STUDIES ON THE FAUNA OF CURAÇAO AND OTHER CARIBBEAN ISLANDS: No. 150.

INTERTIDAL AND SHALLOW WATER CIRRIPEDIA OF THE CARIBBEAN

by

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The Cirripedia of the Caribbean region are surprisingly little-known. Since the monograph on the American species (PILSBRY 1916) only a few papers have been published dealing specifically with caribbean cirripedes: one by PILSBRY himself (1927), two by NILSSON-CANTELL (1933, 1939), and two by ROSS (1968, 1969). To some extent the picture has been improved by papers dealing with other geographical regions where a few of the caribbean species are also encountered (PILSBRY 1953; HENRY 1954, 1958; MOORE & FRUE 1959; MOORE & MCPHERSON 1963; ZULLO 1966; WELLS 1966; WERNER 1967; STUBBINGS 1967) but up to now there has been a great lack of knowledge of the common intertidal species. The geography of the Caribbean prevents quick surveys of the type that have been carried out in Europe and North America, and I was therefore delighted to find that the faunal collections made by Dr. P. WAGENAAR HUMMELINCK since 1930 contained a wealth of information on the distribution of the shore and shallow water species.

This contribution is based mainly on the samples collected by Dr. HUMMELINCK: each sample bears a serial number and these are quoted in the text, full station details being given in the annexed list. For further information on the samples and the geography of the sampling areas reference should be made to WAGENAAR HUMMELINCK (1933, 1940, 1953). Additional material was collected for me by the NOTTINGHAM UNIVERSITY EXPEDITION to the Netherlands Antilles, 1962: these samples are denoted N.U. in the text. Some further samples from Trinidad were sent to me in 1962 by the Trinidad and Tobago Electricity Commission, by arrangement with

Messrs. HOWARD HUMPHREYS AND SONS: these samples are denoted T.T. in the text. Samples from the northern Caribbean have been supplemented by material kindly loaned to me by the Institute of Oceanography, Cuba, by arrangement through Dr. J. H. WICKSTEAD: this material is denoted (W) in the text. My own samples are listed by the month and year of collection.

This report deals only with the region from Cuba to Trinidad and Aruba (the Antilles as defined by HUMMELINCK 1953) together with some mainland localities in Panamá, Colombia and Venezuela. Subsequent reports will cover adjacent regions, thus allowing some general conclusions to be drawn about the distribution of Cirripedia in this part of the tropics.

I would like to express my gratitude to Dr. P. WAGENAAR HUMMELINCK for allowing me to work up his collections, and to him and Drs. LOUISE J. VAN DER STEEN and Drs. H. A. TEN HOVE for their assistance and hospitality during my stay in Utrecht.

Additional investigations on Caribbean material were carried out at the Zoological Museum, Amsterdam; this material is denoted (A) in the text, and I am indebted to Dr. J. H. STOCK and Dr. S. PINKSTER for their help. Thanks are also due to Dr. T. H. BOWMAN of the Smithsonian Institution, Washington, for arranging the loan of some of PILSBRY's material, which is listed under the U.S.N.M. number.

I am indebted to the Organising Committee for CICAR and Dr. HARVEY BULLIS of the U.S. National Marine Fisheries Service for an invitation to join a cruise of F.R.V. "Oregon II" which led to my being able to visit several Caribbean localities, and to the Royal Society of London for financial assistance in this connection. Local help in collecting cirripede samples was provided by Prof. I. GOODBODY and Dr. P. MEADOWS in Jamaica; Prof. R. KAUFMANN in Colombia; Dr. I KRISTENSEN in Curaçao; Prof. J. S. KENNY and Dr. P. BACON in Trinidad; and Dr. J. B. LEWIS in Barbados. My thanks are also due to Mr. H. V. MORRIS and other members of the Nottingham University Expedition for their unflinching persistence in collecting samples of coral and millepore-dwelling barnacles.

The manuscript has been read by Dr. J. P. HARDING and Dr. W. A. NEWMAN, who have helped to correct the taxonomy and have given valuable advice on presentation of the results.

Finally, I wish to thank my wife, Dr. EVE SOUTHWARD, for her assistance during the field work and in dealing with the samples at Utrecht and Amsterdam.

In the following pages, I have, as far as possible, retained the taxonomic arrangement and nomenclature of PILSBRY (1916), which is basically that of DARWIN (1854), so that the non-specialist can make easier reference to previous distribution records for the Western Hemisphere. However, the taxonomy of the Cirripedia is today in a state of flux, and revisions of the basic Darwinian system are appearing several times a year and more are threatened. Of these particular revisions, the most necessary has been that of HARDING (1962), who has redescribed and rearranged the Darwin types of the so-called varieties of *Balanus amphitrite*: this new arrangement has been followed in full. The genus *Tetraclita* has recently been revised by ROSS (1969) and the coral-inhabiting barnacles by ROSS & NEWMAN (1973): since these involve very marked changes in genus names I am giving both the old and new names to avoid confusion. Apart from this I have avoided giving an exhaustive list of synonyms for each species, and instead the reader is referred to the most recent contribution containing such a list.

As most of the material collected came from rocky shores, mangroves, and the immediate sub-littoral, most attention has been focussed on the sessile balanomorph species abundant in such habitats. Some records of Lepadomorph species are given below, but no attempt has been made to study them fully.

LEPADOMORPHA

Lithotrya dorsalis (Ellis)

This species lives in burrows in coral rock and other limestones and has already been recorded from Jamaica, Puerto Rico and Curaçao by PILSBRY (1916, 1927) and from Bonaire (1058, 1057 and 1049a resp.) by NILSSON-CANTELL (1933). Additional material comes from: JAMAICA, cays off Port Royal (Oct. 1970), CAYMAN BRAC, 1703; FOURCHE, 1124; BONAIRE, 1056Ba, 1058C; and CURAÇAO, 1017, 1021, 1024, 1330, 1354, Westpunt Baai (N.U.). It appears to be restricted to clean open coast sites with some degree of wave-action, and is probably dependent on water movement for a supply of food (cf. CANNON 1947).

Lepas anatifera L.

A variety of this widespread species was washed up on driftwood at FOURCHE, 1124; ST. EUSTATIUS, 1433, and Schildpaddenbaai (21.II.1949, A. C. J. Burgers); BARBADOS, Conset Bay (6.VII.1967); and TOBAGO, Scarborough (19.I.1955).

Lepas anserifera L.

Another widely distributed goose-barnacle which has already been recorded from Bonaire (1061, 1070), Curaçao (1016, Playa Canoa) and Aruba (1011), on either

Sargassum, *Spirula*, wood or cork. Additional material was collected at JAMAICA, Port Royal beach, 1973; BARBUDA, 1531; BONAIRE, 1070c, 1593A, Cay 17.IX.1948, Lagoen 9.III.1955); and CURAÇAO, Boca Tabla 11.III.1949 and Caracasbaai 21.XI.1954 (Zaneveld).

BALANOMORPHA

Balanus (Megabalanus) tintinnabulum antillensis Pilsbry

CUBA, a few from near Havana (W).
ST. EUSTATIUS, few dead shells, 1117.
TRINIDAD, common on jetty of Monos island (T.T.).
CENTINELA (Venezuela), several on silicified shales, 1212.
BONAIRE, dead shells from limestone, 1378, and Malmok.
CURAÇAO, 2 specimens from iron poles at entrance to Piscadera Baai, 1462.
ARUBA, on iron beam at Eagle Wharf, 1302.
PARAGUANÁ (Venezuela), several sub-fossil in escarpment near Carirubana, II.1937.

Synonymy: PILSBRY 1916.

PILSBRY described the antillean subspecies of *B. tintinnabulum* on the basis of material from St. Thomas and Jamaica; other previous records are from Curaçao (PILSBRY 1927), Centinela and the Venezuelan coast (NILSSON-CANTELL 1939). The specimens I have seen correspond very well with PILSBRY's descriptions and photographs (PILSBRY, pl. 13). The distinctive colours of the tergoscutal flaps in life have been illustrated from the Trinidad samples in SOUTHWARD & CRISP (1963). A substantially similar colour pattern of dark green contrasting with dark red was seen in the tergo-scutal flaps of live specimens in S. Florida. Unfortunately, quite similar, though brighter, colours have been seen in live material in California (*B. tintinnabulum californicus* Pilsbry) and also in fouling specimens attributable to *B. tintinnabulum zebra* Pilsbry taken from the hull of R.R.S. "Discovery", hence the colour appears to be of little use in distinguishing the subspecies of races of this variable species.

The antillean form must be much more widespread than is indicated by the existing records; it is most common sublittorally or on very wave-beaten rocks, and is not easily collected.

Balanus (Balanus) eburneus Gould

FLORIDA, Virginia Key, few dead shells on concrete, 1409. Key Biscayne, dead shell on *Rhizophora*, 1412.
CUBA, south coast, abundant among mangroves and in sheltered places (W).
JAMAICA, Kingston Harbour, near Port Royal, common to abundant, 1677, 1678, 1679, 1680A, 1681.
PUERTO RICO, common on mangroves in Bahía Fosforescente, 1420, 1421.
ST. THOMAS, few on mangroves, 1674.
GUADELOUPE, common on mangroves in Rivière Salée, 1543.
MARTINIQUE, present on mangroves near Trois Rivières, 1547.
ST. LUCIA, dead shells on mangroves and wreck at Port Castries, 1548.
ST. VINCENT, present on dead *Conocarpus* at Calliaque Bay, 1549.
GRENADA, common on jetty in Lagoon St. George, 1391; mangroves at Hog Island, 1550.
TRINIDAD, common off Port of Spain and on mangroves at Monos Island (T.T.)
MARGARITA, common on mangroves, 1217a, 1446, 1448, 1449.
CURAÇAO, dead shells from rock in Schottegat, 1034; dead shells in St. Martha Baai (ten Hove, 1970); common to abundant in Piscadera inner bay, 1469, 1473b, 1476, 1487, 1493b, 1498, 1621, 1708; sub-fossil at St. Jan excavation (Ethn. Museum, Leiden).
ARUBA, common on dead mangroves, rock and mussels, Spaans Lagoen, 1008A, 1305.
COLOMBIA, common on pilings from harbour at Cartagena (Nov. 1970).

Synonymy: PILSBRY 1916.

Previous records within the Caribbean area are from Cuba and Jamaica (PILSBRY 1916) and Trinidad (BACON 1971) this is a species typical of estuarine, muddy or polluted habitats, and can be presumed to be present in suitable places throughout the Caribbean.

Some dead shells of *B. eburneus* came from an anthropological excavation at St. Jan, Curaçao, recorded as "on a deer antler (possibly used as a tool) at 25–30 cm depth". PILSBRY (1918) has recorded other subfossil shells of the species from 10 ft. above present sea level near the lower end of the Gatun locks at the Atlantic end of the Panama Canal.

Balanus (Balanus) improvisus Darwin

Synonymy: PILSBRY (1916).

Balanus improvisus is a widespread fouling barnacle which has often been confused with other species of the genus, especially *B. eburneus.* Both DARWIN (1854) and PILSBRY (1916) record it from the West Indies, and it would appear to have once been common in Jamaica, from which locality DARWIN also recorded a hyaline-striped form, his variety *assimilis.* Surprisingly, it is not present in any of the collections reported on here, and I have not seen it in fouling habitats where it ought to be present. Prof. D. J. CRISP (personal comm.) could find no trace of it in Southern Florida in spite of extensive searches in the sort of habitat where it would be expected, though it is common on the Gulf Coast further north.

Balanus (Balanus) "assimilis"

FLORIDA, Virginia Key, few on rock and concrete piling, 1408A, 1409. Key Biscayne, near mangroves, 1410.
JAMAICA, Kingston Harbour, on pilings, 1148; at and near Port Royal, 1679, 1680A, (Oct. 1970).
PUERTO RICO, on dead *Rhizophora* at 10 m, near Mayagüez, 1416.
GUADELOUPE, fairly common on *Rhizophora* and oyster shells, Rivière Salée, 1484, 1543, 1545A.
STA. LUCIA, on *Rhizophora* and wreck in Port Castries, 1548.

In some of the samples where *Balanus eburneus* was present there were specimens of a barnacle related to the *amphitrite* series, but definitely not *Balanus improvisus.* While working in Florida Prof. CRISP and I called this barnacle *Balanus "assimilis"* because it had colourless hyaline stripes on the shell similar to those reported by DARWIN (1854) for his variety *B. improvisus assimilis.* The exact taxonomic status of this barnacle will be dealt with elsewhere by SOUTHWARD & CRISP. It is probably the species recorded as *improvisus* by MOORE and FRUE (1959). I have seen very similar specimens from Brazil, and I suspect that *B. improvisus assimilis* of F. MÜLLER (1867) is also referable to this undescribed species.

Balanus (Balanus) amphitrite amphitrite Darwin

(Plate I figs. 1–3)

FLORIDA, Virginia Key, common on piles, 1409. Key Biscayne, common on mangroves, 1410A, 1412.

JAMAICA, Kingston Harbour, Port Royal, one only (Oct. 1970).
TRINIDAD, intake screens to power station at Port of Spain, several (Dec. 1970).
MARGARITA, common on *Rhizophora*, 1446, 1447, 1448, some very large.
BONAIRE, abundant on hull of schooner moored at Kralendijk Harbour for about 18 months since dry-docking in Colombia (N.U.)
CURAÇAO, on hull of ship from Venezuela, 3.III.1955; in 1970 collected for the first time in Piscadera inlet, on mangroves, 1487; in 1973 present in small numbers at several sites in inner Piscadera Bay, 1469a, 1473b, 1498a, 1620, 1621Ab, 1622, 1623, 1708.

Synonymy: HARDING 1962, ZULLO 1966, STUBBINGS 1967, UTINOMI 1967.

The exact distributional status of this species is still extremely confused; owing to the ambiguity of the original description by DARWIN (1854) and the extreme variability of the species (which DARWIN well realised) a large number of sub-species have been described from different localities. In selecting some of DARWIN's material for a lectotype of the "common purple striped variety" (i.e. "*communis*" of DARWIN), HARDING (1962) chose specimens which possess a multidenticulate labrum and other characters which indicate that the worldwide forms previously called *B. amphitrite denticulata* Broch and *B. amphitrite hawaiensis* Broch are synonyms of this common variety. Under modern nomenclature this widespread "purple-striped variety" therefore becomes *B. amphitrite amphitrite*. However, UTINOMI (1960) had previously regarded a different barnacle of the *amphitrite* series as the equivalent of DARWIN's "*communis*", and this barnacle possesses a labrum with few teeth and has other characters which distinguish it from *B. amphitrite amphitrite*. While accepting HARDINGS' revision, UTINOMI (1967) believes that DARWIN's "common purple striped variety" may have included more than one variety or subspecies, including this form that UTINOMI regarded as "*communis*" in earlier publications. UTINOMI has renamed this form and recently accorded it full specific rank as *Balanus reticulatus* (see p. 11). Owing to the close superficial resemblance of *B. amphitrite amphitrite* and this other species, and the fact that they can sometimes be collected together from the same habitat, there is a chance that the two have been confused by previous investigators and may still be confused in future. For distinguishing features and further discussion see Table I and p. 12. It should be noted that the maxilla of *amphitrite*

TABLE 1

COMPARISON OF CHARACTERS OF *Balanus amphitrite amphitrite* AND *B. reticulatus*

CHARACTER	*Balanus amphitrite amphitrite*	*Balanus reticulatus*
radii	horizontal to slightly oblique	v. oblique, usually over 45°
pores in parietes	simple, rounded	simple, rounded to square
colour in parietes	a white ground colour, with purplish stripes, opposite pores	a white ground colour with purplish to reddish stripes opposite pores, crossed by horizontal bands or flecks of white
length of spur of tergum	short	medium
ratio: distance of spur from scutal margin of tergum/width of spur	0.54 to 0.66 (including lectotype)	0.66 to 1.66 (mean of 13 : 0.97)
crests for depressor muscles on tergum	3 to 5, mostly 4	5 to 7, mostly 6
No. of teeth on labrum	multidenticulate	4 + 4, but one specimen out of 17 with 4 + 3.
hooked spines on basal segments of cirrus 3	very obvious	present, but less obvious than in *amphitrite*
lower corner of maxilla	Usually not prominent. Out of 10 specimens examined only 2 had projection equal to width of one of the large spines, and 3 had slight projection less than this.	Prominent: out of 10 specimens examined 7 had projection equal to width of one of the large spines; none with more projection than this, three with less.

is more variable than might be expected from previous accounts; half the specimens examined showed some degree of prominence of the lower angle, though only 20% had a prominence equal to the thickness of one of the spines. The only reliable single character is the number of teeth on the labrum (see Fig. 1).

Balanus amphitrite amphitrite does not appear to have been common in the Caribbean or in Eastern U.S.A. before 1916, as the monograph published by PILSBRY that year does not mention it at all, though we should note that PILSBRY's later account (1953) of the barnacles collected in Florida in 1952 does not mention it either. The only possible early record from the Western Hemisphere is DARWIN (1854) "on a ship from the West Indies". I have re-examined the remaining specimens so-labelled in the collections at the British Museum (Natural History); they are without valves or animal parts but from shell characters I do not think they are *amphitrite amphitrite*, but possibly referable to *stutsburi*, *obscurus* or even "*assimilis*" (see Table 2). It would appear, therefore, that ZULLO (1966) is quite correct in coming to the conclusion that *B. amphitrite amphitrite* must have been introduced into south-east U.S.A. fairly recently. The taxon is now well-established all along the eastern shores of U.S.A., with a seemingly continuous population from Florida to North Carolina, and its spread may well have been assisted by the prevailing currents (Florida current and Gulf Stream). In contrast, records from the central and southern Caribbean area are extremely scattered, and suggestive of small scale isolated introductions by shipping traffic. The species is probably still spreading, and the records from Curaçao and Trinidad strongly indicate very recent establishment.

Balanus (Balanus) amphitrite?

There are several lots of dead shells in the collections, lacking opercular valves and soft parts, which cannot at present be identified fully. These are from: ST. JOHN, 1407, ST. LUCIA, 1548, TRINIDAD, s.n., and CURAÇAO, 1034.

Balanus (Balanus) pallidus stutsburi Darwin

TRINIDAD, Nariva River mouth, 792A.
BONAIRE, on washed up tree-trunk, 1070A.
CURAÇAO, Schottegat, from hull of ship after six months service in Lake Maracaibo, abundant, 3.III.1955.

Synonymy: HARDING 1962, STUBBINGS 1967.

TABLE 2

DRY SPECIMENS FROM THE "DARWIN" COLLECTION AT THE BRITISH MUSEUM (N.H.) NOW REFERABLE TO *Balanus reticulatus*, FORMERLY REGARDED AS *B. amphitrite communis* OR *B. amphitrite amphitrite*

B.M. (N.H.) REGISTER NO.	LOCALITY	LABEL OR WRITING ON CARD
1961.12.6. 8c, 9c, 10c, 11c	ships bottoms	"var. communis"
1961.12.6. 18e tergum no. 6	none	"communis"
1961.12.6. 22c	none	"B. amphitrite"
old material not yet re-registered		
card no. 2 (3 out of 6 shells)	none	"M. Cuming, B. amphitrite vars"
card no. 11 (135) 2 lots	none	none (card also bears specimen of *B. variegatus*)
card no. 32 (136)	none	"B. amphitrite"

N.B. the material re-registered as 1961.12.6. 6c, 7c labelled as "var communis. ship from West Indies" (HARDING, 1962) is probably neither *reticulatus* nor *amphitrite.*

For the moment, I am placing in this striped subspecies of *B. pallidus* the Bonaire specimens which NILSSON-CANTELL (1933) regarded as *B. amphitrite inexpectatus* Pilsbry. I have seen material referable to PILSBRY's subspecies on rocks in the Pacific at Panama City, and the barnacles collected by HUMMELINCK at Bonaire are quite unlike these. The multiple nature of the pores in the shell parietes is definitely characteristic of *B. pallidus* as redefined by HARDING (1962), but the Bonaire specimens have the coloured stripes opposite the septa not the larger pores. The tergum has a large rather blunt spur and the lower margin hollowed out, as in some African specimens (STUBBINGS 1967); there are three teeth on the labrum each side, and the lower segments of the third cirri bear only some very small conical spines on the anterior edge. The material thus approaches *B. venustus obscurus* Darwin.

The specimens from Trinidad and Lake Maracaibo are much more typical of the species, and come from brackish water localities where it would be expected.

Previous records of this species from the Caribbean are scanty. PILSBRY (1916) did not record either *pallidus* or *stutsburi* in his account of the American forms of the *amphitrite* series, though the DARWIN collection contains a few specimens of *stutsburi* including the lectotypes, which are believed to have come from the West Indies (HARDING 1962).

Balanus (Balanus) venustus niveus Darwin

Synonymy: HARDING (1962), ZULLO (1966).

This is the subspecies listed by PILSBRY (1916) as being common in Florida and present in Cuba and Honduras. It was reported by NILSSON-CANTELL (1939) in HUMMELINCK's collections from Margarita and mainland South America. As NILSSON-CANTELL was not always correct in his identification of the *amphitrite* series as now revised, I have checked some additional material from one of HUMMELINCK's other localities (COLOMBIA, Río Hacha, 20.I.1937). These specimens do appear to fit the description of *B. venustus niveus*, but I have not seen material from the other localities listed by NILSSON-CANTELL (1939). The species would not seem to be very common in the Caribbean, as apart from the above records the only other material is some specimens in the DARWIN collection labelled as from the West Indies (HARDING 1962).

Balanus (Balanus) reticulatus Utinomi

(Plate I figs. 4–15)

JAMAICA, Kingston Harbour, Port Royal, common to abundant on mangroves and piles, 1679, 1680A.

TRINIDAD, Port of Spain, near generating station and on intake filters, on yacht club jetty and near Five Islands (T.T. and Dec. 1970); Monos Island (T.T.).

BONAIRE, washed up on tree-trunk (1593A).

PANAMA CANAL ZONE, Cristobal, on pilings from harbour (Nov. 1970).

Synonymy: UTINOMI 1967, 1970.

I am placing in this recently erected species a barnacle which is quite abundant in Trinidad and in Kingston Harbour, Jamaica. It has a strong superficial resemblance to *B. amphitrite amphitrite* which may be found with it at the same place (as for example on the intake screens at Port of Spain generating station). When the Trinidad material was first reported (SOUTHWARD 1962, addendum on p. 175) the specimens were regarded as a variety or subspecies of *B. variegatus* as redefined by HARDING, but the resemblance to "*communis*" of UTINOMI (1960) had also been seen. This resemblance was noticed by UTINOMI (1967) on the basis of colour photographs of the Trinidad material published by SOUTHWARD & CRISP (1963, as *B. amphitrite* variety). The Japanese material has been referred to variously as *communis*, *variegatus tesselatus*, *tesselatus*, and *reticulatus* (see UTINOMI 1967), and I agree with UTINOMI that this form is best regarded as a separate species, even though many of the characters do not differ materially from those of *B. variegatus*. The best distinguishing feature of the species is the nature of the shell colour pattern; this is much more definitely striped than true *variegatus*, often astonishingly like *amphitrite amphitrite*, but the stripes are interrupted by bands or flecks of white (see Plate I fig 8) to give the reticulate effect. The ground colour of the parietes is much closer to white than is that of *variegatus*.

In young, fast grown specimens it is extremely difficult to separate *B. amphitrite* and *B. reticulatus* without examining them under a stereomicroscope or strong hand lens. In older and taller specimens the reticulate appearance is more obvious (Pl. I fig 5), but the orifice is then relatively larger than described by UTINOMI (1967), and the concave nature of the compartments disappears. Apart from the reticulated appearance of the stripes on the shell the two species can be separated by a combination of other characters, as listed in Table 1, and of course when dissected the difference in the teeth on the labrum is quite distinctive (Fig. 1).

With regard to previous records of this species from the Caribbean, and from the Atlantic generally, I have recently taken the opportunity to re-examine the dried material and the alcohol-preserved specimens in the collections of the British Museum (Natural History). It has become clear that UTINOMI was correct

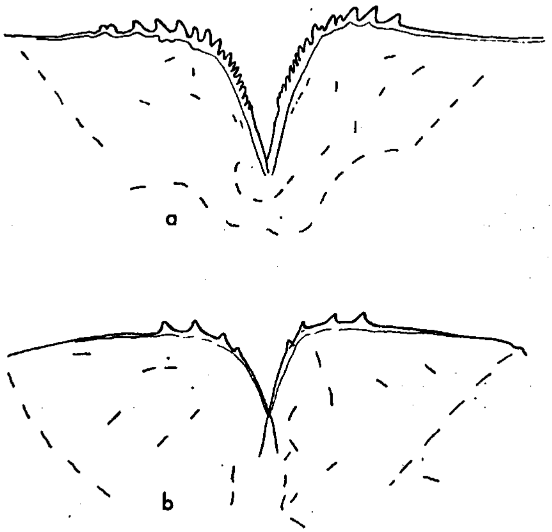

Fig. 1. Comparison of the arrangement and number of teeth on the labrum of a) *Balanus amphitrite amphitrite*, and b) *Balanus reticulatus*

in suspecting that the Darwinian variety "*communis*" may have included more than one taxon. Table 2 shows the register numbers of the dry material referable to *reticulatus*. There is a strong possibility that much of the unlabelled material is of West Indian origin or taken off ships from the West Indies, and hence *reticulatus* is an older inhabitant of the Caribbean than *amphitrite amphitrite*. The occurrence of *reticulatus* in more recent samples collected in the Indian Ocean, in Hawaii (personal communications Dr. W. A. NEWMAN and Mr. C. MATSUDA), and in West Africa supports UTINOMI's view that the species is of world-wide distribution. It has presumably escaped attention owing to the resemblance to *amphitrite amphitrite*. However, the two have somewhat different habitats: *B. amphitrite amphitrite* is pre-eminently a fouling barnacle, equally at home in the intertidal zone and in muddy, polluted and low salinity harbours; *B. reticulatus* is much less of a fouling species and is mostly restricted to sublittoral situations with normal or moderate salinity.

Balanus trigonus Darwin

FLORIDA, Virginia Key and Key Biscayne, abundant, 1408A, 1409, 1410A.
JAMAICA, common to abundant in Kingston Harbour, 1148, 1678, 1680A.
PUERTO RICO, abundant in deeper water off Mayagüez, 1415, 1416.
STA LUCIA, dead shells in Port Castries, 1548.
TRINIDAD, Port of Spain, off Five Islands, common (T.T.); Los Gallos Pt.
MARGARITA, common on mangroves, 1447, 1448, 1449; also very abundant on shells in deeper water north of Margarita.
VENEZUELA, Puerto Santo, near Carúpano, common, 1203.
CURAÇAO, on hard substrate in Piscadera outer bay, 1453, and Caracas Baai.
ARUBA, several on pilings and mangroves, 1008A, and girders, 1302.
COLOMBIA, Cartagena, dead shells on pilings from harbour; common off North coast on stones, shells and hermit crab inhabited shells ("Oregon II" stations 11256, 11272); La Goajira, El Cardón, subfossil shells (as NILSSON-CANTELL 1939).
PANAMA CANAL ZONE, Galeta Pt., under large fragments of coral rock (Nov. 1970).

Synonymy: PILSBRY (1916).

This species is quite common on ship's bottoms and other fouling habitats. DARWIN (1854) records it only from Indo-Pacific localities, but it appears to have become common in the South Atlantic since then, and PILSBRY (1916) saw specimens taken from the bottom of a ship from the West Indies. It has recently been recorded from several caribbean localities by WERNER (1967) who has discussed the problem more fully. The present material is mostly sub-littoral, and the species is only found intertidally under stones or when washed up. The apparently discontinuous nature of the records gives a false picture of the distribution of a widespread species which probably occurs all over the Caribbean and the Gulf of Mexico (WELLS 1966).

Balanus (Megabalanus) stultus Darwin

(Plate II figs. 1–3)

ANGUILLA, dead shell in *Millepora*, 1142.
ST. EUSTATIUS, dead shell, 1116A.
KLEIN BONAIRE, abundant in *Millepora* on fringing reef (N.U. 1962).

Synonymy: ROSS 1968, ROSS & NEWMAN 1973.

ROSS (1968) and ROSS & NEWMAN (1973) regard this species as belonging to the *Megabalanus* section, and fairly close to *B. tintinnabulum,* whereas DARWIN was of the opinion it was a linking form between *B. tintinnabulum* and the true coral-living *Balanus* species (subgenus *Conopea*). There is indeed considerable resemblance to *B. tintinnabulum,* and PILSBRY (1927) clearly mistook the two species (NILSSON-CANTELL 1939, ROSS 1968) as I did myself when first seeing the Bonaire material. The original description was quite short (DARWIN 1854), and the characteristic appearance of the shell was not illustrated (see Pl. II fig. 2). The valves and soft parts have now been fully described by ROSS (1968), and I can add nothing further other than the photographs in Plate II.

Previous records: Curaçao, Caracas Baai (PILSBRY 1927 as corrected by NILSSON-CANTELL 1939 and ROSS 1968); Southern Florida (NILSSON-CANTELL 1929); Southeast Florida (PILSBRY 1953); Dominica (ROSS 1968); Cuba (KOLOSVÁRY 1966).

From the Bonaire material it seems that the life-cycle of *B. stultus* is keyed to that of the *Millepora,* in much the same way as *Conopea* and *Boscia* (*Pyrgoma*) to their coelenterate hosts. Newly settled young are present near the growing tips of the millepore, and older specimens occur further down, while near the base of the colonies there are dead shells of the barnacle almost completely invested by the millepore. In life, a thin layer of the millepore covers the opercular plates as well as the shell, so that the only surface free of millepore is the region of the sheath in which the opercular plates move.

Balanus (Conopea) galeatus (L.)

ST. JOHN, one specimen in debris from surf-swept rock, 1407.

Synonymy: PILSBRY 1953.

Previously recorded from the West Indies generally and Bahamas (PILSBRY 1916), Curaçao, Caracas Baai (PILSBRY 1927), south-east Florida (PILSBRY 1953) .Also found outside the present area, off the Carolinas (MCDOUGALL 1943; ZULLO 1966), it must be more common than indicated by the present records.

Tetraclita stalactifera (Lamarck)

[*Tetraclita* (*Tetraclita*) *squamosa stalactifera* (Lamarck)]

(Plate II fig. 4)

FLORIDA, Key Biscayne, abundant on beachrock and mangroves, 1410A, 1411.
BAHAMAS, North Bimini, common on beachrock and pilings, 1151, 1152.
ST. JOHN, common on rocks, 1407, 1408.
ANGUILLA, Crocus Bay, on rocks, abundant, 1704.
ST. MARTIN, common on boulders and pilings, 1125, 1125A, 1126, 1128, 1129.
FOURCHE, present on rock, 1124.
ST. BARTS, on andesite debris, 1121.
SABA, on andesite debris, 1120, 1120A.
ST. EUSTATIUS, on andesite debris, 1116, 1117, 1119.
ST. KITTS, common on volcanic rock, 1397, 1398.
ANTIGUA, on pilings, 1541; abundant outside English Harbour at Fort Barclay (Dec. 1970).
LA DÉSIRADE, on pilings, 1438.
ISLOTE AVES, occasional on beachrock, 1115.
DOMINICA, common on volcanic boulders, 1546, 1548.
MARTINIQUE, present on andesite, 1439.
ST. VINCENT, common on pebbles, 1549.
BARBADOS, Six Men's Bay, common, and Little Bay, present (Dec. 1970).
GRENADA, common on rocks, jetty and mangroves, 1389, 1391, 1551.
TOBAGO, and Little Tobago, on volcanic rock, 1388 and other samples.
TRINIDAD, common on rock, 1382; several localities along the north coast from Monos Island to Galera Pt., abundant (T.T. and Dec. 1970).
BONAIRE, common on limestone, 1056b, 1056A, 1056Ba, 1594, and on buoy, 1053; Kralendijk Harbour, very abundant on concrete pilings (N.U. 1962).
CURAÇAO, outside Piscadera Baai, not very common, 1029, 1029A, and western shore, 1020A; Westpunt Baai, fairly common (N.U. 2).
ARUBA, present on dead mangroves, 1008A.
COLOMBIA, Sta Marta and Playa de la Concha, abundant (Nov. 1970).
PANAMA CANAL ZONE, Galeta Pt., common (Nov. 1970).

Synonymy: Ross (1968).

This species of *Tetraclita* is one of the most characteristic components of the intertidal zone of rocky shores along the open coasts of the Caribbean. PILSBRY (1916, 1953) records it from several localities from Ft. Worth in Florida down to Colombia; it was later recorded from Curaçao (PILSBRY 1927), Bonaire (NILSSON-CANTELL 1933), St. Kitts, St. Martin and Venezuela (NILSSON-CANTELL 1939), and more recently from Dominica (Ross 1968).

It appears to be continuously distributed all over the Caribbean, from Florida to the South American Mainland and down to Brazil. The exact limits on the Central American coast remain to be determined, but the species has not sofar been recorded from the Gulf of Mexico (HENRY 1954, WELLS 1966).

Newmanella radiata (Blainville)

[*Tetraclita radiata* (Blainville)]

(Plate II figs. 5, 7–8)

CUBA, west of Havana, common (W).
ISLOTE AVES (W of Dominica), common on beachrock, 1115.
TRINIDAD, Monos island, and Gaspare Grande, common to abundant (T.T.).
BONAIRE, Kralendijk, common on concrete pilings (N.U. 1962).
CURAÇAO, on fence and mangroves outside Piscadera Baai, not common, 1029A, 1463.

Synonymy: ROSS 1969.

This species has been fully redescribed by ROSS (1969), but I give here some general views of the shell and of groups of animals to show the very characteristic appearance (Pl. II figs. 5 and 7).

Previous records: West Indies, unspecified, type material; St. Thomas (PILSBRY 1916); Florida (PILSBRY 1953); Bimini, Puerto Rico, Dominica, Margarita and Trinidad (ROSS 1969). It would seem to be generally distributed throughout the Caribbean, but appears to be commonest in wave-beaten places or just within the sublittoral. ROSS (1969) regards it as a caribbean species; I have the impression that it gets more abundant towards the south in my samples, and hence it may be a more tropical species than *T. stalactifera* (*T. squamosa*), which appears to extend further into colder waters at the northern end of its range.

Tetraclitella divisa (Nilsson-Cantell)

[*Tetraclita divisa* Nilsson-Cantell]
(Plate II fig. 6)

SABA, Fort Bay, abundant on andesite, 1120, 1120A.
TOBAGO, abundant on volcanic rock, 1388.
COLOMBIA, Playa de la Concha, near Sta. Marta, locally numerous under large stones (Nov. 1970).

Synonymy: Ross 1968.

This species is easily recognised by its external appearance, see Plate II fig. 6.

The only other record from the Caribbean is that for Dominica (Ross 1968). The material examined and the specimens seen in the field suggest that the species favours either wave-beaten habitats or damp places under stones and in crevices. This habit, and its relatively inconspicuous form, may have led to it being overlooked in the past. The incubation of the larvae within the mantle cavity up to the cypris stage (NILSSON-CANTELL 1921; Ross 1968), and the consequent absence of a long pelagic stage, may well produce a rather discontinuous distribution pattern.

Boscia madreporarum (Bosc)

[*Pyrgoma stokesii* (Gray)]
(Plate II figs. 10–12)

KLEIN BONAIRE, abundant in *Agaricia* (fungus coral) in the immediate sublittoral (N.U. 1962).

Synonymy: DARWIN 1854, Ross & NEWMAN 1973.

This species was described by DARWIN from specimens named but not otherwise described by GRAY, and thought to be West Indian in origin. Rather incomplete descriptions were also given by several French authors (see Ross & NEWMAN 1973). DARWIN illustrated the external appearance of the shell, of which photographs are given in Plate II figs. 10 & 11, but mentioned only the differences of the valves from those of *P. anglicum*, notably that in the tergum "the basal margin is more inclined to, or forms a greater angle with, the spur". It will be seen from Plate II fig. 12, that in the present material the terga are greatly elongated in the basal direction. The coral-living barnacles have now been revised by Ross & Newman (1973), and they illustrate the valves of the two species side by side, to show the difference.

Chelonibia spp.

The Hummelinck collection contains samples of cirripedes removed from the carapace of turtles (*Chelonia mydas*) washed up or captured north of Margarita, 1955, Bonaire, 1955, and Curaçao, 1948. These have not yet been identified to species.

Chelonibia patula (Ranzani), which is generally associated with crabs, and has been reported from Florida, Cuba and Puerto Rico by Pilsbry (1916, 1953), was fairly common on gastropod shells inhabited by hermit crabs along the north coast of Colombia at 50–60 m depth ("Oregon II" trawl stations, Nov. 1970).

Chthamalus fragilis Darwin

(Plate III fig. 9)

This species has previously been recorded from the Caribbean, as follows: Southern Florida, Cuba, Jamaica (Pilsbry 1916); Curaçao (Pilsbry 1927); Bonaire, Curaçao, St. Thomas, Paraguaná in Venezuela (Nilsson-Cantell 1933, 1939); Trinidad (Southward 1972, Bacon 1971). I have re-examined most of this material or material from similar localities, and can confirm only the Florida location. The other records are referable either to *C. angustitergum* Pilsbry or to *C. bisinuatus* Pilsbry or to a mixture of both of these species, and it would seem that the true *C. fragilis* is a warm-temperate and sub-tropical form that does not occur south of Florida. It is abundant in the northern Gulf of Mexico (Henry 1954, Wells 1966; personal observations) but its southern limit along the Central American mainland has not yet been determined. It does not occur in Bermuda (Henry 1958; personal observations).

Chthamalus angustitergum Pilsbry

(Plate III figs. 1, 3, 5–8; Plate IV figs. 1–11)

FLORIDA, Virginia Key and Key Biscayne, common, 1409, 1410A, 1411.
BAHAMAS, Bimini, 1151, and Nassau Beach (Oct. 1970).
CUBA, Esperanza, material from U.S. National Museum (no. 48856), abundant on piece of wood piling, 65% *C. angustitergum* and 35% *C. bisinuatus* (recorded by PILSBRY 1916 as *C. fragilis*); west of Havana, few (W).
JAMAICA, Kingston Harbour, from U.S.N.M. (no. 51794) on coconut husks and fan shells, one small specimen among large numbers of small *C. bisinuatus* (recorded by PILSBRY 1916 as *C. fragilis*); Lime Cay off Port Royal, few (Oct. 1970); Discovery Bay, not uncommon on undersides of pieces of coral rock (Oct. 1970).
GRAND CAYMAN, North Sound, abundant on mangroves, 1685, 1689; abundant on mangroves from lagoon (coll. by Dr. M. E. C. Giglioli).
LITTLE CAYMAN, South Hole Sound, present on mangroves, 1698.
PUERTO RICO, off Mayagüez, 1419.
ST. THOMAS, Magens Bay, fairly common, 1675.
ST JOHN, common on rocks, 1407.
ANGUILLA, Crocus Bay, abundant on rocks, 1704.
ST MARTIN, abundant on coral rock, mangroves and wood pilings, 1125, 1125A, 1126, 1128, 1129, 1131, 1132, 1399, 1429, 1429A.
ST BARTS, common on rock, 1121.
SABA, on rock, 1120, 1120A; Fort Bay, abundant on pilings, 1705.
ST EUSTATIUS, on rock, 1116, 1117, 1119.
ST KITTS, on rock, 1397, 1398, s.n.
BARBUDA, open coast, common on beach rock (coll. by Dr. P. Gibbs, 1970).
ANTIGUA, on rock, accompanied by an equal number of *C. bisinuatus*, 1393, 1540A; English Harbour, common to abundant (Dec. 1970, details p. 35).
DOMINICA, few, 1548.
ST VINCENT, common on rock, 1549.
BARBADOS, Six Mens Reef, locally abundant (Dec. 1970) and Little Bay, few (Dec. 1970).
GRENADINES, exact location?, abundant (coll. by Dr J. B. Lewis).
GRENADA, on mangroves and rock, 1389, 1551.
TRINIDAD, Galera Pt, few specimens near high tide level among much *C. bisinuatus* (Dec. 1970).
BONAIRE, common on beach rock at Paloe Lechi, 1056A, 1056b, 1056Ba; locally common on mangroves in the Lac, 1062a, 1064a, 1064c, 1575, 1578, 1580, 1589, 1590; abundant on *Tetraclita* and on concrete pilings at Kralendijk (N.U.).
CURAÇAO, abundant on mangroves at Spaanse Water, 1035 (few specimens on shells recorded by NILSSON-CANTELL 1933 as *C. fragilis*), 1037A, 1629, and on igneous rocks, collected in 1920 by C. J. van der Horst (seen by PILSBRY 1927); Fuik Baai, 1038A; one dead specimen from Westpunt Baai (N.U.); and two specimens below Carmabi outside Piscadera Baai (Dec. 1970).
ARUBA, common on mangroves near Oranjestad, 1005a, 1005b, 1303.
COLOMBIA, present at entrance to harbour at Sta Marta but more abundant at Playa de la Concha together with some *C. bisinuatus* (Nov. 1970).

PANAMA CANAL ZONE, Galeta Pt, on coral rock, not very common (Nov. 1970).

Synonymy and previous records:
C. stellatus angustitergum PILSBRY (1916), Bahamas and Florida Keys.
C. stellatus angustitergum (in part), PILSBRY (1927), Curaçao, Spaanse Water (includes *C. bisinuatus* also).
C. stellatus angustitergum, Ross (1968), Dominica; also mention of this species in previous ecological papers.
Not *C. stellatus angustitergum*, NILSSON-CANTELL (1933).
C. fragilis, PILSBRY (1916), from Cuba, includes this species.
C. fragilis, NILSSON-CANTELL (1933), Curaçao, Spaanse Water, and Bonaire, Kralendijk and Lac.
C. fragilis, PILSBRY (1927), from Curaçao, Caracas Baai (A), is probably this species.
C. stellatus thompsoni HENRY (1958), from Bermuda, is probably this species.

Although recording this form as a subspecies of *C. stellatus*, PILSBRY (1916) expressed the opinion that it was probably distinct. This view was adopted by some ecologists (e.g. NEWELL, IMBRIE, PURDY & THURBER 1959; SOUTHWARD 1964) who referred to it as *C. angustitergum*, and physiological evidence for this separation will be published by CRISP & SOUTHWARD in a forthcoming paper. Ross (1968) has now formally raised it to specific rank, and described the cirri and mouth parts. It is necessary to go into further details of the morphology in order to show clearly how to separate the species from *C. bisinuatus*.

Cirral characters

We must first consider certain characters of the first and second cirri which have been put forward as specific features by previous authors (PILSBRY 1916, HENRY 1958). In nearly all balanomorph cirripedes these two cirri help to transfer to the mouth food particles captured by the larger cirri, and may also form a filter for capture of very small particles (CRISP & SOUTHWARD 1961). The setae on these cirri are of various types, presumably modified to help in food collection and transfer. It is possible to distinguish three main types: A) ordinary, with small setules; B) plumose setae with more elongated setules, usually arranged in a circular manner round the seta, rather like a bottle-brush, but sometimes in rows only; and C) a much modified type, short and stiff, with two rows of comb-like stiff setules, usually termed pectinate setae. The last type of seta can be separated into two subtypes according to whether or not there are large blunt setules, termed guards, at the base of each comb-like row (see Pl. V figs. 12–13).

From published accounts it is clear that the pectinate setae of barnacles can be a useful character in separating species which have few other distinguishing features, but their occurrence has not always been recorded in the past, nor the extent of their variability within the species. I have therefore investigated the occurrence of pectinate setae on the first and second cirri of *angustitergum*, and of the two other species found in the Caribbean and adjacent regions, *bisinuatus* and *fragilis*, and compared them with the former parent species, *stellatus* from northern Europe.

Chthamalus angustitergum. – Pectinate setae have been reported by ROSS (1968) in specimens collected in Dominica. Material from Key Biscayne, Florida, which is closer to the original type locality, shows some variation with habitat and age. Specimens from mangroves have stout conical spines on the inner side of the basal segments of the anterior ramus of cirrus I (Pl. IV fig. 7), similar to those described in *C. stellatus thompsoni* by HENRY (1958), but specimens from nearby rocks do not. The terminal tufts of cirrus I carry many plumose setae (Pl. IV fig. 8) on the longer ramus in all specimens; the shorter ramus bears pectinate setae at the tip, some 5 or 6 in the mangrove specimens but only 3–4 in the rock specimens; there are no basal guards. Cirrus II bears 13 to 14 pectinate setae on the long ramus and 4 to 5 on the short ramus, all without basal guards. Specimens from other Caribbean habitats do not differ essentially from this plan, and most show the conical spines on cirrus I.

Chthamalus bisinuatus. – Caribbean specimens have no conical spines on the basal segments of the anterior ramus of cirrus I, though some very large and old specimens collected by DARWIN in South America, and now in the collections of the British Museum (N.H.), do in fact have such spines. Several of the older Caribbean specimens do, however, have some thin short spines in a corresponding position (Pl. V fig. 1). Generally the long ramus of cirrus I bears plumose setae, while the short ramus carries 5 to 6 pectinate setae with basal guards (Pl. IV fig. 13). On cirrus II there are usually many pectinate setae with basal guards: the long ramus carries about 10 in the terminal tuft, and there may be a few more on the segment below (Pl. IV fig. 12); the short ramus bears up to 12 pectinate setae in the terminal tuft, up to 10 in the segment below, and up to 6 in the next segment. Some local and habitat differences may be found from this plan: very small specimens collected near Sta. Marta, Colombia, lack the pectinate setae on cirrus I, while large specimens from Piscadera Baai, Curaçao have very large pectinate setae, with correspondingly large and stout setules and basal guards.

Chthamalus fragilis. – Specimens from south-eastern U.S.A. do not have conical spines on the basal segments of cirrus I, and the terminal tufts of both rami carry the plumose type of setae. In some specimens 3 to 4 pectinate setae are found on both rami of cirrus II, but in others the long ramus bears plumose setae and the short ramus only carries 2 to 3 pectinate setae. In both types the pectinate setae have basal guards as illustrated by PILSBRY (1916).

Chthamalus stellatus. – In material from Plymouth, south-west England, there are no conical spines on the basal segments of the

TABLE 3

SEPARATION OF SOME SPECIES OF *Chthamalus*
by means of the setae and spines found on the first and second cirri

CHARACTER	*C. stellatus*	*C. fragilis*	*C. bisinuatus*	*C. angustitergum*
pectinate setae on cirrus I	none	none	usually on short ramus	short ramus
pectinate setae on cirrus II	short ramus	sometimes both rami, sometimes short only	many on both rami	both rami
basal guards on pectinate setae	no	yes	yes	no
conical spines on base of ramus of cirrus I	no	no	rarely	usually

rami of cirrus I: the terminal tufts of ordinary setae on both rami contain some of the plumose type, but I have not seen any pectinate setae in the specimens examined so far. Cirrus II shows the plumose setae on the longer ramus, and the pectinate type, without basal guards, are found only in the terminal tuft of the shorter ramus.

From the foregoing description it is apparent that these four species do differ in their armament of setae, and the essential differences are set out in Table 3. *C. stellatus* differs the most from the American forms, emphasising the distinctness of the latter. *C. angustitergum* can be separated from the remaining two species by its lack of basal guards on the pectinate setae, and usually by the presence of the conical spines on cirrus I. *C. bisinuatus* can usually be separated from *fragilis* by the presence of pectinate setae on cirrus I, and the large number of pectinate setae on cirrus II, but obviously other characters will have to be taken into consideration as well.

Supplementary description

The external appearance of specimens of *Chthamalus angustitergum* is shown in Plate III figs. 1, 3, 5–8 in comparison with the next species, *C. bisinuatus*. It can be seen that at all sizes the tergum is

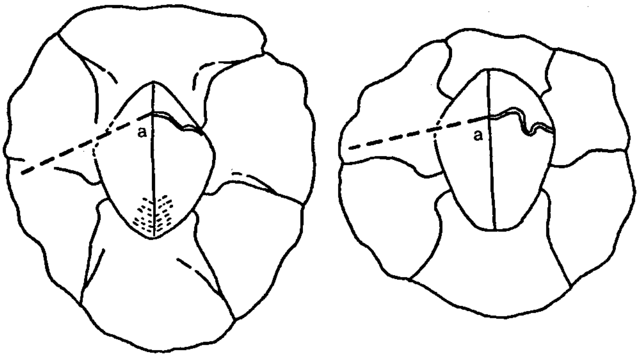

Fig. 2. Diagram showing the angles formed by a line through the junction between tergum and scutum relative to the centre line between terga and scuta; left *Chthamalus angustitergum*, right *C. bisinuatus*.

extremely short along the rostro-carinal axis (mid line of shell), and that a line drawn from the outer edge of the boundary between the tergum and scutum to the mid line (Fig. 2) forms an angle much less than 90°. This angle is usually about 65° in older individuals, which also have a sinuous boundary, but is closer to 70° in younger specimens which have a less sinuous boundary. The compartments are usually easily separable even in corroded individuals, unlike *C. stellatus*, but they are nearly always thicker and the epidermis less persistent than in *C. fragilis*.

It should be noted that most juvenile *Chthamalus* have a relatively straight boundary at the junction of the tergum and scutum, possess thin shells with persistent epidermis, and have radii clearly separated from the parietes. As the shell grows in thickness and overall size, and as the outer surface becomes eroded, these juvenile characters disappear to be replaced by the more typical appearance of the particular species. In *C. fragilis* however, most of them are retained thoughout life, leading to the possibility that this species was derived from some other chthamalid by a process akin to neoteny. In the species being described, *C. angustitergum*, some of the juvenile characters can be retained to sexual maturity, especially among specimens living on mangroves. In the latter habitat radii can be found in quite large individuals, and the shell is often comparatively smooth and the junction between terga and scuta less sinuous than in nearby rock-living individuals, and a degree of resemblance to the true mangrove barnacle, *C. rhizophorae*, may be recognisable (see Pl. III fig. 3).

After dissection of the valves and appendages in the conventional manner, the "narrowness" of the terga, i.e. their shortness in relation to width, is the most distinctive character, with a length/breadth ratio between 0.6 and 0.7 (see Fig. 3). The scutum is much less distinctive than would appear at first, and its length/breadth ratio is not significantly different from that of the next species, though the rostral corner appears to be more bluntly pointed than in *bisinuatus*. Apart from the less pronounced sinuosity of the tergal boundary, the main difference in the scutum of *C. angustitergum* relative to *bisinuatus* is in the size and nature of the adductor muscle insertion. According to PILSBRY (1916), the pit for the adductor muscle is very shallow, and there is no adductor ridge on the tergal side. However, examination of the type specimens shows that the adductor muscle insertion is more obvious than shown in PILSBRY's figure, and that although there is no ridge on the tergal side there is a slight ridge on the outer side of the pit. There is a well-marked ridge or roll running down the whole of the straight side of the scutum in the type, as illustrated by PILSBRY (1916), but this is not present in all Caribbean specimens I have seen and is less obvious in young individuals. In his redescription of the species based on specimens from Dominica, ROSS (1968) states that the adductor muscle pit "is very small and deep". The apparent conflict in the two descriptions can be resolved from the wide range of material now available. The adductor muscle scar is very shallow in young specimens, as for example individuals from Trinidad and Spanish Water, Curaçao, and also in mangrove-living specimens from Grenada and in various-sized specimens from Bermuda. However a very deep small scar is found in specimens from Cuba and Puerto

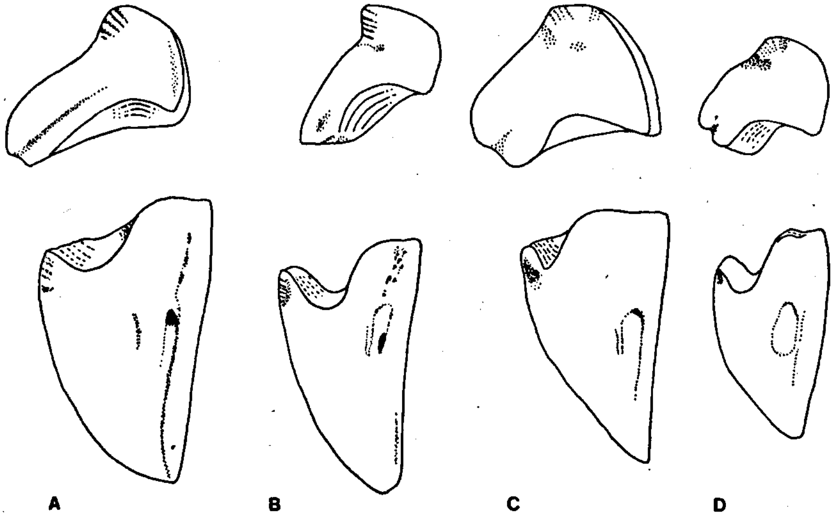

Fig. 3. Diagrammatic drawings of the inside surface of the tergum and scutum to illustrate some of the variation: a) *Chthamalus angustitergum*, Lac, Bonaire; b) *C. angustitergum*, English Harbour, Antigua; c) *C. bisinuatus*, Piscadera Baai, Curaçao; d) *C. bisinuatus*, English Harbour, Antigua.

Rico; and an intermediate condition, with a very deep very small pit in the centre of a shallower depression is seen in some specimens from Antigua. Where the pit is very deep, and the shell outer surface much corroded, there is often a distinct ridge or protuberance on

TABLE 4

COMPARISON OF CHARACTERS OF *Chthamalus angustitergum* AND *C. bisinuatus*
collected at localities between Miami and Trinidad

CHARACTER	*C. angustitergum*	*C. bisinuatus*
angle between centre line of operculum when closed, and line formed by junction of tergum and scutum (see Fig. 2)	old specimens 60–72° mean 65° young specimens 63–74° mean 68°	old specimens 76–88° mean 81° young specimens 75–90° mean 88°
ratio: width/length of tergum	.59–.74, mean .66	.63–.95, mean .85
ratio: width/length of scutum	.48–.57, mean .54	.50–.59, mean .54
adductor muscle scar shape, and ratio: width of scar/width of scutum	narrow and shallow, but often with small very deep pit as well .12–.18, mean .15	medium, overall deeper, no additional small pit .23–.35, mean .28
adductor ridge	present, not very obvious	present, more obvious
depressor muscle insertions on tergum	4–5 crests, deeply incised	4–5 crests, not deeply incised, on raised mound
conical spines on cirrus I	usually present	usually not present
Pectinate setae	on short ramus of cirrus I and both rami of cirrus II, no basal guards	on short ramus of cirrus I and both rami of cirrus II, basal guards present
mandible	pectinate part with 14–23 small teeth (mean 20), then one large tooth and 1 or 2 smaller teeth	pectinate part with 11–17 small teeth (mean 13), then 3, sometimes 4, larger teeth, the second two often fused together like an old fashioned can-opener.

the outer side of the scutum, corresponding to the pit, as for example in the specimens from rocks in Florida (Pl. IV fig. 6). There can sometimes be a slight ridge on the tergal side of the scar, as reported by HENRY (1958) for Bermudan specimens. The most distinctive feature of the adductor muscle scar in *angustitergum* is its narrowness, and the corresponding flattened character of the adductor muscle itself is obvious compared with that found in *C. bisinuatus* when the animal is being dissected. The ratio of the width of the adductor scar, measured at its centre, relative to the width of the scutum at the same level is nearly half that of the corresponding ratio in *C. bisinuatus*.

The major characters which differ in *C. angustitergum* and *C. bisinuatus* are listed in Table 4 and are discussed further in the next section. The distribution is dealt with on p. 33.

Chthamalus bisinuatus Pilsbry

(Plate III figs. 2, 4–7; Plate IV figs. 12–13; Plate V figs. 1–12)

CUBA, Esperanza (U.S. Nat. Mus. 48856), several specimens (recorded by PILSBRY 1916 as *C. fragilis*).

JAMAICA, Kingston Harbour (U.S. Nat. Mus. 51794), many small specimens (recorded by PILSBRY 1916 as *C. fragilis*); Kingston Harbour and Port Royal, abundant on pilings and mussel shells, 1148, 1680A, and Oct. 1970.

PUERTO RICO, few on mangroves near La Parguera, 1419, 1420.

ST. THOMAS, abundant on rock in harbour Charlotte Amalie (identified by NILSSON-CANTELL 1939 as *C. fragilis*).

ANTIGUA, on rock, 1393, 1540a, wooden piling, 1541; also common at English Harbour (Dec. 1970).

GUADELOUPE, many on mangroves, 1543, 1544.

MARTINIQUE, few on rock, 1439.

ST. LUCIA, few in harbour, 1548.

GRENADA, common on mangroves, wood pilings and rock, 1389, 1391, 1551

TOBAGO, few on rock, 1388.

TRINIDAD, on rock, 1384, and wood, 792A, common to abundant at all intertidal localities, Port of Spain, Monos island (TT), Galera Pt. and Balandra Bay (Dec. 1970).

MARGARITA, common on mangroves, 1446, 1448.

BONAIRE, abundant on mangroves and rocks from Lagoen, 1070c, 1070A, 1070Ba, 1558; several lots (recorded by NILSSON-CANTELL 1933 as *C. fragilis*, and *C. stellatus angustitergum*); not observed in Lac.

CURAÇAO, very abundant on mangroves, shells and stones from large number of places inside Piscadera Baai (see Appendix), but one specimen only seen just outside,

below Carmabi; common in St. Joris Baai, 1641, 1668A, and other places, 1359; several in Spaanse Water 1920 (A), together with more abundant *C. angustitergum* (recorded as *C. angustitergum* by PILSBRY 1927).
COLOMBIA, Sta. Marta and Playa de la Concha, present (Nov. 1970).
PANAMA CANAL ZONE, Galeta Pt., few (Nov. 1970).

Synonymy and previous records:
C. stellatus bisinuatus, PILSBRY (1916), Brazil.
C. stellatus bisinuatus, DE OLIVEIRA (1943), Brazil.
C. stellatus bisinuatus, WELLS (1966), Florida.
C. stellatus bisinuatus, VERMEIJ & PORTER (1971), Brazil.
C. stellatus cornutus, NILSSON-CANTELL (1925), Uruguay.
C. fragilis, PILSBRY (1916), from Cuba, includes this species.
C. fragilis, PILSBRY (1916), Jamaica.
C. fragilis, NILSSON-CANTELL (1933), Bonaire (Lagoen).
C. fragilis, NILSSON-CANTELL (1939), St. Thomas.
C. fragilis, SOUTHWARD (1962), Trinidad.
C. fragilis, BACON (1971), Trinidad.

Chthamalus bisinuatus was described as a subspecies of *stellatus* by PILSBRY on the basis of some dried specimens without the animal parts, with the suggestion that DARWIN's specimens of *stellatus* from Uruguay may have belonged to the same subspecies. It was again recorded from Brazil by DE OLIVEIRA (1943), who described some of the animal parts and gave information on the dimensions of the terga and scuta. WELLS (1966) has more recently extended the known range to the west coast of Florida; so that there should be no surprise in its apparent wide distribution within the Caribbean. On the basis of the large amount of material now available I am taking the opportunity to formally raise the status to that of a full species, quite distinct from the European species *stellatus*.

The main difficulty in the recognition of *C. bisinuatus* in the Caribbean cirripede fauna has been its apparent resemblance, while young, to *C. fragilis*, and NILSSON-CANTELL and I have both fallen into this trap. The correspondence of many *Chthamalus* species while in the juvenile form has already been discussed, and it may be noted that even PILSBRY himself at times confounded *C. bisinuatus* and *C. angustitergum* with *C. fragilis*. DARWIN (1854) in describing his var. *fragilis* from one lot of specimens collected at Charleston, expressed doubt whether it was only a habitat modification, suggesting that he was familiar with this problem of the occurrence of juvenile characters in *Chthamalus.* If one has before one a good collection of material from different habitats and of different ages it is not difficult to see the differences in external form between *bisinuatus* and *fragilis.* But if only young specimens are available, or specimens from mangroves or understone habitats, there can be considerable difficulty and it is necessary to dissect and examine the interior of the tergum and scutum and look at the cirri and mouth parts under high magnification.

Supplementary description

The external appearance of *Chthamalus bisinuatus* is illustrated in Plate III figs. 2, 4–7. The junction between the tergum and scutum varies from almost straight in young specimens to very sinuous in old specimens from rocky shores; the angle formed by a line from the outer edge of this junction to the centre line is much closer to a right angle than in *angustitergum,* ranging from 80 to 90° in juveniles to around 80° in older specimens (Fig. 2). The compartments are fairly easy to separate, though not as easily as those of *fragilis,* and are nearly always thicker with a less persistent epidermis than in *fragilis.* After dissection the tergum can be seen to be much less "narrow" than that of *angustitergum,* the length/breadth ratio being about .85 (Fig. 3). There is a more obvious "spur" development, but this is usually overshadowed in prominence in adult specimens by the sinous nature of the scutal edge which keys into the corresponding "bisinuate" margin of the scutum. The crests for the depressor muscles are less obvious than in *angustitergum* and are situated on a slight prominence of the general internal surface. The scutum does not differ greatly in proportions from that in *angustitergum,* although the rostral corner appears slightly more pointed, and it is the sinuosity of the adult scutum along the tergal boundary that gives the most distinctive appearance. The insertion for the lateral depressor muscles generally seems deeper than that in *angustitergum,* with the crests less obvious, but this is a somewhat variable feature. The best criterion of the species is the shape of the adductor muscle insertion. PILSBRY (1916) described the adductor pit as being deep as that in *C. stellatus*, but in fact it is better termed moderately deep in comparison with the small but deep pit often found in *angustitergum*. The adductor muscle of *bisinuatus* is much more rounded in cross section than in the latter species, and this shows in the wider insertion scar on the scutum and the more rounded edges to it. The width of the scar relative to the scutum has a ratio of about .28. Traces of an adductor ridge can be seen in some specimens, and most have an obvious ridge on the outer side of the scar; many also show a ridge running along the straight edge of the scutum as described for *angustitergum*.

The nature of the setae of the first and second cirri, and the presence of basal guards on the pectinate setae has already been described (p. 22). The labrum is in no way remarkable from that found in other chthamalids; the maxilla (Pl. V fig. 3) has the usual pair of stout spines above, separated by a cut-out margin from a group of smaller spines numbering about 13 or 14, divisable into two groups, but I have not examined a wide series. The mandible offers the most helpful additional character (Pl. V figs. 2, 4–6). It is nominally quadridentate, with three large teeth and a fourth double or sometimes triple tooth occupying about 2/3rds of the cutting edge. There follows a relatively short pectinate part with 11 to 17 small teeth (mean 13) and terminating in a group of 3, occasionally 4 larger teeth, the second and third of which usually form a double tooth in the shape of an old-fashioned can opener (Pl. V fig. 4). This lower angle of the mandible often appears to be slightly more convex along the non-cutting edge than that of *angustitergum*. It is necessary to be cautious when examining young specimens of both forms, as *angustitergum* may show this convexity, and may at the same time show a relatively smaller number of the fine teeth (as few as 14 in very small individuals).

From the nature of the variation already described it is obvious that no single character should be relied upon when attempting to separate *bisinuatus* and *angustitergum*, and hence all the characters listed in Table 4 should be noted carefully.

Chthamalus rhizophorae de Oliveira

(Plate III fig. 8; Plate IV fig. 14)

TRINIDAD, Caroni Swamp (collected by Dr. P. Bacon; BACON 1970).
PANAMA CANAL ZONE, near Galeta Pt., on mangroves, several (collected by Miss C. Simon, Univ. of Florida, Gainesville, 1973).

This mangrove-living chthamalid was described from Rio de Janeiro by DE OLIVEIRA (1940) and further details of its morphology given later (DE OLIVEIRA 1941). I have seen new material from the original locality, and the caribbean specimens agree quite well. It should be noted that this species belongs to the *hembeli* group (PILSBRY 1916), and has a characteristic mandible which lacks the long pectinate part found in the other Caribbean species described here and bears only 3 large teeth (Pl. IV fig. 14). The first cirrus bears plumose setae only, while both rami of the second cirrus show several very delicate pectinate setae when examined under high magnification.

This species may well be more widespread than appears from the records.

Cataphragmus imbricatus Sowerby

(Plate II fig. 9)

CUBA, West of Havana, frequent (W).
ISLOTE AVES (West of Dominica), common on beachrock, 1115.

Synonymy: HENRY 1958.

This species was recorded from Antigua and Bermuda by PILSBRY (1916), and from Bermuda by HENRY (1958). It is restricted to very wave-beaten places, and has probably a much wider distribution than appears from these records.

DISCUSSION

The collections described here comprise 22 taxa, three Lepadomorpha and 19 Balanomorpha. Among the latter only one species is new to the Caribbean; only two appear to be exclusively found there and one of these is also found in Bermuda. It is proposed therefore to leave a general discussion on distribution until more is known about the neighbouring parts of Florida, the Guianas and Brazil. However, the taxonomic status of the two common species of *Chthamalus* in the Caribbean has been elucidated, and since many locality records are now available their distribution will be considered in relation to environmental factors.

DISTRIBUTION OF *Chthamalus angustitergum* AND *Chthamalus bisinuatus*

As already noted, *C. fragilis*, the common species along the eastern coast of the United States has not been confirmed to occur south of Florida, and hence in the Caribbean as strictly defined we have only *C. angustitergum* and *C. bisinuatus*, formerly regarded as subspecies of *C. stellatus*. The raising of these two forms to full specific status presents a serious problem in biogeography. DARWIN (1854) noted that he was not aware of any locality where more than two species of *Chthamalus* were present, and allowing for recent raising of varieties to species, it is still rare for even two species to be found side by side. In the Caribbean, however, *C. angustitergum* has been found on most of the island groups and on places in the Central American mainland, and has a distribution extending from Trinidad northwards to Florida, the Bahamas, and (as a possible subspecies) to Bermuda (Fig. 7). *C. bisinuatus*, which has not yet been recorded from all the islands, extends from Cuba and Puerto Rico in the north down through Trinidad and mainland South America to the Río de la Plata, and has also been reported from the west coast of Florida (Fig. 8). Thus these species have distributions which overlap by at least 1000 nautical miles. Comparable overlaps in distribution of *Chthamalus* species in other seas are usually much shorter. Thus on the eastern side of the North Atlantic *C. stellatus* and the South African species *C. dentatus* overlap only in the Cap Verde Islands and on the immediately adjacent part of the West African coast (STUBBINGS 1967). On the western side of the Pacific *C. dalli* does not occur south of the straits of Tsugaru and overlaps with *C. challengeri* only for a short distance on Hokkaido (UTINOMI 1970). Even when there is more overlapping, as in S. California, where *C. dalli* and *C. fissus* can occur together over 400 miles of coast (personal observations), the two species tend to have different vertical zonations, the colder water form occurring lower down the shore than the warmer water form. A similar difference in vertical zonation can be seen between *C. imperatrix* Pilsbry (high level) and

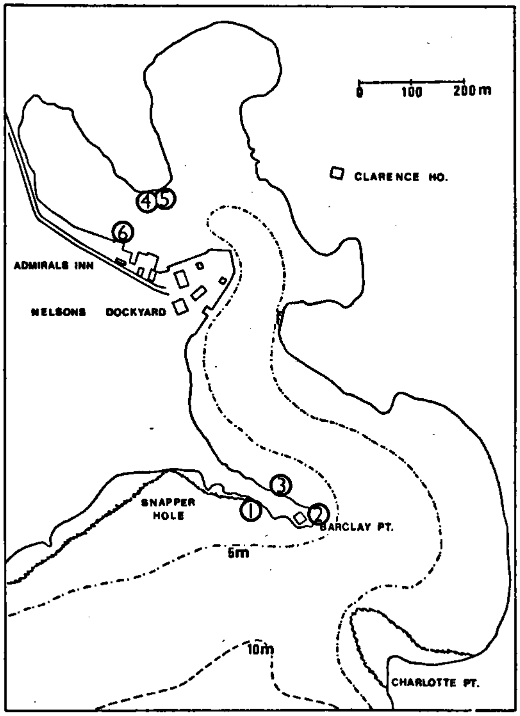

Fig. 4. Outline chart of English Harbour, Antigua, showing collecting stations listed in table 5; approximate depth contours in metres.

TABLE 5

DISTRIBUTION OF *Chthamalus* SPECIES at English Harbour, Antigua

STATION (see Fig. 4)	Percentage of *Chthamalus angustitergum* out of total population of *C. angustitergum* and *C. bisinuatus*
1. Snapper Hole (exposed)	95%
2. Barclay Pt. (partly sheltered)	33%
3. Fort Barclay steps (sheltered)	30%
4. on mangroves in mud	9%
5. on small stones in mud near mangroves	3%
6. on mussels growing on stone wall, in shade, at Admirals Inn	2%

C. panamensis Pilsbry (mid-tide and low level) on the Pacific Coast of Panama (personal observation).

In the Caribbean the tidal range is very small, and it has not been possible to discern any differences in vertical zonation of *C. angustitergum* and *C. bisinuatus*, even though the latter species extends further into the tropics. Since the two species are not always found together in one locality, it follows that some factor other than climate controls their distribution and there must be some difference in living requirements that enables them to co-exist over such a wide geographical range. Examination of the habitats suggests that the two species may have quite different environmental optima, and this is clearly brought out if we examine the details of distribution around English Harbour, Antigua (Fig. 4 and Table 5). In this locality *angustitergum* is the species of the open ocean coast while *bisinuatus* is dominant inside the almost landlocked harbour, and in between these two extremes the two species show a gradient in abundance. Less detailed records for other regions suggest a similar partition of habitats. In Jamaica only *angustitergum* occurs on the outer Cays, while *bisinuatus* is abundant inside Kingston Harbour; in St. Thomas, *bisinuatus* is abundant in the muddy harbour at Charlotte Amalie, while *angustitergum* is found outside; in Trinidad a few specimens of *angustitergum* were found along the exposed north-east coast, but only *bisinuatus* around Port of Spain in the sheltered Gulf of Paria; in Curaçao *bisinuatus* is very abundant in muddy inland bays such as Piscadera Baai and St Joris Baai, but on the open coast where cirripedes are less common, *angustitergum* is the dominant species; in Bonaire *angustitergum* is present along the open coast, and *bisinuatus* is abundant in the muddy Lagoen. Some apparent exceptions to this rule can be found, localities where *angustitergum* is abundant or dominant in what seem to be sheltered inlets: these are Spaanse Water, Curaçao; the Lac at Bonaire; the Great Lagoon in Grand Cayman; and the lagoon system at Simpson Bay, St Martin. Figs. 5 and 6 illustrate how the different inlet systems are dominated by different species of *Chthamalus* in parts of Curaçao and Bonaire, two islands in which the lagoon systems have been investigated ecologically. Bonaire Lac, in particular, has been well studied (HUMMELINCK & ROOS 1967); it appears to have

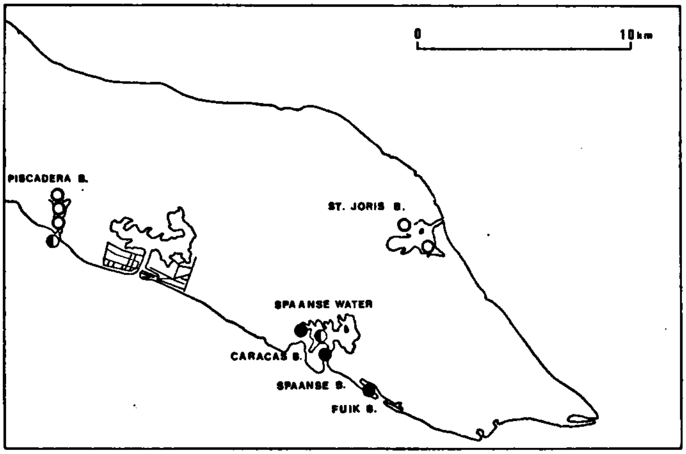

Fig. 5. Sketch map of the eastern half of Curaçao showing localities where *Chthamalus* was collected. Open circles: *C. bisinuatus* only; closed circles: *C. angustitergum* only; half closed circles: both species together.

a stable ecosystem with water of high clarity, and the plankton and the benthic fauna appear to have much in common with those of the open sea. It is a strong assumption that the other enclosed bodies of water where *angustitergum* flourishes also have an ecosystem of this type; Spaanse Water is now partly industrialised, but the ecosystem still appears to favour *angustitergum*. The absence of large growths of mussels and harbour barnacles such as *B. eburneus* from these inlets is an additional indication of the type of production system.

On the above basis therefore, we can suggest that *Chthamalus angustitergum* is pre-eminently a Caribbean barnacle, adapted to life in clear blue waters, mostly places with a small tidal range, a low biomass of plankton and little organic matter in suspension. *C. bisi-*

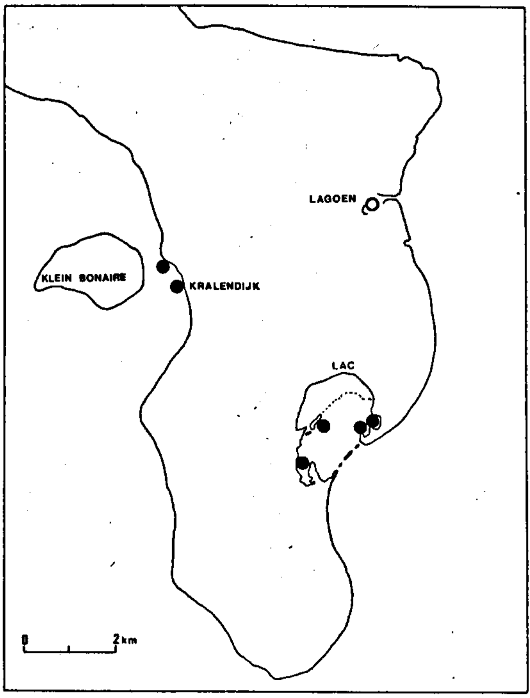

Fig. 6. Sketch map of the southern part of Bonaire showing localities where *Chthamalus* was collected. Open circles: *C. bisinuatus*; closed circles: *C. angustitergum.*

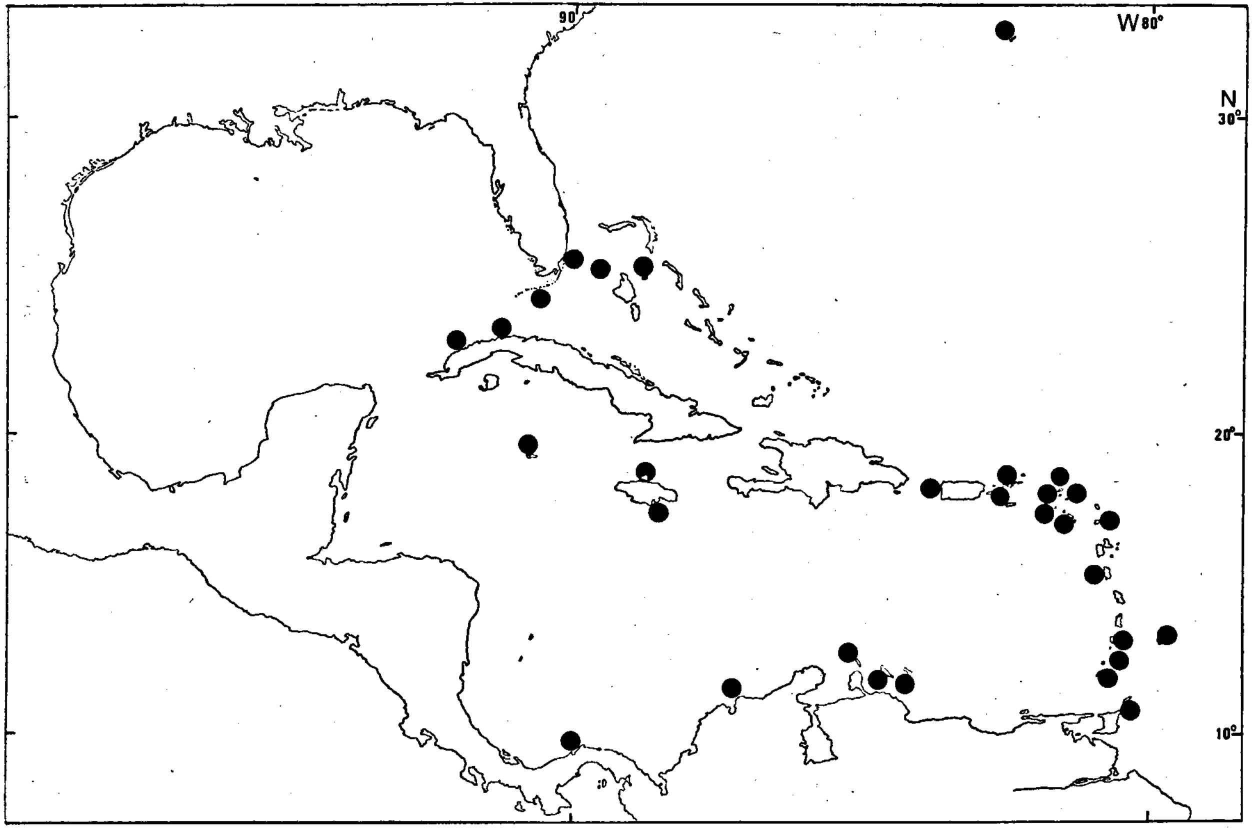

Fig. 7. Outline chart of the Caribbean showing localities from which *Chthamalus angustitergum* has been recorded. For some localities several records are available, but space does not allow showing them all.

nuatus, on the other hand, is less well adapted to blue-water Caribbean situations, but is able to compete with and sometimes replace *C. angustitergum* in muddy sheltered waters where the salinity is not too low, and is keyed in some way (feeding habits of the larval or adult stages) to the greater quantity of plankton and detritus found in such less blue-water situations. An examination of the food contents of the gut and the methods used by the species to collect food would obviously be the next step in the study of these Caribbean chthamalids. However, the hypothesis presented here would go a long way to explaining the otherwise puzzling distribution of these two species (Figs. 7–8).

So far only *C. angustitergum* has been found in Bermuda. According to HENRY (1958) the subspecies *thompsoni* found there is characterised by the persistence of the radii and the epidermis; a raised ridge on the tergal side of the adductor muscle pit; the shape of the articular ridge of the scutum and the spur on the tergum; the presence of conical spines on the basal segments of cirrus I; and the occurrence of thick pectinated spines on cirri I and II. Most of these are differences of degree and can be found to a greater or lesser extent in specimens of *angustitergum* from other localities, though they do serve to emphasise the separation of *angustitergum* from *stellatus*. Examination of a large number of Bermudan specimens shows that these tend to have more rugged shells than Caribbean material, with radii showing even when the shell has begun to thicken. However, individuals of a similar type have also been found in another isolated island, Barbados, and may perhaps be regarded as a growth form related to slightly slower rates of growth and longer life than in more favoured locations. The one major difference discernible in the Bermudan specimens is the intense hairiness of cirri I and II, which have large numbers of the plumose type of setae and relatively more of the pectinate setae than specimens from the nearest mainland locality, Miami. For this reason it appears to be necessary to retain *thompsoni* as a subspecies of *angustitergum*.

There is thus a clear geographical separation of the common North Atlantic chthamalids. On the western side we have *C. fragilis* in the temperate-subtropical region and *C. angustitergum* and *C.*

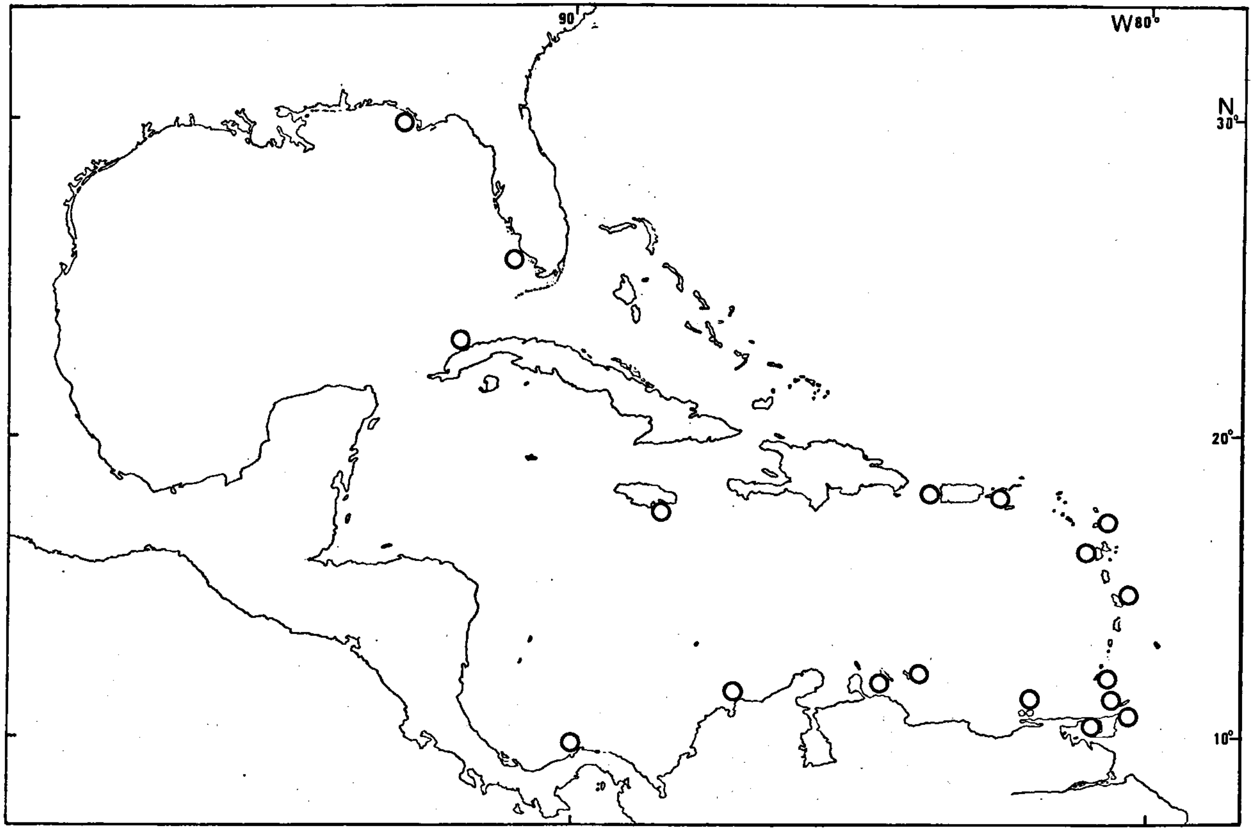

Fig. 8. Outline chart of the Caribbean showing localities from which *Chthamalus bisinuatus* has been recorded. As with Fig. 7 not all individual records can be shown.

bisinuatus in the tropical region, with a subspecies of *C. angustitergum* in the isolated "tropical type" island of Bermuda. On the eastern side *C. stellatus* occurs from the temperate zone to the tropical regions of West Africa, where it meets the South Atlantic species *C. dentatus* (STUBBINGS 1967), and is also found on the oceanic islands of the Azores (personal observations and personal communications D. J. CRISP: collections by expeditions from Queen Mary College and Chelsea College) and Madeira (personal observations). The American species are clearly more closely related to each other than to *C. stellatus*, and can easily be separated from the latter when alive by the colours of the soft flaps of tissue that line the entrance to the shell cavity. In *stellatus* these flaps are a brilliant blue, with patches of dark brown at each end and a small area of light brown or bright orange in the centre each side (SOUTHWARD & CRISP 1963). All the American species so far seen have almost identical colours of the flaps: a basic dark brown contrasting with a more or less lighter coloured brown all round the rim of the flaps where the edge is reflexed when fully expanded. This latter pattern has also been seen in most indo-pacific species; a whitish colour, without the electric blue effect of *stellatus*, has been seen only in *C. dentatus* and in *Tetrachthamalus*.

The specialised mangrove-living chthamalids, which are confined to the extreme tropics, also have distinct species on each side of the Atlantic, *C. rhizophorae* in Brazil and the Caribbean, and *C. aestuarii* (STUBBINGS 1967) in West Africa.

SUMMARY

Some 22 taxa of barnacles, including 19 Balanomorpha, are recorded from a large number of Caribbean localities, ranging from S. Florida to Trinidad, and from the Panama Canal Zone to Barbados. *Balanus reticulatus* Utinomi is recorded for the first time from the region and its morphology compared with *B. amphitrite amphitrite* Darwin, with which it has been confused. *Chthamalus stellatus bisinuatus* Pilsbry is raised to full specific rank and details given of the morphological differences between this species and the other common Caribbean chthamalid, *C. angustitergum* Pilsbry. Full discussion of the distribution of barnacles in the Caribbean is reserved to a later occasion, but some details are given of the relationship of the *Chthamalus* species to environmental factors. It is suggested that *C. angustitergum* in contrast to *C. bisinuatus* is especially adapted to life in the clear blue waters of the Caribbean, with their low standing crops of plankton and little detritus.

ADDENDUM

While this contribution was being prepared for printing two further publications appeared concerning the Cirripedia of the caribbean and adjacent regions. MOORE, ALBERTSON & MILLER (1974) describe changes in settlement of barnacle cyprids in the Miami area, including cyprids of *Balanus improvisus* (see this paper), and also report the presence of *Balanus reticulatus* Utinomi. HENRY (1973 publ. 1974) describes two new species of the *amphitrite* complex from the atlantic side of America. One of these, formerly recorded as *B. amphitrite pallidus* (HENRY 1959) is reported from Trinidad; I have seen specimens of this species, *B. subalbidus* Henry, from the Gulf coast of Florida, but none from the collections described here. The other new species *Balanus citerosum* Henry, includes some material formerly recorded as *B. amphitrite niveus* from Brazil; at present this new form seems better regarded as belonging to *Balanus pallidus* sensu lato, in view of its shell structure and the wide variation in this species as recorded by STUBBINGS (1967).

APPENDIX

SAMPLES OF RECENT SHALLOW-WATER BALANOMORPH CIRRIPEDIA FROM THE CARIBBEAN

collected by P. WAGENAAR HUMMELINCK, at present stored at the Zoölogisch Laboratorium, Utrecht; the greater part of this collection will be presented to the Rijksmuseum van Natuurlijke Historie, Leiden.

The following abbreviations are used *B.* = *Balanus*, *C.* = *Chthamalus*, *N.* = *Newmanella* (Tetraclita), *T.* = *Tetraclita* for the genera; the specific names have been shortened where convenient. As a rough abundance scale the following symbols are used, based on CRISP & SOUTHWARD (1958): A = abundant, C = common, F = less common, 0 = few present; the very rare category (R) is not used as the samples were not collected especially for the purpose of studying barnacle distribution. Where two species of *Chthamalus* occur together, the numbers of each in the sample are also given.

FLORIDA

1408A Virginia Key, NE, 4.IX.1963, pieces of rock in sand, with sea grass (1–2 m).
Several *B. "assimilis"*, *B. trig.* A.

1409 Virginia Key, Marine Lab., 1.IX.1963, concrete pilings in muddy water (0–1 m).
B. "assimilis", 0; *B. eburn.* 0 dead; *B. amph. amph.* C; *B. trig.* A; *C. angust.* C.

1410–A Key Biscayne, N Pt., 1.IX.1963, *Rhizophora* in sea grass area.
B. "assimilis" 0 dead; *B. amph. amph.* C; *B. trig.* A; *T. stal.* C; *C. angust.* C.

1411 Key Biscayne, NE, 7.IX.1963, surf-swept beach-rock (0–1 m).
T. stal. A; *C. angust.* C–A.

1412 Key Biscayne, NW, 31.VIII.1963, mangroves and loose rocks in swampy creek with tidal flow.
B. eburn. 0 dead; *B. amph. amph.* C.

BIMINI (Bahamas)

1151 North Bimini, lagoon side, 20.VIII.1949, wood pilings in muddy sand with *Thalassia* (0–1 m).
T. stal. A; *C. angust.* 0.

1152 North Bimini, Entrance Pt., 18.VIII.1949, beach-rock (0–1 m).
T. stal. A.

GRAND CAYMAN (Cayman Islands)

1685 North Sound, Head of Barkers, 10.VI.1973, young *Rhizophora* in soft mud (0–½ m).
C. angust. C.

1689 North Sound, SW part at Turtle Crawls, 25.V.1973, *Rhizophora* and pilings in mud (0–1 m).
C. angust. A.

LITTLE CAYMAN

1698 South Hole Sound, 5.VI.1973, *Rhizophora* in muddy sand (0–¾ m).
C. angust. 0.

JAMAICA

1148 Kingston Harbour, Myrtle Bank, 15.VIII.1949, pilings in muddy water (0–1 m).
B. "assimilis" C; *B. trig.* C; *C. bisin.* C.

1677 Kingston Harbour, Port Royal side, near airport, 7.V.1973, *Rhizophora* and timber in mud (0–1 m).
B. eburn. A.

1678 Kingston Harbour, Port Royal side, further west, 7.V.1973, *Rhizophora* in mud (0–1 m).
B. eburn. C; *B. trig.* F.

1679 Fort Rupert Lagoon, Port Royal, 15.V.1973, *Rhizophora* in mud (0–1 m).
B. "assimilis" 0; *B. eburn.* A; *B. retic.* F.

1680A Port Royal, Mar. Lab., 10.V.1973, concrete pilings (0–1 m).
B. "assimilis" F; *B. trig.* A; *B. retic.* C–A; *C. bisin.* C.

1681 Great Saltpond, recently closed off from sea, entrance, 8.V.1973, *Rhizophora* in sand.
B. eburn. C.

Puerto Rico

1415 Mayagüez, 4 km off Pta Cadena, 14.IX.1963, muddy sand with shells (90 m).
B. trig. C.

1416 Mayagüez, 4 km off Anasco R., 14.IX.1963, muddy sand & dead *Rhizophora* (10 m).
B. "assimilis" C; *B. trig.* A.

1419 Mata de la Gata, Parguera, 12.IX.1963, weak *Rhizophora* in mud.
C. angust. 11 (C); *C. bisin.* 4 (F).

1420 Bahía Fosforescente, Parguera, 17.IX.1963, *Rhizophora* in mud.
B. eburn. 0; *C. bisin.* 0.

1421 Bahía Fosforescente, Parguera, 17.IX.1963, *Rhizophora* in sand.
B. eburn. A.

St. Thomas

s.n. Charlotte Amalie harbour, 16.III.1937, pieces of rock (0–1 m).
C. bisin. A.

1674 Benner Bay Lagoon, 30.IV.1973, *Rhizophora* in mud (0–1 m).
B. eburn F; *B. amph. amph.* C.

1675 Magens Bay, 30.IV.1973, sandy rock at water line.
T. stal. C; *C. angust.* C.

St. John

1407 Turner Bay, 18.VI.1955, surf-swept porfiritic rock (0–1 m).
B. amph.? 0 dead; *B. galeatus* 0; *T. stal.* C; *C. angust.* A.

1408 South of Cruz Bay, 19.VI.1955, rock debris in surf (½ m).
T. stal. C.

Anguilla

1142 North of Sandy Ground, 19.VI.1949, *Millepora* in sandy reef (1–2 m).
B. stultus 0 dead.

1704 Crocus Bay, 3.VII.1973, limestone and igneous rock near sand (0–1½ m).
T. stal. A; *C. angust.* A.

St. Martin

1125–A Great Bay, Pt. Blanche, 26.VI.1949, tuffoid rocks and limestone (0–½ m).
T. stal. C; *C. angust.* A.

1126 Great Bay, E, 11.VI.1949, boulders (0–1 m).
T. stal. F dead.

1128 Great Bay, NE, 16.VI.1949, boulders in sand (0–1½ m).
T. stal. F; *C. angust.* C.

1129 Simson Bay bridge, 4.VIII.1949, wood pilings at lagoon entrance (0–1 m).
T. stal. C; *C. angust.* A.

1131 Simson Bay Lagoon, Little Key, 2.VIII.1949, *Rhizophora* in muddy sand.
C. angust. C.

1132 Simson Bay, Flamingo Pond, 8.VI.1949, mangroves in mud.
C. angust. A.

1339 Pt. Blanche Bay, 5.VI.1955, surf swept beach-rock (0–1 m).
C. angust. C.

1429-A Oyster Pond, 13.X.1963, *Rhizophora* and rock (0–½ m).
C. angust. F.

s.n. Lay Bay, 27.V.1949, rock (0–½ m).
T. stal. F.

FOURCHE (= Five Island, W of St. Barts)

1124 Five Island Bay, 2.VI.1949, rock (0–1 m).
T. stal. A.

ST. BARTHÉLEMY (= St. Barts)

1121 Public, 4.VI.1949, andesite debris (0–1 m).
T. stal. C; *C. angust.* A.

SABA

1120 Fort Bay, 21.VII.1949, andesite rock on open coast (0–1½ m).
T. stal. C; *T. divisa* C; *C. angust.* C.

1120A same, 6.X.1963.
T. stal. C; *T. divisa* C; *C. angust.* F.

1705 Fort Bay Pier, 7.VII.1973, wood pilings (0–1 m).
N. radiata F; *C. angust.* A.

s.n. Spring Bay, 28.VII.1949, surf-swept andesite (0–½ m).
T. stal. F.

ST. EUSTATIUS

1116 Gallows Bay, Oranjestad, 15.VII.1949, andesitic pebbles (0–½ m).
T. stal. C; *C. angust.* C.

1116A Gallows Bay, 15.VII.1949, cast ashore.
B. stultus 0 dead; *T. stal.* 0.

1117 Billy Gut, Oranjestad, 13.VII.1949, andesitic boulders in sand (0–1 m).
B. tintin. ant. F dead; *T. stal.* C; *C. angust.* F.

1119 Tumble Down Dick Bay, 10.VII.1949, andesite boulders in sand (0–1 m).
T. stal. F; *C. angust.* F.

ST. CHRISTOPHER (= St. Kitts)

1397 Frigate Bay, 20.VII.1955, volcanic tuff and boulders (0–1 m).
T. stal. C; *C. angust.* C–A.

1398 Basseterre, St. Thomas Pt., 30.VII.1955, andesitic rock (0–1 m).
T. stal. C; *C. angust.* C.

s.n. Basseterre, E, 19.III.1937, volcanic rock (0–½ m).
C. angust. F.

ANTIGUA

1393 Deep Bay, 17.VII.1955, tuffoid pebbles (0–1 m).
C. angust. 10 (A); *C. bisin.* 6 (C).

1540A Dickinson Bay, N, 19.VII.1967, boulders in sand (½–1 m).
C. angust. 1; *C. bisin.* 6 (C), and juv. of both.

1541 Dickinson Bay, jetty, 28.VII.1967, wood pilings in sand (0–1 m).
T. stal. F; *C. bisin.* C.

GUADELOUPE

1484 Rivière Salée, Pont de la Gabarre, 4.II.1964, *Rhizophora* in mud.
B. "assimilis" C.

1543 Rivière Salée, N entrance, 16.VII.1967, *Rhizophora* and oysters in muddy sand.
B. "assimilis" 0; *B. eburn.* C.

1545A Rivière Salée, Manche à l'Eau, 16.VII.1967, shells in muddy sand near mangroves (½–1 m).
B. "assimilis" F.

LA DÉSIRADE

1438 Grande Anse, Pier, 25.I.1964, pools in sandy *Thalassia* flat (0–1 m).
T. stal. C.

ISLOTE AVES (Ven., W of Dominica)

1115 Northern reef flat, 12.V.1949, beach rock (0–1 m).
T. stal. F; *N. radiata* C; *Cataphragmus imbricatus* C.

DOMINICA

1546 Prince Rupert Bay, Portsmouth, 15.VII.1967, volcanic boulders (0–1 m).
T. stal. C; *C. angust.* F.

MARTINIQUE

1439 Anse de l'Âne, Trois Islets, 10.II.1964, sandy volcanic rock (0–1 m).
T. stal. C; *C. bisin.* C.

1547 Trois Rivières, Ste Lucie, 12.VII.1967, *Rhizophora* in muddy sand (0–1 m).
B. eburn. C.

ST. LUCIA

1548 Port Castries, Trou Garnier, 11.VII.1967, *Rhizophora*, wood, wreck (0–1½ m).
B. eburn. F dead; *B. "assimilis"* C; *B. amph.?* 0 dead; *B. trig.* F dead; *C. bisin.* F.

ST. VINCENT

1549 Calliaque Bay, Johnson Pt, 10.VII.1967, dead *Conocarpus*, pebbles (0–1 m).
B. eburn. F; *T. stal.* C; *C. angust.* C–A.

GRENADA

1389 White Bay, Pt Salines, 26.I.1955, volcanic rock (0–1 m).
T. stal. C; *C. angust.* 4 (F); *C. bisin.* 1 (0).
1391 Lagoon St. George, 24.I.1955, wooden jetty in mud, turbid (0–1 m).
B. eburn. C; *T. stal.* C; *C. bisin.* C.
1550 Hog Island, Pt Salines, 8.VII.1967, *Rhizophora* in mud.
B. eburn. C.
1551 Mount Hartmann, nr Hog I., 8.VII.1967, *Rhizophora* in muddy sand.
T. stal. C; *C. angust.* 6 (F); *C. bisin.* 60 (A).

TOBAGO

1388 Red Pt, Scarborough, 14.I.1955, volcanic rock (0–1 m).
T. stal. C; *T. divisa* A; *C. bisin.* F.
s.n. Little Tobago, landing, 18.I.1955, volcanic rock (0–½ m).
T. stal. C.

TRINIDAD

792A Mouth of Nariva swamp, 17.I.1964, *Rhizophora* and pilings in brackish water.
B. pallidus stuts. C; *C. bisin.* 0.
1382 Monos Island, Avalon Bay, 10.I.1955, volcanic rock in muddy sand (0–½ m).
T. stal. C.
1384 Maracas Bay, 29.I.1955, sandy rock (0–½ m).
C. bisin. C.
s.n. Cocos Beach at Nariva Bridge, 17.I.1964, beach debris.
B. amph.? 0 dead.
s.n. Los Gallos Pt, 16.I.1964, shells on sandy beach.
B. amph.? F dead; *B. trig.* C dead; *T. stal.* C; *C. bisin.* C.

MARGARITA (Ven.)

1446 Punta Mangle, 11.I.1964, *Rhizophora*, in mud, turbid water.
B. amph. amph. F; *B. eburn.* F; *C. bisin.* 0.

1217a Laguna de las Maritas, S of Pta Mosquito, 13.I.1964, *Rhizophora* in mud, with *Ruppia*.
B. eburn. F.

1447 Pta de Piedras, Inst. Inv. Mar., 12.I.1964, poles in muddy sand (0–1 m).
B. amph. amph. F; *B. trig.* C.

1448 Pta de Piedras, lagoon entrance, 12.I.1964, *Rhizophora* in mud with turbid tidal flow.
B. eburn. C; *B. amph. amph.* F; *B. trig.* C; *C. bisin.* C.

1449 Pte de la Restinga, 11.I.1964, *Rhizophora* in mud.
B. eburn. C; *B. trig.* C.

s.n. Pta de Piedras, 9 & 13.I.1964, shells on sandy beach.
B. trig. A.

s.n. 25 miles N of Margarita (trawled by T. Blok), 9.XII.1954, on shells (37 m).
B. trig. A.

CENTINELA (Ven.)

1212 SW shore of Centinela, 31.VII.1936, surf-swept rocks (0–½ m).
B. tint. ant. C.

VENEZUELA (mainland)

1203 Puerto Santo, near Carúpano, 12.VI.1936, sandy debris (2 m).
B. trig. C.

BONAIRE

1053–1054 Kralendijk roads, 21.IX.1948, on buoys.
T. stal. 0; *N. radiata* F.

1056b–A–Ba Paloe Lechi, 27.II.1947–4.IX.1948–6.IV.1955, beach rock & dead coral.
T. stal. C; *C. angust.* A.

1378 Boca Spelonk (Zaneveld) 14.IV.1955, surf-swept limestone (0–½ m).
B. tint. ant. 0 dead.

s.n. Malmok, Washington, 29.X.1968, limestone (0–½ m).
B. tint. ant. F dead.

Lac

1062a Sorobon (= Soerebon), 17.IV.1955, *Rhizophora* in muddy sand.
C. angust. F.

1064a–c Puitu (= Poejito), 10.XI.1930–17.IV.1955. *Rhizophora* in muddy sand
C. angust. F.

1575–1578–1580 Puitu. 10.VIII & 11.VIII.1967, *Rhizophora* in muddy sand.
C. angust. locally C.

1589 Boca Fogon, 14.VIII.1967, *Rhizophora* in soft mud.
C. angust. locally C.

1590 S of Boca Fogon, 14.VIII.1967, *Rhizophora* in soft mud.
C. angust. F.

1593A Punta Palu Calbas, 5.IX.1967, drift-wood.
B. retic. C.

1594 Playa Mangel Altu, 23.VIII.1967, limestone in muddy sand (0–½ m).
T. stal. F.

Lagoen

1070c–Ba SE Lagoen, 9.IV.1955–14.IX.1948, *Rhizophora*, rocks and shells.
C. bisin. A.

1558 SE Lagoen, 19.IX.1967, *Rhizophora* in muddy sand.
C. bisin. A.

1070A SE Lagoen, 2.XI.1930, tree trunk washed ashore.
B. pall. stuts. C.

CURAÇAO

1020A Boca Lagoen, 13.XI.1948, limestone (0–1 m).
T. stal. F.

1034 Schottegat, Parera, 2.VIII.1948, rocks in muddy water (0–½ m).
B. eburn. F dead; *B. amph.*? F dead.

1037A Spaanse Baai, 21.IV.1949, *Rhizophora* in sand.
C. angust. locally C.

1629 Spaanse Water, N Jan Sofat, 17.XI.1968, *Rhizophora* and rocks.
C. angust. locally C.

1038A Fuik Baai, Duitse Bad, 2.III.1949, *Rhizophora* and rocks in mud.
C. angust. F.

1359 Playa Grandi (coll. by J. S. Zaneveld), 30.I.1955, rock (0–1 m).
C. bisin. F.

1641 St. Joris Baai, S shore, 23.X.1968, *Rhizophora* and shells in muddy sand.
C. bisin. A.

1668A St. Joris Baai, NW inlet, 25.II.1970, *Rhizophora* and rocks in mud.
C. bisin. A.

s.n. St. Martha Baai, 12.VI.1970, muddy (0–½ m).
B. eburn. F dead.

s.n. Caracas Baai, IV. 1955, on *Fasciolaria*.
B. trig. F dead.

Piscadera Baai

1029 Boca (= Outer Bay), 29.I.1949, iron fence (1–1½ m).
T. stal. C; *N. radiata* 0.

1453 Boca, 3.I.1966 (3½ m).
B. trig. 0.

1620 Boca, Carmabi, 14.X.1967, piling (0–1 m).
B. amph. amph. 0; *B. trig.* C.

s.n. Boca (coll. by J. S. Zaneveld), 10.XI.1954, cast ashore.
B. tint. ant. 0 dead.

1460–A–1707 Entrance, 14.XII.1963–27.VII.1973, *Rhizophora* in sand.
T. stal. F; *C. bisin.* C–A.

1462 Entrance, 2.I.1964, iron poles in tidal flow (0–1 m).
B. tint. ant. F; *C. bisin.* C.

1463 Entrance, 14.XII.1963, *Rhizophora* in muddy sand.
N. radiata 0; *C. bisin.* C.

1464–1469–a–B Inner Bay, S part, 28.IX.1963–18.XII.1963–27.VII.1973, *Rhizophora* in muddy sand.
B. amph. amph. C; *B. eburn.* C; *C. bisin.* A.

1470 Inner Bay, S part, 4th buoy, 31.X.1963.
C. bisin. C.

1473–b–c–1475–1476a–b Inner Bay, centre, 26.IX.1962–13.XII.1963, 25 & 26.VII.1973, *Rhizophora* and shells.
B. eburn. A–C; *B. amph. amph.* 0; *C. bisin.* A.

1477 Inner Bay, centre, 3rd buoy, 31.X.1963.
C. bisin. C.

1479–a–A–1481–a Inner Bay, N part, 25.VII.1962–26.IX.1962–11.XII.1963–26.VIII.1973, *Rhizophora*, stones and shells.
C. bisin. C.

1482–1484 Inner Bay, N part, 1st and 2nd buoys, 31.X.1963.
C. bisin C.

1485–1487–b–1493–b Inner Bay, N part, 25.XI.1963–11.XII.1963–15 & 26.VII.1973, *Rhizophora*.
B. eburn. A; *C. bisin.* A.

1495–1497–1498–a Inner Bay, N part, 29.X.1963–25.XI.1963–26.VII.1973, *Rhizophora*.
B. amph. amph. 0; *C. bisin.* A.

1621a–A–1622–1623 Inner Bay, N part, 25.VII.1973, 26, 29 and 26.IX.1967, *Rhizophora* in mud.
B. eburn. A; *B. amph. amph.* O; *B. "assimilis"* O; *C. bisin.* A.

1671 29.III.1970.
B. trig. 0.

1708–A Inner Bay, S part, 27.VII.1973, *Rhizophora* in mud.
B. eburn. C; *B. amph. amph.* 0.

ARUBA

1005a–b Rif Bucuti (= Boekoeti), lagoon side, 18.II.1937–17.I.1949, *Rhizophora* in muddy sand.
C. angust. C.

1008A Spaans Lagoen, NW, 1.I.1949, dead *Rhizophora* in mud (0–1½ m).
B. eburn. C; *B. trig.* C; *T. stal.* C.

1302 Wharf of Arend Petrol Co., 4.V.1949, iron beam, sandy coast (1–2 m).
B. tint. ant. F; *B. trig.* C.

1303 Paardenbaai, Oranjestad, 28.IV.1955, *Rhizophora* in sand.
C. angust. locally C.

1305 Spaans Lagoen, N of (old) bridge, 15.V.1955, rock and shells in mud (0–1 m).
B. eburn. A.

LA GOAJIRA (Col.)

s.n. Río Hacha, 20.I.1937, driftwood.
B. venustus niveus F.

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1. *Balanus amphitrite amphitrite*, large specimen from Margarita, seen from above (× 2.9)

2. *Balanus amphitrite amphitrite*, Margarita, opercular plates. (× 3.3)

3. *Balanus amphitrite amphitrite*, Trinidad, seen from side. (× 4.9)

4. *Balanus reticulatus*, Trinidad, section of parietes showing arrangement of colour stripes. (× 6.3)

5. *Balanus reticulatus*, Trinidad, large elongate specimen seen from above. (× 3.1)

6. *Balanus reticulatus*, Trinidad, opercular valves from specimen similar to fig. 5, but smaller. (× 5.1)

7. *Balanus reticulatus*, Trinidad, small specimen in side view showing the very oblique radii. (× 5.0)

8. *Balanus reticulatus*, Trinidad, enlarged view of colour stripes. (× 6)

9. *Balanus reticulatus*, Trinidad, labrum of large specimen. (× 66)

10. *Balanus reticulatus*, Trinidad, part of labrum of small specimen, showing details of teeth. (× 480)

11. *Balanus reticulatus*, Panama Canal Zone, Cristobal, labrum of dried specimen. (× 107)

12. *Balanus reticulatus*, Trinidad, maxilla. (× 55)

13. *Balanus reticulatus*, Trinidad, Monos Is., labrum. (× 60)

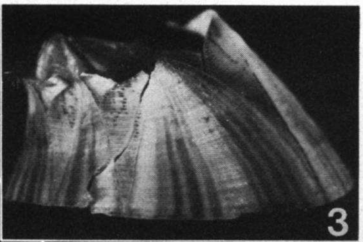
14. *Balanus reticulatus*, Panama Canal Zone, Cristóbal, maxilla. (× 60)

15. *Balanus reticulatus*, Trinidad, cirrus 3, small spines on basal segments of rami. (× 50)

PLATE I


1


2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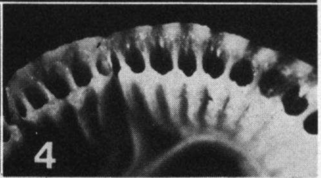
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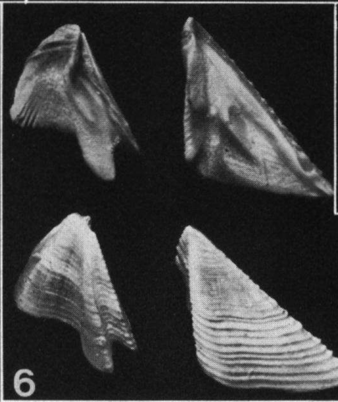
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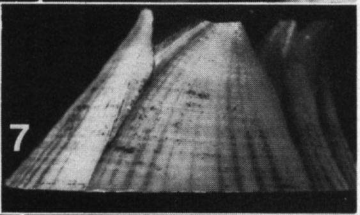
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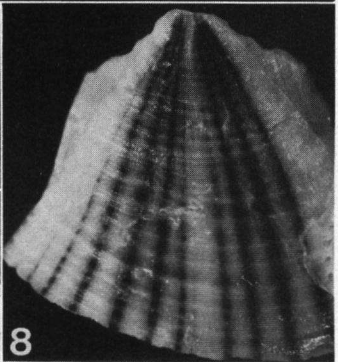
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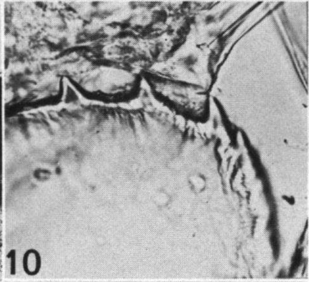
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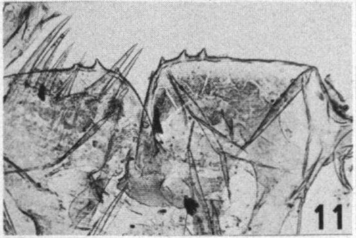
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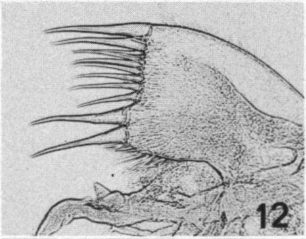
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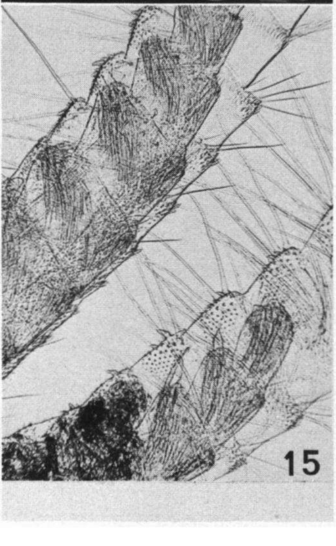
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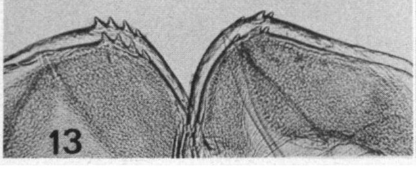
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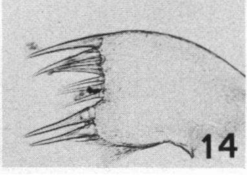
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1. *Balanus stultus*, Klein Bonaire, large, medium and very small specimens on pieces of *Millepora*. (× 1.5)

2. *Balanus stultus*, Klein Bonaire, large shell after cleaning. (× 2.5)

3. *Balanus stultus*, opercular valves. (× 3.5)

4. *Tetraclita stalactifera*, Galera Pt, Trinidad: medium to small specimens and spat, to compare with fig. 5. Two small *Chthamalus* also present. (× 2.1)

5. *Newmanella radiata* (*Tetraclita radiata*), Trinidad, Monos Is., small specimens with very white shells. (× 2.5)

6. *Tetraclitella divisa*, Saba. (× 9.3)

7. *Newmanella radiata* (*Tetraclita radiata*), Cuba, medium size, showing characteristic appearance of operculum. (× 4.3)

8. *Newmanella radiata*, Cuba, opercular valves. (× 4.3)

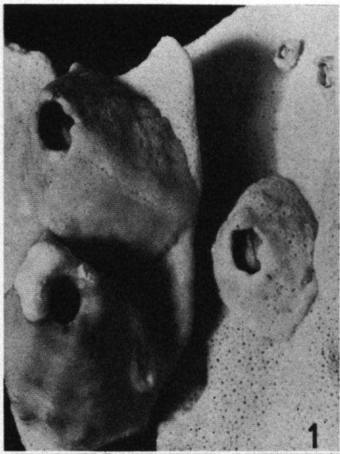
9. *Cataphragmus imbricatus*, Islote Aves, medium to small. (× 3.7)

10. *Boscia madreporarum* (*Pyrgoma stokesii*), Klein Bonaire, medium and very small specimen in situ in coral (*Agaricia*). (× 5.3)

11. *Boscia madreporarum*, Klein Bonaire, internal and external views of large shells after cleaning. (× 4.9)

12. *Boscia madreporarum*, Klein Bonaire, internal side of tergum. (× 14.7)

PLATE II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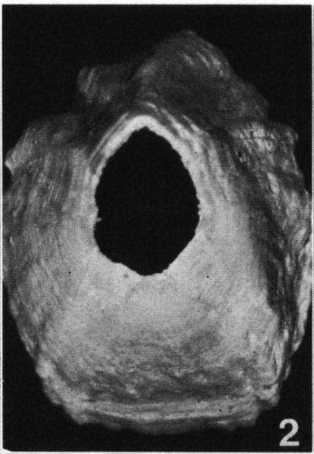
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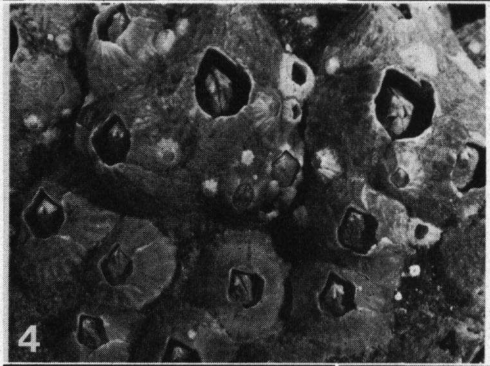
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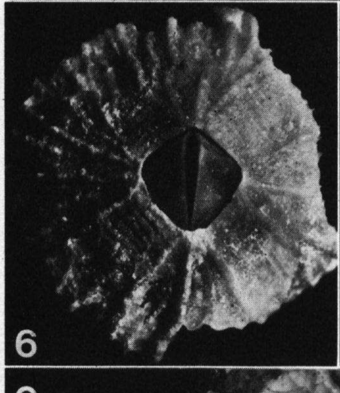
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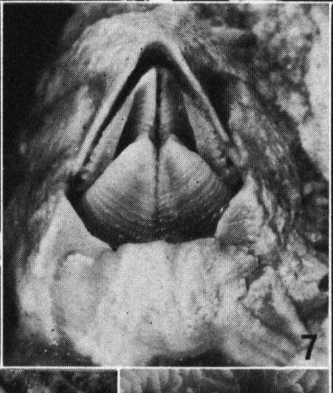
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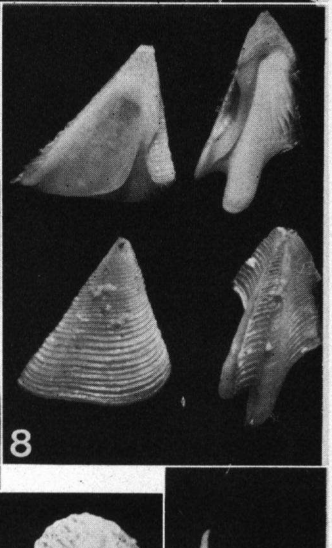
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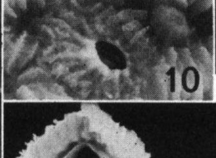
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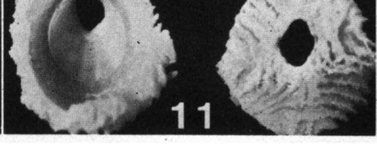
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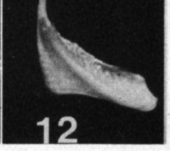
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1. ***Chthamalus angustitergum***, Esperanza, Cuba, medium and large specimens; the lower one superficially resembles ***Chthamalus rhizophorae***. (× 3.4)

2. ***Chthamalus bisinuatus***, Piscadera Baai, Curaçao, large specimens. (× 3.8)

3. ***Chthamalus angustitergum***, Key Biscayne, Florida, medium sized specimens from mangroves, showing persistence of radii. (× 5.9)

4. ***Chthamalus bisinuatus***, Kingston Harbour, Jamaica; two older individuals surrounded by recently settled young which superficially resemble *C. fragilis*. (× 6.5)

5. Mixed ***Chthamalus***, Puerto Rico, on mangroves. Top left, a large and a small specimen of ***Chthamalus bisinuatus***; right and below, two medium sized ***Chthamalus angustitergum***. (× 4.8)

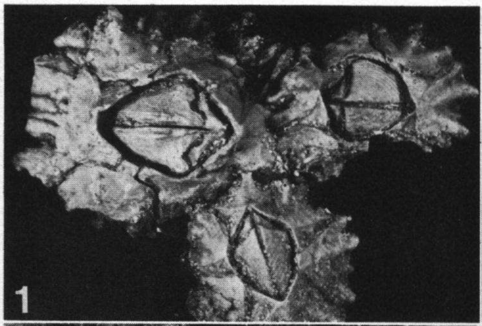
6. Mixed ***Chthamalus***, Grenada, on mangroves. Top left and top centre, two medium to small ***Chthamalus angustitergum***; the rest are ***Chthamalus bisinuatus***, with a fast-grown thin shell, showing some resemblance to ***Chthamalus fragilis***. (× 4.1)

7. Mixed juvenile ***Chthamalus***, Trinidad, Galera Pt., rocks. Left, ***Chthamalus bisinuatus***; right ***Chthamalus angustitergum***; the other small white barnacles are newly settled *Tetraclita stalactifera*. (× 8.7)

8. ***Chthamalus rhizophorae***, near Galeta Pt., Panama Canal Zone. (× 2.9)

9. ***Chthamalus fragilis***, Key Biscayne, Florida, on mangroves, with a very young ***Chthamalus angustitergum***. (× 5.4)

PLATE III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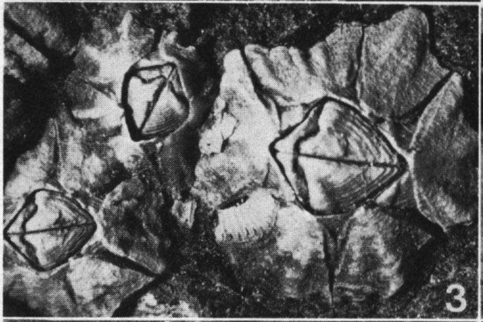
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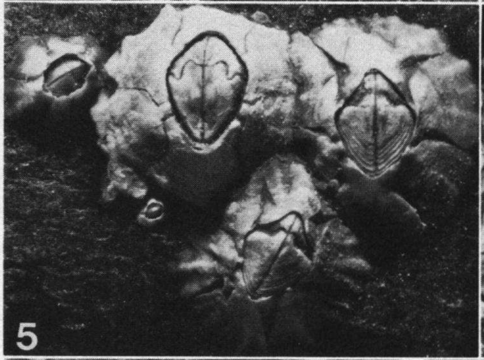
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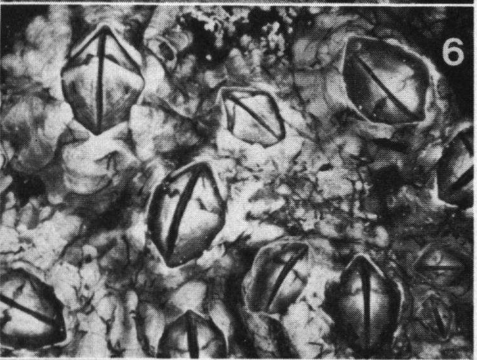
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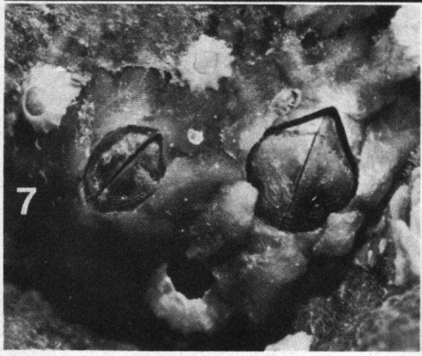
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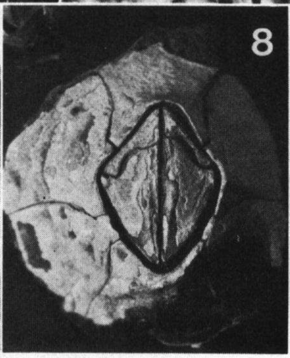
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1. *Chthamalus angustitergum*, Puerto Rico, interior of tergum and scutum. (× 12)

2. *Chthamalus angustitergum*, Antigua, interior of tergum and scutum. (× 12)

3. *Chthamalus angustitergum*, Lac, Bonaire, on mangroves, interior of tergum and scutum. (× 10.4)

4. *Chthamalus angustitergum*, Lac, Bonaire, small specimen, interior of tergum and scutum. (× 13.6)

5. *Chthamalus angustitergum*, Kabrieten Baai, Spaanse Water, Curaçao, interior of tergum and scutum. (× 12.8)

6. *Chthamalus angustitergum*, Key Biscayne, Florida, on rock, interior of terga and scuta. (× 12.8)

7. *Chthamalus angustitergum*, Key Biscayne, Florida, on mangroves; conical spines on inside of lower segments of anterior ramus of 1st cirrus. (× 370)

8. *Chthamalus angustitergum*, Key Biscayne, Florida, on mangroves; plumose setae on long ramus of 1st cirrus. (× 575)

9. *Chthamalus angustitergum*, Lac, Bonaire, mandible. (× 160)

10. *Chthamalus angustitergum*, Lac., Bonaire, pectinate lower part of mandible. (× 430)

11. *Chthamalus angustitergum*, Galera Pt., Trinidad, pectinate lower angle of mandible. (× 475)

12. *Chthamalus bisinuatus*, Kingston Harbour, Jamaica, pectinate setae of 2nd cirrus. (× 450)

13. *Chthamalus bisinuatus*, Sta. Marta, Colombia, pectinate setae on long ramus of 1st cirrus. (× 450)

14. *Chthamalus rhizophorae*, Galeta Pt., Panama Canal Zone, mandible. (× 73.5)


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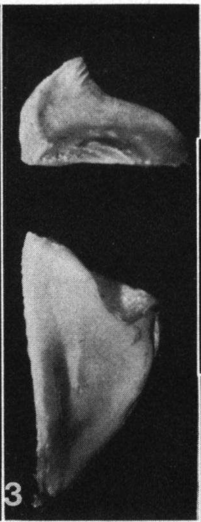
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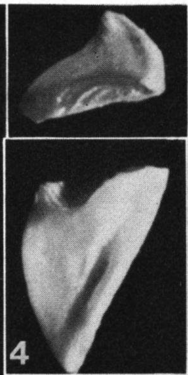
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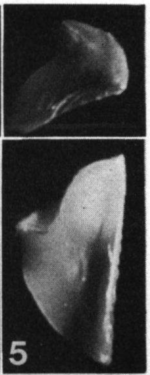
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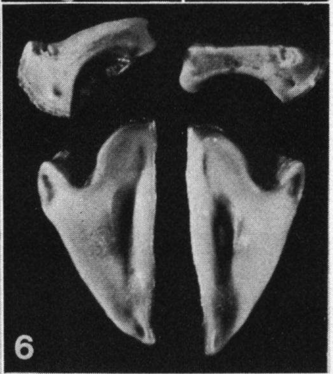
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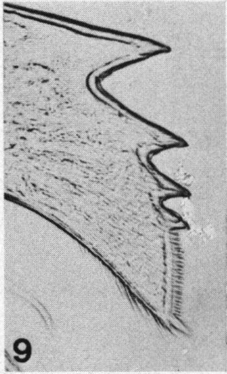
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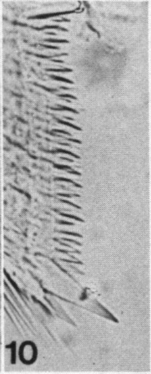
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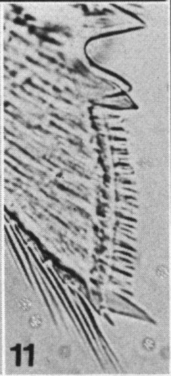
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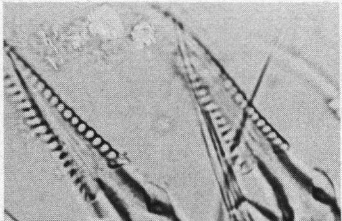
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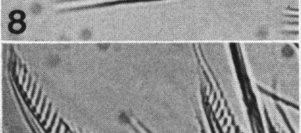
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14

1. ***Chthamalus bisinuatus***, Esperanza, Cuba, small spines on inner side of anterior ramus of cirrus 1. (× 475)

2. ***Chthamalus bisinuatus***, Lagoen, Bonaire, mandible. (× 100)

3. ***Chthamalus bisinuatus***, Lagoen, Bonaire, maxilla. (× 100)

4. ***Chthamalus bisinuatus***, Lagoen, Bonaire, pectinate lower part of mandible. (× 460)

5. ***Chthamalus bisinuatus***, Piscadera Baai, Curaçao, pectinate lower part of mandible. (× 460)

6. ***Chthamalus bisinuatus***, Esperanza, Cuba, pectinate lower part of mandible. (× 432)

7. ***Chthamalus bisinuatus***, Sta Marta, Colombia, interior of scutum. (× 13,6)

8. ***Chthamalus bisinuatus***, Puerto Rico, exterior of tergum and interior of scutum. (× 8)

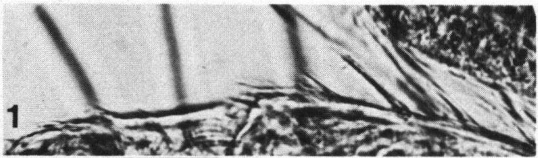
9. ***Chthamalus bisinuatus***, Esperanza, Cuba, interior of scutum. (× 16.8)

10. ***Chthamalus bisinuatus***, Antigua, interior of tergum and scutum. (× 13.6)

11. ***Chthamalus bisinuatus***, Lagoen,Bonaire, interior of tergum and scutum of old specimens with very sinuous junction between tergum and scutum. (× 13)

12. ***Chthamalus bisinuatus***, Lagoen, Bonaire, exterior and interior of terga and scuta of younger specimen with less sinuous junction. (× 13)

PLATE V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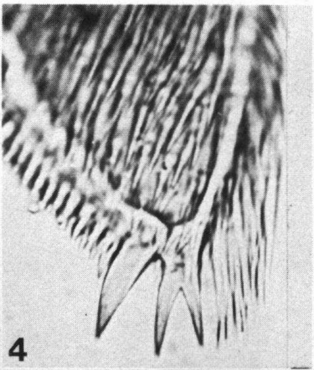
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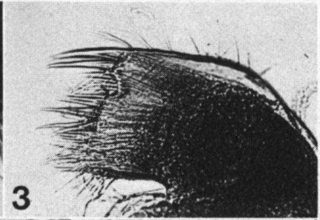
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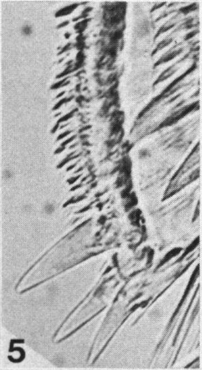
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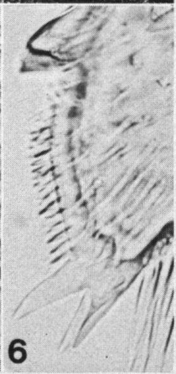
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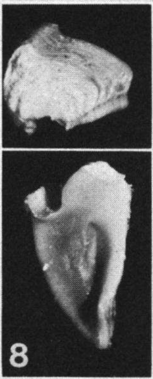
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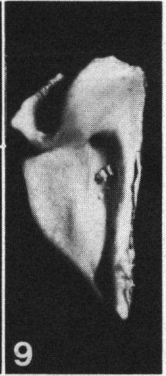
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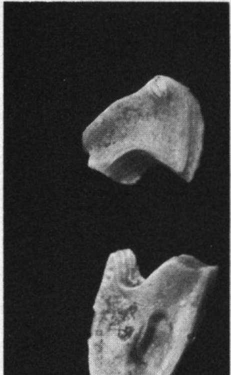
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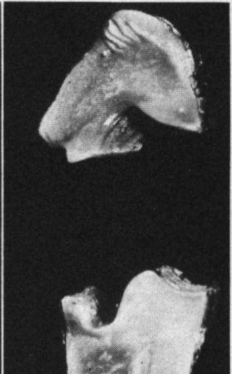
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