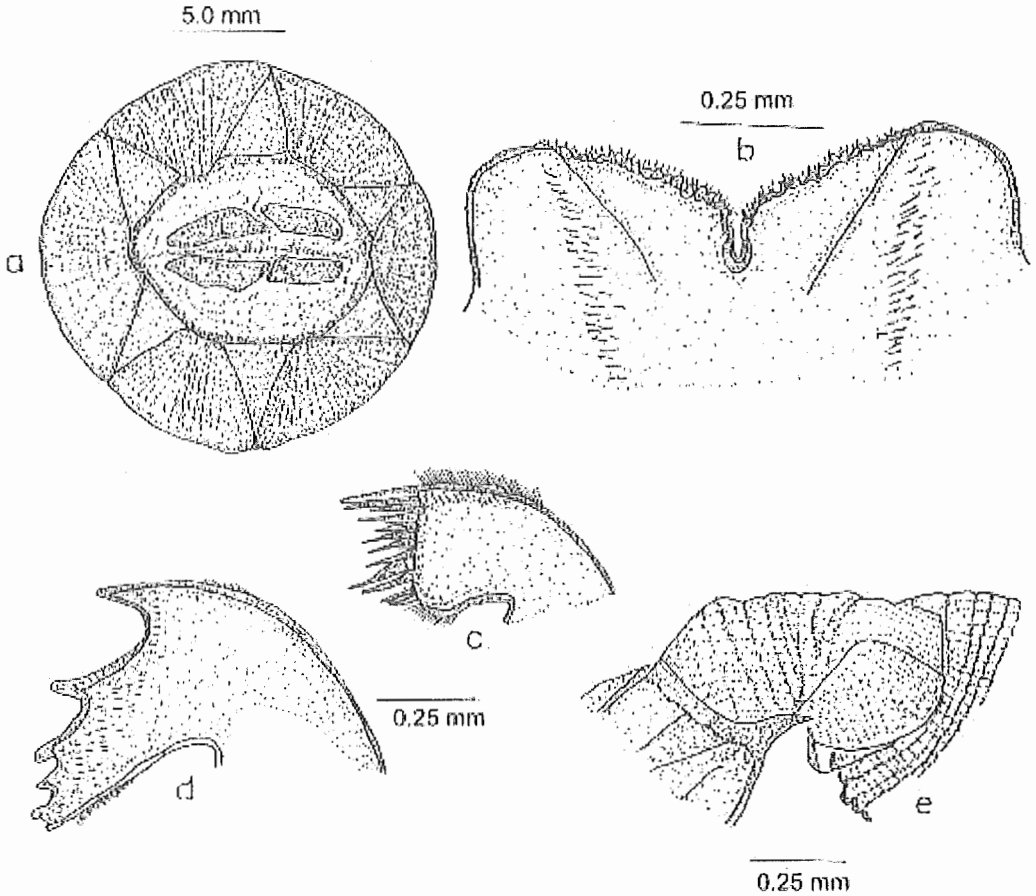

Fig. 4. *Chelonibia patula*: a, shell. b, labrum. c, maxilla I. d, mandible. e, pedicel of penis.

Habitat:

This species is usually found attached to the carapace of pelagic crabs *Portunus pelagicus* and *P. sanguionolentus.*

Distribution Along Pakistan Coast:

Shallow coastal waters and intertidal areas along the Pakistan coast especially along south coast of Sindh, Sonmiani Bay, Pasni and off Gwadar.

Remarks:

This species is widely distributed in the Indo-Pacific and tropical Atlantic areas (Newman and Ross, 1976). It was previously reported from Pakistan by Javed and

Mustaquim (1992). It is reported from India by Daniel (1955) and Nilsson-Cantell (1938).

5. *Chelonibia testudinaria* (Linnaeus, 1757)
(Fig. 5)

Description:

Shell conical, depressed, massive, heavy, oval in outline (Fig. 5a). Surface smooth, dirty white. Parieties extremely thick, membranous vertical septa of varying length extend interrupted from outer lamina to the broad solid inner lamina; flattened cavities (tubes) extend up the length of parieties . Radii narrow, with teeth like notches on both sides along the length of parities, summits horizontal. Sheath long, extend down to basal membrane; with loop-holes for the entrance of corium ribbon on the sutural edge and in the middle of each compartment. Opercular valves similar to *C. caretta*, attached by a strong opercular membrane. Labrum with a long row of teeth on each side of notch (Fig. 5b). Maxilla I without notch (Fig. 5c). Maxilla II bilobed on its inner side. First pair of cirri with unequal rami, separated from other cirri by a gap. Second pair shorter and thicker than in *C. caretta*. Third pair almost as long as the posterior pair. Cirrus IV, VI with a tuft of fine spines between two pairs of main spines on each segment. Mandible with 5 teeth, last four laterally double (Fig. 5d). Pedicel of penis with broad girdle with wavy lower margin, long narrow lateral processes; carinal processes also long, no horn (Fig. 5e).

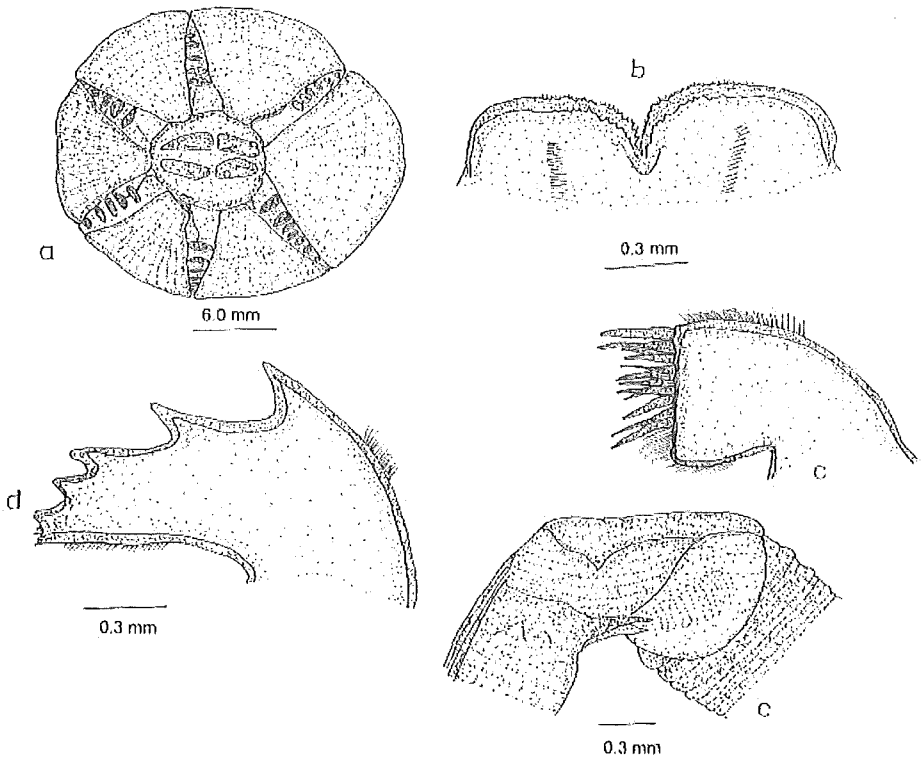

Fig. 5. *Chelonibia testudinaria*: a, shell. b, labrum. c, maxilla I. d, mandible. e, pedicel of penis.

Habitat:
This species is usually found attached to the carapace of *Chelonia mydas.*

Distribution Along Pakistan Coast:
Paradise Point, Karachi, Ormara (Pedi Zur), Jiwani.

Remarks:
The species is distributed in all temperate and tropical seas on sea turtles (Newman and Ross, 1976; Nilsson-Cantell, 1921), It was reported from Pakistan by Javed and Mustaquim (1993), from India by Annandale 1906a; Daniel, 1955; Nilsson-Cantell, 1938) and from Persian Gulf by Utinomi, 1969.

Subfamily PLATYLEPADINAE NEWMAN AND ROSS, 1976
Genus *Platylepas* Gray, 1825

6. ***Platylepas ophiophilus*** **Lanchester, 1902**
(Fig. 6)

Description:
Shell subconical, oval in outline, somewhat depressed, white with pinkish tint, covered by a thin membrane. Orifice large and oval. Basis larger than the orifice. Parieties nonporous. Sheath approximately ½ length of compartments. Outer surfaces of wall longitudinally ribbed, crossed by transverse growth line (Fig. 6a). Sutural surfaces between the compartments rather deep, transversely grooved. Palps small elongated in parallel with the cutting edge of labrum, fringed with many short curved pectinate setae along the lateral edge, long simple bristles on the outer surface. Labrum bullate, with 3 obtuse teeth on each side of the deep notch (Fig. 6b). Maxilla I narrow, with a distinct notch along the cutting edge, about 7-18 spines on this edge (Fig. 6c). Maxilla II bilobed, with comb like long bristles and a series of spinules at the distal end. Mandible usually with four strong teeth, 5^{th} rudimentary and a pectinated lower angle, 2^{nd}, 3^{rd} and 4 tooth with additional teeth on sides (Fig. 6d). Cirri laterally flattened and bear 3 pairs of long setae along the ventral edge of each segment of cirrus IV-VI. Pedicel 1 of penis with girdle making an oblique angle with shield, girdle incomplete, no horn (basidorsal point) (Fig. 6e). Penis very long, finely annulated, with a few scattered hairs along the length and a tuft of hairs at the apex (Fig. 6f).

Habitat:
This species is usually found attached to or imbedded in the scales of marine snakes especially *Enhydrina schistose.*

Distribution Along Pakistan Coast:
Distributed widely along coastal and offshore waters of the Pakistan Coast.

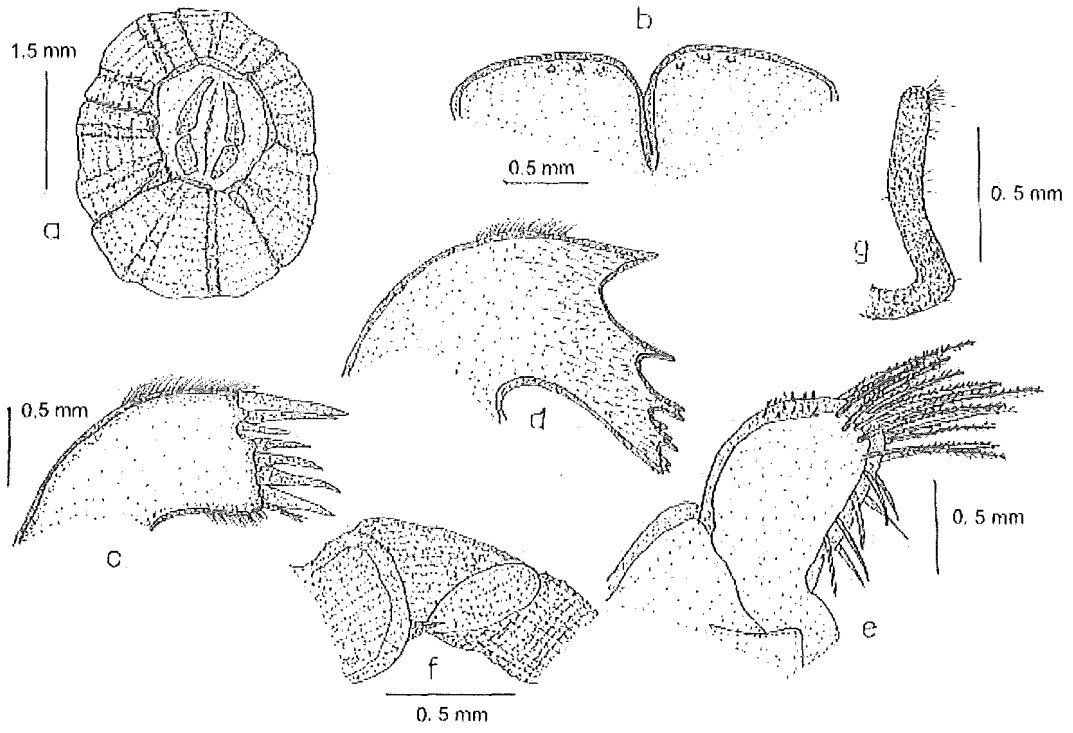

Fig. 6. *Platylepas ophiophilus*: a, shell. b, labrum. c, maxilla I. d, maxilla II. e, mandible. f, pedicel of penis. G, upper part of penis.

Remarks:

The specimens examined during the present study were very small in size and agree well with the description of this species given by Utinomi (1970). The noticeable variations are: (i) Maxilla I has a distinct notch, (ii) cirri bear 3-4 pairs of setae instead of 5 long pairs (iii) in many specimens the labrum bears normal small teeth which are not exactly as obtuse as figured by Utinomi (1970). The species has already been reported from the Karachi coast on the sea snake *Enhydrina valakadyn* by Nilsson-Cantell (1938) and from Gwadar by Kruger (1912) as *Cryptolepas ophiophilus*. Various aspects of the biology of this species were studied by Zinn (1975).

Family TETRACLITIDAE GRUVEL, 1903
Subfamily TETRACLITINAE GRUVEL, 1903
Genus *Tetraclita* Schumacher, 1817

7. *Tetraclita rufotincta* Pilsbry, 1916
(Fig. 7)

Description:

Shell conical, more of less depressed (Fig. 7a). Compartments four, without any trace of sutures externally in uneroded specimens. Orifice rather small, varies from diamond shape to oval shape. Pinkish purple in colour. Radii obsolete. Parietes tubiferous, generally in five rows. Surface of the wall eroded, and with numerous short

and interrupted ridges radiating from apex towards basis (Fig. 7a). Sheath tinted with pinkish purple. Scutum livid brown and white internally with pinkish tint particularly in the apical part; a little higher than wide; articular ridge extending more than ½ length of tergal margin; adductor ridge very prominent long, arched, with a deep groove below extending upto the basal margin; small prominent crests for lateral and rostral depressor muscles; pit for adductor muscle distinct (Fig. 7b). Tergum white, tinged with reddish brown particularly in the apical part; transversely elongated; with a distinct beak; external surface of spur placed quite close to the basiscutal angle; basal margin form an angle of 130° with carinal side of spur; basal end of spur broad, truncated; crests for lateral depressor muscles present (Fig. 7c). Basis calcareous. Labrum with slight inward flexion at the middle, usually 2-3 strong teeth on each side of crests (Fig. 7d). Maxilla I with a distinct notch below the upper pair of large spine (Fig. 7e). Mandible usually with 4 teeth and a strong region below the fourth tooth; 2nd and 3rd tooth bifid (Fig. 7f). Cirrus I with unequal rami; the longer ramus about double the length of shorter ramus. Pedicel of penis with girdle thin carinally, a slightly raised surface on the upper surface of the distal part in place of horn (Fig. 7g).

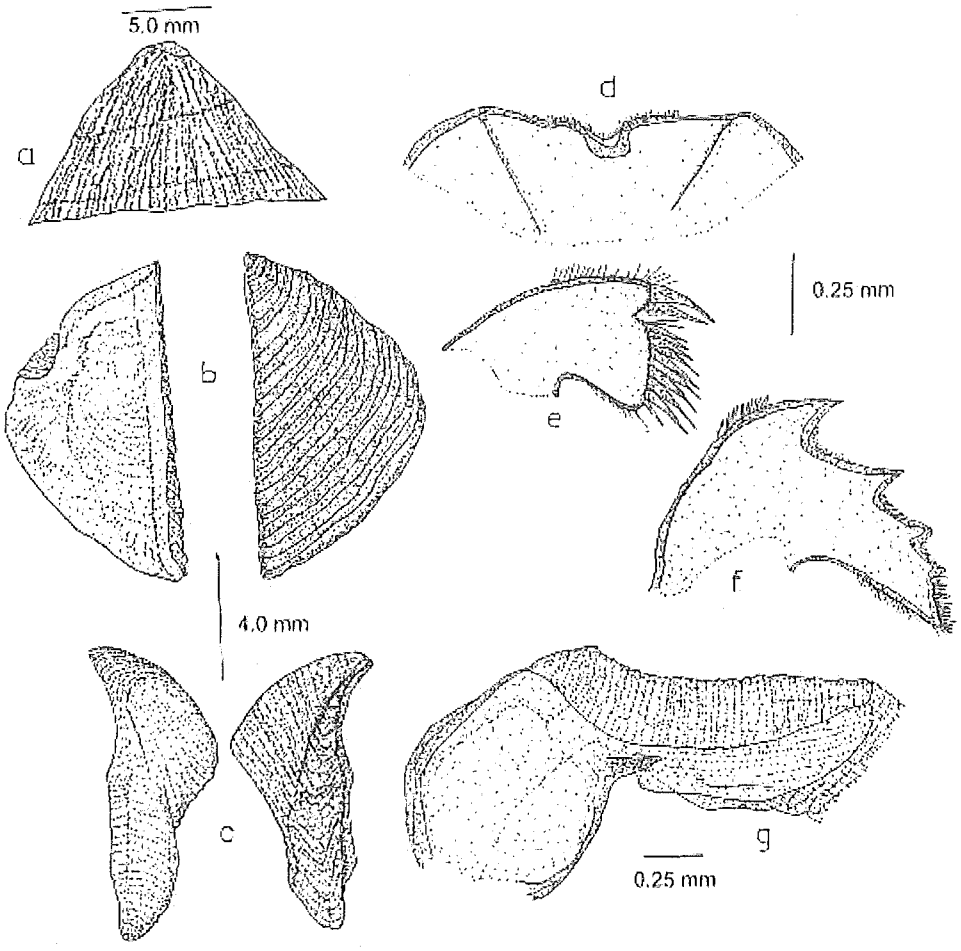

Fig. 7. *Tetraclita rufotincta*: a, shell. b, scutum (internal and external views). c, tergum. d, labrum. e, maxilla I. f, mandible. g, pedicel of penis.

Habitat:

This species is usually found attached to bare rocks in the intertidal region especially in the lower littoral zone. Its ecology on rocky shores at Paradise Point, Karachi has been described by Haq *et al* (1978).

Distribution Along Pakistan Coast:

Manora, Buleji, Paradise Point, Pasha Bundar, Cape Monz, Goth Mubbarak, Gaddani, Hingol, Ormara, Pasni, Gwadar and Jiwani.

Remarks:

The species is reported from the Red Sea by Achituv and Borut (1975) as *T. squamosa*, Pilsbry (1916) and Ross (1999), from the Persian Gulf and Arabian Sea by Utinomi (1969), from islands of Western Indian Ocean by Stubbings (1936)and from west coast of India by Daniel (1972). Haq *et al* (1978) and Ross (1999) reported this species from the Pakistan coast. Ross (1999) described this species as well as two new species i.e. *Tetraclita achituvi* and *T. barnesorum* from Red Sea. Apparently at least one more species of *Tetraclita* is noticeable on the rocky shores along the coast of Pakistan but it would require further study to ascertain its identity. The Pakistani specimens resemble the Red Sea specimens described by Ross (1999). However, he noticed that the medial sulcus of the labrum was devoid of any teeth in specimens from Red Sea. Pakistani specimens have 2 to 3 teeth on each side as well as fine hairs along the crest as observed by Nilsson-Cantell (1928) in specimens from Oman.

Super family BALANOIDEA Leach, 1817
Family ARCHAEOBALANIDAE Newman and Ross, 1976
Genus *Chirona* Gray, 1835

8. ***Chirona (Striatobalanus) amaryllis* (Darwin, 1854)**
(Fig. 8)

Description:

Shell tubulo-conical; orifice moderately large, pentagonal or subtriangular, toothed; surface smooth, pinkish purple with yellowish tint; lower half very lighter in colour, usually white; with leaden purple or purplish longitudinal stripes distinct on the upper half of the shell (Fig. 8a). Radii narrow, arched, with oblique summits; usually covered with a thin yellowish membrane; dirty white colour except the upper part which has purplish tint. Sheath dark purple. Alae broader and darker in colour; with summits rounded. Parities solid, non porous, smooth externally and ribbed internally. Basis calcareous, porous, flat or cup shaped. Scutum plainly striated longitudinally, with striate dividing distinct line of growth into squarish beads; articular ridge blunt, slightly prominent (Fig. 8b). Tergum long, with apex forming a slight beak; with noticeable longitudinal stripes on the scutal part only; a distinct longitunal furrow present; spur length more than twice the distance from basiscutal angle to spur (Fig. 8c). Labrum with 2 to 3 small teeth on each side of notch on the crest (Fig. 8d). Maxilla I with inferior part of cutting edge forming a distinct step like projection with two large spines; about 14 spines between the upper and lower pair of large spines (Fig. 8e). Mandible with 5 teeth; 2nd and 3rd bifid; 4th and 5th rudimentary which together with inferior angle form a blunt knob (Fig 8f). Basidorsal point of penis (horn) nude (Fig. 8g).

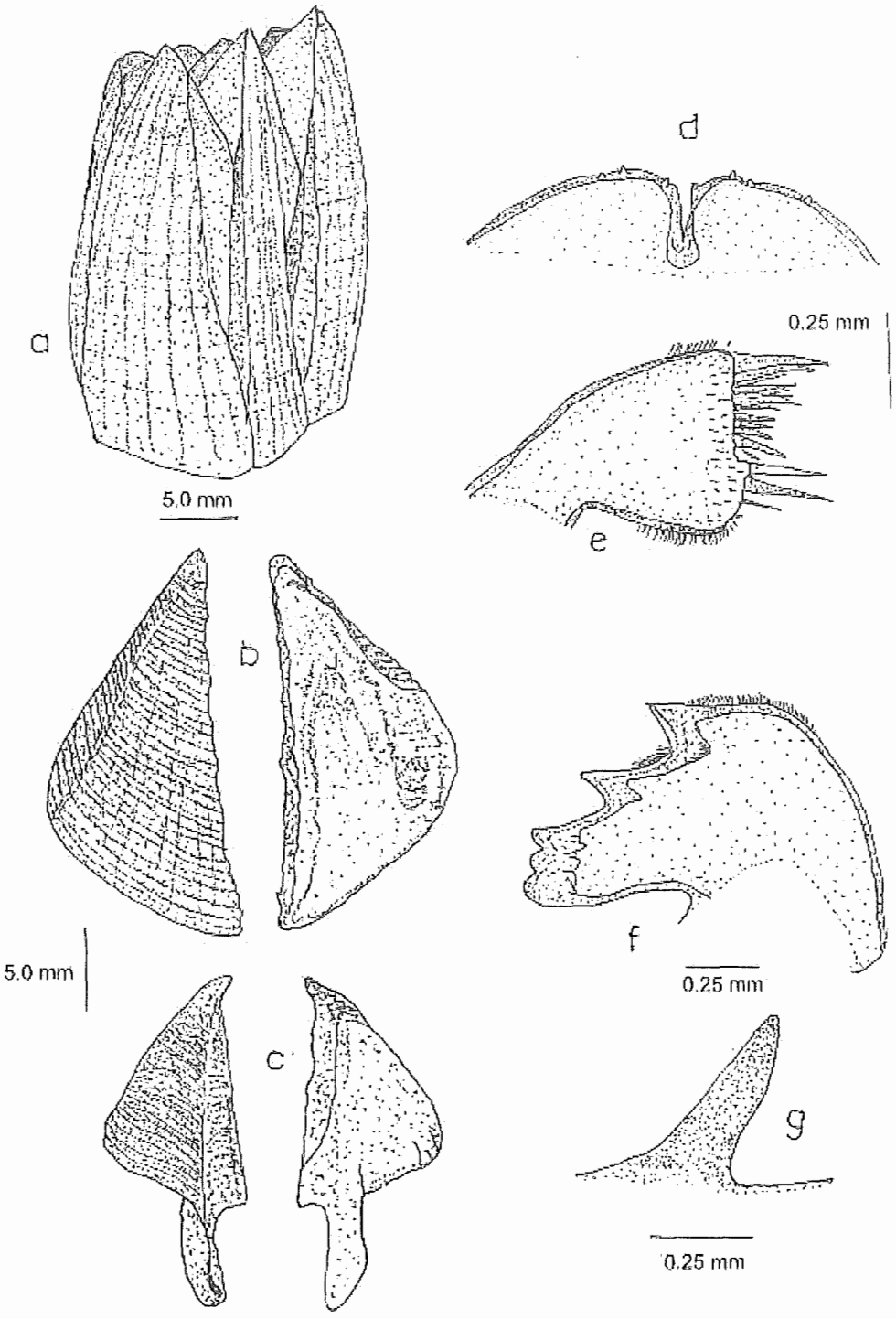

Fig. 8. *Chirona (Striatobalanus) amaryllis*: a, shell. b, scutum (internal and external views). c, tergum (internal and external views). d, labrum. e, maxilla I. f, mandible . g, basidorsal point of penis.

Habitat:

This species is usually found subtidally growing attached to molluscs, especially oysters.

Distribution Along Pakistan Coast:

River Indus, Paradise Point, Karachi.

Remarks:

The species was reported from the mouth of the River Indus (Darwin, 1854), from India (Daniel, 1955, 1972; Karande and Palekar, 1966; Wagh and Bal, 1974) and from Persian Gulf (Utinomi, 1969). The colour of the specimens from Pakistan is usually dirty white with purplish tinge on upper part instead of uniform snow white as described by Darwin (1854). All other characters are in agreement with the description of this species given by Darwin (1854) and Hoek (1913).

9. *Chirona (Striatobalanus) tenuis* (Hoek, 1883)

(Fig. 9)

Description:

Shell conical, almost as broad as high, dirty white. Orifice moderately broad, pentagonal, distinctly toothed (Fig. 9a). Radii narrow, without pores; summits oblique, broader towards basis. Alae broad with rounded summits. Parieties nonporous, strongly ribbed internally. Sheath white, striped horizontally. Basis calcareous, rounded, porous, thin. Scutum with distinct growth ridges crossed by delicate longitudinal striae; aritcular ridge prominent, half as long as the tergal margin, adductor ridge feebly developed (Fig. 9b). Tergum with scutal margin feebly hollowed out, apex beaked and curved towards scutum, longitudinal striae present; longitudinal furrow represented by a pair of curved crests running in a line almost from apex to extremity of spur separating scutal and carinal sides of spur and making appearance of a shallow, wide channel on the external side of tergum; spur width equal or more than the distance from basiscutal angle of spur; spur length almost ¼ th length of basal margin; crests for depressor muscles feebly developed (Fig. 9c). Labrum with 2-3 teeth close to each other on the crest on each side of notch, 3rd and 4th tooth often rudimentary; small hairs are present on the crest (Fig. 9d). Maxilla I with a nearly straight cutting edge and a slight notch below the upper pair of large spines; lower pair of large spines not on a step-like projection at base; a number of spine like hairs below the lower pair of large spines (Fig. 9e). Mandible bears 5 teeth, with 2nd to 4th double; inferior angle represented by a small portion (Fig. 9f). Basidorsal point of penis (horn) nude (Fig. 9g).

Habitat:

This species is usually found subtidally; growing attached to gastropod shells. It has been reported from depths down to 500 m (Newman and Ross, 1976).

Distribution Along Pakistan Coast:

Coastal and offshore areas along Sindh and Balochistan Coasts, Korangi and Gharo Creek, Gwadar (Demi Zur).

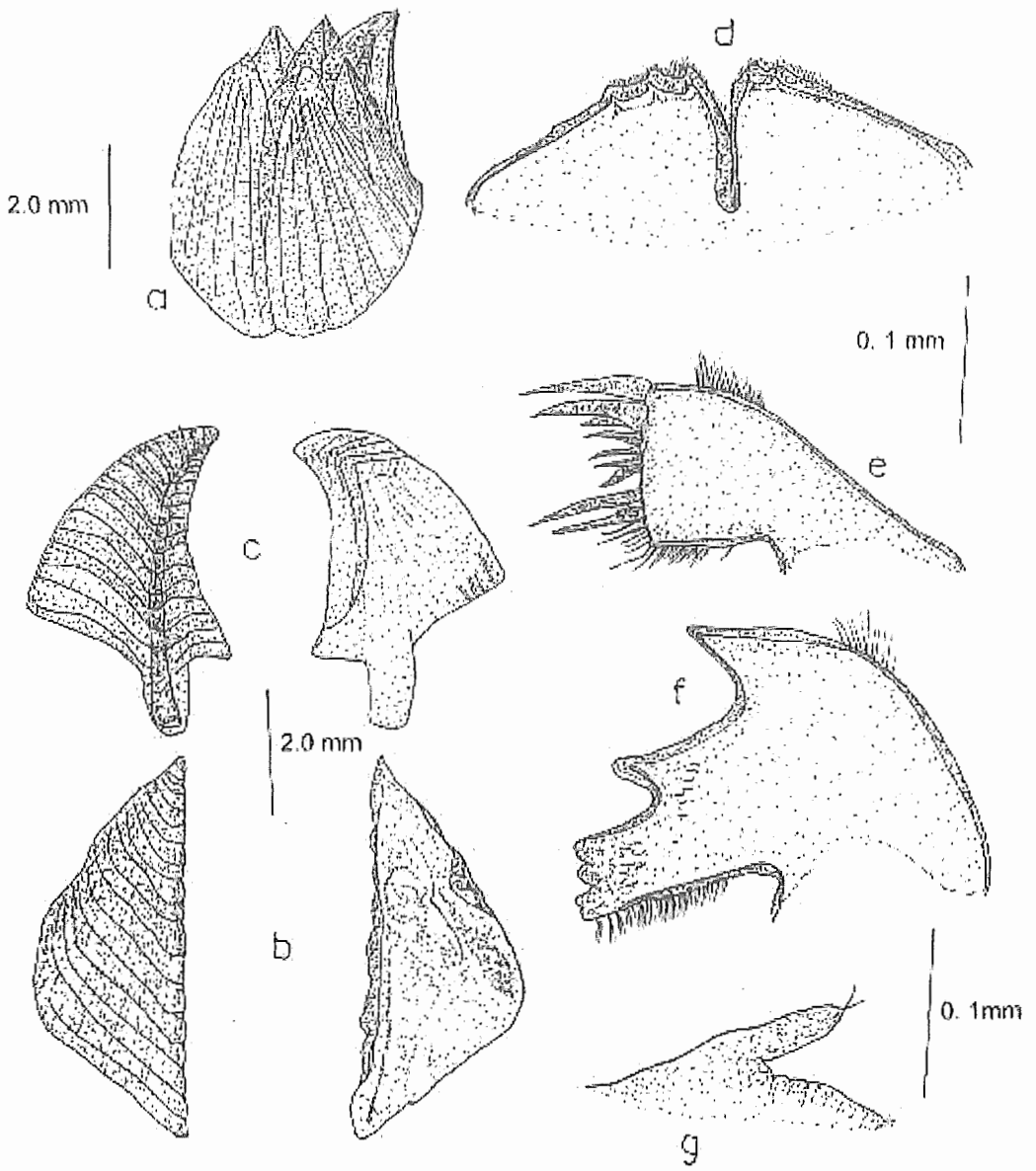

Fig. 9. *Chirona (Striatobalanus) tenuis*: a, shell. b, scutum (internal and external views). c, tergum (internal and external views). d, labrum. e, maxilla I. f, mandible. g, basidorsal point of penis.

Remarks:

The characters of the specimens from Pakistan agree with the description given by Hoek (1913) and Hiro (1937) except there are two distinct crests on the tergal surface making the appearance of a shallow wide open channel instead of only one crest as figured (Plate XVI Fig. 13) by Hoek (1913). Tergum in Pakistani specimens also resembles with tergum of *Balanus maculatus* as given in Plate XVII. Fig. 8d of Hoek (1913) except that the spur is not as broad and its posterior margin not going almost into basal margin of the tergum. It appears that the character of tergum might be variable

since most of the other characters described by Hoek (1913) are similar for *B. tenuis, B. maculatus* and *B. albus* Considering the similarity between *B. albus* and *B. tenuis* of Hoek (1913) these species have already been merged together (Newman and Ross, 1976).

This species has been reported from India (Daniel, 1955), Persian Gulf (Utinomi, 1969) and from Zanzibar, Maldives and Gulf of Aden (Stubbing, 1936). This is the first record for the Pakistan coast.

Genus *Solidobalanus* Hoek, 1913

10. *Solidobalanus (Solidobalanus) socialis* (Hoek, 1883)
(Fig. 10)

Description:

Shell conical, dirty white (Fig. 10a). Orifice large, elongately pentagonal. Radii narrow, oblique with rounded margin, solid. Alae triangular with upper margin parallel to basis. Parieties nonporous, solid, with longitudinal hyaline stripes. Basis calcareous, nonporous. Scutum with growth ridges prominent, longitudinal striae present; articular ridge prominent, more than half the length of tergal margin; with a distinct adductor furrow in the center, internally bending downwards (Fig. 10b). Tergum with spur short, bluntly truncated; spur width greater than the distance from basiscutal angle; tergal furrow present; crests for depressor muscles long and many (Fig. 10c). Labrum with 3 strong pointed teeth on the crest on each side of notch; sometimes 1-2 teeth on one side (Fig. 10d). Maxilla I with about 3-6 spines between the upper and lower pair of large spines on the cutting edge; all spines except the upper pair are broad, swollen at the base and sharply pointed (Fig. 10e). mandible with 5 teeth, four of them of nearly equal size with 2nd, 3rd bifid and 4th with a characteristic knob, 5th tooth somewhat blunt (Fig. 10f). Pedicel of penis with complete girdle and a large prominent horn (basi-dorsal point) nude (Fig. 10g).

Habitat:

This species is usually found subtidally; growing attached to molluscs. It has been recorded from depths down to 91 m (Newman and Ross, 1976).

Distribution Along Pakistan Coast:

Pipri, Paradise Point, Karachi

Remarks:

The specimens collected from Pakistan show similar characters as described by Hoek (1913) and Zullo and Newman (1964) except that the tergum of Pakistani specimens shows more or less distinct tergal furrow running from near the apex to the length of spur. In smaller specimens it was somewhat indistinct. The longitudinal striae are also noticed on scutum in comparison to none in the description of type specimen. It was also noted that maxilla I bears 5-6 instead of 3 spines located on a slight projected portion.

The species has been reported from Sri Lanka by Annandale (1906a) as *Balanus aeneas* and from Persian Gulf by Utinomi (1969). This is the first record for the Pakistan coast.

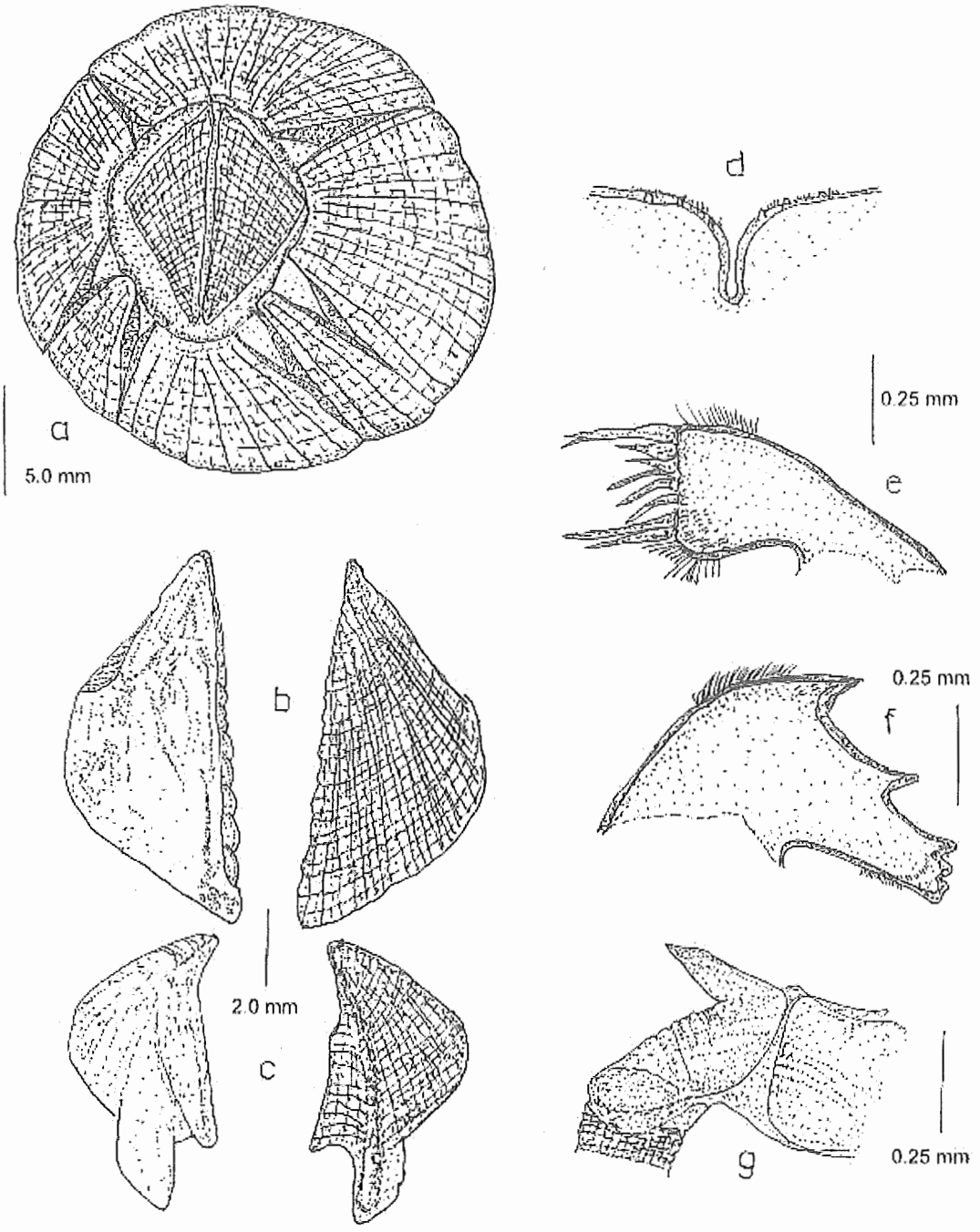

Fig. 10. *Solidobalanus (Solidobalanus) socialis*: a, shell. b, scutum (internal and external views). c, tergum (internal and external views). d, labrum. e, maxilla I. f, mandible. g, pedicel of penis.

Genus *Conopea* Say, 1822

11. *Conopea calceola* (Ellis, 1758)

(Fig. 11)

Description:

Shell elongate along rostro-carinal axis; usually covered with the 'bark' of *Gorgonia* to which it is attached (Fig. 11 a, d). Parietes porous, purplish red with longitudinal stripes. Rostrum white; sometimes feebly tinted with purplish red; with a notch at base point. Orifice rather small, heart shaped. Radii white, sometimes feebly tinted with the colour of shell; summit horizontal, extending from apex to apex of adjoining compartments; transversely striated; sutural edges obscurely dentated approximate septa; nonporous. Alae with oblique summits. Basis boat shaped, porous; with deep furrow on the underside due to the clasping of the branch of *Gorgonia* (Fig. 11d). Scutum with basi-tergal point rounded; with articular edge indistinct; adductor ridge usually absent; pit for lateral depressor muscle distinct (Fig. 11b). Tergum with spur, short and broad; spur width about 1/3 length of basal margin; spur end almost rounded; tergal apex slightly curved towards scutum, crests for depressor muscles feebly developed (Fig. 11c). Labrum with 3 teeth on the crest of each side of notch (Fig. 11e). Maxilla I with about 4 pairs of spines; sometimes a slight notch below upper pair of large spines (Fig. 11f). Mandible with 5 teeth (Fig. 11g).

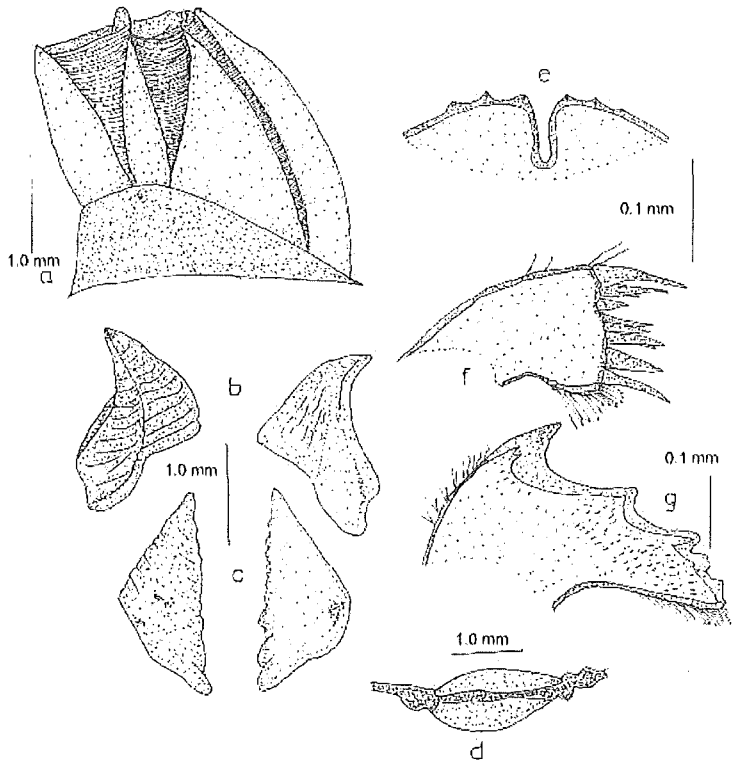

Fig. 11. *Conopea calceola*: a, shell. b, tergum (internal and external views). c, scutum (external and internal views). d, basal part of clasping basis of shell on *Gorgonia* branch as viewed from below. e, labrum. f, maxilla I. g, mandible.

Habitat:

This species is usually found subtidally; growing attached to *Gorgonia sp.* It has been recorded from a depth of 18 to 250 m (Newman and Ross, 1976).

Distribution Along Pakistan Coast:

Kemari backwaters, Clifton, Manora, Goth Mubbarak, Jiwani

Remarks:

The species has been reported from India by Daniel (1955) and Darwin (1854) and from the Persian Gulf by Nilsson-Cantell (1938) and Utinomi (1969). Kazmi (2001) reported it from the Pakistan Coast.

Family BALANIDAE Leach, 1817
Genus *Balanus* De Costa, 1878

12. ***Balanus amphitrite amphitrite* Darwin, 1854**
(Fig. 12)

Description:

Shell conical, white or bluish white, with longitudinal purple stripes (Fig. 12a) Radii broad, summits horizontal, slightly oblique. Sheath solid. Parietes with tubes in single row, without transverse septa. Basis with radial tubes and fine transverse septa. Scutum flat, with apex slightly recurved; articular ridge about 3/5 length of tergal margin; adductor ridge long and separated from articular ridge (Fig. 12b). Tergum with spur fascicole; spur length slightly less than spur width; carinal margin protuberance in about upper 1/3; distance from basidorsal angle to spur usually less than spur width (Fig. 12c). Labrum multidenticulate (Fig. 12d). Cirrus III without complex setae (12e). Cirrus III and VI with erect teeth below postero-distal angles. Basi-dorsal point (horn) of penis moderately large and nude (Fig. 12f).

Habitat:

This species is usually found in the intertidal area. It is also found abundantly on the hulls of ships and fishing craft and other floating structures. It is one of the most important fouling organisms causing heavy damage to shore installations.

Distribution Along Pakistan Coast:

All along the Pakistan coast especially in creek areas along Sindh Coast, Manora, Buleji, Paradise Point, Cape Monz, Goth Mubbarak, Gaddani, Miani Hor, Ormara, Kalmat Khor, Pasni, Ras Shumal Bundar, Gwadar and Jiwani.

Remarks:

The species exhibits considerable variation in its taxonomic characters. These variations have led to considerable confusion in the past in designating specimens from different localities to this species. The discrepancies in this regard have been described by Harding (1962), Utinomi (1960, 1967), Stubbing (1967), Southward (1975) and Henry and McLaughlin (1975) etc. A detailed description of the species was given by Henry and McLaughlin (1975) who reviewed and redescribed the species of *Balanus amphitrite* complex and redesignated the previous record of this species to its revised status.

Accordingly previous records of this species from Indian waters include those of Sunda Raj (1927) as *Balanus amphitrite venustis,* Nilsson-Cantell (1938) as *Balanus amphitrite cochiensis* and Karande and Palekar (1966) as *Balanus amphitrite communis*, *Balanus amphitrite hawaiiensis* and *Balanus amphitrite concinensis.* This species is reported from Pakistan by Hasan (1960, 1963), Haq *et al* (1978), Ahmed *et al* (1978) and Javed and Mustaquim (1995). The larval settlement of this species has been studied from Pakistan by Hasan (1960, 1963) and Ahmed *et al* (1978).

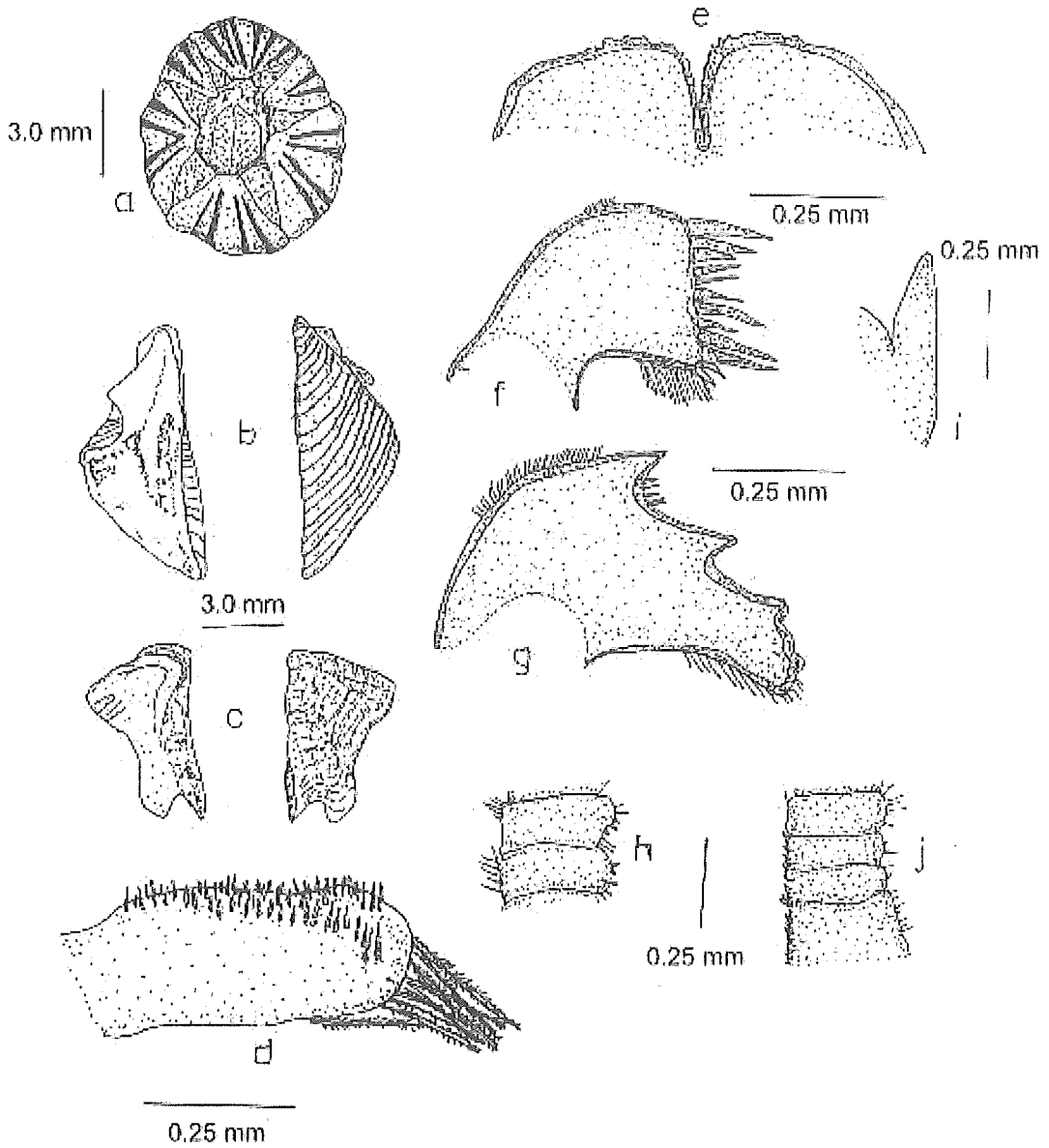

Fig. 12. *Balanus amphitrite amphitrite*: a, shell. b, scutum (internal and external views). c, tergum (internal and external view). d, palp. e, labrum. f, maxilla I. g, mandible. h, 5th and 6th segments of anterior ramus of cirrus III. i, first four basal segments of posterior ramus of cirrus III. j, pedicel of penis.

13. *Balanus reticulatus* Utinomi, 1967
(Fig. 13)

Description:

Shell conical with narrow to sometime wide radii, summits usually beveled or very oblique (Fig. 13a). Usually reddish gray with dark purple stripes, sometimes white. Orifice toothed. Parieties crossed by horizontal bands or flecks of white, with squarish pores, tubes in single row. Scutum usually flat with recurved apex articular ridge about 2/3 length of tergal margin. Adductor ridge well separated from articular ridge (Fig. 13b). Tergum with carinal margin slightly convex, sometimes protuberant in upper half; spur fasciole separated by narrow grooves from scutal and carinal sides; spur length about 1 ¼ width of spur or equal to the distance from basiscutal angle, about 1/5th of basal margin (Fig. 13c). Basal margin usually straight. Labrum simple, with 3-4 teeth on the crest on each side of notch (Fig. 13d). Maxilla I with slight prominence at the base of lower pair of spines (Fig. 13e). All cirri with simple spinules. Cirrus II to VI with conic teeth near anterior margins (Fig. 13i). Cirrus III without complex setae. Cirrus II-VI bear erect teeth below postero-distal angles. Basidorsal point of penis narrow, usually with 1-2 apical setae.

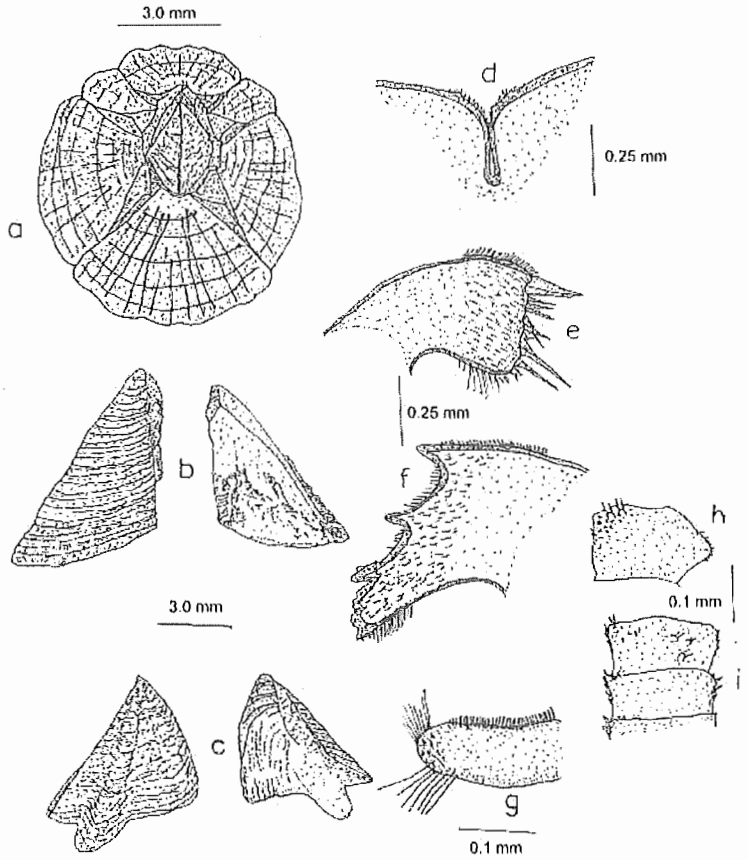

Fig. 13. *Balanus reticulatus*: a, shell. b, scutum (internal and external views). c, tergum (internal and external view). d, labrum. e, maxilla I. f, mandible. g, palp. h, 5th segment of anterior ramus of cirrus II. i, 3rd and 4th segments of posterior ramus of cirrus III.

Habitat:
This species is usually found in intertidal areas attached to rocks, shells of molluscs, wood, boats, ships and shore installations.

Distribution Along Pakistan Coast:
Manora, Buleji, Paradise Point, Karachi and Pasni

Remarks:
The species can be confused with *Balanus amphitrite amphtrite.* The taxonomic description of this species was established by Utinomi (1967). Later on Southward (1975) and Henry and McLaughlin (1975) gave additional diagnostic characters. This species was reported from India by Karande and Palekar (1966) as *Balanus denticulatus* (Henry and McLaughlin, 1975). Present paper records it for the first time from Pakistan Coast.

14. *Balanus trigonus* Darwin, 1854
(Fig. 14)

Description:
Shell conical pinkish purple (Fig. 14a). Orifice distinctly trigonal. Parieties with a single row of tubes, without transverse septa; with distinct raised ribs externally. Radii solid; pale pink or white; radii of the rostrum with summits slightly oblique. Basis calcareous, porous. Scutum with characteristics longitudinal rows of small pits, usually 2-3 rows but may vary from 1-6 (Fig. 14b). Tergum without longitudinal furrow; spur blunt and wide; spur width about half the width of valve (Fig. 14c). Labrum with 3 teeth on each side of the notch on the crest (Fig. 14d). Maxilla I without notch; lower pair of spines longer than the rest spines (Fig. 14e). Mandible with 4 teeth; with 4^{th} tooth double and 5^{th} rudimentary or absent (Fig. 14f). All cirri with pectinate setae; Cirrus I with shorter ramus about half the length of longer; Cirrus II with conic teeth on antero-distal margins; Cirrus II, III with erect tooth on the basal segments of anterior ramii; Cirrus V with usually 2 erect teeth on posterior margin of basal segment (Fig. 14g-i). Basidorsal point of penis prominent, slightly curved and nude (Fig. 14j).

Habitat:
This species is found attached to crustaceans, molluscan shells and underwater submerged structures.

Distribution Along Pakistan Coast:
Paradise Point, Karachi, Ormara, Gwadar.

Remarks:
The species has been reported from Indian coast by Stubbing (1936), Nilsson-Cantell (1938) and from the Persian Gulf by Utinomi (1969). The present report is the first from the Pakistan coast.

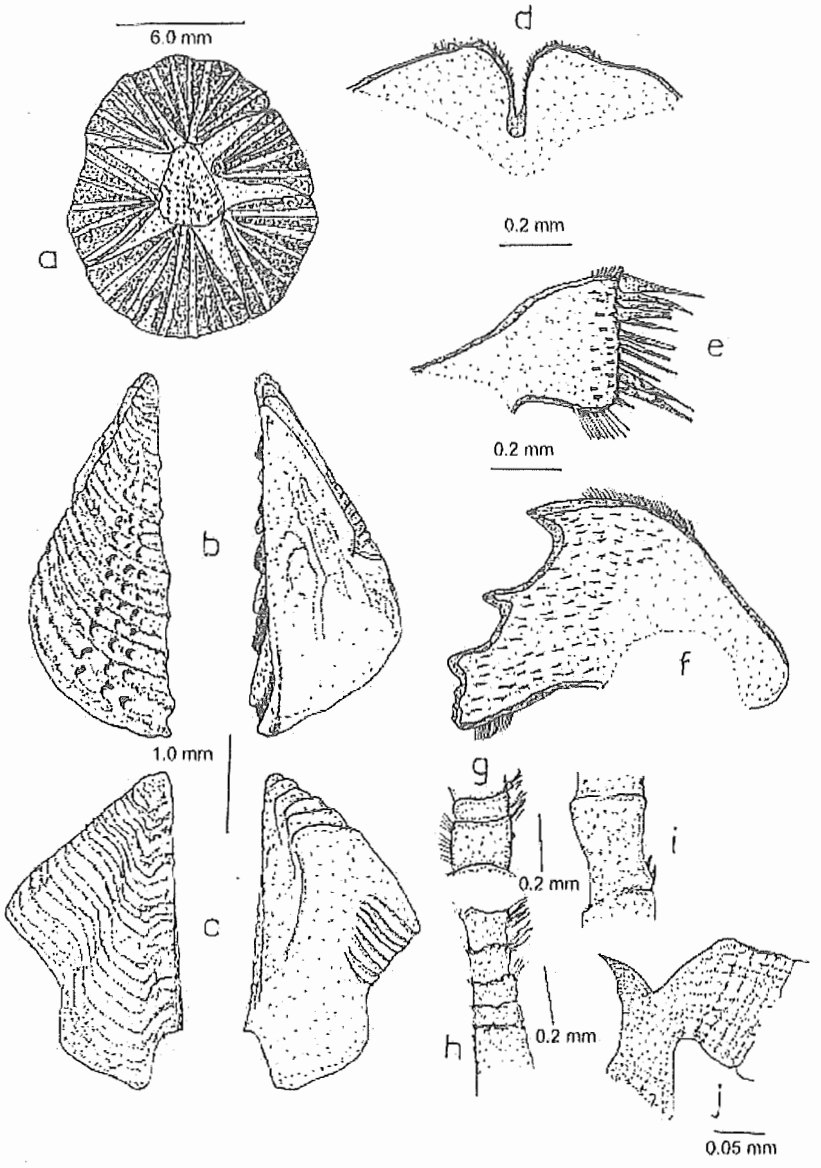

Fig. 14. *Balanus trigonus*: a, shell. b, scutum (internal and external views). c, tergum (internal and external view). d, labrum. e, maxilla I. f, mandible. g, first two segments of anterior ramus of cirrus II. h, first five segments of anterior ramus of cirrus III. i, basal segment of cirrus V. j, basidorsal point of penis.

Genus *Megabalanus* Hoek, 1913

14. ***Megabalanus tintinnabulum* (Linnaeus, 1758)**
(Fig. 14)

Description:

Shell large sized, tubo-conical, colour varies from pink to blackish purple (Fig. 15a). Orifice usually entire, nearly trigonal Shell solid about half as long as parieties, overhanging, tinted with the colour of shell. Internal lamina of shell generally smooth.

Parietes with a single row of tubes, longitudinally striped, somewhat ribbed or folded externally. Radii very wide, smooth, transversely porous, summits horizontal, with longitudinal striae more pronounced than transverse striae in uneroded specimens. Basis calcareous, much stronger than compartments, porous. Scutum relatively narrow, basal margin about 2/3 length of tergal margin, basi-tergal corner almost parallel to occludent margin; articular ridge broad and very prominent, about half as long as tergal margin, ending in a free point; adductor ridge indistinct, confluent with the articular ridge and runs down the valve bordering the pit for depressor muscles; adductor muscle pit oval; pit for lateral depressor muscle deep and distinct (Fig. 15b). Tergum broad, usually white, basal margin form nearly an obtuse angle with tergal on both sides; distance from basi-scutal angle to spur 1-2 times spur width and less than the spur length; tergal furrow closed; articular ridge indistinct; articular furrow distinct, moderately deep, becomes narrower towards apex; crests for lateral depressor muscles feebly developed and usually 3-5 (Fig. 15c). Labrum hairy, with 2-3 teeth on the crest on each side of notch; teeth often obscured or absent (Fig. 15d). Maxilla I with cutting edge straight, upper pair of large spines followed by 7-10 spines below, lower 2/3 of cutting edge with 2 large spines and about 4-6 small spines below (Fig. 15e). Mandible with 5 teeth, 2nd and 3rd bifid (Fig. 15f). Basidorsal point of penis short, blunt and nude (Fig. 15g).

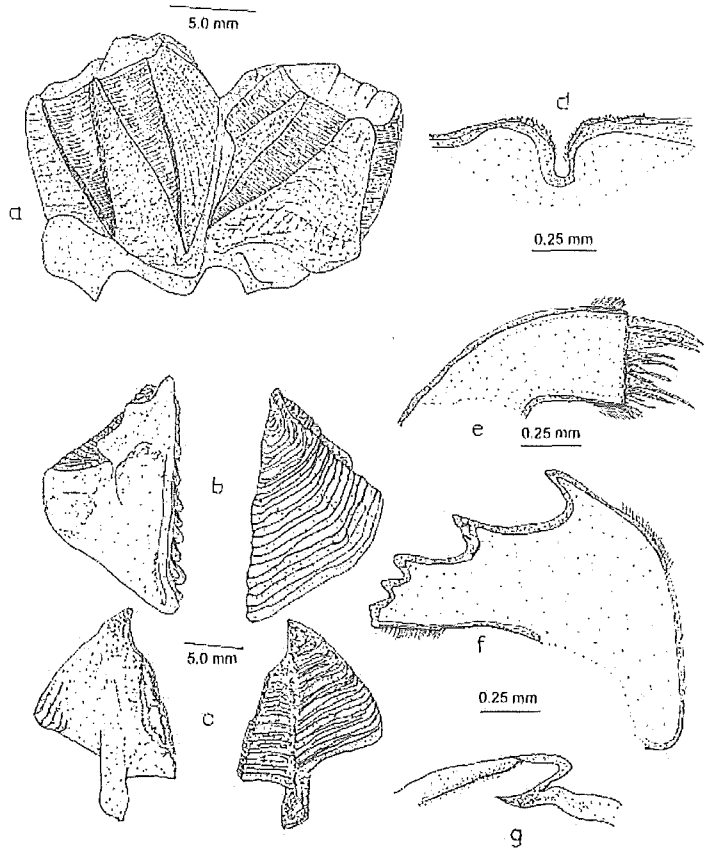

Fig. 15. *Megabalanus tintinnabulum*: a, shell. b, scutum (internal and external views). c, tergum (internal and external views). d, labrum. e, maxilla I. f, mandible. g, basidorsal point of penis.

Habitat:

This species is usually found at or below low water mark on rocky coasts. It forms clumps attached to rocks and submerged structures.

Distribution Along Pakistan Coast:

Manora, Buleji, Paradise Point, Cape Monz, Goth Mubbarak, Gaddani, Ormara, Pasni, Gwadar and Jiwani

Remarks:

The species shows variations in various characters of the opercular valves i.e. the structure of adductor ridge on scutum, spur length, crests for depressor muscles, tergal furrow and the angle of basal margin on both sides of spur. The number of teeth on labrum vary from none to 3 on each side of the notch. The number of spines between the upper and lower pairs of spines on the cutting edge of maxilla I may vary from 7 to 10. A notch may be present below the first pair of spines in maxilla I while it is absent in many specimens. The range of such variations often make it difficult to ascertain some specimens to this species. Henry and McLaughlin (1986) have studied *Megabalanus* group in detail and noted considerable variations in various characters. It is interesting to note that Sagar (1962) had noticed almost similar variations in his specimens of barnacles collected from the Karachi coast. He was unable to place them under *Megabalanus tintinnabulum* or *B. tulipiformis* and consequently he proposed that his specimens probably belonged to a new species. Considering the range of variations in certain characters of this species, his specimens most probably belong to *Megabalanus tintinnabulum*. This species has been reported from India by Daniel (1955, 1972), Karande and Palekar (1966), Nilsson-Cantell (1938), Wagh and Bal (1974) and from Arabian Sea by Stubbing (1936).

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