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Characterization of the Environmental Distribution and Morphs of *Ralfsia hancockii* Dawson (Phaeophyta) in the Mexican Tropical Pacific

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The environmental distribution, growth forms of the communities where *Ralfsia hancockii* Dawson grows and morphs of the species are described. The species is widely distributed environmentally. It grows best in places where a combination of gradient of factors gives extreme micro-conditions such as strong wave shock at high tide with dessication and high solar radiation at low tide or under the quiet conditions of high mid-littoral shallow pools. Under these conditions it forms extensive growths becoming the dominant species. These growths can form isolated patches or they can be interrupted by erect thalli of different species. *Chaetomorpha antennina* (Bory) Kütz. and *Chnoospora minima* (Hering) Papenfuss are its principal associated species. Two morphs are described in relation to the micro-conditions in which they are most frequently found.

Introduction

The study of *Ralfsia hancockii* Dawson (1944, 1952, 1954, 1961) is complicated by many of the problems common to all crustose algae: polymorphism and/or pleomorphism and convergence between species making it difficult to distinguish one from another in the field (Woelkerling 1988, León-Alvarez and González-González 1993 a). The confusion can be avoided if detailed observations of the variant morphs of the species and of the micro-conditions in which each morph is found in the field are included in the descriptions of the species.

Ralfsia hancockii is very similar to other species that have been reported in the Mexican Tropical Pacific (MTP) such as *R. pacifica* Hollenberg (Hollenberg 1969, Dreckmann *et al.* 1990, Mateo-Cid and Mendoza-González 1991 a), *R. hesperia* Setchell *et* Gardner (Mateo-Cid and Mendoza-González 1991 a, Mendoza-González and Mateo-Cid 1991) and *R. expansa* (J. Ag.) J. Ag. (Chávez 1972). However, *R. hancockii* may be distinguished from these species mainly by the presence of a cortical layer of small cells clearly differentiated from the medullary cells, and of unilocular reproductive structures with mostly 4-celled stalks (León-Alvarez and González-González 1993 b).

Ralfsia hancockii is widely distributed and frequent in the MTP (León-Alvarez and González-González 1993 a). It is found in many general and specific environments in each locality. In specific environments it has different morphs, abundance and density that give different physiognomies to the communities where it is found.

In this study we describe the environmental distribution of *R. hancockii* belong the coast of the MTP, including the general and specific conditions where it is found, the growth forms of the algal communities where it grows and its different morphs.

This will not only contribute to our knowledge of the ecological distribution of the species but it will promote an explanation of its different morphs, an assessment of its diagnostic features and help understand its adaptive range.

Methods

Thirty-six samples of *Ralfsia hancockii* Dawson from the littoral of the MTP were analyzed in detail (the localities are marked with an asterisk in Figure 1). The localities were selected because they were physiographically and environmentally the most diverse. In this way the greatest morphological differences could be expected in the specimens collected. These samples were supplimented by observations of the species made in the same and other localities (Fig. 1) over several years as part of the project 'Algas costrosas del Pacífico tropical mexicano' (CAMTP) carried out from the Laboratorio de Ficología and Herbario of the Facultad de Ciencias, UNAM.

A qualitative description of each locality was made determining general and specific factors according to their magnitude and possible influence on the presence of *R. hancockii* and on the physiognomy of the communities where it grows according to the methodological strategy proposed by González-González (1992, 1993) for phycofloristic studies.

For each set of specific conditions (e. g. vertical walls of the deep tidal pools), one or more micro-

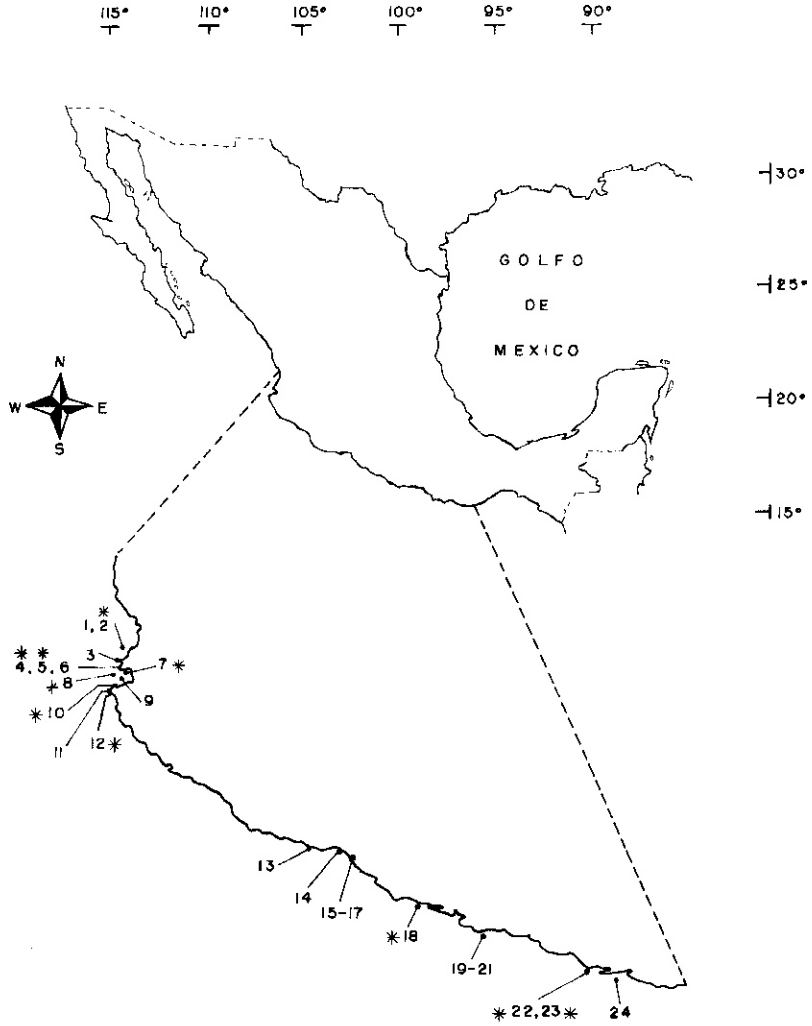

Fig. 1. Localities studied. * Sites intensively reviewed. 1. Sayulita, Nayarit; 2. Los Muertos, Nayarit; 3. Careyeros Nayarit; 4. Las Cuevas, Nayarit; 5. Las Manzanillas, Nayarit; 6. Embarcadero, Punta Mita, Nayarit; 7. El Tizate, Nayarit; 8. Isla Larga, Nayarit; 9. Boca Tomatlán, Jalisco; 10. Colemilla, Jalisco; 11. Corrales, Jalisco; 12. Playitas, Cabo Corrientes, Jalisco; 13. Caleta de Campos, Michoacán; 14. Lázaro Cárdenas, Michoacán; 15. Las Cuatas, Zihuatanejo, Guerrero; 16. Las Gatas, Zihuatanejo, Guerrero; 17. La Ropa, Zihuatanejo, Guerrero; 18. Puerto Escondido, Guerrero; 19. Muelle del puerto, Acapulco, Guerrero; 20. El Corsario, Acapulco, Guerrero; 21. El Yunque, Acapulco, Guerrero; 22. La Cruz, Barra Santa Elena, Oaxaca; 23. Zona de plataformas, Barra Santa Elena, Oaxaca; 24. Barra Copalita, Huatulco, Oaxaca.

conditions could be recognized by the presence of one or more communities, each with a distinctive growth form (Tavera-Sierra and González-González 1990). The growth forms of the communities where *R. hancockii* was found were recorded with respect to the appearance of the growth given by the dominant species and/or clustering or scattering of the set of species. The growth of *R. hancockii* was described considering continuity of the crust (patch-like), overlapping and relative abundance with respect to other species in the micro-environment.

External features of the crusts (e. g. out-line, color when wet, growth lines, shape of the thallus surface and presence and shape of lobes) that vary under differing environmental conditions were established in the field previously. These external features were recorded after collecting. The specimens were detached under the dissecting microscope, sectioned by hand and mounted in glycerine jelly (Johansen 1940) after staining with Malachite green. Internal features important for species identification (rhizoids, thickness, symmetry, presence and number of cell of the cortical layer, and reproductive characters) were observed under the light microscope.

A similarity analysis was carried out on the basis of 30 non-reproductive characters. Gower's distance was calculated using DELTA package (Dallwitz and Paine 1986), weighting the features that were observed to have the greatest differences in the field (out-line of patches, growth lines, shape of the thallus surface, presence and shape of the lobes and adherence to the substrate) and some internal characters (presence of rhizoids and symmetry). A phenogram was made using SAHN clustering method (arithmetic average) of the NTSYS package (Rohlf 1990). The groups formed include the whole gradient of microconditions in which each specimen was found.

The samples and the slides are deposited in the Herbarium of the Science Faculty, UNAM (FCME) with the following entry numbers: Los Muertos, Nay. (20/04/88), PTM3544, 3547; Sayulita, Nay. (07/10/87), 3356, 3355, 3351, 3350; Careyeros, Nay. (06/10/87), 3330, 3331, (21/04/88), 3588; Punta Mita, Las Cuevas, Nay. (21/04/88), 3570, 3571, (06/10/87), 3336, 3342, 3344; Las Manzanillas, Nay. (05/10/87), 3324, 3325, 3326, (19/04/88), 3540, 3541; Isla Larga, Nay. (09/10/87), 3381; Colemilla, Jal. (23/04/88), 3617, 3621, 3622; Caleta de Campos, Mich. (01/09/90), 4028; Lázaro Cárdenas, Mich. (20/03/84), De193 b; Playa Las Cuatas, Zihuatanejo, Gro. (?/02/92), without entry number; Playa La Ropa, Zihuatanejo, Gro. (12/09/92), PTM4345; Puerto Escondido, Gro. (15/01/86), 2814, 2817, 2852; Muelle del Puerto, Acapulco, Gro. (25/02/92), 4292; La Cruz in Barra Santa Elena, Oax. (24/06/82), 2213, (24/06/82), 2215, (21/03/86), 2996, 3005; Platform area in Barra Santa Elena, Oax. (1/08/88), 3773.

Results

Ralfsia hancockii was found along the coast of the MTP from the state of Nayarit to the state of Oaxaca (Fig. 1). In Table I the physiography and factors of the general or complex environments (González-González 1993) where the species was found are described.

Ralfsia hancockii occurred in several general-environments and in one or more environments per locality. In each one the species was found in several specific environments such as those exposed to waveshock (with uneven numbers; I, III, V, VII in Table II) with different types and degrees of pounding (I), drag (III), turbulence (V) and superficial currents (VII) or in specific-environments protected from the surf (with even numbers; II, IV, VI) or on more or less vertical walls (I and II) or horizontal surfaces of crags and platforms (IV, V and VI). It was always found on stable, rocky substrates.

Ralfsia hancockii also occurred in several microenvironments (with subordinate arabic numerals in Table II) composed of different combinations of tide level, intensity and form of wave shock, radiation, spray, winds, evaporation and depth; it was found with a large number (61) of different species (Table III).

It was very abundant in microconditions I.1, V.1 and VI.1 (Table II), as the only species or associated with a few other species, always forming continuous crusts (overlapping or not) interrupted by tufts of *Chnoospora minima* (Hering) Papenfuss (PTM2213), or by tufts, shrub-like forms and rosettes of *Centroceras clavulatum* (C. Ag.) Mont., *Dermonema frappierii* (Mont. *et* Millard.) Boerg., *Ulva lobata* (Kütz.) Setchell *et* Gardner and *Lyngbya* sp. (PTM3540) or by scattered filaments of *Polysiphonia scopulorum* Harvey var. *villum* (J. Ag.) Hollenberg (PTM3544) or by scattered dots of *Spongites* sp. (PTM3622) or scattered tufts of *Hincksia breviarticulatus* (J. Ag.) Silva (PTM 2817). In microconditions I.1 and V.1 *Ralfsia hancockii* also produced isolated patches on the margins of the micro-environment.

Less abundant than in the previous cases, yet abundant to medium-abundant *R. hancockii* was part of the following communties: in microconditions I.2, it formed a continuous growth under the tufts of *Chaetomorpha antennina* (Bory) Kütz.; in microconditions I.4, it formed scattered patches between the caespitose growth of *Gelidium pusillum* (Stackhouse) Le Jolis as the dominant species or in V.2 as continuous to isolated patches; in microconditions IV.1 it grew together with *Spongites* sp. and *Pseudolithoderma nigra* Hollenberg as isolated patches covered by foliose or filamentous mats of *Padina crispata* Thivy, and *Spyridia filamentosa* (Wulfen) Harvey and in microconditions VII.1 and VII.2, it produced isolated patches alternating with shrub-like forms of *Lauren-*

Table I. General or complex environments where *R. hancockii* was found.

1. Rocky shores protected from the waves by headlands (Sayulita, Las Manzanillas e Isla Larga, Nay. and Colemilla, Jal.): the species occurred in specific environments such as channels, tide pools and crags.
2. Areas with rocky outcroppings, principally schists and gneiss, producing great extensions of irregular and heterogeneous formations, from the shore to 20–30 m inland (Los Muertos, Nay., Puerto Escondido, Gro. and La Cruz en Barra Santa Elena, Oax.): the species occurred in crags and channels between them.
3. An area of large crags separated from the coast, more or less isolated from one another partially emergent even at high tide (Las Cuevas, Nay.): the species occurred on the plateaus and more or less vertical walls of crags.
4. Bays and/or beaches with large rocky platforms with shallow partially submerged and partially emergent portions with different degrees of exposition to the surf depending on the tide (Caleta de Campos, Mich., Playa Las Cuatas in Zihuatanejo, Gro, and area of platforms in Barra Santa Elena, Oax): the species occurred on the plateau and vertical walls and tide pools of the platform.
5. Bays and/or sandy beaches of pebbles or of more or less compacted rocks, always submerged and more or less sheltered from the surf (Playa Careyeros, Nay., Muelle del Puerto de Acapulco, Gro., Playa La Ropa in Zihuatanejo, Gro.): the species occurred on vertical, submerged walls of crags.
6. An breakwave with a combination of factors of the previous environments (Lázaro Cárdenas, Mich.): the species occurred on more or less verticals walls of concrete blocks.

Table II. Microconditions of *Ralfsia hancockii*. Roman numerals = specific conditions: I = more or less vertical walls of rocky barriers or crags, II = sloping walls or rocky horizontal surfaces; III = low midlittoral of crags, headlands or large rocks, IV = small bays and shallow platforms rocky, sandy, with pebbles or with mixed compacted sandy/rock, V = rocky or compacted rocky/sandy channels, VI = tidal pools, VII = infralittoral zone less than 5 m; Arabic numerals = set of microconditions (their sequences corresponds to gradients found in the field); increasing number of asterisks within each item = increase of the intensity, length or frequency of the factor; asterisks are not equivalent between different sets of specific conditions; – = absence of the factor; LOW-S = lower-supralittoral zone; HIGH-M = high midlittoral; MID-M = mid-midlittoral; LOW-M = low-midlittoral; HIGH-M = high-infralittoral; STRONG-L = strong wave shock at low tide; WEAK-L = weak wave shock at low tide; STRONG-H = strong wave shock at high tide; WEAK-H = weak wave shock at high tide; FRONT-L = Frontal pounding at low tide; LATERA-L = lateral drag at low tide; LATERA-H = lateral wave shock at high tide; CURRENT = intensity of the current; TURBULEN = amount of turbulence and turbidity; RADIATI = radiation period (when drain); ILLUMINA = illumination period (submerged included); WINDS = presence of winds; SPRAY = frequency of spray at low tide; RENEWAL = frequency of renewal of water; SLOPE, VERTICAL, HORIZONT = slope of the substrate; DEEP, SHALLOW = depth of the tidal pools; EVAPORAT = intensity of evaporation in tidal pools; NH = entry herbarium number's (FCME).

	I				II			III	IV		V			VI			VII	
	1	2	3	4	1	2	3	1	1	2	1	2	3	1	2	3	1	2
LOW-S																		
HIGH-M	*	*			*									*	*			
MID-M		*	*	*	*	*									*			
LOW-M			*	*		*	*	*	*							*	*	
HIGH-I				*						*								*
STRONG-L	–	*	**	***				*			***	**	*					
WEAK-L					*	*	*		*	*							*	*
STRONG-H	*	**	***	****				*										
WEAK-H									*	*							*	*
FRONT-L			*															
LATERA-L				*				*			*	*	*					
FRONT-H	*	*	*															
LATERA-H				*	*	*	*	*			*	*	*					
CURRENT					*	**	*	*			***	**	*				*	*
TURBULEN					*	**	*	*			*	*	*				*	*
RADIATI	***	**	*	–	**	*	–		*									
ILLUMINA									*	**							**	*
WINDS	*																	
SPRAY	*	**			*	–	–											
RENEWAL														*	**	***		
SLOPE											*							
VERTICAL	*	*	*	*	*	*	*	*	*			*					*	*
HORIZONT										*			*					
DEEP															*	*		
SHALLOW														*		*		
EVAPORAT														***	**	*		
NH	2213 2996 2215 3381	2814 3336 3344 3005	3570 3621	3571	3540 3544 De193 b	2852	3547	3342	3331 3588	3330	3541 With- out#	3326 3773	3617 3356	3622 4028 2817	3350 3325 3355	3351 3324	4292	4345

Table III. Species associated with *R. hancockii*

1. *Ahnfeltiopsis concinna* (J. Ag.) Silva *et* DeCew
2. *Amphiroa beauvoisii* Lamour.
3. *Amphiroa misakiensis* Yendo
4. *Amphiroa valonioides* Yendo
5. *Asparagopsis taxoformis* (Delile) Trevisan
6. *Bryopsis galapaguensis* Taylor
7. *Bryopsis hypnoides* Lamour.
8. *Bryopsis pennatula* J. Ag.
9. *Caulerpa racemosa* (Forssk.) J. Ag. var. *peltata* Lamour.
10. *Centroceras clavulatum* (C. Ag.) Mont.
11. *Chaetomorpha antennina* (Bory) Kütz.
12. *Chnoospora minima* (Hering) Papenfuss
13. *Chondria arcuata* Hollenberg
14. *Chondria dasyphylla* (Woodw.) C. Ag.
15. *Cladophora laetevirens* (Dillwyn) Kütz.
16. *Spongites* sp
17. *Dermonema frappierii* (Mont. *et* Millard.) Boerg.
18. *Dictyota baratyresiana* Lamour.
19. *Dilophus pinnatus* Dawson
20. *Diplura simulans* Hollenberg
21. *Hincksia breviarticulatus* (J. Ag.) Silva
22. *Gelidiella hancockii* Dawson
23. *Gelidiopsis tenuis* Setchell *et* Gardner
24. *Gelidium pusillum* (Stackhouse) Le Jolis
25. *Gelidium sclerophyllum* Taylor
26. *Gracilaria crispata* Setchell *et* Gardner
27. *Grateloupia doryphora* (Mont.) Howe
28. *Grateloupia versicolor* J. Ag.
29. *Ahnfeltiopsis serenei* (Dawson) Masuda
30. *Halimeda discoidea* Decaisne
31. *Herposiphonia verticillata* (Harvey) Kylin
32. *Hildenbrandia rubra* (Sommer.) Menegh.
33. *Hypnea pannosa* J. Ag.
34. *Jania capillacea* Harvey
35. *Jania pacifica Aresch.*
36. *Jania tenella* (Kütz.) Grun.
37. *Jania tenella* (Kütz.) Grun. var. *zacae* Dawson
38. *Laurencia clarionensis* Setchell *et* Gardner
39. *Laurencia lajolla* Dawson
40. *Laurencia richardsii* Dawson
41. *Lobophora variegata* (Lamour.) Womersley
42. *Lyngbya* sp
43. *Padina caulescens* Thivy
44. *Padina crispata* Thivy
45. *Padina durvillaei* Bory
46. *Padina gymnospora* (Kütz.) Sonder
47. *Peyssonnelia mexicana* Dawson
48. *Peyssonnelia rubra* (Greville) J. Ag. var. *orientalis* Weber van Bosse
49. *Polysiphonia scopulorum* Harvey var. *villum* (J. Ag.) Hollenberg
50. *Polysiphonia simplex* Hollenberg
51. *Pseudolithoderma nigra* Hollenberg
52. *Pterocladia caloglossoides* (Howe) Dawson
53. *Pterocladia capillacea* (S. G. Gmelin) Bornet *et* Thuret
54. *Rhizoclonium kerneri* Stockmayer
55. *Sargassum howellii* Setchell
56. *Sphacelaria rigidula* Kütz.
57. *Spyridia filamentosa* (Wulfen) Harvey
58. *Stragularia clavata* (Harvey *in* Hook.) Hamel
59. *Tayloriella dictyurus* (J. Ag.) Kylin
60. *Ulva californica* Wille
61. *Ulva lobata* (Kütz.) Setchell *et* Gardner

cia clarionensis Setchell *et* Gardner or crusts of *Lobophora variegata* (Lamour.) Womersley.

Ralfsia hancockii was also found as a rare species, forming continuous but small and isolated patches in communities with a relatively high diversity. In microconditions IV.2 it was part of a community where *Spyridia filamentosa* and *Padina gymnospora* (Kütz.) Sonder were the dominant species and *Cladophora laetevirens* (Dillwyn) Kütz. and *Rhizoclonium kerneri* Stockmayer were abundant (PTM3330); in microconditions V.3, it was part of a community of *Jania capillacea* Harvey and in VI.2 it was part of a community of *Amphiroa misakiensis* Yendo, *A. beauvoisii* Lamour., *Jania tenella* (Kütz.) Grun. and *J. tenella* var. *zacae* Dawson as dominant species and in microconditions VI.3 in a community of *Hypnea pannosa* J. Ag.

In each one of the above-mentioned communities *R. hancockii* had different morphs with the features listed in Table IV. Although a morphological continuum is formed (PTM3570-De193b), two groups of morphs are evident in Figure 2 (distance level 0.48), which we have called morph 'A' and 'B':

Morph A

Orbicular crusts 3.5–12.5 cm in diameter, light yellowish brown to dark brown, sometimes greenish surfaces; smooth, generally without growth lines. Crusts are adhering totally to the substrate and not forming lobes (they are more difficult to detach from the substrate). They are generally without rhizoids or scattered underneath, and tending to have unilateral symmetry (Fig. 3). The crusts are 165–495 μm thick and the ratio of dimensions of basal cells to dimensions of apical cells of the paraphyses is 1.2 to 2.1 (PTM3621, 2817, 3547, 4292, 4345, 3355, 3622, 3544, 4028, 3356, 3541 and 3344). This form can be found in the following gradient of microconditions: I.2, I.3, II.1, II.3, V.1, V.3, VI.1, VI.2, VII.1 and VII.2.

Morph B

Orbicular to irregular crusts, 1.5 to 10 cm in diameter, light brown to greenish, with radial, and/or concentric growth lines, generally with an irregular, rough and sometimes verrucose surface. Crusts are adhering partially to the substrate, sometimes only in the middle, others along the margin (they can be detached easily). They form shallow to deep lobes; generally with rhizoids and with a variable symmetry, tending to be bilateral (Fig. 4). Crusts are 108–750 μm thick; the ratio of dimensions of basal cells to dimensions of apical cells of the paraphyses is 2.2 to 5.6 (Table IV). This form can be found in the following gradient of microconditions I.1, I.2, I.4, II.1, II.2, IV.1, IV.2, and V.2 (PTM 3540, 3571, 3005, 3588, 2215, 3381, 3773, 3336, 3326).

Table IV. Relevant features of *Ralfsia hancockii*. Groups of specimens with similar morphs are separated by one line space; NE = unspecified; HN = herbarium entry number; OP, OUt-line of patches: ORB = orbicular, IRR = irregular; SIZE = size in cm; COLOR when wet, BR = brown, YE = yellowish, RE = redish, GR = green, GY = grey, BL = black, D = dark, L = light; GRLN = growth lines: N = absent, RA = radial, CO = concentric, RC = radial and concentric; SHAPE = shape of the thallus surface: SM = smooth, RG = rough, IRR = irregular; ADH = adherence to substrate: TT = total, PA = parcial, OM = only margin, OC = only center; LOB = presence and shape of lobes: N = absent, SLL = slightly lobed, DPL = deeply lobed, OVR = overlapping; THICK = thickness in μm; RHZ = presence and distribution of rhizoids: N = absent, TM = towards margin, IP = isolated parts, CE = center, WT = whole thallus; SYMM = symmetry: UN = unilateral, BI = bilateral, BIT = bilateral on thick parts, BIM = bilateral on margin; CRTL = presence (Y) and number of cells; PHEN = phenology: VE = vegetative, PL = plurangial; UN = unangial; RATPAR = ratio of dimensions of basal cells to dimensions of apical cells of the paraphyses.

HN	OP	SIZE	COLOR	GRLN	SHAPE	ADH	LOB	THICK	RHZ	SYMM	CRTL	PHEN	RATPAR
3621	ORB	3	NE	N	SM	TT	N	207–279	N	UN	Y	UN	1.2–2.1
2817	ORB	5–10	RE BR-YE	RC	SM	TT	N	250–330	N	UN	4–6	VE	
3547	ORB	12.5	D BR	RA	SM[2]-RG	TT[4]	N	360–414	N	UN	5–6	VE	
3355	IRR	1.5	NE	N	SM	TT	N	NE	N	UN	Y	UN	
4292	ORB-IRR	1.7	D BR	RA	RG	TT	N	206–280	N	UN	5–6	VE	
4345	ORB-IRR	1.7	D BR	RA	RG	TT	N	200–270	N	UN	5–6	VE	
3622	ORB	3	D GR	N	SM	TT	N	162–306	TM	UN-BI	3–7	UN	1.2–2.1
3544	ORB	3.5	YE BR	CO	SM	TT	N	495	IP	BI[2]-UN	NE	UN	1.2–2.1
4028	ORB	10	D BR	N	SM	TT	N	450–792	N	BI	3–4	UN	
3356	IRR	0.5	NE	N	IRR	TT	N	NE	NE	NE	NE	UN	
3344	IRR	3	NE	NE	IRR	TT	N	NE	NE	NE	NE	UN	
3541	ORB	2	GR	RC	SM-RG[3]	OM	N	100–138	WT	UN[2]-BI	2–5	VE	
3570	IRR	3	BL	N	RG	TT	N	171–405	CE[5]	UN-BI	3–5	UN	1.2–2.1
3330	ORB	8	D GR	RC	RG	TT	N	225–315	WT	BI	3–5	VE	
2852	IRR	5–10	D BR	RC	SM	TT	SLL	370–650	WT	BI	4–5	PL?	
2213	NE	NE	NE	N	RG	PA	SLL	162–306	WT	UN-BI[2]	3–5	VE	
De193b	ORB	NE	NE	CO	NE	NE	SLL	96–480N	N	BI	4–5	PL	
2814	ORB-IRR	NE	NE	RC	RG	PA	DPL	320–650	N	UN[2]-BI	6–9	VE?	
3540	ORB	1	GR	CO	SM	PA	SLL	234–306	TM	BI-UN	3–6	VE	
3571	IRR	1.5	BR	RA[1]	RG	PA	SLL OVR	180–324	WT	BI-UN	3–6	PL?	
3005	IRR	3	NE	CO[2]	RG	OC	SLL	252–405	TM	UN-BIT	4–5	UN	2.5–5.1
3588	ORB	4.5	D BR	RC	RG	TT	SLL	360–423	WT	UN-BIM	4–5	UN	2.2–5.1
2215	ORB	3	L BR	–	RG	OC	DPL	162–360	WT	UN[2]-BI	3–5	UN	2.2–5.1
3381	ORB	6.5	BR	RC[2]	RG-VE	PA	N	108–324	IP	BI[2]-UN	5	UN	2.4–5.6
3773	ORB	2.5	GR	RC	NE	PA	DPL OVR	330–324	IP	UN[2]-BIM	4–6	UN	2.4–5.6
3336	IRR	1	L BR	CO	RG	OC	DPL	450–750	WT	BI	7–9	UN	1.7
3326	ORB	–	D GR BR	RA/N	RG-VE	PA	DPL	252–405	WT	BI	3–6	UN	

? = dubious; / = or; – = to; 1 = inconspicuous; 2 = only margin; 3 = few; 4 = more or less on margin.

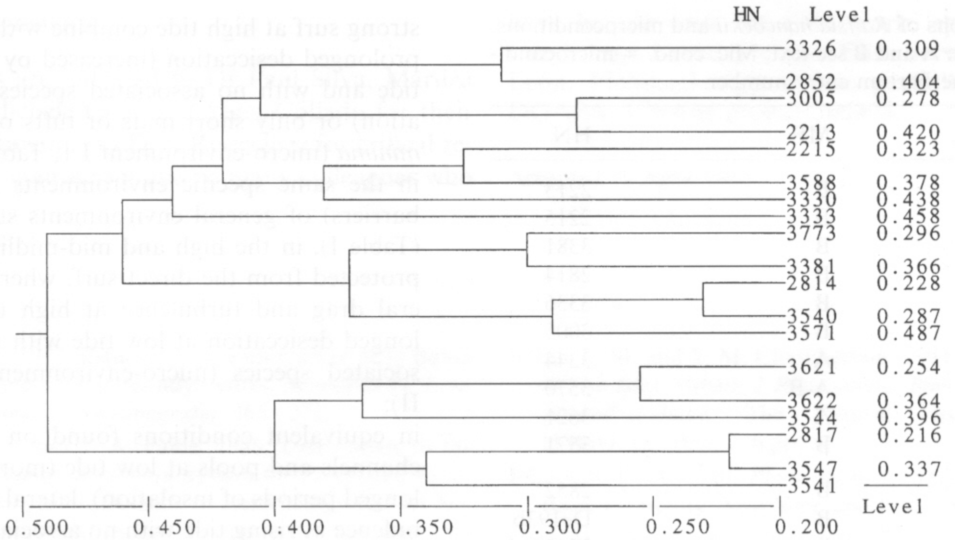

Fig. 2. Phenogram of specimens of *Ralfsia hancockii*. Level = average Gower's distance; HN = entry herbarium number's.

In contrast to morph 'A' of *R. hancockii* morph 'B' was most frequently found under stressful conditions provoked by high solar radiation in the high and mid-midlittoral, on the walls of crags at low tide (I.1, I.2 and II.1, Table V), whereas morph 'A' was found growing under tide pool conditions (VI.1, PTM 3622, 2817 and VI.2, PTM 3325, 3355, Table V), which are also found on the lower portion of certain crags in depression or channels at low tide (PTM361 in I.3; PTM3544 in II.1; PTM3547 in II.2) or in shallow platforms with little or no wave motion (PTM3330 in IV.2, Table V).

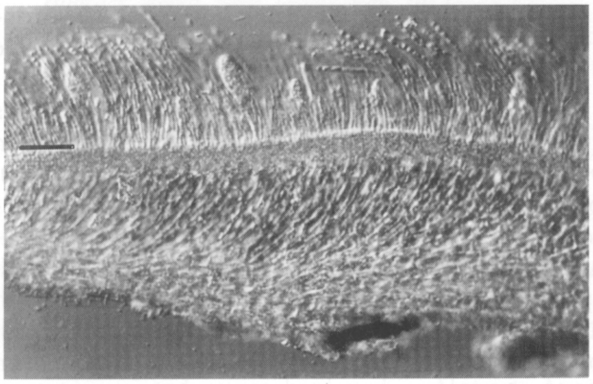

Fig. 3. Radial longitudinal section of a morph 'A' specimen.
Bar = 63 μm.

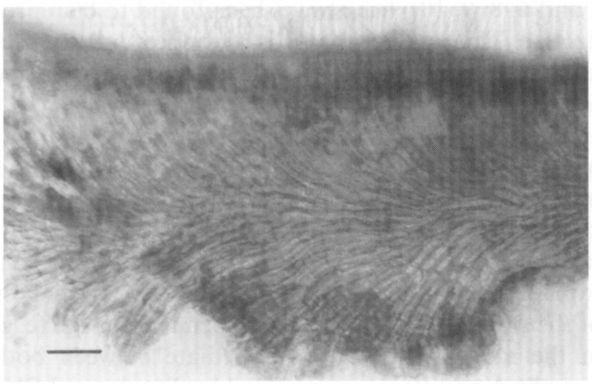

Fig. 4. Radial longitudinal section of a morph 'B' specimen.
Bar = 63 μm.

Discussion and Conclusions

The presence of *Ralfsia hancockii* in a wide range of localities can be explained by the capacity of the species to be present into a wide gradient of environmental factors as is evident from Tables I and II. The extent of the gradient is also suggested by the fact that *R. hancockii* can occur with as many as 61 other species.

However *Ralfsia hancockii* disappears from some general environments which could suggests that the species is limited by extreme macro-conditions. For example *R. hancockii* is absent from cliffs or barriers with strong surf, intense lateral drag and darkness (Playa Playitas, Cabo Corrientes Jal.); on the exposed part of headlands of general environment 1 (Table I), (shade walls of the east side of Isla Larga, Nay. and Bahía Corrales, Cabo Corrientes, Jal.); on pebbly beaches of unstable substrates (the west side of Puerto Escondido, Gro.); in river mouths with tidal influence, protected from the surf in (Boca Tomatlán, Jal. and Barra Copalita, Huatulco, Oax.), in sublittoral environments more than 3 m deep (El Yunque and El Corsario, Acapulco, Gro.)

According to the present results *Ralfsia hancockii* is a typically intertidal species and it shares this habitat and the functional morphology of crusts with many taxonomically unrelated groups (Table III), since according to Dethier (1987), many intertidal as-

Table V. Morphs of *Ralfsia hancockii* and microconditions. MF = morphs: A and B see text; Mic. cond. = microconditions; HN = herbarium entry number.

Mic. cond.	MF	HN
I.1	B	2213
	B	2215
	B	3381
I.2	B	2814
	B	3336
	B	3005
	A	3344
I.3	A-B	3570
	A	3621
I.4	B	3571
II.1	B	2852
	B	De193b
	B	3540
	A	3544
II.2	B	2852
II.3	A	3547
IV.1	B	3588
IV.2	B	3330
V.1	A	3541
V.2	B	3326
	B	3772
V.3	A	3356
VI.1	A	3622
	A	4028
	A	2817
VI.2	A	3355
VII.1	A	4292
VII.2	A	4345

sociated algae have holdfasts or extensive basal systems that are encrusting (*Ahnfeltiopsis*, *Amphiroa*, *Jania*, *Padina*, *Pterocladia*) or are wholly crustose (*Spongites*, *Stragularia*, *Hildenbrandia*).

Ralfsia hancockii appears to be limited by excessive desiccation such as occurs in the supralittoral zone where it is not found and is replaced by *Hapalospongidion gelatinosum* Saunders, a commonly observed species in these conditions (León-Alvarez and González-González 1983 a). It also appears to be limited by light because it is absent from permanently shaded habitats and is limited in the subtidal (environment VII, Table II) to a depth of 3 m.

An analysis of the micro-environments where *Ralfsia hancockii* is found reveals that not one factor but a combination of gradient of factors gives extreme microconditions in which the species grows best alone or as dominant species and as continuous crusts. Such extreme micro-conditions are the following:

- more or less vertical walls of rocky barriers or crags in general environment 1 (Table I), in the high and mid-midlittoral where factors such as strong surf at high tide combine with more or less prolonged desiccation (increased by wind) at low tide and with no associated species (direct radiation) or only short mats or tufts of *Chnoospora minima* (micro-environment I.1, Table II);
- in the same specific environments (crags, rocky barriers) of general environments such as 1 or 2 (Table I), in the high and mid-midlittoral in sites protected from the direct surf, where there is lateral drag and turbulence at high tide and prolonged desiccation at low tide with no or few associated species (micro-environment II.1, Table II);
- in equivalent conditions found on the edges of channels and pools at low tide (more or less prolonged periods of insolation), lateral drag and turbulence at rising tide with no associated species or with *Hildenbrandia rubra* which is a widely distributed (Irvine and Chamberlain 1994) and resistant species (Dethier 1987), for instance in general environment 4 (Table I), micro-environment V.1, Table II);
- in tide pools distant from the surf or in the upper parts of the tide level, with infrequent water exchange at low tide (high insolation and changes in pH, temperature and salinity) with no or scattered associated species, for instance in general environment 1 (Table I), micro-environment VI.1 (Table II).

We have observed other species resistant to factors such as strong and direct wave shock (*Chnoospora minima*), or to intense drag (*Dermonema frappierii*), both in the high intertidal fringe; but when such factors are combined with long desiccation and radiation in zones more or less distant from the surf both species disappear and *R. hancockii* extends its growth and becomes the dominant species. Similar growth occurs in shallow tidal pools, where if distant from the surf, other commonly observed species such as *Amphiroa beauvoisii* and *Spongites* sp (León *et al.* 1993) disappear.

Ralfsia hancockii has a wide adaptative range and over several years of observations (during months 3, 4 and 6, 8, 9, 10), has always been found to be reproductive. This suggest that it is an opportunistic species and grows best when factors appear to be extreme for other species.

On the other hand, although the present results appear to show a direct relation between morphs and microconditions, this is only an hypothesis and knowledge of the development of the species is necessary. Studies of development in culture could help explain if some characters (growth lines or roughness of the surface of the crust) are dependent on age (e. g. in the morphs that are intermediate between both morphs A and B), as is suggested by Tanaka and Chihara (1980) for *R. expansa sensu* Tanaka and Chihara (1980) which is possibly the same species (León-Alvarez and González-González 1993 b).

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