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Gastropod Shell Species Occupied by Hermit Crabs (Anomura: Decapoda) along the Turkish Coast of the Aegean Sea

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Abstract: This study aimed to describe the gastropod shell species inhabited by hermit crabs (Anomura: Decapoda) collected during investigations of the decapod fauna of the Turkish Aegean Sea coast. We documented 12 hermit crab species inhabiting 16 species of gastropod shells. The hermit crab, *Pagurus anachoretus* Risso, 1827, had the highest inhabitation frequency (IF), inhabiting 37.5% of all the samples collected. The gastropod shell most inhabited was *Bittium latreillii* (Payraudeau, 1826), which accounted for 66.7% of inhabited shells.

Key Words: Shell utilization, Anomura Decapoda, Eastern Aegean Sea, Turkey

Ege Denizi Türkiye Kıyılarındaki Paguroid (Anomura: Decapoda)'ler Tarafından İşgal Edilen Gastropod Kabuğu Türleri

Özet: Bu çalışma Ege Denizi Türkiye Kıyıları dekapod faunası üzerine yürütülen araştırmalar sırasında toplanan Paguroid (Anomura: Decapoda)'ler tarafından kullanılan gastropod kabuklarını tanımlamayı amaçlamaktadır. 16 farklı gastropod kabuğunu kullanan toplam 12 Paguroid türü türü kaydedilmiştir. Paguroid türü *Pagurus anachoretus* Risso, 1827 % 37,5'lik bir değerle en yüksek yerleşme frekansına sahiptir. En fazla işgal edilen gastropod kabuğu % 66,7'lik frekans değeriyle *Bittium latreillii* (Payraudeau, 1826)'dir.

Anahtar Sözcükler: Kabuk kullanımı, Anomura Decapoda, Doğu Ege Denizi, Türkiye

Introduction

According to Reese (1969), hermit crabs are typically marine organisms, although some species have physiological and behavioral adaptations for living in various habitats. Most are small decapod crustaceans that occupy empty gastropod shells for protection against predation (Leonard et al., 2001) and depend on gastropod shells throughout their lifespan (Turra and Leita, 2000). These shells act as shelters from biotic factors, including predation (Angel, 2000). Hermit crabs need increasingly larger shells during their life cycle, a fact that keeps them in constant activity searching for suitable shells (Bertness, 1981). The life cycle of hermit crabs depends mostly on the processes that make suitable gastropod shells (Hazlett, 1981). According to the hypothesis more commonly used, in their natural habitat, hermit crabs inhabit smaller shells than in laboratory experiments (Vance, 1972; Scully, 1979). Hermit crabs seem to select among the available empty gastropod shells the most suitable one for their size and shape (Koutsoubas et al., 1993). Studies on the utilization of gastropod shells by hermit crabs have been conducted by many authors (Fotheringham, 1976; Bertness, 1980, 1981, 1982; Blackstone, 1985, 1989; Gherardi and Vannini, 1989; Hazlett, 1989, 1990, 1992; Gherardi, 1991; Manjón-Cabeza and García Raso, 1999).

Previous studies on the decapod fauna of the Aegean Sea can be considered preliminary work. Of the 35 anomuran species listed by Koukouras et al. (1992), 21 were identified as hermit crabs, as were 21 of the 36

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anomuran species reported by Kocataş and Katağan (2003). The only study on the occupation of gastropoda shells by hermit crabs was carried out by Koutsoubas et al. (1993) in the Greek waters of the northern Aegean Sea. To the best of our knowledge, the present study is the first to document hermit crab use of gastropod shells along the Turkish coast of the Aegean Sea.

Materials and Methods

In present study, the sublittoral zones of the region between Saros Bay in the north and Marmaris Bay in the south of the Turkish Aegean Sea coast (between lat 40° 35′ 50″ N, long 26° 22′ 40″ E and lat 36° 47′ 30″ N, long 28° 37′ 00″ E) were chosen as the investigation area (Figure 1).

Samples of hermit crabs were collected by beam-trawl, dredge, or grab from a total of 52 stations in July, August, and September 2000, at depths between 5 and 109 m. The sediment was composed mostly of *Posidonia oceanica* (L.) Delile meadows. The biotopes of the stations can be characterized as follows: 2 of the stations (38 and 48) were fine gravel; 5 of the stations (10, 14, 18, 23, and 52) were sandy; 5 of the stations (11, 26, 29, 32, and 35) were muddy; 9 of the stations (4, 13, 20, 25, 28, 30, 41, 44, and 46) were sandy-muddy; 10 of the stations (16, 17, 33, 34, 36, 37, 39, 43, 49, and 50) were covered by photophilic algae; and 21 of the stations (1, 2, 3, 5, 6, 7, 8, 9, 12, 15, 19, 21, 22, 24, 27, 31, 40, 42, 45, 47, and 51) were covered by *Posidonia oceanica* (L.) Delile meadows. Distribution of the hermit crab species at the 52 stations is shown in Table 1.

The hermit crab and gastropod species were identified based on the works of Ingle (1993), Falciai and Minervini (1996), and Pope and Goto (1991), using the European Register of Marine Species (ERMS) nomenclature (2003).

Results

We documented 12 hermit crab species inhabiting 16 different gastropod shell species (Table 2).

The gastropod families, Barleeidae, Cerithiidae, Muricidae, Nassariidae, Rissoidae, Trochidae, and Turritellidae were inhabited by hermit crabs. Frequencies (Fr) of gastropod shells occupied by hermit crabs are shown in Figure 2. The main gastropod species found in the studied area and used by hermit crabs was *Bittium latreillii*, which was inhabited by 66.7% of the collected hermit crabs (8 different species). This species was followed by *Cerithium vulgatum* (Fr = 41.7%) inhabited by 5 different hermit crabs; *Cerithium protractum, Gibbula fanulum, Pollia dorbignyi,* and *Turritella communis* (Fr = 16.7%) by 2 hermit crabs; and *Bela nebula, Gibbula ardens, Gibbula albida, Jujubinus striatus, Jujubinus exasperatus, Muricopsis cristata, Nassarius incrassatus, Ocenebra aciculata, Pusilina* sp., and *Rissoa auriscalptum* (Fr = 8.33%) by 1 hermit crab.

Figure 1. Location of the study area showing sampling stations.

Pagurus anachoretus occupied shells of 8 different gastropod species and had the highest inhabitation frequency (IF = 37.5%) of gastropod shells, followed by *Pagurus prideauxi* (IF = 31.25%). *Pagurus cuanensis* had an IF of 25.0%, and *Anapagurus petiti* and *Pagurus forbesii* had an IF of 18.8%. The IF of *Diogenes pugilator, Pagurus alatus,* and *Pagurus chevreuxi* were

Table 1. Distribution of hermit crabs at the sampling stations.

Hermit crab species	Stations
Dardanus arrosor (Herbst, 1796)	34
Diogenes pugilator (Roux, 1829)	34, 35
Paguristes eremita (Linnaeus, 1767)	15, 22, 49
Paguristes syrtensis De Saint Laurent, 1971	6, 15, 19, 34, 36, 39, 40, 41, 42, 43, 44, 45, 47, 48
Anapagurus laevis (Bell, 1845)	13, 28
Anapagurus petiti Dechancé & Forest, 1962	2,3, 4, 18, 28, 31, 32, 44, 51
Pagurus alatus Fabricius, 1775	10, 19, 23, 24, 29, 36, 42, 43, 44, 48
Pagurus anachoretus Risso, 1827	2, 8, 12, 14, 15, 20, 22, 25, 27, 30, 33, 36, 37, 38, 44, 45, 47
Pagurus chevreuxi (Bouvier, 1896)	21, 23, 25, 26, 33, 37, 39, 40, 42, 43, 45, 51, 52
Pagurus cuanensis Bell, 1845	1, 4, 5, 7, 9, 11, 15, 16, 17, 23, 24, 29, 33, 34, 38, 40, 44, 45, 47, 51, 52
Pagurus forbesii Bell, 1845	7, 10, 13, 34, 45, 50
Pagurus prideaux Leach, 1815	19, 26, 38, 45, 46, 49, 52

Table 2. Gastropod shells used by 12 species of hermit crabs collected in the Aegean Sea (1. *Bela nebula* (Montagu, 1803), 2. *Bittium latreilli* (Payradeau, 1826), 3. *Cerithium vulgatum* (Bruguière, 1792), 4. *C. protractum* Ant. Bivona, in and Bivona 1838, 5. *Gibbula fanulum* (Gmelin, 1791), 6. *G. ardens* (von Salis, 1793), 7. *G. albida* (Gmelin, 1791), 8. *Jujubinus striatus* (Linnaeus, 1767), 9. *J. exasperatus* (Pennant, 1777), 10. *Muricopsis cristata* (Brocchi, 1814), 11. *Nassarius incrassatus* (Ström, 1768), 12. *Ocenebra aciculata* (Lamarck 1822), 13. *Pollia dorbignyi* (Payraudeau, 1826), 14. *Pusilina* sp., 15. *Rissoa auriscalpium* (Linnaeus, 1758), 16. *Turritella communis* Risso, 1826).

	Gastropod shell species															
Hermit crab species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Dardanus arrosor		+														
Diogenes pugilator			+		+											
Paguristes eremita			+													
Paguristes syrtensis		+														
Anapagurus laevis		+														
Anapagurus petiti				+									+		+	
Pagurus alatus		+														
Pagurus anachoretus		+		+		+		+	+	+						+
Pagurus chevreuxi		+			+											
Pagurus cuanensis		+	+										+			
Pagurus forbesii			+								+	+				+
Pagurus prideauxi	+	+	+				+							+		

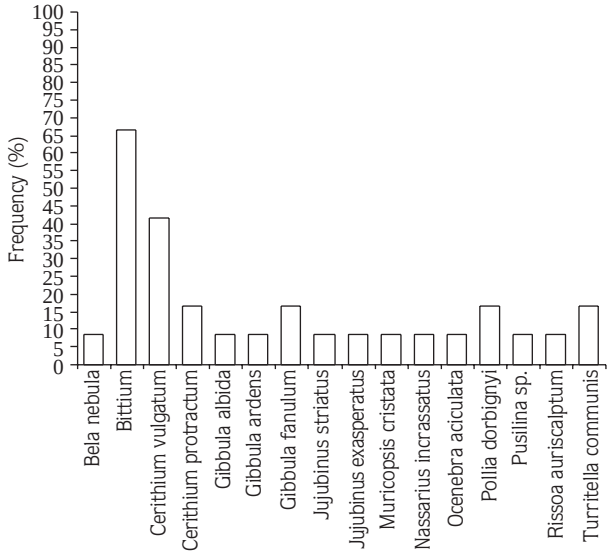

Figure 2. Gastropod shells used by hermit crabs and inhabitation frequencies.

12.5%, whereas *Dardanus arrosor, Paguristes eremita, P. syrtensis*, and *Anagurus laevis* had the lowest IF, 6.23%. Inhabitation frequencies (IF) of gastropod shells by hermit crabs are given in Figure 3.

IF = Inhabitation Frequency (%)

Discussion

In the study area, 12 hermit crab species inhabited 16 different gastropod shells in the Aegean Sea. The majority of hermit crabs recorded in the study area inhabited the biotope of *Posidonia oceanica* meadows. The hermit crab species most observed on *Posidonia oceanica* beds in the study area was *Pagurus cuanensis*.

The gastropod species occupied by the highest number of hermit crab species was *Bittium latreillii*, with a frequency value of 66.7%, whereas the hermit crab species that inhabited the highest number of gastropod species was *Pagurus anachoretus*, with an IF of 37.5%. Koutsoubas et al. (1993) reported a total of 11 hermit crab species (*Anapagurus laevis, Cestopagurus timidus, Clibanarius erythropus, Dardanus calidus, Diogenes pugilator, Paguristes eremita, Pagurus anachoretus, Pagurus cuanensis, Pagurus excavatus, Pagurus forbesii*, and *Pagurus prideauxi*) inhabited 56 different gastropod shell species collected from 2 to 300 m. The species *C. timidus* (Roux, 1830), *C. erythropus* (Latreille, 1818), *D. calidus* (Risso, 1827), and *P. excavatus* (Herbst, 1791), reported by Koutsoubas et al. (1993), were not recorded in the present study. On the other hand, the hermit crabs, *D. arrosor, P. syrtensis, A. petiti, P. alatus*, and *P. chevreuxi*, reported in the present study were not recorded by Koutsoubas et al. (1993).

According to Kocataş and Katağan (2003), the hermit crab community of the Turkish coasts of the Aegean Sea is composed of 21 species. The present taxocoenosis in this area was controlled by *Pagurus cuanensis*, recorded from 21 stations of the 52 different stations, with 94 specimens. Although *Pagurus cuanensis*

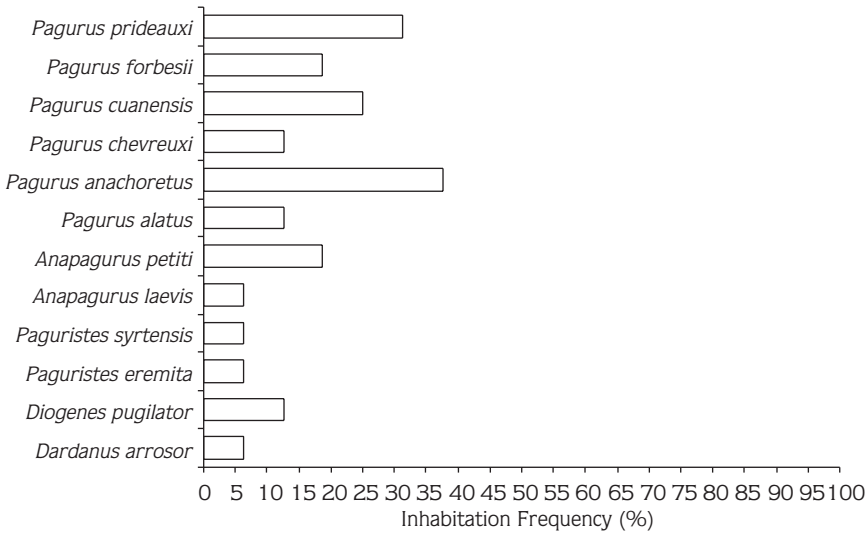

Figure 3. Hermit crab species inhabiting gastropod shell species and inhabitation frequencies.

was the most observed species in the area, it occupied only 3 different gastropod species. Similar studies related to the utilization of gastropod shells by hermit crab populations have been carried out previously in the Mediterranean. Manjón-Cabeza and García Raso (1999) studied the gastropod shell utilization by hermit crabs *Diogenes pugilator*, *Paguristes eremite*, and *Pagurus forbesii* along the Atlantic Ocean shores of Spain (Cadiz) and reported that these hermit crab species used many different gastropod shells, with *Paguristes eremita* being the largest species inhabiting heavier gastropod shell species belonging to the family Muricidae. The same authors reported that *Diogenes pugilator* and *Pagurus forbesii* inhabit smaller turrids. Also in this study, the gastropod families used by *Diogenes pugilator, Paguristes eremite*, and *Pagurus forbesii* in the area were Cerithiidae, Muricidae, Nassariidae, and Turriteliidae. In addition, in the present work, relationships between some morphological parameters of hermit crab species (i.e. relative growth, cephalothoracic shield length, maximum width, cheliped length, and male/female ratio) and gastropod shells (i.e. aperture widths) were not analyzed.

In summary, 12 of the most common hermit crab species of the Turkish coast of the Aegean Sea have been found to occupy 16 different gastropod shell species. Although the species compositions of gastropods and hermit crabs reported previously differ from one study to another, in general, a great number of hermit crab species use a relatively limited number of gastropoda species in particular areas.

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