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Artículo

Checklist of seaweeds of Al-Hoceima National Park of Morocco (Mediterranean Marine Protected Area)

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Abstract

The Mediterranean basin is a marine biodiversity hot spot. Despite this, the macroalgal diversity of the Mediterranean Sea is still not fully known, especially in the Mediterranean Marine Protected Areas (MPAs) including, Al-Hoceima National Park of Morocco (PNAH). This paper provides the first comprehensive checklist of the seaweeds of PNAH, based chiefly on our own original collections, and complimented by literature records. Using present-day taxonomy, the total number of taxa at both specific and infraspecific levels currently accepted is 306 taxa with 207 Rhodophyta (39 families), 51 Ochrophyta (13 families) and 48 Chlorophyta (12 families). Ninety five of these species were not found in our samples, 93 were new to the PNAH, and the taxonomic identity of 26 taxa was amended. From the totality of taxa, ten species were reported for the first time from Morocco: 9 Rhodophyta and one green alga. Furthermore, 12 others species (10 red, 1 brown and 1 green alga) are new records for the Mediterranean coast of Morocco. Besides this, confirmed records are mentioned for 20 species, whether in Africa, in Morocco or in the Moroccan Mediterranean coast. This accessible checklist to the international community could serve as an infrastructure for future algal investigations of the taxa in this Specially Protected Area of Mediterranean Importance.

Key words: Al-Hoceima National Park, Checklist, Mediterranean Marine Protected Areas, Morocco, Seaweeds.

Resumen

Lista de algas marinas del Parque Nacional de Alhucemas en Marruecos (Área Marina Protegida del Mediterráneo)

La cuenca del Mediterráneo es un Hot Spot de biodiversidad marina. Aún así, la diversidad de macroalgas del Mediterráneo no está plenamente conocida, especialmente en las Áreas Marinas Protegidas del Mediterráneo (AMP) incluido el Parque Nacional de Alhucemas en Marruecos (PNAH). Este documento proporciona la primera lista exhaustiva de las algas marinas del PNAH. Usando la taxonomía actual, el número total de taxones a niveles específicos y infraespecíficos actualmente aceptados es de 306 taxones con 207 Rhodophyta (39 familias), 51 Ochrophyta (13 familias) y 48 Chlorophyta (12 familias). Noventa y cinco de estas especies no se encontraron en nuestras muestras, 93 eran nuevas en el PNAH y se modificó la identidad taxonómica de 26 taxones. De la totalidad de las macroalgas, 10 especies (9 Rhodophyta y 1 Ulvophyceae) fueron registradas por primera vez desde Marruecos. Además, 12 otras especies (10 Rhodophyta, 1 Phaeophyceae y 1 Ulvophyceae) son nuevos registros para la costa mediterránea de Marruecos. También, se mencionan los registros confirmados de 20 especies, ya sea en África, en Marruecos o en la costa mediterránea marroquí. Esta lista de algas accesibles a la comunidad internacional podría servir como una infraestructura

para futuras investigaciones algales de los taxones en esta zona especialmente protegida de importancia para el Mediterráneo.

Palabras clave: Parque Nacional de Alhucemas, Lista de algas, Áreas Marinas Protegidas del Mediterráneo, Marruecos, Algas marinas.

Introduction

The National Park of Al-Hoceima (PNAH) is located in the Alboran Sea in the Southern Mediterranean, Northern Morocco, 150 km east from the Gibraltar Strait, near to the city of Al-Hoceima. From the ten National Parks that have a seaboard on the Mediterranean Sea, the PNAH is considered the only National Park that covering a coastline of 40 km. Due to its particular biogeography and important biodiversity, comparable to major Mediterranean Hotspots (Tunesi *et al.,* 2003), the UN classified the PNAH in 2009 as a Specially Protected Area of Mediterranean Importance (PNUE-PAMCAR/ASP, 2009).

The Mediterranean Sea is a region of high biodiversity that ranks among the best known worldwide, and it is considered as a suitable laboratory to study marine ecosystems (Coll *et al*., 2010). The Mediterranean seaweeds have attracted many botanists (Ballesteros 1990; Ribera *et al*., 1992; Gómez Garreta *et al*., 2001; Furnari *et al*., 2003; Cormaci *et al*., 2004; Altamirano *et al*., 2010; Ni-Ni-Win *et al*., 2011; Tsiamis *et al*., 2013; Katsanevakis *et al*., 2014; Verlaque *et al*., 2015; Cormaci *et al*., 2012, 2014, 2017; González García *et al*., 2017). Nevertheless, the knowledge of marine macroalgal diversity of Moroccan Mediterranean coast remains limited by a short history of investigations by some authors (e.g., Conde-Poyales, 1984, 1989; Navarro & Gallardo, 1989; González-García & Conde-Poyales, 1991, 1994; González García, 1994; Bueno del Campo & González García, 1996; Flores Moya & Conde-Poyales, 1998). All of these investigations were afterward included as bibliographic references in the single checklists of marine flora of Morocco (Benhissoune et al,. 2001, 2002a, b, 2003). Recently, the combined research efforts of the local phycologists have yielded an important number of new records of seaweeds from the Moroccan coasts and new species to the Mediterranean marine flora (Riadi *et al*., 2011, 2013; Moussa *et al*., 2015; Hassoun *et al*., 2014, 2015, 2016a, b, 2018a, b; Salhi *et al*., 2016, 2018).

Despite several algal works on the Mediterranean part of Morocco, there is no thorough listing of the seaweeds recorded in the Specially Protected Mediterranean Area (PNAH). However, it is interesting to signal that the catalogue of marine seaweed conducted by González-García & Conde-Poyales (1994) includes data from 34 sites spreading on the Moroccan Mediterranean coast, but only two sites among them belong to the Al-Hoceima National Park. Recently, González-García *et al.* (2017) have published a catalogue of macroalgae of the Peñones de Alhucemas and Vélez de la Gomera (Western Mediterranean, Alboran Sea), and they have reported a total of 107 species in Badis (Peñón de Vélez de la Gomera), the site which localize in the middle of the PNAH.

In light of the previous reasons. In this paper, we attempt to provide a comprehensive database of different macroalgae groups of the PNAH, based chiefly on our own original collections, and complimented by the previous publications. This accessible checklist to the international community would contribute as a serving tool in the Mediterranean marine environmental studies, including prospective research of seaweeds.

Materials and methods

Study area and time of sampling

Field collections were performed at seven sites along the 40 km of coastline of the Al-Hoceima National Park in Morocco (Fig. 1). All specimens were collected by scuba diving down to 15 m depth and by snorkeling in rocky midlittoral and sublittoral zones (0–2 m depth) throughout the years 2012-2014 and during each season.

Identification of marine algae

Seaweeds were transported to the laboratory and stored in 5% buffered formalin-seawater solution. Species were studied under dissecting or compound microscopes and they were sectioned manually with a razor blade when necessary. Specimens of most of the species included in this checklist are deposited in the Phycological Herbarium of the Phycology and Mycology Group at the Faculty of Sciences, Department of Biology, Abdelmalek Essaâdi University, Tetouan, Morocco. For taxonomic nomenclature purposes, the on-line databases Index Nominum Algarum and AlgaeBase (Guiry & Guiry, 2018) were used. The checklist

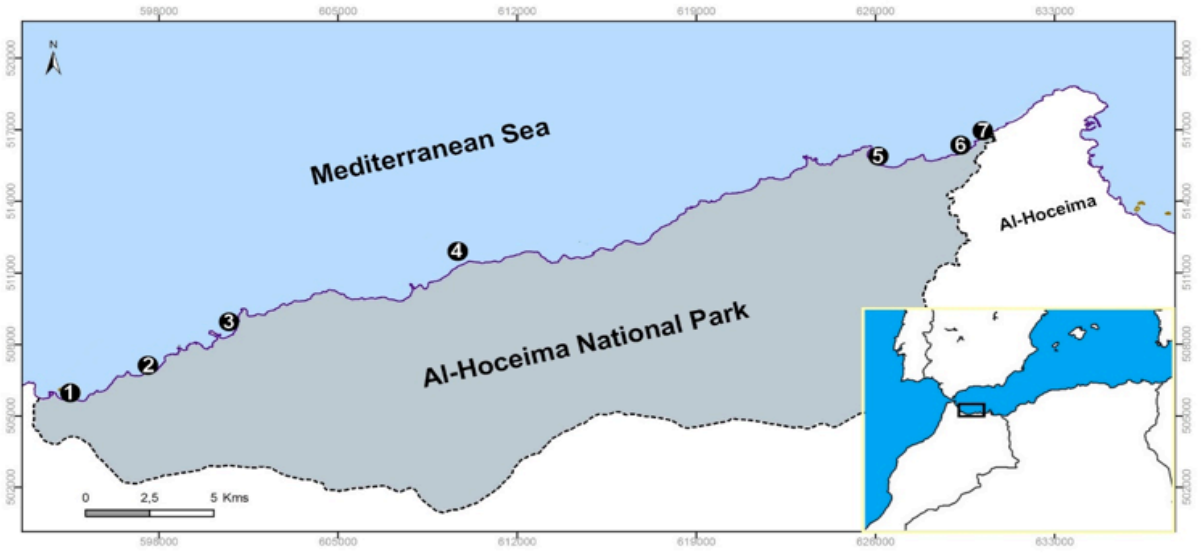

Figure 1. Geographical distribution of the Sampling sites along the Al-Hoceima National Park, northeast of Morocco "Mediterranean Sea": 1- Cala Iris (35°08'53.0"N 4°21'56.4"W), 2- Torres (35°09′25.1″N, 4°20′01.6″W), 3- Badis (35°10'34.7"N 4°17'20.1"W), 4- Topo (35°11'56.5"N 4°11'21.7"W), 5- Boumehdi (35°14'16.8"N 4°01'03.8"W), 6- Tala Youssef (35°14′11.7″N 3°58′55.5″W), 7- Rmoud (35°14′41.5″N, 3°57′55.7″W).

Figura 1: *Distribución geográfica de los sitios de muestreo a lo largo del Parque Nacional de Alhucemas, al noreste de Marruecos "Mar Mediterráneo": 1- Cala Iris (35°08'53.0"N 4°21'56.4"W), 2- Torres (35°09′25.1″N, 4°20′01.6″W), 3- Badis (35°10'34.7"N 4°17'20.1"W), 4- Topo (35°11'56.5"N 4°11'21.7"W), 5- Boumehdi (35°14'16.8"N 4°01'03.8"W), 6- Tala Youssef (35°14′11.7″N 3°58′55.5″W), 7- Rmoud (35°14′41.5″N, 3°57′55.7″W).*

of marine macroalgae of PNAH was compiled of personal collections in this study and two previous literatures data: González-García & Conde-Poyales (1994) and González-García *et al.* (2017). The previously known species, together with the new species from PNAH and Morocco were mainly verified using AlgaeBase and after a careful review of all published records including, the checklists of seaweeds of Morocco (Benhissoune *et al*., 2001, 2002a, b, 2003). On the other side, unpublished works such as thesis, master dissertations and technical reports have not been considered owing to the lack a scrutinized in their elaboration.

Results and discussion

The checklist presented in this work includes 306 taxa at specific and intraspecific level, including 207 Rhodophyta, 51 Ochrophyta, and 48 Chlorophyta (List of taxa: Accepted seaweed taxa hitherto reported in the Al-Hoceima National Park according to their sampling site, based on both our collections and previous records by González-García & Conde-Poyales (1994) and González-García *et al.* (2017). Principally, 211 taxa (144 Rhodophyta, 30 Phaeophyceae and 37 Ulvophyceae) were identified from all of our sampling expeditions. Among our collections, 10 species are new for Morocco and 12 others species are new records for the Mediterranean cost of Morocco.

In the catalogue, taxa of marine macroalgae are arranged alphabetically in three major groups (Chlorophyta, Ochrophyta and Rhodophyta), and following the classification systems and the nomenclature presented in AlgaeBase (Guiry & Guiry, 2018). The species locations in the current study are given (1-7) and previous reference records are also provided (González-García & Conde-Poyales, 1994 and González-García *et al.*, 2017).

The sites are as follows: Cala Iris (1); Torres (2); Badis (3); Topo (4); Boumehdi (5); Tala Youssef (6) and Rmod (7). Confirmed presence in previous study (P1: González-García & Conde-Poyales (1994), P2: González-García *et al.* (2017). Superscript number refer to the Notes. Authors of taxa are given in full, and synonyms of amended taxa are also given. New records for Morocco are marked with an asterisk [*] before the name of a taxon.

LIST OF TAXA

Taxa	Location in this study	Previous reference
Phylum Chlorophyta		
Class Ulvophyceae		
Order Bryopsidales		
Family Bryopsidaceae		
Bryopsidella neglecta (Berthold) G. Furnari & M. Cormaci		P_1
***** *Bryopsis cupressina* J.V. Lamouroux	1, 2, 5, 6, 7	
Bryopsis duplex De Notaris	1	P_1
Bryopsis hypnoides J.V. Lamouroux	1, 6,7	P_1
Bryopsis muscosa J.V. Lamouroux		P_2
Bryopsis plumosa (Hudson) C. Agardh	1, 4,6	P_1, P_2
Family Codiaceae		
Codium adhaerens C. Agardh	1, 2, 3, 5, 6, 7	P_1, P_2
Codium decorticatum (Woodward) M. Howe	1, 7	
Codium effusum (Rafinesque) Delle Chiaje		P_1, P_2
Codium tomentosum Stackhouse	1, 4	P_2
Family Derbesiaceae		
Derbesia tenuissima (Moris & De Notaris) P.L. Crouan & H.M. Crouan		P_1, P_2
Family Udoteaceae		
Pseudochlorodesmis furcellata (Zanardini) Børgesen [9]	1, 7	
Order Cladophorales		
Family Boodleaceae		
Cladophoropsis membranacea (Hofman Bang ex C. Agardh) Børgesen [1]	1,7	
Family Cladophoraceae		
Chaetomorpha aerea (Dillwyn) Kützing	1, 6, 7	
Chaetomorpha ligustica (Kützing) Kützing	6,7	
Chaetomorpha linum (O.F. Müller) Kützing	2, 5, 6, 7	P_1
Cladophora albida (Nees) Kutzing	1, 2, 5, 7	
Cladophora coelothrix Kützing	1, 5, 6, 7	P_1, P_2
Cladophora dalmatica Kützing	1,7	P_1
Cladophora hutchinsiae (Dillwyn) Kützing	1, 6, 7	P_1
Cladophora laetevirens (Dillwyn) Kützing	1,7	
Cladophora lehmanniana (Lindenberg) Kützing	1, 2, 4, 5, 6, 7	P_1
Cladophora prolifera (Roth) Kützing	1, 7	P_1
Cladophora rupestris (Linnaeus) Kützing	7	P_1

Taxa	Location in this study	Previous reference
Cladophora sericea (Hudson) Kützing	1	P_1
Cladophora socialis Kützing [8]	1, 2, 7	
Cladophora vagabunda (Linnaeus) Hoek	1	P_1, P_2
Lychaete battersii (C.Hoek) M.J. Wynne [8]	3, 7	
Lychaete echinus (Biasoletto) M.J. Wynne = *Cladophora echinus* (Biasoletto) Kützing		P_1
Rhizoclonium tortuosum (Dillwyn) Kützing		P_1, P_2
Family Siphonocladaceae		
Siphonocladus tropicus (P. Crouan & H. Crouan) J. Agardh	1	
Family Valoniaceae		
Valonia macrophysa Kützing	6	
Valonia utricularis (Roth) C. Agardh	1, 6, 7	P_1
Order Ulvales		
Family Kornmanniaceae		
Blidingia marginata (J. Agardh) P.J.L. Dangeard ex Bliding	1	P_1
Blidingia minima (Nägeli ex Kützing) Kylin		P_2
Family Phaeophilaceae		
Phaeophila dendroides (P. Crouan & H. Crouan) Batters	7	P_1
Order Ulotrichales		
Family Ulotrichaceae		
Ulothrix flacca (Dillwyn) Thuret		P_2
Family Ulvaceae		
Ulva clathrata (Roth) C. Agardh	1, 4, 6, 7	P_2
Ulva compressa Linnaeus	1, 2, 3, 6, 7	P_2
Ulva flexuosa Wulfen		P_1
Ulva intestinalis Linnaeus = *Enteromorpha intestinalis* (Linnaeus) Nees	1, 4, 6, 7	P_1
Ulva lactuca Linnaeus	1, 2, 3, 4, 5, 6, 7	
Ulva linza Linnaeus	1	P_1, P_2
Ulva polyclada Kraft		P_1, P_2
Ulva prolifera O.F. Müller =*Enteromorpha prolifera* (O.F.Müller) J.Agardh	1	P_1
Ulva rigida C. Agardh	1, 2, 5, 6, 7	P_1, P_2
Ulva torta (Mertens) Trevisan		P_2
Family Ulvellaceae		
Ulvella viridis (Reinke) R. Nielsen, C.J. O'Kelly & B. Wysor = *Entocladia viridis* Reinke	1, 7	P_1
Phylum Ochrophyta		
Class Phaeophyceae		

Taxa	Location in this study	Previous reference
Order Dictyotales		
Family Dictyptaceae		
Dictyopteris polypodioides (A.P. De Candolle) J.V. Lamouroux	6, 7	P_1
Dictyota dichotoma (Hudson) J.V. Lamouroux var. *dichotoma*	1, 2, 4, 5, 6, 7	P_1, P_2
Dictyota dichotoma var. *intricata* (C. Agardh) Greville	7	P_1
Dictyota fasciola (Roth) J.V. Lamouroux		P_1
Dictyota spiralis Montagne		P_1
Padina pavonica (Linnaeus) Thivy	1, 3, 4, 5, 6, 7	P_1, P_2
Spatoglossum solieri (Chauvin ex Montagne) Kützing *Taonia atomaria* (Woodward) J. Agardh		P_1
		P_1
Zonaria tournefortii (J.V. Lamouroux) Montagne		P_1
Order Ectocarpales		
Family Acinetosporaceae		
Feldmannia irregularis (Kützing) Hamel	1	P_1
Feldmannia lebelii (Areschoug ex P. Crouan & H. Crouan) Hamel	1, 2, 3	
Feldmannia mitchelliae (Harvey) H.-S. Kim		P_1, P_2
Feldmannia simplex (P. Crouan & H. Crouan) Hamel [9]	1	
Hincksia hincksiae (Harvey) P.C. Silva	1	
Family Ectocarpaceae		
Ectocarpus crouanii Thuret [5]	1	
Ectocarpus fasciculatus Harvey		P_1
Ectocarpus siliculosus (Dillwyn) Lyngbye	1, 7	
Family Scytosiphonaceae		
Colpomenia peregrina Sauvageau		P_2
Colpomenia sinuosa (Mertens ex Roth) Derbès & Solier	1, 2, 4, 5, 6, 7	P_1, P_2
Petalonia fascia (O.F. Müller) Kuntze	6	P_1
Scytosiphon lomentaria (Lyngbye) Link	6	P_1, P_2
Order Fucales		
Family Fucaceae		
Fucus spiralis Linnaeus	1	P_1
Fucus vesiculosus Linnaeus	1	
Family Sargassaceae		
Cystoseira brachycarpa J. Agardh		P_1
Cystoseira compressa (Esper) Gerloff & Nizamuddin	1, 4, 5, 6, 7	P_1, P_2
Cystoseira elegans Sauvageau		P_1
Cystoseira humilis Schousboe ex Kützing		P_1
Cystoseira mauritanica Sauvageau		P_1

Taxa	Location in this study	Previous reference
Cystoseira mediterranea Sauvageau	6, 7	
Cystoseira montagnei J.Agardh = *Cystoseira spinosa* Sauvageau		P_2
Cystoseira nodicaulis (Withering) M.Roberts		P_2
Cystoseira sauvageauana Hamel		P_1
Cystoseira spinosa Sauvageau		P_2
Cystoseira tamariscifolia (Hudson) Papenfuss	1, 2, 4, 5, 6, 7	P_1, P_2
Cystoseira usneoides (Linnaeus) M. Roberts		P_1
Sargassum hornschuchii C. Agardh		P_1
Sargassum vulgare C. Agardh	1, 3, 6, 7	P_1, P_2
Order Ralfsiales		
Family Hapalospongidiaceae		
Hapalospongidion macrocarpum (Feldmann) León-Álvarez & González-González		P_1, P_2
Ralfsia verrucosa (Areschoug) Areschoug	1	P_2
Order Sphacelariales		
Family Cladostephaceae		
Cladostephus spongiosum (Hudson) C. Agardh	1, 3, 4, 5, 7	
Cladostephus spongiosum f. *verticillatum* (Lightf.) Prud'homme van Reine		P_1
Family Lithodermataceae		
Pseudolithoderma adriaticum (Hauck) Verlaque [1]	1,7	
Family Sphacelariaceae		
Sphacelaria cirrosa (Roth) C. Agardh	1, 5, 6, 7	P_1
Sphacelaria fusca (Hudson) S.F. Gray	3, 7	P_1
Sphacelaria plumula Zanardini	1, 3, 7	P_1, P_2
Sphacelaria rigidula Kützing	1, 4, 7	P_1, P_2
Sphacelaria tribuloides Meneghini	1, 5, 7	P_2
Family Stypocaulaceae		
Halopteris filicina (Grateloup) Kützing	1, 7	P_1, P_2
Halopteris scoparia (Linnaeus) Sauvageau	1, 2, 3, 5, 6, 7	P_1, P_2
Order Tilopteridales		
Family Phyllariaceae		
Phyllariopsis brevipes (C. Agardh) E.C. Henry & G.R. South		P_1
Saccorhiza polyschides (Lightfoot) Batters	4	
Phylum Rhodophyta		
Class Bangiophyceae		
Order Bangiales		

Taxa	Location in this study	Previous reference
Family Bangiaceae		
Bangia atropurpurea (Mertens ex Roth) C. Agardh	1, 7	
Bangia fuscopurpurea (Dillwyn) Lyngbye		P_2
Porphyra umbilicalis Kützing	7	P_2
Pyropia leucosticta (Thuret) Neefus & J. Brodie	1, 2, 6, 7	
Class Compsopogonophyceae		
Order Erythropeltales		
Family Erythrotrichiaceae		
*****_Erythrotrichia bertholdii_ Batters	1, 7	
Erythrotrichia carnea (Dillwyn) J. Agardh	1, 2, 4, 6, 7	P_1, P_2
Erythrotrichia investiens (Zanardini) Bornet [6]	1, 7	
Erytrotrichia reflexa (P.L. Crouan et H.M. Crouan) Thuret ex De Toni		P_2
Porphyrostromium ciliare (Carmichael) M.J. Wynne [1,7]	1	
Class Florideophyceae		
Order Acrochaetiales		
Family Acrochaetiaceae		
Acrochaetium microscopicum (Nägeli ex Kützing) Nägeli		P_1, P_2
Acrochaetium parvulum (Kylin) Hoyt		P_1, P_2
Acrochaetium trifilum (Buffham) Batters		P_1
Grania efflorescens (J. Agardh) Kylin = *Acrochaetium thuretii* (Bornet) Collins & Hervey		P_1
Order Bonnemaisoniales		
Family Bonnemaisoniaceae		
Asparagopsis armata Harvey	1, 2, 4, 5, 6, 7	P_1, P_2
Asparagopsis taxiformis (Delile) Trevisan [8]	1, 3, 4, 5, 6, 7	
Bonnemaisonia hamifera Hariot	1, 7	
Order Ceramiales		
Family Callithamniaceae		
Aglaothamnion cordatum Feldmann-Mazoyer	1, 4	
Aglaothamnion tenuissimum (Bonnemaison) Feldmann-Mazoyer =*Aglaothamnion byssoides* (Arnott ex Harvey) C.F. Boudouresque & M.M.Perret-Boudouresque	1, 6	P_1
Callithamnion corymbosum (Smith) Lyngbye	1, 2, 3, 5, 6, 7	P_1, P_2
Callithamnion granulatum (Ducluzeau) C. Agardh	1, 6, 7	P_1
Callithamnion tetragonum (Withering) S.F. Gray	1, 3, 6, 7	P_1
Callithamnion tetricum (Dillwyn) S.F.Gray [9]	1, 2, 4, 6, 7	
Gaillona gallica (Nägeli) Athanasiadis = *Aglaothamnion gallicum* (Nägeli) L'Hardy-Halos ex F. Ardré		P_2

Taxa	Location in this study	Previous reference
Gaillona hookeri (Dillwyn) Athanasiadis = *Aglaothamniom hookeri* (Dillwyn) C.M. Maggs et M.H. Hommersand		P_1, P_2
Gaillona scopulorum (C. Agardh) Athanasiadis [9]	2	
Gayliella flaccida (Harvey ex Kützing) T.O. Cho & L.J. McIvor	4	P_1, P_2
Gayliella taylorii (E.Y. Dawson) T.O. Cho & S. M.Boo [8]	1, 2, 3, 5, 7	
Seirospora giraudyi (Kützing) De Toni		P_1
Family Ceramiaceae		
Antithamnion amphigeneum A. Millar = *Antithamnion algeriense* M.Verlaque & Seridi		P_1
Antithamnion cruciatum (C. Agardh) Nägeli	7	P_1, P_2
**Antithamnion decipiens* (J. Agardh) Athanasiadis	1	
**Antithamnionella boergesenii* (Cormaci & G. Furnari) Athanasiadis	7	
Antithamnionella elegans (Berthold) J.H. Price & D. M.John		P_1
Antithamnionella spirographidis (Schiffner) E.M. Wollaston	1	P_2
Centroceras gasparrinii (Meneghini) Kützing [4]	1, 2, 3, 5, 6, 7	
Ceramium ciliatum (J. Ellis) Ducluzeau var. *ciliatum*	1, 2, 3, 4, 5, 6, 7	P_1, P_2
Ceramium ciliatum var. *robustum* (J. Agardh) Mazoyer		P_1
Ceramium circinatum (Kützing) J. Agardh		P_1
Ceramium codii (H. Richards) Mazoyer	1, 4, 7	
Ceramium diaphanum (Lightfoot) Roth	1, 2, 3, 4, 6, 7	P_1, P_2
Ceramium echionotum J. Agardh	1, 4, 6, 7	P_1, P_2
Ceramium giacconei Cormaci & G.Furnari [2]	1, 4	
Ceramium secundatum Lyngbye	5, 6, 7	P_2
Ceramium siliquosum var. *lophophorum* (Feldman-Mazoyer) Serio =*Ceramium diaphanum* var. *lophophorum* Feldmann-Mazoyer		P_1
Ceramium tenerrimum (G. Martens) Okamura		P_1, P_2
Ceramium virgatum Roth var. *virgatum* [3]	1, 2, 5, 6, 7	
Ceramium virgatum var. *implexocontortum* (Solier) G. Furnari		P_1
Compsothamnion thuioides (Smith) Nägeli		P_2
Crouania attenuata (C. Agardh) J. Agardh	1, 5, 6, 7	P_1
Pleonosporium borreri (Smith) Nägeli	1, 2, 6, 7	P_1
Pterothamnion crispum (Ducluzeau) Nägeli	1, 4, 7	P_1
Pterothamnion plumula (J. Ellis) Nägeli	4, 7	P_1
Spongoclonium caribaeum (Børgesen) M.J. Wynne [8]	4	
Family Dasyaceae		
Dasya corymbifera J. Agardh [1]	1, 2, 4, 6	

Taxa	Location in this study	Previous reference
Dasya hutchinsiae Harvey	1, 4, 7	P_1, P_2
Dasya ocellata (Grateloup) Harvey	7	
Dasya rigidula (Kützing) Ardissone	1, 2, 5, 7	P_1
Family Delesseriaceae		
Acrosorium ciliolatum (Harvey) Kylin = *Acrosorium venulosum* (Zanardini) Kylin	1, 3, 4, 6, 7	P_1
Apoglossum ruscifolium (Turner) J. Agardh	4	P_1, P_2
Cryptopleura ramosa (Hudson) L. Newton	1, 7	P_1
Myriogramme minuta Kylin		P_1, P_2
Nitophyllum punctatum (Stackhouse) Greville [9]	1, 2	
Radicilingua thysanorhizans (Holmes) Papenfuss	1	
Taenioma nanum (Kützing) Papenfuss	1, 2, 5, 7	
Family Rhodomelaceae		
Alsidium corallinum C. Agardh		P_2
Aphanocladia stichidiosa (Funk) Ardré	1, 4, 6, 7	P_1, P_2
Chondria capillaris (Hudson) M.J. Wynne	1, 2, 5, 6, 7	P_1
Chondria coerulescens (J. Agardh) Sauvageau	1, 2, 6 ,7	P_1
Chondria dasyphylla (Woodward) C. Agardh	1, 2, 3, 6, 7	P_1, P_2
Chondria mairei G. Feldmann		P_1
Chondrophycus undulatus (Yamada) Garbary & Harper		P_1
Halopithys incurva (Hudson) Batters	6, 7	P_1
Herposiphonia secunda (C. Agardh) Ambronn	1, 2, 3, 5, 6, 7	P_1, P_2
Herposiphonia secunda f. *tenella* (C. Agardh) M.J. Wynne		P_1
Herposiphonia tenella (C. Agardh) Ambronn	1, 2, 4, 5, 6	
Heterosiphonia crispella (C. Agardh) M.J. Wynne	1, 6, 7	P_1, P_2
Hypoglossum hypoglossoides (Stackhouse) Collins & Hervey	1, 7	P_1, P_2
Laurencia obtusa (Hudson) J.V. Lamouroux	6, 7	P_1, P_2
**Melanothamnus harveyi* (Bailey) Díaz-Tapia & Maggs	7	
**Melanothamnus sphaerocarpus* (Børgesen) Díaz-Tapia & Maggs	1, 4, 7	
Osmundea pinnatifida (Hudson) Stackhouse	1, 2, 3, 6, 7	P_1, P_2
Palisada perforata (Bory) K.W. Nam = *Laurencia papillosa* (C.Agardh) Greville		P_1
Polysiphonia atlantica Kapraun & J.N. Norris	7	
Polysiphonia brodiei (Dillwyn) Sprengel	6	
Polysiphonia denudata (Dillwyn) Greville ex Harvey	1, 4, 7	P_1
Polysiphonia dichotoma Kützing		P_1
Polysiphonia elongata (Hudson) Sprengel		P_1

Taxa	Location in this study	Previous reference
Polysiphonia fibrillosa (Dillwyn) Sprengel	6	
***** *Polysiphonia flocculosa* (C. Agardh) Endlichter	1	
Polysiphonia havanensis Montagne	6, 7	
Polysiphonia opaca (C. Agardh) Moris & De Notaris	1, 6, 7	P_1, P_2
Polysiphonia sertularioides (Grateloup) J. Agardh	3, 6	P_1, P_2
Polysiphonia stricta (Mertens ex Dillwyn) Greville [5]	6, 7	
Pterosiphonia complanata (Clemente) Falkenberg	1, 2, 3, 5, 6, 7	P_1, P_2
Rytiphlaea tinctoria (Clemente) C. Agardh	7	
Symphyocladia parasitica (Hudson) Savoie & G.W. Saunders		P_1
= *Pterosiphonia parasitica* (Hudson) Falkenberg	1, 2, 5, 6, 7	P_1, P_2
Vertebrata fruticulosa (Wulfen) Kuntze		
= *Boergeseniella fruticulosa* (Wulfen) Kylin		P_1
Vertebrata fucoides (Hudson) Kuntze		
= *Polysiphonia fucoides* (Hudson) Greville		P_1
Vertebrata reptabunda (Suhr) Díaz-Tapia & Maggs	1, 6, 7	P_1, P_2
= *Lophosiphonia reptabunda* (Suhr) Kylin	1, 7	
Vertebrata thuyoides (Harvey) Kuntze	7	P_1, P_2
Vertebrata tripinnata (Harvey) Kuntze		
Xiphosiphonia pennata (C. Agardh) Savoie & G.W. Saunders		P_2
Family Sarcomeniaceae		
Cottoniella filamentosa (M. Howe) Børgesen	1, 7	P_1
Family Spyridiaceae		
Spyridia filamentosa (Wulfen) Harvey	1, 7	
Family Wrangeliaceae		
Diplothamnion jolyi C. Hoek	1, 4, 6, 7	P_1
Griffithsia opuntioides J. Agardh		P_1
Halurus flosculosus (J. Ellis) Maggs & Hommersand		P_1
Lejolisia mediterranea Bornet	1, 6	
Monosporus pedicellatus (Smith) Solier		P_1
Spermothamnion flabellatum Bornet	7	
Spermothamnion repens (Dillwyn) Magnus [9]	5	
Tiffaniella capitata (Bornet) Doty & Meñez [1]	5, 7	
Tiffaniella gorgonea (Montagne) Doty & Meñez 1960		
Order Colaconematales		
Family Colaconemataceae	1	
Colaconema caespitosum (J. Agardh) Jackelman, Stegenga & J.J. Bolton	1, 4	P_1, P_2
Colaconema daviesii (Dillwyn) Stegenga		

Taxa	Location in this study	Previous reference
Colaconema savianm (Meneghini) R. Nielsen = *Acrochaetium savianum* (Meneghini) Nägeli		P_1
Order Corallinales		
Family Corallinaceae		
Amphiroa beauvoisii J.V. Lamouroux	4, 7	P_1
Amphiroa cryptarthrodia Zanardini		P_1
Amphiroa fragilissima (Linnaeus) J.V. Lamouroux	1	
Amphiroa rigida J.V. Lamouroux	7	P_1
Corallina officinalis Linnaeus	1, 2, 3, 5, 6, 7	P_1
Ellisolandia elongata (J. Ellis & Solander) K.R. Hind & G.W. Saunders	1, 2, 3, 4, 5, 6, 7	P_1, P_2
Hydrolithon farinosum (J.V. Lamouroux) Penrose & Y.M. Chamberlain = *Fosliella farinosa* (J.V.Lamouroux) M.Howe		P_1
*****_Jania capillacea_ Harvey	6	
Jania longifurca Zanardini	1, 2, 4, 5, 6, 7	P_1, P_2
Jania rubens (Linnaeus) J.V. Lamouroux	1, 2, 3, 4, 5, 7	P_1, P_2
Jania rubens var. *corniculata* (Linnaeus) Yendo = *Jania corniculata* (Linnaeus) J.V.Lamouroux		P_1
Jania squamata (Linnaeus) J.H. Kim, Guiry & H.-G. Choi [9]	1, 3, 5, 7	
Jania virgata (Zanardini) Montagne = *Corallina granifera* J.Ellis & Solander		P_1
Lithophyllum byssoides (Lamarck) Foslie		P_2
Lithophyllum corallinae (P. Crouan & H. Crouan) Heydrich [1]	6	
Lithophyllum cystoseirae (Hauck) Heydrich = *Titanoderma cystoseirae* (Hauck) Woelkerling, Y.M.Chamberlain & P.C.Silva		P_1
Lithophyllum dentatum (Kützing) Foslie = *Spongites dentatus* Kützing	7	P_1
Lithophyllum incrustans Philippi	1, 4, 6, 7	P_1, P_2
Neogoniolithon brassica-florida (Harvey) Setchell & L.R. Mason		P_1, P_2
Pneophyllum confervicola (Kützing) Y.M. Chamberlain [8]	1, 7	
Pneophyllum fragile Kützing = *Pneophyllum lejolisii* (Rosanoff) Y.M.Chamberlain		P_1
Tenarea tortuosa (Esper) Me. Lemoine	1, 6, 7	
Titanoderma pustulatum (J.V. Lamouroux) Nägeli	1, 2, 3, 5, 6, 7	P_1, P_2
Family Lithothamniaceae		
Phymatolithon lenormandii (Areschoug) W.H.Adey		P_2
Order Gelidiales		
Family Gelidiaceae		

Taxa	Location in this study	Previous reference
Gelidiella lubrica (Kützing) Feldmann & Hamel	1, 7	
Gelidium attenuatum (Turner) Thuret	3, 6, 7	
Gelidium bipectinatum G. Furnari [1]	1	
Gelidium corneum (Hudson) J.V. Lamouroux	7	P_1, P_2
Gelidium crinale (Hare ex Turner) Gaillon	2, 5, 6, 7	P_1, P_2
Gelidium microdon Kützing	1	
Gelidium minusculum (Weber-van Bosse) R.E. Norris	1, 7	
Gelidium pulchellum (Turner) Kützing	1, 6, 7	
Gelidium pusillum (Stackhouse) Le Jolis var. *pusillum*	1, 6, 7	P_1, P_2
Gelidium pusillum var. *pulvinatum* (C. Agardh) Feldmann	1, 2, 7	
Gelidium spathulatum (Kützing) Bornet	1	P_1, P_2
Gelidium spinosum (S.G. Gmelin) P.C. Silva var. *spinosum*	1, 2, 6, 7	P_1, P_2
Gelidium spinosum var. *hystrix* (J. Agardh) G. Furnari = *Gelidium latifolium* var. *hystrix* (J.Agardh) Hauck		P_1
Family Pterocladiaceae		
Pterocladiella capillacea (S.G. Gmelin) Santelices & Hommersand	1, 6, 7	P_1, P_2
Pterocladiella melanoidea (Schousboe ex Bornet) Santelices & Hommersand	7	
Order Gigartinales		
Family Caulacanthaceae		
Caulacanthus ustulatus (Mertens ex Turner) Kützing	1, 7	P_2
Family Cystocloniaceae		
Hypnea musciformis (Wulfen) J.V. Lamouroux	1, 3, 5, 6, 7	P_1, P_2
Hypnea spinella (C. Agardh) Kützing [1]	5, 7	
**Hypnea valentiae* (Turner) Montagne	7	
Rhodophyllis divaricata (Stackhouse) Papenfuss [1]	1, 6, 7	
Family Gigartinaceae		
Chondracanthus acicularis (Roth) Fredericq	1, 2, 3, 4, 6, 7	P_1, P_2
Chondracanthus teedei (Mertens ex Roth) Kützing	7	
Gigartina pistillata (S.G. Gmelin) Stackhouse	6, 7	P_1, P_2
Family Phyllophoraceae		
Gymnogongrus crenulatus (Turner) J. Agardh		P_1, P_2
Gymnogongrus griffithsiae (Turner) Martius	6, 7	
Gymnogongrus patens (Goodenough & Woodward) J. Agardh	1, 3, 6, 7	
Phyllophora crispa (Hudson) P.S. Dixon		P_1
Phyllophora sicula (Kützing) Guiry & L.M. Irvine		P_1
Schottera nicaeensis (J.V. Lamouroux ex Duby) Guiry & Hollenberg		P_1, P_2

Taxa	Location in this study	Previous reference
Stenogramma interruptum (C. Agardh) Montagne [9]	6	P_2
Family Rissoellaceae		
Rissoella verruculosa (Bertoloni) J. Agardh	1, 2	P_1
Family Schmitziellaceae		
Schmitziella endophloea Bornet & Batters		P_1, P_2
Family Sphaerococcaceae		
Sphaerococcus coronopifolius Stackhouse	1, 4, 7	P_1, P_2
Order Gracilariales		
Family Gracilariaceae		
Gracilaria armata (C. Agardh) Greville		P_1
Gracilaria bursa-pastoris (S.G. Gmelin) P.C. Silva		P_1, P_2
Gracilaria conferta (Schousboe ex Montagne) Montagne [1]	7	
Gracilaria dura (C. Agardh) J. Agardh [1]	7	
Gracilaria multipartita (Clemente) Harvey	6	
Gracilariopsis longissima (S.G. Gmelin) M. Steentoft, L.M. Irvine & W.F. Farnham	3, 7	
Order Halymeniales		
Family Halymeniaceae		
Grateloupia filicina (J.V. Lamouroux) C. Agardh	6, 7	P_1
Order Hapalidiales		
Family Hapalidiaceae		
Choreonema thuretii (Bornet) F. Schmitz		P_1
Melobesia membranacea (Esper) J.V. Lamouroux	2	P_1, P_2
Family Mesophyllaceae		
Mesophyllum expansum (Philippi) Cabioch & M.L. Mendoza = *Lithophyllum expansum* Philippi	1	P_1
Mesophyllum lichenoides (J.Ellis) Me. Lemoine	1, 6, 7	P_1, P_2
Order Hildenbrandiales		
Family Hildenbrandiaceae		
Hildenbrandia rubra (Sommerfelt) Meneguini		P_2
Order Nemaliales		
Family Liagoraceae		
Liagora distenta (Mertens ex Roth) J.V. Lamouroux		P_1
Liagora viscida (Forsskål) C. Agardh		P_1
Family Nemaliaceae		
Nemalion elminthoides (Velley) Batters	6, 7	P_1, P_2
Family Scinaiaceae		

Taxa	Location in this study	Previous reference
Scinaia furcellata (Turner) J. Agardh		P_1
Order Peyssonneliales		
Family Peyssonneliaceae		
Peyssonnelia bornetii Boudouresque & Denizot		P_1
Peyssonnelia coriacea Feldmann		P_2
Peyssonnelia dubyi P. Crouan & H. Crouan		P_1
Peyssonnelia squamaria (S.G. Gmelin) Decaisne		P_1, P_2
Order Plocamiales		
Family Plocamiaceae		
Plocamium cartilagineum (Linnaeus) P.S. Dixon		P_1, P_2
Plocamium raphelisianum P.J.L. Dangeard	1, 3, 4, 6, 7	
Order Rhodymeniales		
Family Champiaceae		
Champia compressa Harvey	1, 2, 4, 7	
Champia parvula (C. Agardh) Harvey	1, 2, 5, 7	P_1
Gastroclonium clavatum (Roth) Ardissone	1, 7	P_1, P_2
Gastroclonium reflexum (Chauvin) Kützing [1]	1, 4, 7	
Family Lomentariaceae		
Lomentaria articulata (Hudson) Lyngbye [9]	1, 6, 7	
***Lomentaria articulata* var. *linearis* Zanardini	7	
Family Rhodymeniaceae		
Botryocladia botryoides (Wulfen) Feldmann	6	P_1
Rhodymenia caespitosa P.J.L. Dangeard	7	
Rhodymenia pseudopalmata (J.V. Lamouroux) P.C. Silva [9]	6, 7	
Classe Stylonematophyceae		
Order Stylonematales		
Family Stylonemataceae		
Chroodactylon ornatum (C. Agardh) Basson		P_1
Stylonema alsidii (Zanardini) K.M. Drew	1, 4, 6, 7	P_1, P_2
Stylonema cornu-cervi Reinsch		P_1

Notes

[1]The twelve species identified in this study were reported newly for the Mediterranean coast of Morocco. However, all of these species have been signaled in the Atlantic coast of Morocco by Benhissoune *et al.* (2001, 2002a, b, 2003).

[2]*Ceramium giacconei* was described by Cormaci and Furnari (1991) to accommodate the entity previously known in the Mediterranean as *Ceramium cingulatum* Weber-van Bosse. Therefore, the single record of the later species by González-García and Conde-Poyales (1994), should be treated as C. giacconei.

[3]Reported as *Ceramium nodulosum* by González-García and Conde-Poyales (1994). *Ceramium virgatum* was cited by C. Agardh (l811) as a synonym of *C.*

rubrum and later noted as possibly conspecific with *C. nodulosum* (Maggs & Hommersand, 1993). But Silva *et al*. (1996) point out that *C. nodulosum* Ducluzeau, the name proposed by Maggs and Hommersand (1993) to accommodate the species commonly reported as *C. rubrum* (Hudson) C. Agardh, cannot be used. Later, Maggs *et al*. (2002) suggested that the name *C. virgatum* Roth should be used for *C. nodulosum* (Lightfoot) Ducluzeau.

[4]Barros-Barreto *et al*. (2006) reported that *Centroceras clavulatum* (C. Agardh) Montagne may consist of a species complex. Recently, Won *et al*. (2009) indicated that *C. clavulatum* has a biogeographic distribution limited to the Pacific Ocean. More recently, Hassoun *et al*. (2018) pointed out that all specimens of *Centroceras* examined from Morocco are not *C. clavulatum* but *C. gasparrini*. As a result, *C. clavulatum* was excluded from Moroccan flora and replaced with *C. gasparrinii*.

[5]*Polysiphonia stricta* and *Ectocarpus crouanii* were previously reported only in one reference in an unpublished thesis (Kazzaz, 1989). Thus, the presence of the two species in Morocco was confirmed in this study. Furthermore, this is the first record of *Ectocarpus crouanii* in Africa.

[6]Confirmation of presence in Morocco for *Erythrotrichia investiens*, which was reported just in the study of González-García and Conde-Poyales (1991). This is one of the rare records of this species in Africa after the first report was made by John *et al*. (1979).

[7]This is the first record of *Porphyrostromium ciliare* in Morocco and Africa after the only record of this species was made by Dangeard (1949) from the Atlantic.

[8]The two green algae and four red seaweeds present in our checklist were reported from Morocco for the second time after the investigation conducted by Riadi *et al.* (2011).

[9]Confirmation of presence in the Mediterranean coast of Morocco for ten species previously signaled in an unpublished national thesis (Kazzaz, 1989).

In this study, the results have indicated that Rhodophyta represent the dominant group with four classes (Bangiophyceae, Compsopogonophyceae, Florideophyceae and Stylonematophyceae) and 19 orders (see table 1). They encompass 207 taxa within 39 families. The family Rhodomelaceae contained the most species (38) grouped in 17 genera, followed by the Ceramiaceae with 25 species. Moreover, *Ceramium* (12), *Gelidium* (12) and *Polysiphonia* (11) were the most diverse genera among the red algae.

A total of 51 taxa belonging to the Ochrophyta (Phaeophyceae) were signaled in this catalogue, under 13 different families. Sargassaceae was the most diverse family among brown algae with 14 taxa, followed by the Dictyotaceae with 8 species. Additionally, the genus *Cystoseira* has the most taxa (12 species) among the brown algae of PNAH.

Regarding the Ulvophyceae, 48 taxa from 12 families have been reported from the coastline of the National Park of Al-Hoceima. The most species-rich family among the Ulvophyceae, was the Cladophoraceae with 17 taxa, followed by the Ulvaceae with 10 species. Furthermore, *Cladophora* with 11 and *Ulva* with 10 were the most species-rich genera in green algae of the Park.

Using present-day taxonomy, 306 taxa of marine algae have been registered from the Al-Hoceima National Park in this investigation. The data were amended and complemented by the bibliographic analysis of the following works (González-García & Conde-Poyales, 1994 and González-García *et al.*, 2017). Among the 306 taxa, 95 species were not found in our samples and 93 were newly reported to the Park, and the taxonomic identity of 26 taxa was amended (Figure 2).

In comparison with the checklist of seaweed of Morocco (Benhissoune *et al.*, 2001, 2002a, 2002b, 2003), our checklist found to contain more than two-third (306 vs. 403) of the species recorded in the Mediterranean coast of Morocco, which represent a high percentage (76%) (Figure 3).

Conclusion

In conclusion, to the best of our knowledge, this is the first inclusive seaweeds checklist of Al-Hoceima National Park. The seaweeds catalogue encompasses 306 taxa, which represent more than two-third of the total species reported in the Mediterranean shore of Morocco. This fact evidences that Al-Hoceima National Park

	Class	Order	Family	Genus	Species
Chlorophyta	1	3	12	17	48
Ochrophyta	1	6	13	23	51
Rhodophyta	4	19	39	103	207
Total	6	28	64	143	306

Table 1. Number of seaweeds taxa according to different taxonomic groups (Class, order, family, genus and species).

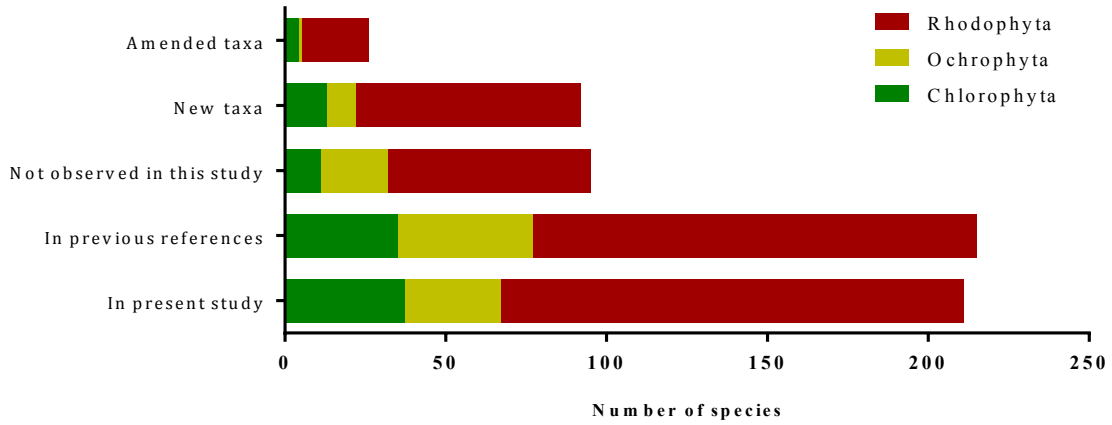

Figure 2. Detailed comparison of the PNAH seaweed flora: our study and previous works

Figura 2. *Comparación detallada de la flora de algas marinas PNAH: nuestro estudio y trabajos anteriores*

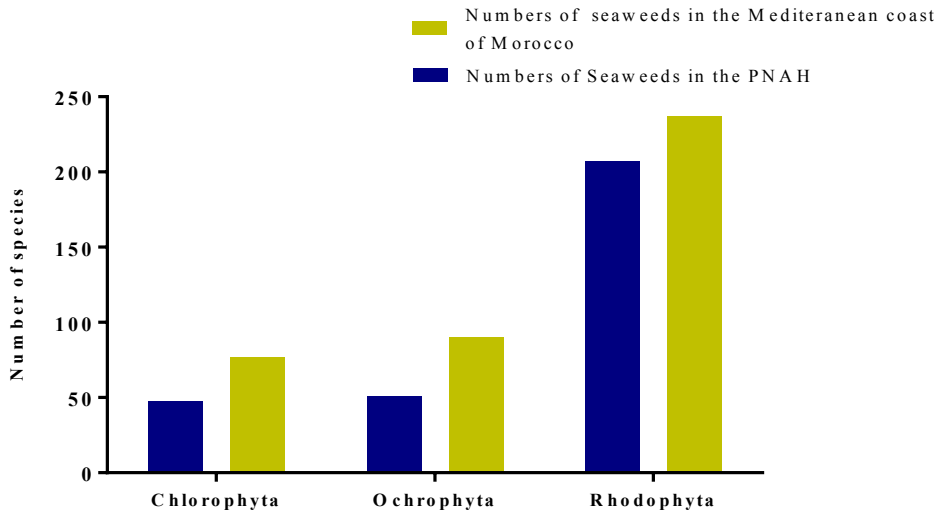

Figure 3. Numbers of species of seaweeds listed in the Mediterranean coast of Morocco (Benhissoune et al,. 2001, 2002a, b, 2003) and Al-Hoceima National Park (this study).

Figura 3. *Números de especies de algas marinas identificadas en la costa Mediterránea de Marruecos (Benhissoune* et al,. *2001, 2002a, b, 2003) y en el Parque Nacional de Al-Hoceima (En nuestra investigación).*

of Morocco has a great diversity of species. Moreover, this study showcases the need for more phycological studies in other localities along the Mediterranean coast of Morocco, in order to clarify their algal biodiversity.

Publishing this checklist will improve its accessibility to the international society. Furthermore, the seaweed diversity information provided in this catalogue could serve as an infrastructure for future phycological investigations of the taxa in this Specially Protected Area of Mediterranean Importance.

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