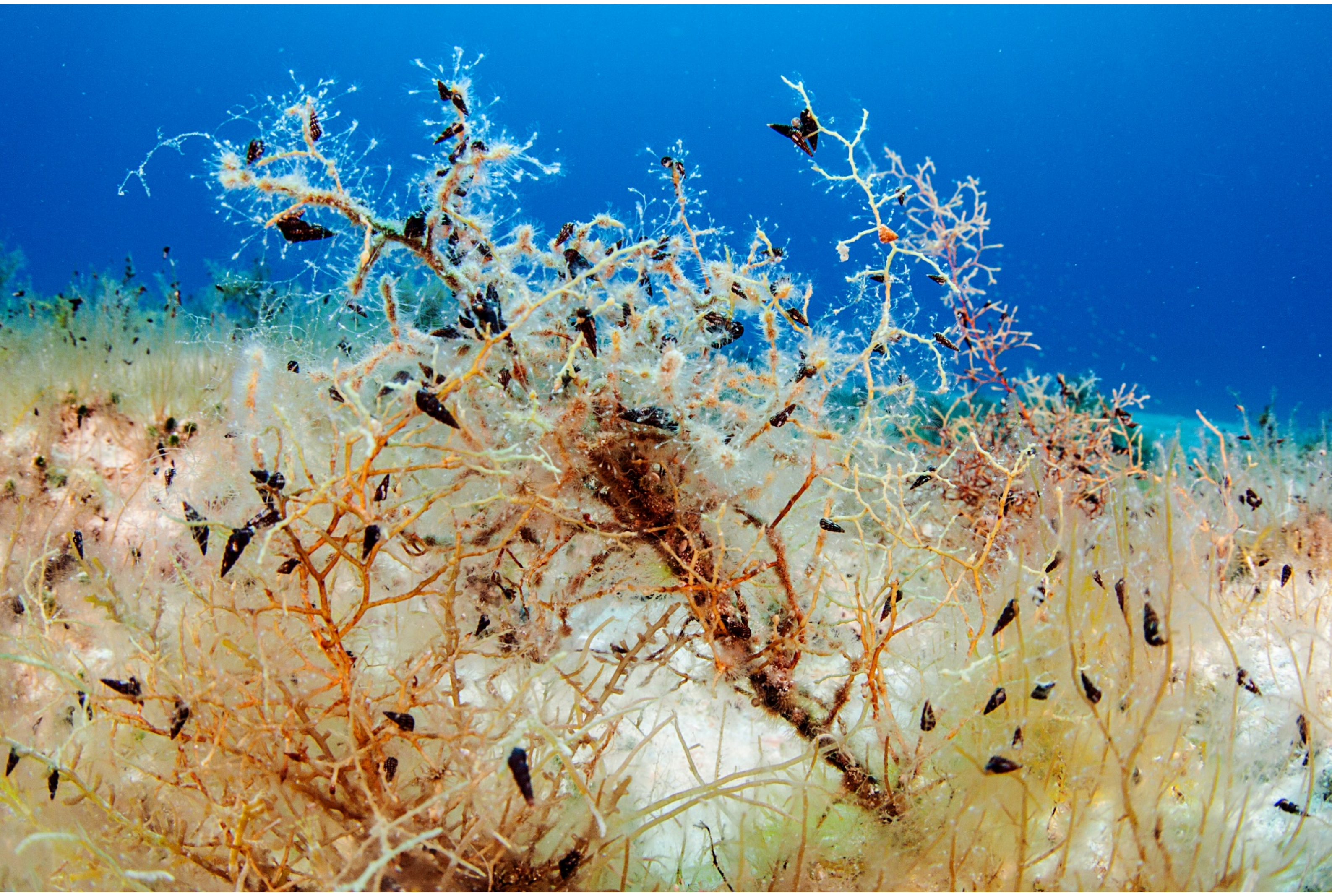
Οικολογικά πρότυπα και πρότυπα Ποικιλότητας της ταξοκοινωνίας των Μαλακίων σε ενδιαιτήματα σκληρού υποστρώματος στις ακτές της Κρήτης

Δημήτρης Πουρσανίδης

Διδακτορική διατριβή



Νοέμβριος 2016

Τμήμα Επιστημών της Θάλασσας

Σχολή Περιβάλλοντος

Πανεπιστήμιο Αιγαίου

Οικολογικά πρότυπα και πρότυπα Ποικιλότητας της ταξοκοινωνίας των Μαλακίων σε ενδιαιτήματα σκληρού υποστρώματος στις ακτές της Κρήτης

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Νοέμβριος 2016

Αφιερωμένο στην οικογένεια μου

Στην Ελένη μου

Στον Γιάννη μου

Σ’ αυτό το σύντομο ταξίδι της ζωής
που προχωράς πεζός ή καβαλάρης
κοίταξε να’ ναι της δικής σου επιλογής
το μονοπάτι και η στράτα που θα πάρεις

Άμα δεν κάμεις το χατίρι του κορμιού
και τα θελήματα δε γίνουν του πνευμάτου
έχασες το παιχνίδι της ζωής
και θέλεις να κερδίσεις του θανάτου

Δεν είναι ο πόνος κανενός κληρονομιά
και δεν κληροδοτείται η ευτυχία
πάντρεψε δάκρυ και χαρά με μαστοριά
λόγια και πράξεις να βρεθούνε σ `αρμονία

Όποιος του έρωτα δε φάει δοξαριά
και δεν πιστέψει ή δε μνώξει στη φιλία
περίγελως θα γίνει του ντουνιά
μα και του χρόνου του φονιά εύκολη λεία

Άμα δεν κάμεις το χατίρι του κορμιού
και τα θελήματα δε γίνουν του πνευμάτου
έχασες το παιχνίδι της ζωής
και θέλεις να κερδίσεις του θανάτου

Μήτσος Σταυρακάκης – Το χατήρι

Περιεχόμενα

Κεφάλαιο 1

Εισαγωγή

Στη χώρα μας η εκτεταμένη ακτογραμμή (18.000 km) χαρακτηρίζεται από πληθώρα παράκτιων θαλάσσιων οικοτόπων Διεθνούς και Κοινοτικής Σημασίας που περιλαμβάνουν Παράκτια Μεταβατικά Οικοσυστήματα (π.χ. εκβολές, λιμνοθάλασσες), αμμοθίνες, αμμώδη υποστρώματα, βραχώδεις ακτές. Ειδικότερα, τα βραχώδη υποστρώματα (hard substrate) της υποπαραλιακής ζώνης, αποτελούν, όχι μόνον στις Ελληνικές Θάλασσες αλλά και σε Μεσογειακό και σε παγκόσμιο επίπεδο, έναν ιδιαίτερο τύπο οικοτόπου με σημαντικές ιδιομορφίες ως προς την σύνθεση, τη δομή και τη δυναμική των βιοκοινοτήτων που φιλοξενούν. Ενδεικτικά μέρος των βιοκοινοτήτων που εξαπλώνονται στα ενδιαιτήματα αυτά χαρακτηρίζονται από τις φάσεις των μαλακών φωτόφιλων και σκιόφιλων φυκών. Εξαιτίας της υψηλής παραγωγικότητάς τους τα ενδιαιτήματα αυτά λειτουργούν ως 'νηπιοτροφία' για πολλά είδη ασπόνδυλων (Katsanevakis, 2004, Koutsoubas et al., 2007) και ψαριών με μεγάλο εμπορικό ενδιαφέρον (π.χ. χταπόδι, κουτσομούρα, σαργός, φαγκρί, ροφός, συναγρίδα) αλλά υφίστανται και τις ποικίλες ανθρωπογενείς δραστηριότητες που λαμβάνουν χώρα στην παράκτια ζώνη (π.χ. επέκταση αστικής δομής, αλιεία, τουρισμός).

Η υποβάθμιση των οικοτόπων αυτών σε πολλές περιοχές της ΕΕ, ιδιαίτερα την τελευταία εικοσαετία, είχε ως αποτέλεσμα σήμερα οι οικότοποι αυτοί – 'Υποθαλάσσιοι Ύφαλοι' – να προστατεύονται (Οικότοπος 1170 NATURA 2000, Κοινοτική Οδηγία 92/43/ΕΕC). Παρά το μεγάλο οικολογικό ενδιαφέρον που έχουν οι συγκεκριμένοι οικότοποι η υπάρχουσα επιστημονική γνώση στις Ελληνικές θάλασσες σχετικά με την εκτίμηση της οικολογικής τους κατάστασης είναι πολύ μικρή κυρίως λόγω των δυσκολιών που ενέχουν οι επιστημονικές μέθοδοι δειγματοληψίας που απαιτούνται (υποβρύχια επιστημονική κατάδυση). Σήμερα η αναγκαιότητα διεύρυνσης των γνώσεων μας για τα ενδιαιτήματα αυτά καθίσταται περισσότερο επιτακτική καθώς η ανάπτυξη μεθόδων οικολογικής εκτίμησης και ταξινόμησης στα παράκτια οικοσυστήματα και η οικολογική εκτίμηση της κατάστασης των ενδιαιτημάτων τους αποτελεί έναν από τους βασικούς στόχους της Οδηγίας Πλαίσιο για τα νερά (Water Framework Directive) της Ε.Ε. (2000/60/EC). Ο στόχος αυτός θα αξιοποιηθεί, ως βάση αναφοράς, για την επίτευξη μιας συνολικής και ουσιαστικής βελτίωσης στα πλαίσια της ολοκληρωμένης και βιώσιμης διαχείρισης της παράκτιας ζώνης (EEC, 2000). Ένα από τα βασικά βιολογικά ποιοτικά στοιχεία (biological quality elements) που χρησιμοποιούνται ως κριτήρια από την επιστημονική κοινότητα για την εκτίμηση της οικολογικής κατάστασης είναι τα μακροβενθικά ασπόνδυλα.

Τα Μαλάκια αποτελούν μια από τις πλέον σημαντικές από άποψη ποικιλότητας ειδών, αφθονίας και βιομάζας της μακροβενθικής πανίδας στο θαλάσσιο παράκτιο περιβάλλον και η μελέτη τους - ως υποκατατάστατων (surrogates) εκτίμησης της συνολικής μακροβενθικής πανίδας - οδηγεί σε αξιόπιστα αποτελέσματα σχετικά με την εκτίμηση της οικολογικής κατάστασης σε μια παράκτια θαλάσσια περιοχή όπως έχει καταγραφεί σε πληθώρα σχετικών μελετών (π.χ. Barnes 1994, Zenetos 1996, Rueda *et al*., 2001, Arvanitidis *et al*., 2005, Koulouri *et al*., 2006, Koutsoubas & Dimitriadis 2008). Επιπρόσθετα τα Μαλάκια είναι πιο ανθεκτικά σε περιοχές όπου η περιβαλλοντική πίεση είναι έντονη, σε αντίθεση με άλλες ταξινομικές ομάδες (π.χ. Καρκινοειδή, Εχινόδερμα) που είναι είναι συχνά απούσες, επομένως θεωρούνται και πιο κατάλληλα για την εκτίμηση της οικολογικής κατάστασης σε διαβαθμίσεις περιβαλλοντικής πίεσης (Pearson & Rosenberg, 1978).

Η δομή και η λειτουργία των βιοκοινοτήτων του σκληρού υποστρώματος της κατώτερης υποπαραλιακής ζώνης αποτελούν ένα από τα σημαντικότερα θέματα έντονου προβληματισμού των θαλάσσιων οικολόγων και περιβαλλοντολόγων της Μεσογείου καθώς τα ενδιαιτήματα αυτά:

1. Αποτελούν το μεγαλύτερο ποσοστό των παράκτιων περιοχών στη Μεσόγειο και στις Ελληνικές θάλασσες,
2. Φιλοξενούν βιοκοινότητες με ιδιαίτερη δομή και λειτουργία καθώς και είδη οργανισμών, πολλοί από τους οποίους έχουν ιδιαίτερο οικονομικό ενδιαφέρον για τον άνθρωπο,

3. Αποτελούν ενδιαίτημα (κωδικός Οικοτόπου 1170) που λόγω της ιδιαιτερότητας και της τρωτότητας του έχει αναγνωριστεί ότι χρήζει προστασίας και παρακολούθησης (Οδηγία 92/43/EEC),
4. Κινδυνεύουν ιδιαίτερα από τις ανθρωπογενείς δραστηριότητες στην παράκτια ζώνη (π.χ. μεγάλες μονάδες ξενοδοχείων που αυθαίρετα τοποθετούνται σε παράκτιες περιοχές που γειτνιάζουν με βραχώδεις βυθούς, ανεξέλεγκτες κατασκευές μικρών λιμανιών στο σύνολο της ακτογραμμής),
5. Πέρα από το επιστημονικό τους ενδιαφέρον, είναι οι περιοχές όπου πραγματοποιούνται δραστηριότητες καταδύσεων αναψυχής σε πολλές δε περιπτώσεις στα όρια τους έχουν αναπτυχθεί Θαλάσσιες Προστατευόμενες Περιοχές (MPAs),
6. Η προστασία, διαχείριση και αξιοποίησή τους σχετίζεται με ζητήματα Ολοκληρωμένης Διαχείρισης της Παράκτιας Ζώνης (ICZM).

Η παρουσία σκληρού υποστρώματος (βραχωδών βυθών) χαρακτηρίζει το μεγαλύτερο ποσοστό των ακτών της Ελλάδος. Παρά ταύτα η πλειοψηφία των μελετών στις Ελληνικές θάλασσες αφορά την διερεύνηση του κινητού (μαλακού) υποστρώματος (π.χ. λασπώδεις, αμμώδεις βυθοί) κυρίως λόγω της ευκολίας που έχουν οι δειγματοληψίες (ερευνητικά σκάφη εφοδιασμένα με αρπάγες, δράγες, άλλα συρόμενα εργαλεία) και της πληθώρας των μεθόδων ανάλυσης των δεδομένων που μέχρι τώρα υπάρχουν (Zenetos *et al*., 2005). Η αναντιστοιχία που προαναφέρθηκε οφείλεται σε μεγάλο βαθμό στο γεγονός ότι το σκληρό υπόστρωμα παρουσιάζει αρκετές δυσκολίες πρόσβασης και η μεθοδική μελέτη αυτού του τύπου των ακτών άρχισε να γίνεται συστηματική μετά από την ανάπτυξη της αυτόνομης κατάδυσης (SCUBA Diving) που είναι και ο κύριος τρόπος προσέγγισης για επιστημονικές αναλύσεις (Chintiroglou *et al*., 2005). Επιπρόσθετα το νομικό καθεστώς που ίσχυε στην χώρα μας μέχρι πριν από λίγα χρόνια σχετικά με τις περιοχές που επιτρεπόταν η κατάδυση στην Ελλάδα καθιστούσε περίπλοκή την διαδικασία για την λήψη ειδικών αδειών από πολλές υπηρεσίες του δημοσίου για την διεξαγωγή επιστημονικών μελετών. Οι μελέτες που έχουν γίνει σχετικά με την βιοποικιλότητα των βιοκοινοτήτων σε σκληρό υπόστρωμα μέχρι σήμερα στη Μεσόγειο επικεντρώνονται κυρίως στην Δ. Μεσόγειο (π.χ. Pérès & Picard, 1958; Bellan-Santini, 1969; Ballesteros *et al.*, 1998; Marinopoulos, 1988; Sala *et al.*, 1996, Bianchi & Morri, 2000, Bianchi *et al.*, 2004), ενώ πολύ λίγες αντίστοιχες μελέτες έχουν πραγματοποιηθεί - σχετικά πρόσφατα - στην Α. Μεσόγειο (π.χ. Kocatas, 1978; Antoniadou 2003, Kitsos & Koukouras 2003; Chintiroglou, 2004; Antoniadou *et al.*, 2005). Όπως προκύπτει από την ανασκόπηση της σχετικής επιστημονικής βιβλιογραφίας είναι σαφές ότι αν και το μεγαλύτερο μέρος των Ελληνικών ακτών αποτελείται από βραχώδεις ακτές, η βιοποικιλότητα των ενδιαιτημάτων αυτών είναι ‘mare incognita’.

Μία από τις κύριες ταξινομικές ομάδες που απαντώνται στα σκληρά υποστρώματα είναι τα Μαλάκια (κυρίως εκπρόσωποι από τις κλάσεις πολυπλακοφόρα, γαστερόποδα, δίθυρα και κεφαλόποδα). Στις Ελληνικές Θάλασσες η μελέτη της συγκεκριμένης ταξοκοινωνίας επικεντρώνεται σε συγκεκριμένες κλάσεις (Γαστερόποδα, Δίθυρα, Κεφαλόποδα, Delamotte & Vardala, 2001) που έχουν πραγματοποιηθεί σε συγκεκριμένες γεωγραφικές περιοχές - Β. Αιγαίο, Πατραϊκός Κόλπος, Ιόνιο Πέλαγος) και αφορούν την ταξινομία, γεωγραφική διανομή και οικολογία τους σε οικοτόπους με κινητό (μαλακό) υπόστρωμα (π.χ. Koutsoubas, 1992a; Zenetos, 1986, Zenetos, 1993, 1996; Lefkaditou, 2006, 2007). Ανάλογο ‘κενό γνώσης’ εμφανίζεται και στο Ν. Αιγαίο και ειδικότερα στις ακτές της Κρήτης, καθώς οι μελέτες που αφορούν την πανίδα των Μαλακίων έχουν κυρίως πραγματοποιηθεί στο κινητό υπόστρωμα (π.χ. Koutsoubas *et al*., 1992b, 2000, Koulouri et al., 2006). Το Κρητικό πέλαγος αποτελεί μια περιοχή των Ελληνικών θαλασσών με ιδιαίτερη σημασία λόγω της γεωγραφικής θέσης του νησιού στη Α. Μεσόγειο, ενώ οι ακτές της Κρήτης εμφανίζουν ιδιαίτερα περιβαλλοντικά και ωκεανογραφικά χαρακτηριστικά που απορρέουν κυρίως από το μεγάλο βαθμό της έκθεσής τους στον υδροδυναμισμό και την σχετική απομόνωσή τους από τις υφαλοκρηπίδες της ηπειρωτικής Ελλάδας και της Αφρικής. Είναι ένα ολιγοτροφικό θαλάσσιο σύστημα, τυπικό της Ανατολικής Μεσογείου (Karakassis et al., 1997;

Psarra et al., 2000). Η ακτογραμμή της Κρήτης έχει μήκος που ξεπερνάει τα 800 χιλιόμετρα ενώ περισσότερο από το 65% αυτής είναι βραχώδη με συνέχεια βραχώδους υποστρώματος και στο θαλάσσιο περιβάλλον (Alexandrakis et al., 2014).

Αντικείμενο και δομή της διατριβής.

Το γενικό αντικείμενο της παρούσας διδακτορικής διατριβής είναι η διερεύνηση των οικολογικών προτύπων και προτύπων ποικιλότητας της ταξοκοινωνίας των Μαλακίων σε σκληρό υπόστρωμα σε διαφορετικές περιοχές των ακτών της Κρήτης στο Ν. Αιγαίο. Ειδικότερα, οι στόχοι της διδακτορικής διατριβής είναι:

- Η ανασκόπηση της διαθέσιμης δημοσιευμένης και γκρίζας βιβλιογραφίας σχετικά με την θαλάσσια μαλακοπανίδα της Κρήτης.
- Η ανασκόπηση της διαθέσιμης δημοσιευμένης και γκρίζας βιβλιογραφίας σχετικά με τον Οικότοπο 1170 της Κοινοτικής Οδηγίας 92/43/EEC
- Η ποσοτική καταγραφή της βιοποικιλότητας και διερεύνηση της δυναμικής των συνερεύσεων των Μαλακίων σε επιλεγμένες περιοχές με ενδιαιτήματα σκληρού υποστρώματος στην υποπαραλιακή ζώνη των ακτών της Κρήτης με την εφαρμογή του διεθνούς πρωτόκολλου NaGISA καθώς και η διερεύνηση του ρόλου που διαδραματίζουν τα μαλάκια και οι βενθικές βιοκοινότητες στους μηχανισμούς λειτουργίας του οικοσυστήματος στα συγκεκριμένα ενδιαιτήματα καθώς και οι παράγοντες που ορίζουν τις συναθροίσεις.

Για την επίτευξη των στόχων της διατριβής, σημαντικό μέρος της αφιερώθηκε στην ανασκόπηση της διαθέσιμης βιβλιογραφίας για την θαλάσσια μαλακοπανίδα της Κρήτης (1843 – 2015) καθώς και του οικότοπου 1170 της Κοινοτικής Οδηγίας 92/43/EEC. Σχετικά με τον οικότοπο 1170, κρίθηκε απαραίτητος ο διαχωρισμός της σχετικής διαθέσιμης και προσβάσιμης βιβλιογραφίας σε δυο υποτυπους: α) η ζώνη των φωτοφιλων φυκών και β) η ζωνη των κοραλλιγενών/βιογενών σχηματισμών. Επιλέχθηκε η χρήση του πρωτοκόλλου δειγματοληψίας της πρωτοβουλίας NaGISA (Natural Geography in Shore Areas) για την συλλογή δειγμάτων από την ζώνη των φωτοφιλων φυκών σε 2 θέσεις στον Βόρειο Κρητικό Πελαγος, δεδομένου του ότι η πρωτοβουλία αυτή θεωρεί πως 2 σταθμοί μπορούν να δώσουν αντιπροσωπευτικά δείγματα του οικοτόπου που μελετάται. Τα δεδομένα που συλλέγονται με αυτό το πρωτόκολλο είναι άμεσα συγκρίσιμα με σταθμούς σε άλλες περιοχές της Μεσογείου (εφόσον υπάρχουν) καθώς και σε παγκόσμιο επίπεδο, δεδομένου του ότι το πρωτόλλο αυτό εφαρμόζεται σε διάφορες περιοχές στις 5 ηπείρους. Καθώς όλες οι δειγματοληψίες πραγματοποιούνται με την χρήση αυτόνομης συσκευής κατάδυσης (SCUBA diving equipment), υπάρχουν περιορισμοί τόσο στον χρόνο παραμονής στον βυθό όσο και στο μέγιστο βάθος προσέγγισης. Επιπρόσθετα, οικονομοτεχνικοί λόγοι δεν επιτρέπουν την μελέτη πολλών θέσεων διάσπαρτων στην ακτογραμμή της Κρήτης, παρόλο που θα ήταν το ιδανικό. Τα ευρήματα από τις δράσεις αυτές αξιοποιήθηκαν κατάλληλα, μέρος αυτών έχει ήδη δημοσιευτεί σε επιστημονικά περιοδικά με κριτές ενώ μέρος είναι υπο δημοσίευση σε αντίστοιχα περιοδικά.
Στην συνέχεια παρατίθεται περιληπτικά το περιεχόμενο και η σύνδεση των 3 κεφαλαίων της διδακτορικής διατριβής.

Κεφάλαιο 2

Η ύπαρξη μιας ενημερωμένης λίστα ειδών για μια γεωγραφική περιοχή αποτελεί μια πρόκληση στην σημερινή εποχή της αφθονίας των δεδομένων και ενώ φαντάζει εύκολη υπόθεση, εντούτοις ειναι μια δύσκολη διαδικασία. Απαιτεί καλή γνωση των πηγών, την ικανότητα επαληθεύσης των δεδομένων που παρατίθενται από τους ερευνητές χωρίς να υπάρχει δυνατότητα πρόσβασης στο επιστημονικό υλικό ενώ το τελικό προιόν είναι μια ολοκληρωμένη λίστα ειδών, στην προκειμένη περίπτωση την λίστα των θαλάσσιων μαλακίων της Κρήτης μέχρι το έτος 2016. Εξετάστηκαν συνολικά 53 δημοσιεύσεις (επιστημονικές δημοσιεύσεις σε περιοδικά, τεχνικές αναφορές ερευνητικών έργων, διδακτορικές διατριβές). 733 είναι τα μεχρι σήμερα καταγεγραμένα μαλάκια που έχουν βρεθεί στις θάλασσες της Κρήτης (FAO area 23). Αυτά ανήκουν σε 5 κλάσεις: Χαιτοδέρματα (2 είδη), Πολυπλακοφόρα (11 είδη), Γαστερόποδα (503 είδη), Δίθυρα (205 είδη) και Σκαφόποδα (12 είδη). Από αυτά, 16 είδη έχουν τον χαρακτηρισμό των αλλόχθωνων βιολογικών εισβολέων. Οι έρευνες μέχρι σήμερα έχουν γίνει κυρίως για το μαλακό υπόστρωμα της υποπαραλιακής ζώνης, με λίγα δεδομένα να προέρχονται από την βαθειά θάλασσα (> 100μ. βάθος) ενώ ένα μικρό ποσοστό προέρχεται από την μελέτη των θανατοκοινωνιών που απαντώνται ως άδεια όστρακα στις παραλίες. Δεν υπάρχει καμία πληροφορία για την βιοποικιλότητα των μαλακίων από το σκληρό υπόστρωμα (1170). Τα αποτελέσματα της μελέτης συγκρίθηκαν με τα δεδομένα της Μεσογείου καθώς και γειτονικών χωρών για την εκτίμηση ομοιοτήτων/διαφορών ενώ χρησιμοποιήθηκαν στις συγκριτικές αναλύσεις της ταξινομικής ποικιλότητας στο κεφάλαιο 3. Τα δεδομένα θα διατεθούν ελεύθερα σε πρότυπο Darwin Core από τον επιστημονικό αποθηκευτικό χώρο PANGAEA και από την εθνική πλατφόρμα βιοποικιλότητας LifeWatch Greece για χρήση από κάθε ενδιαφερόμενο. Μέρος των αποτελεσμάτων έχει δημοσιευτεί στον επετειακό τόμο προς τιμή του Μαλακολόγου Henk Meinis που εκδόθηκε από το επιστημονικό περιοδικό Quaternary International.

Κεφάλαιο 3

Η Μεσόγειος θάλασσα αποτελεί την μεγαλύτερη κλειστή λεκάνη σε παγκόσμιο επίπεδο. Ένα μεγάλο ποσοστό της ακτογραμμής της αποτελείται από βραχώδες υπόστρωμα ή όπως ονομάζονται «μεσογειακοί ύφαλοι», κυρίως ασβεστολιθικά πετρώματα, χαρακτηριστικό υλικο της Μεσογειακής ακτογραμμής. Σε αυτές τις περιοχές υπάρχουν θαλάσσιοι οικότοποι υψηλής οικολογικής και βιολογικής σημασίας. Λόγω αυτού, η Ευρωπαική Επιτροπή αποφάσισε να εντάξει τους βραχώδεις βυθούς της υποπαραλιακής ζώνης υπο καθεστώς προστασίας (Κωδικός οικοτόπου 1170 - ονομάσια «Μεσογειακοί Ύφαλοι» - 92/43/EEC). Στην ζώνη αυτή απαντώνται διάφορες υποκατηγορίες-φάσεις τις οποίες δημιουργούν ομάδες ζώων η φυκών. Δυο είναι οι κύριες κατηγορίες που κυριαρχούν, η ζώνη των φωτόφιλων μακροφυκών και η ζώνη των κοραλλιγενών σχηματισμών. Τα φωτοφιλα μακροφύκη αποτελούν καταφύγιο για μια από τις μεγαλύτερες ταξινομικές ομάδες της Μεσογείου, τα μαλάκια. Αποτελούν το 17% της συνολικής θαλάσσιας βιοποικιλότητας που απαντάται στην Μεσόγειο. Η ζώνη των φωτόφιλων φυκών δεν έχει μελετηθεί εκτενώς, αναφορικά με την βιοποικιλότητα των μαλακίων και τα λειτουργικά χαρακτηριστικά που έχουν για αυτά. Οι κοραλλιγενείς σχηματισμοί έχουν ιδιαίτερη σημασία για το μεσογειακό θαλάσσιο οικοσύστημα καθώς αποτελει πεδίο αναπαραγωγής εμπορικών ειδών, συσωρευτής CO2 μέσω των ασβεστοφυκών που αποτελούν και τον κύριο δομιτή του οικοσυστήματος αυτού καθώς και αγαπημένο πεδίο εφαρμογής δραστηριοτήτων αναψυχής όπως είναι η αυτόνομη κατάδυση.

Πραγματοποιήθηκε εκτενή αναζήτηση για τον εντοπισμό και την συλλογή των διαθέσιμων βιβλιογραφικών πηγών σχετικά με την βιοποικιλότητα των μαλακίων και των δυο κατηγοριών ώστε να αποκτήθεί μια συνολική εικόνα. 22 επιστημονικές αναφορές εντοπίστηκαν και αποδελτιώθηκαν αναφορικά με την κατηγορία των φωτοφιλων φυκών ενω 12 για την κατηγορία των κοραλλιγενών σχηματισμων. 599 είδη έχουν αναφερθεί από την ζώνη των φωτόφιλων φυκών με την Δυτική & Κεντρική Μεσόγειο να αποτελούν τις περισσότερο μελετημένες γεωγραφικές περιοχες. Στην Ανατολική Μεσόγειο, έχουν γίνει μόνο 3 σχετικές μελέτες, όλες στο Βόρειο Αιγαίο. Αντίστοιχη εικόνα έχουν και τα μαλάκια των κοραλλιγενών σχηματισμών με 511 είδη, με την Δυτική Μεσόγειο την περισσότερο μελετημένη και μόλις μια θέση στην Ανατολική Μεσόγειο/Αιγαίο Πέλαγος να έχει μελετηθεί σχετικά.

Τα αποτελέσματα της ανασκόπησης της βιοποιοκιλότητας των μαλακίων των φωτοφιλων φυκών αξιοποιήθηκαν στην σύγκριση με τα νεα δεδομένα που προέκυψαν από την εφαρμογή του πρωτοκόλλου NaGISA στην Κρήτη για την εκτίμηση ομοιοτήτων/διαφορών ενώ χρησιμοποιήθηκαν στις συγκριτικές αναλύσεις της ταξινομικής ποικιλότητας στο κεφάλαιο 4. Τα αποτελέσματα της ανασκόπησης της βιοποικιλότητας των μαλακίων των κοραλλιγενών σχηματισμών παραχωρηθηκαν στον Μεσογειακό Οργανισμό RAC/SPA, ο οποίος έχει θέσει ως προτεραιότητα την δημιουργία βάσεων δεδομένων για την αποθήκευση της βιοποικιλότητας των κοραλλιγενών σχηματισμών.

Τα δεδομένα των μαλακίων των φωτοφιλων φυκών είναι διαθέσιμα από την εθνική πλατφόρμα LifeWatch Greece για χρήση από κάθε ενδιαφερόμενο. Τα αποτελέσματα δημοσίευτηκαν από το επιστημονικό περιοδικό Biodiversity Data Journal (tracked for IF) του εκδοτικού οίκου Pensoft στο ειδικό τόμο LifeWatchGreece: Research infrastructure (ESFRI) for biodiversity data and data observatories.

Τα δεδομένα των μαλακίων των κοραλλιγενών σχηματισμών είναι διαθέσιμα από την πλατφόρμα διάθεσης επιστημονικών δεδομένων PANGAEA. Τα αποτελέσματα του κεφαλαίου αυτού δημοσιευθήκαν στον επετειακό τόμο προς τιμή του Μαλακολόγου Henk Meinis που εκδόθηκε από το επιστημονικό περιοδικό Quaternary International.

Κεφάλαιο 4

Η Κρήτη αποτελεί ένα από τα μεγαλύτερα νησία της Μεσογείου με μια δαντελωτή και εκτεταμένη ακτογραμμή. Εφαρμόστηκε το διεθνές πρωτόκολλο δειγματοληψίας NaGISA. Το συγκεκριμένο πρόγραμμα επικεντρώνεται στην καταγραφή, παρακολούθηση και τη δημιουργία χρονοσειρών της παράκτιας ποικιλότητας (μέχρι το βάθος των 20 m). Το ακρωνύμιο του προγράμματος προέρχεται από την Ιαπωνική λέξη «nagisa» που σημαίνει το σημείο όπου η θάλασσα συναντά την ακτή. Έως σήμερα έχουν εγκαθιδρυθεί 8 περιφερειακά γραφεία, σε 40 χώρες και 240 σημεία δειγματοληψίας. Δύο είναι τα ενδιαιτήματα που μελετώνται μέσα από το πρόγραμμα: α) βιοκοινωνίες σκληρού υποστρώματος (rocky bottom macroalgae communities) και λιβάδια φανερογάμων (soft bottom seagrass communities).

Τα δύο αυτά ενδιαιτήματα εμφανίζουν μεγάλη πολυπλοκότητα, κατανέμονται παγκοσμίως και δεν είναι επαρκώς μελετημένα. Το πρόγραμμα NaGISA συμπεριλήφθηκε στο δίκτυο του CoML (Census of Marine Life) το 2002, με δύο κεντρικά γραφεία στην Αλάσκα και το Κιότο και 6 περιφερειακά. Ένα από περιφερειακά γραφεία ονομάζεται EuroNaGISA, το οποίο συντονίζει τις δραστηριότητες του προγράμματος σε ευρωπαϊκό επίπεδο με έδρα την Πίζα της Ιταλίας. Οκτώ χώρες συμμετέχουν στον Ευρωπαϊκό τομέα, δύο εκ των οποίων δραστηριοποιούνται στη Μεσόγειο (Ιταλία –Ελλάδα). Στη Μεσόγειο υπάρχουν πέντε σταθμοί δειγματοληψίας, ένας στη θάλασσα της Λιγουρίας, δύο στην Αδριατική και δύο στην Κρήτη. Στη Κρήτη οι σταθμοί εγκαταστάθηκαν το 2007. Σε κάθε σταθμό, 5 βάθη (1-5-10-15-20μ.) και 5 επαναληπτικά δείγματα ανα βάθος συλλέχθηκαν με την χρήση υποβρύχιου αναρροφητήρα (underwater sucker), ενώ στα πλαισια της παρούσας εργασίας αναλύθηκαν τα δεδομένα για 2 έτη (Σεπτέμβριος 2007 – Ιούνιος 2008).

Συνολικά καταγραφηκαν 127 είδη μαλακίων από τις 2 περιοχές που ανήκουν σε 3 κλάσεις (7 πολυπλακοφόρα, 97 γαστερόποδα, 23 δίθυρα). 34 από τα είδη αυτά αποτελούν νέες καταγραφές για το Κρητικό πέλαγος. 2 είδη είναι κυρίαρχα σε όλα τα βάθη και έτη, το γαστερόποδο *Bittium latreilii* και το δίθυρο *Musculus costulatus*. Ένας μεγάλος αριθμων ειδών είχε μόνο ένα δείγμα (άτομο) ενώ κυριαρχούσαν πολύ λίγα είδη. Αυτό αποτελεί και ένα από τα χαρακτηριστικά της Μεσογειακής μαλακοπανίδας. Η ποικιλότητα των μαλακίων που συλλέχθηκαν από την ζώνη των φωτόφιλων φυκών είναι συγκρίσιμη με αυτή της Δυτικής Μεσογείου ενώ η ανάλυση της ταξινομικής ποικιλότητας με την χρήση των δεικτών Δ^+ και Λ^+ έδειξε πως μπορεί να θεωρηθεί αντιπροσωπευτική της Μεσογείου, δεδομένου του ότι τα δεδομένα αυτά αποτελούν τα μόνα διαθέσιμα από την Νότια Ανατολική

Μεσόγειο. Υπάρχει μια διακριτή βαθυμετρική ζώνωση στην βιοκοινωνία των μαλακίων και στις 2 θέσεις που μελετήθηκαν. Η βαθυμετρική ζώνη ενός (1) μέτρου είναι διαφορετική από τα υπόλοιπα βάθη και κύρια αιτία φαίνεται πως αποτελεί η κυματική δράση. Αυτή καθορίζει και την φυτοκάλυψη σε μεγάλο βαθμό. Η Κρήτη αποτελεί το ανατολικότερο όριο στην Μεσόγειο με διαθέσιμα μακροβενθικά δεδομένα απο τους Μεσογειακους υφάλους – την ζώνη των φωτοφιλών μακροφυκών. Τα δεδομένα είναι διαθέσιμα από την εθνική πλατφόρμα LifeWatch Greece για χρήση από κάθε ενδιαφερόμενο.

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Κεφάλαιο 2

Τα θαλάσσια μαλάκια της Κρήτης, η ιστορία τους και η επικαιροποιημένη λίστα των ειδών

Εκτεταμένη περίληψη

Το φύλο των μαλακίων αποτελεί ένα από τα μεγαλύτερα και ποιο μελετημένα φύλα του ζωικού βασιλείου. Εκτιμάται πως 50.000 είδη έχουν περιγραφεί μέχρι σήμερα, εκ των οποίων 2000 είδη έχουν αναφερθεί από την Μεσόγειο. Αν και η βιοποικιλότητα της μαλακοπανίδας της Μεσογείου θεωρείται ως η καλύτερα μελετημένη σε παγκόσμιο επίπεδο, εντούτοις διαφορές υπάρχουν ανάμεσα στην Δυτική και Ανατολική λεκάνη της Μεσογείου, με την Δυτική Μεσόγειο να αριθμεί περισσότερα είδη τόσο λόγω της διαφορετικής ερευνητικής έντασης (research effort), της ύπαρξης ειδικών σε διαφορετικές ομάδες των μαλακίων αλλά και λόγω της ανεπτυγμένης σε επίπεδο ερασιτεχνών συλλογής μαλακίων και την ύπαρξη τοπικών συλλόγων που ασχολούνται αποκλειστικά με το θέμα της τοπικής μαλακοπανίδας. Η ιστορία της μαλακοπανίδας της Μεσογείου ξεκινά περίπου από τα τέλη του 1700 με τις πρώτες ερευνητικές αποστολές να οργανώνονται στην Σικελία από τον Poli το 1791 και στον κόλπο της Σμύρνης από το Forsskal το 1775. Στην συνέχεια ακολούθησαν πολλές αποστολές δημιουργώντας τις πρώτες λίστες ειδών σε τοπικό επίπεδο. Η ανατολική Μεσόγειος αποτελεί πεδίο μελέτης της βιοποικιλότητας των μαλακίων εδώ και 2 αιώνες. Πολλοί είναι οι φυσιοδίφες που από τις αρχές του 18^{ο} αιώνα ξεκίνησαν ερευνητικές αποστολές που σκοπό είχαν την μελέτη της βιοποικιλότητας, χερσαίας και θαλάσσιας, αναμεσά τους και την βιοποικιλότητα των μαλακίων. Ο Peter Forsskål, ο Edward Forbes, ο Charles Jeffreys είναι μερικοί από τους ποιο γνωστούς φυσιοδίφες της εποχής εκείνης, οι οποίοι περιέγραψαν πολλά νέα είδη μαλακίων από την Ανατολίκη Μεσόγειο ενώ δημιούργησαν λίστες ειδών για νησιά και άλλες περιοχές από τις οποίες συνέλεξαν υλικό με δράγες. Στις αρχές του 20^{ου} αιώνα, ο Γαλλο-Αλγερινός μαλακολόγος Paul Maurice Pallary μελέτησε την μαλακοπανίδα της Αιγύπτου (Μεσόγειος – Ερυθρά θάλασσα) και Συρίας και εξέδωσε τις πρώτες λίστες ειδών σε επίπεδο κράτους. Αρκετοί από τους προαναφερθέντες φυσιοδίφες, ταξιδεύοντας στην Ανατολική Μεσόγειο με τα ερευνητικά τους σκάφη, είχαν ενδιάμεσες στάσεις τόσο για ανεφοδιασμό όσο και για συλλογή υλικού, διάφορα νησιά στο Αιγαίο πέλαγος, από τα οποία, σημαντικός σταθμός ήταν η Κρήτη – κυρίως ο κόλπος της Σούδας. Από την περιοχή αυτή συλλέχθηκε υλικό με την χρήση δράγας και προέκυψαν τα πρώτα δεδομένα για την μαλακοπανίδα της Κρήτης. Η Κρήτη αποτελεί το μεγαλύτερο νησί της Ελλάδας και ένα από τα μεγαλύτερα της Μεσογείου. Έχει μακρόστενο σχήμα, με ακτογραμμή που ξεπερνά τα 1000 χιλιόμετρα, μήκος 260 χιλιόμετρα και πλάτος από 60 μέγιστο έως 12 ελάχιστο (κοντά στην Ιεράπετρα). Γεωγραφικά βρίσκεται 160 χιλιόμετρα νότια της ηπειρωτικής Ελλάδας, στην Ανατολική λεκάνη της Μεσογείου, μια λεκάνη που θεωρείται ολιγοτροφική αναφορικά με την πρωτογενή παραγωγή και την συγκέντρωση χλωροφύλλης.

Η θάλασσα της Κρήτης, όπως αυτή ορίζεται γεωγραφικά από τον Παγκόσμιο Οργανισμό Τροφίμων και Αγροτικής παραγωγής (FAO – FAO code 23), αποτελεί ένα μεγάλο τμήμα του νοτίου Αιγαίου Πελάγους και θεωρείτε ως ένα διακριτό υποσύστημα στην Ανατολική Μεσόγειο λόγω των διαφορετικών γεωμορφολογικών, υδρογραφικών και κλιματικών συνθηκών, ο υψηλός ρυθμός εξάτμισης και η βιοποικιλότητα. Οι πρώτες μελέτες για την βιοποικιλότητα των μαλακίων από την περιοχή της Κρήτης προέρχονται από τον Forbes το 1843, τον Raulin το 1889, τον Jeffreys το 1883 και τον Sturany το 1896. Αργότερα, τον 20^{ο} αιώνα και μετά τον Δεύτερο Παγκόσμιο πόλεμο, άρχισαν να εμφανίζονται λίγες μελέτες με αρχή την μελέτη και παρουσίαση του υλικού από την αποστολή του ερευνητικού σκάφους «Καλυψώ» με αρχηγό τον Ζακ Υβ Κουστώ από τους Peres & Picard το 1958. Αργότερα, την δεκαετία του 1970 άρχισαν να εμφανίζονται νέες μελέτες που όπως οι προηγούμενες, αποτελούσαν μέρος ερευνητικών πλοών ή και μελετών από νέους φυσιοδίφες. Ορόσημο για την μελέτη της Κρητικής μαλακοπανίδας αποτελεί η δουλειά που δημοσιεύτηκε το 1992 από την ομάδα του Δρ. Δρόσου Κουτσούμπα και των συνεργατών του. Έγινε ενδελεχή ανασκόπηση της διαθέσιμης επιστημονικής και γκρίζας βιβλιογραφίας ενώ παράλληλα, στα πλαίσια ερευνητικών δραστηριοτήτων, συλλέχθηκε και νέο υλικό από της υποπαραλιακή ζώνη της Κρήτης. Ως αποτέλεσμα, παρουσιάστηκε και δημοσιεύτηκε η πρώτη ολοκληρωμένη λίστα της θαλάσσιας μαλακοπανίδας της Κρήτης. Στην συνέχεια εμφανίστηκαν νέες μελέτες που παρουσίαζαν νέα δεδομένα από την βαθιά θάλασσα της Κρήτης, νέα είδη για την Ανατολική Μεσόγειο, νέα είδη από άλλες θάλασσες (θαλάσσιοι βιολογικοί εισβολείς) ή μελέτες για συγκεκριμένες ομάδες μαλακίων (οπισθοβράγχια) και ανάλυση υλικού από θανατοκοινωνίες (υλικό νεκρών μαλακίων από τις παραλίες). Καθώς έχουν περάσει 25 χρόνια από την τελευταία ολοκληρωμένη δημοσίευση της λίστας των ειδών της θαλάσσιας μαλακοπανίδας της Κρήτης, είναι πλέον υποχρεωτική η ενημέρωση της λίστας αυτής καθώς νέα δεδομένα έχουν εμφανιστεί, η συστηματική πολλών ειδών έχει αλλάξει (επικαιροποίηση) ενώ νέα είδη για την γεωγραφική ζώνη αυτή έχουν συλλεχθεί. Η διαθέσιμη και προσβάσιμη βιβλιογραφία συλλέχθηκε και αποδελτιώθηκε, ενώ υλικό που συλλέχθηκε μεταξύ του 2000 και 2016 από δραστηριότητες παράκτιας αλιείας, τράτες και επιστημονικές καταδύσεις και είναι κατατεθειμένο στις συλλογές του Μουσείου Φυσικής Ιστορίας του Πανεπιστημίου Κρήτης αξιοποιήθηκε. Συνολικά, αναλύθηκαν 51 βιβλιογραφικές πηγές. Σχεδιάστηκε μια βάση δεδομένων σε περιβάλλον Microsoft Access ώστε τα δεδομένα να αποθηκευτούν και να είναι εφικτή η περαιτέρω αξιοποίηση τους. Η χρήση της Microsoft Access είναι η ποιο κοινή για τέτοιες εφαρμογές σε τοπικό επίπεδο ενώ μπορεί να διαχειριστεί μεγάλο όγκο δεδομένων και να συνδεθεί με λογισμικά γεωγραφικών συστημάτων πληροφοριών για την χωρική οπτικοποίηση των δεδομένων, εφόσον αυτά συνοδεύονται με γεωγραφικά δεδομένα – συντεταγμένες αλλά και άλλες πληροφορίες (βάθος, υπόστρωμα, ημερομηνία συλλογής/δημοσίευσης) με σκοπό τον σχεδιασμό χαρτών κατανομής ειδών – ανάμεσα στα άλλα. Επιπρόσθετα, εφόσον παραστεί αναγκαίο, είναι εφικτή η μεταφορά των δεδομένων και της δομής της βάσης δεδομένων σε άλλα συστήματα διαχείρισης πληροφορίας (MySQL, PostegreSQL) και οπτικοποίηση γεωγραφικής πληροφορίας στο διαδίκτυο (WebGIS). Ακολουθήθηκε η συστηματική που είναι διαθέσιμη από το Παγκόσμιο Μητρώο των Οργανισμών της Θάλασσας (World Registered of Marine Species – WORMS). Για την ανάλυση των δεδομένων χρησιμοποιήθηκαν τα διαγράμματα Venn καθώς και οι δείκτες της ταξινομικής ποικιλότητας/διακριτότητας.

735 είδη θαλάσσιων μαλακίων (δεν συμπεριλαμβάνονται τα κεφαλόποδα) έχουν καταγραφεί από την Κρήτη μέχρι σήμερα. Από αυτά, 16 έχουν κατηγοριοποιηθεί ως θαλάσσιοι βιολογικοί εισβολείς/αλλόχθονα είδη ενώ από το νέο υλικό που συλλέχθηκε την περίοδο 2000 – 2016, τα νέα είδη για την Κρήτη είναι 6, τα προσοβράγχια γαστερόποδα *Ranella olearium*, *Cymatium parthenopeum*, *Cymatium corrugatum*, *Cabestana cutacea* και τα οπισθοβράγχια *Chelidonura africana* και *Aporodoris millegrana*. Τα προσοβράγχια γαστερόποδα ανήκουν όλα στην οικογένεια Rannelidae. Είναι συνήθως κάτοικοι των βαθιών νερών, ειδικά στην Ανατολική Μεσόγειο, ενώ αλιεύονται κυρίως από βενθικές τράτες, σπανιότερα από εργαλεία παράκτιας αλιείας. Αποτελούν είδη – στόχοι για τους συλλέκτες κογχυλιών ενώ όταν αλιευθούν από τις τράτες πωλούνται σε υψηλές τιμές από τους αλιείς προς κάθε ενδιαφερόμενο. Από τα 735 είδη, 503 ανήκουν στα γαστερόποδα, 205 στα δίθυρα, 11 στα πολυπλακοφόρα, 12 στα σκαφόποδα και 2 στα χαιτοδέρματα. 5 είδη είναι υπο κάποιο καθεστώς προστασίας (IUCN Red list, Barcelona / Bern Convention). Συγκρίνοντας τα δεδομένα της βιοποικιλότητας των μαλακίων της Κρήτης με αυτή του Βόρειου Αιγαίου (Ελληνική πλευρά) βλέπουμε πως ο αριθμός των ειδών των πολυπλακοφόρων (11 στην Κρήτη – 14 στο Βόρειο Αιγαίο) και των γαστερόποδων (508 στην Κρήτη – 416 στο Βόρειο Αιγαίο)είναι παρόμοιος. Για τα δίθυρα, συγκλίνοντας με την λίστα των δίθυρων της Ελλάδας, 205 από τα 300 συνολικά είδη αναφέρονται από την Κρήτη. Σε Μεσογειακό επίπεδο, από τα νέα διαθέσιμα δεδομένα, σχεδόν ο μισός αριθμός των γνωστών πολυπλακοφόρων και διθύρων καθώς και το 30% των γαστεροπόδων της Μεσογείου αναφέρονται από την Κρήτη. Σε επίπεδο ταξινομικής ποικιλότητας, η θαλάσσια βιοποικιλότητα των μαλακίων της Κρήτης μπορεί να θεωρηθεί ως αντιπροσωπευτική της Μεσογείου. Ο αριθμός των μαλακίων που αναφέρονται από την Κρήτη προέρχεται κυρίως από μελέτες και εργασίες για τις οποίες το υλικό τους έχει συλλεχθεί από μαλακό υπόστρωμα (αμμώδεις/λασπώδεις βυθοί) από την υποπαραλιακή ζώνη. Μικρό τμήμα του αφορά την μελέτη θανατοκοινωνιών που συλλέχθηκαν από την παραλία. Μόνο δυο εργασίες παρουσιάζουν δεδομένα από την βαθιά θάλασσα της Κρήτης. Δεν υπάρχει εργασία που να έχει γίνει και να αφορά το σκληρό υπόστρωμα, είτε την ζώνη των φωτοφιλων φυκών είτε την ζώνη των κοραλλιγενών/βιογενών σχηματισμών είτε τα υποθαλάσσια σπήλαια και τα λιβάδια της ποσειδωνίας. Όλοι αυτοί οι θαλάσσιοι βιότοποι/οικότοποι αποτελούν προστατευόμενους οικότοπους από την

Ευρωπαϊκή Ένωση (92/45 EC) και ιδιαίτερη διαχείριση απαιτείται, κυρίως για τα λιβάδια της ποσειδωνίας που είναι και οικότοπος προτεραιότητας. Η απουσία υλικού και δεδομένων από τους προαναφερθέντες οικοτόπους οφείλεται κυρίως στο γεγονός ότι η συλλογή υλικού απαιτεί την χρήση συσκευών αυτόνομης κατάδυσης (SCUBA diving) καθώς και τον χειρισμό υποβρύχιων συσκευών για την συλλογή του υλικού. Επιπρόσθετα, ο χρόνος παραμονής στην θάλασσα, καθώς σχετίζεται με το βάθος και τον τύπο των αεριών που καταναλώνει ο δύτης, είναι ένας ακόμα περιοριστικός παράγοντας. Είναι ιδιαίτερα σημαντική η ύπαρξη δεδομένων από αυτούς τους θαλάσσιους οικοτόπους από την Κρήτη καθώς δεν υπάρχουν διαθέσιμα δημοσιευμένα δεδομένα όχι μόνο από το νησί αλλά και από την Ανατολική Μεσόγειο γενικότερα (ανατολικά της Κρήτης). Επιπρόσθετα, τέτοια δεδομένα, ως δεδομένα βάσης για αυτή την γεωγραφική περιοχή, θα αποτελέσουν συγκριτικά δεδομένα για το μέλλον για τον εντοπισμό αλλαγών στην σύνθεση της θαλάσσιας βιοποικιλότητας καθώς βρίσκεται σε μια ζώνη που έχει άμεση επιρροή από τους θαλάσσιους βιολογικούς εισβολείς που μπαίνουν στην Μεσόγειο από την διώρυγα του Σουέζ, καθώς και για βιογεωγραφικές αναλύσεις σε σύγκριση με διαθέσιμα δεδομένα από άλλες περιοχές της Μεσογείου. Τα δεδομένα που δημιουργήθηκαν από την παρούσα εργασία, επιλέχθηκε να διατεθούν ελεύθερα μέσω αποθηκευτικών χώρων επιστημονικών δεδομένων καθώς η ελεύθερη διάθεση των δεδομένων αυτών στην επιστημονική κοινότητα θα δώσει την δυνατότητα για περαιτέρω αξιοποίηση και χρήση σε εφαρμογές που σχετίζονται με την διαχείριση του θαλάσσιου χώρου.

Marine Mollusca of Crete, its history and the update regional checklist

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Abstract
The present study provide an update and comprehensive species list on the marine mollusca fauna of Crete. The compilation of the available publications revealed a total of 733 species belonging to 5 classes (Caudofoveata, Polyplacophora, Gastropoda, Bivalvia and Scaphopoda). Most of the species belong to the class Gastropoda (503), followed by Bivalvia (205), Scaphopoda (12), Polyplacophora (11) and Caudofoveata (2). 34% of the Mediterranean Malacofauna has been found in Crete so far. From the 733 species, only 16 are invasive aliens; ones that originated outside the Mediterranean Sea and have established populations. Among the listed species the prosobranch gastropods *Ranella olearium*, *Monoplex parthenopeus*, *Monoplex corrugatus*, *Cabestana cutacea* and the opisthobranchs *Chelidonura africana* and *Aporodoris millegrana* are reported for the first time from the Cretan Sea. Major contribution to the local malacofauna has been done through amateurs collections. Five species are classified in the IUCN Red list or Barcelona/Bern Convetioned. The present study, even if reveal a high number of molluscan species in comparison to neighbour areas, higjlights the absence of information from habitats like the photophilic macroalgae, the coralligenous formations, the seagrass meadows and the underwater marine caves while other sensitive habitats like the deep sea (circalittoraland bathyal) are represented by only 2 studies. The absence of the information from this habitats reflects also to the taxonomic distinctness analysis, which shows that the Cretan marine malacofauna cannot be considered representative malacofauna of the Mediterranean Sea.

Keywords: Crete, East Mediterranean, Molluscan diversity, Rannelidae, New records.

Introduction
It is well known that the phylum Mollusca constitutes one of the largest and well-studied group of animals. Approximately, 50.000 marine species have been described so far (Bouchet, 2006) while in the Mediterranean Sea, the described species are approximately 2000 (Coll et al., 2010, Sabelli & Taviani, 2014). The Mediterranean marine malacofauna is believed tha is the best known malacofauna globally (Oliveiro 2003). Differences exists between the West and East Mediterranean basin, mainly because of the research effort that the western-basin-laid countries have set by, the availability of highly expertise scientist but also the existence of a large number of amateur collectors and local shell clubs (Oliveiro 2003). The history of the Mediterranean malacofauna lays back to 1800 with the first local expeditions to be held at Sicily by Poli at 1791 and Izmir bay by Forsskal at 1775. Afterthought, numerus studies have been done, establishing the first checklists of the Mediterranean malacofaunal at local scale (Oliveiro 2003). The East Mediterranean has been the field of malacofaunal studies for over 2 centuries. Several naturalists have sail in order to investigate the local biodiversity, among them the molluscs. Peter Forsskål, Edward Forbes, Charles Jeffreys are some of the naturalists that study the malacofaunal of the east basin between the 18th and 19th century, describing several new species setting the start of local checklists (Ozturk et al., 2014). In the entry of 20th century, Paul Maurice Pallary, a French-Algerian malacologist publish the first checklist for Egypt (Pallary 1913) and for Syria (Pallary, 1929,

1934). Several of the abovementioned naturalists, during their trips have stopovers around the Aegean Sea, with their one of their stopover to be the island of Crete. There, they collect material with dredges and provide the first insights on the local marine malacofauna.

Crete is the largest island of Greece and one of the biggest islands of the Mediterranean, counting more than 1046 km of coastline including that of the surrounding islands (Alexandrakis, 2014). Crete has an elongated shape and spans approximately 260 km from east to west, while the vertical axis of the island varies between 60 and 12 km (in the region close to Ierapetra). Crete lies approximately 160 km south of the Greek mainland, in the eastern part of the Mediterranean basin, a highly oligotrophic region in terms of both primary productivity and chlorophyll a concentrations (Psarra et al., 2000). The Cretan Sea, as is geographically defined by FAO (FAO code 23, http://www.marineregions.org/gazetteer.php?p=details&id=48617) comprises a large part of the South Aegean Sea, and is considered as a separate subsystem of the Eastern Mediterranean due to the geomorphological, hydrographic and climatic diversities, the high evaporation, and the biodiversity. The first malacological studies of this region come from Forbes at 1843 (Forbes, 1844), Raulin at 1889 (Raulin 1870), Jeffreys at 1883 (Jeffreys 1883) and Sturany at 1896 (Sturany 1896). Late in 20th century, after the Second World War, few studies appear like the one from the Calypso expedition (Peres and Picard 1958, Ledoyer 1969) while later at 70's more studies appear (Vamvakas 1970, Oberling 1970). The milestone for the Cretan malacofaunal is the study by Koutsoubas and his colleagues (Koutsoubas et al., 1992) who review the available literature, collect new material, mainly from soft bottom biocoenosis, around Crete Island (Cretan Sea and Libyan Sea) and provide the first comprehensive checklist of the Cretan malacofaunal. As a follow-up, more publications appear, providing information for understudied habitats like the deep sea (Koutsoubas et al., 2000), new species as expansions to the east (Poursanidis et al., 2011, 2014), marine invasive species (Daskos & Zenetos, 2007), understudied groups like the opisthobranchia (Crocetta et al., 2015) or information based on thanatocoensis material (Vervaet 2007). The present study aims at reviewing all available literature related to the Cretan marine malacofauna (excluding the class Cephalopoda) dating back to 18th century as well as providing information on new findings in order to create an update regional checklist. It is also aim to answer the hypothesis: Is the Cretan malacofaunal representative of the regional species pool of the entire Mediterranean Sea?

Materials and Methods

Literature review

The designation of the present work is based on the published data in indexed and grey literature (i.e. non peer-reviewed, non-indexed papers, PhD thesis, and Project technical reports) as well as on new material collected from the period 2000 - 2016. Most of the historical journals are still non-indexed, and malacological works are still published in non-indexed journals as well as in Conference Proceedings. The database has been designed within the framework of Microsoft Access Database System ver. 2013. The Access Database system is one of the most common database systems used for offline purposes to act as an end-to-end solution for data management. Furthermore, it can handle a vast amount of information and can be easily connected with any available GIS software for the spatial visualization of its contents, when spatial information associate the data, such as the location of each research project and the related collected data (substrate, depth, date), as well as in order to create distribution maps for certain species. In addition, the database scheme and its components can easily be transferred to other database systems (MySQL, PostegreSQL) for integration or for the design of an online information system on the regional biodiversity of Crete (webGIS). Updated taxonomy and nomenclature used follows WoRMS (Boxshall et al., 2016). As all checklists reflect the taxonomic knowledge in the literature up to a given cut-off date, the present one reflects the status up to July 2016. For taxa lacking a recent taxonomic revision, lists of species names may not be based on sound taxonomy, and inferences may be erroneous. Up to now, 51 literature sources have been analysed in order to extract the published information (S1.doc). An area-proportional Venn diagram has been created in order to visualize the amount of overlap with the Mediterranean molluscan species list (Coll et al., 2010) using BioVenn (Hulsen et al., 2008).

Randomness testing

The taxonomic relatedness of the molluscan diversity from the Cretan Sea was compared to the Mediterranean molluscan species pool. For this purpose we used the average taxonomic distinctness (Δ^+) and the variation in taxonomic distinctness (Λ^+) (Clarke & Warwick, 1998, Warwick & Clarke, 2001). These indices are known to be sample size/sample effort free diversity measures of species taxonomic relatedness. The average taxonomic distinctness Δ^+ measures the taxonomic relationships in a sample. It uses presence/absence data and calculates the average path length between every pair of species by using information on their higher classification within a sample. The variation of the taxonomic distinctness Λ^+ assesses the degree to which species are evenly distributed to higher taxonomic categories. As both indices are independent of the sampling size and effort, they can be considered as an appropriate means to analyzing datasets that have been collected in different sampling design and performance methods (Clark and Warwick 2001). Expected distribution funnels were calculated by simulations derived from randomly constructed subsets of species from Cretan marine malacofauna and Mediterranean species pool. If the local malacofauna is a random sample from the regional species pool, the observed Δ^+/ Λ^+ are expected to fall into the 95% confindence limits of the simulated funnel.

Additional data

During the period 2000 – 2016, new material have been collected by the first author, as part of his research interest in the local marine malacofauna. The material come from artisanal fisheries activities, from trammel nets, from beached material as well as from scientific diving activities. The material has been examined carefully and stored in the collection of the Natural History Museum of Crete for further use from any interested scientist.

Results

Updating the references reviewed in the milestone work of Koutsoubas and his colleagues (Koutsoubas et al., 1992) and examining new publications from 1992 onwards (Appendix), a total number of 735 species has been recorded so far from the Cretan Sea (first half of 2016) (table 1). These are the 34% of the total Mediterranean marine malacofauna (figure 1). From these, 16 species have been classified as aliens (IAS) and are marked with asterisk * while 6 species have been recorded for the first time from Crete and are marked with + in the table 1.

Table 1. The checklist of the marine molluscs of Crete.

Class	Family	Species
Caudofoveata	Chaetodermatidae	Falcidens gutturosus (Kowalevsky, 1901)
	Prochaetodermatidae	Prochaetoderma raduliferum (Kowalevsky, 1901)
Polyplacophora	Acanthochitonidae	Acanthochitona crinita (Pennant, 1777)
	Acanthochitonidae	Acanthochitona fascicularis (Linnaeus, 1767)
	Callochitonidae	Callochiton septemvalvis (Montagu, 1803)
	Chitonidae	Chiton corallinus (Risso, 1826)

	Chitonidae	Chiton olivaceus Spengler, 1797
	Ischnochitonidae	Ischnochiton rissoi (Payraudeau, 1826)
	Lepidochitonidae	Lepidochitona caprearum (Scacchi, 1836)
	Leptochitonidae	Lepidopleurus cajetanus (Poli, 1791)
	Leptochitonidae	Leptochiton cancellatus (Sowerby, 1840)
	Leptochitonidae	Leptochiton scabridus (Jeffreys, 1880)
Gastropoda	Aclididae	Aclis ascaris (Turton, 1819)
	Aclididae	Aclis attenuans Jeffreys, 1883
	Aclididae	Aclis minor (Brown, 1827)
	Aclididae	Aclis walleri Jeffreys, 1867
	Acteonidae	Acteon tornatilis (Linnaeus, 1758)
	Acteonidae	Crenilabium exile (Jeffreys, 1870)
	Acteonidae	Japonactaeon pusillus (Forbes, 1844)
	Aeolidiidae	Spurilla neapolitana (Delle Chiaje, 1841)
	Aglajidae	Chelidonura africana Pruvot-Fol, 1953 +
	Aglajidae	Philinopsis depicta (Renier, 1807)
	Akeridae	Akera bullata O. F. Müller, 1776
	Amathinidae	Clathrella clathrata (Philippi, 1844)
	Anabathridae	Pisinna glabrata (Megerle von Mühlfeld, 1824)
	Anatomidae	Anatoma aspera (Philippi, 1844)
	Anatomidae	Anatoma crispata (Fleming, 1828)
	Aplysiidae	Aplysia dactylomela Rang, 1828 *
	Aplysiidae	Aplysia depilans Gmelin, 1791
	Aplysiidae	Aplysia fasciata Poiret, 1789
	Aplysiidae	Aplysia parvula Mörch, 1863 *
	Aplysiidae	Aplysia punctata (Cuvier, 1803)
	Aplysiidae	Bursatella leachii Blainville, 1817 *
	Aplysiidae	Petalifera petalifera (Rang, 1828)
	Aporrhaidae	Aporrhais pespelecani (Linnaeus, 1758)
	Aporrhaidae	Aporrhais serresianus (Michaud, 1828)
	Architectonicidae	Discotectonica discus (Philippi, 1844)
	Atlantidae	Atlanta inflata J.E. Gray, 1850
	Atlantidae	Atlanta peronii Lesueur, 1817
	Barleeiidae	Barleeia unifasciata (Montagu, 1803)
	Borsoniidae	Drilliola emendata (Monterosato, 1872)
	Borsoniidae	Drilliola loprestiana (Calcara, 1841)
	Buccinidae	Chauvetia affinis (Monterosato, 1889)
	Buccinidae	Chauvetia brunnea (Donovan, 1804)
	Buccinidae	Chauvetia candidissima (Philippi, 1836)
	Buccinidae	Chauvetia ventrosa Nordsieck, 1976
	Buccinidae	Enginella leucozona (Philippi, 1844)
	Buccinidae	Euthria cornea (Linnaeus, 1758)
	Buccinidae	Pisania striata (Gmelin, 1791)
	Buccinidae	Pollia dorbignyi (Payraudeau, 1826)
	Buccinidae	Pollia scabra Locard, 1892
	Buccinidae	Pollia scacchiana (Philippi, 1844)

Bullidae	Bulla striata Bruguière, 1792
Caecidae	Caecum armoricum de Folin, 1869
Caecidae	Caecum auriculatum de Folin, 1868
Caecidae	Caecum clarkii Carpenter, 1859
Caecidae	Caecum subannulatum de Folin, 1870
Caecidae	Caecum trachea (Montagu, 1803)
Calliostomatidae	Calliostoma conulus (Linnaeus, 1758)
Calliostomatidae	Calliostoma gualterianum (Philippi, 1848)
Calliostomatidae	Calliostoma laugieri (Payraudeau, 1826)
Calliostomatidae	Calliostoma zizyphinum (Linnaeus, 1758)
Calliotropidae	Putzeysia wiseri (Calcara, 1842)
Calyptraeidae	Calyptraea chinensis (Linnaeus, 1758)
Calyptraeidae	Crepidula unguiformis Lamarck, 1822
Capulidae	Capulus ungaricus (Linnaeus, 1758)
Cassidae	Galeodea echinophora (Linnaeus, 1758)
Cassidae	Semicassis granulata (Born, 1778)
Cassidae	Semicassis saburon (Bruguière, 1792)
Cavoliniidae	Cavolinia gibbosa (d'Orbigny, 1834)
Cavoliniidae	Cavolinia inflexa (Lesueur, 1813)
Cerithiidae	Bittium lacteum (Philippi, 1836)
Cerithiidae	Bittium latreillii (Payraudeau, 1826)
Cerithiidae	Bittium reticulatum (da Costa, 1778)
Cerithiidae	Bittium submamillatum (de Rayneval & Ponzi, 1854)
Cerithiidae	Cerithium caeruleum G. B. Sowerby II, 1855
Cerithiidae	Cerithium lividulum Risso, 1826
Cerithiidae	Cerithium renovatum Monterosato, 1884
Cerithiidae	Cerithium scabridum Philippi, 1848 *
Cerithiidae	Cerithium vulgatum Bruguière, 1792
Cerithiopsidae	Cerithiopsis minima (Brusina, 1865)
Cerithiopsidae	Cerithiopsis tubercularis (Montagu, 1803)
Cerithiopsidae	Dizoniopsis bilineata (Hoernes, 1848)
Cerithiopsidae	Dizoniopsis coppolae (Aradas, 1870)
Cerithiopsidae	Krachia cylindrata (Jeffreys, 1885)
Cerithiopsidae	Seila trilineata (Philippi, 1836)
Chilodontidae	Danilia otaviana (Cantraine, 1835)
Chilodontidae	Danilia tinei (Calcara, 1839)
Chromodorididae	Felimare orsinii (Vérany, 1846)
Chromodorididae	Felimare picta (Schultz in Philippi, 1836)
Chromodorididae	Felimare tricolor (Cantraine, 1835)
Chromodorididae	Felimare villafranca (Risso, 1818)
Chromodorididae	Felimida britoi (Ortea & Pérez, 1983)
Chromodorididae	Felimida luteorosea (Rapp, 1827)
Cimidae	Cima cylindrica (Jeffreys, 1856)
Cimidae	Cima minima (Jeffreys, 1858)
Cingulopsidae	Eatonina cossurae (Calcara, 1841)
Cingulopsidae	Eatonina ochroleuca (Brusina, 1869)

Clathurellidae	Comarmondia gracilis (Montagu, 1803)
Cliidae	Clio pyramidata Linnaeus, 1767
Colloniidae	Homalopoma sanguineum (Linnaeus, 1758)
Columbellidae	Amphissa acutecostata (Philippi, 1844)
Columbellidae	Columbella rustica (Linnaeus, 1758)
Columbellidae	Mitrella gervillii (Payraudeau, 1826)
Columbellidae	Mitrella scripta (Linnaeus, 1758)
Conidae	Conomurex persicus (Swainson, 1821) *
Conidae	Conus ventricosus Gmelin, 1791
Cornirostridae	Tomura depressa (Granata-Grillo, 1877)
Costellariidae	Vexillum ebenus (Lamarck, 1811)
Costellariidae	Vexillum granum (Forbes, 1844)
Costellariidae	Vexillum savignyi (Payraudeau, 1826)
Costellariidae	Vexillum tricolor (Gmelin, 1791)
Creseidae	Creseis clava (Rang, 1828)
Creseidae	Creseis virgula (Rang, 1828)
Creseidae	Styliola subula (Quoy & Gaimard, 1827)
Cylichnidae	Cylichna cylindracea (Pennant, 1777)
Cypraeidae	Erosaria spurca (Linnaeus, 1758)
Cystiscidae	Gibberula miliaria (Linnaeus, 1758)
Cystiscidae	Gibberula philippii (Monterosato, 1878)
Dendrodorididae	Dendrodoris grandiflora (Rapp, 1827)
Diaphanidae	Diaphana cretica (Forbes, 1844)
Diaphanidae	Diaphana globosa (Lovén, 1846)
Diaphanidae	Diaphana lactea (Jeffreys, 1877)
Discodoridae	Aporodoris millegrana +
Discodorididae	Peltodoris atromaculata Bergh, 1880
Discodorididae	Tayuva lilacina (Gould, 1852) *
Drilliidae	Crassopleura maravignae (Bivona Ant. in Bivona And., 1838)
Ellobiidae	Auriculinella bidentata (Montagu, 1808)
Ellobiidae	Trimusculus mammillaris (Linnaeus, 1758)
Epitoniidae	Cirsotrema cochlea (G. B. Sowerby II, 1844)
Epitoniidae	Epitonium algerianum (Weinkauff, 1866)
Epitoniidae	Epitonium celesti (Aradas, 1854)
Epitoniidae	Epitonium clathratulum (Kanmacher, 1798)
Epitoniidae	Epitonium clathrus (Linnaeus, 1758)
Epitoniidae	Epitonium muricatum (Risso, 1826)
Epitoniidae	Epitonium pulchellum (Bivona, 1832)
Epitoniidae	Epitonium turtonis (Turton, 1819)
Epitoniidae	Gyroscala lamellosa (Lamarck, 1822)
Eubranchidae	Eubranchus exiguus (Alder & Hancock, 1848)
Eubranchidae	Eubranchus farrani (Alder & Hancock, 1844)
Eulimidae	Eulima bilineata Alder, 1848
Eulimidae	Eulima glabra (da Costa, 1778)
Eulimidae	Melanella alba (da Costa, 1778)
Eulimidae	Melanella polita (Linnaeus, 1758)

Eulimidae	Melanella spiridioni (Dautzenberg & H. Fischer, 1896)
Eulimidae	Nanobalcis nana (Monterosato, 1878)
Eulimidae	Parvioris ibizenca (Nordsieck, 1968)
Eulimidae	Pelseneeria minor Koehler & Vaney, 1908
Eulimidae	Vitreolina antiflexa (Monterosato, 1884)
Eulimidae	Vitreolina curva (Monterosato, 1874)
Eulimidae	Vitreolina perminima (Jeffreys, 1883)
Eulimidae	Vitreolina philippi (de Rayneval & Ponzi, 1854)
Facelinidae	Cratena peregrina (Gmelin, 1791)
Facelinidae	Facelina bostoniensis (Couthouy, 1838)
Fasciolariidae	Aptyxis syracusanus (Linnaeus, 1758)
Fasciolariidae	Fusinus dimitrii Buzzurro & Ovalis in Buzzurro & Russo, 2007
Fasciolariidae	Fusinus patriciae Russo & Olivieri in Russo, 2013
Fasciolariidae	Fusinus pulchellus (Philippi, 1840)
Fasciolariidae	Fusinus rostratus (Olivi, 1792)
Fasciolariidae	Tarantinaea lignaria (Linnaeus, 1758)
Fionidae	Fiona pinnata (Eschscholtz, 1831)
Fissurellidae	Diodora gibberula (Lamarck, 1822)
Fissurellidae	Diodora graeca (Linnaeus, 1758)
Fissurellidae	Emarginula adriatica O. G. Costa, 1830
Fissurellidae	Emarginula huzardii Payraudeau, 1826
Fissurellidae	Emarginula octaviana Coen, 1939
Fissurellidae	Emarginula rosea Bell, 1824
Fissurellidae	Emarginula sicula J.E. Gray, 1825
Fissurellidae	Fissurella nubecula (Linnaeus, 1758)
Flabellinidae	Flabellina affinis (Gmelin, 1791)
Flabellinidae	Flabellina pedata (Montagu, 1816)
Gastropteridae	Gastropteron rubrum (Rafinesque, 1814)
Haliotidae	Haliotis tuberculata Linnaeus, 1758
Haliotidae	Haliotis tuberculata lamellosa Lamarck, 1822
Haminoeidae	Atys jeffreysi (Weinkauff, 1866)
Haminoeidae	Haminoea cyanomarginata Heller & Thompson, 1983 *
Haminoeidae	Haminoea hydatis (Linnaeus, 1758)
Haminoeidae	Haminoea orteai Talavera, Murillo & Templado, 1987
Haminoeidae	Weinkauffia turgidula (Forbes, 1844)
Hancockiidae	Hancockia uncinata (Hesse, 1872)
Horaiclavidae	Haedropleura septangularis (Montagu, 1803)
Hyalogyrinidae	Xenoskenea pellucida (Monterosato, 1874)
Hydrobiidae	Hydrobia acuta (Draparnaud, 1805)
Iravadiidae	Hyala vitrea (Montagu, 1803)
Janthinidae	Janthina janthina (Linnaeus, 1758)
Lepetellidae	Lepetella ionica F. Nordsieck, 1973
Lepetellidae	Lepetella laterocompressa (de Rayneval & Ponzi, 1854)
Lepetidae	Propilidium pertenue Jeffreys, 1882
Limacinidae	Heliconoides inflatus (d'Orbigny, 1834)
Limacinidae	Limacina trochiformis (d'Orbigny, 1834)

Littorinidae	Echinolittorina punctata (Gmelin, 1791)
Littorinidae	Melarhaphe neritoides (Linnaeus, 1758)
Lottiidae	Tectura virginea (O. F. Müller, 1776)
Mangeliidae	Bela menkhorsti van Aartsen, 1988
Mangeliidae	Bela nebula (Montagu, 1803)
Mangeliidae	Bela nuperrima (Tiberi, 1855)
Mangeliidae	Bela zenetouae (van Aartsen, 1988)
Mangeliidae	Benthomangelia macra (Watson, 1881)
Mangeliidae	Mangelia attenuata (Montagu, 1803)
Mangeliidae	Mangelia barashi (van Aartsen & Fehr-de Wal, 1978)
Mangeliidae	Mangelia costulata Risso, 1826
Mangeliidae	Mangelia multilineolata (Deshayes, 1835)
Mangeliidae	Mangelia paciniana (Calcara, 1839)
Mangeliidae	Mangelia scabrida Monterosato, 1890
Mangeliidae	Mangelia secreta (van Aartsen & Fehr-de Wal, 1978)
Mangeliidae	Mangelia stosiciana Brusina, 1869
Mangeliidae	Mangelia striolata Risso, 1826
Mangeliidae	Mangelia taeniata (Deshayes, 1835)
Mangeliidae	Mangelia tenuicosta (Brugnone, 1862)
Mangeliidae	Mangelia unifasciata (Deshayes, 1835)
Mangeliidae	Mangelia vauquelini (Payraudeau, 1826)
Mangeliidae	Obesotoma laevigata (Dall, 1871)
Mangeliidae	Sorgenfreispira brachystoma (Philippi, 1844)
Marginellidae	Granulina boucheti Gofas, 1992
Marginellidae	Granulina clandestina (Brocchi, 1814)
Marginellidae	Granulina marginata (Bivona, 1832)
Marginellidae	Volvarina mitrella (Risso, 1826)
Mathildidae	Mathilda gemmulata Semper, 1865
Mitridae	Mitra cornicula (Linnaeus, 1758)
Mitromorphidae	Mitromorpha columbellaria (Scacchi, 1836)
Mitromorphidae	Mitromorpha crenipicta (Dautzenberg, 1889)
Mitromorphidae	Mitromorpha olivoidea (Cantraine, 1835)
Mnestiidae	Ventomnestia girardi (Audouin, 1826) *
Murchisonellidae	Ebala nitidissima (Montagu, 1803)
Murchisonellidae	Ebala pointeli (de Folin, 1868)
Muricidae	Bolinus brandaris (Linnaeus, 1758)
Muricidae	Coralliophila brevis (Blainville, 1832)
Muricidae	Coralliophila meyendorffii (Calcara, 1845)
Muricidae	Coralliophila scalaris (Brocchi, 1814)
Muricidae	Dermomurex scalaroides (Blainville, 1829)
Muricidae	Ergalatax junionae Houart, 2008 *
Muricidae	Hadriania craticulata Bucquoy & Dautzenberg, 1882
Muricidae	Hexaplex trunculus (Linnaeus, 1758)
Muricidae	Muricopsis cristata (Brocchi, 1814)
Muricidae	Ocenebra erinaceus (Linnaeus, 1758)
Muricidae	Ocinebrina aciculata (Lamarck, 1822)

Muricidae	Ocinebrina edwardsii (Payraudeau, 1826)
Muricidae	Pagodula echinata (Kiener, 1840)
Muricidae	Stramonita haemastoma (Linnaeus, 1767)
Muricidae	Trophonopsis muricata (Montagu, 1803)
Muricidae	Typhinellus labiatus (de Cristofori & Jan, 1832)
Nassariidae	Nassarius gibbosulus (Linnaeus, 1758)
Nassariidae	Nassarius semistriatus (Brocchi, 1814)
Nassariidae	Tritia corniculum (Olivi, 1792)
Nassariidae	Tritia cuvierii (Payraudeau, 1826)
Nassariidae	Tritia grana (Lamarck, 1822)
Nassariidae	Tritia incrassata (Strøm, 1768)
Nassariidae	Tritia mutabilis (Linnaeus, 1758)
Nassariidae	Tritia neritea (Linnaeus, 1758)
Nassariidae	Tritia pellucida (Risso, 1826)
Nassariidae	Tritia reticulata (Linnaeus, 1758)
Nassariidae	Tritia unifasciata (Kiener, 1834)
Naticidae	Euspira catena (da Costa, 1778)
Naticidae	Euspira fusca (Blainville, 1825)
Naticidae	Euspira guilleminii (Payraudeau, 1826)
Naticidae	Euspira intricata (Donovan, 1804)
Naticidae	Euspira macilenta (Philippi, 1844)
Naticidae	Euspira nitida (Donovan, 1804)
Naticidae	Natica multipunctata Blainville, 1825
Naticidae	Naticarius hebraeus (Martyn, 1786)
Naticidae	Naticarius stercusmuscarum (Gmelin, 1791)
Naticidae	Neverita josephinia Risso, 1826
Naticidae	Notocochlis dillwynii (Payraudeau, 1826)
Naticidae	Tectonatica sagraiana (d'Orbigny, 1842)
Neritidae	Smaragdia viridis (Linnaeus, 1758)
Nystiellidae	Opaliopsis atlantis (Clench & Turner, 1952)
Omalogyridae	Ammonicera fischeriana (Monterosato, 1869)
Omalogyridae	Omalogyra atomus (Philippi, 1841)
Oxynoidae	Lobiger serradifalci (Calcara, 1840)
Oxynoidae	Oxynoe olivacea Rafinesque, 1814
Patellidae	Patella aspera Röding, 1798
Patellidae	Patella caerulea Linnaeus, 1758
Patellidae	Patella rustica Linnaeus, 1758
Patellidae	Patella ulyssiponensis Gmelin, 1791
Phasianellidae	Tricolia pullus (Linnaeus, 1758)
Phasianellidae	Tricolia speciosa (Megerle von Mühlfeld, 1824)
Phasianellidae	Tricolia tenuis (Michaud, 1829)
Philinidae	Philine catena (Montagu, 1803)
Philinidae	Philine intricata Monterosato, 1884
Philinidae	Philine punctata (J. Adams, 1800)
Philinidae	Philine quadrata (S. Wood, 1839)
Philinidae	Philine quadripartita Ascanius, 1772

Philinidae	Philine vestita (Philippi, 1840)
Piseinotecidae	Piseinotecus gabinierei (Vicente, 1975)
Plakobranchidae	Elysia gordanae Thompson & Jaklin, 1988
Plakobranchidae	Elysia timida (Risso, 1818)
Plakobranchidae	Elysia viridis (Montagu, 1804)
Plakobranchidae	Thuridilla hopei (Vérany, 1853)
Planaxidae	Fossarus ambiguus (Linnaeus, 1758)
Pleurobranchaeidae	Pleurobranchaea meckeli (Blainville, 1825)
Pleurobranchidae	Berthella ocellata (Delle Chiaje, 1830)
Pleurobranchidae	Pleurobranchus testudinarius Cantraine, 1835
Polyceridae	Kaloplocamus ramosus (Cantraine, 1835)
Potamididae	Pirenella conica (Blainville, 1829)
Proctonotidae	Janolus cristatus (Delle Chiaje, 1841)
Pseudococculinidae	Copulabyssia corrugata (Jeffreys, 1883)
Pterotracheidae	Firoloida desmarestia Lesueur, 1817
Pyramidellidae	Auristomia erjaveciana (Brusina, 1869)
Pyramidellidae	Brachystomia scalaris (MacGillivray, 1843)
Pyramidellidae	Careliopsis modesta (de Folin, 1870)
Pyramidellidae	Doliella nitens (Jeffreys, 1870)
Pyramidellidae	Eulimella scillae (Scacchi, 1835)
Pyramidellidae	Euparthenia bulinea (Lowe, 1841)
Pyramidellidae	Folinella excavata (Phillippi, 1836)
Pyramidellidae	Kejdonia cachiai (Mifsud, 1998)
Pyramidellidae	Megastomia conoidea (Brocchi, 1814)
Pyramidellidae	Odostomella doliolum (Philippi, 1844)
Pyramidellidae	Odostomia acuta Jeffreys, 1848
Pyramidellidae	Odostomia clavulina P. Fischer, 1877
Pyramidellidae	Odostomia conspicua Alder, 1850
Pyramidellidae	Odostomia kromi van Aartsen, Menkhorst & Gittenberger, 1984
Pyramidellidae	Odostomia lukisii Jeffreys, 1859
Pyramidellidae	Odostomia plicata (Montagu, 1803)
Pyramidellidae	Odostomia turriculata Monterosato, 1869
Pyramidellidae	Odostomia unidentata (Montagu, 1803)
Pyramidellidae	Ondina diaphana (Jeffreys, 1848)
Pyramidellidae	Ondina obliqua (Alder, 1844)
Pyramidellidae	Ondina vitrea (Brusina, 1866)
Pyramidellidae	Ondina warreni (Thompson, 1845)
Pyramidellidae	Parthenina alesii Micali, Nofroni & Perna, 2012
Pyramidellidae	Parthenina emaciata (Brusina, 1866)
Pyramidellidae	Parthenina flexuosa (Monterosato, 1874)
Pyramidellidae	Parthenina indistincta (Montagu, 1808)
Pyramidellidae	Parthenina interstincta (J. Adams, 1797)
Pyramidellidae	Parthenina monozona (Brusina, 1869)
Pyramidellidae	Parthenina suturalis (Philippi, 1844)
Pyramidellidae	Parthenina terebellum (Philippi, 1844)
Pyramidellidae	Pyrgiscus rufus (Philippi, 1836)

Pyramidellidae	Pyrgostylus striatulus (Linnaeus, 1758)
Pyramidellidae	Spiralinella incerta (Milaschewich, 1916)
Pyramidellidae	Spiralinella spiralis (Montagu, 1803)
Pyramidellidae	Styloptygma aciculina (Souverbie, 1865)
Pyramidellidae	Tiberia minuscula (Monterosato, 1880)
Pyramidellidae	Tibersyrnola unifasciata (Forbes, 1844)
Pyramidellidae	Trabecula jeffreysiana Monterosato, 1884
Pyramidellidae	Tragula fenestrata (Jeffreys, 1848)
Pyramidellidae	Turbonilla amoena (Monterosato, 1878)
Pyramidellidae	Turbonilla gradata Bucquoy, Dautzenberg & Dollfus, 1883
Pyramidellidae	Turbonilla hamata Nordsieck, 1972
Pyramidellidae	Turbonilla jeffreysii (Jeffreys, 1848)
Pyramidellidae	Turbonilla pusilla (Philippi, 1844)
Ranellidae	Cabestana cutacea +
Ranellidae	Charonia lampas (Linnaeus, 1758)
Ranellidae	Charonia variegata (Lamarck, 1816)
Ranellidae	Monoplex corrugatus +
Ranellidae	Monoplex parthenopeus +
Ranellidae	Ranella olearium +
Raphitomidae	Clathromangelia granum (Philippi, 1844)
Raphitomidae	Clathromangelia loiselieri Oberling, 1970
Raphitomidae	Gymnobela subaraneosa (Dautzenberg & Fischer, 1896)
Raphitomidae	Pleurotomella eurybrocha (Dautzenberg & Fischer, 1896)
Raphitomidae	Raphitoma bofilliana (Sulliotti, 1889)
Raphitomidae	Raphitoma concinna (Scacchi, 1836)
Raphitomidae	Raphitoma cordieri (Payraudeau, 1826)
Raphitomidae	Raphitoma laviae (Philippi, 1844)
Raphitomidae	Raphitoma leufroyi (Michaud, 1828)
Raphitomidae	Raphitoma linearis (Montagu, 1803)
Raphitomidae	Raphitoma philberti (Michaud, 1829)
Raphitomidae	Raphitoma pseudohystrix (Sykes, 1906)
Raphitomidae	Raphitoma purpurea (Montagu, 1803)
Raphitomidae	Teretia teres (Reeve, 1844)
Raphitomidae	Xanthodaphne dalmasi (Dautzenberg & Fischer, 1897)
Retusidae	Retusa leptoeneilema (Brusina, 1866)
Retusidae	Retusa mammillata (Philippi, 1836)
Retusidae	Retusa minutissima (Monterosato, 1878)
Retusidae	Retusa parvula (Jeffreys, 1883)
Retusidae	Retusa truncatula (Bruguière, 1792)
Retusidae	Retusa umbilicata (Montagu, 1803)
Rhizoridae	Volvulella acuminata (Bruguière, 1792)
Ringiculidae	Ringicula auriculata (Ménard de la Groye, 1811)
Ringiculidae	Ringicula conformis Monterosato, 1877
Rissoellidae	Rissoella diaphana (Alder, 1848)
Rissoellidae	Rissoella inflata (Monterosato, 1880)
Rissoidae	Alvania amatii Oliverio, 1986

Rissoidae	Alvania aspera (Philippi, 1844)
Rissoidae	Alvania beanii (Hanley in Thorpe, 1844)
Rissoidae	Alvania cancellata (da Costa, 1778)
Rissoidae	Alvania cimex (Linnaeus, 1758)
Rissoidae	Alvania cimicoides (Forbes, 1844)
Rissoidae	Alvania colossophilus Oberling, 1970
Rissoidae	Alvania discors (Allan, 1818)
Rissoidae	Alvania lactea (Michaud, 1830)
Rissoidae	Alvania lineata Risso, 1826
Rissoidae	Alvania pagodula (Bucquoy, Dautzenberg & Dollfus, 1884)
Rissoidae	Alvania punctura (Montagu, 1803)
Rissoidae	Alvania rudis (Philippi, 1844)
Rissoidae	Alvania scabra (Philippi, 1844)
Rissoidae	Alvania subcrenulata (Bucquoy, Dautzenberg & Dollfus, 1884)
Rissoidae	Alvania zetlandica (Montagu, 1815)
Rissoidae	Benthonella tenella (Jeffreys, 1869)
Rissoidae	Crisilla chiarellii (Cecalupo & Quadri, 1995)
Rissoidae	Crisilla semistriata (Montagu, 1808)
Rissoidae	Manzonia crassa (Kanmacher, 1798)
Rissoidae	Obtusella intersecta (S. Wood, 1857)
Rissoidae	Obtusella macilenta (Monterosato, 1880)
Rissoidae	Pusillina inconspicua (Alder, 1844)
Rissoidae	Pusillina lineolata (Michaud, 1830)
Rissoidae	Pusillina marginata (Michaud, 1830)
Rissoidae	Pusillina munda (Monterosato, 1884)
Rissoidae	Pusillina philippi (Aradas & Maggiore, 1844)
Rissoidae	Pusillina radiata (Philippi, 1836)
Rissoidae	Rissoa auriformis Pallary, 1904
Rissoidae	Rissoa auriscalpium (Linnaeus, 1758)
Rissoidae	Rissoa guerinii Récluz, 1843
Rissoidae	Rissoa monodonta Philippi, 1836
Rissoidae	Rissoa multicincta Smriglio & Mariottini, 1995
Rissoidae	Rissoa rodhensis Verduin, 1985
Rissoidae	Rissoa scurra (Monterosato, 1917)
Rissoidae	Rissoa similis Scacchi, 1836
Rissoidae	Rissoa variabilis (Megerle von Mühlfeld, 1824)
Rissoidae	Rissoa ventricosa Desmarest, 1814
Rissoidae	Rissoa violacea Desmarest, 1814
Rissoidae	Setia amabilis (Locard, 1886)
Rissoidae	Setia ambigua (Brugnone, 1873)
Rissoidae	Setia antipolitana (van der Linden & W. M. Wagner, 1987)
Rissoidae	Setia maculata (Monterosato, 1869)
Rissoidae	Setia pulcherrima (Jeffreys, 1848)
Rissoidae	Setia scillae (Aradas & Benoit, 1876)
Rissoidae	Setia turriculata Monterosato, 1884
Rissoinidae	Rissoina bruguieri (Payraudeau, 1826)

Rissoinidae	Rissoina reticulata (Sowerby I, 1833)
Scaphandridae	Cylichnium africanum (Locard, 1897)
Scaphandridae	Roxania pinguicula (Seguenza, 1880)
Scaphandridae	Roxania utriculus (Brocchi, 1814)
Scaphandridae	Scaphander lignarius (Linnaeus, 1758)
Scaphandridae	Scaphander punctostriatus (Mighels & Adams, 1842)
Scissurellidae	Scissurella costata d'Orbigny, 1824
Scissurellidae	Sinezona cingulata (O. G. Costa, 1861)
Scyllaeidae	Scyllaea pelagica Linnaeus, 1758
Seguenzioidea	Akritogyra conspicua (Monterosato, 1880)
Skeneidae	Dikoleps cutleriana (Clark, 1849)
Skeneidae	Dikoleps nitens (Philippi, 1844)
Skeneidae	Skeneoides exilissima (Philippi, 1844)
Skeneidae	Skeneoides jeffreysii (Monterosato, 1872)
Tethydidae	Melibe viridis (Kelaart, 1858) *
Tethydidae	Tethys fimbria Linnaeus, 1767
Tjaernoeiidae	Tjaernoeia exquisita (Jeffreys, 1883)
Tofanellidae	Graphis albida (Kanmacher, 1798)
Tonnidae	Tonna galea (Linnaeus, 1758)
Tornidae	Tornus subcarinatus (Montagu, 1803)
Triphoridae	Cheirodonta pallescens (Jeffreys, 1867)
Triphoridae	Metaxia metaxa (Delle Chiaje, 1828)
Triphoridae	Monophorus erythrosoma (Bouchet & Guillemot, 1978)
Triphoridae	Monophorus perversus (Linnaeus, 1758)
Triviidae	Erato voluta (Montagu, 1803)
Triviidae	Trivia mediterranea (Risso, 1826)
Triviidae	Trivia monacha (da Costa, 1778)
Trochidae	Clanculus corallinus (Gmelin, 1791)
Trochidae	Clanculus cruciatus (Linnaeus, 1758)
Trochidae	Clanculus jussieui (Payraudeau, 1826)
Trochidae	Clanculus miniatus (Anton, 1838)
Trochidae	Gibbula adansonii (Payraudeau, 1826)
Trochidae	Gibbula adriatica (Philippi, 1844)
Trochidae	Gibbula ardens (Salis Marschlins, 1793)
Trochidae	Gibbula divaricata (Linnaeus, 1758)
Trochidae	Gibbula fanulum (Gmelin, 1791)
Trochidae	Gibbula guttadauri (Philippi, 1836)
Trochidae	Gibbula magus (Linnaeus, 1758)
Trochidae	Gibbula philberti (Récluz, 1843)
Trochidae	Gibbula racketti (Payraudeau, 1826)
Trochidae	Gibbula rarilineata (Michaud, 1829)
Trochidae	Gibbula spratti (Forbes, 1844)
Trochidae	Gibbula turbinoides (Deshayes, 1835)
Trochidae	Gibbula umbilicaris (Linnaeus, 1758)
Trochidae	Gibbula umbilicaris nebulosa (Philippi, 1848)
Trochidae	Gibbula varia (Linnaeus, 1758)

	Trochidae	Jujubinus exasperatus (Pennant, 1777)
	Trochidae	Jujubinus gravinae (Dautzenberg, 1881)
	Trochidae	Jujubinus karpathoensis Nordsieck, 1973
	Trochidae	Jujubinus montagui (Wood, 1828)
	Trochidae	Jujubinus striatus (Linnaeus, 1758)
	Trochidae	Phorcus richardi (Payraudeau, 1826)
	Trochidae	Phorcus turbinatus (Born, 1778)
	Trochidae	Trochus erithreus Brocchi, 1821 *
	Truncatellidae	Truncatella subcylindrica (Linnaeus, 1767)
	Turbinidae	Bolma rugosa (Linnaeus, 1767)
	Turritellidae	Turritella communis Risso, 1826
	Turritellidae	Turritella terebra (Linnaeus, 1758)
	Turritellidae	Turritella triplicata (Brocchi, 1814)
	Turritellidae	Turritella turbona Monterosato, 1877
	Tylodinidae	Tylodina perversa (Gmelin, 1791)
	Umbraculidae	Umbraculum umbraculum (Lightfoot, 1786)
	Vanikoridae	Megalomphalus azoneus (Brusina, 1865)
	Vanikoridae	Megalomphalus disciformis (Granata-Grillo, 1877)
	Velutinidae	Lamellaria perspicua (Linnaeus, 1758)
	Vermetidae	Dendropoma cristatum (Biondi, 1859)
	Vermetidae	Petaloconchus glomeratus (Linnaeus, 1758)
	Vermetidae	Thylacodes arenarius (Linnaeus, 1758)
	Vermetidae	Thylaeodus semisurrectus (Bivona-Bernardi, 1832)
	Vermetidae	Vermetus triquetrus Bivona-Bernardi, 1832
	Volvatellidae	Ascobulla fragilis (Jeffreys, 1856)
Bivalvia	Anomiidae	Anomia ephippium Linnaeus, 1758
	Anomiidae	Monia patelliformis (Linnaeus, 1761)
	Arcidae	Acar clathrata (Defrance, 1816)
	Arcidae	Anadara corbuloides (Monterosato, 1878)
	Arcidae	Arca noae Linnaeus, 1758
	Arcidae	Arca tetragona Poli, 1795
	Arcidae	Asperarca nodulosa (O. F. Müller, 1776)
	Arcidae	Barbatia barbata (Linnaeus, 1758)
	Arcidae	Bathyarca pectunculoides (Scacchi, 1835)
	Arcidae	Bathyarca philippiana (Nyst, 1848)
	Astartidae	Digitaria digitaria (Linnaeus, 1758)
	Astartidae	Gonilia calliglypta (Dall, 1903)
	Cardiidae	Acanthocardia aculeata (Linnaeus, 1758)
	Cardiidae	Acanthocardia echinata (Linnaeus, 1758)
	Cardiidae	Acanthocardia paucicostata (G. B. Sowerby II, 1834)
	Cardiidae	Acanthocardia spinosa (Lightfoot, 1786)
	Cardiidae	Acanthocardia tuberculata (Linnaeus, 1758)
	Cardiidae	Cerastoderma edule (Linnaeus, 1758)
	Cardiidae	Laevicardium oblongum (Gmelin, 1791)
	Cardiidae	Papillicardium papillosum (Poli, 1791)
	Cardiidae	Parvicardium exiguum (Gmelin, 1791)

Cardiidae	Parvicardium minimum (Philippi, 1836)
Cardiidae	Parvicardium pinnulatum (Conrad, 1831)
Cardiidae	Parvicardium scabrum (Philippi, 1844)
Cardiidae	Parvicardium scriptum (Bucquoy, Dautzenberg & Dollfus, 1892)
Carditidae	Cardita calyculata (Linnaeus, 1758)
Carditidae	Cardites antiquatus (Linnaeus, 1758)
Carditidae	Centrocardita aculeata (Poli, 1795)
Carditidae	Glans trapezia (Linnaeus, 1767)
Chamidae	Chama gryphoides Linnaeus, 1758
Chamidae	Pseudochama gryphina (Lamarck, 1819)
Corbulidae	Corbula gibba (Olivi, 1792)
Corbulidae	Lentidium mediterraneum (O. G. Costa, 1830)
Cuspidariidae	Cardiomya costellata (Deshayes, 1835)
Cuspidariidae	Cuspidaria cuspidata (Olivi, 1792)
Cuspidariidae	Cuspidaria rostrata (Spengler, 1793)
Cuspidariidae	Tropidomya abbreviata (Forbes, 1843)
Donacidae	Donax semistriatus Poli, 1795
Donacidae	Donax trunculus Linnaeus, 1758
Donacidae	Donax variegatus (Gmelin, 1791)
Galeommatidae	Galeomma turtoni Turton, 1825
Gastrochaenidae	Rocellaria dubia (Pennant, 1777)
Glossidae	Glossus humanus Poli, 1795
Glycymerididae	Glycymeris glycymeris (Linnaeus, 1758)
Glycymerididae	Glycymeris nummaria (Linnaeus, 1758)
Glycymerididae	Glycymeris pilosa (Linnaeus, 1767)
Hiatellidae	Hiatella arctica (Linnaeus, 1767)
Hiatellidae	Hiatella rugosa (Linnaeus, 1767)
Kelliellidae	Kelliella miliaris (Philippi, 1844)
Kelliidae	Bornia sebetia (O. G. Costa, 1830)
Kelliidae	Kellia suborbicularis (Montagu, 1803)
Lasaeidae	Hemilepton nitidum (Turton, 1822)
Lasaeidae	Scacchia oblonga (Philippi, 1836)
Limidae	Lima lima (Linnaeus, 1758)
Limidae	Limaria hians (Gmelin, 1791)
Limidae	Limatula gwyni (Sykes, 1903)
Limidae	Limatula subauriculata (Montagu, 1808)
Limidae	Limatula subovata (Monterosato, 1875)
Limidae	Limea crassa (Forbes, 1844)
Lucinidae	Ctena decussata (O. G. Costa, 1829)
Lucinidae	Loripes orbiculatus Poli, 1791
Lucinidae	Loripinus fragilis (Philippi, 1836)
Lucinidae	Lucinella divaricata (Linnaeus, 1758)
Lucinidae	Megaxinus unguiculinus Pallary, 1904
Lucinidae	Myrtea spinifera (Montagu, 1803)
Lyonsiellidae	Allogramma formosa (Jeffreys, 1882)
Lyonsiellidae	Policordia gemma (A. E. Verrill, 1880)

Lyonsiidae	Lyonsia norwegica (Gmelin, 1791)
Mactridae	Mactra stultorum (Linnaeus, 1758)
Mactridae	Spisula subtruncata (da Costa, 1778)
Malletiidae	Malletia obtusa (Sars G. O., 1872)
Mesodesmatidae	Donacilla cornea (Poli, 1791)
Montacutidae	Kurtiella bidentata (Montagu, 1803)
Montacutidae	Montacuta substriata (Montagu, 1808)
Montacutidae	Tellimya ferruginosa (Montagu, 1808)
Myidae	Sphenia binghami Turton, 1822
Mytilidae	Brachidontes pharaonis (P. Fischer, 1870) *
Mytilidae	Dacrydium hyalinum (Monterosato, 1875)
Mytilidae	Dacrydium vitreum (Møller, 1842)
Mytilidae	Gibbomodiola adriatica (Lamarck, 1819)
Mytilidae	Idas argenteus Jeffreys, 1876
Mytilidae	Lithophaga lithophaga (Linnaeus, 1758)
Mytilidae	Modiolula phaseolina (Philippi, 1844)
Mytilidae	Modiolus barbatus (Linnaeus, 1758)
Mytilidae	Musculus costulatus (Risso, 1826)
Mytilidae	Musculus discors (Linnaeus, 1767)
Mytilidae	Musculus subpictus (Cantraine, 1835)
Mytilidae	Mytilaster minimus (Poli, 1795)
Mytilidae	Septifer cumingii Récluz, 1848 *
Neoleptonidae	Neolepton sulcatulum (Jeffreys, 1859)
Noetiidae	Striarca lactea (Linnaeus, 1758)
Nuculanidae	Lembulus pella (Linnaeus, 1767)
Nuculanidae	Saccella commutata (Philippi, 1844)
Nuculidae	Ennucula aegeensis (Forbes, 1844)
Nuculidae	Ennucula corbuloides (Seguenza, 1877)
Nuculidae	Ennucula tenuis (Montagu, 1808)
Nuculidae	Nucula hanleyi Winckworth, 1931
Nuculidae	Nucula nitidosa Winckworth, 1930
Nuculidae	Nucula nucleus (Linnaeus, 1758)
Nuculidae	Nucula sulcata Bronn, 1831
Nuculidae	Nucula turgida Gould, 1846
Ostreidae	Dendostrea cf. folium (Linnaeus, 1758) *
Pandoridae	Pandora inaequivalvis (Linnaeus, 1758)
Pandoridae	Pandora pinna (Montagu, 1803)
Pectinidae	Aequipecten opercularis (Linnaeus, 1758)
Pectinidae	Delectopecten vitreus (Gmelin, 1791)
Pectinidae	Flexopecten flexuosus (Poli, 1795)
Pectinidae	Flexopecten glaber (Linnaeus, 1758)
Pectinidae	Flexopecten hyalinus (Poli, 1795)
Pectinidae	Mimachlamys varia (Linnaeus, 1758)
Pectinidae	Palliolum incomparabile (Risso, 1826)
Pectinidae	Pecten jacobaeus (Linnaeus, 1758)
Pectinidae	Pseudamussium peslutrae (Linnaeus, 1771)

Pectinidae	Talochlamys multistriata (Poli, 1795)
Pharidae	Ensis minor (Chenu, 1843)
Pharidae	Phaxas adriaticus (Coen, 1933)
Pharidae	Phaxas pellucidus (Pennant, 1777)
Pinnidae	Atrina pectinata (Linnaeus, 1767)
Pinnidae	Pinna nobilis Linnaeus, 1758
Poromyidae	Cetomya neaeroides (Seguenza, 1877)
Poromyidae	Poromya granulata (Nyst & Westendorp, 1839)
Propeamussiidae	Cyclopecten hoskynsi (Forbes, 1844)
Propeamussiidae	Parvamussium fenestratum (Forbes, 1844)
Propeamussiidae	Similipecten similis (Laskey, 1811)
Psammobiidae	Gari costulata (Turton, 1822)
Psammobiidae	Gari depressa (Pennant, 1777)
Psammobiidae	Gari fervensis (Gmelin, 1791)
Psammobiidae	Gari tellinella (Lamarck, 1818)
Pteriidae	Pinctada imbricata radiata (Leach, 1814) *
Semelidae	Abra alba (W. Wood, 1802)
Semelidae	Abra longicallus (Scacchi, 1835)
Semelidae	Abra nitida (O. F. Müller, 1776)
Semelidae	Abra prismatica (Montagu, 1808)
Semelidae	Scrobicularia cottardii (Payraudeau, 1826)
Solecurtidae	Azorinus chamasolen (da Costa, 1778)
Solecurtidae	Solecurtus scopula (Turton, 1822)
Solemyidae	Solemya togata (Poli, 1791)
Spondylidae	Spondylus gaederopus Linnaeus, 1758
Spondylidae	Spondylus gussonii O. G. Costa, 1830
Tellinidae	Arcopagia crassa (Pennant, 1777)
Tellinidae	Arcopella balaustina (Linnaeus, 1758)
Tellinidae	Asbjornsenia pygmaea (Lovén, 1846)
Tellinidae	Atlantella pulchella (Lamarck, 1818)
Tellinidae	Bosemprella incarnata (Linnaeus, 1758)
Tellinidae	Fabulina fabula (Gmelin, 1791)
Tellinidae	Macomangulus tenuis (da Costa, 1778)
Tellinidae	Moerella donacina (Linnaeus, 1758)
Tellinidae	Oudardia compressa (Brocchi, 1814)
Tellinidae	Peronaea planata (Linnaeus, 1758)
Tellinidae	Peronidia albicans (Gmelin, 1791)
Tellinidae	Serratina serrata (Brocchi, 1814)
Thraciidae	Thracia convexa (W. Wood, 1815)
Thraciidae	Thracia corbuloidea Blainville, 1827
Thraciidae	Thracia phaseolina (Lamarck, 1818)
Thraciidae	Thracia pubescens (Pulteney, 1799)
Thyasiridae	Axinulus croulinensis (Jeffreys, 1847)
Thyasiridae	Leptaxinus Verrill & Bush, 1898
Thyasiridae	Mendicula ferruginosa (Forbes, 1844)
Thyasiridae	Mendicula oblonga (Monterosato, 1880)

	Thyasiridae	Parathyasira granulosa (Monterosato, 1874)
	Thyasiridae	Thyasira flexuosa (Montagu, 1803)
	Thyasiridae	Thyasira gouldi (Philippi, 1845)
	Ungulinidae	Diplodonta rotundata (Montagu, 1803)
	Veneridae	Callista chione (Linnaeus, 1758)
	Veneridae	Chamelea gallina (Linnaeus, 1758)
	Veneridae	Clausinella fasciata (da Costa, 1778)
	Veneridae	Clementia papyracea (Gmelin, 1791) *
	Veneridae	Dosinia lupinus (Linnaeus, 1758)
	Veneridae	Gouldia minima (Montagu, 1803)
	Veneridae	Irus irus (Linnaeus, 1758)
	Veneridae	Lajonkairia lajonkairii (Payraudeau, 1826)
	Veneridae	Pitar rudis (Poli, 1795)
	Veneridae	Polititapes aureus (Gmelin, 1791)
	Veneridae	Ruditapes decussatus (Linnaeus, 1758)
	Veneridae	Timoclea ovata (Pennant, 1777)
	Veneridae	Turtonia minuta (Fabricius, 1780)
	Veneridae	Venerupis geographica (Gmelin, 1791)
	Veneridae	Venus casina Linnaeus, 1758
	Veneridae	Venus verrucosa Linnaeus, 1758
	Verticordiidae	Mytilimeria compressa Locard, 1898
	Xylophagidae	Xylophaga dorsalis (Turton, 1819)
	Yoldiidae	Yoldiella frigida (Torell, 1859)
	Yoldiidae	Yoldiella wareni La Perna, 2004
Scaphopoda	Dentaliidae	Antalis agilis (M. Sars in G.O. Sars, 1872)
	Dentaliidae	Antalis ariannae Caprotti, 2015
	Dentaliidae	Antalis dentalis (Linnaeus, 1758)
	Dentaliidae	Antalis inaequicostata (Dautzenberg, 1891)
	Dentaliidae	Antalis rossati (Caprotti, 1966)
	Dentaliidae	Antalis vulgaris (da Costa, 1778)
	Entalinidae	Entalina tetragona (Brocchi, 1814)
	Fustiariidae	Fustiaria rubescens (Deshayes, 1825)
	Gadilidae	Cadulus jeffreysi (Monterosato, 1875)
	Gadilidae	Cadulus subfusiformis (M. Sars, 1865)
	Gadilidae	Dischides politus (S. Wood, 1842)

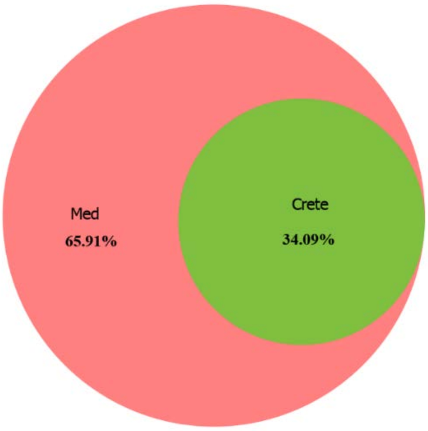


Figure 1. The Venn diagram providing information on the percentage of the Cretan malacofauna in comparison to the Mediterraean.

Figure 2 present the number of species per class that have been found around Crete island. In Figure 2, the total number of the recorder species per class in the Mediterranean Sea after Coll et al. (Coll et al., 2010) is provided for comparisons.

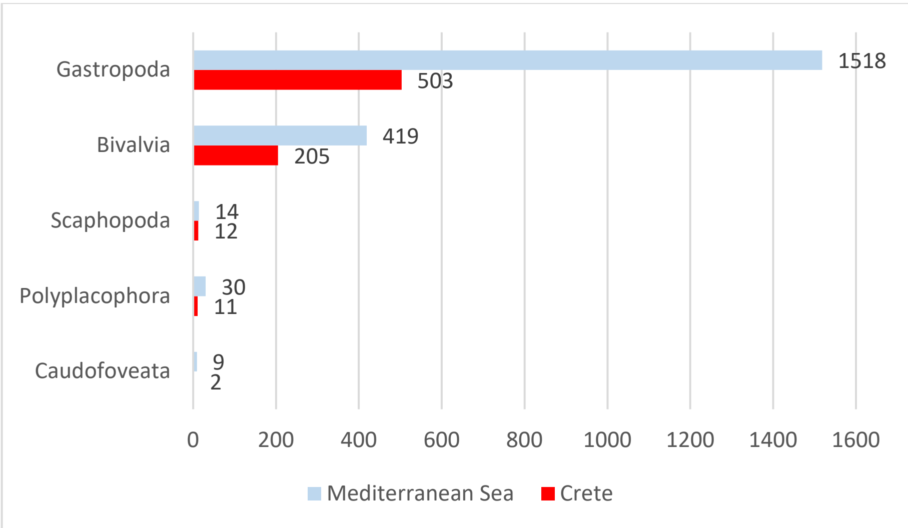


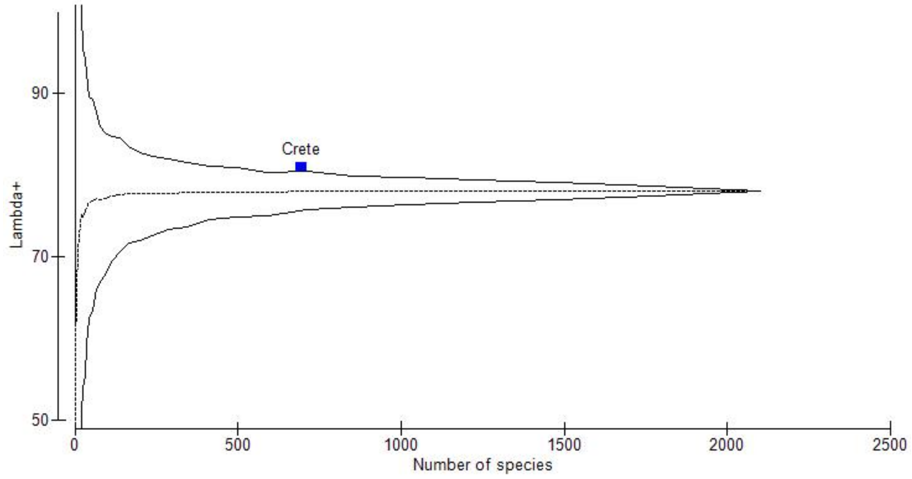
Figure 2. The number of species per class, as these have been found in the Cretan Sea.

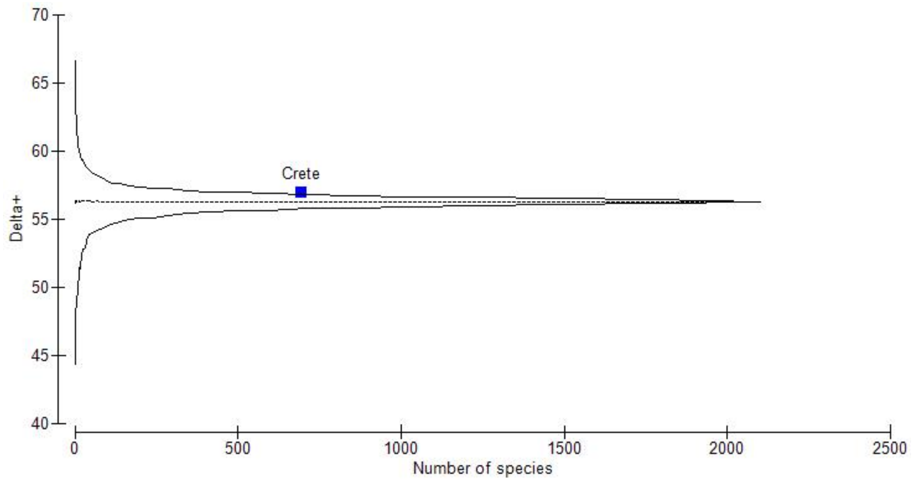
From the table 1, the prosobranch gastropods *Ranella olearium*, *Monoplex parthenopeus*, *Monoplex corrugatus*, *Cabestana cutacea* and the opisthobranchs *Chelidonura africana* and *Aporodoris millegrana* are reported for the first time from the Cretan Sea. The first 4 species belong to the family Ranellidae. *Ranella olearium* is a deep sea species, inhabiting soft substrates. It is usually collected by trammel nets in Crete and is sold by the fishermen instead of returning to the sea, something that potential can cause a decline to local populations. *Monoplex parthenopeus*, *Monoplex corrugatus*, *Cabestana cutacea* are considered as rare species in the Mediterranean Sea (Donnedu et al., 2013). In Crete, they have been collected by artisanal fisheries activities and from trammel nets from waters of 60-70 meters depth with mud-clay bottoms. *Monoplex parthenopeus* once, has been also found at 15 depth on rocky substrates close to Agia Pelagia (figure 3).

Figure 3. Apex view of *Monoplex parthenopeus* with intact periostracum.

Figure 3. Frontal view of *Monoplex parthenopeus* with live animal and intact periostracum

Chelidonura africana and *Aporodoris millegrana* are two opisthobranchs that recently have been found in Crete in 2016. The first one has been observed in Souda bay, in March crawling on soft substrate (silt/clay) at the depth of 45 meters during a scientific diving activity exploring shipwreck biodiversity. *Aporodoris millegrana* has been found during snorkelling activity in the city front of Heraklion in January, close to the Natural History Museum exhibition. The latter is stored in 96 % alcohol at the museum collection for further investigation as the family Dendrodorididae is species complex and material is difficult to be found. From the analysed literature, no information on the molluscan diversity from habitats like the photophilic macroalgae, the coralligenous bioconcretions, the seagrass meadows or the marine caves is available from Crete while few information is available from the deep sea habitats (Koutsoubas 2000, Jansen 1989). The majority of the species mentioned in the literature come from studies on the soft bottoms at the infralittoral zone or studding thanatocoenosis from beached material from areas that mixed bottoms exists. The taxonomic distinctness analysis shows that both Δ+ and Λ+ marginally fall out of the calculated funnels (figure 5 & 6).





Figures 5 & 6. The 95% confidence interval funnels, as calculated for the taxonomic distinctness indicesfunnels for the: (a) Λ+, and (b) Δ+; the expected funnel limits have been calculated based on the Mediterranean malacofaunal inventory. Superimposed, are taxonomic distinctness values calculated for Crete. Expected average is indicated by the dotted line in the middle of the funnel.

Few species that have been reported by previous works have been excluded from the present checklist mainly due to the fact that these species are considered as fossils (table 2).

Table 2. Species previously mentioned from Crete but excluded from the present checklist being incorrect information.

Class	Species	Source	Remarks
Gastropoda	*Pleurotoma clathrata*	Jeffreys 1883	FOSSIL
Gastropoda	*Pleurotoma costata*	Jeffreys 1883	FOSSIL
Scafopoda	*Siphodentalium lofotense*	Jeffreys 1883	FOSSIL
Gastropoda	*Utriculus globosis*	Jeffreys 1883	FOSSIL

Gastropoda	*Zebinella decussata*	Jeffreys 1883	FOSSIL
Gastropoda	*Cypraeolina clandestina*	Jannsen 1989	FOSSIL
Bivalvia	*Spondylus aculeatus*	Raulin 1870	FOSSIL
Bivalvia	*Ostrea plicata*	Raulin 1870	FOSSIL

It is not unusual for material from thanatocoenosis coming from deep or low circulation waters to be confused with recently dead. Experts only can distinguish them and the availability of local material from Natural History Museums or from amateur's collections for intercomparisons is a very important aspect of the marine malacology.

Discussion

The present study almost triple the recorded mollusca species from the Cretan Sea. The milestone of 1992 provide a check list of 233 species, while the present one a check list of 735 species. This is an expected situation as after 25 years, several relevant publications come out while studies focused on the malacofauna biodiversity of Crete have been done, mainly for specific group of molluscs (Crocetta et al., 2015) or by amateur collectors (Vaervet 2007, Simons 2015). As such, all these works reveal a vast new number of information highlighting the hidden marine molluscan diversity of Crete. Comparisons with the available data from the Greek Aegean (Polyplacofora: Koukouras et al., 2004, Gastropoda: Koutsoubas et al., 1993 Koutsoubas et al., 1997) the number of species reported from Crete are quite high. 11 species of Polyplacofora out of 14 and 503 species of Gastropoda in comparison to the 416 from the Aegean Sea. For the Bivalvia, the milestone work of A. Zenetos (Zenetos 1996) provide a number of 300 bivalves from Greece while our study a number of 205 species. Looking into the numbers and trying to make a comparison with the Turkish malacofauna – this from the Turkish Aegean part (review by Ozturk et al., 2014) we can see that the numbers are similar. From this region, 531 Gastropoda, 219 Bivalvia, 10 Scaphopoda, 17 Polyplacofora and 1 Caudofoveata have been reported recently. Looking to the known Mediterranean marine malacofauna (Coll et al., 2010) the recorder number of species is not low. Almost half of the Polyplacophora and Bivalvia are reported from Crete, almost all Scaphopoda (14 out of 14) and the 30% of the known Gastropoda. 2 out of 9 Caudofoveata are mentioned from Crete, indicating that targeted research is needed for some groups. Interesting is the absence of aplacofora from the region, something that has been mentioned also from other areas of the East Mediterranean like Turkey or Cyprus (Ozturk et al., 2014).

Even if such comparisons can be criticized as the studies that are used for comparisons refer to previous decades, the information that is extracted lead us to understand that the molluscan diversity of Crete is quite high in terms of number of species, despite the oligotrophic characterization that the Easter Mediterranean basin has (Psarra et al., 2000). The information coming from the 18th and 19th century is quite scattered in time with only 4 studies to provide relevant information (figure 7). After that, a quite large gap exist with new studies to start at 1958 by the pioneers of the Mediterranean benthos during the Calypso expedition (Peres & Picard 1958). The golden period for the Cretan malacofauna start at 1980 with the material by Sumner (Sumner 1981) and Dimitrakis (1987), two amateur collectors. As a follow up, the milestone work of Koutsoubas and his colleagues (Koutsoubas et al., 1992) provide the first regional species list.

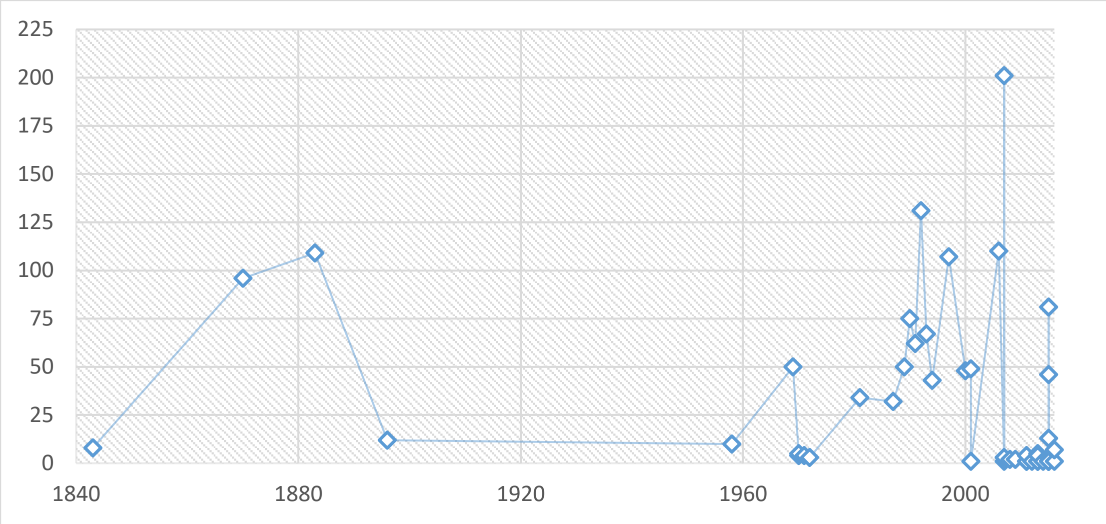


Figure 7. Number of reported species according to the year of publication.

After 1992, several new publications appear, especially during the decade of 2000 highlighting the necessity of focused studies on the molluscan diversity, ecology and seasonal dynamics in the region. As such, is the case of the work by Crocetta and his colleagues (Crocetta et al., 2015) who review and provide the regional checklist of the Opisthobranchia of Crete along with a list of the material which is deposited at the wet collection of the Natural History Museum of Crete. This work is the result of several field campaigns by the second author focused on the reveal of the opisthobranchia fauna of Crete. Also, on the collection of fresh material and the storage with proper scientific means (pure alcohol suitable for molecular analysis, controlled storage conditions, voucher codes) and availability in the official collection of the Natural History Museum of Crete in the East Mediterranean for use from any interested. This a continuous activity as Natural History Museum collections are important archives of the regional natural history and arc for the future. Unfortunately, this is not the situation for material collected during research activities from other research bodies of Crete. Special focus has been on the investigation of the marine Invasive Alien Species (IAS) that occur in Crete. Crete is situated in the margins of the Levantine basin and potentially could be a stepping stone for a western distribution of IAS. During a COST mission by Fabio Crocetta (Crocetta 2015) accompanied by the first author, a total number of 16 alien molluscs has been catalogued after the investigation of 36 coastal locations around Crete (figure 8). No new species has been found so far from what has been published except from one bivalve (*Clementia papyracea*) for which, material has been collected from two locations back in 1985 (Crocetta et al., 2016). From this mission what has come out is the abundance of 3 bivalves (*Pinctada imbricata radiata*, *Dendostrea cf. folium* and *Septifer cumingii*) and 1 gastropod (*Conomurex persicus*) almost on any coastal habitat that has been investigated (figure 6). Interesting is the fact that the bivalves, even if exists on natural habitats, when shallow artificial substrates exists, the abundance on them are higher that on the natural. Also, when enclosed areas exist, like Elounda gulf, high popoulation density exist (figure 9).The opposite situation is for the gastropod who prefer soft bottoms and waters of 5 meters and deeper.

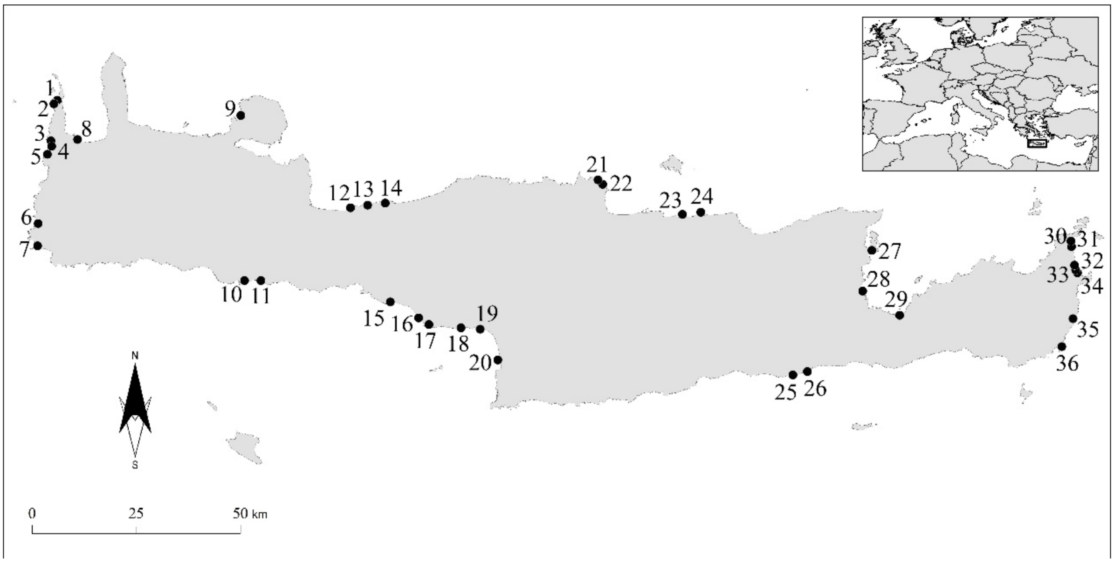


Figure 8. The explored coastal locations for IAS during 2015.

Figure 9. *Pinctada imbricata radiata* from Elounda bay.

From 1844 to day, almost no quantitative work has been done in order to investigate the molluscan diversity from habitats like the photophilic macroalgae, the coralligenous formations, seagrass meadows or the underwater caves. Some of the studies provide qualitative information related to some species from precoralligenous or coralligenous habitats (Ledoyer 1969) but in principles, no study has been up to day. For the molluscan diversity of the photophilic macroalgae, recently (2007) the NaGISA initiative has been established in the Mediterranean Sea and the photophilic macroalgae is the habitat that will be investigated under a specific protocol. For the coralligenous formations, this habitat in Crete exist, but deeper than usuall. In the Western Mediterranean coralligenous formations start from 15 meters while in Crete this could reach depths of 35-40 m for solid and concrete coralligenous. This is caused by the clarity of the water column and the penetration of the light to deeper waters; light is the limiting factor for the existence of coralligenous (Ballesteros et al., 2006). In depths like the mentioned, the logistics, the special diving training and equipment and the small time window that divers have are the three main factors that have prevent the research centers for quantitative studies. Similar is also the situation for the marine underwater caves. The absence of information from these habitats could the reason the Cretan malacofauna to be out of the expected funnels that have been calculated from the entire Mediterranean malacofauna. According to the published and new data, 735 species have been reported from Crete. This the 34% of the total Mediterranean Marine malacofauna excluding Pteropoda (Thecosomata and Gymnosomata) (Templado and Villanueva in Coll et al., 2010). Taxonomy is unresolved for several species listed in Coll et al. (2010), and a future perspective may be to homogenize the huge quantity of data provided by single countries or specific research groups. Even if our species numbers are numerically in agreement with those reported from nearby eastern Mediterranean countries a higher number of molluscan species is clearly expected from Crete, including at least those recorded from other eastern Mediterranean countries, hopefully with focused biodiversity targeted research. Special focus has to be on the understudied habitats, from which new species will come out for the local marine biodiversity. The present data, in Darwin Core format and Microsoft Access format are available from PANGAEA. These data can be used in regional biodiversity assesments, in maritime spatial planning – at least for the data that spatial information can be retreaved from the sources as well as for any corrections, notes and ammendments that other experts can find in this work– if any, is welcome for fruitfull discussion.The present paper constitutes an important step when providing large-scale and well-defined Mediterranean molluscan distributional patterns, while emphasizes the necessity of more intensive studies of the molluscan communities in the area. The future will show if this will hold true, or not.

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Biodiversity of sea slugs and shelled relatives (Mollusca: Gastropoda) of the Cretan Archipelago (Greece), with taxonomic remarks on selected species

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ABSTRACT

To date, the knowledge of the biodiversity of Cretan Archipelago sea slugs and shelled relatives is poor in comparison to other parts of the Greek seas and to the Mediterranean Sea in general. Based on an extensive review of literature data, complemented by recent field observations, we provide an updated checklist of 81 taxa from the Cretan Archipelago, 11 of which constitute new records. Careful attention has been given to molluscan species described from the area (four taxa, two of which valid), as well as to doubtful records (five taxa). Finally, taxonomic remarks are offered for *Bulla vestita* Philippi, 1840, *Cylichna parvula* Jeffreys, 1883 and *Bulla girardi* Audouin, 1826. *B. vestita* has priority over *Bulla retifer* Forbes, 1844, that is definitively considered a junior synonym of the former. *C. parvula* is redescribed, changed of family (from Cylichnidae H. Adams & A. Adams, 1854 to Retusidae Thiele, 1925), first moved to the genus *Retusa* T. Brown, 1827 and compared with similar congeneric species. Within this framework, we also figure a syntype of *Cylichna laevisculpta* Granata-Grillo, 1877 for the first time. Finally, the attribution of *B. girardi* to the genus *Ventomnestia* Iredale, 1936 is discussed and its establishment status in Greece is re-evaluated. The present paper lays the foundations to extend local studies on sea slugs and shelled relatives and fills some expected gaps in the Mediterranean distribution of several taxa. It therefore constitutes a mandatory step when providing large-scale and well-defined Mediterranean molluscan distributional patterns, and emphasizes the necessity of more intensive studies of the molluscan communities in the area.

1. Introduction

Crete is the largest island of Greece and one of the biggest islands of the Mediterranean, counting more than 1046 km of coastline including that of the surrounding islands (Alexandrakis, 2014). Crete has an elongated shape and spans approximately 260 km from east to west, while the vertical axis of the island varies between 60 and 12 km (in the region close to Ierapetra). It is bordered by several small islands, most of which are uninhabited, including Dia (north, close to Heraklion), Gavdos (southwest), the southernmost island of Europe, and Chrysi and Koufonisia (southeast) (see Fig. 1). Crete lies approximately 160 km south of the Greek mainland, in the eastern part of the Mediterranean basin, a highly oligotrophic region in terms of both primary productivity and chlorophyll *a* concentrations (Psarra et al., 2000). To the north is the Cretan Sea, to the south the Libyan Sea, in the west the Myrtoan Sea, and toward the east the Karpathion Sea (Koutsoubas et al., 2000). The Cretan Sea comprises the major part of the South Aegean Sea, and is considered as a separate subsystem of the Eastern Mediterranean due to the geomorphological, hydrographic and climatic diversities, the high evaporation, and the fauna. It is also the largest and deepest basin in the southern Aegean Sea, with an average depth of ~1000 m and two deeper troughs in the eastern part (2561 and 2295 m). It is linked with the Levantine basin and the Ionian Sea through the eastern and western straits of the Cretan Arc, respectively, via sills that are no deeper than 700 m (Tselepides et al., 2000). Even if the Cretan Sea has unique characteristics, its fauna is still one of the least studied in the area: moreover, the majority of the available data comes from research

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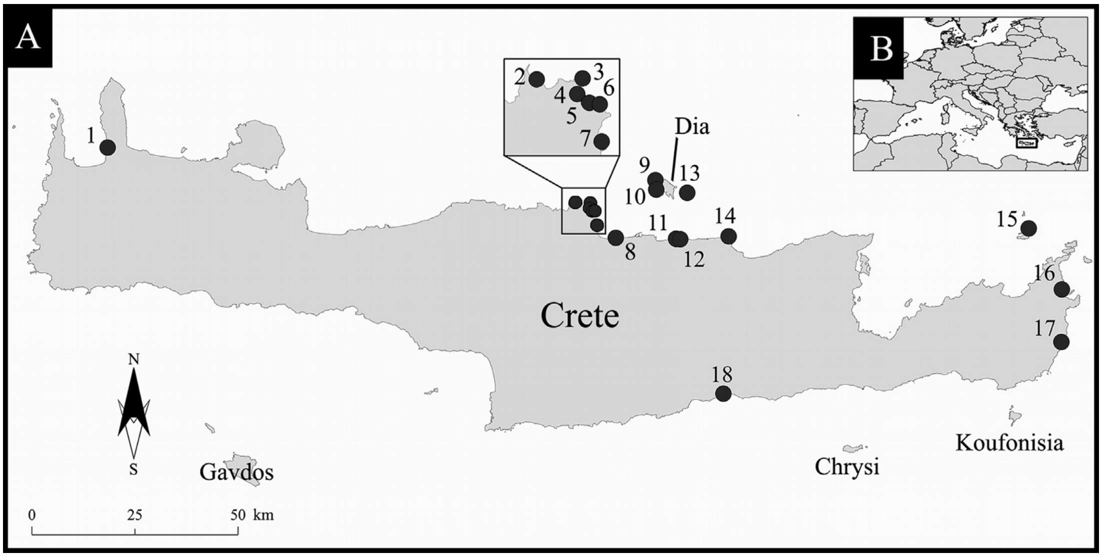

Fig. 1. The Cretan Archipelago (Greece). **A**. Map of the sampling sites (numbers corresponding to the localities reported in Table 1). **B**. The Mediterranean Sea, with location of Crete.

on the continental shelf rather than from coastal habitats, highly affected by human activities (Koutsoubas et al., 2000). This holds true even for molluscan fauna, although the Mollusca are a 'popular' and thus frequently-investigated group.

Within the formal/informal divisions in the phylum Mollusca, the taxon Opisthobranchia has become obsolete (Wägele et al., 2014), and taxa historically assigned to opisthobranchs are now referred to as sea slugs (included in the much larger Heterobranchia). Information on sea slug molluscs, and their shelled relatives, of the eastern Mediterranean is poor with respect to the western part, and, despite some authors having provided information on sea slugs of the Greek seas (e.g. Koutsoubas and Koukouras, 1993; Koutsoubas et al., 1993), our current knowledge on the "opisthobranch" fauna of Cretan Archipelago is poorly known and very far from exhaustive, with a few exceptions (e.g. alien species). Records are currently scattered in several indexed and non-indexed papers (see Table 2 for the detailed list).

This study first aims to provide new data and information about sea slugs and shelled relatives that have been recently collected and photographed alive in various sites of the Cretan Archipelago, along with details on their distribution and habitat, and contributes to a better understanding of the local biodiversity. Moreover, it collates and reviews, when possible, all the known records of "opisthobranch" species from the Cretan Archipelago, providing an accurate check list of the species living in the area and paying careful attention to molluscan species described from local material. Taxonomic remarks are offered for *Cylichna parvula* Jeffreys, 1883, a native species described from Crete and assigned to the genus *Retusa* T. Brown, 1827 (Family Retusidae Thiele, 1925), *Bulla vestita* Philippi, 1840, here considered senior synonym of *Bulla retifer* Forbes, 1844, and *Bulla girardi* Audouin, 1826, an alien species whose attribution to the genus *Ventomnestia* Iredale, 1936 (unassigned family) and establishment status in Greece are discussed.

2. Materials and methods

2.1. Abbreviations and acronyms

The following abbreviations and acronyms were used: coll – collection/s; CS – Christoffer Schander, University of Bergen (Norway); fms – fathoms; frg – fragment/s; IN – Italo Nofroni, Roma (Italy); KN – Kety Nicolay, Roma (Italy); LPT – Lionello Paolo Tringali, Roma (Italy); m – meter/s; LSL – The Linnean Society of London (U.K.); MO – Marco Oliverio, Università di Roma La Sapienza (Italy); MNHN - Muséum National d'Histoire Naturelle, Paris (France); MTRS – Monterosato collection – Museo Civico di Zoologia, Roma (Italy); NHMC – Natural History Museum of Crete (Greece); RR – Ruggero Ruggeri, Roma (Italy); RV – Raimondo Villa, Anguillara Sabazia – Roma (Italy); sh – shell/s; spm – specimen/s; SR - Stefano Rufini, Università di Roma 2 – Tor Vergata (Italy); USNM – United States National Museum, Washington (U.S.A.); WS – Willi Segers, Aartselaar (Belgium); ZMR – Museo Civico di Zoologia, Roma (Italy).

2.2. Bibliographic data

Published records of sea slugs were searched both in indexed and grey literature (i.e. non peer-reviewed and/or non-indexed papers): most of the historical journals are not indexed, and malacological records are still being published in non-indexed journals. Bibliographic data were critically analysed and taxonomically updated to the latest nomenclature available. In addition, the availability of all taxon names introduced from the area has been checked.

2.3. Crete sea slugs: sampling, laboratory work, updated taxonomy and nomenclature

Eighteen sampling localities were sampled from 2008 to 2012 primarily by hand collection during snorkelling and SCUBA diving in daylight hours only, from the intertidal to a maximum depth of 40 m (Table 1; Fig. 1). All the "opisthobranch" specimens were manually captured, measured and photographed *in situ*, then placed in plastic jars and brought to laboratories for examination. They were finally stored in 100% ethanol and deposited in the collection of the NHMC. Updated taxonomy and nomenclature used follow World Register of Marine Species (WoRMS), unless clearly specified (see below the two species listed in "Taxonomical Remarks").

2.4. Taxonomical remarks on selected species

Taxonomical remarks are provided for selected species. Material from several European sampling localities was used for

Table 1
Sampling sites (numbers as in Fig. 1) and geographic coordinates in WGS 84.

N	Location	X	Y
1	Rodopou beach	35,5398	23,7263
2	Blue Cave (Agia Pelagia)	35,42	24,9798
3	Mononaftis	35,4183	25,0219
4	Agia Pelagia	35,4064	25,0194
5	Lygaria	35,399832	25,027
6	Mades	35,4006	25,0341
7	Palaiokastro	35,3674	25,0396
8	Ammoudara	35,3383	25,0883
9	Dia Island 1	35,4631	25,1905
10	Dia Island 2	35,442584	25,19238
11	Kokkini Chani	35,334	25,2444
12	Arina Reef	35,3345	25,2437
13	Petalidi Island	35,434663	25,274868
14	Royal Mare Annisaras	35,3383	25,3841
15	Dionysades Islands	35,3438	26,1849
16	Kouremenos	35,2091	26,2693
17	Kato Zakros	35,0946	26,265
18	Keratokambos	34,9952	25,3643

comparison, and was listed under each taxon in the systematics section of the paper. Gizzard plates were mechanically extracted from rehydrated specimens and subsequently air-dried and mounted on SEM stubs. Shells and gizzard plates were either gold-palladium coated or left uncoated for SEM examination with a Philips XL30.

3. Results

3.1. Bibliographic data

The literature analysis revealed records of 70 sea slugs and shelled relatives from the Cretan Archipelago (belonging to 30 families), distributed in 30 published articles and 2 “opisthobranch”-targeted websites (see Table 2 and references therein). Only four taxa were originally introduced from Crete: *Bulla striatula* and *Bulla cretica* by Forbes (1844), *Cylichna parvula* by Jeffreys (1883), and *Retusa icarae* by Oberling (1970). Two of them are now considered junior synonyms: in particular, *Bulla striatula* Forbes, 1844 is now a junior synonym of *Retusa mammillata* (Philippi, 1836), whilst *Retusa icarae* Oberling, 1970 was originally introduced as a valid species, although only one year later the same author considered it a subspecies (with dubious validity) of *Retusa leptoeneilema* (Brusina, 1866) (as *Retusa leptoneilema* sous-esp. *icarae* Oberl.: see Oberling, 1971). The type material of *R. icarae* is currently lost (NMBE – LPT, personal observation), but we are also inclined to consider it a junior synonym of *R. leptoeneilema*. On the contrary, both *Cylichna parvula* Jeffreys, 1883 and *Bulla cretica* Forbes, 1844 are still valid. *C. parvula* is here moved to the family Retusidae Thiele, 1925 and the genus *Retusa* T. Brown, 1827 (see below in “Taxonomical remarks”), whilst the latter is currently ascribed to the genus *Diaphana* T. Brown, 1827 [*Diaphana cretica* (Forbes, 1844)]. Records of five species were considered doubtful and are marked with an asterisk in Table 2. These are: *i) Diaphana globosa* (Lovén, 1846), reported from Crete by Jeffreys (1883). It has been originally described from Norway and is currently known with certainty from the Atlantic Ocean only (Schiøtte, 1998; Ohnheiser and Malaquias, 2014); *ii) Cylichnium africanum* (Locard, 1897), first reported from the Mediterranean based on 4 specimens from Crete deepwaters (Janssen, 1989). This species was described from north-west African shores and is widely distributed in the Atlantic Ocean (Bouchet, 1975). There have been no subsequent records after Janssen (1989) from the Mediterranean basin; *iii) Roxania pinguicula* (G. Seguenza, 1880), recorded from Crete by Janssen (1989). It was described as a Pleistocene fossil from Italy (see Seguenza, 1880), and is widely distributed in the Atlantic Ocean (Cervera et al., 2004; García and Bertsch, 2009; Rosenberg et al., 2009). No confirmed records of living specimens are known from the Mediterranean; *iv) Scaphander punctostriatus* (Mighels and C.B. Adams, 1842), recorded from Crete by both Jeffreys (1883) and Janssen (1989). It was described from Maine (USA) and is well known from the Atlantic (Eilertsen and Malaquias, 2013), but no records of living specimens are known with certainty from the entire Mediterranean; *v) Haminoea orteai* P. Talavera, Murillo and Templado, 1987, described from Murcia (Spain, western Mediterranean) (see Talavera et al., 1987) and reported from local shell grit by Vervaet (2007). No confirmed Mediterranean records of this species exist outside the Spanish coasts, and therefore its presence in Crete should be confirmed by a careful re-analysis of the material recorded, if not by living specimens.

3.2. New records

Altogether, we report unpublished records belonging to 24 taxa (Supplementary Material 1). Eleven of these constitute new records from the area (Table 2; Fig. 2). Eight species (belonging to eight families) were identified with certainty up to species level: *Tylodina perversa* (Gmelin, 1791), *Aplysia fasciata* Poiret, 1789, *Berthella ocellata* (Delle Chiaje, 1830), *Felimida luteorosea* (Rapp, 1827), *Hancockia uncinata* (Hesse, 1872), *Scyllaea pelagica* Linnaeus, 1758, *Spurilla neapolitana* (Delle Chiaje, 1841) and *Fiona pinnata* (Eschscholtz, 1831). Three taxa were respectively: *i)* doubtfully identified as *Aplysia parvula* Mörch, 1863, due to the taxonomic status of Mediterranean specimens identified as such [as well as their relationships with *Aplysia punctata* (Cuvier, 1803)], the possibly correct binomial name to be used and its Mediterranan spreading pattern [if they really belong to the *A. parvula* complex] (see recent discussions in Zenetos et al., 2010; Crocetta, 2012; amongst others); *ii)* listed as *Tayuva lilacina* (Gould, 1852) complex, after Dayrat (2010, 2011) and until a phylogeographic study of this group based on molecular markers clarifies the taxonomic status of the species involved; *iii)* reported by genus only (as *Doto* sp.), pending a general and comprehensive taxonomical review of the genus in the Northeastern Atlantic–Mediterranean. Despite the number of articles covering the taxonomy of the Atlantic–Mediterranean species of the genus *Doto* Oken, 1815 (e.g. Ortea and Urgorri, 1978; Picton and Brown, 1981; Thompson et al., 1990; Morrow et al., 1992), with 36 accepted species and several synonyms (CLEMAM, 2014), as well as the description of new species up to recently (e.g. Ortea and Bouchet, 1989; Ortea et al., 2010), a general and comprehensive taxonomical review of the group is mandatory, including the establishment of objective diagnostic characters coupled with molecular data.

3.3. Taxonomic remarks

Class GASTROPODA Cuvier, 1795
Order CEPHALASPIDEA P. Fischer, 1883
Family PHILINIDAE J.E. Gray, 1850
Genus *Philine* Ascanius, 1772
Philine vestita (Philippi, 1840)

Remarks: nomenclatural issues – So far it was unclear whether Forbes (1844), who instituted *Bulla retifer*, or Philippi (1844), who instituted *Bulla vestita*, has priority as author of this minute philinid species. Despite the type material of both species was broken or lost (Van Der Linden, 1995), the original descriptions of both species leave no doubts on their conspecificity. Of the two binomial names mentioned before, *Philine retifera* (Forbes, 1844) has been commonly used in the recent literature. Furthermore, Ohnheiser and Malaquias (2013) stated that Forbes' publication is a report from 1843 and was therefore probably published

Table 2
Checklist of sea-slugs and shelled relatives of the Cretan Archipelago (Greece). Doubtful records are emphasized and marked with an asterisk. Aliens, possible aliens and cryptogenic species are marked in bold. Abbreviations used: N – Notes and new records [see "New records" (R) and "Taxonomical Remarks" (T)]; References – R1: Forbes, 1844; R2: Jeffreys, 1883; R3: Ledoyer, 1969; R4: Oberling, 1970; R5: Oberling, 1971; R6: Dimitrakis, 1987; R7: Janssen, 1989; R8: Eleftheriou et al., 1990; R9: Barash and Zenziper, 1991; R10: Koutsoubas et al., 1992; R11: van Aartsen, 1993; R12: Siakavara, 1994; R13: Cosenza and Fasulo, 1997; R14: Koutsoubas et al., 2000; R15: Coggan et al., 2001; R16: Oliverio and Tringali, 2001; R17: Tringali, 2001; R18: Tringali and Oliverio, 2001; R19: Sarneel, 2002a; R20: Sarneel, 2002b; R21: Andersson, 2006; R22: Corso, 2006; R23: Koulouri et al., 2006; R24: Anderson, 2007; R25: Daskos and Zenetos, 2007; R26: Vervaet, 2007; R27: Poursanidis, 2008; R28: Poddubetskaia Ossokine, 2009; R29: Poursanidis et al., 2009a; R30: Poursanidis et al., 2009b; R31: Glampedakis, 2011; R32: Poursanidis, 2011; R33: Crocetta and Galil, 2012; R34: Poursanidis and Koutsogiannopoulos in Bilecenoglu et al. (2013); R35: Valdés et al., 2013; R36: Zenetos et al., 2013; R37: Poursanidis and Koutsoubas, 2015; R38: Crocetta and Tringali, 2015.

Taxa	Records	N
Family ACTEONIDAE d'Orbigny, 1843		
Acteon tornatilis (Linnaeus, 1758)	R10, R14, R23	
Crenilabium exile (Jeffreys, 1870)	R7, R10, R14	
Japonactaeon pusillus (MacGillivray, 1843)	R7, R10	
Family RINGICULIDAE Philippi, 1853		
Ringicula auriculata (Ménard de la Groye, 1811)	R2, R14	
Ringicula conformis Monterosato, 1877	R9, R23	
Family DIAPHANIDAE Odhner, 1914		
Diaphana lactea (Jeffreys, 1877)	R7	
Diaphana cretica (Forbes, 1844)	R1	
* *Diaphana globosa* (Lovén, 1846)	R2	
Family BULLIDAE Gray, 1827		
Bulla striata Bruguière, 1792	R2, R6, R12, R26	
Family HAMINOEIDAE Pilsbry, 1895		
Atys jeffreysi (Weinkauff, 1866)	R2, R10, R14, R23	
* *Cylichnium africanum* (Locard, 1897)	R7	
***Haminoea cyanomarginata* Heller & Thompson, 1983**	R22, R29	
Haminoea hydatis (Linnaeus, 1758)	R10	
* *Haminoea orteai* P. Talavera, Murillo & Templado, 1987	R26	
Weinkauffia turgidula (Forbes, 1844)	R10, R14	
Unassigned family		
***Ventomnestia girardi* (Audouin, 1826)**	R13	T
Family PHILINIDAE J.E. Gray, 1850		
Philine catena (Montagu, 1803)	R3, R8, R10, R14	
Philine intricata Monterosato, 1884	R17	
Philine punctata (J. Adams, 1800)	R11	
Philine quadrata (S. Wood, 1839)	R2	
Philine quadripartita Ascanius, 1772	R13, R14, R23	
Philine vestita (Philippi, 1840)	R8	T
Family AGLAJIDAE Pilsbry, 1895		
Philinopsis depicta (Renier, 1807)	R28	
Family CYLICHNIDAE H. Adams & A. Adams, 1854		
Cylichna cylindracea (Pennant, 1777)	R11, R14, R26	
Family SCAPHANDRIDAE G.O. Sars, 1878		
* *Roxania pinguicula* (G. Seguenza, 1880)	R7	
Roxania utriculus (Brocchi, 1814)	R10	
Scaphander lignarius (Linnaeus, 1758)	R2, R14, R15	
* *Scaphander punctostriatus* (Mighels & C.B. Adams, 1842)	R2, R7	
Family GASTROPTERIDAE Swainson, 1840		
Gastropteron rubrum (Rafinesque, 1814)	R14	
Family RETUSIDAE Thiele, 1925		
Retusa leptoeneilema (Brusina, 1866)	R4, R5, R13	
Retusa mammillata (Philippi, 1836)	R1, R14, R26	
Retusa minutissima (Monterosato, 1878)	R16, R38	
Retusa parvula (Jeffreys, 1883)	R2	T
Retusa truncatula (Bruguière, 1792)	R3, R9, R10, R14, R23, R26	
Retusa umbilicata (Montagu, 1803)	R10	
Family RHIZORIDAE Dell, 1952		
Volvulella acuminata (Bruguière, 1792)	R10, R23	
Family OXYNOIDAE Stoliczka, 1868		
Lobiger serradifalci (Calcara, 1840)	R23	
Oxynoe olivacea Rafinesque, 1814	R23	
Family VOLVATELLIDAE Pilsbry, 1895		
Ascobulla fragilis (Jeffreys, 1856)	R8, R10, R12, R14, R23	
Family PLAKOBRANCHIDAE Gray, 1840		
Elysia gordanae Thompson & Jaklin, 1988	R37	
Elysia timida (Risso, 1818)	R29, R32	
Elysia viridis (Montagu, 1804)	R28	
Thuridilla hopei (Vérany, 1853)	R29, R32	
Family UMBRACULIDAE Dall, 1889		
Umbraculum umbraculum (Lightfoot, 1786)	R15, R29	
Family TYLODINIDAE J.E. Gray, 1847		
Tylodina perversa (Gmelin, 1791)		R
Family AKERIDAE Mazzarelli, 1891		
Akera bullata O.F. Müller, 1776	R26	

(*continued on next page*)

Table 2 (*continued*)

Taxa	Records	N
Family APLYSIIDAE Lamarck, 1809		
***Aplysia dactylomela* Rang, 1828**	R21, R22, R29, R33, R35, R36	
Aplysia depilans Gmelin, 1791	R29	
Aplysia fasciata Poiret, 1789		R
***Aplysia parvula* Mörch, 1863**		R
Aplysia punctata (Cuvier, 1803)	R3, R10, R29	
***Bursatella leachii* Blainville, 1817**	R25, R29	
Petalifera petalifera (Rang, 1828)	R23	
Family PLEUROBRANCHIDAE J.E. Gray, 1827		
Berthella ocellata (Delle Chiaje, 1830)		R
Pleurobranchus testudinarius Cantraine, 1835	R30	
Family PLEUROBRANCHAEIDAE Pilsbry, 1896		
Pleurobranchaea meckeli (Blainville, 1825)	R14, R15	
Family DISCODORIDIDAE Bergh, 1891		
Peltodoris atromaculata Bergh, 1880	R19, R29	
***Tayuva lilacina* (Gould, 1852) complex**		R
Family CHROMODORIDIDAE Bergh, 1891		
Felimare orsinii (Vérany, 1846)	R29	
Felimare picta (Schultz in Philippi, 1836)	R18, R29, R32	
Felimare tricolor (Cantraine, 1835)	R32	
Felimare villafranca (Risso, 1818)	R29	
Felimida britoi (Ortea & Pérez, 1983)	R33	
Felimida luteorosea (Rapp, 1827)		R
Family DENDRODORIDIDAE O'Donoghue, 1924		
Dendrodoris grandiflora (Rapp, 1827)	R27, R29	
Family POLYCERIDAE Alder & Hancock, 1845		
Kaloplocamus ramosus (Cantraine, 1835)	R14, R15	
Family HANCOCKIIDAE MacFarland, 1923		
Hancockia uncinata (Hesse, 1872)		R
Family SCYLLAEIDAE Alder & Hancock, 1855		
Scyllaea pelagica Linnaeus, 1758		R
Family TETHYDIDAE Rafinesque, 1815		
***Melibe viridis* (Kelaart, 1858)**	R36	
Tethys fimbria Linnaeus, 1767	R15	
Family DOTIDAE J.E. Gray, 1853		
Doto sp.		R
Family PROCTONOTIDAE J.E. Gray, 1853		
Janolus cristatus (Delle Chiaje, 1841)	R29, R30	
Family AEOLIDIIDAE J.E. Gray, 1827		
Spurilla neapolitana (Delle Chiaje, 1841)		R
Family FACELINIDAE Bergh, 1889		
Cratena peregrina (Gmelin, 1791)	R29	
Facelina bostoniensis (Couthouy, 1838)	R31	
Family PISEINOTECIDAE Edmunds, 1970		
Piseinotecus gabinierei (Vicente, 1975)	R29, R32	
Family FLABELLINIDAE Bergh, 1889		
Flabellina affinis (Gmelin, 1791)	R29	
Flabellina pedata (Montagu, 1815)	R29	
Family FIONIDAE J.E. Gray, 1857		
Fiona pinnata (Eschscholtz, 1831)		R
Family EUBRANCHIDAE Odhner, 1934		
Eubranchus exiguus (Alder & Hancock, 1848)	R23	
Eubranchus farrani (Alder & Hancock, 1844)	R23	

earlier than Philippi's work. However, more than a decade ago, Palazzi (2002: unpublished) pointed out the presence of an overlooked article (Philippi, 1840) where this and other taxa were first established (rather than in the well known book of 1844). It was published on a local Italian journal and constituted by a letter from Rudolph Amandus Philippi to Andrea Aradas, definitively published under the care of the latter. Our bibliographic research has confirmed Palazzi (2002: unpublished) statements. Due to the unavailability of the mentioned article in the common internet sources, it is hereby attached as supplementary material (see Supplementary Material 2). This therefore suggests that 1840, and not 1844, is the correct year of institution of *Bulla vestita* and that *Bulla retifer* Forbes 1844 has to be considered a junior synonym of the former. The same holds for *Rissoa coronata* Scacchi in Philippi, 1840 with respect to *Scalaria hellenica* Forbes, 1844. This also modifies the publication dates of three further molluscan and one brachiopod species, two of which are well known species (*Fusinus pulchellus* – MOLLUSCA and *Platidia anomioides* – BRACHIOPODA).

Class GASTROPODA Cuvier, 1795
Order CEPHALASPIDEA P. Fischer, 1883
Family RETUSIDAE Thiele, 1925
Genus *Retusa* T. Brown, 1827
Retusa parvula (Jeffreys, 1883) *comb. nov*.
(Fig. 3A–G)

Material examined – Type material: Crete Island (Greece, Aegean Sea), 4 sh (syntypes) originally glued on black paper, labelled by Jeffreys on the box cover (Fig. 3C–D) (MTRS box 16084). **Note:** the large number of syntypes deposited in USNM (see Warén, 1980) has not been examined. **Additional material:** Fossa di Roseto (off Roseto degli Abruzzi, Italy), 100–120 m, 3 sh (IN coll); Southern Adriatic Sea, 215 m, 2 sh (LPT coll); Taranto (Italy), unrecorded depth, 8 sh (C. Praus-Franceschini *legit*, MTRS box 16135); Golfo di Napoli (Italy), several hundreds of sh/spm (Tiberi coll, MTRS box 16136); Sorrento (Napoli, Italy), 80 m, 8 sh (SR coll.); off Fiumicino (Roma, Italy) several hundreds of sh/spm from

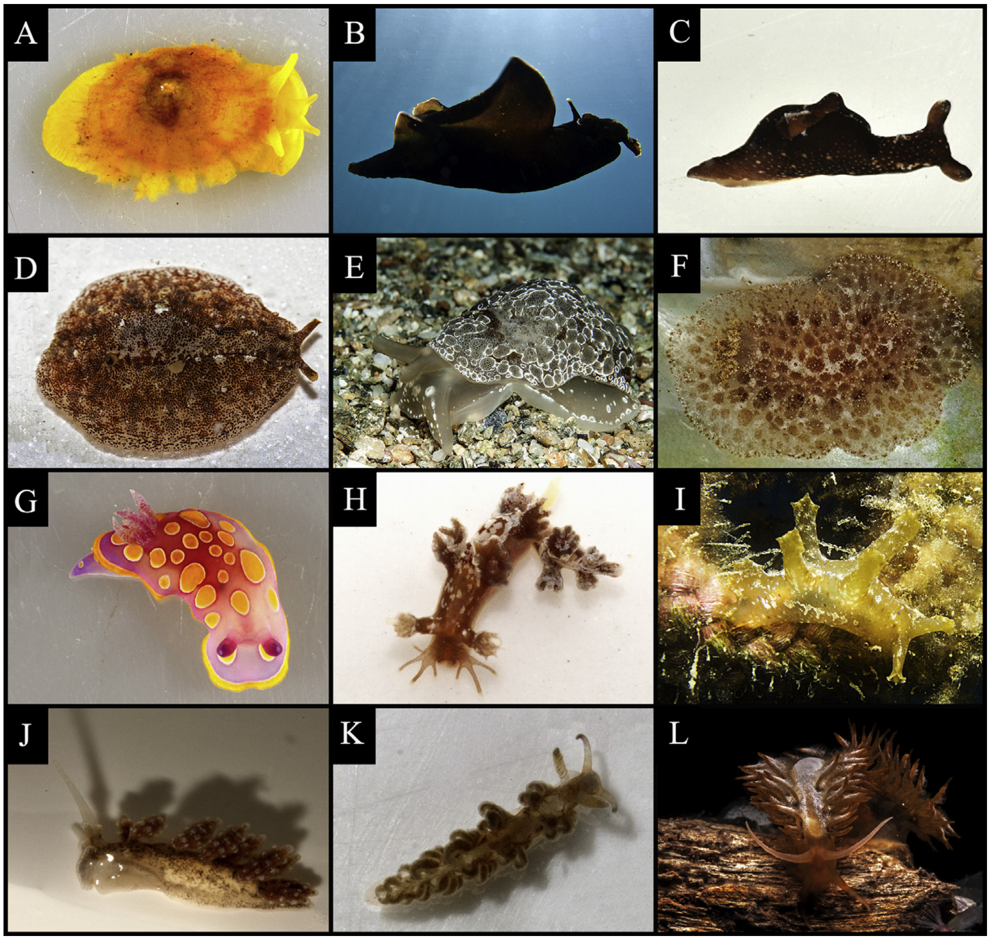

Fig. 2. A–L. Sea slugs from the Cretan Archipelago (Greece). **A**. *Tylodina perversa* (Gmelin, 1791). **B**. *Aplysia fasciata* Poiret, 1789. **C**. *Aplysia parvula* Mörch, 1863. **D**. *Petalifera petalifera* (Rang, 1828). **E**. *Berthella ocellata* (Delle Chiaje, 1830). **F**. *Tayuva lilacina* (Gould, 1852) complex. **G**. *Felimida luteorosea* (Rapp, 1827). **H**. *Hancockia uncinata* (Hesse, 1872). **I**. *Scyllaea pelagica* Linnaeus, 1758. **J**. *Doto* sp. **K**. *Spurilla neapolitana* (Delle Chiaje, 1841). **L**. *Fiona pinnata* (Eschscholtz, 1831) and its egg masses.

the gastric contents of the asteroid starfish *Astropecten irregularis pentacanthus* (Delle Chiaje, 1827), 100–300 m (IN; RV; LPT coll) (Fig. 3B); off Terracina (Latina, Italy), circalittoral mud, unrecorded depth, 8 sh (LPT coll); Viareggio (Italy), unrecorded depth, 13 spm (ex R. Del Prete coll, MTRS box 16135); Golfo di Genova (Italy), 4 sh (KN coll); off Capo Pecora (Cagliari, Italy), 7 sh (IN coll); Villefrance-sur-Mer (France), 3 spm, 2 sh (MTRS box 16135); Capo San Vito and Palermo (Italy), 337 sh/spm [a mixed lot, including few sh from Palermo (*fide* Brugnone, on the label), possibly belonging to *Retusa nitidula* (Lovén, 1846)] ex Brugnone coll (MTRS box 16135); Termini-Imerese (Italy), 2 spm, 23 sh (MTRS box 16135).

Environment, depth range, and distribution – The species inhabits sandy-muddy bottoms at ~80–300 m depth, in agreement with the original description by Jeffreys (1883) [70–120 fms (= ~130–220 m)]. It occurs in the whole Mediterranean, having been recorded from the eastern (see Jeffreys, 1883) up to the western basin, often *sub nomine Cylichnina umbilicata* (Montagu, 1803) (e.g. see Giribet and Peñas, 1997). Sykes (1904) recorded it from the Bay of Biscay (northeast Atlantic): however, the latter record should be carefully re-examined as it considerably broadens the geographic range of the species.

Shells and gizzard plates morphology – Shell globose with short cylindrical outline, rounded anteriorly and posteriorly in mature specimens and with a narrow apical umbilicus nearly concealed by body whorl. In juveniles, apical umbilicus very evident and shell more abruptly truncated posteriorly. Maximum shell diameter in mature specimens lower than in non-mature ones. Spiral lines and axial riblets absent. Fresh shells translucent, colourless, quite characteristic with the silky sheen made by close-set growth lines, frequently smoothed on empty shells from bioclastic sediments. The '*thickened riblet or ridge*' around the crown (see Jeffreys, 1883) is the weak keel made by the body whorl around the apical umbilicus, typical of many species ascribed by recent works to the genus *Retusa* T. Brown, 1827. Gizzard plates corneous, shield-shaped, with paired ones narrower than the unpaired one. Several small, pointed tubercles on the plates, darker than the brown background (Fig. 3E–F). Original description (Jeffreys, 1883) and original drawings (copied in Fig. 3A) effective in order to identify the species, and closely fitting its syntypes (Fig. 3C) and additional shells figured herein (Fig. 3B, G).

Feeding behaviour – Several foraminiferan tests were found near or among the gizzard plates, therefore suggesting that it feeds on Foraminifera, as is known for other cephalaspidean gastropods (Cedhagen, 1996).

Remarks: family and genus assignment – *R. parvula* (Jeffreys, 1883) *comb. nov.* has been usually assigned to the family Cylichnidae H. Adams and A. Adams, 1854 following its original genus designation *Cylichna* Lovén, 1846 (e.g. Thiele, 1931; Nordsieck, 1972; Sabelli et al., 1990–1992; Koutsoubas and Koukouras, 1993; Bedulli et al., 1995; Coll et al., 2010; Gofas, 2014). Jeffreys (1883) himself, despite being the author of the species, was not really satisfied with the proposed systematic position, and just below the original description assigned *Cylichna parvula* to the new genus *Cryptaxis* Jeffreys, 1883. It is, however, preoccupied by *Cryptaxis*

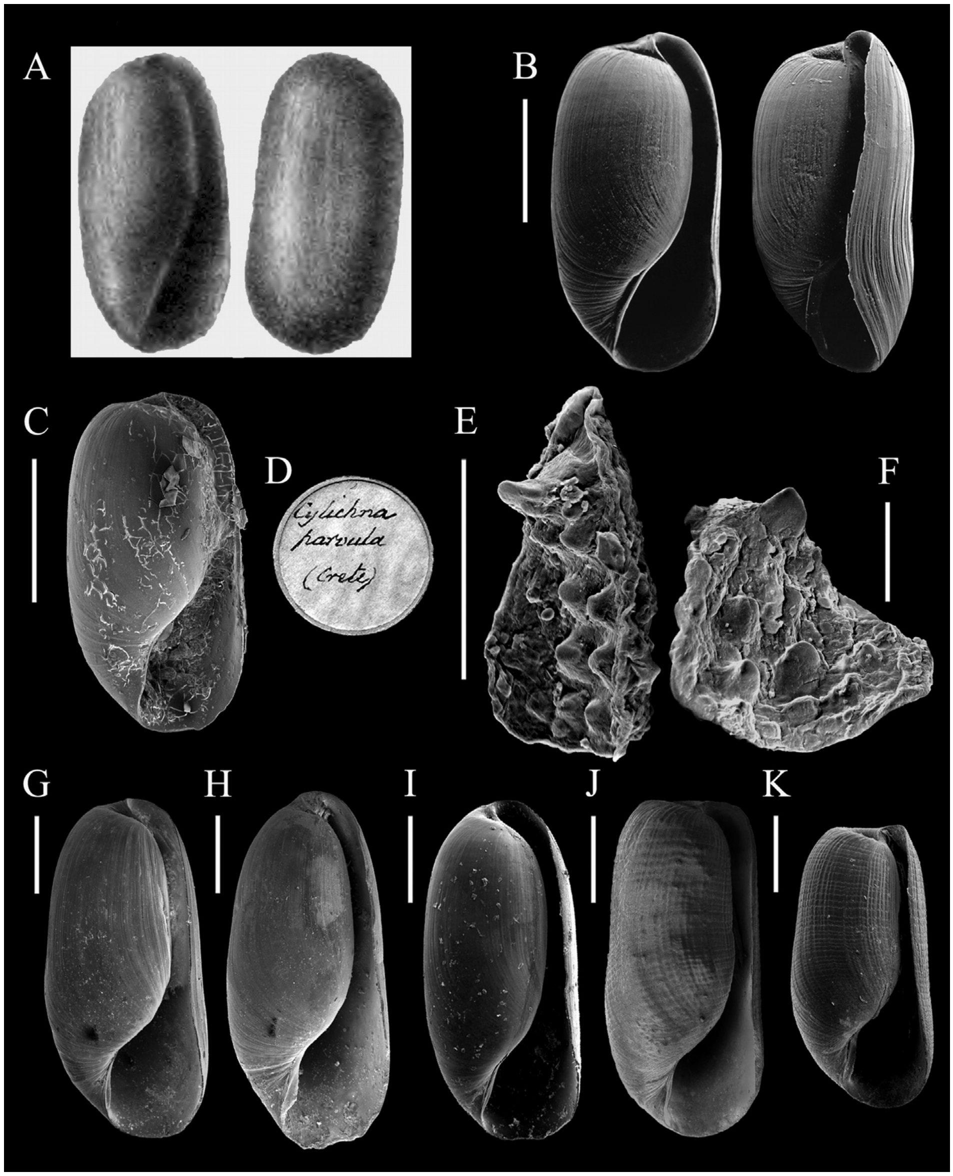

Fig. 3. A-G. *Retusa parvula* (Jeffreys, 1883). **H–I**. *Retusa nitidula* (Lovén, 1846). **J-K**. *Retusa laevisculpta* (Granata-Grillo, 1877). Scale bars: B–C, G–K: 500 μm; E–F: 50 μm. **A**. *R. parvula*: Jeffreys (1883: pl. XVI, Fig. 9) original drawings. **B**. *R. parvula*: apertural and lateral view – Fiumicino (Italy) 100–300 m, in gastric contents of *Astropecten irregularis pentacanthus* (Delle Chiaje, 1827) (IN *legit*). **C**. *R. parvula*: apertural view – selected syntype, Crete Island (Greece) ~130–220 m (labelled by Jeffreys, ex "Triton" expedition, 1882, MTRS box 16084). **D**. *R. parvula*: box cover of *Cylichna parvula* syntypes labelled by Jeffreys (MTRS box 16084). **E-F**. *R. parvula*: paired (E) and unpaired (F) gizzard plates of the specimen figured in B. **G**. *R. parvula*: apertural view of a large shell, close to *Retusa nitidula* (Lovén, 1846) - Taranto (Italy) unrecorded depth (C. Praus-Franceschini *legit*, MTRS box 16135). **H**. *R. nitidula*: apertural view – Corse (France), unrecorded depth (*ex* N. Tiberi collection, MTRS box 16135). **I**. *R. nitidula*: apertural view – southwest of Lilleskär (Bohuslän Region, Sweden: type locality) ~30 m, dredging on mud (CS *legit*). **J**. *R. laevisculpta*: apertural view – syntype of *Cylichna laevisculpta*, Messina (Italy), unrecorded depth (*ex* G. Granata-Grillo collection, MTRS box 16112). **K**. *R. laevisculpta*: apertural view – Kaş (Turkey) 34 m, bioclastic sediment – "Akdeniz'92" expedition, Stn. 22 (see Oliverio et al., 1993).

Lowe, 1854. The analysis of gizzard plates (the main character utilized to distinguish retusid genera: see Chaban, 2000) of *R. parvula* from off Fiumicino (Latium, Italy) (Fig. 3E–F) revealed a typical *Retusa* morphology (see also Sars, 1878; Pilsbry, 1895; Marcus and Marcus, 1969; Burn and Bell, 1974; Oliverio and Tringali, 2001; Tringali and Oliverio, 2001; Chaban and Chernyshev, 2013). That strongly disagrees with the generic attribution of *R. parvula* to the genus *Cylichna*. *Cylichna* gizzard plates are readily distinguished from those of *Retusa* in: *i)* being of nearly equal shape and size; *ii)* lacking tubercles/knobs; and *iii)* having a whitish opaque aspect (not actually calcified, in spite of many different reports) (Sars, 1878; Pilsbry, 1895; Vayssière, 1913; Thiele, 1931; Mikkelsen, 1996; Valdés and Camacho-García, 2004). Finally, *Cylichna* species bear a radula (Pilsbry, 1895; Vayssière, 1913; Lemche, 1948), whilst retusid gastropods are radula-less (Pilsbry, 1895; Thiele, 1931; Hurst, 1965; Chaban, 2000); no radula was found in any *R. parvula* examined in the present study.

To date, the specific systematics and taxonomy of the family Retusidae Thiele, 1925 is very confusing, with "*Retusa*" species often split into two different genera (e.g. see Coll et al., 2010): *Retusa* T. Brown, 1827 and *Cylichnina* Monterosato, 1884. More recently, Marshall et al. (2014) considered the latter a synonym of the former. In agreement with these authors, and as also underlined by Lemche (1948), there is no valid reason to distinguish between the two genera. The very small sizes of species assigned to *Cylichnina*, as well as the sunken spire, cannot be claimed as a distinctive feature. Small sizes are present also in species previously ascribed to *Retusa sensu stricto*, and further cephalaspidean genera (e.g.

Diaphana T. Brown, 1827, *Cylichnium* Dall, 1908 or *Philine* Ascanius, 1772) include both species with a concealed spire and others with protruding whorls. Additionally, a highly variable degree of immersion *vs* prominence of the spire is also shown by some species usually regarded as members of *Retusa*. The case of *R. mammillata* and *R. minutissima* is illustrative, both showing an almost sunken, "*Cylichna*-like" spire, up to a much protruding, "*Acteocina*-like" one (see Oliverio and Tringali, 2001; Tringali and Oliverio, 2001). In addition, *Retusa* and *Cylichnina* gizzard plates morphology is identical (with three small corneous subtriangular plates bearing several small tubercles *vs* the gizzard plates morphology of other retusid genera, such as *Pyrunculus* Pilsbry, 1895, with only two larger tubercles on each plate, and *Relichna* Rudman, 1971, lacking any tubercle – see Thiele, 1931; Rudman, 1971; Bouchet, 1975; Chaban, 2000; Tringali and Oliverio, 2001).

Remarks: taxon validity – *Retusa parvula* mostly differs in sculpture with respect to the other north-eastern Atlantic and Mediterranean species belonging to *Retusa* and usually provided with an apical umbilicus – all previously ascribed to the genus *Cylichnina* Monterosato, 1884 [less than 10 species according to list and taxonomy of Coll et al. (2010) and Check List of European Marine Mollusca (CLEMAM)]. *Retusa canariensis* (F. Nordsieck and F.G. Talavera, 1979) is the only species that lacks a true apical umbilicus and shows a more typical *Retusa* outline (see discussion in Crocetta and Tringali, 2015), therefore being different from the others, whilst *Retusa tenerifensis* (F. Nordsieck and F.G. Talavera, 1979) was clearly established on a juvenile of *Bulla* sp. (authors' personal observation on the MNHN-IM-2000-27686 syntype; see figure in Valdés and Héros, 1998). With regards to the other species, all but *Retusa nitidula* (Lovén, 1846) show more or less numerous spiral lines, simple and slightly flexuous. It is the case of *Retusa crebrisculpta* (Monterosato, 1884) (see Monterosato, 1884; Oliverio and Tringali, 2001), *Retusa crossei* (Bucquoy, Dautzenberg & Dollfus, 1886) (see Bucquoy et al., 1886; Gaglini, 1991), *Retusa laevisculpta* (Granata-Grillo, 1877) (see Granata-Grillo, 1877; Gaglini, 1991; authors personal observation on 2 syntypes: Fig. 3J–K) and the puzzling *Retusa multiquadrata* Oberling, 1970 (see Oberling, 1970, 1971), often forgotten by recent authors (see discussions in Crocetta and Tringali, 2015). *Retusa robagliana* (P. Fischer in de Folin and Périer, 1869) is a poorly-known *Cylichnina*-like species described from the Bay of Biscay, which bears a network of weak axial ribs and spiral lines, thus not fitting *R. parvula*, but possibly being conspecific with *R. multiquadrata* (see discussions in Crocetta and Tringali, 2015). *Retusa umbilicata* (Montagu, 1803) is the oldest available name in the Northeastern Atlantic–Mediterranean for all *Retusa* species with an apical umbilicus. Its identity, however, is not yet very clear due to a poor original description and figure. Although the species was not described or figured as spirally sculptured by Montagu (1803) (the species was originally described as "smooth"), a sculpture of spiral lines is usually ascribed to *R. umbilicata* by subsequent authors (e.g. Jeffreys, 1867; Bucquoy et al., 1886). *R. umbilicata* may definitively fit either *R. nitidula* (not spirally striated) or *Retusa strigella* (Lovén, 1846) (spirally striated), although the majority of recent authors considered *R. umbilicata* as a most plausible senior synonym of *R. strigella* (see Oliverio and Tringali, 2001), and therefore, *R. umbilicata* is sculptured in a different way than *R. parvula*. Finally, the most difficult one is the relationship of *R. parvula* and the only other non-spirally sculptured species, *R. nitidula*, a North European species occasionally recorded also in the Mediterranean (Fig. 3H–I). Lovén (1846), describing the taxon as belonging to *Cylichna*, considered *R. nitidula* as similar to *R. umbilicata*, differing in having a smooth surface (arguably: not spirally sculptured), a more slender outline, which restrains toward the top (*postice attenuata*) and a sinuous columellar callus with a faint fold, less evident than on *R. umbilicata*. However, *R. nitidula* has been frequently regarded as a simple *R. umbilicata* morphotype, mostly after Lemche (1948), who considered *R. umbilicata*, *R. nitidula* and *R. strigella* as a single variable species due to the presence of intermediate forms. A previous examination by one of us (LPT) of some Swedish retusid material, including lots from the Bohuslän Region (CS *legit*), type locality of both *R. nitidula* and *R. strigella*, contained both *R. nitidula* and *R. strigella*, with no intermediate forms, therefore suggesting that they may be different species (with *R. strigella* as a junior synonym of *R. umbilicata*). The examination of additional Mediterranean specimens ascribed to *R. nitidula* revealed a high similarity between *R. parvula* and *R. nitidula*. However, taking into account the *R. nitidula* sizes provided in the original description (height = 3 mm, diameter = 1.4 mm), the latter may attain a much larger size than *R. parvula*. *R. nitidula* is furthermore more slender and less rounded posteriorly, with the upper edge of the aperture more protruding above the last whorl. Its columellar callus is thin, but less than the *R. parvula* one, more sinuous and with a weak fold, but more evident than that of *R. parvula*. We are prone to consider *R. parvula* and *R. nitidula* as different morphospecies, therefore both valid species. Molecular studies may provide further evidence.

Class GASTROPODA Cuvier, 1795
Order CEPHALASPIDEA P. Fischer, 1883
Unassigned family (see below)
Genus *Ventomnestia* Iredale, 1936
Ventomnestia girardi (Audouin, 1826)

Material examined – Type material: not examined. **Note:** the holotype (Savigny coll) is figured in Bouchet and Danrigal (1982) and Valdés and Héros (1998). **Additional material:** Analipsi (Astypalea Island, Greece, Mediterranean Sea), 08/06/1996, bioclastic sediment, 6 m, 1 sh (RV *legit*); Analipsi, 04/07/2013, bioclastic sediment, 6 m, 12 sh (RV *legit*); Bisson (Astypalea Island, Greece, Mediterranean Sea), 03/07/2013, bioclastic sediment, 10 m, 4 sh (RV *legit*); Soğuksu Cove (Aydincik, Turkey, Mediterranean Sea), 26/07/1989, bioclastic sediment of a *Posidonia oceanica* meadow, 9 m, 1 sh (RV *legit*) (see Tringali and Villa, 1990); Soğuksu Cove, 09/06/1990, bioclastic sediment of a *P. oceanica* meadow, 10 m, 1 frg (RV legit); Aydincik (Turkey, Mediterranean Sea), 1990s, bioclastic sediment, 1 sh (WS coll) and 3 sh (RR coll); Sanganeb Reef (off Marsa Derur, Sudan, Red Sea), 02/02/1992, coralligenous bioclastic sediment, 95 m, 1 sh (MO *legit*); Shaab Rumi Reef (off Marsa Derur, Sudan, Red Sea), 03/02/1992, coralligenous bioclastic sediment, 60 m, 1 sh (MO *legit*); Shaab Rumi Reef (off Marsa Derur, Sudan, Red Sea), 04/02/1992, coralligenous bioclastic sediment, 25 m, 1 sh (MO *legit*).

Distribution – According to its synonymy (see Bouchet, 2014), *Ventomnestia girardi* (Audouin, 1826) is widespread in the Indo-Pacific, Red Sea included (Zenetos et al., 2004; Yonow, 2008). However, *Ventomnestia* species need to be critically reviewed, and therefore the geographic range of *V. girardi* may be not correct. This taxon was also found in the Suez Canal (Pallary, 1926; Moazzo, 1939; Hoenselaar and Dekker, 1998) and is a well-know Lessepsian migrant species, considered as established in the Mediterranean (Zenetos et al., 2010, 2012) and recorded from Egypt, Israel, Lebanon, Turkey, Cyprus and Greece (review in Crocetta et al., 2013).

Greek establishment status – The presence of *Ventomnestia girardi* (Audouin, 1826) in Greece has been considered as "casual" (Zenetos et al., 2009, 2011), being recorded based on a single shell from Crete in 1994 (Cosenza and Fasulo, 1997). Manousis (2012) recently reported a digital drawing of this species when covering the Greek molluscan fauna. Although the author stated that most of the material comes from the Thermaikos Gulf, and the original reference from Greece [Cosenza and Fasulo, 1997] is not included in the book's references (see Manousis, 2012), we were not able to trace with certainty the bases of its inclusion, and the absence of photos lead us to exclude additional unpublished records from Greece by the author. Two locally restricted records (with no number of specimens specified) were both stated in 2012 from Saronikos (Zenetos et al., 2013) and Kalimnos Island (Perna, 2013). Our repeated findings in Astypalea Island, as well as the conspicuous number of specimens recorded in 2013, would be the first suggestion of *V. girardi* establishment in Greece.

Shell morphology – Shell globose with slender oval outline constricted anteriorly and posteriorly, with slightly and evenly rounded sides. Spire abruptly sunk within an evident and deep apical umbilicus. Very narrow umbilical chink at the base. Juvenile shells less slender than adult ones. Aperture well rising above last whorl, columellar callus straight or slightly curved, weakly thickened and expanded, but usually with no fold or tooth. Fresh shells shiny. The colour (examined on empty shells) varies from whitish (with or without a pale to intense yellowish band on the middle) to brownish- or greenish-yellow, mottled or speckled, and with a central dark band between two paler bands. Several shells may have two thin and irregular darker lines bordering the central band. Sculpture of many close-set spiral lines on the last whorl, shallow but clearly evident, and of more or less marked growth lines. Animal unknown.

Remarks: genus assignment – The taxon *Bulla girardi* was originally introduced by Audouin (1826) by referring to the Figs. 3.1–3.2 of Savigny's molluscs pl. 5 (Savigny, 1817; also in, Pallary, 1926). Valdés and Héros (1998) reported it as the type species of *Bullina* Risso in Audouin, 1826 (non *Bullina* Férussac, 1822). However Audouin (1826) was originally referring to *Bulla villersii*, now *Cylichna villersii* (Audouin, 1826). In the recent literature, *B. girardi* has been ascribed to three different genera: *Cylichna* Lovén, 1846 (e.g. Pallary, 1926; Moazzo, 1939; Hoenselaar and Dekker, 1998), *Cylichnina* Monterosato, 1884 (e.g. Barash and Danin, 1977; Sabelli et al., 1990-1992; Bogi and Galil, 2013; Zenetos et al., 2013) and *Ventomnestia* Iredale, 1936 (e.g. Mienis, 1976, 2004) [***Cylichna*** Lovén, 1846: type species *Bulla cylindracea* Pennant, 1777, subsequent designation by Pilsbry (1895) - family Cylichnidae H. Adams & A. Adams, 1854; ***Cylichnina*** Monterosato, 1884: type species *Cylichna laevisculpta* Granata-Grillo, 1877, subsequent designation by Crosse (1885) - now in synonymy of *Retusa* T. Brown, 1827 (see above), type species *Bulla obtusa* Montagu, 1803, subsequent designation by Iredale (1915) - family Retusidae Thiele, 1925; ***Ventomnestia*** Iredale, 1936: type species *Ventomnestia colorata* Iredale, 1936, by original designation – Unassigned family (see below)].

Shells usually ascribed to *Ventomnestia* share a peculiar colour pattern, yellowish-, reddish- or greenish-brown, ranging from pale to dark, mottled, or speckled, frequently with a large darker band running around the middle of the shell, bordered by an upper and a lower pale band (occasionally the central band is split into thinner bands). This colour pattern is quite distinct from the uniform whitish or faint yellowish one of other cephalaspidean shells, including those belonging to the genera *Cylichna* and *Retusa*, therefore suggesting that *Bulla girardi* belongs to the genus *Ventomnestia*, in agreement with Mienis (1976, 2004) and Bouchet (2014).

Ventomnestia has, however, a problematic history. Zilch (1959) listed it among the junior synonyms of *Cylichnina*, arguably influencing most subsequent workers to consider *Bulla girardi* as a species of *Cylichnina*. Rehder (1980) also ascribed *Haminaea pusilla* Pease, 1860 to *Cylichnina*. This taxon is a synonym of *Ventomnestia bizona* (A. Adams, 1850) and, in turn, of *V. girardi*. He also regarded *Cylichnina* as a subgenus of *Retusa* and as a senior synonym of both *Cylichnania* Marwick, 1931 and *Ventomnestia*. However, Rehder (1980) remarked that the above-mentioned synonymy could be rejected after more careful research on the relationships of living Mediterranean and Indo-Pacific species, and, if a distinction could be demonstrated, the correct genus to be used for *H. pusilla* and related forms should be *Cylichnania*, which predates *Ventomnestia*. More recently, Carlson and Hoff (2000) examined the soft parts of *Ventomnestia villica* (Gould, 1859) from Guam, highlighting the presence of a radula (formula 2.1.2). Therefore, *Ventomnestia* does not fit in the family Retusidae, as all retusid genera actually lack a radula (Pilsbry, 1895; Thiele, 1931; Hurst, 1965; Chaban, 2000). Carlson and Hoff (2000) also noticed the occurrence of gizzard plates with 6–7 heavy ridges covered with rods, and, "the absorption of all but the outer 1–1/2 whorls of the shell" (except the periostracum). According to this set of characters, they concluded that the genus *Ventomnestia* belongs to the family Haminoeidae, and therefore it cannot be a synonym of *Cylichnina*. A recent investigation based on molecular phylogenetic analysis, however, questioned the assignment of *Ventomnestia* to Haminoeidae, even if close to it, and left its systematic position as open to question (Malaquias et al., 2009).

Cylichnania was based on a fossil type species, *Cylichnania bartrumi* Marwick, 1931, described from Neogene deposits of North Island, New Zealand (Marwick, 1931). *Cylichnania* lacks any colour pattern, a feature, however, frequently lost on fossil shells. Marwick (1931) pointed out that *Cylichnania* is similar to *Cylichna* Lovén, 1846, but it is distinguished by a longer columella with an obvious fold. The occurrence of a columellar fold is also reported as a diagnostic feature by Beu and Maxwell (1990). This character, however, does not fit *Ventomnestia*, which usually lacks any clear fold on the evenly curved columella. Moreover, the original illustration of *C. bartrumi*, as well as the drawing by Beu and Maxwell (1990), shows more marked spiral lines. *Cylichnania* also inhabited moderately deep water bottoms – outer shelf or upper bathyal (Beu and Maxwell, 1990), whereas *Ventomnestia* inhabits shallow waters, definitively suggesting that *Ventomnestia* and *Cylichnania* should be considered as distinct, and that *Ventomnestia* Iredale, 1936 is the correct genus to be used for *Bulla girardi* Audouin, 1826.

4. Discussion

A renewed interest on Mediterranean marine biodiversity (e.g. Bianchi and Morri, 2000; Boudouresque, 2004; Coll et al., 2010) has recently led to the necessity of further exploration and taxonomic work on various taxa. Although taxonomic inventories have long been considered old-fashioned, and the overall value of detailed biodiversity work has been often neglected in the recent past, they constitute useful bases for further studies, assessments and conservation programmes, and are a valid tool for making long-term comparisons, especially when data are reviewed under the prism of modern taxonomic studies (e.g. Hendrickx and Harvey, 1999; Mikkelsen and Cracraft, 2001; Boero, 2013; Macali et al., 2013). Despite the general decline in taxonomical knowledge (e.g. Boero, 2001; Boero and Bernardi, 2014), numerous recent inventories exists, mostly at country level or classes-specific only.

Despite these limitations, the Mediterranean molluscan fauna has always been considered as the best known in the world (Oliverio, 2003). However, a general discrepancy occurs between the western/northern and eastern/southern parts and with regards to different environments and depths. Although our knowledge on the Mollusca of the continental shelf may be considered quite satisfactory, that on the bathyal fauna is far from complete and has been poorly explored, with few recent exceptions (e.g. Galil and Zibrowius, 1998; Bogi and Galil, 2004; Galil, 2004; Olu-Le Roy et al., 2004; Ritt et al., 2012). In the past, empty shells have often been counted as living specimens, which often has led to the inclusion of doubtful/fossil species in the Mediterranean resident fauna [e.g. *Veleropilina reticulata* (G. Seguenza, 1876): see Warén and Gofas, 1996; *Gibbula tantilla* Monterosato, 1890: see Smriglio et al., 1991; Campani and Bogi, 2008; the not-yet-discussed *Zeidora* *naufraga* Watson, 1883]. Qualitative data obtained from the study of thanatocoenosis, however, should always be complemented by a critical approach, and this is why we include published records of four molluscan species from Crete among the doubtful ones. These records could be easily based on fossil or subfossil specimens. An increasing knowledge of the Mediterranean bathyal fauna may definitively clarify whether these species belong, or not, not only to the Cretan fauna, but also to the Mediterranean fauna at large.

An additional value of recent check-lists is that they are often based on a new bulk of unpublished material, often preserved (as in our case) in alcohol for further molecular analysis. Despite hundreds of taxonomic studies covering the Atlantic—Mediterranean area, the alpha taxonomy of local molluscan species is primarily based on shell morphology and colour pattern (Sabelli and Taviani, 2014), and only few groups have been molecularly investigated, often with puzzling results (e.g.: Barco et al., 2013a, 2013b). The same holds for "opisthobranchs", in which, in absence of shell morphology, the study of taxonomically important characters is mostly substituted by external morphology and anatomy of soft parts (Gosliner et al., 2008), and for which only the taxonomy of some Atlantic–Mediterranean groups/species has been molecularly solved (e.g. Eilertsen and Malaquias, 2013; Carmona et al., 2014). This is, as an example, at the basis of our doubts regarding the Crete record of *Haminoea orteai* P. Talavera, Murillo & Templado, 1987 and our uncertainties regarding the identification of *Aplysia parvula* Mörch, 1863, *Tayuva lilacina* (Gould, 1852) complex, and *Doto* sp. The alpha-taxonomy of *Haminoea* species is still controversial, and constitutes a puzzling problem for non (and even for) *Haminoea*-trained molluscan taxonomists: as recent examples, despite deep uncertainties regarding the objective taxonomic identity of *Haminoea hydatis* (Linnaeus, 1758), whose type material is constituted by a shell in poor conditions only (LSL.318), this species is still commonly recorded in several articles covering the Atlantic–Mediterranean fauna (e.g. Carvalho et al., 2011; Fèlix et al., 2013; Ludovisi et al., 2013; Abushaala et al., 2014). An alien *Haminoea* species (*Haminoea japonica* Pilsbry, 1895) has spread undetected in the European seas for decades due to taxonomic impediments and despite early Mediterranean records (Hanson et al., 2013). The recently described *Haminoea templadoi* García, Perez-Hurtado & García-Gómez, 1991 (see García et al., 1991) and even the recent records of *Haminoea orbignyana* (Férussac, 1822) from the Adriatic (Rinaldi, 2012) may easily belong to *H. japonica*. In turn, recent records of *H. orbygniana* have been ascribed to *H. hydatis* (e.g. Scaperrotta et al., 2013). Since the material at the basis of several records is constituted by empty shells, photos, and/or formaldehyde-preserved specimens, no existing methods are suitable to confirm or correct these identifications. Unfortunately, we have found no *Haminoea orteai*-like specimens in our samples, and therefore cannot be resolute on the topic. However, our alcohol-preserved material belonging to the other three species may be definitively useful when reviewing their current taxonomy with modern molecular phylogenetic approaches.

Finally, according to published and new data, only 81 sea slugs and shelled relatives were recorded from Crete to date (76 excluding the doubtful records), and these account for ~20% of the known Mediterranean sea-slugs and shelled relatives [Opisthobranchia excluding Pteropoda (Thecosomata and Gymnosomata): Templado and Villanueva in Coll et al., 2010]. Taxonomy is unresolved for several species listed in Coll et al. (2010), and a future perspective may be to homogenize the huge quantity of data provided by single countries or specific research groups. Even if our species numbers are numerically in agreement with those reported from whole nearby eastern Mediterranean countries (except Syria, Lebanon and Egypt for which few sea slugs data are available) (see discussions in Crocetta et al., 2013), and the absence of several common species with Atlantic–Mediterranean distribution from the eastern Mediterranean fauna may be plausible, a higher number of sea slug species is clearly expected from Crete, including at least those recorded from other eastern Mediterranean countries, hopefully with focused biodiversity targeted research. Despite the number of species lower than expectable, we hereby lay the foundations to extend local studies on sea slugs and shelled relatives and fill expected gaps in the Mediterranean distribution of several taxa. The present paper therefore constitutes a mandatory step when providing large-scale and well-defined Mediterranean molluscan distributional patterns, and emphasizes the necessity of more intensive studies of the molluscan communities in the area. The future will show if this will hold true, or not.

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Appendix A. Supplementary data

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SENCKENBERG

OCEANARIUM

On the occurrence of *Elysia gordanae* Thompson & Jaklin, 1988 (Mollusca, Opisthobranchia) in East Mediterranean Sea

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In the East Mediterranean, five species of the family Plakobranchidae have been recorded (Koutsoubas and Koukouras 1993; Turkmen and Demirsoy 2009). *Elysia gordanae* Thompson & Jaklin 1988 is a small elysiid, between 10 and 17 mm in length, and can be found in shallow waters on rocky bottoms. It feeds upon *Acetabularia acetabulum* (Linnaeus) P.C. Silva 1952 and other filamentous algae. In the summer of 2012, a survey was conducted in the area of Kouremenos in eastern Crete by a team of two divers in order to record the biodiversity of the shallow waters (< 10 m). By means of visual census with free diving, ten dives of two-hour fixed duration were led along predefined transects (Katsanevakis et al. 2012). The findings were recorded on waterproof paper, as this is an ideal means of writing underwater and then transferring the data safely to the laboratory. Whenever necessary, specimens were collected and transferred alive and intact in the laboratory for stereoscopic vision and in situ photography. Among the species, one specimen of *Elysia gordanae* Thompson & Jaklin, 1988 (Fig. 1) was found in one location. It was semi-buried at a depth of 1 m under the mud on the rocky bottom. Part of the rocky bottom was covered by a dense community of the Actiniaria *Anemonia viridis* (Forskal, 1775) and *Acetabularia acetabulum* (Linnaeus) P.C. Silva 1952. This is the first record of *Elysia gordanae* Thompson & Jaklin, 1988 in the East Mediterranean Sea. Other Opisthobranchia that were abundant in the region were *Elysia timida* (Risso, 1818) and *Thuridilla hopei* (Verany, 1853) while a young (60 mm) opisthobranch, *Aplysia dactylomela* Rang 1828, was recorded crawling among the *Cymodocea nodosa* (Ucria) Ascherson 1870 meadow that covers part of the gulf. The specimen is deposited in the collection of invertebrates at the Natural History Museum of Crete in 96 % alcohol (NHMC 52.114). This is the easternmost location that has been found, in a particularly oligotrophic sea compared to the type of locality in the northeastern Adriatic Sea and other locations that have been recorded thus far. The species has a color variation due to the muddy bottom, which ultimately prevents researchers and divers from detecting it easily, compared to its white counterpart with red dots known as *Elysia timida* (Risso, 1818), which is easily located on the rocky bottoms of the shallow waters. More intensive and intrinsically thorough research is likely to show more species that, to date, have never been recorded in the East Mediterranean.

Fig 1 *Elysia gordanae* Thompson & Jaklin, 1988 in different views

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7. GREECE

7.1 A new locality for *Amathia (Zoobotryon) verticillata* (Delle Chiaje, 1822) from Aegina Island, Saronikos Gulf, Greece

D. Minchin

Several colonies of the spaghetti bryozoan, measuring up to ~25cm, *Amathia verticillata* were found attached to the quay wall, and close to the water surface, adjacent to where fishing vessels berth in the Port of Aegina (37.74611° N, 23.42750° E). Colonies, seen on October 6th 2015, were confined to one part of the port. Larger colonies were found attached to mooring ropes and boat hulls, extending up to ~50cm (Fig. 15). This species is now considered to be a pseudo-indigenous species, a non-indigenous species having been considered to be a native species, according to Ferrario *et al.* (2014). The species continues to expand within the Mediterranean Sea and Macaronesia (Marchini *et al.,* 2015). There are five previous records from Hellenic waters; these are from Piraeus, ~30km to the NE, in 1969 and 1978. More distant records in Greece are from Chalkis, 85km to the NNE and from Korinthiakos and Patraikos gulfs and Rodos >400km to the east. All these records (Castritsi-Catharios & Ganias, 1989) were reported more than thirty years ago. In 2014, *A. verticillata* was discovered while snorkelling close to a marina in Rodos. This is the only other recent record from the Aegean Sea (Corsini-Foka *et al.,* 2015).

Fig. 15: A colony of *Amathia verticillata* attached to the hull of a fishing vessel, Aegina Port.

This species can be frequent in sheltered harbours, often appearing on floating marina pontoons (Marchini *et al.,* 2015). Its frequent occurrence on the hulls of small craft implicates hull transmission as a likely spreading mode. Other localities for this species are likely to be reported in the future.

The species has undergone a recent nomenclature revision of ctenostome bryozoans and the genus of *Zoobotryon* is now considered to be a junior synonym of *Amathia*. Currently, the name *A. verticillata* (Delle Chiaje, 1822) is used (Waeschenbach *et al.,* 2015).

Material has been supplied to the University of Pavia.

7.2 *Syphonota geographica* (A. Adams & Reeve, 1850) spreading in Greece

D. Poursanidis and F. Crocetta

The sea slug *Syphonota geographica* (A. Adams & Reeve, 1850) is a conspicuous sea slug species that has entered the Mediterranean basin in the last two decades, and was found for the first time in Italy in 1999 (Crocetta, 2012), in Turkey in 2002 (incorrectly reported in 1999 in Cinar *et al.*, 2011: Bilal Öztürk, personal communication), in Greece in 2002 (Mollo *et al.*, 2008) and in Lebanon in 2003 (Crocetta *et al.*, 2013). So far, the species is only known by a few Mediterranean records due to objective difficulties in its identification. It is thus speculated that its actual distribution is partially overlooked, in agreement with several past misidentification in the Mediterranean Sea. In Greece, the species is known from the Porto Germeno coasts (Korinthiakos Gulf), where eight individuals were reported by Mollo *et al.* (2008). We hereby first report its further spreading in Greece based on two sightings by recreational divers and confirm its establishment in the country. One specimen was found by Giorgos Karelas in May 2013 in Drepano, Achaia (Korinthiakos Gulf) (~38.3402967° N, 21.8525472° E), whilst a second specimen was observed in Kolymbari (Chania, Kriti) (~35.555184° N, 23.784677° E) in June 2014 by the team of the Oceanis Diving Centre (Fig. 16). Both specimens were found on a muddy bottom at ~15 m of depth. The key role of citizen scientists in reporting newly introduced species or further spreading of species already known from the Mediterranean is again confirmed as an invaluable parallel source of information.

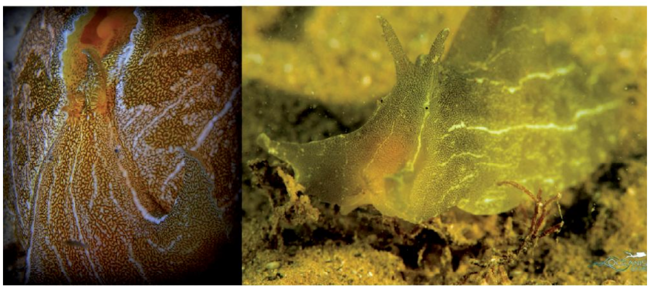

Fig. 16: *Syphonota geographica* from Drepano, Achaia (left) and Kolymbari (right).

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First record of *Piseinotecus gabinierei* (Mollusca: Gastropoda: Nudibranchia: Piseinotecidae) from the Aegean Sea

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The present paper reports the first record of Piseinotecus gabinierei *(Mollusca: Piseinotecidae) in the Aegean Sea; the nudibranchs were found in December 2008 in two different sites on the island of Crete (South Greece). In the first location it was feeding on* Eudendrium racemosum*, a hydroid very common in this area while in the second location it was found crawling among algae.*

Keywords: new species, Aegean Sea, Greece, Crete, Mollusca, Nudibranchia

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INTRODUCTION

Piseinotecus gabinierei (Vicente, 1975) is an aeolidian nudibranch (Mollusca: Piseinotecidae), endemic to the Mediterranean Sea, growing up to a maximum size of about 30 mm (Vicente, 1975; Rudman, 2003). The body is long shaped, transparent with opaque white blotches all over except for the cerata, through which the brown hepatic glands show. The spindle-shaped cerata are set in groups on either side of the body. The anterior clusters have a common stalk which may branch once. The rugose rhinophores are as long as the smooth oral tentacles and about one-quarter of the body length. The foot corners are tentaculiform (Cattaneo-Vietti *et al.*, 1990).

In the Mediterranean Sea *P. gabinierei* species has been reported from Spain (Cervera *et al.*, 2004; Pontes, 2008), France (Vicente, 1975; Poddubetskaia, 2003; Horst, 2008), Corsica (Cattaneo-Vietti *et al.*, 1990), Italy (Schmekel & Portmann, 1982; Koehler, 1996; Velling, 2002; Mas, 2008), Croatia (Koehler, 2000; Frijsinger and Vestjens, 2008) and Turkey (Aegean Sea and Levantine) (Akbatur, 2003; Buyukbaykal, 2003; Yokes, 2009) (Figure 1; geographical coordinates in Table 1).

MATERIALS AND METHODS

Diving activity by the author took place at two locations in December 2008 (see Results and Discussion). Ten dives in each location at a depth ranging between 2 and 20 m took place along the most vertical cliffs and vegetated rocks of these areas. Specimens were collected and transferred alive

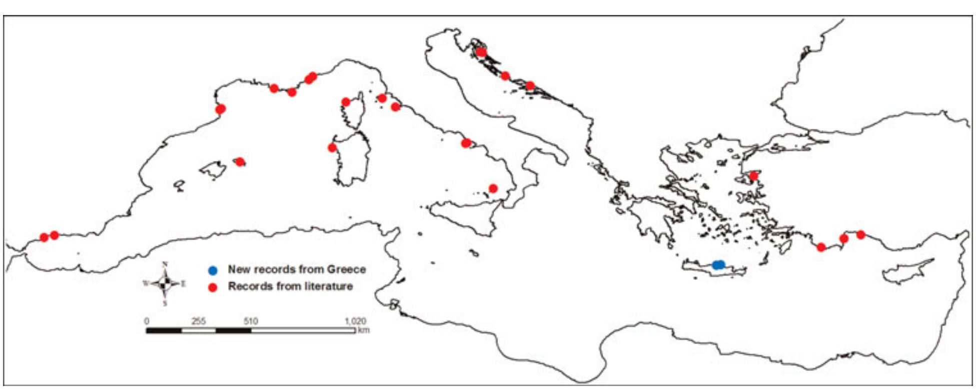

Fig. 1. Map showing where specimens of *Piseinotecus gabinierei* have been reported from in the Mediterranean Sea (blue circle, new records from Greece; red circle, records from the literature).

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Table 1. The geographical coordinates for where specimens of *Piseinotecus gabinierei* have been reported from in the Mediterranean Sea.

Country	Location	Latitude	Longtitude
Corsica	Calvi	42.566782	8.757109
Croatia	Vodice, Tijat	43.721812	15.767394
Croatia	Rab	44.754551	14.761787
Croatia	Rab	44.777586	14.667984
Croatia	Selce	43.295551	16.84877
France	La Ciotat	43.174035	5.60429
France	Antibes	43.555225	7.136894
France	Villefranche-sur-mer	43.704175	7.310058
France	Parc National de Port-Cros	42.997756	6.386444
Italy	Elba, Punta del Praticiolo	42.739848	10.366728
Italy	Sardena Capo Caccia	40.56337	8.162969
Italy	Capo Miseno	40.783333	14.083333
Italy	Punta pizzaco	40.766636	14.021618
Italy	Giglio	42.352108	10.923722
Italy	Stromboli	38.778262	15.227956
Spain	Cala Caials	42.288957	3.278389
Spain	Costa Brava	42.234137	3.215762
Spain	Eastern Andalusia	36.716284	−4.044705
Spain	Menorca	39.949629	4.110445
Spain	Costa del Sol	36.631346	−4.486891
Turkey	Kas	36.198376	29.633735
Turkey	Ayvalik-Balikesir, Kerbela	39.318137	26.677208
Turkey	Antalya, Kap	36.757294	31.382739
Turkey	Antalya, Uc Adalar	36.582427	30.635531

Fig. 2. Photograph of *Piseinotecus gabinierei in situ*.

to the laboratory of the Natural History Museum of Crete for stereoscope vision and photography.

RESULTS AND DISCUSSION

This is the first record of a *P. gabinerei* nudibranch in the Aegean Sea. The species was found twice in two different locations on the island of Crete. The first location was the island of Dia (coordinates 35.462889°N and 25.191013°E), north of the town of Heraklion. This island is protected by law against SCUBA diving (except for research purposes) and spear fishing by the Greek Archaeological Society, and generally it is not affected by tourism activities. Thus, this location seems to be a hot spot biodiversity area, with high diversity of fish and invertebrates. Other species of Opisthobranchia that are abundant in this area are *Hypselodoris picta*, *Elysia timida*, *Thuridilla hopei* and *Hypselodoris tricolor*. One individual of *P. gabinerei*, about 20 mm length, with wrinkled rhinophores, was observed and collected at 15 m depth on *Cystoseira* sp. vegetation with *Eudendrium* sp. colonies. The specimen was photographed *in situ* (Figure 2) and in the laboratory (Figure 3A dorsal view; Figure 3B ventral view).

The second location was the Gulf of Agia Pelagia (coordinates 35.405508°N and 25.018606°E). This is a closed and protected small gulf with shallow waters and mixed bottom substrata (rocky with sandy patches and patches of *Posidonia oceanica* meadows). At the opening of the gulf there are rocky formations, covered by algae, such as *Padina pavonica*, *Acetabularia acetabulum* and *Cystoseira* sp. Other species of Opisthobranchia that are abundant in this area

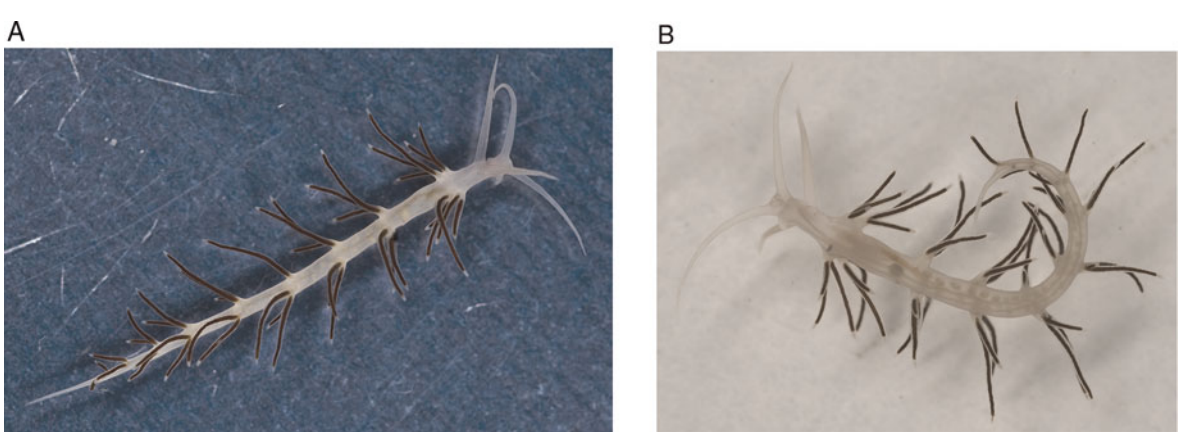

Fig. 3. (A) Photograph showing dorsal view of *Piseinotecus gabinierei*; (B) photograph showing ventral view of *P. gabinierei*.

are *Elysia timida*, *Thuridilla hopei* and *Dendrodoris grandiflora* which are found mainly at the beginning of the summer. One individual of *P. gabinerei*, about 25 mm in length, with smooth rhinophores, was observed and collected at 2 m depth on a small cliff covered with algae.

Both locations are rocky with algae and colonies of *Eudendrium* sp. on which *P. gabinierei* feeds (Schmekel & Portmann, 1982; Trainito, 2005). All specimens are deposited in the invertebrate collection of the Natural History Museum of the University of Crete in 96% alcohol.

The records for two new specimens of *P. gabineri* in both areas show that the presence of this opisthobranch may not be occasional; however, even if this species was rare due to its small size it is not easily located.

More than 160 (31%) opisthobranch species (Poursanidis *et al.*, 2009) out of the 515 known Mediterranean species have been recorded in Greek waters (Aegean and Ionian Seas) to date. Further research is expected to reveal the occurrence of more species in the area and also species new to science, possibly including lessepsian immigrants due to global climate change.

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Κεφάλαιο 3

Η βιοποικιλότητα των μαλακίων των Μεσογειακων υφάλων

Η Μεσόγειος θάλασσα αποτελεί το μεγαλύτερο κλειστό θαλάσσιο οικοσύστημα σε παγκόσμιο επίπεδο. Μεγάλο τμήμα της ακτογραμμής της είναι βραχώδες, αποτελούμενο κυρίως από ασβεστολιθικά πετρώματα, ένα χαρακτηριστικό φυσικό υλικό της λεκάνης της Μεσογείου. Στις περιοχές αυτές αναπτύσσονται θαλάσσιοι οικότοποι υψηλής βιολογικής και οικονομικής αξίας για την παράκτια ζώνη. Η υψηλή αξία τους είναι λόγω της υψηλής πολυπλοκότητας που έχουν τα οικοσυστήματα αυτά, της υψηλής βιοποκιλότητας που φιλοξενούν αλλά και των οικοσυστημικών λειτουργιών και υπηρεσιών που παρέχουν στο ευρύτεροι φυσικό και κοινωνικό περιβάλλον. Λόγω της υψηλής αξίας και σημασίας των οικοσυστημάτων αυτών, η Ευρωπαϊκή Επιτροπή ενέταξε τον οικότοπο των Μεσογειακών υφάλων (κωδικός οικοτόπου 1170) υπο την οδηγία για την διατήρηση και προστασία των Ευρωπαϊκών Οικοσυστημάτων του δικτύου προστατευόμενων περιοχών NATURA 2000 (92/43/EEC). Στην υποπαραλιακή ζώνη των Μεσογειακών υφάλων, απαντώνται δυο κύριες βιοκοινωνίες που συνθέτουν το πολύπλοκο αυτό οικοσύστημα. Η βιοκοινωνία των φωτοφιλων μακροφυκών και οι κοραλλιγενείς σχηματισμοί.

Η πρώτη είναι και κυρίαρχη στην ζώνη από 1 έως 30 μέτρα, το εύρος της καθορίζεται από την θολερότητα της στήλης του νερού, την διαπερατότητα του ηλιακού φωτός και την διαθεσιμότητα θρεπτικών στοιχείων στο νερό. Βαθύτερα και μεχρι τα 120 μέτρα απαντώνται οι κοραλλιγενείς σχηματισμοί, ένα ιδιαίτερα παραγωγικό οικοσύστημα που τα λειτουργικά του χαρακτηριστικά αλλά και η βιοποικιλότητα που φιλοξενεί παραμένουν μερικώς άγνωστα μέχρι σήμερα. Το όνομα του δόθηκε από τον Γάλλο ζωολόγο A.F. Marion το 1883, όταν κατά την διάρκεια των μελετών που έκανε για τους βιογενείς σχηματισμούς στον κόλπο της Μασσαλίας, ανέσειρε θραύσματα από διάφορα είδη κοραλλιών, ανάμεσα τους και αποικίες του κόκκινου κοραλλιού (*Corallium rubrum*). Η ύπαρξη των κοραλλιγενών σχηματισμών εξαρτάται από το διαθέσιμο ηλιακό φως, σε αντίθεση με την βιοκοινωνία των φωτοφιλων φυκών – όπου το φως αποτελεί κύρια πηγή ενέργειας/τροφής μέσω της διαδικασίας της φωτοσύνθεσης – οι κοραλλιγενείς σχηματισμοί αναπτύσσονται στις θέσεις αυτές που φτάνει λιγότερο από το 1% του διαθέσιμου φωτός στον πυθμένα της θάλασσας. Κύριο συστατικό των σχηματισμών αυτών είναι τα ενασβεστωμένα ροδοφύκη που δημιουργούν αποικίες με πολύ αργή ανάπτυξη τους μέσω της διαδικασίας της φωτοσύνθεσης με χαμηλά επίπεδα ηλιακής ακτινοβολίας και της απορρόφησης διοξειδίου του άνθρακα (CO_2) ως δομικό συστατικό. Και οι δυο βιοκοινωνίες αποτελούν καταφύγιο για πάρα πολλούς οργανισμούς, νηπιαγωγείο για πολλά εμπορικά είδη ψαριών ενώ παρέχουν τροφή και κάλυψη σε μια από τις κυρίαρχες ταξινομικές ομάδες στην βιοκοινωνία αυτή, τα μαλάκια. Η ταξινομική ομάδα αυτή, αποτελεί και μια από τις ποιο μελετημένες ομάδες της θαλάσσιας βιοποικιλότητας της Μεσογείου, όπου από το σύνολο των 17.000 οργανισμών που ζουν εκεί, το 13% είναι τα μαλάκια. Παρόλα αυτά, η βιοποικιλότητα των μαλακίων των Μεσογειακών υφάλων είναι ελάχιστα μελετημένη στην Μεσόγειο. Ο κύριος όγκος των μελετών έρχεται από την Δυτική Μεσόγειο στις αρχές του 1960 ενώ ελάχιστες μελέτες αφορούν την Ανατολική Μεσόγειο.

Σκοπός των εργασιών είναι: (α) η συλλογή και αποδελτίωση της διαθέσιμης και προσβάσιμης δημοσιευμένης και γκρίζας βιβλιογραφίας σχετικά με την βιοποικιλότητα των μαλακίων των φωτοφιλων φυκών και των κοραλλιγενών σχηματισμών της Μεσογείου, (β) η αξιοποίηση του υλικού που συλλέχθηκε από τις Βόρειες ακτές της Κρήτης στα πλαίσια του προγράμματος παρακολούθησης παράκτιων θαλάσσιων οικοτόπων NaGISA και (γ) η δωρεάν διάθεση των παραχθέντων δεδομένων με την χρήση της δομής Darwin Core και βάσης δεδομένων Microsoft Access σε διαδικτυακά επιστημονικά αποθετήρια (Lifewatch, GBIF, PANGAEA) για περαιτέρω χρήση από την επιστημονική κοινότητα. Ακολουθήθηκε η συστηματική των ειδών που είναι διαθέσιμη από το Παγκόσμιο Μητρώο των Οργανισμών της Θάλασσας (World Registered of Marine Species – WORMS) για να επικαιροποιηθούν τα παραχθέντα δεδομένα. Εντοπίσθηκαν και αξιοποιήθηκαν 22 επιστημονικές αναφορές, διδακτορικές διατριβές καθώς σχετικές εκδόσεις για την ανάκτηση της πληροφορίας αναφορικά με τα μαλάκια των φωτοφιλων φυκών και 12 για τους κοραλλιγενείς σχηματισμούς. Η πρώτη διαθέσιμη εργασία αφορά το έτος 1966 και την τελευταία το 2014. Ο μεγάλος όγκος των βιβλιογραφικών δεδομένων προέρχεται από την Δυτική και Κεντρική Μεσόγειο και Αδριατική ενώ λιγότερα είναι τα δεδομένα που προέρχονται από την Ανατολική Μεσόγειο. Στην Ανατολική Μεσόγειο, τα δεδομένα προέρχονται κυρίως από το Βόρειο Αιγαίο πέλαγος ενώ από το νότιο και ανατολικότερα στην θάλασσα της Λεβαντίνης είναι εμφανή η απουσία δημοσιευμένων και προσβάσιμων δεδομένων. Νέα δεδομένα που δημοσιεύονται για πρώτη φορά προέρχονται από τις ακτές της Κρήτης, το βόρειο Κρητικό πέλαγος ενω αυτά αποτελούν και το ανατολικότερο όριο διάθεσης επιστημονικών δεδομένων για την βιοποικιλότητα των μαλακίων των φωτοφιλων φυκών στην Μεσόγειο. Τα δεδομένα αυτά συλλέχθηκαν στα πλαίσια του προγράμματος παρακολούθησης παράκτιων θαλάσσιων οικοτόπων NaGISA. Δυο θέσεις μελετήθηκαν στην Κρήτη. Μια στον νομό Ηρακλείου στην περιοχή της Αγίας Πελαγίας και μια θέση στον νομό Λασιθίου στην περιοχή της Ελούντας. Και οι δυο θέσεις μοιράζονται κοινά χαρακτηριστικά όπως είναι το μέγιστο βάθος ύπαρξης φωτοφιλων φυκών, η μη γειτνίαση με ανθρωπογενείς πηγές ρύπανσης και η κλίση του βυθού. Το βενθικό υλικό συλλέχθηκε με την χρήση συσκευών αυτόνομης κατάδυσης (SCUBA Diving) τον Σεπτέμβριο του 2007 και τον Ιούνιο του 2008 ακολουθώντας το πρωτόκολλο NaGISA. Από 5 διαφορετικά βάθη (1-5-10-15-20μ.) συλλέχθηκαν 5 επαναληπτικά δείγματα εντός πλαισίου 20*20 εκατ. Πριν την συλλογή του υλικού, σε ένα μεγαλύτερο πλαίσιο (50*50 εκατ.) πραγματοποιήθηκε σχετική υποβρύχια φωτογράφηση του περιεχομένου για εκτίμηση ποσοστού κάλυψης των μακροφυκών. Στην συνέχεια αφαιρέθηκε εντός των ορίων του μικρού πλαισίου η φυτοκάλυψη και αποθηκεύτηκε σε ανθεκτικές πλαστικές σακούλες για περαιτέρω χρήση. Τέλος, έγινε χρήση υποβρύχιου αναρροφητήρα για την συλλογή του βενθικού υλικού καθώς αυτός εξασφαλίζει την ελάχιστη απώλεια δείγματος.

Συνολικά, 599 είδη μαλακίων έχουν αναφερθεί από την βιοκοινωνία των φωτοφιλων φυκών. 155 είναι οι οικογένειες που ανήκουν, με 71 από αυτές να έχουν από ένα μόνο είδος στην βιοκοινωνία αυτή και μόνο 14 να έχουν περισσότερα από 10 είδη. Τα γαστερόποδα αποτελούν και την κυρίαρχη κλάση, ακολουθούμενα από τα δίθυρα και τα πολυπλακοφόρα. Ο απόλυτος αριθμός των αναφερθέντων ειδών στις περιοχές μελέτης διαφέρει σε μεγάλο βαθμό. Ο μικρότερος αριθμός ειδών αναφέρεται από την περιοχή της Μασσαλίας στην Γαλλία (n=38) ενώ ο μεγαλύτερος από την περιοχή της Τύνιδας στην Τυνησία (n=281). Σε επίπεδο οικογενειών, η Μασσαλία (Γαλλία), η Αυλώνα (Αλβανία) και το ακρωτήρι της Παναγιάς (Ιταλία) έχουν τον χαμηλότερο αριθμό (n=25) ενώ η Τυνιδα και η Χαλκιδική έχουν το μεγαλύτερο αριθμό (n=73 & n=76). Συγκρίνοντας τον συνολικό αριθμό των θαλάσσιων μαλακίων της παρούσας εργασίας με την Μεσογειακή μαλακοπανίδα, βλέπουμε πως σχεδόν το ¼ αυτής (599 από το σύνολο των ~ 2000 ειδών) απαντάται στην βιοκοινωνία των φωτοφιλων φυκών. Αντίστοιχος είναι και ο αριθμός των μαλακίων που απαντώνται στην ζώνη των κοραλλιγενών σχηματισμών. 511 είδη μαλακίων έχουν αναφερθεί από τους κοραλλιγενείς σχηματισμούς, ανήκουν σε 143 οικογένειες και 5 κλάσεις. Τα γαστερόποδα είναι η κυρίαρχη κλάση με 357 είδη ακολουθούμενη από τα δίθυρα με 137 είδη, τα πολυπλακοφόρα με 14 είδη, τα κεφαλόποδα με 2 είδη και τα σκαφόποδα με 1 είδος. Τα γαστερόποδα αποτελούνται από 92 οικογένειες, τα δίθυρα από 42 οικογένειες, τα πολυπλακοφόρα από 6 οικογένειες, τα κεφαλόποδα από 2 οικογένειες και τα σκαφόποδα από 1 οικογένεια. Το μεγαλύτερο μέρος των δεδομένων προέρχεται από την Δυτική Μεσόγειο και αυτό είναι εμφανές στο σχετικό διάγραμμα Venn. Από το σύνολο των καταγεγραμμένων ειδών, 462 είδη έχει καταγραφεί στην Δυτική Μεσόγειο από τους κοραλλιγενείς σχηματισμούς, 102 από την Αδριατική και μόλις 8 από την Ανατολική Μεσόγειο. Τα δεδομένα παρουσιάζουν κάποιες ομαδοποιήσεις στην ανάλυση ταξιθέτησης. Μεγάλο μέρος αυτών παρουσιάζουν μια τάση για ομαδοποίηση, ενώ μερικές έχουν τάση για απομόνωση. Ενδιαφέρον παρουσιάζουν οι θέσεις από τις οποίες μελετήθηκαν οι συναθροίσεις των μαλακίων που ζουν στο κόκκινο κοράλλι, που αν και αναμένεται να έχουν τάση για ομαδοποίηση, εντούτοις αυτό δεν συμβαίνει. Πιθανός λόγος για αυτό είναι το διαφορετικό βάθος συλλογή του υλικού καθώς και των σχετικών δειγματοληπτικών μέσων.

Αν και ο αριθμός των μαλακίων των φωτοφιλων φυκών φαίνεται μεγάλος, εντούτοις είναι εμφανής η απουσία δεδομένων από την θάλασσα της Λεβαντίνης καθώς και η συστηματική μελέτη της βιοκοινωνίας αυτής ώστε να γίνουν κατανοητά τα λειτουργικά χαρακτηριστικά της, η δυναμική της μέσα στον χρόνο καθώς και οι ικανότητες αντίστασης σε ανθρωπογενείς δραστηριότητες. Πέρα από τα δεδομένα της πρωτοβουλίας NaGISA, δεν υπάρχουν άλλα ποσοτικά διαθέσιμα και δημοσιευμένα δεδομένα που να αφορούν την βιοκοινωνία των φωτοφιλων φυκών. Επιπρόσθετα την τελευταία δεκαετία υπάρχει η τάση της μη συλλογής βιολογικού υλικού και της εφαρμογής μη καταστρεπτικών μεθόδων για την μελέτη των θαλασσίων οικοσυστημάτων των Μεσογειακών υφάλων. Αυτό θα έχει ως αποτέλεσμα την αδυναμία στην εμβάθυνση της γνώσης για την βιοποικιλότητα των κοραλλιγενών σχηματισμών καθώς αποτελεί ένα οικοσύστημα τεσσάρων διαστάσεων (όπου η τέταρτη διάσταση είναι ο χρόνος – μέρα/νύχτα). Εντός των σπηλαιωμάτων και των ανοιγμάτων ζουν μια πλειάδα από οργανισμούς, εδραίους και μη που έχουν κρυπτική συμπεριφορά, οι οποίοι είτε δεν μετακινούνται είτε δραστηριοποιούνται κατά την διάρκεια της νύχτας. Η εφαρμογή μη καταστρεπτικών μεθόδων (φωτογραφικά πλαίσια) δεν έχει την ικανότητα να παρέχει πρόσβαση σε αυτά τα είδη, που αποτελούν την πλειονότητα της βιοποικιλότητας. Σε μια από τις μελέτες που αναλύθηκαν, αναφέρεται πως αν δεν είχαν συλλεχθεί δείγματα από τα μπλόκ που σχηματίζουν τα ροδοφύκη, δεν θα ήταν εφικτός ο εντοπισμός και η μελέτη οργανισμών που ζουν και αναπτύσσονται σε θέσεις εντός των σχηματισμών.

Δεδομένου του ότι η παράκτια ζώνη βρίσκεται υπο συνεχή πίεση κυρίως από ανθρωπογενείς δραστηριότητες που μειώνουν την οικολογική αξία και καταστρέφουν το θαλάσσιο οικοσύστημα, απαραίτητη κρίνεται η υιοθέτηση ενός κοινού πρωτοκόλλου για την παρακολούθηση των δυο αυτών οικοτόπων. Επιπρόσθετα, είναι κοινή απαίτηση η ύπαρξη διαθέσιμων δεδομένων για την βιοποικιλότητα όλων των θαλάσσιων οικοσυστημάτων από διεθνείς οργανισμούς όπως το RAC/SPA και η UNEP/MAP, ώστε να μπορούν και γίνουν συγκριτικές μελέτες για τις λειτουργίες και υπηρεσίες που παρέχουν αλλά και τα δεδομένα αυτά να μπορούν να χρησιμοποιηθούν σε αναλύσεις όπως ο θαλάσσιος χωρικός σχεδιασμός και η εφαρμογή της οδηγίας για την θαλάσσια στρατηγική και την επίτευξη της καλής κατάστασης των θαλασσών. Τα δεδομένα αυτά αποτελούν τα μόνα διαθέσιμα σε επίπεδο βιοκοινωνίας και αποτελούν την έναρξη της δημιουργίας σχετικών καταλόγων σε επίπεδο οικοσυστημάτων για την Μεσόγειο.

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Data Paper

ReefMedMol: Mollusca from the infralittoral rocky shores - the biocoenosis of photophilic algae - in the Mediterranean Sea

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Abstract

Background

This paper describes two datasets on the molluscan fauna from the Mediterranean infralittoral reef ecosystem - the biocoenosis of photophilic algae. The first dataset is taken from the East Mediterranean node of the NAGISA project. The second one is a compilation based on the available published material in peer - reviewed journals as well as from the accessible grey literature. These datasets cover a time period of 43 years from 1969 to 2012 from several locations spanning the Mediterranean Sea.

New information

This dataset is the only one available from this important Mediterranean Habitat, coded as 1170 in the Habitats Directive (92/43/EEC) and can provide valuable information on the

needs of ecosystems functions and services assessment, habitat and species conservation as well as marine spatial planning.

Keywords

Infralittoral zone, Mollusca, Reefs, 1170, Photophilic algae, Mediterranean Sea, Biodiversity, 1969–2014

Introduction

The Mediterranean Sea is the largest enclosed marine environment globally (Coll et al. 2010). A large proportion of its coastline is rocky and mainly made by limestone, a defining characteristic of this marine basin (Gerovasileiou and Voultsiadou 2012). There, marine hard substrates exists which is of great ecological and economic value due to the high structural complexity on which rich marine communities are based. Yet, several goods and services are provided by (Salomidi et al. 2012). Due to the importance of this marine ecosystem, Habitat Directive 92/43/EEC includes it under the code 1170 (Reefs). In the infralittoral zone of the hard substrate, several biocoenoses exist (Pérès and Picard 1964). Among them, the biocoenosis of the photophilic algae is the one that dominates the hard substrates in depths up to 30 meters, depending on the water turbidity, light penetration and availability of nutrients (Coppejans 1980). Macroalgae, the main component of this biocoenosis, provides an excellent host for food and shelter to the taxonomic group of molluscs. This is one of the most important animal groups found in the Mediterranean Sea, and its molluscan fauna is the best known in the world (Sabelli and Taviani 2013) while from the 17,000 marine species that have been found in the Mediterranean, 13% are molluscs (Coll et al. 2010). The biocoenosis of photophilic algae is, however, poorly studied in terms of molluscan biodiversity; few studies examine the species communities in the infralittoral zone. All of them are paper-based, while the detection of them as well as the compilation of the included published information about the species and other associated data (sampling method, depths, location, time period) cannot be retrieved automatically by machine-learning methods and tools.

This study attempts to expand the current knowledge on the rocky infralittoral zone of the Mediterranean Sea by providing occurrence data of molluscan species from two different sources. The first one comes from the sampling campaign of the NAGISA project in the East Mediterranean Sea while the second one comes from the compilation of the available and accessible published material in peer-reviewed journals and grey literature. The present datasets include georeferenced and fully documented information from 22 regions/ sampling sites across the Mediterranean Sea, from 1969 to 2012 (Table 1) on 599 species of molluscs (Table 2). Additional information based on the dataset of the NAGISA project about the recorded individuals per species is alsoincluded (127 species, 10326 individuals).

Table 1.

Coordinates, depth and sampling dates of the sampling localities

Country	Sampling site	Minimum depth (in meters)	Maximum depth (in meters)	Latitude	Longitude	Sampling period
Albania	Vlora bay	1	15	40.36343	19.473392	2004-2006
France	Marseille area	5	25	43.18859	5.546588	1969
France	Calvi	3	30	42.57192	8.747125	1980-1983
Greece	Chalkidiki peninsula	15	30	40.11722	23.984323	1997-1998
Greece	Chalkidiki peninsula	15	40	39.98843	23.858191	1997-1998
Greece	Chalkidiki peninsula	15	40	39.98843	23.858191	1998-1999
Greece	Pelagos - Piperi - Gioura	2	8	39.32063	24.054025	1995
Italy	Isola Bella	1	30	37.84993	15.300747	1990
Italy	Lampedusa	0	10	35.52305	12.59324	1990
Italy	Ionian coast of Salento			40.2732	17.791895	1992-2002
Italy	Capo Madonna, Lampedusa Island	1	6	35.4982	12.589623	1994
Italy	Gulf of Castellammare	16	22	38.03581	12.874333	1995
Italy	Ustica island	1	15	38.6938	13.178993	1996
Italy	Otranto	5	25	40.14283	18.507785	2000
Italy	South-western coast of Apulia	3	4	40.18485	17.92297	2002
Italy	Torre del Serpe	1	20	40.145	18.505	2004-2009
Slovenia	Gulf or Trieste	1	4	45.54799	13.662176	2008-2012
Spain	Medes island	1	30	42.04534	3.224491	1984
Spain	Bay of Algeciras	3	5	36.13232	-5.418617	1992-1993
Tunisia	Tunis town	1	2	36.82333	10.31931	2009-2010
Tunisia	Tunis town	3	15	36.82333	10.31931	2009-2010
Turkey	Izmir bay	1	20	38.41861	27.139167	1978

Table 2.

The assembled species list in phylogenetic order.

Class	Family	Species	Authority
Polyplacophora	Chitonidae	*Chiton olivaceus*	Spengler, 1797
Polyplacophora	Chitonidae	*Chiton corallinus*	(Risso, 1826)
Polyplacophora	Chitonidae	*Chiton phaseolinus*	Monterosato, 1879
Polyplacophora	Leptochitonidae	*Lepidopleurus cajetanus*	(Poli, 1791)
Polyplacophora	Leptochitonidae	*Lepidopleurus* sp.	Risso, 1826
Polyplacophora	Leptochitonidae	*Leptochiton scabridus*	(Jeffreys, 1880)
Polyplacophora	Ischnochitonidae	*Ischnochiton rissoi*	(Payraudeau, 1826)
Polyplacophora	Ischnochitonidae	*Ischnochiton* sp.	
Polyplacophora	Callistoplacidae	*Callistochiton pachylasmae*	(Monterosato, 1879)
Polyplacophora	Callochitonidae	*Callochiton septemvalvis*	(Montagu, 1803)
Polyplacophora	Lepidochitonidae	*Lepidochitona* sp.	Gray, 1821
Polyplacophora	Lepidochitonidae	*Lepidochitona caprearum*	(Scacchi, 1836)
Polyplacophora	Lepidochitonidae	*Lepidochitona cinerea*	(Linnaeus, 1767)
Polyplacophora	Lepidochitonidae	*Lepidochitona furtiva*	(Monterosato, 1879)
Polyplacophora	Lepidochitonidae	*Lepidochitona monterosatoi*	Kaas & Van Belle, 1981
Polyplacophora	Acanthochitonidae	*Acanthochitona discrepans*	(Brown, 1827)
Polyplacophora	Acanthochitonidae	*Acanthochitona fascicularis*	(Linnaeus, 1767)
Gastropoda	Patellidae	*Patella caerulea*	Linnaeus, 1758
Gastropoda	Patellidae	*Patella rustica*	Linnaeus, 1758
Gastropoda	Patellidae	*Patella ulyssiponensis*	Gmelin, 1791
Gastropoda	Lottiidae	*Tectura virginea*	(O. F. Müller, 1776)
Gastropoda	Fissurellidae	*Diodora dorsata*	(Monterosato, 1878)
Gastropoda	Fissurellidae	*Diodora gibberula*	(Lamarck, 1822)
Gastropoda	Fissurellidae	*Diodora graeca*	(Linnaeus, 1758)
Gastropoda	Fissurellidae	*Diodora italica*	(Defrance, 1820)
Gastropoda	Fissurellidae	*Emarginula* sp.	
Gastropoda	Fissurellidae	*Emarginula adriatica*	O. G. Costa, 1830
Gastropoda	Fissurellidae	*Emarginula huzardii*	Payraudeau, 1826

Gastropoda	Fissurellidae	*Emarginula octaviana*	Coen, 1939
Gastropoda	Fissurellidae	*Emarginula tenera*	Locard, 1892
Gastropoda	Fissurellidae	*Fissurella nubecula*	(Linnaeus, 1758)
Gastropoda	Fissurellidae	*Puncturella noachina*	(Linnaeus, 1771)
Gastropoda	Scissurellidae	*Scissurella costata*	d'Orbigny, 1824
Gastropoda	Scissurellidae	*Sinezona cingulata*	(O. G. Costa, 1861)
Gastropoda	Anatomidae	*Anatoma crispata*	(Fleming, 1828)
Gastropoda	Haliotidae	*Haliotis tuberculata*	Linnaeus, 1758
Gastropoda	Haliotidae	*Haliotis tuberculata lamellosa*	Lamarck, 1822
Gastropoda	Trochidae	*Clanculus* sp.	
Gastropoda	Trochidae	*Clanculus corallinus*	(Gmelin, 1791)
Gastropoda	Trochidae	*Clanculus cruciatus*	(Linnaeus, 1758)
Gastropoda	Trochidae	*Clanculus jussieui*	(Payraudeau, 1826)
Gastropoda	Trochidae	*Gibbula adansonii*	(Payraudeau, 1826)
Gastropoda	Trochidae	*Gibbula adriatica*	(Philippi, 1844)
Gastropoda	Trochidae	*Gibbula albida*	(Gmelin, 1791)
Gastropoda	Trochidae	*Gibbula ardens*	(Salis Marschlins, 1793)
Gastropoda	Trochidae	*Gibbula divaricata*	(Linnaeus, 1758)
Gastropoda	Trochidae	*Gibbula drepanensis*	(Brugnone, 1873)
Gastropoda	Trochidae	*Gibbula fanulum*	(Gmelin, 1791)
Gastropoda	Trochidae	*Gibbula guttadauri*	(Philippi, 1836)
Gastropoda	Trochidae	*Gibbula leucophaea*	(Philippi, 1836)
Gastropoda	Trochidae	*Gibbula magus*	(Linnaeus, 1758)
Gastropoda	Trochidae	*Gibbula philberti*	(Récluz, 1843)
Gastropoda	Trochidae	*Gibbula racketti*	(Payraudeau, 1826)
Gastropoda	Trochidae	*Gibbula rarilineata*	(Michaud, 1829)
Gastropoda	Trochidae	*Gibbula tingitana*	Pallary, 1901
Gastropoda	Trochidae	*Gibbula turbinoides*	(Deshayes, 1835)
Gastropoda	Trochidae	*Gibbula umbilicaris*	(Linnaeus, 1758)
Gastropoda	Trochidae	*Gibbula varia*	(Linnaeus, 1758)
Gastropoda	Trochidae	*Jujubinus exasperatus*	(Pennant, 1777)

Gastropoda	Trochidae	*Jujubinus gravinae*	(Dautzenberg, 1881)
Gastropoda	Trochidae	*Jujubinus ruscurianus*	(Weinkauff, 1868)
Gastropoda	Trochidae	*Jujubinus striatus*	(Linnaeus, 1758)
Gastropoda	Trochidae	*Phorcus articulatus*	(Lamarck, 1822)
Gastropoda	Trochidae	*Phorcus turbinatus*	(Born, 1778)
Gastropoda	Calliostomatidae	*Calliostoma conulus*	(Linnaeus, 1758)
Gastropoda	Calliostomatidae	*Calliostoma gualterianum*	(Philippi, 1848)
Gastropoda	Calliostomatidae	*Calliostoma laugieri*	(Payraudeau, 1826)
Gastropoda	Calliostomatidae	*Calliostoma zizyphinum*	(Linnaeus, 1758)
Gastropoda	Turbinidae	*Bolma rugosa*	(Linnaeus, 1767)
Gastropoda	Skeneidae	*Skenea serpuloides*	(Montagu, 1808)
Gastropoda	Chilodontidae	*Danilia otaviana*	(Cantraine, 1835)
Gastropoda	Phasianellidae	*Tricolia* sp.	
Gastropoda	Phasianellidae	*Tricolia entomocheila*	Gofas, 1993
Gastropoda	Phasianellidae	*Tricolia miniata*	(Monterosato, 1884)
Gastropoda	Phasianellidae	*Tricolia pullus*	(Linnaeus, 1758)
Gastropoda	Phasianellidae	*Tricolia speciosa*	(Megerle von Mühlfeld, 1824)
Gastropoda	Phasianellidae	*Tricolia tenuis*	(Michaud, 1829)
Gastropoda	Phasianellidae	*Tricolia tingitana*	Gofas, 1982
Gastropoda	Colloniidae	*Homalopoma sanguineum*	(Linnaeus, 1758)
Gastropoda	Neritidae	*Smaragdia viridis*	(Linnaeus, 1758)
Gastropoda	Neritidae	*Theodoxus fluviatilis*	(Linnaeus, 1758)
Gastropoda	Cerithiidae	*Bittium* sp.	
Gastropoda	Cerithiidae	*Bittium lacteum*	(Philippi, 1836)
Gastropoda	Cerithiidae	*Bittium latreillii*	(Payraudeau, 1826)
Gastropoda	Cerithiidae	*Bittium nanum*	(Mayer, 1864)
Gastropoda	Cerithiidae	*Bittium reticulatum*	(da Costa, 1778)
Gastropoda	Cerithiidae	*Bittium submamillatum*	(de Rayneval & Ponzi, 1854)
Gastropoda	Cerithiidae	*Cerithium* sp.	
Gastropoda	Cerithiidae	*Cerithium lividulum*	Risso, 1826
Gastropoda	Cerithiidae	*Cerithium renovatum*	Monterosato, 1884

Gastropoda	Cerithiidae	*Cerithium vulgatum*	Bruguière, 1792
Gastropoda	Cerithiidae	*Cerithium scabridum*	Philippi, 1848
Gastropoda	Cerithiidae	*Cerithium vulgatum*	Bruguière, 1792
Gastropoda	Planaxidae	*Fossarus ambiguus*	(Linnaeus, 1758)
Gastropoda	Potamididae	*Pirenella conica*	(Blainville, 1829)
Gastropoda	Turritellidae	*Turritella communis*	Risso, 1826
Gastropoda	Turritellidae	*Turritella triplicata*	(Brocchi, 1814)
Gastropoda	Triphoridae	*Cheirodonta pallescens*	(Jeffreys, 1867)
Gastropoda	Triphoridae	*Cosmotriphora melanura*	(C. B. Adams, 1850)
Gastropoda	Triphoridae	*Marshallora adversa*	(Montagu, 1803)
Gastropoda	Triphoridae	*Metaxia metaxa*	(Delle Chiaje, 1828)
Gastropoda	Triphoridae	*Monophorus* sp.	
Gastropoda	Triphoridae	*Monophorus erythrosoma*	(Bouchet & Guillemot, 1978)
Gastropoda	Triphoridae	*Monophorus perversus*	(Linnaeus, 1758)
Gastropoda	Triphoridae	*Monophorus thiriotae*	Bouchet, 1985
Gastropoda	Triphoridae	*Similiphora similior*	(Bouchet & Guillemot, 1978)
Gastropoda	Cerithiopsidae	*Cerithiopsis* sp.	
Gastropoda	Cerithiopsidae	*Cerithiopsis atalaya*	Watson, 1885
Gastropoda	Cerithiopsidae	*Cerithiopsis barleei*	Jeffreys, 1867
Gastropoda	Cerithiopsidae	*Cerithiopsis fayalensis*	Watson, 1880
Gastropoda	Cerithiopsidae	*Cerithiopsis minima*	(Brusina, 1865)
Gastropoda	Cerithiopsidae	*Cerithiopsis scalaris*	Locard, 1892
Gastropoda	Cerithiopsidae	*Cerithiopsis tubercularis*	(Montagu, 1803)
Gastropoda	Cerithiopsidae	*Dizoniopsis bilineata*	(Hoernes, 1848)
Gastropoda	Cerithiopsidae	*Dizoniopsis coppolae*	(Aradas, 1870)
Gastropoda	Cerithiopsidae	*Krachia tiara*	(Monterosato, 1874)
Gastropoda	Cerithiopsidae	*Seila trilineata*	(Philippi, 1836)
Gastropoda	Epitoniidae	*Epitonium clathrus*	(Linnaeus, 1758)
Gastropoda	Epitoniidae	*Epitonium tenuicostatum*	(G. B. Sowerby, 1844)
Gastropoda	Epitoniidae	*Epitonium turtonis*	(Turton, 1819)
Gastropoda	Epitoniidae	*Gyroscala lamellosa*	(Lamarck, 1822)

Gastropoda	Eulimidae	*Eulima glabra*	(da Costa, 1778)
Gastropoda	Eulimidae	*Melanella lubrica*	(Monterosato, 1890)
Gastropoda	Eulimidae	*Melanella petitiana*	(Brusina, 1869)
Gastropoda	Eulimidae	*Melanella polita*	(Linnaeus, 1758)
Gastropoda	Eulimidae	*Melanella praecurta*	(Pallary, 1904)
Gastropoda	Eulimidae	*Vitreolina incurva*	(Bucquoy, Dautzenberg & Dollfus, 1883)
Gastropoda	Eulimidae	*Vitreolina philippi*	(de Rayneval & Ponzi, 1854)
Gastropoda	Littorinidae	*Echinolittorina punctata*	(Gmelin, 1791)
Gastropoda	Littorinidae	*Melarhaphe neritoides*	(Linnaeus, 1758)
Gastropoda	Skeneopsidae	*Skeneopsis planorbis*	(O. Fabricius, 1780)
Gastropoda	Cingulopsidae	*Eatonina cossurae*	(Calcara, 1841)
Gastropoda	Cingulopsidae	*Eatonina fulgida*	(Adams J., 1797)
Gastropoda	Cingulopsidae	*Tubbreva micrometrica*	(Aradas & Benoit, 1876)
Gastropoda	Rissoidae	*Alvania* sp.	
Gastropoda	Rissoidae	*Alvania aspera*	(Philippi, 1844)
Gastropoda	Rissoidae	*Alvania beanii*	(Hanley in Thorpe, 1844)
Gastropoda	Rissoidae	*Crisilla beniamina*	(Monterosato, 1884)
Gastropoda	Rissoidae	*Alvania cancellata*	(da Costa, 1778)
Gastropoda	Rissoidae	*Alvania cimex*	(Linnaeus, 1758)
Gastropoda	Rissoidae	*Alvania colossophilus*	Oberling, 1970
Gastropoda	Rissoidae	*Alvania discors*	(Allan, 1818)
Gastropoda	Rissoidae	*Alvania dorbignyi*	(Audouin, 1826)
Gastropoda	Rissoidae	*Alvania geryonia*	(Nardo, 1847)
Gastropoda	Rissoidae	*Alvania hallgassi*	Amati & Oliverio, 1985
Gastropoda	Rissoidae	*Alvania lactea*	(Michaud, 1830)
Gastropoda	Rissoidae	*Alvania lanciae*	(Calcara, 1845)
Gastropoda	Rissoidae	*Alvania lineata*	Risso, 1826
Gastropoda	Rissoidae	*Alvania mamillata*	Risso, 1826
Gastropoda	Rissoidae	*Alvania pagodula*	(Bucquoy, Dautzenberg & Dollfus, 1884)
Gastropoda	Rissoidae	*Alvania parvula*	(Jeffreys, 1884)

Gastropoda	Rissoidae	*Alvania rudis*	(Philippi, 1844)
Gastropoda	Rissoidae	*Alvania scabra*	(Philippi, 1844)
Gastropoda	Rissoidae	*Alvania simulans*	Locard, 1886
Gastropoda	Rissoidae	*Alvania spinosa*	(Monterosato, 1890)
Gastropoda	Rissoidae	*Alvania subcrenulata*	(Bucquoy, Dautzenberg & Dollfus, 1884)
Gastropoda	Rissoidae	*Alvania tenera*	(Philippi, 1844)
Gastropoda	Rissoidae	*Alvania tessellata*	Schwartz in Weinkauff, 1868
Gastropoda	Rissoidae	*Benthonella tenella*	(Jeffreys, 1869)
Gastropoda	Rissoidae	*Crisilla beniamina*	(Monterosato, 1884)
Gastropoda	Rissoidae	*Crisilla semistriata*	(Montagu, 1808)
Gastropoda	Rissoidae	*Manzonia crassa*	(Kanmacher, 1798)
Gastropoda	Rissoidae	*Peringiella elegans*	(Locard, 1892)
Gastropoda	Rissoidae	*Pusillina* sp.	
Gastropoda	Rissoidae	*Pusillina benzi*	(Aradas & Maggiore, 1844)
Gastropoda	Rissoidae	*Pusillina inconspicua*	(Alder, 1844)
Gastropoda	Rissoidae	*Pusillina lineolata*	(Michaud, 1830)
Gastropoda	Rissoidae	*Pusillina marginata*	(Michaud, 1830)
Gastropoda	Rissoidae	*Pusillina philippi*	(Aradas & Maggiore, 1844)
Gastropoda	Rissoidae	*Pusillina radiata*	(Philippi, 1836)
Gastropoda	Rissoidae	*Rissoa* sp.	
Gastropoda	Rissoidae	*Rissoa auriscalpium*	(Linnaeus, 1758)
Gastropoda	Rissoidae	*Rissoa decorata*	Philippi, 1846
Gastropoda	Rissoidae	*Rissoa guerinii*	Récluz, 1843
Gastropoda	Rissoidae	*Rissoa lia*	(Monterosato, 1884)
Gastropoda	Rissoidae	*Rissoa lilacina*	Récluz, 1843
Gastropoda	Rissoidae	*Rissoa membranacea*	(J. Adams, 1800)
Gastropoda	Rissoidae	*Rissoa monodonta*	Philippi, 1836
Gastropoda	Rissoidae	*Rissoa parva*	(da Costa, 1778)
Gastropoda	Rissoidae	*Rissoa scurra*	(Monterosato, 1917)
Gastropoda	Rissoidae	*Rissoa similis*	Scacchi, 1836
Gastropoda	Rissoidae	*Rissoa splendida*	Eichwald, 1830

Gastropoda	Rissoidae	*Rissoa variabilis*	(Von Mühlfeldt, 1824)
Gastropoda	Rissoidae	*Rissoa ventricosa*	Desmarest, 1814
Gastropoda	Rissoidae	*Rissoa violacea*	Desmarest, 1814
Gastropoda	Rissoidae	*Setia amabilis*	(Locard, 1886)
Gastropoda	Rissoidae	*Setia ambigua*	(Brugnone, 1873)
Gastropoda	Rissoidae	*Setia antipolitana*	(van der Linden & W. M. Wagner, 1987)
Gastropoda	Rissoidae	*Setia maculata*	(Monterosato, 1869)
Gastropoda	Rissoidae	*Setia turriculata*	Monterosato, 1884
Gastropoda	Anabathridae	*Nodulus contortus*	(Jeffreys, 1856)
Gastropoda	Anabathridae	*Pisinna glabrata*	(Megerle von Mühlfeld, 1824)
Gastropoda	Barleeiidae	*Barleeia unifasciata*	(Montagu, 1803)
Gastropoda	Caecidae	*Caecum antillarum*	Carpenter, 1858
Gastropoda	Caecidae	*Caecum clarkii*	Carpenter, 1859
Gastropoda	Caecidae	*Caecum subannulatum*	de Folin, 1870
Gastropoda	Caecidae	*Caecum trachea*	(Montagu, 1803)
Gastropoda	Caecidae	*Parastrophia asturiana*	de Folin, 1870
Gastropoda	Iravadiidae	*Hyala vitrea*	(Montagu, 1803)
Gastropoda	Tornidae	*Circulus striatus*	(Philippi, 1836)
Gastropoda	Truncatellidae	*Truncatella subcylindrica*	(Linnaeus, 1767)
Gastropoda	Vermetidae	*Dendropoma cristatum*	(Biondi, 1859)
Gastropoda	Vermetidae	*Thylacodes arenarius*	(Linnaeus, 1758)
Gastropoda	Vermetidae	*Thylaeodus rugulosus*	(Monterosato, 1878)
Gastropoda	Vermetidae	*Vermetus granulatus*	(Gravenhorst, 1831)
Gastropoda	Vermetidae	*Vermetus triquetrus*	Bivona-Bernardi, 1832
Gastropoda	Volvatellidae	*Ascobulla fragilis*	(Jeffreys, 1856)
Gastropoda	Strombidae	*Conomurex persicus*	(Swainson, 1821)
Gastropoda	Vanikoridae	*Megalomphalus azoneus*	(Brusina, 1865)
Gastropoda	Calyptraeidae	*Calyptraea chinensis*	(Linnaeus, 1758)
Gastropoda	Calyptraeidae	*Crepidula fornicata*	(Linnaeus, 1758)
Gastropoda	Calyptraeidae	*Crepidula moulinsii*	Michaud, 1829
Gastropoda	Calyptraeidae	*Crepidula unguiformis*	Lamarck, 1822

Gastropoda	Capulidae	*Capulus ungaricus*	(Linnaeus, 1758)
Gastropoda	Triviidae	*Erato voluta*	(Montagu, 1803)
Gastropoda	Triviidae	*Trivia mediterranea*	(Risso, 1826)
Gastropoda	Triviidae	*Trivia monacha*	(da Costa, 1778)
Gastropoda	Cypraeidae	*Erosaria spurca*	(Linnaeus, 1758)
Gastropoda	Cypraeidae	*Luria lurida*	(Linnaeus, 1758)
Gastropoda	Cypraeidae	*Zonaria pyrum*	(Gmelin, 1791)
Gastropoda	Ovulidae	*Pseudosimnia carnea*	(Poiret, 1789)
Gastropoda	Naticidae	*Euspira intricata*	(Donovan, 1804)
Gastropoda	Naticidae	*Euspira macilenta*	(Philippi, 1844)
Gastropoda	Naticidae	*Naticarius stercusmuscarum*	(Gmelin, 1791)
Gastropoda	Naticidae	*Neverita josephinia*	Risso, 1826
Gastropoda	Naticidae	*Notocochlis dillwynii*	(Payraudeau, 1826)
Gastropoda	Ranellidae	*Cabestana cutacea*	(Linnaeus, 1767)
Gastropoda	Ranellidae	*Charonia variegata*	(Lamarck, 1816)
Gastropoda	Bursidae	*Bursa scrobilator*	(Linnaeus, 1758)
Gastropoda	Muricidae	*Bolinus brandaris*	(Linnaeus, 1758)
Gastropoda	Muricidae	*Coralliophila brevis*	(Blainville, 1832)
Gastropoda	Muricidae	*Coralliophila meyendorffii*	(Calcara, 1845)
Gastropoda	Muricidae	*Hadriania craticulata*	Bucquoy, Dautzenberg & Dollfus, 1882
Gastropoda	Muricidae	*Hexaplex trunculus*	(Linnaeus, 1758)
Gastropoda	Muricidae	*Hirtomurex squamosus*	(Bivona Ant. in Bivona And., 1838)
Gastropoda	Muricidae	*Murexsul cevikeri*	(Houart, 2000)
Gastropoda	Muricidae	*Muricopsis cristata*	(Brocchi, 1814)
Gastropoda	Muricidae	*Ocenebra erinaceus*	(Linnaeus, 1758)
Gastropoda	Muricidae	*Ocinebrina* sp.	
Gastropoda	Muricidae	*Ocinebrina aciculata*	(Lamarck, 1822)
Gastropoda	Muricidae	*Ocinebrina edwardsii*	(Payraudeau, 1826)
Gastropoda	Muricidae	*Stramonita haemastoma*	(Linnaeus, 1767)

Gastropoda	Muricidae	*Trophonopsis alboranensis*	(Smriglio, Mariottini & Bonfitto, 1997)
Gastropoda	Muricidae	*Trophonopsis muricata*	(Montagu, 1803)
Gastropoda	Marginellidae	*Granulina boucheti*	Gofas, 1992
Gastropoda	Marginellidae	*Granulina clandestina*	(Brocchi, 1814)
Gastropoda	Marginellidae	*Granulina marginata*	(Bivona, 1832)
Gastropoda	Marginellidae	*Volvarina mitrella*	(Risso, 1826)
Gastropoda	Cystiscidae	*Gibberula caelata*	(Monterosato, 1877)
Gastropoda	Cystiscidae	*Gibberula jansseni*	van Aartsen, Menkhorst & Gittenberger, 1984
Gastropoda	Cystiscidae	*Gibberula miliaria*	(Linnaeus, 1758)
Gastropoda	Cystiscidae	*Gibberula philippii*	(Monterosato, 1878)
Gastropoda	Cystiscidae	*Gibberula recondita*	Monterosato, 1884
Gastropoda	Mitridae	*Mitra cornicula*	(Linnaeus, 1758)
Gastropoda	Costellariidae	*Vexillum ebenus*	(Lamarck, 1811)
Gastropoda	Costellariidae	*Vexillum granum*	(Forbes, 1844)
Gastropoda	Costellariidae	*Vexillum savignyi*	(Payraudeau, 1826)
Gastropoda	Costellariidae	*Vexillum tricolor*	(Gmelin, 1791)
Gastropoda	Buccinidae	*Euthria cornea*	(Linnaeus, 1758)
Gastropoda	Buccinidae	*Chauvetia affinis*	(Monterosato, 1889)
Gastropoda	Buccinidae	*Chauvetia brunnea*	(Donovan, 1804)
Gastropoda	Buccinidae	*Chauvetia lefebvrii*	(Maravigna, 1840)
Gastropoda	Buccinidae	*Chauvetia mamillata*	(Risso, 1826)
Gastropoda	Buccinidae	*Chauvetia recondita*	(Brugnone, 1873)
Gastropoda	Buccinidae	*Chauvetia mamillata*	(Risso, 1826)
Gastropoda	Buccinidae	*Chauvetia turritellata*	(Deshayes, 1835)
Gastropoda	Buccinidae	*Enginella leucozona*	(Philippi, 1844)
Gastropoda	Buccinidae	*Euthria cornea*	(Linnaeus, 1758)
Gastropoda	Buccinidae	*Pisania striata*	(Gmelin, 1791)
Gastropoda	Buccinidae	*Pollia* sp.	
Gastropoda	Buccinidae	*Pollia dorbignyi*	(Payraudeau, 1826)
Gastropoda	Buccinidae	*Pollia scabra*	Locard, 1892

Gastropoda	Buccinidae	*Pollia scacchiana*	(Philippi, 1844)
Gastropoda	Colubrariidae	*Cumia reticulata*	(Blainville, 1829)
Gastropoda	Nassariidae	*Nassarius* sp.	
Gastropoda	Nassariidae	*Nassarius corniculum*	(Olivi, 1792)
Gastropoda	Nassariidae	*Nassarius crenulatus*	(Bruguière, 1792)
Gastropoda	Nassariidae	*Nassarius cuvierii*	(Payraudeau, 1826)
Gastropoda	Nassariidae	*Nassarius incrassatus*	(Strøm, 1768)
Gastropoda	Nassariidae	*Nassarius lima*	(Dillwyn, 1817)
Gastropoda	Nassariidae	*Nassarius mutabilis*	(Linnaeus, 1758)
Gastropoda	Nassariidae	*Nassarius pygmaeus*	(Lamarck, 1822)
Gastropoda	Nassariidae	*Nassarius reticulatus*	(Linnaeus, 1758)
Gastropoda	Nassariidae	*Nassarius unifasciatus*	(Kiener, 1834)
Gastropoda	Columbellidae	*Columbella rustica*	(Linnaeus, 1758)
Gastropoda	Columbellidae	*Mitrella bruggeni*	van Aartsen, Menkhorst & Gittenberger, 1984
Gastropoda	Columbellidae	*Mitrella gervillii*	(Payraudeau, 1826)
Gastropoda	Columbellidae	*Mitrella psilla*	(Duclos, 1846)
Gastropoda	Columbellidae	*Mitrella scripta*	(Linnaeus, 1758)
Gastropoda	Columbellidae	*Mitrella spelta*	(Kobelt, 1889)
Gastropoda	Fasciolariidae	*Aptyxis syracusanus*	(Linnaeus, 1758)
Gastropoda	Fasciolariidae	*Tarantinaea lignaria*	(Linnaeus, 1758)
Gastropoda	Fasciolariidae	*Fusinus* sp.	
Gastropoda	Fasciolariidae	*Fusinus pulchellus*	(Philippi, 1840)
Gastropoda	Fasciolariidae	*Fusinus rostratus*	(Olivi, 1792)
Gastropoda	Fasciolariidae	*Fusinus rudis*	(Philippi, 1844)
Gastropoda	Fasciolariidae	*Aptyxis syracusanus*	(Linnaeus, 1758)
Gastropoda	Fasciolariidae	*Tarantinaea lignaria*	(Linnaeus, 1758)
Gastropoda	Conidae	*Conus ventricosus*	Gmelin, 1791
Gastropoda	Drilliidae	*Crassopleura maravignae*	(Bivona Ant. in Bivona And., 1838)
Gastropoda	Horaiclavidae	*Haedropleura septangularis*	(Montagu, 1803)

Gastropoda	Clavatulidae	*Fusiturris undatiruga*	(Bivona Ant. in Bivona And., 1838)
Gastropoda	Clathurellidae	*Clathromangelia granum*	(Philippi, 1844)
Gastropoda	Clathurellidae	*Clathromangelia quadrillum*	(Dujardin, 1837)
Gastropoda	Clathurellidae	*Comarmondia gracilis*	(Montagu, 1803)
Gastropoda	Mitromorphidae	*Mitromorpha* sp.	
Gastropoda	Mitromorphidae	*Mitromorpha columbellaria*	(Scacchi, 1836)
Gastropoda	Mitromorphidae	*Mitromorpha crenipicta*	(Dautzenberg, 1889)
Gastropoda	Mitromorphidae	*Mitromorpha olivoidea*	(Cantraine, 1835)
Gastropoda	Mitromorphidae	*Mitromorpha wilhelminae*	(van Aartsen, Menkhorst & Gittenberger, 1984)
Gastropoda	Mangeliidae	*Bela zenetouae*	(van Aartsen, 1988)
Gastropoda	Mangeliidae	*Bela zonata*	(Locard, 1892)
Gastropoda	Mangeliidae	*Mangelia* sp.	
Gastropoda	Mangeliidae	*Mangelia attenuata*	(Montagu, 1803)
Gastropoda	Mangeliidae	*Mangelia multilineolata*	(Deshayes, 1835)
Gastropoda	Mangeliidae	*Mangelia paciniana*	(Calcara, 1839)
Gastropoda	Mangeliidae	*Mangelia stosiciana*	Brusina, 1869
Gastropoda	Mangeliidae	*Mangelia taeniata*	(Deshayes, 1835)
Gastropoda	Mangeliidae	*Mangelia unifasciata*	(Deshayes, 1835)
Gastropoda	Mangeliidae	*Mangelia vauquelini*	(Payraudeau, 1826)
Gastropoda	Mangeliidae	*Sorgenfreispira brachystoma*	(Philippi, 1844)
Gastropoda	Raphitomidae	*Raphitoma mirabilis*	(Pallary, 1904)
Gastropoda	Raphitomidae	*Raphitoma* sp.	
Gastropoda	Raphitomidae	*Raphitoma bicolor*	(Risso, 1826)
Gastropoda	Raphitomidae	*Raphitoma concinna*	(Scacchi, 1836)
Gastropoda	Raphitomidae	*Raphitoma densa*	(Monterosato, 1884)
Gastropoda	Raphitomidae	*Raphitoma echinata*	(Brocchi, 1814)
Gastropoda	Raphitomidae	*Raphitoma horrida*	(Monterosato, 1884)
Gastropoda	Raphitomidae	*Raphitoma laviae*	(Philippi, 1844)
Gastropoda	Raphitomidae	*Raphitoma leufroyi*	(Michaud, 1828)
Gastropoda	Raphitomidae	*Raphitoma linearis*	(Montagu, 1803)

Gastropoda	Raphitomidae	*Raphitoma lineolata*	(Bucquoy, Dautzenberg & Dollfus, 1883)
Gastropoda	Raphitomidae	*Raphitoma philberti*	(Michaud, 1829)
Gastropoda	Raphitomidae	*Raphitoma purpurea*	(Montagu, 1803)
Gastropoda	Architectonicidae	*Pseudotorinia architae*	(O. G. Costa, 1841)
Gastropoda	Rissoellidae	*Rissoella diaphana*	(Alder, 1848)
Gastropoda	Rissoellidae	*Rissoella inflata*	(Monterosato, 1880)
Gastropoda	Rissoellidae	*Rissoella opalina*	(Jeffreys, 1848)
Gastropoda	Rissoinidae	*Rissoina bruguieri*	(Payraudeau, 1826)
Gastropoda	Omalogyridae	*Ammonicera fischeriana*	(Monterosato, 1869)
Gastropoda	Omalogyridae	*Ammonicera rota*	(Forbes & Hanley, 1850)
Gastropoda	Omalogyridae	*Omalogyra atomus*	(Philippi, 1841)
Gastropoda	Omalogyridae	*Omalogyra simplex*	(Costa O. G., 1861)
Gastropoda	Pyramidellidae	*Auristomia erjaveciana*	(Brusina, 1869)
Gastropoda	Pyramidellidae	*Brachystomia eulimoides*	(Hanley, 1844)
Gastropoda	Pyramidellidae	*Eulimella acicula*	(Philippi, 1836)
Gastropoda	Pyramidellidae	*Euparthenia humboldti*	(Risso, 1826)
Gastropoda	Pyramidellidae	*Folinella excavata*	(Phillippi, 1836)
Gastropoda	Pyramidellidae	*Jordaniella nivosa*	(Montagu, 1803)
Gastropoda	Pyramidellidae	*Megastomia conoidea*	(Brocchi, 1814)
Gastropoda	Pyramidellidae	*Noemiamea dolioliformis*	(Jeffreys, 1848)
Gastropoda	Pyramidellidae	*Odostomella doliolum*	(Philippi, 1844)
Gastropoda	Pyramidellidae	*Odostomia* sp.	
Gastropoda	Pyramidellidae	*Odostomia acuta*	Jeffreys, 1848
Gastropoda	Pyramidellidae	*Megastomia conoidea*	(Brocchi, 1814)
Gastropoda	Pyramidellidae	*Odostomia kromi*	van Aartsen, Menkhorst & Gittenberger, 1984
Gastropoda	Pyramidellidae	*Odostomia lukisii*	Jeffreys, 1859
Gastropoda	Pyramidellidae	*Odostomia plicata*	(Montagu, 1803)
Gastropoda	Pyramidellidae	*Brachystomia scalaris*	(MacGillivray, 1843)
Gastropoda	Pyramidellidae	*Odostomia striolata*	Forbes & Hanley, 1850
Gastropoda	Pyramidellidae	*Ondina vitrea*	(Brusina, 1866)

Gastropoda	Pyramidellidae	*Ondina warreni*	(Thompson, 1845)
Gastropoda	Pyramidellidae	*Parthenina emaciata*	(Brusina, 1866)
Gastropoda	Pyramidellidae	*Parthenina indistincta*	(Montagu, 1808)
Gastropoda	Pyramidellidae	*Parthenina interstincta*	(J. Adams, 1797)
Gastropoda	Pyramidellidae	*Parthenina juliae*	(de Folin, 1872)
Gastropoda	Pyramidellidae	*Parthenina monozona*	(Brusina, 1869)
Gastropoda	Pyramidellidae	*Parthenina terebellum*	(Philippi, 1844)
Gastropoda	Pyramidellidae	*Pyrgiscus crenatus*	(Brown, 1827)
Gastropoda	Pyramidellidae	*Pyrgiscus jeffreysii*	(Jeffreys, 1848)
Gastropoda	Pyramidellidae	*Pyrgiscus rufus*	(Philippi, 1836)
Gastropoda	Pyramidellidae	*Spiralinella incerta*	(Milaschewich, 1916)
Gastropoda	Pyramidellidae	*Strioturbonilla sigmoidea*	(Monterosato, 1880)
Gastropoda	Pyramidellidae	*Tragula fenestrata*	(Jeffreys, 1848)
Gastropoda	Pyramidellidae	*Turbonilla acuta*	(Donovan, 1804)
Gastropoda	Pyramidellidae	*Turbonilla gradata*	Bucquoy, Dautzenberg & Dollfus, 1883
Gastropoda	Pyramidellidae	*Turbonilla lactea*	(Linnaeus, 1758)
Gastropoda	Pyramidellidae	*Turbonilla pulchella*	(d'Orbigny, 1841)
Gastropoda	Pyramidellidae	*Turbonilla pumila*	Seguenza G., 1876
Gastropoda	Pyramidellidae	*Turbonilla pusilla*	(Philippi, 1844)
Gastropoda	Pyramidellidae	*Turbonilla sinuosa*	(Jeffreys, 1884)
Gastropoda	Amathinidae	*Clathrella clathrata*	(Philippi, 1844)
Gastropoda	Murchisonellidae	*Ebala pointeli*	(de Folin, 1868)
Gastropoda	Tofanellidae	*Graphis albida*	(Kanmacher, 1798)
Gastropoda	Acteonidae	*Acteon tornatilis*	(Linnaeus, 1758)
Gastropoda	Ringiculidae	*Ringicula auriculata*	(Ménard de la Groye, 1811)
Gastropoda	Ringiculidae	*Ringicula conformis*	Monterosato, 1877
Gastropoda	Bullidae	*Bulla striata*	Bruguière, 1792
Gastropoda	Haminoeidae	*Atys jeffreysi*	(Weinkauff, 1866)
Gastropoda	Haminoeidae	*Haminoea exigua*	Schaefer, 1992
Gastropoda	Haminoeidae	*Haminoea hydatis*	(Linnaeus, 1758)
Gastropoda	Haminoeidae	*Haminoea navicula*	(da Costa, 1778)

Gastropoda	Haminoeidae	*Haminoea orbignyana*	(Férussac, 1822)
Gastropoda	Haminoeidae	*Weinkauffia turgidula*	(Forbes, 1844)
Gastropoda	Philinidae	*Philine catena*	(Montagu, 1803)
Gastropoda	Philinidae	*Philine quadripartita*	Ascanius, 1772
Gastropoda	Aglajidae	*Aglaja tricolorata*	Renier, 1807
Gastropoda	Aglajidae	*Chelidonura africana*	Pruvot-Fol, 1953
Gastropoda	Cylichnidae	*Cylichna cylindracea*	(Pennant, 1777)
Gastropoda	Retusidae	*Pyrunculus hoernesii*	(Weinkauff, 1866)
Gastropoda	Retusidae	*Retusa candidula*	(Locard, 1892)
Gastropoda	Retusidae	*Retusa laevisculpta*	(Granata-Grillo, 1877)
Gastropoda	Retusidae	*Retusa minutissima*	(Monterosato, 1878)
Gastropoda	Retusidae	*Retusa truncatula*	(Bruguière, 1792)
Gastropoda	Retusidae	*Retusa umbilicata*	(Montagu, 1803)
Gastropoda	Rhizoridae	*Volvulella acuminata*	(Bruguière, 1792)
Gastropoda	Runcinidae	*Runcina* sp.	
Gastropoda	Runcinidae	*Runcina coronata*	(Quatrefages, 1844)
Gastropoda	Runcinidae	*Runcina ferruginea*	Kress, 1977
Gastropoda	Oxynoidae	*Lobiger serradifalci*	(Calcara, 1840)
Gastropoda	Oxynoidae	*Oxynoe olivacea*	Rafinesque, 1814
Gastropoda	Plakobranchidae	*Elysia timida*	(Risso, 1818)
Gastropoda	Plakobranchidae	*Elysia viridis*	(Montagu, 1804)
Gastropoda	Plakobranchidae	*Thuridilla hopei*	(Vérany, 1853)
Gastropoda	Limapontiidae	*Limapontia capitata*	(O. F. Müller, 1774)
Gastropoda	Limapontiidae	*Placida verticilata*	Ortea, 1982
Gastropoda	Umbraculidae	*Umbraculum umbraculum*	(Lightfoot, 1786)
Gastropoda	Tylodinidae	*Tylodina perversa*	(Gmelin, 1791)
Gastropoda	Aplysiidae	*Aplysia* sp.	
Gastropoda	Aplysiidae	*Aplysia depilans*	Gmelin, 1791
Gastropoda	Aplysiidae	*Aplysia fasciata*	Poiret, 1789
Gastropoda	Aplysiidae	*Aplysia parvula*	Mörch, 1863
Gastropoda	Aplysiidae	*Aplysia punctata*	(Cuvier, 1803)

Gastropoda	Aplysiidae	*Petalifera petalifera*	(Rang, 1828)
Gastropoda	Aplysiidae	*Phyllaplysia lafonti*	P. Fischer, 1872
Gastropoda	Pleurobranchidae	*Berthella aurantiaca*	(Risso, 1818)
Gastropoda	Pleurobranchidae	*Pleurobranchus membranaceus*	(Montagu, 1816)
Gastropoda	Discodorididae	*Paradoris indecora*	(Bergh, 1881)
Gastropoda	Discodorididae	*Peltodoris atromaculata*	Bergh, 1880
Gastropoda	Discodorididae	*Tayuva lilacina*	(Gould, 1852)
Gastropoda	Chromodorididae	*Felimare orsinii*	(Vérany, 1846)
Gastropoda	Chromodorididae	*Felimare picta*	(Schultz in Philippi, 1836)
Gastropoda	Chromodorididae	*Felimare tricolor*	(Cantraine, 1835)
Gastropoda	Chromodorididae	*Felimare villafranca*	(Risso, 1818)
Gastropoda	Chromodorididae	*Felimida krohni*	(Vérany, 1846)
Gastropoda	Phyllidiidae	*Phyllidia flava*	Aradas, 1847
Gastropoda	Dendrodorididae	*Dendrodoris limbata*	(Cuvier, 1804)
Gastropoda	Dendrodorididae	*Dendrodoris grandiflora*	(Rapp, 1827)
Gastropoda	Dendrodorididae	*Doriopsilla areolata*	Bergh, 1880
Gastropoda	Onchidorididae	*Onchidoris neapolitana*	(Delle Chiaje, 1841)
Bivalvia	Tellinidae	*Gastrana fragilis*	(Linnaeus, 1758)
Bivalvia	Tellinidae	*Macoma cumana*	(O. G. Costa, 1830)
Bivalvia	Tellinidae	*Atlantella distorta*	(Poli, 1791)
Bivalvia	Tellinidae	*Tellina albicans*	Gmelin, 1791
Bivalvia	Tellinidae	*Tellina fabula*	Gmelin, 1791
Bivalvia	Tellinidae	*Tellina planata*	Linnaeus, 1758
Bivalvia	Tellinidae	*Tellina pulchella*	Lamarck, 1818
Bivalvia	Tellinidae	*Tellina tenuis*	da Costa, 1778
Gastropoda	Goniodorididae	*Goniodoris castanea*	Alder & Hancock, 1845
Gastropoda	Goniodorididae	*Trapania maculata*	Haefelfinger, 1960
Gastropoda	Polyceridae	*Limacia clavigera*	(O. F. Müller, 1776)
Gastropoda	Polyceridae	*Palio dubia*	(M. Sars, 1829)
Gastropoda	Polyceridae	*Polycera quadrilineata*	(O. F. Müller, 1776)
Gastropoda	Polyceridae	*Polycerella emertoni*	A. E. Verrill, 1880

Gastropoda	Aegiridae	*Aegires leuckartii*	Vérany, 1853
Gastropoda	Tritoniidae	*Tritonia lineata*	Alder & Hancock, 1848
Gastropoda	Tritoniidae	*Tritonia manicata*	Deshayes, 1853
Gastropoda	Proctonotidae	*Janolus cristatus*	(Delle Chiaje, 1841)
Gastropoda	Facelinidae	*Caloria elegans*	(Alder & Hancock, 1845)
Gastropoda	Facelinidae	*Cratena peregrina*	(Gmelin, 1791)
Gastropoda	Facelinidae	*Favorinus branchialis*	(Rathke, 1806)
Gastropoda	Flabellinidae	*Calmella cavolini*	(Vérany, 1846)
Gastropoda	Flabellinidae	*Flabellina affinis*	(Gmelin, 1791)
Gastropoda	Flabellinidae	*Flabellina lineata*	(Lovén, 1846)
Gastropoda	Flabellinidae	*Flabellina pedata*	(Montagu, 1816)
Gastropoda	Calmidae	*Calma glaucoides*	(Alder & Hancock, 1854)
Gastropoda	Tergipedidae	*Cuthona caerulea*	(Montagu, 1804)
Gastropoda	Tergipedidae	*Cuthona genovae*	(O'Donoghue, 1929)
Gastropoda	Tergipedidae	*Tergipes tergipes*	(Forsskål in Niebuhr, 1775)
Gastropoda	Siphonariidae	*Williamia gussoni*	(Costa O. G., 1829)
Gastropoda	Ellobiidae	*Trimusculus mammillaris*	(Linnaeus, 1758)
Bivalvia	Nuculidae	*Nucula nitidosa*	Winckworth, 1930
Bivalvia	Nuculanidae	*Lembulus pella*	(Linnaeus, 1767)
Bivalvia	Arcidae	*Acar clathrata*	(Defrance, 1816)
Bivalvia	Arcidae	*Anadara corbuloides*	(Monterosato, 1878)
Bivalvia	Arcidae	*Arca noae*	Linnaeus, 1758
Bivalvia	Arcidae	*Arca tetragona*	Poli, 1795
Bivalvia	Arcidae	*Asperarca nodulosa*	(O. F. Müller, 1776)
Bivalvia	Arcidae	*Barbatia barbata*	(Linnaeus, 1758)
Bivalvia	Noetiidae	*Striarca lactea*	(Linnaeus, 1758)
Bivalvia	Glycymerididae	*Glycymeris nummaria*	(Linnaeus, 1758)
Bivalvia	Mytilidae	*Musculus subpictus*	(Cantraine, 1835)
Bivalvia	Mytilidae	*Amygdalum politum*	(Verrill & S. Smith [in Verrill], 1880)
Bivalvia	Mytilidae	*Arcuatula senhousia*	(Benson in Cantor, 1842)
Bivalvia	Mytilidae	*Brachidontes pharaonis*	(P. Fischer, 1870)

Bivalvia	Mytilidae	*Crenella pellucida*	(Jeffreys, 1859)
Bivalvia	Mytilidae	*Gibbomodiola adriatica*	(Lamarck, 1819)
Bivalvia	Mytilidae	*Gregariella petagnae*	(Scacchi, 1832)
Bivalvia	Mytilidae	*Jolya martorelli*	(Hidalgo, 1878)
Bivalvia	Mytilidae	*Lithophaga lithophaga*	(Linnaeus, 1758)
Bivalvia	Mytilidae	*Modiolula phaseolina*	(Philippi, 1844)
Bivalvia	Mytilidae	*Modiolus barbatus*	(Linnaeus, 1758)
Bivalvia	Mytilidae	*Musculus costulatus*	(Risso, 1826)
Bivalvia	Mytilidae	*Musculus discors*	(Linnaeus, 1767)
Bivalvia	Mytilidae	*Musculus niger*	(J.E. Gray, 1824)
Bivalvia	Mytilidae	*Mytilaster lineatus*	(Gmelin, 1791)
Bivalvia	Mytilidae	*Mytilaster minimus*	(Poli, 1795)
Bivalvia	Mytilidae	*Mytilus* sp.	
Bivalvia	Mytilidae	*Mytilus galloprovincialis*	Lamarck, 1819
Bivalvia	Mytilidae	*Rhomboidella prideauxi*	(Leach, 1815)
Bivalvia	Mytilidae	*Mytilus edulis*	Linnaeus, 1758
Bivalvia	Pinnidae	*Pinna nobilis*	Linnaeus, 1758
Bivalvia	Pteriidae	*Pinctada imbricata radiata*	(Leach, 1814)
Bivalvia	Pectinidae	*Aequipecten opercularis*	(Linnaeus, 1758)
Bivalvia	Pectinidae	*Flexopecten glaber*	(Linnaeus, 1758)
Bivalvia	Pectinidae	*Flexopecten hyalinus*	(Poli, 1795)
Bivalvia	Pectinidae	*Manupecten pesfelis*	(Linnaeus, 1758)
Bivalvia	Pectinidae	*Mimachlamys varia*	(Linnaeus, 1758)
Bivalvia	Pectinidae	*Pecten* sp.	
Bivalvia	Pectinidae	*Talochlamys multistriata*	(Poli, 1795)
Bivalvia	Spondylidae	*Spondylus gaederopus*	Linnaeus, 1758
Bivalvia	Anomiidae	*Anomia ephippium*	Linnaeus, 1758
Bivalvia	Limidae	*Lima lima*	(Linnaeus, 1758)
Bivalvia	Limidae	*Limaria hians*	(Gmelin, 1791)
Bivalvia	Limidae	*Limaria loscombi*	(G. B. Sowerby I, 1823)
Bivalvia	Limidae	*Limaria tuberculata*	(Olivi, 1792)

Bivalvia	Limidae	*Limatula subovata*	(Monterosato, 1875)
Bivalvia	Limidae	*Limaria hians*	(Gmelin, 1791)
Bivalvia	Ostreidae	*Crassostrea gigas*	(Thunberg, 1793)
Bivalvia	Ostreidae	*Ostrea edulis*	Linnaeus, 1758
Bivalvia	Ostreidae	*Ostrea stentina*	Payraudeau, 1826
Bivalvia	Gryphaeidae	*Neopycnodonte cochlear*	(Poli, 1795)
Bivalvia	Carditidae	*Cardita calyculata*	(Linnaeus, 1758)
Bivalvia	Carditidae	*Cardites antiquatus*	(Linnaeus, 1758)
Bivalvia	Carditidae	*Centrocardita aculeata*	(Poli, 1795)
Bivalvia	Carditidae	*Glans trapezia*	(Linnaeus, 1767)
Bivalvia	Cardiidae	*Acanthocardia aculeata*	(Linnaeus, 1758)
Bivalvia	Cardiidae	*Acanthocardia paucicostata*	(G. B. Sowerby II, 1834)
Bivalvia	Cardiidae	*Acanthocardia tuberculata*	(Linnaeus, 1758)
Bivalvia	Cardiidae	*Fulvia fragilis*	(Forsskål in Niebuhr, 1775)
Bivalvia	Cardiidae	*Papillicardium papillosum*	(Poli, 1791)
Bivalvia	Cardiidae	*Parvicardium* sp.	
Bivalvia	Cardiidae	*Parvicardium exiguum*	(Gmelin, 1791)
Bivalvia	Cardiidae	*Parvicardium minimum*	(Philippi, 1836)
Bivalvia	Cardiidae	*Parvicardium pinnulatum*	(Conrad, 1831)
Bivalvia	Cardiidae	*Parvicardium scriptum*	(Bucquoy, Dautzenberg & Dollfus, 1892)
Bivalvia	Cardiidae	*Parvicardium vroomi*	van Aartsen, Menkhorst & Gittenberger, 1984
Bivalvia	Lucinidae	*Ctena decussata*	(O. G. Costa, 1829)
Bivalvia	Lucinidae	*Loripes lucinalis*	(Lamarck, 1818)
Bivalvia	Lucinidae	*Loripinus fragilis*	(Philippi, 1836)
Bivalvia	Lucinidae	*Lucinella divaricata*	(Linnaeus, 1758)
Bivalvia	Lucinidae	*Myrtea spinifera*	(Montagu, 1803)
Bivalvia	Thyasiridae	*Thyasira flexuosa*	(Montagu, 1803)
Bivalvia	Chamidae	*Chama asperella*	Lamarck, 1819
Bivalvia	Chamidae	*Chama gryphoides*	Linnaeus, 1758
Bivalvia	Chamidae	*Pseudochama gryphina*	(Lamarck, 1819)

Bivalvia	Galeommatidae	*Galeomma turtoni*	Turton, 1825
Bivalvia	Kelliidae	*Kellia suborbicularis*	(Montagu, 1803)
Bivalvia	Lasaeidae	*Hemilepton nitidum*	(Turton, 1822)
Bivalvia	Lasaeidae	*Lasaea adansoni*	(Gmelin, 1791)
Bivalvia	Lasaeidae	*Scacchia oblonga*	(Philippi, 1836)
Bivalvia	Lasaeidae	*Lasaea adansoni*	(Gmelin, 1791)
Bivalvia	Montacutidae	*Kurtiella bidentata*	(Montagu, 1803)
Bivalvia	Mactridae	*Eastonia rugosa*	(Helbling, 1779)
Bivalvia	Mactridae	*Mactra stultorum*	(Linnaeus, 1758)
Bivalvia	Mactridae	*Spisula subtruncata*	(da Costa, 1778)
Bivalvia	Donacidae	*Donax semistriatus*	Poli, 1795
Bivalvia	Donacidae	*Donax venustus*	Poli, 1795
Bivalvia	Psammobiidae	*Gari depressa*	(Pennant, 1777)
Bivalvia	Semelidae	*Abra* sp.	
Bivalvia	Semelidae	*Abra alba*	(W. Wood, 1802)
Bivalvia	Semelidae	*Abra nitida*	(O. F. Müller, 1776)
Bivalvia	Semelidae	*Scrobicularia cottardii*	(Payraudeau, 1826)
Bivalvia	Solecurtidae	*Azorinus chamasolen*	(da Costa, 1778)
Bivalvia	Trapezidae	*Coralliophaga lithophagella*	(Lamarck, 1819)
Bivalvia	Veneridae	*Chamelea gallina*	(Linnaeus, 1758)
Bivalvia	Veneridae	*Clausinella fasciata*	(da Costa, 1778)
Bivalvia	Veneridae	*Dosinia exoleta*	(Linnaeus, 1758)
Bivalvia	Veneridae	*Dosinia lupinus*	(Linnaeus, 1758)
Bivalvia	Veneridae	*Gouldia minima*	(Montagu, 1803)
Bivalvia	Veneridae	*Irus irus*	(Linnaeus, 1758)
Bivalvia	Veneridae	*Lajonkairia lajonkairii*	(Payraudeau, 1826)
Bivalvia	Veneridae	*Petricola lithophaga*	(Retzius, 1788)
Bivalvia	Veneridae	*Petricola substriata*	Montagu, 1808
Bivalvia	Veneridae	*Pitar rudis*	(Poli, 1795)
Bivalvia	Veneridae	*Polititapes aureus*	(Gmelin, 1791)
Bivalvia	Veneridae	*Polititapes rhomboides*	(Pennant, 1777)

Bivalvia	Veneridae	*Ruditapes decussatus*	(Linnaeus, 1758)
Bivalvia	Veneridae	*Venerupis corrugata*	(Gmelin, 1791)
Bivalvia	Veneridae	*Venerupis geographica*	(Gmelin, 1791)
Bivalvia	Veneridae	*Venus verrucosa*	Linnaeus, 1758
Bivalvia	Neoleptonidae	*Neolepton sulcatulum*	(Jeffreys, 1859)
Bivalvia	Myidae	*Sphenia binghami*	Turton, 1822
Bivalvia	Corbulidae	*Corbula gibba*	(Olivi, 1792)
Bivalvia	Corbulidae	*Lentidium mediterraneum*	(O. G. Costa, 1830)
Bivalvia	Gastrochaenidae	*Rocellaria dubia*	(Pennant, 1777)
Bivalvia	Solenidae	*Solen marginatus*	Pulteney, 1799
Bivalvia	Pharidae	*Pharus legumen*	(Linnaeus, 1758)
Bivalvia	Pharidae	*Phaxas pellucidus*	(Pennant, 1777)
Bivalvia	Hiatellidae	*Hiatella arctica*	(Linnaeus, 1767)
Bivalvia	Hiatellidae	*Hiatella rugosa*	(Linnaeus, 1767)
Bivalvia	Thraciidae	*Thracia distorta*	(Montagu, 1803)
Bivalvia	Clavagellidae	*Bryopa aperta*	(G. B. Sowerby I, 1823)
Bivalvia	Pandoridae	*Pandora inaequivalvis*	(Linnaeus, 1758)
Scaphopoda	Dentaliidae	*Antalis novemcostata*	(Lamarck, 1818)
Scaphopoda	Dentaliidae	*Antalis vulgaris*	(da Costa, 1778)
Scaphopoda	Fustiariidae	*Fustiaria rubescens*	(Deshayes, 1825)
Cephalopoda	Sepiidae	*Sepia officinalis*	Linnaeus, 1758
Cephalopoda	Octopodidae	*Octopus vulgaris*	Cuvier, 1797

Project description

Title: This dataset combines the data of two sources: (a) the monitoring of infralittoral rocky shores in Crete in the framework of the NaGISA project (Natural Geography in Shore Areas, http://www.coml.org/projects/natural-geography-shore-areas-nagisa); (b) the collection and indexing of available and accessible paper published material in peer-review journals as well as grey literature sources.

Personnel: Christos Arvanitidis, HCMR (NaGISA project coordinator, sample collection), Dimitris Poursanidis, FORTH & UniAegean (sample collection, species identification, data management, literature collection, information indexing), Georgios Chatzigeorgiou, HCMR (sample collection), Dimitra Mavraki (data management), Drosos Koutsoubas, UniAegean (species identification).

Study area description: This dataset includes records from 19 sampling sites at 18 different locations (Table 1,Fig. 1).

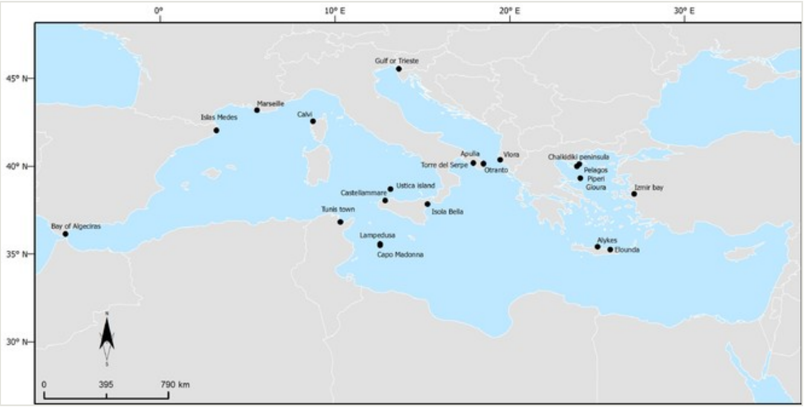

Figure 1.

Map of the locations.

East Mediterranean NAGISA project data - Alykes and Elounda: Both sampling sites are located on the North coast of Crete (Eastern Mediterranean) and are characterised by a continuous hard bottom habitat with dense algal coverage (*Cystoseira* spp., *Sargassum* sp., *Corallinales* spp.) and a moderate wave exposure. The area of Alykes has on average a denser algal coverage than the area of Elounda. The substrate is dominated by limestone rocks. Neither of the two sites is impacted by detectable anthropogenic activity, though a sandy beach in ca 500 m distance of the sampling area in Elounda is subjected to moderate beach tourism and increased leisure boat traffic in the summer months.

Mediterranean literature data: The majority of the information come from the analysis of the collected literature (Antit and Azzouna. 2012, Antit M. et al. 2013, Antoniadou and Chintiroglou 2007, Antoniadou et al. 2006, Antoniadou et al. 2005, Badalamenti et al. 2002, Bellan-Santini 1969, Huelin and J. 1984, Kasemi et al. 2008, Kocataş 1978, Milazzo et al. 2000, Miloslavich et al. 2013, Pitacco et al. 2014, Poulicek 1985, Sanchez-Moyano et al. 2000, Simboura et al. 1995, Terlizzi et al. 2005, Terlizzi et al. 2003, Trono 2006, Villari 1993, Russo 1998, Chemello and Milazzo 2002). The extracted information (species list per site/paper) has been indexed in a descriptive database system (Microsoft Access 2010) in order to handle and manage the collected information (meta-analysis, quering). When authors provide species identification in .sp level, this has been kept as is but without authority, as for .sp is not valid.

Sampling methods

Study extent: The data covers 2 sampling events under the NaGISA initiative and several independent sampling events over a time period of 45 years (1969–2012). The dataset originates from 18 sampling sites in several countries of the Mediterranean Sea. Samples were collected from the infralittoral zone from a maximum depth of 40 m (in few studies), having a maximum sampling depth of 20m. Concerning the distribution of molluscs, this habitat is understudied in the Mediterranean Sea — in fact, the Ocean Biogeographic Information System contains only 2 datasets regarding the mollusca fauna over hard bottoms for the entire Mediterranean Sea, and neither of these two are from the infralittoral zone. The present dataset thus provides an important addition to the exiting data for this habitat in the region.

Sampling description: Samples from Crete were collected from two sites, Alykes and Elounda. Both sites were sampled in September 2007 and June 2008. Samples were collected according to the NaGISA protocol (Iken and Konar 2003). At each site, 5 sampling depths have been defined (1, 5, 10, 15, 20 m.) and five random replicate units per ddepth were collected (Chatzigeorgiou et al. 2012). In the laboratory, all samples were identified in the most precise taxonomic level possible, using the most recent literature for the taxon. Animals with half of the size of known adult size are considered as juveniles.

Samples form the other sites have been collected in different periods over the year or over several years under different frameworks. The published available information contains the sampling methods and only the species list that have consequently found in the studied area.

Quality control: All scientific names were standardized against the World Register of Marine species using the Taxon Match tool (http://www.marinespecies.org/aphia.php?p=match). If recent taxonomic reviews were available that had not been incorporated into WoRMS at the time of standardization, nomenclature follows those reviews.

Geographic coverage

Description: Samples were collected at 22 regions/sampling sites across the Mediterranean Sea LME (http://www.marineregions.org/gazetteer.php?p=details&id=1905), from a maximum depth of 40 m (Table 1,Fig. 1).All data are collected from the infralittoral zone - the biocoenosis of photophilic algae.

The present dataset contains the first electronically available quantitative data on the infralittoral molluscs from the Mediterranean Sea. Moreover, it provides the first qualitative information (species list) about the molluscs from the hard substrates – the biocoenosis of photophilic algae - from that region. As for the coralligenous formations of the infralittoral zone, available dataset can be found at http://doi.pangaea.de/10.1594/PANGAEA.847623 (Poursanidis and Koutsoubas 2015).

Coordinates: 36.2173 and -6.0327 Latitude; 30.2639 and 45.7833 Longitude.

Taxonomic coverage

Description: The present dataset, after updating the taxonomy, contains distribution records for 599 species (Table 2).

In total, 155 families have been found over the studied biocoenosis. The distribution of species over them is quite unequal; 71 families are represented by only 1 species (singletones or rare) while only 14 families are represented by more than 10 species. Families Pyramidellidae and Rissoidae have the largest number of species, 38 and 56 respectively. Detailed information on the structure of species/families can be found in Suppl. material 1

Species richness at the different sites is also unequal. Marseille area has the lowest number of species (38 species) while Tunis town shows the largest number of species (281 species). In terms of families, Marseille, Capo Madonna and Vlora bay have the lowest number (25 families) while Tunis town and Chalkidiki peninsula have the largest number (73 & 76 families respectively (Fig. 2)

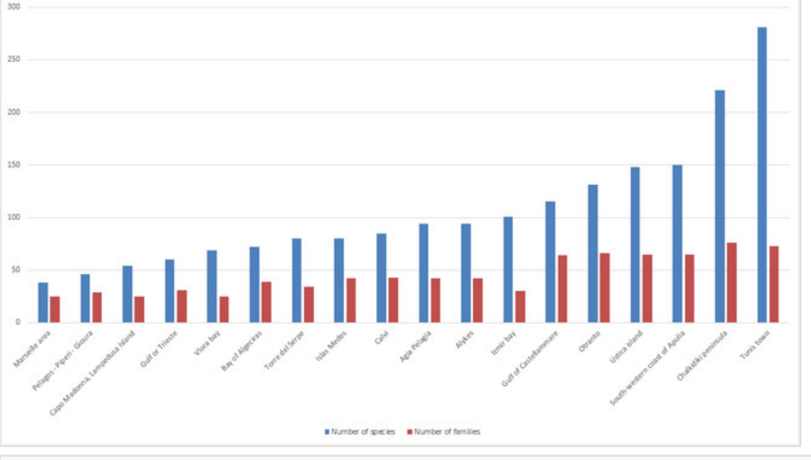

Figure 2.

Number of species and families per sampling location. Diagram based on the data from Suppl. material 2

A comparison with the Mediterranean malacofauna (excluding cephalopods) (Coll et al. 2010), which has estimated around 2000 species, shows that more than one quarter of the malacofauna (599 species) is present in the studied habitat - the photophilic algae biocoensis. Similar is the state of the malacofauna from the coralligenous formations

(Poursanidis and Koutsoubas 2015) where the same percentage of molluscs have been found.

During the last decade, research in several areas in the Mediterranean has shed light on the ecology of these habitats and revealed a vast amount of information on the biodiversity of the biocoenosis of the photophilic algae (Antit and Azzouna. 2012, Antit M. et al. 2013, Antoniadou and Chintiroglou 2007, Antoniadou et al. 2006, Antoniadou et al. 2005, Badalamenti et al. 2002, Chemello and Milazzo 2002, Kasemi et al. 2008, Milazzo et al. 2000, Miloslavich et al. 2013, Pitacco et al. 2014, Sanchez-Moyano et al. 2000, Terlizzi et al. 2005, Terlizzi et al. 2003). The increased research effort on these habitats along with the initiative of the NAGISA project, addresses the need for a better understanding of the role of this important in the coastal marine environment which is under continuus pressures and threats (EEA 2015). Moreover, species list per habitat for the European waters are a request from RAC/SPA as well as from the forthcoming Integrated Monitoring and Assessment Programme (IMAP) and the Ecosystem Approach (EcAp) of UNEP/MAP and RAC/SPA (http://www.rac-spa.org/ecap).

Taxa included:

Rank	Scientific Name
kingdom	Animalia
phylum	Mollusca
class	Bivalvia
class	Gastropoda
class	Cephalopoda
class	Polyplacophora
class	Scaphopoda

Temporal coverage

Data range: 1969 1 01 - 2012 12 31.

Usage rights

Use license: Open Data Commons Public Domain Dedication and License (PDDL)

IP rights notes: The dataset can be freely used provided it is cited.

Data resources

Data package title: Mollusca from the infralittoral rocky shores - the biocoenosis of photophilic algae - in the Mediterranean Sea

Number of data sets: 2

Data set name: Molluscs from two rocky shores of the North coast of Crete

Character set: UTF-8

Download URL: http://lifewww-00.her.hcmr.gr:8080/medobis/resource.do?r=molluscs_nagisa

Data format: Darwin Core Archive

Data format version: ver 1.0

Description: The dataset is available via the Lifewatch node of Greece of the Hellenic Center of Marine Research. The data will also be harvested by and made available through the International OBIS database, as well as through the data portal of the Global Biodiversity Information Facility (GBIF). The dataset is available as a Darwin CoreArchive, all fields are mapped to DarwinCore terms (http://rs.tdwg.org/dwc/).

This publication refers to the most recent version of the dataset available through the IPT server. Future changes to the dataset due to quality control activities might change its content or structure.

Column label	Column description
id	A unique identifier for the record within the data set or collection.
type	The type of the source
language	The used language
dataset	The number of the dataset
institutionCode	The name (or acronym) in use by the institution having custody of the object (s) or information referred to in the record.
collectionCode	The code of the Collection, in which belongs to
basisOfRecord	The specific nature of the data record, as described in http://rs.tdwg.org/dwc/terms/type-vocabulary/index.htm.
occurrenceID	The replicate in which the record belongs to
catalogNumber	The catalog number of the dataset
individualCount	The abundance of the specimen in the replicate
samplingProtocol	The description of the method or protocol used for sample collection.

samplingEffort	The description of the sampling effort for the specimens collection
eventDate	The exact date of the sampling event
fieldNumber	The combination of the location and the sampling year
locationID	The code of the location
higherGeographyID	The code of the higher geography
higherGeography	The marine basin that the sampling area belongs to
waterBody	The name of the water body in which the sampling location occurs.
island	The name of the island on or near which the sampling location occurs.
country	The name of the country on which the sampling location occurs.
municipality	The full, unabbreviated name of the next smaller administrative region than county (city, municipality, etc.) in which the sampling location occurs.
locality	The exact locality where the sampling procedure took place
minimumDepthInMeters	The lesser depth of a range of depth below the local surface, in meters.
maximumDepthInMeters	The greater depth of a range of depth below the local surface, in meters.
locationRemarks	The method that the location has been located by using Google Earth app.
verbatimLatitude	The geographic latitude (in decimal degrees, using the spatial reference system given in geodeticDatum) of the geographic center of a Location. Positive values are north of the Equator, negative values are south of it. Legal values lie between -90 and 90, inclusive.
verbatimLongitude	The geographic longitude (in decimal degrees, using the spatial reference system given in geodeticDatum) of the geographic center of a Location. Positive values are east of the Greenwich Meridian, negative values are west of it. Legal values lie between -180 and 180, inclusive.
geodeticDatum	The geodetic datum of the pair of coordinates
coordinateUncertaintyInMeters	The horizontal distance (in meters) from the given decimalLatitude and decimalLongitude describing the smallest circle containing the whole of the sampling location.
scientificNameID	The Life Science Identifiers code of the scientific name
scientificName	The scientific name of the taxon
scientificNameAuthorship	The authorship information for the scientificName formatted according to the conventions of the applicable nomenclaturalCode.
Kingdom	The full scientific name of the kingdom in which the taxon is classified.
Phylum	The full scientific name of the phylum in which the taxon is classified.
Class	The full scientific name of the class in which the taxon is classified.

Order	The full scientific name of the order in which the taxon is classified.
Family	The full scientific name of the family in which the taxon is classified.
Genus	The full scientific name of the genus in which the taxon is classified.
specificEpithet	The full scientific name of the specie in which the taxon is classified.

Data set name: Mollusca fauna from the Mediterranean reef ecosystem (1170) – the zone of the photophilic algae.

Character set: UTF-8

Download URL: http://lifewww-00.her.hcmr.gr:8080/medobis/resource.do?r=moll_poursani

Data format: Darwin Core Archive

Data format version: ver 1.0

Description: The dataset is available via the Lifewatch node of Greece of the Hellenic Center of Marine Research. The data will also be harvested by and made available through the International OBIS database, as well as through the data portal of the Global Biodiversity Information Facility (GBIF). The dataset is available as a Darwin CoreArchive, all fields are mapped to DarwinCore terms (http://rs.tdwg.org/dwc/).

This publication refers to the most recent version of the dataset available through the IPT server. Future changes to the dataset due to quality control activities might change its content or structure.

Column label	Column description
Source	The literature source used for
basisOfRecord	The specific nature of the data record, as described in http://rs.tdwg.org/dwc/terms/type-vocabulary/index.htm.
type	The type of the record
eventDate	The period of the observation
higherGeographyID	The code of the geographic area as is given by the http://www.marineregions.org/index.php
higherGeography	The name of the geographic area
waterBody	The name of the water body in which the sampling location occurs.
country	The name of the country in which the sampling location occurs.
locality	The specific location where the sample was taken.
minimumDepthInMeters	The lesser depth of a range of depth below the local surface, in meters.

maximumDepthInMeters	The greater depth of a range of depth below the local surface, in meters.
locationRemarks	Details on the exact location
verbatimLatitude	The geographic latitude (in decimal degrees, using the spatial reference system given in geodeticDatum) of the geographic center of a Location. Positive values are north of the Equator, negative values are south of it. Legal values lie between -90 and 90, inclusive.
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geodeticDatum	The geodetic datum of the used coordinate system.
coordinateUncertaintyInMeters	The horizontal distance (in meters) from the given decimalLatitude and decimalLongitude describing the smallest circle containing the whole of the sampling location.
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family	The full scientific name of the family in which the taxon is classified.
genus	The full scientific name of the genus in which the taxon is classified.
specificEpithet	The species epithet of the scientificName.
scientificNameAuthorship	The authorship information for the scientificName formatted according to the conventions of the applicable nomenclaturalCode.
taxonRemarks	Comments or notes about the taxon or name.

Additional information

Resource citation

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Dimitris Poursanidis, Dimitra Mavraki & Drosos Koutsoubas (2015). Mollusca fauna from the Mediterranean reef ecosystem (1170) – the zone of the photophilic algae.

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Supplementary materials

Suppl. material 1: Number of Species per Family

Authors: Dimitris Poursanidis
Data type: Microsoft Excel spreadsheet
Brief description: Summary of the number of species per family.
Filename: S1. NrOfSpeciesPerFamily.xlsx - Download file (11.08 kb)

Suppl. material 2: Species and Families per studied site

Authors: Dimitris Poursanidis
Data type: Microsoft Excel spreadsheet
Brief description: Overview of the number of taxa per sampling station
Filename: S2. SpeciesandFamiliesperSite.xlsx - Download file (14.38 kb)

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A computerized database (CorMol) on the molluscan fauna from the Mediterranean reef ecosystems: Part I, the coralligenous formations

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ABSTRACT

In the Mediterranean Sea, infralittoral and circalittoral rocky bottoms (from 15 to 120 m) are characterized by a biogenic habitat, named "coralligenous", formed by the concretion of calcareous organisms, mainly algal thalli, and to a lesser extent by animal skeletons. This complex habitat is inhabited by a rich fauna that belongs to different taxonomic groups. Sponges, bryozoans, cnidarians and ascidians are the most common sessile organisms that inhabit the area, while crustacea and molluscs are the most common mobile organisms. Little information on the diversity of the molluscs that thrive in the coralligenous habitat is known, though this information is highly important for biodiversity management purposes. A database for the molluscs of the coralligenous habitat was compiled and a method implemented for the management of this information. More than 511 species of molluscs have been recorded so far from the coralligenous formations, the majority of which belong to the class Gastropoda (357 sp.) followed by Bivalvia (137 sp.), Polyplacophora (14 sp.), Cephalopoda (2 sp.) and Scaphopoda (1 sp.). Among these, the gastropod *Luria lurida* (Linnaeus, 1758) and *Charonia lampas* (Linnaeus, 1758), the endemic bivalve *Pinna nobilis* (Linnaeus, 1758) and the endolithic bivalve *Lithophaga lithophaga* (Linnaeus, 1758), are protected by international conventions.

1. Introduction

Among the bioconstructed habitats in the Mediterranean Sea, the "Coralligenous assemblages", known also as the "Coralligenous framework" or "Coralligenous", are undoubtedly among the most important and complex habitats that occur in the Mediterranean Sea. The name of this peculiar habitat was established in 1883, when the French zoologist A.F. Marion coined the term coralligenous during his studies of the calcareous concretions in the Gulf of Marseilles. He found pieces of corals, including the red coral *Corallium rubrum*, and because of that he called this habitat Coralligène, meaning "coral-producing".

Coralligenous formations are the temperate reefs of the Mediterranean Sea, and alongside the seagrass meadows formed by the endemic plant *Posidonia oceanica* (Buia et al., 2004; Boudouresque et al., 2012; Campagne et al., 2015) one can find biodiversity hot spots in different light zones. Light is the most important environmental factor restricting the development of this distinctive formation in the dark of the rocky bottoms. Even if enough light is necessary for the development and growth of the coralligenous frameworks, the main "builders" are macroalgae which need substantial amounts of light to grow. These algae, however, cannot withstand high levels of irradiance (Ballesteros, 2003, 2006). During the slow growth, a very complex structure is built, which allows the development of several kinds of communities. Examples of the latter are the living algae on the shallower part of the concretions, suspension feeders in the deeper part in the cavities and overhangs, borers inside the concretions and also soft bottom encounters in the sediment enclosed in the cavities and holes (Hong, 1980; Ballesteros, 2006). Since the research undertaken by Marion in the late 19th century, several other studies have been conducted mostly in the Western Mediterranean investigating the biodiversity and the functional role of this habitat in the marine ecosystem. Laubier (1966) was the first who emphasized the wide biodiversity of the coralligenous, and he provided a list of almost 544 invertebrate species from Banyuls on coast of southern France. Following a thorough survey of the coralligenous off Marseile (France), Hong (1980) succeeded in compiling a list of a total of 682 species, 128 of which are molluscs. During recent decades, a growing body of researchers work either on the biodiversity of the habitat or on the

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structure and functional role in the marine environment by applying both destructive and non-destructive methods (Kipson et al., 2011; Bertolino et al., 2014; Calcinai et al., 2015).

Molluscs are one of the most important groups of animals that are found in the Mediterranean Sea, while its molluscan fauna is the best known in the world (Sabelli and Taviani, 2014). From the 17,000 marine species that have been found in the Mediterranean, 13% are molluscs (Coll et al., 2010). Suprisingly, the rate at which new species and taxa are described each year is still remarkably high (more than 10 species per year, (Crocetta et al., 2012). However, the malacofauna of the coralligenous habitats have been poorly studied due to the complexity of the habitat compared to the well-studied soft bottom assemblages and the depth where these structures are.

Coralligenous formations are accessible mainly by means of Scuba Diving. The amount of time available for quantitative and qualitative sampling is therefore constrained due to this fact. In some cases, and especially when the formations are not in the shape of vertical cliffs, quantitative sampling can be conducted by means of applying destructive methods like the use of grabs or dredges (Laubier, 1966). After the release of the Action Plan for the Conservation of the Coralligenous and other Calcareous Bio-Concretions in the Mediterranean Sea in 2008, emphasis has been placed on the completion of species lists for the animals and algae which are found in these habitats. The Action Plan clearly states the need, "to provide a check list of all the species that are able to thrive in coralligenous/maërl communities using published literature, unpublished reports and expert assessment. Species names (with authorities), citations, geo-referenced localities, abundances, and habitat features have to be included. This check-list has to be designed as a data base with an incorporated GIS" (RAC/SPA 2008). To date, such a species list is available (Bertolino et al., 2013) but not in a form of a database with spatial information (coordinates of stations/site from literature sources associated with species lists), while regarding the other major phyla (Chordata, Arthropoda, Annelida, Bryozoa, etc.) the information is still scattered in the relevant literature. Such Biological databases are one of the most important tools for the storage, analysis, and visualization of the information on the systematic distribution of the species and their habitats (Costello et al., 2014).

Nowadays, in the era of advanced Internet technology and cloud computing revolution, more and more databases on biodiversity have been created providing providing invaluable tools for the scientific community. The majority of them are focused on the systematic analysis of certain groups of animals or plants (Boxshall et al., 2014) or on their spatial distribution (GBIF, 2013) while limited information is given on the habitats in which they can be found.

In the present paper, we demonstrate and implement a database on malacofauna of the Coralligenous, designed for the storage of information on species distributions and based on published literature sources in both scientific journals and the grey literature (Ph.D. thesis, M.Sc. thesis, Project technical reports, etc.). One of the important aspects of this database is that for each source referred to, information on the studied habitat and the location as well as other information (depth, year, etc) is stored in, and thus species are associated with. Here, we also provide a preliminary species list of the molluscan fauna from the coralligenous habitats of the Mediterranean Sea (excluding maërl beds on soft bottoms) with a spatial dimension after a revision of the available literature.

2. Materials and methods

The designation of the present work is based on the published data in indexed and grey literature (i.e. non peer-reviewed, non indexed papers, PhD thesis, Project technical reports). Most of the historical journals are still non-indexed, and malacological works are still published in non-indexed journals as well as in Conference Proceedings. The database has been designed within the framework of Microsoft Access Database System ver. 2013. The Access Database system is one of the most common database systems used for offline purposes to act as an end-to-end solution for data management. Furthermore, it can handle a vast amount of information and can be easily connected with any available GIS software for the spatial visualization of its contents, such as the location of each research project, as well as in order to create distribution maps for certain species. Moreover, the database scheme and its components can easily be transferred to other database systems for integration or for the design of an online information system on the biodiversity of the coralligenous formations of the Mediterranean. Updated taxonomy and nomenclature used follow WoRMS (Boxshall et al., 2014). As all checklists reflect the taxonomic knowledge in the literature up to a given cut-off date, the present one reflects the status up to December 2014. For taxa lacking a recent taxonomic revision, lists of species names may not be based on sound taxonomy, and inferences may be erroneous. Up to now, 12 literature sources have been analyzed in order to extract the published information (Table 1), and more are planned to be added in the near future after securing and allocating the necessary funding for the continuation of such work.

Similarity patterns among published works were explored by using non-metric multidimentional scaling (nMDS, Kruskal 1964), based on a similarity matrix constructed using the Jaccard coefficient (Jaccard, 1901). An area-proportional Venn diagram has been created in order to visualize the amount of overlap among the molluscan species lists of the Western Mediterranean, the Adriatic Sea and the Aegean – Levantine Sea Mediterranean Subregions using BioVenn (http://www.cmbi.ru.nl/cdd/biovenn/index.php, Hulsen et al., 2008).

Table 1
Publications analyzed to date and the associated information on the location and the study depth. More information is stored in the database.

ID	Source	Location	X	Y	Depth	Facies	Subregion
1	Albano and Sabelli, 2011	"Secche di Tor Paterno"	41.5949	12.3261	30 m	Coralline algae	Western Mediterranean
2	Bedini et al., 2014	Pianosa Island	42.5912	10.0955	35 m	Coralline algae	Western Mediterranean
3	Casellato and Stefano, 2008	North Adriatic Sea	45.2611	12.5543	9–40 m	Le Tegnue	Adriatic Sea
4	Crocetta and Spanu, 2008	off Capo Caccia	40.5674	8.1566	100 m	Red Coral	Western Mediterranean
5	Hong, 1980	Gulf of Fos – France	43.3635	4.9503	35 m	Coralline algae	Western Mediterranean
6	Laubier, 1966	Alberes	42.5507	3.0916	20–40 m	Coralline algae	Western Mediterranean
7	Martin et al., 1990	Between Barcelona and Cadaques	41.8211	3.1348	8–27 m	Coralline algae	Western Mediterranean
8	Romdhane et al., 2007	Korbous – Tunisia	36.8171	10.5659	13 m	Coralline algae	Western Mediterranean
9	Salas and Hergueta, 1986	Torrecilla – Narja – Malaga	36.7248	−4.0829	10 m	Coralline algae	Western Mediterranean
10	Templado et al., 1986	Isla de Alboran – Seco de los Olivos	35.9390	−3.0337	50–300 m	Red Coral	Western Mediterranean
11	Topaloglu et al., 2010	Johnston Bank, North Aegean	39.3007	25.3828	40 m	Coralline algae	Aegean-Levantine Sea
12	Urra et al., 2012	Laja del Almirante	36.4540	−4.8141	13–18 m	Coralline algae	Western Mediterranean

3. Results and discussion

3.1. Database design

The database has been designed with the potential to supplement the information for each species stored in it. The database comprises two main tables and several dictionaries (Fig. 1). Information related to the classification of the species is stored in the associated table of the systematics. WORMS is used as the check tool for the systematics while the aphiaID is also stored in the database. For the correct list of species, in a phylogenetic order, the CLEMAM Biotaxis code is used (Gofas, 2015). In the same table, information on the trophic group, the habitat in cases that are found to live also in other habitats and the biogeographic zone have been added, based on a variety of literature sources (Graham, 1988 and references theirin, Macdonald, et al., 2010; Rueda et al., 2009; Urra et al., 2013; Milazzo et al., 2000; Antoniadou et al., 2005; Koutsoubas, 1992 and references theirin, Koutsoubas et al., 1997; Dell' Angelo et al., 2004; Koukouras and Karachle, 2005). New information on species from other sources (reports, personal communication with experts, new material from research activities of the authors) will be included in periodical updates applied to this database. The additional information for each species is stored in autonomous dictionaries and is used every time it is deemed necessary by using combo boxes. Moreover, by means of dictionaries the user avoids making mistakes resulting from mistyping information and this makes the database safer to be used by a multiple number of users. It is very important that the update of these dictionaries with additional information does not affect the stored information on the species and the sources.

Data on the literature and the associated species are added by using a simple designed interface, implemented with a nested form scheme (Fig. 2). In the main form, information on the source are entered with its details, as these have been defined, like the journal, the full title of the article, the habitat, the area, the coordinates and the depths and in the nested form, the information on the species and the associated data are entered, such as the systematic information and ecological data for each species. In the fields where the information is not available, the user can leave it empty and come back in the future for any further addition. Both forms have been also implemented in EXCEL datasheets datasheets as data forms for users that want to submit their data or data from new sources. This will ensure that the format of the forms will be identical to the one used in the database by using the append function of the database, too; the new data will be transferred automatically into the tables of the database without any mistake in the format. Mandatory information for the database is the source, the full title of the literature source as well as the species list (Scientific name in the database) as it is stated in the literature. Data on the literature and the associated species are entering by using a simple designed interface, implemented by a nested form scheme (Fig. 2). Frequent checks of the systematics with WORMS will ensure the classification update of the database (Fig. 3).

3.2. Analysis of the collected information

The literature analysis revealed records of 511 species (belonging to 143 families from 5 classes, Table 2) derived from 12 published articles and Ph.D. thesis (Fig. 3). Looking into the categories that compose this diversity, Gastropods are the dominant group with 357 species followed by the Bivalvia having 137 species, Polyplacophora with 14 species, Cephalopoda with 2 species and Scaphopoda with 1 species (Fig. 4). Gastropods are composed by 92 families, Bivalvia by 42 families, Polyplacophora by 6 families, Cephalopoda by 2 and Scaphopoda by 1 family.

The published material on the molluscan fauna from the coralligenous formations comes from a bathymetric range of 8 m–300 m. Within this range, different facies of this habitat exist like the gorgonians facies (*Eunicella* spp. *Paramuricea* spp.), the red coral (*Corallium rubrum*), and the red algae (*Mesophyllum* spp. *Peyssonnelia* spp.). Similarity analysis presence/absence data per station (station is the source of the information), based on the Jaccard coeficient matrix shows several clusters of stations (Fig. 5).

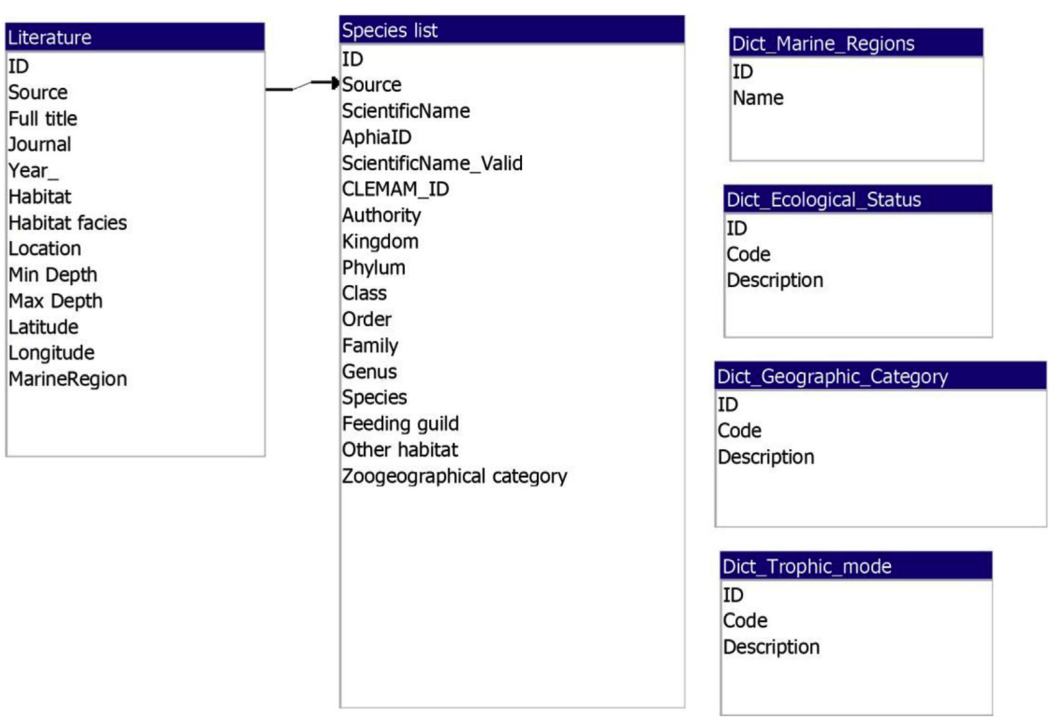

Fig. 1. Database scheme with tables and dictionaries.

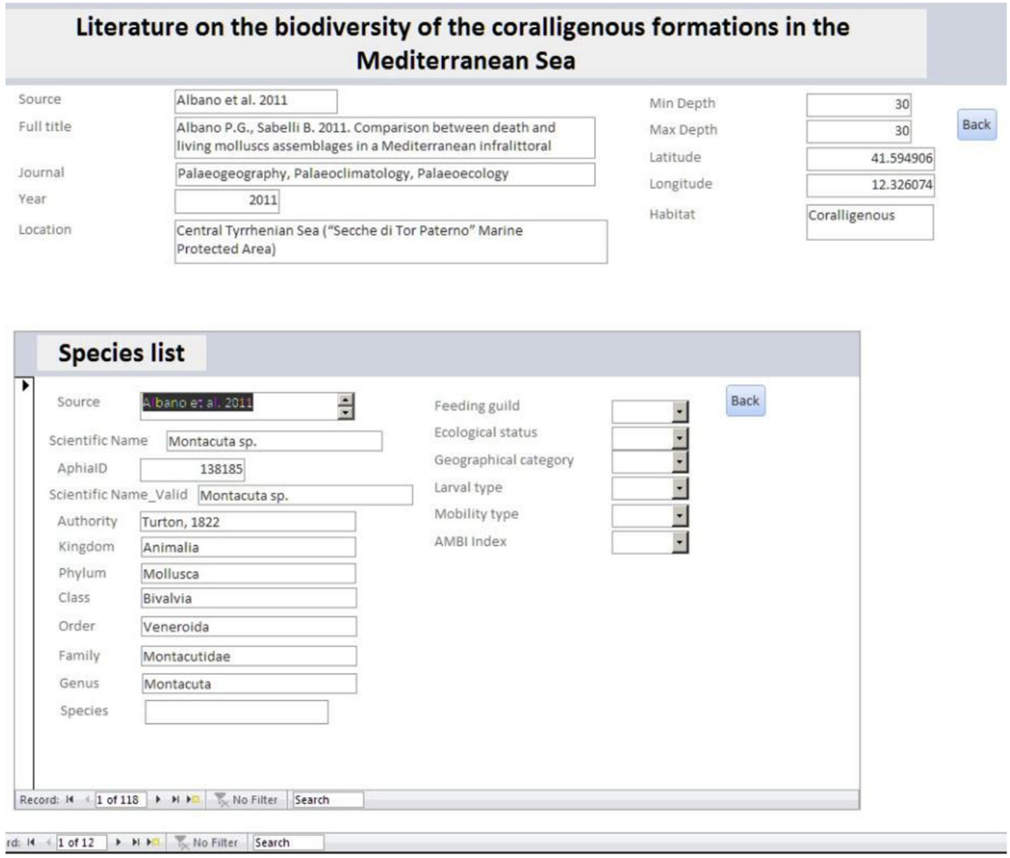

Fig. 2. Form for literature and the nested form for the species list.

The majority of the data, representing collections from a range of depths ranging from 8 m to 40 m, are grouped together (upper part in Fig. 5) with some exceptions on the margins, while the red coral material (deep stations from depths 50–300 m) have two different groups (Crocceta 2008 left bottom and Templado et al., 1986 work – upper left in Fig. 5). This division is mainly due to different sampling depths and methods (100 vs 300 max depth, SCUBA diving vs Saint Andrew's cross). From the remaining work, the one coming from Tunisia is a lot different from the others, possibly due to the different habitat conditions and shallow depths studied (13 m). Lastly, at the right side of the graph, both Bedini and Topaloglu's work lie close together but are not grouped. This is potentially due to the similarly fixed depths of 35 m and 40 m respectively at which both collections were made as well as the low number of species that both works provide (22 vs 27). Similarities between the three identified Mediterranean subregions each studied area belongs to (according to Claus et al., 2014) reveal 3 groups of data with small proportional areas of overlap between them (Fig. 6).

Four hundred and sixty two (approximately 69.68%) species have been recorded only from the Western Mediterranean subregion. One hundred and two (approximately 15.38%) species have

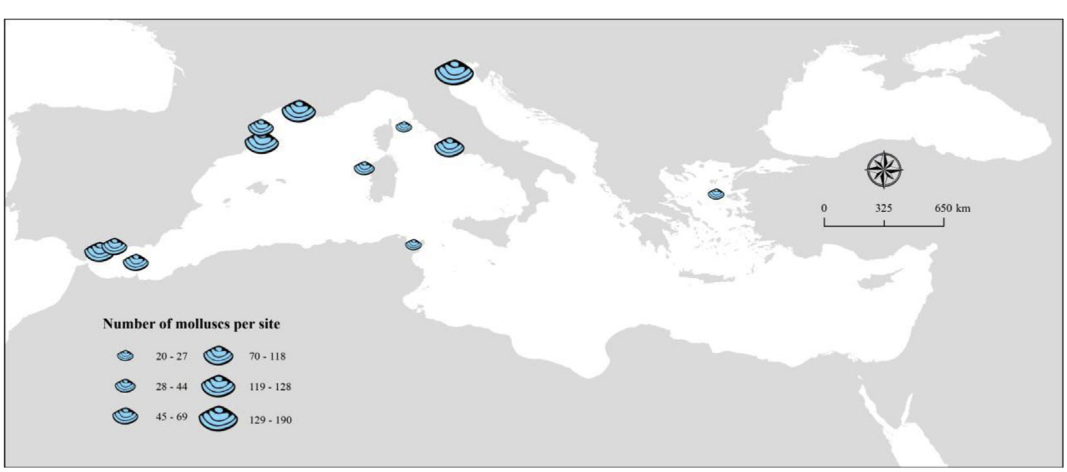

Fig. 3. Distribution of the studied sites in the Mediterranean Sea and the number of species per site.

Table 2
List of molluscan species associated to the coralligenous formations based on this work. PA = Photophilic Algae. Literature source numbers are associated with Table 1.

Class	Family	Species	Literature source	Comments	Other habitat that exist
Polyplacophora	Chitonidae	*Chiton* (Rhyssoplax) *corallinus* (Risso, 1826)	1,3,5,6,7,11		
		Chiton (Rhyssoplax) *olivaceus* Spengler, 1797	3,5,7,8,9,11		PA
	Leptochitonidae	*Lepidopleurus cajetanus* (Poli, 1791)	1,6,7		PA
		Leptochiton scabridus (Jeffreys, 1880)	3,7		PA
		Parachiton africanus (Nierstrasz, 1906)	3		
	Ischnochitonidae	*Ischnochiton* (Ischnochiton) *rissoi* (Payraudeau, 1826)	3,7		PA
	Callochitonidae	*Callochiton septemvalvis* (Montagu, 1803)	1,3,5,6,8,9		PA
	Lepidochitonidae	*Lepidochitona* (Lepidochitona) *caprearum* (Scacchi, 1836)	7		PA
		Lepidochitona (Lepidochitona) *cinerea* (Linnaeus, 1767)	6		PA
		Lepidochitona (Lepidochitona) *monterosatoi* Kaas and Van Belle, 1981	7		PA
	Acanthochitonidae	Acanthochitona Gray, 1821	5		
		Acanthochitona crinita (Pennant, 1777)	1,2,7		PA
		Acanthochitona discrepans (Brown, 1827)	5,6	The existence of this species in the Mediterranean is doubtful. According to Bonfitto et al., 2011, does not exists but according to WORMS, exists	PA
		Acanthochitona fascicularis (Linnaeus, 1767)	5,7,9		PA
Gastropoda	Patellidae	*Patella caerulea* Linnaeus, 1758	7,9		PA
	Lottiidae	*Tectura virginea* (O. F. Müller, 1776)	3,5,6,7,12		PA
	Fissurellidae	*Diodora gibberula* (Lamarck, 1822)	3,5,6,7,9,11		PA
		Diodora graeca (Linnaeus, 1758)	1,3,5,6,7,9,		PA
		Diodora italica (Defrance, 1820)	3,7		PA
		Diodora J.E. Gray, 1821	1		
		Emarginula adriatica O. G. Costa, 1830	4,5,10		PA
		Emarginula fissura (Linnaeus, 1758)	4,5,10		
		Emarginula huzardii Payraudeau, 1826	1,7		PA
		Emarginula octaviana Coen, 1939	1,6		PA
		Emarginula punctulum Piani, 1980	1		
		Emarginula rosea Bell, 1824	1,3,4		
		Emarginula sicula J.E. Gray, 1825	1,6,7		
	Scissurellidae	*Scissurella costata* d'Orbigny, 1824	1,3,5,7		PA
		Sinezona confusa Rolán and Luque, 1994	9		
	Haliotidae	*Haliotis tuberculata* Linnaeus, 1758	7,12		PA
		Haliotis tuberculata lamellosa Lamarck, 1822	1,5,6	valid subspecies of *Haliotis tuberculata*	PA
		Haliotis tuberculata tuberculata Linnaeus, 1758	3	valid subspecies of *Haliotis tuberculata*	
	Trochidae	*Clanculus corallinus* (Gmelin, 1791)	1,3,5,6,11		PA
		Clanculus cruciatus (Linnaeus, 1758)	1,3,7,8,12		PA
		Clanculus jussieui (Payraudeau, 1826)	12		PA
		Gibbula albida (Gmelin, 1791)	3		PA
		Gibbula fanulum (Gmelin, 1791)	12		PA
		Gibbula guttadauri (Philippi, 1836)	3		PA
		Gibbula magus (Linnaeus, 1758)	3,12		PA
		Gibbula turbinoides (Deshayes, 1835)	5		PA
		Jujubinus exasperatus (Pennant, 1777)	1,2,3,4,5,7,8,12		PA
		Jujubinus montagui (Wood, 1828)	3		
		Jujubinus striatus (Linnaeus, 1758)	1,2,11,12		PA
	Calliostomatidae	*Calliostoma conulus* (Linnaeus, 1758)	1,3,4,5,7		PA
		Calliostoma granulatum (Born, 1778)	2,11,12		
		Calliostoma laugieri (Payraudeau, 1826)	12		PA
		Calliostoma zizyphinum (Linnaeus, 1758)	3,4,5,6,9,11,12		PA
	Turbinidae	*Bolma rugosa* (Linnaeus, 1767)	1,2,3,5,7,11,12		PA
	Chilodontidae	*Danilia costellata* (O.G. Costa, 1861)	4		
		Danilia tinei (Calcara, 1839)	1		
	Phasianellidae	*Tricolia pullus* (Linnaeus, 1758)	3,5,9		PA
	Colloniidae	*Homalopoma sanguineum* (Linnaeus, 1758)	1,2,5		PA
	Cerithiidae	*Bittium incile* Watson, 1897	10		
		Bittium latreillii (Payraudeau, 1826)	1,2,8,11,12		PA
		Bittium reticulatum (da Costa, 1778)	2,3,5,6,7,8,12		PA
		Bittium simplex (Jeffreys, 1867)	12		
		Bittium Gray, 1847	1,3,9,10		PA
		Bittium submamillatum (de Rayneval and Ponzi, 1854)	12		PA
		Cerithium vulgatum Bruguière, 1792	5,7		PA
	Siliquariidae	*Petalopoma elisabettae* Schiaparelli, 2002	1		
		Tenagodus obtusus (Schumacher, 1817)	10		
	Turritellidae	*Turritella communis* Risso, 1826	3,7		PA
		Turritella triplicata (Brocchi, 1814)	6		PA
		Turritella turbona Monterosato, 1877	1,4,12		

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Table 2 (*continued*)

Class	Family	Species	Literature source	Comments	Other habitat that exist
	Triphoridae	*Cheirodonta pallescens* (Jeffreys, 1867)	12		PA
		Marshallora adversa (Montagu, 1803)	1,12		PA
		Metaxia metaxa (Delle Chiaje, 1828)	1		PA
		Monophorus erythrosoma (Bouchet and Guillemot, 1978)	1,7		PA
		Monophorus perversus (Linnaeus, 1758)	1,5,7,8		PA
		Monophorus thiriotae Bouchet, 1985	1		PA
		Obesula marisnostri Bouchet, 1985	1		
		Pogonodon pseudocanaricus (Bouchet, 1985)	1		
		Triphora Blainville, 1828	9		
	Cerithiopsidae	*Cerithiopsis atalaya* Watson, 1885	7		PA
		Cerithiopsis fayalensis Watson, 1880	7		PA
		Cerithiopsis nana Jeffreys, 1867	1		
		Cerithiopsis nofronii Amati, 1987	1		
		Cerithiopsis Forbes and Hanley, 1850	1		
		Cerithiopsis tubercularis (Montagu, 1803)	3,5,7		PA
		Dizoniopsis bilineata (Hoernes, 1848)	7		PA
		Dizoniopsis coppolae (Aradas, 1870)	1		PA
	Aclididae	*Aclis attenuans* Jeffreys, 1883	3		
	Epitoniidae	*Epitonium clathrus* (Linnaeus, 1758)	3		PA
	Eulimidae	*Eulima bilineata* Alder, 1848	3		
		Eulima glabra (da Costa, 1778)	3		PA
		Eulima incurva Bucquoy, Dautzenberg & Dollfus, 1883	8		
		Eulima Risso, 1826	3,9		
		Fusceulima minuta (Jeffreys, 1884)	3		
		Melanella polita (Linnaeus, 1758)	7,9		PA
		Melanella pyramidalis (G. B. Sowerby II, 1866)	7		
		Sticteulima jeffreysiana (Brusina, 1869)	1		
		Vitreolina curva (Monterosato, 1874)	3		
		Vitreolina incurva (Bucquoy, Dautzenberg & Dollfus, 1883)	6		PA
		Vitreolina perminima (Jeffreys, 1883)	3		
	Skeneopsidae	*Skeneopsis planorbis* (O. Fabricius, 1780)	7,9		PA
	Rissoidae	*Alvania beanii* (Hanley in Thorpe, 1844)	3		PA
		Alvania cancellata (da Costa, 1778)	1,3,5,7,10		PA
		Alvania carinata (da Costa, 1778)	9		
		Alvania cimex (Linnaeus, 1758)	1,2,3,5,7,8		PA
		Alvania discors (Allan, 1818)	1,2,5,6,7		PA
		Alvania geryonia (Nardo, 1847)	1,3		PA
		Alvania hispidula (Monterosato, 1884)	1		
		Alvania lactea (Michaud, 1830)	3,8		PA
		Alvania lanciae (Calcara, 1845)	7		PA
		Alvania lineata Risso, 1826	1,2,7,8,12		PA
		Alvania punctura (Montagu, 1803)	3,1		
		Alvania scabra (Philippi, 1844)	9		PA
		Alvania settepassii Amati and Nofroni, 1985	1		
		Alvania subcrenulata (Bucquoy, Dautzenberg & Dollfus, 1884)	7		PA
		Alvania tenera (Philippi, 1844)	1,5,7		PA
		Crisilla beniamina (Monterosato, 1884)	1		PA
		Crisilla semistriata (Montagu, 1808)	3,5,7,8,9		PA
		Manzonia crassa (Kanmacher, 1798)	1,5,7		PA
		Obtusella intersecta (S. Wood, 1857)	3		
		Pusillina inconspicua (Alder, 1844)	1,7		PA
		Pusillina philippi (Aradas and Maggiore, 1844)	1,7		PA
		Pusillina radiata (Philippi, 1836)	7		PA
		Pusillina sarsii (Lovén, 1846)	3		
		Pusillina Monterosato, 1884	1		
		Rissoa auriscalpium (Linnaeus, 1758)	3		PA
		Rissoa guerinii Récluz, 1843	5		PA
		Rissoa lia (Monterosato, 1884)	3,12		PA
		Rissoa lilacina Récluz, 1843	12		PA
		Rissoa membranacea (J. Adams, 1800)	12		PA
		Rissoa parva (da Costa, 1778)	7		PA
		Rissoa similis Scacchi, 1836	9		PA
		Rissoa Desmarest, 1814	8		
		Rissoa variabilis (Von Mühlfeldt, 1824)	2,7		PA
		Rissoa ventricosa Desmarest, 1814	5,7		PA
		Rissoa violacea Desmarest, 1814	2,3,5,7		PA
		Setia fusca (Philippi, 1841)	5		
	Rissoinidae	*Rissoina bruguieri* (Payraudeau, 1826)	1,2,3,6		PA
	Anabathridae	*Pisinna glabrata* (Megerle von Mühlfeld, 1824)	7		PA
	Barleeidae	*Barleeia unifasciata* (Montagu, 1803)	3,7		PA
	Caecidae	*Caecum auriculatum* de Folin, 1868	6		
		Caecum clarkii Carpenter, 1859	3		PA
		Caecum imperforatum (Kanmacher, 1798)	6		
		Caecum subannulatum de Folin, 1870	1,3,5		PA
		Caecum trachea (Montagu, 1803)	3		PA

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Table 2 (*continued*)

Class	Family	Species	Literature source	Comments	Other habitat that exist
		Parastrophia asturiana de Folin, 1870	1		PA
	Iravadiidae	*Hyala vitrea* (Montagu, 1803)	3		PA
	Vermetidae	*Thylacodes arenarius* (Linnaeus, 1758)	3,5		PA
		Vermetus triquetrus Bivona-Bernardi, 1832	5,6,7		PA
	Aporrhaidae	*Aporrhais pespelecani* (Linnaeus, 1758)	3,5		
	Calyptraeidae	*Calyptraea chinensis* (Linnaeus, 1758)	3,6,9,11,12		PA
		Crepidula Lamarck, 1799	1		
		Crepidula unguiformis Lamarck, 1822	2		PA
	Capulidae	*Capulus ungaricus* (Linnaeus, 1758)	3,5,8,10		PA
	Velutinidae	*Lamellaria perspicua* (Linnaeus, 1758)	12		
		Velutina Fleming, 1820	5		
	Triviidae	*Erato voluta* (Montagu, 1803)	11		PA
		Trivia arctica (Pulteney, 1799)	1,4,5		
		Trivia monacha (da Costa, 1778)	6,7,12		PA
		Trivia multilirata (G. B. Sowerby II, 1870)	4		
	Cypraeidae	*Luria lurida* (Linnaeus, 1758)	1		PA
	Ovulidae	*Pseudosimnia adriatica* (G. B. Sowerby I, 1828)	4		
		Pseudosimnia carnea (Poiret, 1789)	4,1		PA
		Simnia patula (Pennant, 1777)	10		
		Simnia purpurea Risso, 1826	4		
		Simnia spelta (Linnaeus, 1758)	10,12		
	Naticidae	*Euspira fusca* (Blainville, 1825)	3		
		Euspira macilenta (Philippi, 1844)	12		PA
		Euspira nitida (Donovan, 1804)	1,3,4,7,12		
		Naticarius hebraeus (Martyn, 1786)	3		
		Naticarius stercusmuscarum (Gmelin, 1791)	3		PA
		Tectonatica sagraiana (d'Orbigny, 1842)	12		
	Cassidae	*Phalium saburon* (Bruguière, 1792)	3		
	Ranellidae	*Cabestana cutacea* (Linnaeus, 1767)	10		
	Ranellidae	*Charonia lampas* (Linnaeus, 1758)	6,1		
	Ranellidae	*Monoplex corrugatus* (Lamarck, 1816)	10		
	Muricidae	*Bolinus brandaris* (Linnaeus, 1758)	3		PA
		Coralliophila brevis (Blainville, 1832)	4,5,10		PA
		Coralliophila meyendorffii (Calcara, 1845)	1,2,7,9		PA
		Coralliophila panormitana (Monterosato, 1869)	4		
		Coralliophila sofiae (Aradas and Benoit, 1876)	4		
		Dermomurex scalaroides (Blainville, 1829)	1		
		Hexaplex trunculus (Linnaeus, 1758)	3,8,12		PA
		Hirtomurex squamosus (Bivona Ant. in Bivona And., 1838)	4		PA
		Murexsul aradasii (Monterosato in Poirier, 1883)	1,4		
		Muricopsis cristata (Brocchi, 1814)	1,2,5,6,7,9,12		PA
		Ocenebra erinaceus (Linnaeus, 1758)	3,7,12		PA
		Ocinebrina aciculata (Lamarck, 1822)	1,5,6,7,12		PA
		Ocinebrina edwardsii (Payraudeau, 1826)	2,7,9,12		PA
		Ocinebrina paddeui Bonomolo and Buzzurro, 2006	4		
		Orania fusulus (Brocchi, 1814)	4		
		Trophonopsis droueti (Dautzenberg, 1889)	8		
		Trophonopsis muricata (Montagu, 1803)	11		PA
		Typhinellus labiatus (de Cristofori & Jan, 1832)	1		
	Cystiscidae	*Gibberula miliaria* (Linnaeus, 1758)	3,7,10,12		PA
		Gibberula philippii (Monterosato, 1878)	3,9		PA
	Marginellidae	*Granulina marginata* (Bivona, 1832)	7		PA
	Buccinidae	*Cantharus* Röding, 1798	9		
		Chauvetia affinis (Monterosato, 1889)	10		PA
		Chauvetia brunnea (Donovan, 1804)	1,3,5,6,7,9,12		PA
		Chauvetia lineolata (Tiberi, 1868)	4		
		Chauvetia mamillata (Risso, 1826)	2		PA
		Chauvetia procerula (Monterosato, 1889)	12		
		Chauvetia recondita (Brugnone, 1873)	1		PA
		Chauvetia Monterosato, 1884	10		
		Euthria cornea (Linnaeus, 1758)	1,3,7		PA
		Pollia dorbignyi (Payraudeau, 1826)	1,2,3,7,9,		PA
		Pollia scabra Locard, 1892	1,12		PA
		Pollia scacchiana (Philippi, 1844)	7		PA
	Mitridae	*Mitra cornicula* (Linnaeus, 1758)	1,5,7,10		
	Costellariidae	*Vexillum ebenus* (Lamarck, 1811)	1,6,11		PA
		Vexillum savignyi (Payraudeau, 1826)	1,3		PA
		Vexillum tricolor (Gmelin, 1791)	1,2,3,5,7,11		PA
	Nassariidae	*Cyclope pellucida* Risso, 1826	12		
		Nassarius cuvierii (Payraudeau, 1826)	3		PA
		Nassarius incrassatus (Strøm, 1768)	1,5,6,7,9,12		PA
		Nassarius lima (Dillwyn, 1817)	3,4		PA
		Nassarius pygmaeus (Lamarck, 1822)	12		PA
		Nassarius reticulatus (Linnaeus, 1758)	3,12		PA

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Table 2 (*continued*)

Class	Family	Species	Literature source	Comments	Other habitat that exist
	Fasciolariidae	*Fusinus pulchellus* (Philippi, 1840)	1,4,5,12		PA
		Fusinus rostratus (Olivi, 1792)	3,1		PA
		Fusinus rudis (Philippi, 1844)	3		PA
		Fusinus syracusanus (Linnaeus, 1758)	2		PA
	Columbellidae	*Amphissa cancellata* (Castellanos, 1979)	10		
		Columbella rustica (Linnaeus, 1758)	1,2,5,6,7,9		PA
		Mitrella broderipi (G. B. Sowerby I, 1844)	9,12		
		Mitrella bruggeni van Aartsen, Menkhorst & Gittenberger, 1984	12		PA
		Mitrella coccinea (Philippi, 1836)	1		
		Mitrella gervillii (Payraudeau, 1826)	1,4,6		PA
		Mitrella minor (Scacchi, 1836)	4,12		
		Mitrella pallaryi (Dautzenberg, 1927)	10		
		Mitrella scripta (Linnaeus, 1758)	1,5,7		PA
	Cancellariidae	*Bivetiella cancellata* (Linnaeus, 1767)	12		
	Conidae	*Conus ventricosus* Gmelin, 1791	6		PA
	Drilliidae	*Crassopleura maravignae* (Bivona Ant. in Bivona And., 1838)	4,12		PA
	Clathurellidae	*Clathromangelia granum* (Philippi, 1844)	1		PA
		Comarmondia gracilis (Montagu, 1803)	4,12		PA
	Mitromorphidae	*Mitromorpha crenipicta* (Dautzenberg, 1889)	10		PA
		Mitromorpha olivoidea (Cantraine, 1835)	7,12		PA
	Mangeliidae	*Bela menkhorsti* van Aartsen, 1988	4		
		Bela nebula (Montagu, 1803)	3,12		
		Bela powisiana (Dautzenberg, 1887)	12		
		Bela Leach, 1847	12		PA
		Bela taprurensis (Pallary, 1904)	3		
		Bela zonata (Locard, 1892)	12		PA
		Mangelia attenuata (Montagu, 1803)	12		PA
		Mangelia costulata Risso, 1826	12		
		Mangelia scabrida Monterosato, 1890	1		
		Mangelia stosiciana Brusina, 1869	1		PA
		Mangelia taeniata (Deshayes, 1835)	8		PA
		Mangelia unifasciata (Deshayes, 1835)	3,12		PA
		Mangelia vauquelini (Payraudeau, 1826)	1,7		PA
	Raphitomidae	*Pleurotomella demosia* (Dautzenberg and Fischer, 1896)	4		
		Raphitoma bicolor (Risso, 1826)	12		PA
		Raphitoma concinna (Scacchi, 1836)	1,4		PA
		Raphitoma echinata (Brocchi, 1814)	8		PA
		Raphitoma horrida (Monterosato, 1884)	12		PA
		Raphitoma intermedia Nordsieck, 1968	7		
		Raphitoma laviae (Philippi, 1844)	7		PA
		Raphitoma leufroyi (Michaud, 1828)	1		PA
		Raphitoma linearis (Montagu, 1803)	1,2,5,7,12		PA
		Raphitoma lineolata (Bucquoy, Dautzenberg & Dollfus, 1883)	7		PA
		Raphitoma papillosa (Pallary, 1904)	3		
		Raphitoma purpurea (Montagu, 1803)	2		
		Raphitoma Bellardi, 1847	8		
		Raphitoma sp. 1 Bellardi, 1847	1	This and the following sp's come from the same literature source, indicating that are separate species but not possible to identify them to the species level. We decided to include them here in the same manner as they are given in the sources.	
		Raphitoma sp. 2 Bellardi, 1847	1	As above	
		Raphitoma sp. 3 Bellardi, 1847	1	As above	
	Architectonicidae	*Heliacus fallaciosus* (Tiberi, 1872)	12		
		Philippia hybrida (Linnaeus, 1758)	4		
		Pseudotorinia architae (O. G. Costa, 1841)	12		PA
	Mathildidae	*Mathilda cochlaeformis* Brugnone, 1873	4		
		Mathilda elegantissima (Costa, 1861)	10		
	Omalogyridae	*Ammonicera fischeriana* (Monterosato, 1869)	7		PA
		Ammonicera rota (Forbes and Hanley, 1850)	3		PA
		Omalogyra atomus (Philippi, 1841)	5,7		PA
	Pyramidellidae	*Chrysallida emaciata* (Brusina, 1866)	5		
		Chrysallida excavata (Philippi, 1836)	1,3,5,7		PA
		Chrysallida incerta (Milaschewitsch, 1916)	3		
		Chrysallida intermixta (Monterosato, 1884)	5,7		

(*continued on next page*)

Table 2 (*continued*)

Class	Family	Species	Literature source	Comments	Other habitat that exist
		Chrysallida monozona (Brusina, 1869)	3		
		Chrysallida sigmoidea (Monterosato, 1880)	5		
		Chrysallida Carpenter, 1856	3		
		Chrysallida terebellum (Philippi, 1844)	7		
		Eulimella acicula (Philippi, 1836)	3		PA
		Eulimella scillae (Scacchi, 1835)	3		
		Euparthenia bulinea (Lowe, 1841)	3		
		Euparthenia humboldti (Risso, 1826)	3		PA
		Megastomia conspicua (Alder, 1850)	12		
		Noemiamea dolioliformis (Jeffreys, 1848)	3		PA
		Odostomella doliolum (Philippi, 1844)	1,5		PA
		Odostomia acuta Jeffreys, 1848	3		PA
		Odostomia nardoi Brusina, 1869	5		
		Odostomia nitens Jeffreys, 1870	3		
		Odostomia plicata (Montagu, 1803)	3		PA
		Odostomia polita Pease, 1867	5		
		Odostomia scalaris MacGillivray, 1843	5,7		
		Odostomia striolata Forbes and Hanley, 1850	7		PA
		Odostomia turrita Hanley, 1844	3		
		Odostomia unidentata (Montagu, 1803)	5		
		Ondina divisa (J. Adams, 1797)	3		
		Ondina vitrea (Brusina, 1866)	3		PA
		Parthenina clathrata (Jeffreys, 1848)	5,1		
		Parthenina dollfusi (Kobelt, 1903)	5		
		Parthenina incerta Milaschewitsch, 1916	3,7		
		Parthenina indistincta (Montagu, 1808)	3,5		PA
		Parthenina interstincta (J. Adams, 1797)	5,7		
		Parthenina suturalis (Philippi, 1844)	1		
		Turbonilla gradata Bucquoy, Dautzenberg & Dollfus, 1883	1		PA
		Turbonilla jeffreysii (Jeffreys, 1848)	3		
		Turbonilla lactea (Linnaeus, 1758)	3,5		PA
		Turbonilla micans (Monterosato, 1875)	5		
		Turbonilla pumila Seguenza G., 1876	7		PA
		Turbonilla rosewateri Corgan and van Aartsen, 1993	5		
		Turbonilla Risso, 1826	3		
		Turbonilla striatula (Linnaeus, 1758)	7		
	Amathinidae	*Clathrella clathrata* (Philippi, 1844)	1,3,5		PA
	Tjaernoiidae	*Tjaernoeia exquisita* (Jeffreys, 1883)	3		
	Acteonidae	*Acteon tornatilis* (Linnaeus, 1758)	3		PA
	Ringiculidae	*Ringicula auriculata* (Ménard de la Groye, 1811)	12		PA
	Bullidae	*Bulla striata* Bruguière, 1792	11		PA
	Haminoeidae	*Haminoea hydatis* (Linnaeus, 1758)	3,5		PA
		Haminoea Turton & Kingston in Carrington, 1830	1		
		Weinkauffia turgidula (Forbes, 1844)	1,3		PA
	Philinidae	*Philine aperta* (Linnaeus, 1767)	12		
	Scaphandridae	*Scaphander lignarius* (Linnaeus, 1758)	3		
	Retusidae	*Pyrunculus hoernesii* (Weinkauff, 1866)	12		PA
		Retusa truncatula (Bruguière, 1792)	3,5,9		PA
		Retusa umbilicata (Montagu, 1803)	3		PA
	Runcinidae	*Runcina coronata* (Quatrefages, 1844)	9		PA
	Cavoliniidae	*Cavolinia inflexa* (Lesueur, 1813)	10		
		Diacria trispinosa (Blainville, 1821)	10		
	Cliidae	*Clio pyramidata* Linnaeus, 1767	10		
	Plakobranchidae	*Thuridilla hopei* (Vérany, 1853)	6		PA
	Boselliidae	*Bosellia mimetica* Trinchese, 1891	2,6		
	Hermaeidae	*Hermaea variopicta* (A. Costa, 1869)	2		
	Umbraculidae	*Umbraculum umbraculum* (Lightfoot, 1786)	12		PA
	Tylodinidae	*Tylodina perversa* (Gmelin, 1791)	6		PA
	Akeridae	*Akera bullata* O. F. Müller, 1776	5		
	Aplysiidae	*Aplysia parvula* Mörch, 1863	7,12	The taxonomic status of the Aplysia parvula/punctata is under review	PA
		Aplysia punctata (Cuvier, 1803)	5	The taxonomic status of the Aplysia parvula/punctata is under review	PA
	Pleurobranchidae	*Berthella ocellata* (Delle Chiaje, 1830)	3		
		Pleurobranchus Cuvier, 1804	5		
	Dorididae	*Doris pseudoargus* Rapp, 1827	3,6	The taxonomic status of Dorididae in under consideration	

(*continued on next page*)

Table 2 (*continued*)

Class	Family	Species	Literature source	Comments	Other habitat that exist
		Doris Linnaeus, 1758	5		
	Discodorididae	*Paradoris indecora* (Bergh, 1881)	5		PA
		Peltodoris atromaculata Bergh, 1880	6		PA
	Chromodorididae	*Felimare picta* (Schultz in Philippi, 1836)	6		PA
		Felimare tricolor (Cantraine, 1835)	6		PA
		Felimare villafranca (Risso, 1818)	6		PA
		Felimida krohni (Vérany, 1846)	9		PA
		Felimida luteorosea (Rapp, 1827)	6		
		Hypselodoris Stimpson, 1855	9,12		
	Dendrodorididae	*Dendrodoris grandiflora* (Rapp, 1827)	7		
		Dendrodoris limbata (Cuvier, 1804)	3		PA
		Doriopsilla areolata Bergh, 1880	9,1		PA
	Goniodorididae	*Okenia* Menke, 1830	5,6		
		Trapania maculata Haefelfinger, 1960	12		PA
	Polyceridae	*Colga* Bergh, 1880	5		
		Polycera quadrilineata (O. F. Müller, 1776)	6		PA
	Aegiretidae	*Aegires punctilucens* (d'Orbigny, 1837)	5		
	Tritoniidae	*Marionia blainvillea* (Risso, 1818)	10		
		Tritonia hombergii Cuvier, 1803	5		
		Tritonia manicata Deshayes, 1853	6		PA
		Tritonia striata Haefelfinger, 1963	7		
	Heroidae	*Hero blanchardi* Vayssière, 1888	2		
	Proctonotidae	*Janolus hyalinus* (Alder and Hancock, 1854)	5		
	Aeolidiidae	*Berghia coerulescens* (Laurillard, 1832)	5,6,9		
	Facelinidae	*Dondice banyulensis* Portmann and Sandmeier, 1960	6		PA
		Facelina Alder and Hancock, 1855	9		
	Flabellinidae	*Flabellina* Gray, 1833	3		PA
		Flabellina affinis (Gmelin, 1791)	5,6		PA
		Flabellina pedata (Montagu, 1816)	5,6		PA
	Tergipedidae	*Cratena peregrina* (Gmelin, 1791)	6		PA
		Cuthona caerulea (Montagu, 1804)	2		PA
		Cuthona genovae (O'Donoghue, 1929)	7		PA
	Siphonariidae	*Williamia gussoni* (Costa O. G., 1829)	1		PA
Bivalvia	Nuculidae	*Nucula hanleyi* Winckworth, 1931	12		
		Nucula nitidosa Winckworth, 1930	12		PA
		Nucula nucleus (Linnaeus, 1758)	3		
		Nucula Lamarck, 1799	1,5		
	Nuculanidae	*Nuculana pella* (Linnaeus, 1767)	3,5		PA
	Arcidae	*Anadara diluvii* (Lamarck, 1805)	8		
		Arca noae Linnaeus, 1758	3,8		PA
		Arca tetragona Poli, 1795	5,10,11		PA
		Asperarca nodulosa (O. F. Müller, 1776)	10		PA
		Asperarca secreta La Perna, 1998	4		
		Barbatia barbata (Linnaeus, 1758)	1,3,5,6,7		PA
		Barbatia clathrata (Defrance, 1816)	7		PA
		Bathyarca philippiana (Nyst, 1848)	2		
	Noetiidae	*Striarca lactea* (Linnaeus, 1758)	1,3,5,6,7,9,12		PA
	Limopsidae	*Limopsis anomala* (Eichwald, 1830)	10		
	Glycymerididae	*Glycymeris glycymeris* (Linnaeus, 1758)	3,12		
		Glycymeris nummaria (Linnaeus, 1758)	10		PA
		Glycymeris pilosa (Linnaeus, 1767)	3		
	Mytilidae	*Crenella arenaria* Monterosato, 1875 ex H. Martin, ms.	7		
		Crenella decussata (Montagu, 1808)	5		
		Gibbomodiola adriatica (Lamarck, 1819)	12		PA
		Gregariella coralliophaga (Gmelin, 1791)	9,1		
		Gregariella petagnae (Scacchi, 1832)	12		PA
		Gregariella semigranata (Reeve, 1858)	1,12		
		Lithophaga lithophaga (Linnaeus, 1758)	1,3,5,6,7		PA
		Modiolula phaseolina (Philippi, 1844)	3,4,5,10,11		PA
		Modiolus barbatus (Linnaeus, 1758)	3,5,6,7,8,12		PA
		Musculus costulatus (Risso, 1826)	3,5,7,9,10,12		PA
		Musculus discors (Linnaeus, 1767)	3,7		PA
		Musculus subpictus (Cantraine, 1835)	3,5,7,8,12		PA
		Mytilaster minimus (Poli, 1795)	3,9		PA
		Mytilus galloprovincialis Lamarck, 1819	3,9,12		PA
		Rhomboidella prideauxi (Leach, 1815)	12		PA
	Pinnidae	*Atrina pectinata* (Linnaeus, 1767)	3		
		Pinna nobilis Linnaeus, 1758	3,6		PA
	Pteriidae	*Pteria hirundo* (Linnaeus, 1758)	4,6,10		
	Pectinidae	*Aequipecten opercularis* (Linnaeus, 1758)	3		PA
		Flexopecten Sacco, 1897	12		
		Flexopecten flexuosus (Poli, 1795)	1		
		Flexopecten glaber (Linnaeus, 1758)	1,3		PA
		Flexopecten hyalinus (Poli, 1795)	5		PA
		Mimachlamys varia (Linnaeus, 1758)	3,5,7,8,9,11,12		PA

(*continued on next page*)

Table 2 (*continued*)

Class	Family	Species	Literature source	Comments	Other habitat that exist
		Palliolum incomparabile (Risso, 1826)	4,1		
		Palliolum striatum (O. F. Müller, 1776)	4		
		Pecten jacobaeus (Linnaeus, 1758)	3		
		Pseudamussium sulcatum (Müller O. F., 1776)	4,5		
		Similipecten similis (Laskey, 1811)	10		
	Pectinidae	*Talochlamys multistriata* (Poli, 1795)	1,2,5,6,7,10		PA
	Spondylidae	*Spondylus gaederopus* Linnaeus, 1758	6,1		PA
	Anomiidae	*Anomia ephippium* Linnaeus, 1758	3,5,6,9,12		PA
		Heteranomia squamula (Linnaeus, 1758)	2,4		
		Monia patelliformis (Linnaeus, 1761)	3,4,5,7,9,10,12		
	Limidae	*Lima lima* (Linnaeus, 1758)	1,5,6,7		PA
		Limaria hians (Gmelin, 1791)	5,6,9		PA
		Limaria loscombi (G. B. Sowerby I, 1823)	3		PA
		Limaria tuberculata (Olivi, 1792)	1		PA
		Limatula gwyni (Sykes, 1903)	3		
		Limatula subauriculata (Montagu, 1808)	5,1		
	Ostreidae	*Crassostrea gigas* (Thunberg, 1793)	3		PA
		Ostrea edulis Linnaeus, 1758	3		PA
	Gryphaeidae	*Neopycnodonte cochlear* (Poli, 1795)	4,8,10		PA
	Carditidae	*Cardita calyculata* (Linnaeus, 1758)	5,7,9,10		PA
		Glans trapezia (Linnaeus, 1767)	7		PA
	Astartidae	*Digitaria digitaria* (Linnaeus, 1758)	10,12		
	Astartidae	*Goodallia triangularis* (Montagu, 1803)	12		
	Lucinidae	*Ctena decussata* (O. G. Costa, 1829)	12		PA
		Loripes lucinalis (Lamarck, 1818)	3		PA
		Loripinus fragilis (Philippi, 1836)	3		PA
		Lucinella divaricata (Linnaeus, 1758)	3,11		PA
	Ungulinidae	*Diplodonta trigona* (Scacchi, 1835)	10		
	Chamidae	*Chama gryphoides* Linnaeus, 1758	3,5,6,7,9,10		PA
		Pseudochama gryphina (Lamarck, 1819)	7		PA
	Galeommatidae	*Galeomma turtoni* Turton, 1825	1,3,5,7,12		PA
	Kelliidae	*Hemilepton nitidum* (Turton, 1822)	7		PA
		Kellia suborbicularis (Montagu, 1803)	1,5,7,9,12		PA
	Lasaeidae	*Lasaea adansoni* (Gmelin, 1791)	3		PA
	Montacutidae	*Epilepton clarkiae* (W. Clark, 1852)	5		
		Kurtiella bidentata (Montagu, 1803)	3,5,7,10,12		PA
		Montacuta Turton, 1822	1		
		Montacuta substriata (Montagu, 1808)	5		
	Cardiidae	*Acanthocardia aculeata* (Linnaeus, 1758)	3		PA
		Acanthocardia echinata (Linnaeus, 1758)	3		
		Acanthocardia paucicostata (G. B. Sowerby II, 1834)	12		PA
		Laevicardium crassum (Gmelin, 1791)	12		
		Laevicardium oblongum (Gmelin, 1791)	3		
		Papillicardium papillosum (Poli, 1791)	1,3,5,7		PA
		Parvicardium exiguum (Gmelin, 1791)	3,6		PA
		Parvicardium minimum (Philippi, 1836)	3		PA
		Parvicardium pinnulatum (Conrad, 1831)	3		PA
		Parvicardium scabrum (Philippi, 1844)	12		
		Parvicardium scriptum (Bucquoy, Dautzenberg & Dollfus, 1892)	1		PA
		Parvicardium vroomi van Aartsen, Menkhorst & Gittenberger, 1984	9		PA
	Mactridae	*Spisula subtruncata* (da Costa, 1778)	9,12		PA
	Tellinidae	*Arcopagia balaustina* (Linnaeus, 1758)	1		
		Moerella distorta (Poli, 1791)	3		PA
		Moerella pygmaea (Lovén, 1846)	5		
		Tellina compressa Brocchi, 1814	12		
		Tellina tenuis da Costa, 1778	1		PA
	Donacidae	*Donax trunculus* Linnaeus, 1758	9		
	Psammobiidae	*Gari costulata* (Turton, 1822)	10,12		
		Gari fervensis (Gmelin, 1791)	12		
		Gari tellinella (Lamarck, 1818)	3		
	Semelidae	*Abra alba* (W. Wood, 1802)	3		PA
		Abra segmentum (Récluz, 1843)	3		
		Abra Lamarck, 1818	1		
	Solecurtidae	*Azorinus chamasolen* (da Costa, 1778)	3		PA
	Trapezidae	*Coralliophaga lithophagella* (Lamarck, 1819)	4,5,6,8,10		PA
	Myidae	*Sphenia binghami* Turton, 1822	12		PA
	Veneridae	*Callista chione* (Linnaeus, 1758)	3,12		
		Chamelea gallina (Linnaeus, 1758)	3,12		PA
		Chamelea striatula (da Costa, 1778)	12		
		Clausinella fasciata (da Costa, 1778)	12		PA
		Globivenus helenae (Fischer-Piette, 1975)	10		
		Gouldia minima (Montagu, 1803)	1,3,7,10,12		PA
		Irus irus (Linnaeus, 1758)	5,6,7,9,12		PA
		Petricola lithophaga (Retzius, 1788)	5,6,9		PA

(*continued on next page*)

Table 2 (*continued*)

Class	Family	Species	Literature source	Comments	Other habitat that exist
		Pitar rudis (Poli, 1795)	3,12		PA
		Polititapes aureus (Gmelin, 1791)	3		PA
		Polititapes rhomboides (Pennant, 1777)	3,9,12		PA
		Ruditapes decussatus (Linnaeus, 1758)	3		PA
		Timoclea ovata (Pennant, 1777)	3,5,12		
		Turtonia minuta (Fabricius, 1780)	9		
		Venerupis Lamarck, 1818	5		PA
		Venus verrucosa Linnaeus, 1758	1,3,7		PA
	Neoleptonidae	*Neolepton sulcatulum* (Jeffreys, 1859)	5		PA
	Corbulidae	*Corbula gibba* (Olivi, 1792)	3,5,7,12		PA
	Gastrochaenidae	*Rocellaria dubia* (Pennant, 1777)	3,5,6,7,9,12		PA
	Pharidae	*Ensis coseli* Vierna, 2014	12		SS
		Ensis minor (Chenu, 1843)	3		SS
		Phaxas adriaticus (Coen, 1933)	3		
	Hiatellidae	*Hiatella arctica* (Linnaeus, 1767)	1,3,4,5,6,7,9,10		PA
		Hiatella rugosa (Linnaeus, 1767)	3,7		PA
		Hiatella Bosc, 1801	11		
	Thraciidae	*Thracia distorta* (Montagu, 1803)	1		PA
		Thracia phaseolina (Lamarck, 1818)	3,5,7		
	Clavagellidae	*Bryopa melitensis* (Broderip, 1834)	5,6		
	Pandoridae	*Pandora inaequivalvis* (Linnaeus, 1758)	9,12		PA
Scaphopoda	Fustiariidae	*Fustiaria rubescens* (Deshayes, 1825)	12		PA
Cephalopoda	Sepiidae	*Sepia* Linnaeus, 1758	3,12		PA
	Octopodidae	*Octopus vulgaris* Cuvier, 1797	6,12		PA

been recorded from the Adriatic Sea only, while five (approximately 0.75%) species have been recorded from the Aegean – Levantine Sea so far. Only eight (8) species are common in the three subregions. This is an indicator of the unbalanced research effort that has been carried out in the Mediterranean Sea and the lack of quantative work which focuses on the biodiversity of the coralligenous formations as well as other difficulties, in terms of accessibility and habitats (Gerovasileiou and Voultsiadou, 2012). According to the latest available review on the coralligenous formations and their biodiversity (Ballesteros, 2006), the number noted by Ballesteros is the maximum species diversity found at a single locality. After the collection of all accessible literature, indexing in the designed database and the analysis of the information gathered, 511 species are found in these important Mediterranean habitats. A comparison with the Mediterranean malacofauna (excluding cephalopods) (Coll et al., 2010; S14 file), which has estimated around 2000 species, shows that one quarter of the malacofauna is present in the Coralligenous formations (511 species). Considering the composition of the Coralligenous malacofauna in comparison to the Mediterranean, 47% of the polyplacofora (14 of 30 species), 23% of the gastropods (357 of 1518), 32% of bivalvia (137 of 419) and 7% of scaphopods (1 of 14) have been recorded from these habitats.

During the last decade, research in several areas in the Mediterranean has shed light on the ecology of the dark habitats and revealed a vast amount of information on the biodiversity of the coralligenous (Crocceta et al., 2008; Casellato and Stefano, 2008; Topaloglu et al., 2010; Albano and Sabelli, 2011; Urra et al., 2012; Bedini et al., 2014). The increased research effort on these habitats addresses the need for a better understanding of the role of the coralligenous formation in the coastal marine environment. Coralligenous habitats are important habitats for fisheries, because they act as nurseries for several commercial species side by side with the seagrass meadows formed mainly by Neptune grass (*Posidonia oceanica*). Moreover, it is one of the most popular habitats for recreational divers (with marine caves), where one can witness groupers and gorgonians (*Eunicella* spp., *Paramuricea clavata*, *Eunicella singularis*, etc.), walls covered by colourofull sponges, encrusted bryozoans, and plates of coralline algae as well as the precious red coral (*Coralium rubrum*), which is highly important to

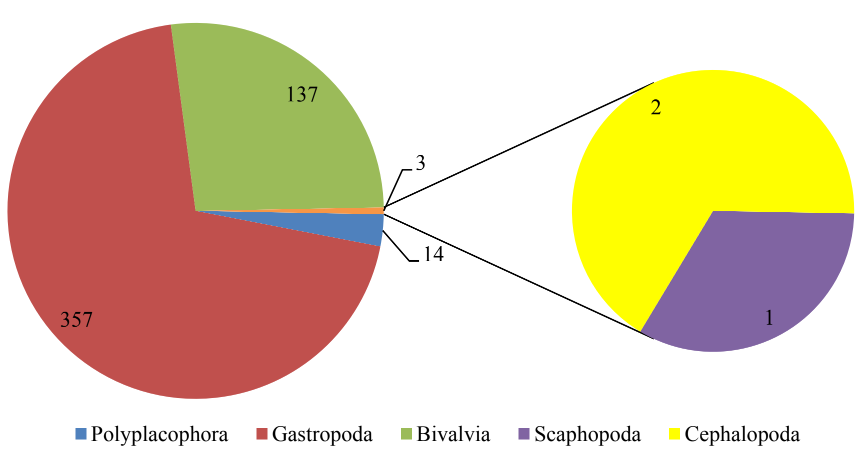

Fig. 4. Class composition of the Molluscs from coralligenous formations.

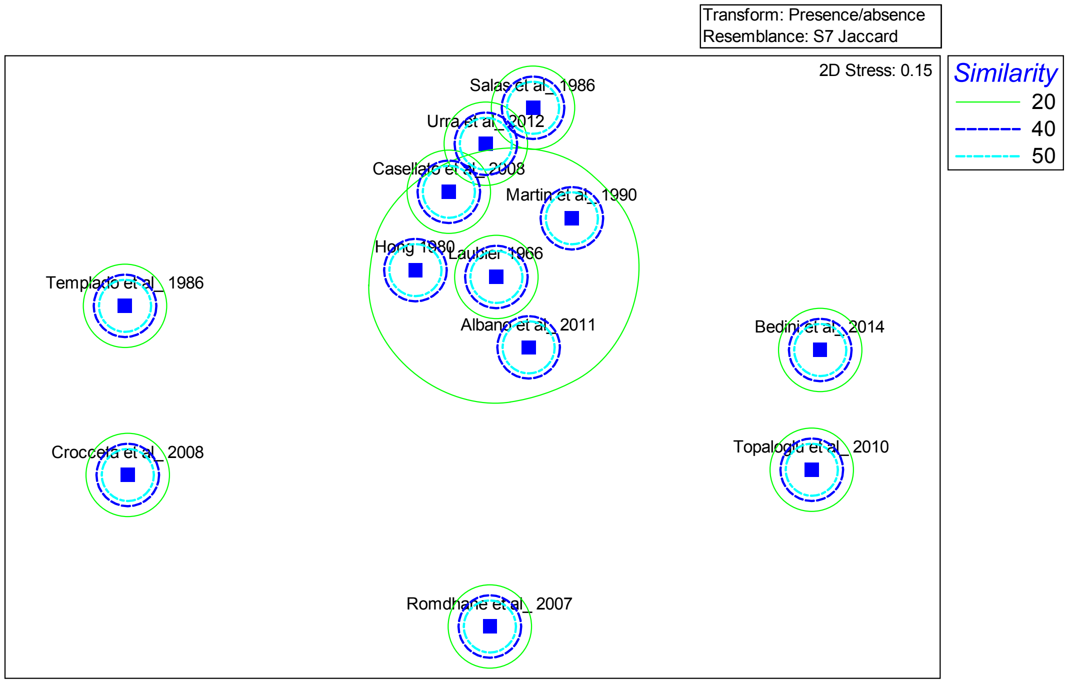

Fig. 5. nMDS graph of the 12 analyzed publications, based on Jaccard similarity of Mollusca species presence/absence data.

the tourism industry as part of the natural heritage. In addition, technological and financial improvements on the means of access (SCUBA Diving) make it safer and more affordable (in terms of logistics) for the scientific community to conduct research into the depths where these habitats are located. Even if these technological advances support research, challenges in the study of the organisms which inhabit the coralligenous formations exist due to the complexity, the high diversity and the depths at which these formations occur. Non-destructive research methods are applied more often, mainly visual census and underwater photographic plots (Kipson et al., 2011; Texeido et al., 2013; Garabbou et al., 2014; Casas-Güell et al., 2015; Sini et al., 2015) in order to establish baseline datasets, to collect data for the designation of ecological indices or for the assessement of impacts from natural and anthropogenic causes. These approaches serve to prevent the scientific community from discovering new information related to the fauna of vagile species such as molluscs.

Bertolino et al. (2013) stated that, “Our study, based on the collection of blocks and their sectioning into slices, allowed the identification of species that would have been otherwise completely disregarded”. Therefore, it is clear that by not applying limited quantitative collection methods to this peculiar habitat it is difficult to discover and understand the inhabitants of the coralligenous formations, those that live in-between the crevices and the sediment pools as well as those which have a cryptic behavior nyctohemeral migration and rarely appear on the surfaces of the coralligenous formations. The latter have been observed from deep seagrass meadows (Russo et al., 1984). Several species that have been found in the coralligenous formations have also been found in other marine habitats, infralittoral hard substrates with photophilic algae (see Table 2), or soft bottoms and seagrass meadows (*Posidonia oceanica*, *Cymodocea nodosa*). The latter and especially those that are formed by the endemic *Posidonia oceanica* appear not be single habitat creators but provide a multidimensional place that hosts species from several different habitats due to the zonation and the micoshelters (Pérès and Picard, 1964; Bianchi et al., 1989; Albano and Sabelli, 2012). The three-dimensional structure of the Coralligenous formations and their rugosity promotes the deposition of fine sediment in the crevices and other cavities and thus turns it into a rich area of microhabitats, a marine seascape which acts as a shelter for several species. Emphasis must be placed on quantitative studies of the formations in tandem with qualitative nondestructive studies, in order to better understand the role and the functions of these formations in the marine environment. Publication of data on the biodiversity of these habitats should be disseminated (Costello et al., 2013) together with other information which the scientific studies reveal, especially the ones carried out in the Eastern Mediterranean, as this area is less studied and the biodiversity is still unknown compared to its western counterpart. The study of the organisms at the level of habitat in the Mediterranean Sea is still far from being complete, and the scientific community will undoubtedly discover an abudance of scientific “gems” in the next decades.

4. Future prespectives for the database

The organization of biodiversity information with the use of database management systems is highly beneficial to the scientific community especially when compared to the simple datasheets that are usually provided as Supplementary material to publications (if at all). The CorMolDB is now an offline database, freely accessible after emailing a request to the authors as well as from the PANGAEA Data Repository (http://doi.pangaea.de/10.1594/PANGAEA.847623). The next step is to disseminate the species list per site via the Global Biodiversity Information Facility (GBIF) through the National Representative (https://www.lifewatchgreece.eu/). Moreover, after the development of a website dedicated to the biodiversity of the coralligenous formations of the Marine Science Department at the University of the Aegean, an online database system will be implemented in order to have an online fully functional database with the potential to grow and enrich itself with more data. Also, new versions of the database will be released periodically since information associated with species will be added within the coming years.

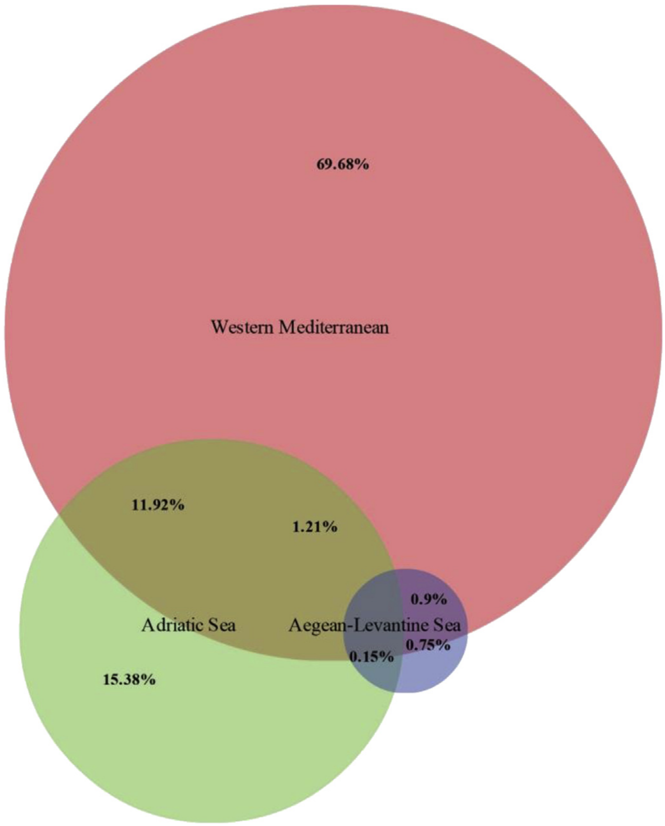

Fig. 6. Area-proportional Venn diagram assessing the overlap of species records among the three Mediterranean subregions (Western Mediterranean, Adriatic Sea, Aegean – Levantine Sea).

5. Conclusion

This work presents a database containg information regarding the elements of the malacofaunal biodiversity deriving from Coralligenous formations. As a model group, we use the phylum Mollusca for the composition of the first preliminary checklist from these habitats. A series of literature sources have been accessed and indexed in the database, which reveal a great number of species that have been recorded so far from this habitat. This work addresses the need for the implementation of such a biodiversity database for the coralligenous formations, as stated by the RAC/SPA in 2008. In addition, it aims at underlying the importance of quantifying the biodiversity of such coralligenous formations in order to gain profound insight on the extent of the biodiversity this environment contains. The same database scheme can be adapted for additional uses in order to answer the same questions for other important habitats in the Mediterranean Sea. The exclusive use of non-destructive methodology for the study of Coralligenous formations has to be sumplemmented by limited quantitative sampling in order to reveal its hidden inhabitants.

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Appendix A. Supplementary material

Supplementary material related to this article can be found at http://dx.doi.org/10.1016/j.quaint.2015.07.029.

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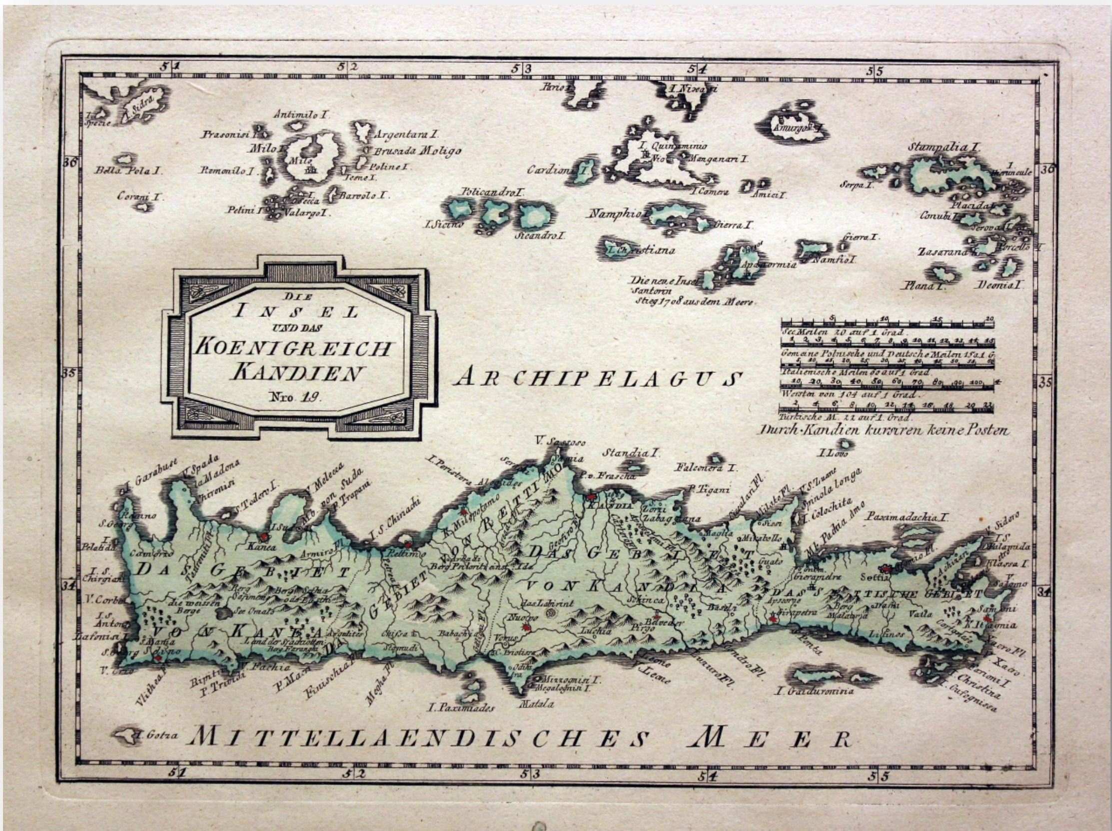
Κεφάλαιο 4

Είναι η παράκτια βιοποικιλότητα της Κρήτης αντιπροσωπευτική της Μεσογείου ? Δοκιμάζοντας την δύναμη του πρωτοκόλλου NaGISA για την μελέτη της ποικιλότητας των μαλακίων σε Μεσογειακούς Υφάλους.



Στα πλαίσια του 10ου συνεδρίου των εταίρων της σύμβασης της βιολογικής ποικιλότητας το 2010 στο Παρίσι έγινε ιδιαίτερη μνεία στο θέμα της ραγδαίας αύξησης της απώλεια βιοποικιλότητας καθώς και τις δράσεις που πρέπει να λάβουν χώρα ώστε ο ρυθμός αυτός να σταματήσει. Οι στόχοι για την ανάσχεση της απώλειας της βιοποικιλότητας που είχαν τεθεί για το 2010 δεν επιτεύχθηκαν και η υιοθέτηση μιας νέας στρατηγικής κρίνεται απαραίτητη ώστε μέχρι το 2020 να έχουν επιτευχθεί. Ανάμεσα στις γεωγραφικές ζώνες υψηλής βιοποικιλότητας, η Μεσόγειος αποτελεί ένα hot-spot με πολλά σπάνια και ενδημικά είδη ενώ φιλοξενεί θαλάσσιους οικοτόπους υψηλής βιολογικής και κοινωνικής αξίας. Έχοντας έκταση που αναλογεί στο 0.7% της συνολικής επιφάνειας των ωκεανών, φιλοξενεί το 7% της παγκόσμιας θαλάσσιας βιοποικιλότητας. Οι παράκτιοι θαλάσσιοι οικότοποι αποτελούν τα ποιο εύθραυστα οικοσυστήματα λόγω των πιέσεων που δέχονται από ανθρωπογενείς δραστηριότητες. Οι βραχώδεις ακτές και οι σχετικοί παράκτιοι βραχώδεις βυθοί, συνήθως καλύπτονται από φωτόφιλα μακροφύκη, ενώ εκτιμάται πως αποτελούν το 54% της συνολικής Μεσογειακής ακτογραμμής. Η παρουσία των μακροφυκών αυξάνει την πολυπλοκότητα του παράκτιου αυτού οικοσυστήματος ενώ αυξάνονται οι λειτουργίες και οι υπηρεσίες που παρέχει στο οικοσύστημα και την κοινωνία. Παρέχει καταφύγιο για τα νεαρά ψάρια, αποτελεί οικότοπο για μια σειρά από άλλους θαλάσσιους οργανισμούς όπως τα καρκινοειδή, τα πολύχαιτα και τα μαλάκια ενώ μειώνει τον υδροδυναμισμό της κυματικής δράσης και δημιουργεί ένα τρισδιάστατο οικοσύστημα. Εξαιτίας της σημαντικότητας του οικοσυστήματος αυτού, ο Ευρωπαϊκός κανονισμός για την διατήρηση των οικοτόπων των περιοχών του δικτύου NATURA 2000, το ενέταξε με το όνομα «ΥΦΑΛΟΙ» και κωδικό 1170. Σε αυτό τον κωδικό εντάσσονται και οι κοραλλιγενείς σχηματισμοί, ευρισκόμενοι βαθύτερα από τα φωτόφιλα φύκη. Τα βενθικά ασπόνδυλα αποτελούν τους κύριους οργανισμούς που ζουν, τρέφονται και αναπαράγονται στους μεσογειακούς υφάλους των φωτόφιλα φύκη και είναι σημαντικά δομικά και λειτουργικά στοιχεία για τις βιοκοινωνίες που αναπτύσσονται εκεί. Ανάμεσα στα βενθικά ασπόνδυλα που απαντώνται, τα μαλάκια είναι ένα από τα κυρίαρχα φύλα της βιοκοινωνίας των φωτοφιλων φυκών ενώ αποτελούν το 13% της Μεσογειακής θαλάσσιας βιοποικιλότητας. Η ποικιλότητα, η δομή και η δυναμική της βιοκοινωνίας των μαλακίων στα φωτόφιλα φύκη έχει μελετηθεί κυρίως στην Δυτική Μεσόγειο, με έναν μικρό αριθμό να έχει εκπονηθεί στην Ανατολική Μεσόγειο – μόνο στο Βόρειο Αιγαίο Πέλαγος. Στο Νότιο Αιγαίο, μελέτες σχετικά με την βιοκοινωνία των μαλακίων έχουν γίνει μόνο για το μαλακό υπόστρωμα, κυρίως από την θαλάσσια περιοχή της Κρήτης. Από το νότιο Αιγαίο και την Κρήτη και ανατολικά προς τις ακτές της Τουρκίας, την Κύπρο και την θάλασσα της Λεβαντίνης, δεν υπάρχει διαθέσιμη πληροφορία σχετικά με την βιοκοινωνία των μαλακίων από τα φωτόφιλα φύκη.

Η Κρήτη θεωρείται ένα τυπικό ολιγοτροφικό θαλάσσιο σύστημα της Ανατολικής Μεσογείου, έχει ακτογραμμή που ξεπερνάει τα 1000 χιλιόμετρα ενώ το 65% των ακτών είναι βραχώδεις – αυτές συνεχίζουν και στην θάλασσα και σχηματίζουν τους μεσογειακούς υφάλους. Η θάλασσα της Κρήτης επιλέχθηκε ως η περιοχή μελέτης στα πλαίσια της πρωτοβουλίας για την μελέτη των παράκτιων θαλάσσιων οικοσυστημάτων NaGISA που είναι υπο την ομπρέλα του παγκόσμιου έργου για την απογραφή της θαλάσσιας ζωής (Census of Marine Life – CoML). Η ποικιλότητα των μαλακίων χρησιμοποιήθηκε ώστε να απαντηθούν μια σειρά από επιστημονικά ερωτήματα: α) Είναι η ποικιλότητα των μαλακίων από την βιοκοινωνία των φωτοφιλων φυκών των ακτών της Κρήτης συγκρίσιμη με άλλες περιοχές της Μεσογείου ? β) Είναι η βιοποικιλότητα που καταγράφηκε από τις δυο θέσεις στην Κρήτη αντιπροσωπευτική της αντίστοιχης της Μεσογείου ? γ) η τοπική μαλακοπανίδα σχηματίζεται τυχαία σε σχέση με την περιφερειακή (θαλάσσια μαλάκια Κρήτης) ?. Οι δειγματοληψίες έγιναν σε 2 θέσεις στις βόρειες ακτές της Κρήτης. Τα δείγματα συλλέχθηκαν ακολουθώντας το πρωτόκολλο δειγματοληψίας που αναπτύχθηκε στα πλαίσια της πρωτοβουλίας για την μελέτη των παράκτιων θαλάσσιων οικοσυστημάτων NaGISA. Η πρώτη θέση βρίσκεται στο νησί Κολοκύθα της Ελούντας, στον νομό Λασιθίου ενώ η δεύτερη θέση στην περιοχή Αλυκές της Αγίας Πελαγίας στον νομό Ηρακλείου. Και οι δυο θέσεις μοιράζονται κοινά χαρακτηριστικά όπως είναι η ύπαρξη του σκληρού υποστρώματος σε βάθος μεγαλύτερο των 20 μέτρων, με ήπια κλίση και μακριά από ανθρωπογενείς πηγές ρύπανσης. Σε κάθε περιοχή ακολουθήθηκε στρωματοποιημένη δειγματοληψία, όπου τα διαφορετικά στρώματα είναι τα βάθη δειγματοληψίας. Μια διατομή ανά δειγματοληπτικό βάθος επιλέχθηκε, και ανά διατομή πέντε επαναληπτικά δείγματα συλλέχθηκαν κατά την περίοδο του καλοκαιριού (Σεπτέμβρης 2007 – Ιούνιος 2008). Τα βάθη δειγματοληψίας είναι 5 (1,5,10,15 & 20μ.). Ένα δειγματοληπτικό πλαίσιο κατασκευασμένο από plexiglas και καλυμμένο με λεπτό δίχτυ ανοίγματος 0.06 χιλιοστών τοποθετήθηκε στη επιφάνεια του βράχου και τα μακροφύκη αφαιρέθηκαν προσεκτικά και τοποθετήθηκαν σε πλαστικές σακούλες για να μην υπάρξει απώλεια βιολογικού υλικού. Στην συνέχεια, το βενθικό υλικό που είναι κάτω από την κόμη των μακροφυκών συλλέχθηκε με την χρήση υποβρύχιου αναρροφητήρα ο οποίος λειτουργεί με την χρήση συμπιεσμένου αέρα. Τα δείγματα ξεπλύθηκαν σε κόσκινο με άνοιγμα ματιού 0.5 χιλιοστά και διατηρήθηκαν σε αλκοόλη 96% υπερκάθαρη για περαιτέρω αναλύσεις. Επιλέχθηκε η χρήση αλκοόλης για να είναι εφικτή η χρήση του βιολογικού υλικού σε μοριακές αναλύσεις, κάτι που δεν είναι εφικτό όταν το διάλυμα συντήρησης είναι η ισορροπημένη φορμαλδεΰδη. Τα δείγματα των μαλακίων αναγνωρίσθηκαν σε επίπεδο είδους, όπου αυτό ήταν εφικτό, με την χρήση κατάλληλων και σύγχρονων επιστημονικών δημοσιεύσεων και βιβλίων ενώ σε κάποιες περιπτώσεις ζητήθηκε γνώμη ειδικών σε κάποιες οικογένειες, για τις οποίες η αναγνώρισή τους απαιτεί πολύχρονη ενασχόληση με αυτές. Τα δεδομένα αποθηκευτήκαν σε μια μήτρα όπου οι στήλες περιείχαν τον αριθμό των ειδών (αφθονία) ανά σταθμό δειγματοληψίας στο μικρότερο επίπεδο (επαναληπτικό δείγμα) και οι σειρές το όνομα των ειδών. Για ένα είδος, το γαστερόποδο μαλάκιο *Bittium latreillii*, τα άτομα που είχαν το μισό μήκος από ένα μέσο ενήλικο, χαρακτηρισθήκαν ως ανήλικα και καταγράφηκαν ως άλλο είδος (Bittium sp.). Ακολουθήθηκε η συστηματική που είναι διαθέσιμη από το Παγκόσμιο Μητρώο των Οργανισμών της Θάλασσας (World Registered of Marine Species – WORMS).

Η ποικιλότητα της βιοκοινωνίας των μαλακίων εξετάστηκε με τον υπολογισμό των εξής δεικτών ποικιλότητας: : α) αριθμός ειδών, β) τιμές αφθονίας, γ) δείκτης ποικιλότητας του Shannon (H΄ loge), δ) δείκτης ομοιομορφίας της Pielou (J΄), ε) δείκτης ποικιλότητας του Simpson (1-lambda), και στ) δείκτης ποικιλότητας του Margalef (d). Το μη παραμετρικό τεστ Kruskal-Whallis και το ζευγαρωτό τεστ Mann-Whitney χρησιμοποιήθηκαν για την διερεύνηση των πιθανών διαφορών των δεικτών ποικιλότητας σε σχέση με την θέση δειγματοληψίας, το βάθος δειγματοληψίας και το έτος δειγματοληψίας. Διάγραμμα απεικόνισης συνόλων τύπου Venn χρησιμοποιήθηκε για την σύγκριση της ποικιλότητας των μαλακίων των θέσεων της Κρήτης που μελετήθηκαν σε σχέση με την συνολική ποικιλότητα των μαλακίων από την βιοκοινωνία των φωτοφιλων φυκών της Μεσογείου. Έγινε διερεύνηση των προτύπων μεταβλητότητας της δομής των συναθροίσεων της πανίδας των μαλακίων στο χώρο με την ανάλυση ταξιθέτησης non-metric Multi-Dimensional Scaling (nMDS) εφαρμόζοντας μια a priori ομαδοποίηση στα βάθη (ομάδα 1= 1μ., ομάδα 2=5,10,15,20μ.). Ο στατιστικός έλεγχος για την ύπαρξη σημαντικής διαφοροποίησης στη δομή των συναθροίσεων των μαλακίων στο χώρο/χρονο πραγματοποιήθηκε με την χρήση PERMANOVA. Όλες οι αναλύσεις της δομής των συναθροίσεων πραγματοποιήθηκαν με μετασχηματισμό τέταρτης τετραγωνικής ρίζας των δεδομένων αφθονίας και επιλογή του συντελεστή απόστασης Bray-Curtis. Για να βρεθούν τα είδη που συμβάλουν περισσότερο στην ομοιότητα - ανομοιότητα των πολυπαραμετρικών προτύπων των κοινωνιών των μαλακίων σε κάθε δειγματοληπτική περιοχή, εφαρμόστηκε η ανάλυση ποσοστιαίας ομοιότητας των δειγμάτων με βάση τις περισσότερο άφθονες ταξινομικές ομάδες SIMPER (SIMilarity PERcentage). Για να ελεγχθεί κατά πόσο τα είδη των μαλακίων από το κατάλογο των ειδών του NaGISA συναθροίζονται τυχαία ή όχι για το σχηματισμό των βιοκοινωνιών εφαρμόστηκε μια μέθοδος ιεραρχικής προσέγγισης. Συνολικά, ορίστηκαν τέσσερα επίπεδα παρατήρησης τα οποία ήταν: α) σταθμός δειγματοληψίας, β) περιοχή δειγματοληψίας, γ) ποικιλότητα θαλάσσιων μαλακίων Κρήτης και δ) ποικιλότητα θαλάσσιων μαλακίων της Μεσογείου από την βιοκοινωνία των φωτοφιλων φυκών. Σε κάθε επίπεδο παρατήρησης, εξετάστηκε αν η βιοποικιλότητα του υποσυνόλου (δηλαδή τα είδη καθώς και οι φυλογενετικές τους σχέσεις) αποτελεί τυχαίο δείγμα των αμέσως επόμενων (ευρύτερων) επιπέδων παρατήρησης. Η τυχαιότητα αυτή εξετάστηκε μέσα από τους δείκτες της ταξινομικής διακριτότητας (μέσος όρος ταξινομικής διακριτότητας Δ+ και μεταβλητότητα ταξινομικής διακριτότητας Λ+), οι οποίοι βασίζονται τόσο στον αριθμό των ειδών όσο και στις φυλογενετικές/ταξινομικές τους σχέσεις.

Συνολικά συλλέχθηκαν 11042 άτομα μαλακίων που ανήκουν σε 127 είδη, 77 γένη και 47 οικογένειες. Από το σύνολο των ατόμων που αναγνωρίστηκαν, τα 9412 ανήκουν στο γαστερόποδο *Bittium latreillii*, 514 στο δίθυρο *Musculus costulatus* και από 108 στα γαστερόποδα *Vexillum granum* και *Alvania cimex*. Στις Αλυκές βρέθηκαν 92 είδη ενώ στην Ελούντα 94 είδη. Το μη παραμετρικό τεστ Kruskal-Whallis έδειξε πως υπάρχουν σημαντικές διαφορές για τους δείκτες α) αριθμός ειδών (s) και β) δείκτης ποικιλότητας του Margalef (d) μεταξύ των διαφορετικών βαθών. Το ζευγαρωτό τεστ Mann-Whitney έδειξε πως οι στατιστικά σημαντικές διαφορές είναι μεταξύ των βαθών 1μ., 5μ. και 20μ ($p<0.001$ for S and $p<0.05$ for d). Η ανάλυση ταξιθέτησης non-metric Multi-Dimensional Scaling (nMDS) εδειξε πως υπάρχουν βαθυμετρικές διαφορές, διαφορές μεταξύ των ετών και των θέσεων δειγματοληψίας. Όλα αυτά επιβεβαιώθηκαν από τον έλεγχο PERMANOVA, ενώ ζευγαρωτές αναλύσεις PERMANOVA έδειξαν πως υπάρχουν στατιστικά σημαντικές διαφορές μεταξύ του βάθους 1μ. με τα υπόλοιπα. Η ανάλυση ποσοστιαίας ομοιότητας των δειγμάτων έδειξε πως για την ομάδα βάθους 1 το δίθυρο *Musculus costulatus*, το γαστερόποδο *Columbella rustica* και το πολυπλακοφόρο *Chiton olivaceus* συνεισφέρουν περισσότερο στην ομοιότητα (30.77%) ενώ για την ομάδα βάθους 2 τα γαστερόποδα *Bittium latreillii, Alvania cimex, Vexillum granum* και το δίθυρο *Musculus costulatus* είναι αυτά που συνεισφέρουν περισσότερο στην ομοιότητα (27.52%). Η ανομοιότητα μεταξύ των δυο ομάδων (80.42 %) οφείλεται κυρίως στα *Bittium latreillii, Musculus costulatus, Alvania cimex, Vexillum granum, Columbella rustica, Tectura virginea* και *Vexillum tricolor*. Ο έλεγχος τυχαιότητας συνάθροισης των μαλακίων έδειξε πως η τοπική ποικιλότητα των μαλακίων από τα φωτόφιλα φύκη είναι αντιπροσωπευτική αυτής της Μεσογειακής.

Μέχρι σήμερα, η ποικιλότητα των θαλασσίων μαλακίων της Κρήτης είχε μελετηθεί μόνο από το μαλακό υπόστρωμα. Η παρούσα εργασία αποτελεί την πρώτη για την Κρήτη και την Ανατολική Μεσόγειο με την καταγραφή 127 είδη, εκ των οποίων τα 34 είδη αποτελούν νέες καταγραφές για την περιοχή (Κρητικό Πέλαγος). Η ποικιλότητα που καταγράφηκε (αριθμός ειδών) είναι συγκρίσιμη με άλλες περιοχές της Δυτικής Μεσογείου και του Βόρειου Αιγαίου πελάγους, από όπου υπάρχει η μόνη διαθέσιμη επιστημονική εργασία για την ζώνη αυτή. Παρόμοιος αριθμός ειδών έχει καταγραφεί και εκεί (128 είδη – Βόρειο Αιγαίο) αλλά και σε άλλες περιοχές της Δυτικής Μεσογείου. Το πρωτόκολλο συλλογής NaGISA που χρησιμοποιήθηκε για πρώτη φορά στην περιοχή αυτή έχει έναν μεγάλο αριθμό δειγματοληπτικών επιφανίων, αγγίζοντας τις 100 δειγματοληπτικές επιφάνειες ανα θέση. Αν και οι δειγματοληψίες είναι άπαξ ετήσιες, εντούτοις, αν υπήρχε δυνατότητα για περισσότερη επαναληψιμότητα εντός του έτους ή την νύχτα, πιθανόν να παρείχε δεδομένα για είδη που έχουν διάρκεια ζωής μικρότερη του έτους ή νυκτόβια δραστηριότητα. Συνολικά, 45 είδη έχουν μόνο ένα άτομο ενώ σύγκριση με τα διαθέσιμα δεδομένα από το Βόρειο Αιγαίο έδειξε πως αντίστοιχος αριθμός είχε μόνο ένα άτομο. Αυτό αποτελεί χαρακτηριστικό της Μεσογειακής μαλακοπανίδας, που ανάμεσα στα άλλα, έχει υψηλό αριθμό ειδών, μικρές αφθονίες αλλά υψηλά ποσοστά ενδημισμού. Τα γαστερόποδα που συλλέχθηκαν από τις δυο περιοχές είναι συγκρίσιμα σε θέμα κυριαρχίας και επίπεδο τροφικών τύπων με αυτά που συλλέχθηκαν από αντίστοιχα οικοσυστήματα σε διάφορες περιοχές του πλανήτη στα πλαίσια της πρωτοβουλίας NaGISA. Αποτελούν την κυρίαρχη κλάση ενώ ο κυρίαρχος τροφικός τύπος είναι ο χορτοφάγος. Οι διαφόρες που βρέθηκαν μεταξύ των ομάδων των βαθών πιθανώς να σχετίζονται με τοπικούς παράγοντες και διαδικασίες όπως είναι ο υδροδυναμισμός και η κυματική δράση. Πρώιμα αποτελέσματα από το μοντέλο κυματικής διάδοσης 2D MIKE Spectral Wave Module έδειξαν πως η ζώνη θραύσης του κύματος και στις 2 περιοχές είναι ρηχότερα από τα 6 μέτρα. Τα αποτελέσματα έρχονται σε συμφωνία με τα αποτελέσματα από την ανάλυση ταξιθέτησης Non-metric Multi-Dimensional Scaling (NMDS). Το βάθος σχετίζεται με παράγοντες που καθορίζουν την σύνθεση των βιοκοινωνιών όπως είναι η διαθεσιμότητα του φωτός και των θρεπτικών, της φυσική διαταραχή από την κυματική δράση, την παραγωγικότητα καθώς και την θήρευση. Ο υψηλός αριθμός των μαλακίων που βρέθηκαν στην βιοκοινωνία των φωτοφιλων φυκών οφείλεται στον μεγάλο αριθμό των δειγματολειπτικών επιφανειών που προσφέρει το πρωτόκολλο του NaGISA, στην ύπαρξη μικροενδιαιτημάτων ανάμεσα στα μακροφύκη και τις οπές του σκληρού υποστρώματος που παγιδεύουν ίζημα καθώς και στην ύπαρξη διάφορων τύπων τροφής διαθέσιμων για θήρευση και κατανάλωση. Η ανάλυση ταξιθέτησης Non-metric Multi-Dimensional Scaling (NMDS) έδειξε πως οι συναθροίσεις των μαλακίων στο 1 μέτρο βάθος είναι διαφορετικές από τα υπόλοιπα βάθη, πιθανότατα λόγω των διαφορετικών υδροδυναμικών συνθηκών και της κυματικής δράσης, όπως αυτό φαίνεται και από το μοντέλο κυματικής διάδοσης. Η ανάλυση PERMANOVA έπιβεβαίωσε την διαφορά αυτή (1μ vs 5-10-15-20μ.) ενώ εδειξε πως υπάρχουν στατιστικά σημαντικές διαφορές τόσο μεταξύ των περιοχών όσο και μεταξύ των ετών.

Ενδιαφέρον παρουσίαζει το γαστερόποδο *Bittium latreilii* όπου παρατηρήθηκε σε όλα τα έτη, τα βάθη και τα συλλεχθέντα επαναληπτικά δείγματα. Είναι το ποιο αφθονο είδος, κάτι που έχει παρατηρηθεί και σε άλλες εργασίες στην Μεσόγειο, όχι μόνο από τα φωτοφιλα φύκη αλλά και από υποθαλάσσια σπήλαια και λιβάδια ποσειδωνίας και κοραλλιγενεις σχηματισμούς. Η τρισδιάστατη δομή των μακροφυκών προσφέρει εξαιρετικό οικολογικό θώκο καθώς προσφέρει πεδίο για αναπαραγωγη, κάλυψη και τροφοληψία. Ο ίδιος παράγοντας εξηγεί και την ύπαρξη μεγάλου αριθμού φυτοφάγων ειδών. Επιπρόσθετα, η ύπαρξη μικροενδιαιτημάτων βασισμένα στο παγιδευμένο ίζημα εξηγεί την ύπαρξη ειδών που απαντώνται κυρίως στο μαλακό υπόστρωμα. Η ταξινομική ποικιλότητα που καταγράφηκε από την βιοκοινωνία των φωτόφιλων φυκών των ακτών της Κρήτης είναι αντιπροσωπευτική της αντίστοιχης της Μεσογειακής, όταν εξετάζουμε την ίδια βιοκοινωνία. Στις θέσεις που πραγματοποιήθηκαν οι σχετικές μελέτες, τα είδη από όλα τα επαναληπτικά δείγματα αποτελούν υποσύνολο των συνολικών δεδομένων του αντίστοιχου βάθος ενώ το ίδιο συμβαίνει και στα ανώτερα επίπεδα. Παρόλο που το NaGISA έχει 4 σταθμούς μελέτης στην Μεσόγειο (2 Ιταλία – 2 Κρήτη/Ελλάδα), εντούτοις τα διαθέσιμα δεδομένα σε χαμηλό ταξινομικό επίπεδο (είδος) για όλα τα είδη που βρέθηκαν είναι διαθέσιμα μόνο από την Κρήτη και έτσι μια ορθη σύγκριση με αντίστοιχα δεδομένα από την Δυτικη Μεσόγειο δεν είναι εφικτή.

Παρόλο που η θάλασσα της Κρήτης θεώρείται μια καλά μελετημένη θάλασσσα στην υποπαραλιακή ζώνη αναφορικά με την βιοποικιλότητα των μαλακίων, εντούτοις βιοτόποι όπως οι ύφαλοι με τα φωτόφιλα φύκη έχουν πολλά μυστικά ακόμα να αποκαλύψουν. Η πολυπλοκότητα της δομής των Μεσογειακών υφάλων στην παράκτια ζώνη δεν έχει επαρκώς μελετηθεί, η σημασία για τις οικοσυστημικές λειτουργίες, τις υπηρεσίες και τα χαρακτηριστικά έχει υποεκτιμηθεί ενώ οι επιπτώσεις τόσο από την κλιματική αλλαγή (θαλάσσιοι βιολογικοι εισβολείς) και από τις ανθρωπογενείς δραστηριότητες αν και είναι εμφανή δεν αξιολογούνται ορθά. Επιπρόσθετα, η μελέτη αυτών ενέχει και τεχνικές δυσκολίες που έχουν μεγάλο κόστος καθώς οι δειγματοληψίες γίνονται μονο με την χρήση συσκευής αυτόνομης κατάδυσης (SCUBA diving). Τα δεδομένα από την παρούσα ανάλυση ακολούθησαν την δομή του πρωτοκόλλου Darwin Core και επιλέχθηκε να διατεθούν ελεύθερα μέσω της εθνικής υποδομής βιοποικιλότητας Lifewatch Greece, ενός αποθηκευτικού χώρου επιστημονικών δεδομένων καθώς η ελεύθερη διάθεση των δεδομένων αυτών στην επιστημονική κοινότητα θα δώσει την δυνατότητα για περαιτέρω αξιοποίηση και χρήση σε εφαρμογές που σχετίζονται με την διαχείριση του θαλάσσιου χώρου αλλά και την μελέτη της βιοποικιλότητας ενός οικοσυστήματος που αποτελεί πόλο έλξης για την επιστημονική κοινότητα, προσελκύει δραστηριότητες τουρισμού αλλά και είναι υπο καθεστώς πίεσης λόγω της κλιματικής αλλαγής.

Is Cretan coastal biodiversity representative of the Mediterranean? Testing the NaGISA protocol robustness by the molluscan fauna.

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Abstract

The NaGISA project (Natural Geography in Shore Areas) is a global initiative within the framework of the Census of Marine Life. The scope of this project is the long-term monitoring of the coastal marine biodiversity. The Mediterranean Sea has joined 4 stations, 2 in Italy and 2 on the island of Crete, Greece. On the basis of the collected material from the hard substrates of Crete, and the datasets from the available literature concerning the molluscan taxon, three questions have been addressed in this study: (a) what is the community structure in the NaGISA sites in Crete? (b) Does local molluscan fauna assemble at random from the regional species pool? (Mediterranean scale), and (c) is the molluscan taxonomic diversity of the hard substrates in NAGISA sites comparable with other similar habitats of the Mediterranean region (local vs regional taxonomic diversity)? Two different sites were sampled at depths ranging from 1 to 20 m in the course of two consecutive years (2007 and 2008) by means of SCUBA diving. Analysis of the molluscan fauna revealed 127 species, belonging to three different classifications (7 Polyplacophora, 97 Gastropoda and 23 Bivalvia). Thirty-four (34) species are reported for the first time as elements of the molluscan fauna of the Cretan Sea. The gastropod *Bittium latreillii* and the bivalve *Musculus costulatus* were the dominant species in both sites during the sampling years. The molluscan taxonomic diversity collected from the infralittoral hard bottom macroalgae communities in the Cretan Sea is similar to other Mediterranean areas, while the molluscan taxon studied can be considered as assembled at random and representative of the entire regional sea, as far as macroalgae rocky communities are concerned.

Keywords: Hard substrate, Reef ecosystem, Mollusca, Eastern Mediterranean, Crete.

1. Introduction

During the 10th meeting of the Conference of the Parties at the Convention on Biological Diversity (2010), the increasing rate of biodiversity loss and the urgent need for counteractions have been acknowledged. However, the initial target for the decrement of the biodiversity loss until 2010 was far from being reached, and therefore an alternative strategic plan is adopted for the period 2011-2020 (COP 10, 2014). The Mediterranean Sea is characterized as a global hotspot in terms of marine biodiversity (Bianchi and Mori, 2000, Coll et al., 2010) since it hosts 7% of the world's marine biodiversity while covering only 0.8% of the total ocean's surface. The Mediterranean Sea is also known for the high level of endemism that it sustains with almost 25% of the faunal and floral species being endemic to this basin (Boudouresque, 2004, UNEP-MAP RAC/SPA 2010). At the same time the marine and coastal habitats of this region are susceptible to a variety of anthropogenic activities which are threatening their ecological health (Coll et al., 2010, Bianchi et al., 2012). The shallow rocky shores comprise 54% of the total Mediterranean coastline and are facing a multitude of intense anthropogenic pressures that are predicted to be increased in the near future (Stewart et al., 2009). The presence of erected and encrusted algae species enhances the heterogeneity of this rocky substrates thus providing shelter and food for many benthic and demersal species (Christie et al., 2009, Tews et al., 2004, Gingold et al., 2010). In addition, the fronts of the photophilic macroalgae reduce the local hydrodynamism thus favoring the formation of enclaves of sediments in the holes and crevices of the rocky substrates (Littler et al., 1983). Due to the importance of this marine habitat, Habitat Directive 92/43/EEC has included it under the code 1170 (Reefs). Reefs consist of photophilic macroalgal communities and coralligenous formations that may co-exist or successively excluding each other depending on light availability, depth and other geomorphological local characteristics. Benthic invertebrates are common inhabitants of the photophilic algae playing ecologically important role in the structure and functioning of the shallow rocky infralittoral communities (Bussell et al., 2007). Benthic molluscs are among the dominant macrofaunal taxa (Sabelli and Taviani, 2014) constituting 13% of the Mediterranean biodiversity while representing ca. 23% of all the recorded marine species worldwide (Appeltans et al., 2012). The diversity, structure and dynamics of the molluscan assemblages of the infralittoral macroalgae communities have been studied in the western Mediterranean Sea (Bellan-Santini, 1969, Badalamenti et al., 2002, Terlizzi et al., 2003, Antit et al., 2012, 2013, Urra et al., 2013, Millazo et al., 2000, Pitacco et al., 2014). Fewer studies have been carried out in the eastern Mediterranean, particularly in the North Aegean Sea (Kocatas 1978, Simboura et al., 1995, Antoniadou et al., 2005) while no information on the hard substrate communities exist from the Cretan Sea.

The Cretan Sea represents a typical oligotrophic system of the eastern Mediterranean basin (Karakassis et al., 1997; Psarra et al., 2000). The coastline of the Crete Island exceeds 800 km of total length while more than 65% is covered by rocky shores (Alexandrakis et al., 2014). Cretan Sea was selected as one of the study areas for NaGISA initiative (http://nagisa.cbm.usb.ve/cms/), within the framework of the Census of Marine Life (CoML, http://www.coml.org), as the easternmost site in the Mediterranean Sea. The NaGISA project aims at inventorying and monitoring coastal biodiversity of macroalgal rocky shores and seagrass beds (Iken & Konar, 2003). In this study, molluscan community data collected from the two NaGISA sites in the Cretan Sea have been used to describe the local community structure and additional ones mined from the relevant Mediterranean literature were used to test the following hypotheses: (a) is hard substrate molluscan diversity of the shallow Cretan Sea comparable to that of other Mediterranean Sea sites? (b) is biodiversity sampled in the two NaGISA sites representative of the regional species pool of the Mediterranean Sea? and (c), is Cretan malacofauna randomly assembled from the regional species pool?

2. Materials and methods

2.1 Study Sites and Sampling Design

Sampling was carried out in two sites along the northern coasts of the island of Crete (Figure 1). The first site is Alykes near Agia Pelagia, Heraklion (35.413847 N, 24.990866 E) and the second site is Elounda, near Agios Nikolaos (35.249942 N, 25.757994 E). Both sites were selected in accordance to the requirements of the standard NaGISA protocol (Iken and Konor, 2003). The macroalgae assemblages in Elounda site included *Padina pavonica* and filamentous species such as *Peyssonellia* sp., *Lithophyllum* sp., *Jania rubens*, *Flabellia petiolata,* and *Bryopsis* sp., while Alykes site consisted of *Fucus virsoides*, *Padina pavonica*, *Cystoseira* spp., *Amphiro*a sp., *Caulerpa racemosa* and *Bryopsis* sp. At each sampling site, a stratified random sampling design was employed, with stations representing vertical heights below low water datum. Regarding the sampling design, 5 sampling stations were successively placed at fixed depths (1m, 5m, 10m, 15m, 20m) across a vertical transect at each site. Within each sampling station five replicate samples were collected in late summer (September) of 2007 and early summer (June) of 2008, respectively. Samples were collected, following the NaGISA protocol, by means of SCUBA diving (Iken & Konar, 2003). A plexiglass frame of 25x25 cm with a net of 60 µm mesh size mounted on its top side was attached to the rock with its base side. The framed surface of the substrate was then hand scraped and the substrate was sucked into a net-bag of 60 µm mesh sieve by means of a customarily designed suction device using an extra air tank to create the suction effect (Chatzigeorgiou et al., 2012). The collected samples were washed through a 0.5 mm mesh sieve, fixed and preserved in 96% ethanol. All living molluscs collected from both sampling sites were identified to species level based on information derived from the available literature (Peres & Picard, 1958, Fretter & Graham, 1962, Zenetos et al, 1997, 2005, Strack, 1988, Cattaneo-Vietti et al., 1990, Koutsoubas 1992, 1997, 2000).

2.2. Additional datasets

The datasets concerning the molluscs of the macroalgal communities from the Mediterranean Sea (as the regional species pool) have been found by mining the available grey and published literature resources. These have been used in order to test the randomness of the molluscan biodiversity on local and regional levels. In total, 24 additional data sets have been found and analyzed so far (Poursanidis et al., 2016). These data cover a period from 1969 to date and are distributed along the Mediterranean, from Gibraltar to Corsica and the Italian shores in the western Mediterranean, as far as Crete in the eastern Basin (present study) and North to the gulf of Trieste in the Adriatic Sea (Figure 2). Up to date, no data were available from the Levantine Basin. The dataset has been taxonomically updated following the WoRMS classification scheme and is considered as the updated Mediterranean species pool. It is available from the MedOBIS data repository: http://lifewww-00.her.hcmr.gr:8080/medobis/resource.do?r=moll_poursani for further use in other studies, in comparisons with findings from other water bodies and projects as well as for use in the marine spatial planning, since such data are commonly not available (Levin et al., 2014, Hiscock 2014).

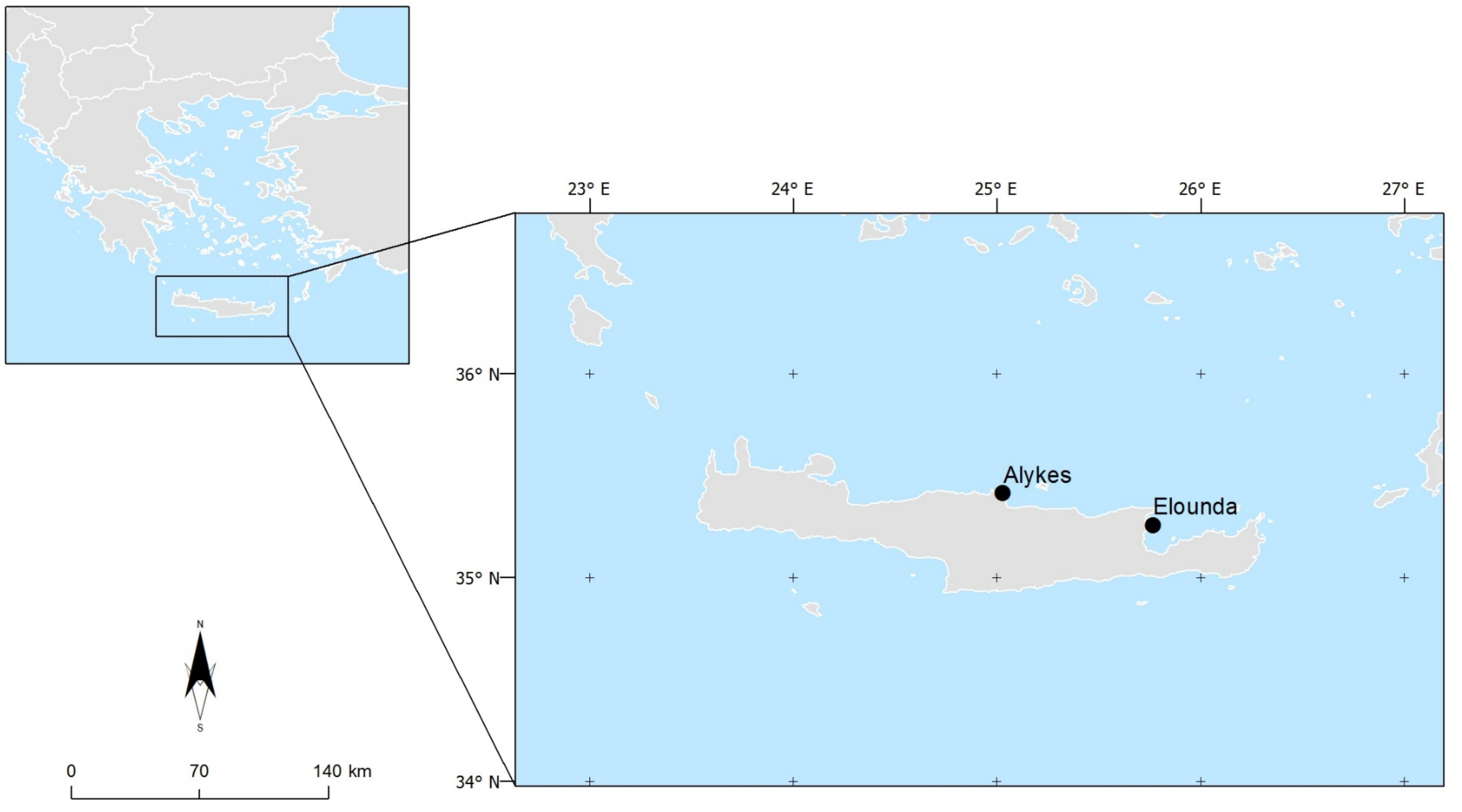


Figure 1. The sampling sites in the two different locations along the northern coasts of Crete Island.

2.3. Data treatment and analysis

With respect to the sampled molluscan species (NAGISA dataset), a species by sample abundance matrix was formulated for the needs of the statistical analyses. For the case of the gastropod *Bittium latreillii* the collected individuals with a size less than the half of the known adult size were considered as juveniles and counted separately. The nomenclature and higher classification of the species follows the one of WoRMS database (WoRMS, 2014). The following diversity indices were involved in the analysis of the NaGISA data set: (1) Total number of species (S), (2) Shannon-Wiener diversity index (H', log_e base), (3) Simpson's index (1-λ), (4) Margalef's species richness (d), and (5) Pielou's evenness (J'). Kruskal-Wallis test and post hoc pairwise Mann-Whitney tests were employed in order to test for significant differences of the indices median values between the sampling locations, periods and depth strata. Ordination of the samples with respect to depth and site was carried out by means of non-metric multidimensional scaling ordinations (nMDS), using the Bray-Curtis similarity coefficient (Bray and Curtis, 1957) on species abundance data. Prior to analysis, data were square root transformed in order to downweight the effect of dominant species on the produced multivariate patterns. Significance of the emerged multivariate patterns (i.e. a posteriori comparison of samples grouping according to depth) was tested by means of one-way, non-parametric multivariate analysis of variance PERMANOVA (Anderson 2001). The SIMPER (SIMilarity of PERcentage, Clarke, 1993) routine was used to identify the species that were mainly responsible for the observed Bray – Curtis dissimilarity among groups of samples. All calculations were carried out in the PRIMER v.6 (Clarke and Gorley 2006) and PAST v.3 (Hammer et al. 2001) software packages. A Venn diagram has been created using the BioVenn online platform (Hulsen et al., 2008) in order to calculate and visualize species overlap between NaGISA sites and the Mediterranean hard bottom malacofauna species pool.

2.4. Randomness testing

The taxonomic relatedness of the molluscan fauna from the two NaGISA sites was compared to the local and the Mediterranean molluscan species pool. For this purpose, the average taxonomic distinctness (Δ^+) and the variation in taxonomic distinctness (Λ^+) indices were calculated for different scales (replicate, depth, location, region) (Clarke & Warwick, 1998, Warwick & Clarke, 2001). The average taxonomic distinctness Δ^+ uses presence/absence data and calculates the average path length between every pair of species by using information on their higher classification within a sample. The variation of the taxonomic distinctness Λ^+ assesses the degree to which species are evenly distributed to higher taxonomic categories. Expected distribution funnels, at 95% confidence intervals, were calculated by simulations derived from randomly constructed subsets of species from the NaGISA sites, local (Cretan) and Mediterranean malacofaunal species pool. If the local malacofauna is composed by species as similar to each other as those of the Mediterranean Sea then, the observed Δ^+/ Λ^+ values are expected to fall within the 95% confidence intervals of the simulated funnel. A hierarchical approach was used in order to test whether or not molluscan species lists, along with their higher classification, in the collected samples are randomly assembled from those of the wider geographic scale. Based on the structure of the available datasets, four successive levels of comparison in the analysis have been defined: (a) replicate unit, (b) depth, (c) location (Cretan species pool) and, (d) region (Mediterranean species pool). Randomness tests have been carried out following the scheme proposed by Chatzigeorgiou et al (Chatzigeorgiou et al., 2012) with the addition of the local species pool. All analyses were performed by using the PRIMER v.6 software package (Clarke & Warwick, 1994).

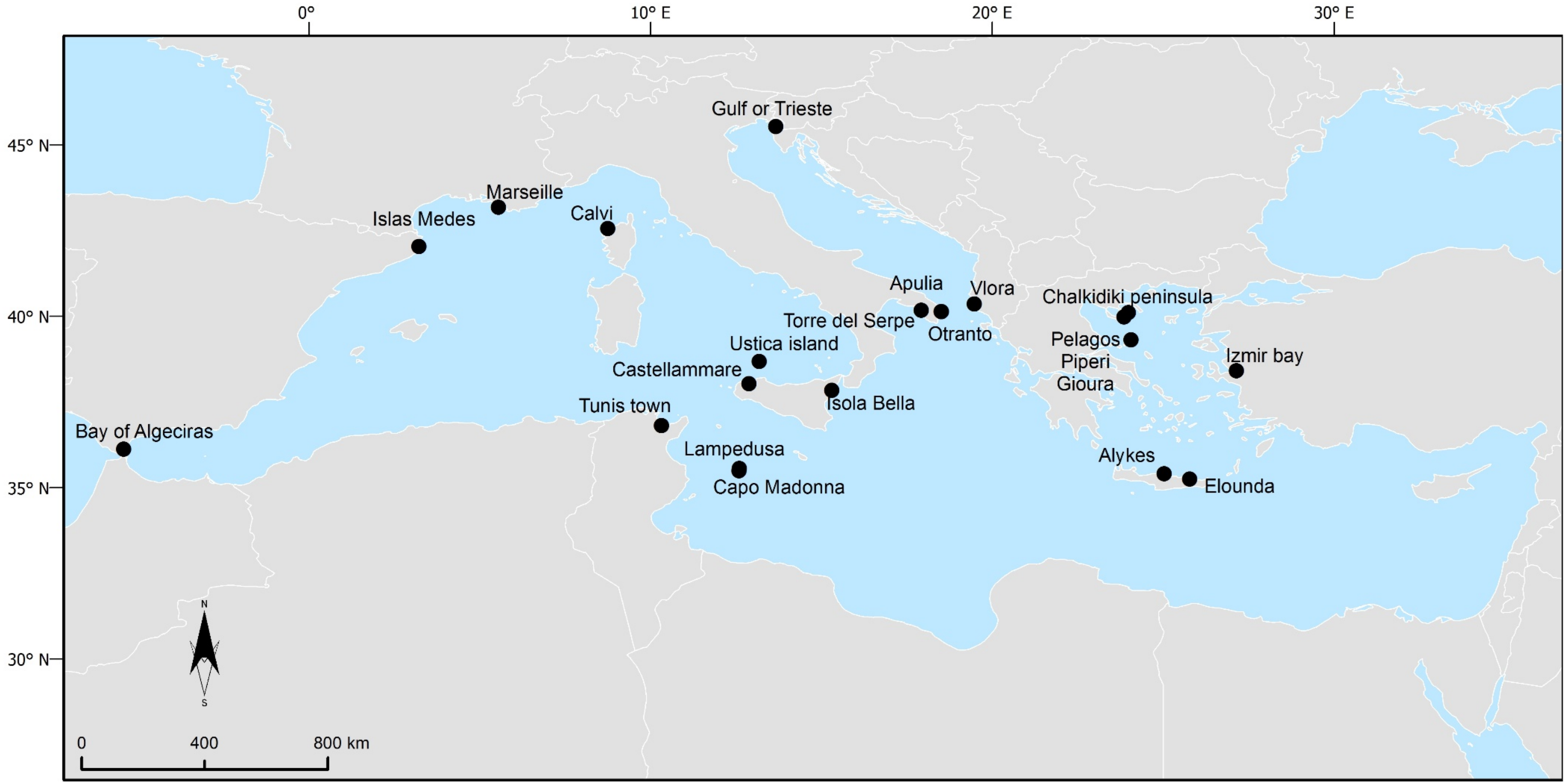


Figure 2. The distribution of the datasets collected and literature mined along the Mediterranean coasts.

3. Results

3.1. Composition and structure of the molluscan assemblage at NAGISA sites.

A total of 11,632 individuals was examined and classified to 127 different species, 77 genera and 47 families. Figures 3 provide an insight to the number of species/individuals per class. The species list is available as supplementary file (S2 file).

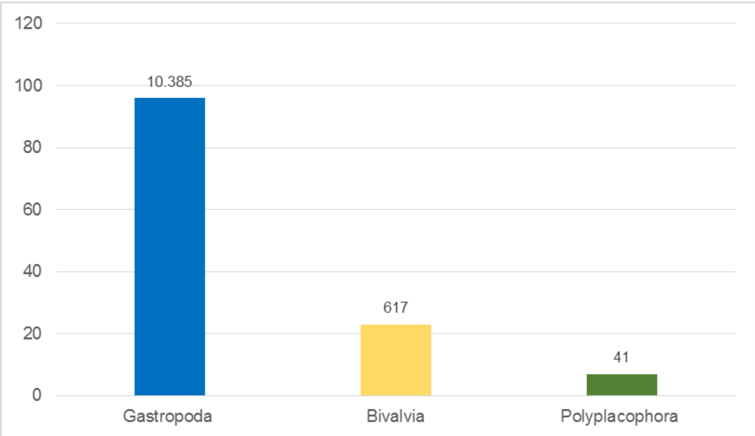


Figure 3. Numbers of molluscan species collected from the Cretan NaGISA sites (on top of each bar the number of individuals per class).

The most frequent and abundant species are the gastropod *Bittium latreilii* with 10,068 individuals (adults and juveniles) followed by the bivalve *Musculus costulatus* with 514 individuals, the gastropods *Vexillum granum* and *Alvania cimex* with 108 individuals each.

3.2. Structural analysis.

Overall, the number of recorded species in both sites was rather similar (92 in Alykes, 94 in Elounda) with 60 common species. In Alykes, 55 species were recorded (44 Gastropoda, 9 Bivalvia, 2 Polyplacophora) in 2007, while 67 (46 Gastropoda, 15 Bivalvia, 6 Polyplacophora) in 2008. In Elounda, 68 species were recorded (57 Gastropoda, 8 Bivalvia, 3 Polyplacophora) in 2007, while 67 species (56 Gastropoda, 5 Bivalvia, 4 Polyplacophora) in 2008. All species fall in the Mediterranean species pool, while the two sites share 60 common species (figure 4).

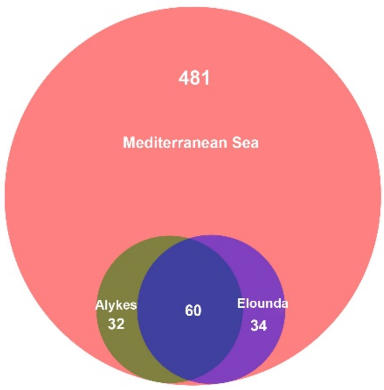


Figure 4. Venn diagram showing the overlap between the two NaGISA sites with the entire Mediterranean molluscan inventory of the photophilic macroalgae.

Kruskal-Wallis test has shown that there were significant differences between depth strata concerning the number of species (S) and the Margalef's species' richness (d) (Table 1). Pair-wise comparisons (Mann-Whitney U test) suggested that there were significant differences among the depths of 1m, 5m and 20m (p<0.001 for S and p<0.05 for d).

Table 1. Results from the Kruskal-Wallis test applied on diversity indices values; statistically significant differences are indicated with bold.

		p values	
	Year	Depth	Location
Index			
S	0.7	**0.001**	0.49
d	0.23	**0.04**	0.23
J'	0.65	0.8	0.65
H'(log^e)	0.75	0.9	0.75
1-Lambda'	0.19	0.9	0.19

The nMDS ordination of the samples (figure 5) suggested the presence of two main groups. PERMANOVA test show that significant differences exist among sampling depths, years and locations (table 2). Samples found at the depth of 1m were separated from the rest of the samples (depths of 5m, 10m, 15m and 20m). The significance of the depths grouping was confirmed by the PERMANOVA pair-wise test (table 3).

Table 2. PERMANOVA analysis results for the 3 factors.

	Df	SS	MS	F	R^2	P
Depth	4	37843	9460,6	4,22	**0,001**	999
Location	1	5433,6	5433,6	2,17	**0,03**	999
Year	1	25010	25010	10,854	**0,001**	997

Table 3. Pair-wise test of PERMANOVA for the factor depth.

Groups	t	P(perm)	Unique perms
1, 5	2,1935	**0,002**	999
1, 10	3,1009	**0,001**	998
1, 15	3,0171	**0,001**	998
1, 20	3,0041	**0,001**	999
5, 10	1,2831	0,091	998
5, 15	1,1657	0,169	998
5, 20	1,2319	0,117	999
10, 15	0,83363	0,733	999
10, 20	1,209	0,136	997
15, 20	1,1728	0,148	999

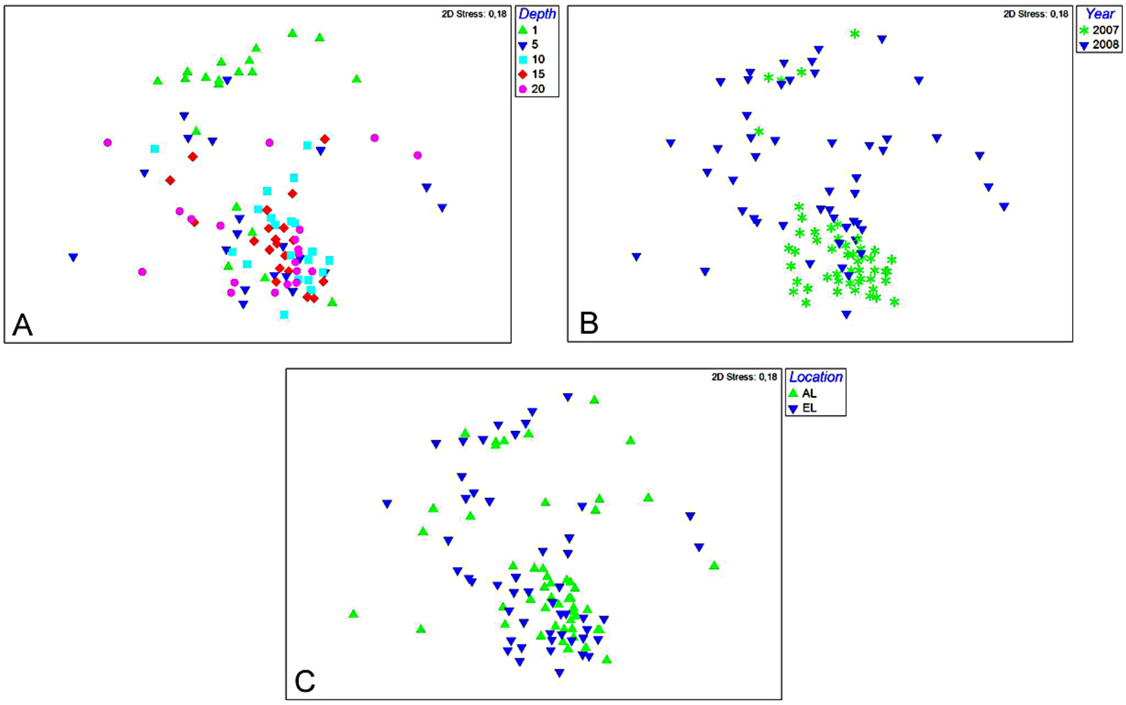
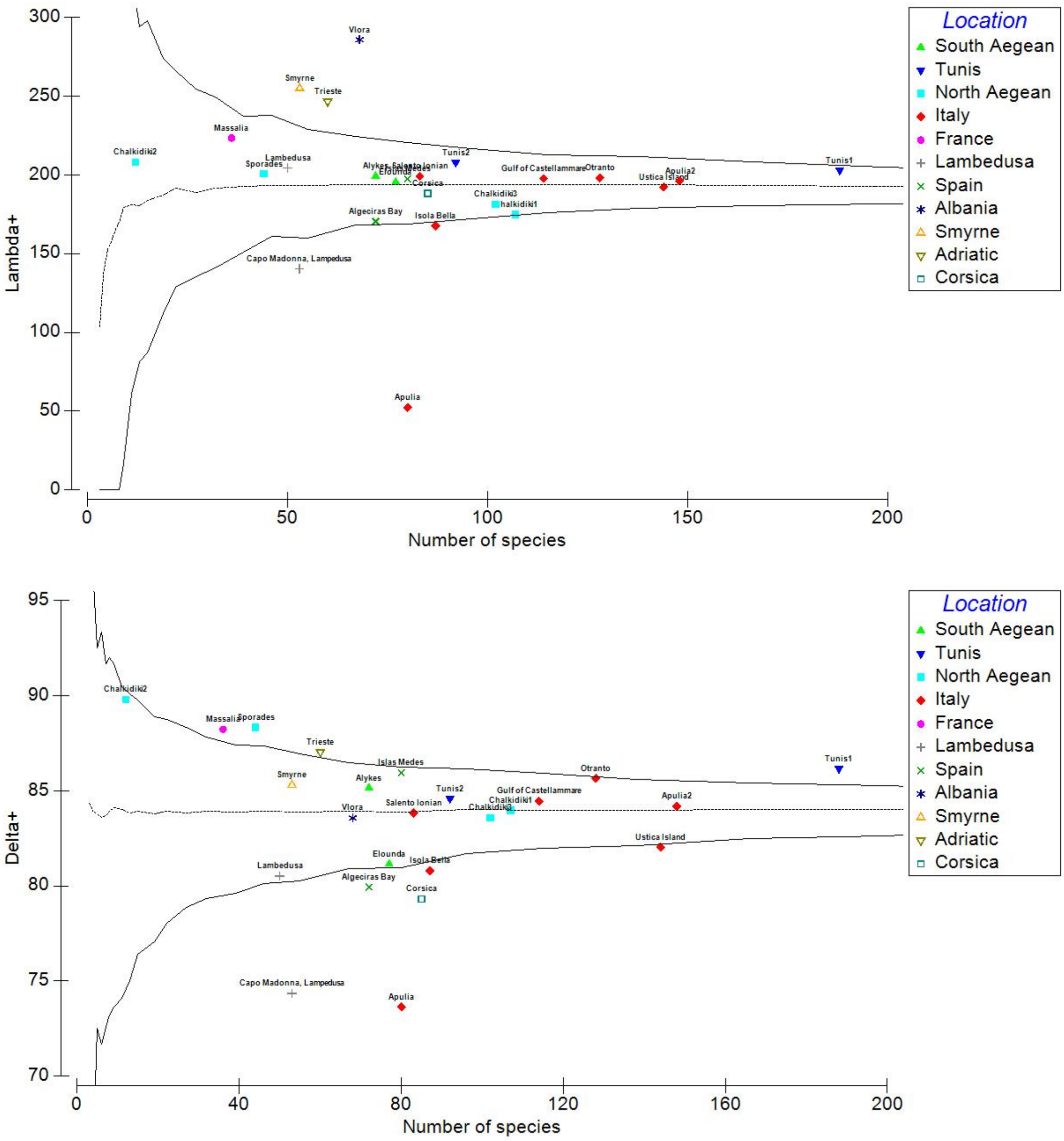


Figure 5. MDS plots based on the molluscan abundance Bray-Curtis similarity coefficient values, as calculated between the replicate units from 5 depths (A), 2 years (B) and 2 sites (C).

The results of SIMPER analysis show that for the depth of 1m the bivalve *Musculus costulatus*, the gastropod *Columbella rustica* and the polyplacophoran *Chiton olivaceus* mostly contribute while for the rest depths (5-20m.) the gastropods *Bittium latreillii*, *Alvania cimex*, *Vexillum granum* and the bivalve *Musculus costulatus* were the top ranked species in terms of contribution. Dissimilarity between the two groups of depths (80.42 %), the two locations (76.17%) and the two years (76.52%) is attributed mainly to the gastropods *Bittium latreillii*, *Alvania cimex* and to the bivalve *Musculus costulatus*.

3.3. Taxonomic Distinctness – Randomization tests

According to the tests performed on the local (Cretan NaGISA) versus the regional species list (Mediterranean species pool), both the Δ^+ and Λ^+ values as calculated for the Cretan NaGISa sites were included within the 95% confidence limits of the funnel(Figures 6a and 6b). From the remainder Mediterranean sites, both Capo Madonna and Apulia and for both indices, these sites fell below the expected funnels.



Figures 6a and 6b. The 95% distinctness funnels for the: (a) Λ+, and (b) Δ+; these have been calculated from the Mediterranean molluscs of the photophilic algae inventory. Superimposed are taxonomic distinctness values calculated for each sampling location. Expected average is indicated by the dotted line in the middle of the funnel.

Table 2 summarizes the results of the randomization tests at all spatial scales, indicating the percentage of samples falling within the 95% confidence limits of the funnel calculated from species lists and their higher classification from the next higher scale of observation.

Table 2. Summary of randomization tests at all scales of observation. In bold the significant results.

	Alykes (%)		Elounda (%)	
	Δ+	Λ+	Δ+	Λ+
Replicates / Depth 1m	90	**100**	90	100
Replicates / Depth 5m	**100**	**100**	**100**	**100**
Replicates / Depth 10m	**100**	**100**	90	90
Replicates / Depth 15m	**100**	90	100	100
Replicates / Depth 20m	90	90	90	100
Depth / Location 1m	50	**100**	**100**	**100**
Depth / Location 5m	**100**	**100**	**100**	**100**
Depth / Location 10m	**100**	75	**100**	**100**
Depth / Location 15m	75	**100**	**100**	**100**
Depth / Location 20m	75	**100**	**100**	**100**
Location / Region CRETE	**100**	50	50	**100**
Location/ Region MED	**100**	**100**	**100**	**100**

4. Discussion

Malacofaunal studies from the Cretan Sea have been conducted mainly on soft bottom assemblages. These have provided a total of 235 molluscan species (Koutsoubas et al. 1992, Koulouri et al., 2006, 2015). This is the first study focusing on the hard bottom assemblages of the Cretan Sea providing an insight to this taxon. As for the first hypothesis, the evidence deriving from this study shows that the photophilic algae molluscan diversity from the hard bottoms of Crete is comparable to the one of other Mediterranean sites. In the Eastern Mediterranean, the only similar study in terms of substrate and depths, has been carried out in the North Aegean Sea and yielded a list of 128 molluscan species (Antoniadou et al., 2005, 2006, 2007). Only 35 five species are common between the present study and that of the North Aegean Sea. This could be attributed to the number of replicated per sampling depth as well as the different depths considered in each area. Considering the available data from the Western Mediterranean, the number of the recorded species in the study area is one of the highest (131 species, Terlizzi et al. 2003; 148 species, Milazzo et al. 2000; 150 species, Terlizzi et al. 2005; 189 species, Antit et al. 2012). Species commonly shared by the studies taken into account are: the chiton *Acanthochitona fascicularis,* the gastropods *Alvania cimex, Alvania lineata, Bittium latreillii, Cerithium vulgatum, Columbella rustica, Hexaplex trunculus, Pollia dorbignyi, Vexillum tricolor* and the bivalves *Musculus costulatus, Arca noae* and *Barbatia barbata*. All species are typical inhabitants of the photophilic macroalgae.

The NaGISA protocol has selected a large number of stations within the Cretan sampling site, reaching the number of 50 replicates per sampling site (25 per location). Monthly or seasonal sampling schemes under the NaGISA initiative could reveal a much higher species diversity as well as cryptic and rare species, while several species have less than a year's life cycle or nocturnal activity (Wilbur & Yonge, 1964, 1966). Forty-five of the recorded number of species have been represented by only one specimen, i.e. singletons. This number is comparable to the available data (species abundance per site) from the North Aegean Sea (Antoniadou et al., 2005), where 40 species have also been found in singletons. These species are considered as rare, a characteristic of the Mediterranean Sea which shows high species richness values, low in abundance of a high number of rare species, and a high rate of endemism (Templado 2014). Habitats with greater heterogeneity of structural elements, such as the seagrass meadows (Stallings et al., 2015) support higher species richness (Heck et al., 1977) due to a greater microhabitat availability, and thus greater niche space (Heck and Wetstone 1977, Wilis et al. 2005) as well as through reduced predation and prey depletion prevention (Kovalenko et al. 2012).

The present study provides similar results to those from the global assessment of the NaGISA dataset (Miloslavich et al., 2013). The global assessment shows that in all studied regions, the assemblages are dominated by a relatively high number of species of gastropods, of which the most abundant are herbivores. Even if Mollusca are considered as one of the best studied phylum in the Mediterranean (Sabelli et al. 2014), up to date the information on the spatial distribution of them as well as on the diversity at the scale of habitat is still limited (Poursanidis et al., 2015). From the review of the literature, 24 similar studies on the malacofauna of the photophilic algae have been found; as expected the majority of them comes from the western Mediterranean Sea. This first study of the molluscan fauna from the hard bottom photophilic algae along the infralittoral zone of Crete revealed a molluscan species richness comparable to those from similar areas of the Mediterranean Sea. The high number of the molluscs from the present study could be attributed to: (a) the standardized sampling method of the NAGISA project which eliminates the escape of any individual from the sampling frame, (b) the presence of several microhabitats in-between the photophilic algae forms and the existence of sediment which provides additional shelter (Olabarria and Chapman 2001a, 2001b, Antoniadou et al., 2005, Balata et al., 2007) and (c) the potential availability of different food sources available for predation/consumption (Edgar et al. 1994, Antoniadou et al., 2005).

The results of the multivariate analysis indicate that the composition and assemblage of the community at 1m depth station seems to be different from the remainder ones, possibly affected by local factors and processes like the wave action and hydrodynamism. Unpublished data from wave model analysis using the 2D MIKE Spectral Wave Module (Alexandrakis unpublished data) show that in both sites, the wave breaker zone and the surf zone are quite shallow (d<4m), affecting the swallow water assemblages. Depth is also related to community structure by determining factors such as the nutrient and light availability, the physical disturbance, the primary and the secondary productivity as well as the predation (Paine, 1974, Moutin et al., 2002, Schwarz et al., 2002).

The herbivore gastropod *Bittium latreilii* is represented by the highest number of individuals (Figure 6) across all depths and sites. It is one of the most abundant species also emerging from the results of other studies. This high abundance is probably related to the 3D form of the dominant erected algae which serves as an excellent niche for this species (Russo et al., 2002): Macroalgae shape acts as a trap for organic material and host for other species while it offers excellent conditions for the trophic needs of the species (Antoniadou et al., 2005). The differences on the abundance among the different sampling periods are mainly associated with *Bittium latreilii* new cohorts settlement (Russo et al., 2002) indicated by the existence of a large number of juveniles (8500 individuals).

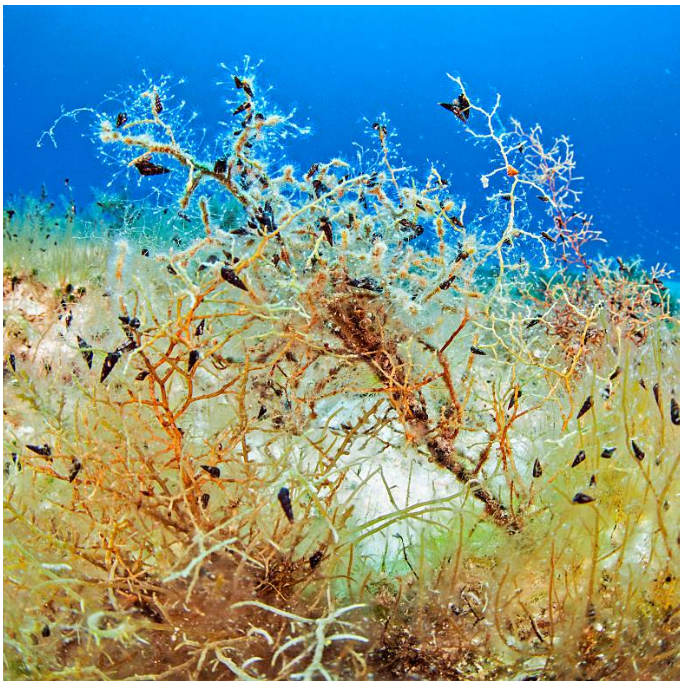


Figure 6. *Cystoseira* spp. with a dense *Bittium latreillii* population on the branches.

Photophilic macroalgae communities have different roles in different periods of the year due to their complex structure. In the Mediterranean, the algal biomass and cover reach their maximum in late spring and minimum at the end of summer (Salas et. al., 1997, Bosc et al., 2004). They can act as food source during the establishment of the new cohorts of species, nursery ground and protective ground from predators (Kohn et al., 1976, Heck et al., 1977, Sala et al., 1997, Tews et al., 2004, Antoniadou et al., 2005). Sedimentation is a natural phenomenon in the hard substrates as sediments are trapped in-between the erected algae and microhabitats are available for typical soft bottom inhabitants (Olabarria and Chapman 2001a, 2001b, Airoldi 2003). More than 15% of the recorded species are inhabitants of the soft substrates (e.g *Venus verrucosa, Gouldia minima, Ctena decussata, Petricola substriata*) indicating the complexity of the habitat and the existence of sediments.

The values of the taxonomic distinction indices calculated form the Cretan NaGISA sites indicate that the mollusc diversity of the Cretan sites can be considered as representative of the taxon in the Mediterranean Sea. As for the third hypothesis, the data from the Cretan NaGISA sites show that the biodiversity from the lower observation scales (sampling surfaces) are in the majority of the comparisons a random sample from the one of the higher observation scale. In both sites, almost all replicates are shown to be a random subset of the species pool at the respective depth. Similar results can be found when replicates and depths are tested against the local species pool. Therefore, the NaGISA protocol is proved to be robust enough for the study of the molluscan communities of the photophilic macroalgae associations. Although the NaGISA protocol is represented in the Mediterranean Sea by only 4 sites, data in high taxonomic level are available only from Crete. This doesn’t allow for a complete comparison with the other NaGISA sites as well as a more coherent taxonomic analysis on the representativeness of the collected data under this framework with local or regional data.

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Κεφάλαιο 5

Συνθεση – Συμπεράσματα

Η θάλασσα της Κρήτης, όπως αυτή ορίζεται γεωγραφικά από τον Παγκόσμιο Οργανισμό Τροφίμων και Αγροτικής παραγωγής (FAO – FAO code 23), αποτελεί ένα μεγάλο τμήμα του νοτίου Αιγαίου Πελάγους ενώ αποτελεί ένα διακριτό θαλάσσιο υποσύστημα στην Ανατολική Μεσόγειο λόγω των διαφορετικών γεωμορφολογικών, υδρογραφικών και κλιματικών συνθηκών, τον υψηλός ρυθμός εξάτμισης και την βιοποικιλότητα. Αποτελεί μια θαλάσσια περιοχή, εντός της οποίας έχουν λάβει χώρα μια σειρά από ερευνητικές δράσεις με πλούσια αποτελέσματα αναφορικά με την θαλάσσια βιοποικιλότητα των μαλακίων. Κύρια θαλάσσια οικοσυστήματα που έχουν μελετηθεί αναφορικά με την βιολογική και την λειτουργική ποικιλότητα, την οικολογία συνερεύσεων αλλά και την είναι οι μαλακοί αμμώδεις βυθοί (soft bottoms) σε βάθη μέχρι και 200 μέτρα, η βαθιά θάλασσα (deep sea) σε βάθη μέχρι τα 1000 μέτρα καθώς και κλειστοί κόλποι αργής ανανέωσης υδάτων (embayment). Επιπρόσθετα, περιστασιακές μελέτες έχουν γίνει σε συνευρέσεις θανατοκοινωνίων από υλικό που έχει συλλεχθεί από παραλίες. Εμφανής είναι η απουσία δεδομένων από βιοκοινωνίες/οικοσυστήματα υψηλής βιολογικής και λειτουργικής ποικιλότητας και οικολογικών λειτουργιών όπως τα υποθαλάσσια σπήλαια (κωδικός οικοτόπου κατά ΕΕ = 8330), οι βραχώδεις βυθοί με κάλυψη φωτόφιλων μακροφυκών (Μεσογειακοί ύφαλοι – κωδικός οικοτόπου κατά ΕΕ =1170) σε βάθη μέχρι τα 30 μέτρα ή οι βιογενείς/κοραλλιγενείς σχηματισμοί σε βάθη μεγαλύτερα των 30 μέτρων οι οποίοι ανήκουν στην ίδια κατηγορία θαλάσσιου οικότοπου της ΕΕ. Η μέχρι σήμερα ανασκόπηση της διαθέσιμης και προσβάσιμης βιβλιογραφίας έδειξε πως μέχρι σήμερα, ο αριθμός των μαλακίων που έχουν καταγραφεί από την θάλασσα της Κρήτης ανέρχεται στα 735 είδη, χωρίς να προσμετρώνται τα κεφαλόποδα. Ο αριθμός αυτός είναι ιδιαίτερα μεγάλος αν τον συγκρίνουμε με την βιοποικιλότητα των μαλακίων της Μεσογείου που ανέρχεται στα ~ 2000 είδη. Ο μεγαλύτερος αριθμός αποτελείται από γαστερόποδα ενώ ακολουθούν τα δίθυρα και οι υπόλοιπες ταξινομικές ομάδας. Η αλληλουχία αυτή είναι σύμφωνη με τα δεδομένα της Μεσογείου, όπου τα γαστερόποδα αποτελούν και τον μεγαλύτερο μέρος συνεχίζοντας με τα δίθυρα και τις άλλες ομάδες. Αν και τα μέχρι σήμερα δεδομένα προέρχονται κυρίως από βιοκοινωνίες όπως οι αμμώδεις βυθοί και σε μικρότερο βαθμό από την βαθιά θάλασσα ή τις θανατοκοινωνίες, εμφανής είναι η απουσία μελετών και ειδών από τους βραχώδεις βυθούς (φωτόφιλα μακροφύκη ή βιογενείς σχηματισμοί), λαμβάνοντας υπόψιν το γεγονός ότι το 65% της ακτογραμμής της Κρήτης αποτελείται από ασβεστολιθικά πετρώματα.

Αναγκαίος κρίνεται ένας σχεδιασμός για την μελέτη των βιοκοινωνιών αυτών στις ακτές της Κρήτης ιδιαίτερα όταν αυτές δέχονται απειλές και πιέσεις τόσο από τις ανθρωπογενείς δραστηριότητες στην παράκτια ζώνη όσο και από την κλιματική αλλαγή. Αναγκαία κρίνεται και η δημιουργία επιστημονικής συλλογής σχετικά με τα θαλάσσια μαλάκια σύμφωνα με τα διεθνή πρότυπα καθώς μέχρι σήμερα δεν υπάρχει διαθέσιμο συγκριτικό υλικό από την γεωγραφική περιοχή. Μέχρι σήμερα, μόνο για την ομάδα των οπισθοβραγχίων υπάρχει υλικό κατατεθημένο στο Μουσείο Φυσικής Ιστορίας του Πανεπιστημίου Κρήτης, αποθηκευμένο σύμφωνα με τα διεθνή πρότυπα ενώ ήδη αξιοποιείται σε συγκριτικές μελέτες. Τα δεδομένα της βιοποικιλότητας των θαλάσσιων μαλακίων της Κρήτης αποθηκευτήκαν σε βάση δεδομένων Microsoft Access ώστε να είναι εφικτός ο σχεδιασμός ερωτημάτων καθώς και η επικαιροποίηση των δεδομένων είτε με νέες μελέτες που βρίσκονται σε εξέλιξη είτε με την αλλαγή της συστηματικής κάποιων ειδών σύμφωνα πάντα με Παγκόσμιο Μητρώο των Οργανισμών της Θάλασσας (World Registered of Marine Species – WORMS). Η απουσία δεδομένων από τις βιοκοινωνίες του σκληρού υποστρώματος (φωτόφιλα μακροφύκη & βιογενείς σχηματισμοί) της Κρήτης οδήγησαν στην ανασκόπηση της διαθέσιμης και προσβάσιμης βιβλιογραφίας σε Μεσογειακό επίπεδο, ώστε να υπάρξει μια γενική εικόνα αναφορικά με την ποικιλότητα των μαλακίων σε αυτές. Το μεγαλύτερο μέρος των επιστημονικών εργασιών προέρχεται από την Δυτική Μεσόγειο και Αδριατική θάλασσα, ενώ ελάχιστες είναι οι μελέτες που έχουν υλοποιηθεί στην Ανατολική Μεσόγειο. Η βιοκοινωνία των φωτοφιλων φυκών φιλοξενεί 599 είδη θαλάσσιων μαλακίων, με τον μεγαλύτερο αριθμό να έχουν καταγραφεί από την Δυτική Μεσόγειο. Στην Ανατολική Μεσόγειο, δεδομένα διαθέσιμα υπάρχουν μόνο από το Βόρειο Αιγαίο πέλαγος. Νοτιότερα στην θάλασσα της Κρήτης και ανατολικότερα προς την λεκάνη της Λεβαντίνης είναι εμφανή η απουσία σχετικών δεδομένων. Η βιοκοινωνία των βιογενών/κοραλλιγενών σχηματισμών φιλοξενεί 511 είδη θαλάσσιων μαλακίων, με τον μεγαλύτερο αριθμό να έχουν καταγραφεί από την Δυτική Μεσόγειο. Στην Ανατολική Μεσόγειο, δεδομένα διαθέσιμα υπάρχουν μόνο από μια θέση στο Βόρειο Αιγαίο πέλαγος.

Από αυτά (511 είδη), περισσότερα από 300 είδη έχουν αναφερθεί και από την βιοκοινωνία των φωτοφιλων μακροφυκών, καταδεικνύοντας της πολυπλοκότητα της βιοκοινωνίας. Εμφανής είναι η απουσία σχετικών δεδομένων από το νότιο Αιγαίο πέλαγος και την Ανατολική Μεσόγειο, ενώ αποτελεί επιτακτική ανάγκη η μελέτη αυτών για την απόκτηση της σχετικής γνώσης. Τα δεδομένα από την βιοκοινωνία των φωτοφιλων μακροφυκών αποθηκεύτηκαν σύμφωνα με το πρότυπο Darwin Core για την αποθήκευση δεδομένων βιοποικιλότητας και κατατέθηκαν για μόνιμη αποθήκευση και ελεύθερη πρόσβαση από την επιστημονική κοινότητα στην εθνική υποδομή βιοποικιλότητας LifeWatch GREECE. Τα δεδομένα από την βιοκοινωνία των βιογενών/κοραλλιγενών σχηματισμών αποθηκεύτηκαν σε βάση δεδομένων Microsoft Access και κατατέθηκαν στο επιστημονικό αποθετήριο PANGAEA για μόνιμη αποθήκευση και ελεύθερη πρόσβαση. Επιπρόσθετα, καθώς για την βιοκοινωνία αυτή, έχει συντεθεί ειδικό σχέδιο δράσης από το Περιφερειακό Κέντρο Δράσης για τις Ειδικά Προστατευόμενες Περιοχές (RAC/SPA - Regional Activity Centre for Specially Protected Areas) και ένας άξονας από το σχέδιο αυτό στοχεύει στην δημιουργία βάσης δεδομένων για την βιοποικιλότητα της βιοκοινωνίας, τα δεδομένα παραδόθηκαν στο Κέντρο για περαιτέρω χρήση και αξιοποίηση. Η ύπαρξη ελεύθερων δεδομένων βιοποικιλότητας δίνει την δυνατότητα στην επιστημονική κοινότητα για περαιτέρω χρήση σε δράσεις όπως ο θαλάσσιος χωροταξικός σχεδιασμός (marine spatial planning), βιογεωγραφικές και ζωογεωγραφικές μελέτες, μελέτες σύνθεσης βιοποικιλότητας ανα ζώνες, αλλά και ο εντοπισμός κενών στην μελέτη ειδών και βιοκοινωνίων που μπορεί να οδηγήσει στην ανεύρεση πόρων για την μελέτη αυτών στις περιοχές που δεν υπάρχει η σχετική γνώση.

Έχοντας εντοπίσει το κενό της γνώσης σχετικά με την βιοκοινωνία των φωτοφιλων μακροφυκών στην θάλασσα της Κρήτης και με το ενδιαφέρον για την εφαρμογή του πρωτοκόλλου δειγματοληψίας της της πρωτοβουλίας NaGISA (Natural Geography in Shore Areas) για την συλλογή δειγμάτων από την ζώνη των φωτοφιλων φυκών, επιλέχθηκαν 2 θέσεις στον Βόρειο Κρητικό Πέλαγος. Η πρωτοβουλία αυτή θεωρεί πως 2 σταθμοί μπορούν να δώσουν αντιπροσωπευτικά δείγματα του οικοτόπου που μελετάται. Τα δεδομένα που συλλέγονται με αυτό το πρωτόκολλο είναι άμεσα συγκρίσιμα με σταθμούς σε άλλες περιοχές της Μεσογείου (εφόσον υπάρχουν) καθώς και σε παγκόσμιο επίπεδο, δεδομένου του ότι το πρωτόκολλο αυτό εφαρμόζεται σε διάφορες περιοχές στις 5 ηπείρους. Οκτώ χώρες συμμετέχουν στον Ευρωπαϊκό τομέα, δύο εκ των οποίων δραστηριοποιούνται στη Μεσόγειο (Ιταλία –Ελλάδα). Στη Μεσόγειο υπάρχουν πέντε σταθμοί δειγματοληψίας, ένας στη θάλασσα της Λιγουρίας, δύο στην Αδριατική και δύο στην Κρήτη. Στη Κρήτη οι σταθμοί εγκαταστάθηκαν το 2007. Σε κάθε σταθμό, 5 βάθη (1-5-10-15-20μ.) και 5 επαναληπτικά δείγματα ανα βάθος συλλέχθηκαν με την χρήση υποβρύχιου αναρροφητήρα (underwater sucker). Καταγραφήκαν 127 είδη μαλακίων από τις 2 περιοχές που ανήκουν σε 3 κλάσεις (7 πολυπλακοφόρα, 97 γαστερόποδα, 23 δίθυρα). 34 από τα είδη αυτά αποτελούν νέες καταγραφές για το Κρητικό πέλαγος αυξάνοντας τον συνολικό αριθμό των ειδών σε 769. Ο αριθμός των μαλακίων είναι συγκρίσιμος με μελέτες αντίστοιχων βιοκοινωνιών από την Δυτική Μεσόγειο. Η ταξινομική ποικιλότητα με την χρήση των δεικτών Δ^+ και Λ^+ έδειξε πως το υλικό που συλλέχθηκε από τις ακτές της Κρήτης είναι αντιπροσωπευτικό της Μεσογείου, καθώς τα δεδομένα αυτά αποτελούν τα μόνα διαθέσιμα από την Νότια Ανατολική Μεσόγειο. Υπάρχει μια διακριτή βαθυμετρική ζώνωση ανάμεσα στο βάθος του 1 μέτρου και των υπόλοιπών βαθών. Η κυματική δράση διαφαίνεται ως ο κύριος περιβαλλοντικός παράγοντας που επηρεάζει την σύνθεση της βιοκοινωνίας, όπως αυτό φάνηκε από την χρήση μαθηματικών μοντέλων κυματικής διάδοσης. Το πρωτόκολλο δειγματοληψίας της πρωτοβουλίας NaGISA φαίνεται να μπορεί να αποτελέσει ένα πρωτόκολλο για συνεχή παρακολούθηση της βιοκοινωνίας ενώ η υιοθέτηση του ως πρότυπο στην Μεσόγειο θα μπορούσε να παρέχει άμεσα συγκρίσιμα δεδομένα.

Συμπερασματικά, η παρούσα διδακτορική διατριβή έδειξε πως παρόλο τον χαρακτηρισμό της Ανατολικής Μεσογείου ως μια θάλασσα ολιγοτροφική, φιλοξενεί υψηλό αριθμό μαλακίων από διάφορα θαλάσσια οικοσυστήματα με χαρακτηριστικά της Μεσογειακής θαλάσσιας μαλακοπανίδας. Εμφανής είναι η απουσία δεδομένων από βιοκοινωνίες όπως τα φωτόφιλα μακροφύκη ή βιογενείς σχηματισμοί από την παράκτια ζώνη, με το κενό προσωρινά να καλύπτεται από τα νέα δεδομένα που εμφανίστηκαν από την παρούσα διατριβή αναφορικά με την βιοκοινωνία των φωτοφιλων μακροφυκών απο την Κρήτη. Η βιοκοινωνία αυτή είναι ιδιαίτερα πολύπλοκη αναφορικά με την δομή και τους τροφικούς τύπους που έχει καθώς και τον αριθμό των ειδών που φιλοξενεί, ενώ φαίνεται πως ο κύριος παράγοντας που ρυθμίζει την σύνθεση της είναι η κυματική δράση και οι υδροδυναμικές συνθήκες που επικρατούν στην υποπαραλιακή ζώνη στις ακτές της Κρήτης. Αυτοί οι δυο παράγοντες καθορίζουν τόσο τις ζώνες ανάπτυξης των μακροφυκών όσο και τα είδη που εγκαθίστανται σε αυτά για αναζήτηση τροφής, καταφυγίου αλλά και ως αναπαραγωγικά πεδία. Το υλικό που συλλέχθηκε, αποθηκεύτηκε σε αλκοόλη κατάλληλη για μακροχρόνια αποθήκευση βιολογικού υλικού ώστε να υπάρχει συγκριτικό υλικό για μελλοντικές έρευνες ή/και συγκριτικές μελέτες για συγκεκριμένα είδη με άλλες περιοχές της Μεσογείου ή άλλων θαλάσσιων περιοχών. Η απουσία ήδη υπάρχοντος συγκριτικού υλικού είναι εμφανής με το μόνο διαθέσιμο και κατατεθημένο σε Μουσείο Φυσικής Ιστορίας να είναι αυτό της ομάδας των οπισθοβραγχίων που έχει δημιουργηθεί από τον υποφαινόμενο στα χρόνια της διδακτορικής διατριβής και συνεχώς εμπλουτίζεται με νέα δείγματα και είδη. Το υλικό αυτό ήδη χρησιμοποιείται σε συγκριτικές μελέτες και αναθεωρήσεις γενών με τα πρώτα αποτελέσματα να είναι ιδιαίτερα ενδιαφέροντα. Το πρωτόκολλο που χρησιμοποιήθηκε για την συλλογή του βιολογικού υλικού έδειξε πως μπορεί να παρέχει δεδομένα όπου το κάθε επίπεδο δεδομένων είναι αντιπροσωπευτικό του επόμενου και έτσι η αντιπροσωπευτικότητα της προς μελέτη ταξινομικής ομάδας μιας ευρύτερης θαλάσσιας περιοχής μπορεί να εξασφαλισθεί με την εφαρμογή αυτού. Δεδομένης της έλλειψης ενός κοινά αποδεκτού πρωτοκόλλου για την χρήση του σε Μεσογειακούς υφάλους και την δυσκολία συγκριτικών μελετών με μετανάλυση παλαιών δεδομένων λόγω κυρίως διαφορετικών μεθόδων δειγματοληψίας, το πρωτόκολλο NaGISA θα μπορούσε να αποτελέσει αυτό που θα επιτρέπει την συλλογή συγκρίσιμου υλικού από διάφορες περιοχές της Μεσογείου.

Παράρτημα

Παράρτημα

1. Επιστημονικά άρθρα συναφή με το αντικείμενο της Διδακτορικής Διατριβής.

1. **Poursanidis D.**, Koutsoubas D, Arvanitidis C, Chatzigeorgiou G (2016) ReefMedMol: Mollusca from the infralittoral rocky shores - the biocoenosis of photophilic algae - in the Mediterranean Sea. Biodiversity Data Journal 4: e7516. https://doi.org/10.3897/BDJ.4.e7516
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4. **Dimitris Poursanidis** & Drosos Koutsoubas. A computerized database on the molluscan fauna from the Mediterranean Reef Ecosystems - Part I, the Coralligenous formations. Quaternary International. Volume 390, 10 December 2015, Pages 29–43. Malacological Studies from the Past and Present: A Special Volume in Honor of Henk K. Mienis. http://dx.doi.org/10.1016/j.quaint.2015.07.029
5. Fabio Crocetta, **Dimitrios Poursanidis**, Lionello Paolo Tringali, Biodiversity of sea slugs and shelled relatives (Mollusca: Gastropoda) of the Cretan Archipelago (Greece), with taxonomic remarks on selected species, Quaternary International, Volume 390, 10 December 2015, Pages 56–68. Malacological Studies from the Past and Present\: A Special Volume in Honor of Henk K. Mienis http://dx.doi.org/10.1016/j.quaint.2015.02.061.
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7. **Poursanidis D.**, 2011. First record of *Piseinotecus gabinierei* (Mollusca: Gastropoda: Nudibranchia: Piseinotecidae) from the Aegean Sea. Marine Biodiversity Records, 4, e7 doi:10.1017/S1755267210001223.

2. Ανακοινώσεις σε Διεθνή και Εθνικά επιστημονικά συνέδρια συναφή με το αντικείμενο της Διδακτορικής Διατριβής.

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