

UNREGULATED TRADE IN LAND HERMIT CRABS IN THAILAND

Thanakhom Bundhitwongrut

ABSTRACT

In the last few decades, land hermit crabs have been occasionally collected and sold as pets in Thailand, especially in Bangkok. Although some conservation measures for these animals were implemented in 1999 and the trade then almost disappeared, unregulated trade in large numbers of land hermit crabs was noticed in June of 2017. The current trade was investigated during July to October 2017 in Chatuchak Weekend Market, the largest market in Bangkok, and in the on-line market, primarily Facebook. Each week, approximately 5,000–10,000 individuals were found in the wholesale market in Bangkok. Five species in the genus *Coenobita* were found for sale in both wholesale and retail markets. They were priced by size. Detailed information on both markets is reported here. This unsustainable trade involves unregulated collecting of large numbers of wild crabs and potentially affects land hermit crab abundance in many natural habitats. Consequently, regulation of collecting, legislation by government agencies, and increased awareness and cooperation of local people and tourists are needed to save these animals in nature. Recommendations for sustainable exploitation and conservation are provided.

Keywords: terrestrial hermit crab, Coenobitidae, *Coenobita*, exploitation, on-line trade, conservation

INTRODUCTION

In Thailand, many groups of animals are exploited or cultured as pets, especially aquatic species such as fishes, mollusks and decapod crustaceans. Crustaceans favored for recreational (rather than gastronomic) purposes include crayfish, caridean shrimps, brachyuran crabs and hermit crabs. In recent years (2015–2017), imported and cultured pet crayfish with different color morphs have become popular for aquaria (SAMRONGYEN, 2017; WANNURAK, 2017a, b). However, their popularity is seemingly fading as the increasing numbers of cultured crayfish exceed market demand. Currently, land hermit crabs of the genus *Coenobita* (Coenobitidae) are becoming more popular than crayfish. These anomuran crabs are attractive to hobbyists due to their relatively low price compared with other pet animals (e.g. dogs, cats), their lovely appearance and interesting behavior.

Recent history of trade and conservation in Thailand

Over the last few decades, land hermit crabs have been occasionally collected and sold as pets, especially in Bangkok (personal observation). However, in 1999, Mr. Pongpol Adireksarn,

Faculty of Fisheries, Kasetsart University, Bangkok 10900, Thailand

E-mail: thanakhom@hotmail.com

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then Minister of Agriculture and Cooperatives, expressed concern over the apparent decrease in land hermit crabs in nature (THONGTHAM, 1999). At that time (6 Feb. 1999), a photograph of a land hermit crab (*Coenobita brevimanus*) that had adopted a piece of broken glass instead of a gastropod shell was taken by Mr. Pitipong Puengboon na Ayutthaya, then Permanent Secretary of Agriculture and Cooperatives, from Adang Island, Tarutao National Marine Park, Satun Province. The photo was disseminated on mass media (VITCHAYAVICHIAN, 1999). The minister then decided to have meeting with relevant government agencies to discuss both the apparent decrease in land hermit crabs and the scarcity of shells in nature available for these creatures. Although there was no concrete evidence for a scarcity of shells in nature in general, there was clear evidence of intense shell exploitation and trade in both local and imported mollusks from Phuket Island, Thailand (AUNGTONYA & TANTICHODOK, 1991; AUNGTONYA & HYLLEBERG, 1992; AUNGTONYA & KHOKIATTIWONG, 1992; BUSSARAWIT, 1995).

Following that meeting, two working committees were set up: an academic committee to find the causes of declines in hermit crabs and recommend conservation measures, and a public relations committee to promote hermit crab conservation through various mass media. The academic committee initially concluded that the causes of hermit crab decrease were habitat modification and the collection of mollusk shells as souvenirs by tourists. The public relations committee issued an announcement to convince local people and tourists to avoid collecting unoccupied shells in nature for these crabs to use as their shelters. Additionally, the Ministry of Agriculture and Cooperatives asked collectors and shell shops to donate gastropod shells to the Department of Fisheries (DOF) and Royal Forest Department for return to natural habitats of land hermit crabs (VITCHAYAVICHIAN, 1999; NU-DAO, 2001). Some activities to return donated shells to natural habitats were launched in protected areas, such as Similan Islands National Marine Park. However, the effects of these campaigns on hermit crabs were never determined. Following these activities trade in land hermit crabs almost disappeared (1999–2016) for reasons that are poorly understood. The shell donation program may have made traders alert to the growing social awareness of threats to land hermit crabs, although these crabs were not protected by any legislation. Nevertheless, at that time some marine hermit crabs (*Dardanus megistos*, *Calcinus elegans*, *Clibanarius longitarsus*) were occasionally collected and sold in marine aquaria or pet stores (personal observations). However, trade involving selling of large numbers of land hermit crabs has resumed since June 2017.

In Thailand, only three species of decapod crustaceans, all freshwater crabs (*Phricothelphusa sirindhorn*, *Thaipotamon chulabhorn*, *Thaiphusa sirikit*), are protected by the Wild Animal Reservation and Protection Act (CHOOKAJORN & GATEPET, 2006; DOF, 2008). As for land hermit crabs of the genus *Coenobita*, there is no domestic legislation to control and regulate trade.

International trade and regulation

Only the coconut crab, *Birgus latro*, also in the land hermit crab family, was evaluated in the wild as Vulnerable in IUCN Red List, 1981, but later this species was listed as Data Deficient (ELDREDGE, 1996; DREW ET AL., 2010). Nevertheless, *B. latro* is exploited as food, exotic pets and curios, and remaining populations are in decline due to habitat loss throughout their range (WELLS ET AL., 1983; DREW ET AL., 2010). However, *B. latro* is not covered by CITES (UNEP-WCMC [COMPS.], 2014).

In the case of land hermit crabs of the genus *Coenobita*, no species has been evaluated by IUCN (WELLS *ET AL.*, 1983; IUCN, 2017), or covered by CITES (UNEP-WCMC [COMPS.], 2014; MINISTRY OF NATURAL RESOURCES AND ENVIRONMENT, 2017). Nevertheless, these crabs are well known to be sold as pets in many countries (NG, 1998; CALADO *ET AL.*, 2003; SASAKI, 2014). The western Atlantic species *C. clypeatus* and the eastern Pacific species *C. compressus* may be collected legally and are the two main species available in most pet stores in the USA (DE VOSJOLI, 2005; PAVIA, 2006; FOX, 2010). In Japan, imported individuals of eight coenobitid species (*C. brevimanus*, *C. cavipes*, *C. clypeatus*, *C. compressus*, *C. perlatus*, *C. purpureus*, *C. rugosus* and *C. violascens*) have been sold as pets (SASAKI, 2014). Nevertheless, indigenous *Coenobita* species in Japan have been designated as a “natural monument” based on the Law for the Protection of Cultural Properties to promote their conservation, meaning that they cannot be collected without permission (NAKASONE, 2001; MIURA, 2011). In Australia, in order to collect and export the endemic land hermit crab *C. variabilis*, traders must first obtain a commercial license from the Department of Fisheries and then submit a proposal to the Department of Sustainability, Environment, Water, Population and Communities to obtain a declaration for an approved wildlife trade operation specifying a collection quota and duration of collection (DOEE, AUSTRALIAN GOVERNMENT, 2012).

Research on hermit crabs in Thailand

Little attention has been paid to hermit crabs in Thailand, although considerable research on these anomuran decapods has been carried out in the Indo-Pacific region, especially in other countries in Southeast Asia (FIZE & SERENE, 1955; FOREST, 1956; FOREST, 1958a, b; HAIG & BALL, 1988; NAKASONE, 1988a; RAHAYU & FOREST, 1993; BONEKA *ET AL.*, 1995; RAHAYU & FOREST, 1995; CASSIDY & McLAUGHLIN, 1996; RAHAYU, 1996; McLAUGHLIN, 1997; McLAUGHLIN & CLARK, 1997; RAHAYU, 1999; RAHAYU & FOREST, 1999; RAHAYU & HORTLE, 2002; RAHAYU, 2003, 2005, 2006; RAHAYU & WAHYUDI, 2008; RAHAYU & FOREST, 2009; ASAKURA, 2010; RAHAYU, 2012; KOMAI, 2013a, b; KOMAI & RAHAYU, 2014; TEOH & CHONG, 2014a, b; TEOH *ET AL.*, 2014; RAHAYU, 2015; TEOH & CHONG, 2015a, b; RAHAYU *ET AL.*, 2016; JUNG *ET AL.*, 2017; MALAY *ET AL.*, 2018). Initial research on hermit crabs in this country has been related to identification. RAHAYU & KOMAI (2000) reported 17 species of marine hermit crabs from intertidal shallow-water areas of Phuket Island on the Andaman Coast of Thailand. Later, a comprehensive review published by McLAUGHLIN (2002) included 55 hermit crab species, three of them land hermit crabs (*Coenobita brevimanus*, *C. rugosus* and *C. violascens*). Recent research on hermit crabs in Thailand has focused on their ecology. ARUNLERTAREE & RODBOON (2006) studied shell selection and growth rate of the marine hermit crab *Clibanarius longitarsus* in the laboratory. BUNDHITWONGRUT *ET AL.* (2014, 2015) investigated population ecology and shell utilization of *C. rugosus* on Phuket Island. Recently, BUNDHITWONGRUT (2018) studied shell occupation by *C. violascens* from the same locality.

This study is aimed at investigating the current trade in land hermit crabs in Thailand. We monitored the trade for four months in 2017 in detail, both at the largest market, Chatuchak Weekend Market in Bangkok, and the on-line market, especially in Facebook.

MATERIALS AND METHODS

This investigation of the current trade in land hermit crabs was carried out in both the physical and on-line markets during July to October 2017. The main physical market investigated was the large Chatuchak Weekend Market in Bangkok. Details on species, size, price and frequency in the trade were recorded. Crab species was identified according to NAKASONE (1988a), McLAUGHLIN (2002), and RAHAYU *ET AL.* (2016). Relative size of each individual crab was indicated by the overall size of both its occupied shell and crab body when fully retracted into the shell. The relative sizes were classified as small (quail egg size or smaller), medium (golf ball size), large (tennis ball size) and extra large (larger than tennis ball size). Prices of the relative sizes of crabs were noted. For crab prices, the currency exchange rate was approximately 33 baht/USD in 2017. The main on-line market investigated was Facebook (www.facebook.com). The number of pages and groups related to land hermit crabs existing during the study period were recorded. Information on the on-line trade and related activities were noted. Moreover, some wholesalers and retailers at the Chatuchak Weekend Market, as well as experienced keepers, were interviewed to obtain additional information on the trade, including the numbers collected, original sites of collection, locations of retail stores, and crab packaging and transport methods.

RESULTS

Trade in the Chatuchak market

Each week, approximately 5,000–10,000 individuals or more of land hermit crabs were collected and transported from their original habitats in the Andaman Coast of Thailand (including islets adjacent to Phuket and Phang-nga provinces) to main wholesalers in Bangkok via public buses (anonymous traders, personal communication). Captured land hermit crabs with moist chopped coconut husks as substrate were kept in Styrofoam shipping boxes and then put onto the buses. The main destination of these crabs was the Chatuchak Weekend Market. The wholesale days were every Wednesday evening to Thursday morning in the same wholesale market used for ornamental fishes (Fig. 1A–C). The retail days were from Tuesday to Sunday in areas adjacent to the wholesale market. In addition, the retailers distributed and sold crabs as pet animals in street markets in many major parts of Bangkok (e.g. Bangkapi, Bangkhen, Ladkrabang, Ram Indra) and in some large provinces (Chiang Mai, Chon Buri, Nakhon Sawan, Nonthaburi).

Trade in the on-line market

Land hermit crabs were also sold on-line by both wholesalers and retailers through 25 pages and 18 groups in Facebook (see the sample in Fig. 1D) during four months of investigation. On-line traders sent live land hermit crabs using express mail serviced by delivery companies (e.g. Kerry Express). The time of delivery from the company to the buyer's address was from within one day for short distances (within a province or between adjacent provinces) to two days for longer distances (between different parts of the country). Each package comprised land hermit crab(s) and moist chopped coconut husks as substrate in a transparent plastic box, which was perforated on the top for ventilation. This plastic box was then put into a closed

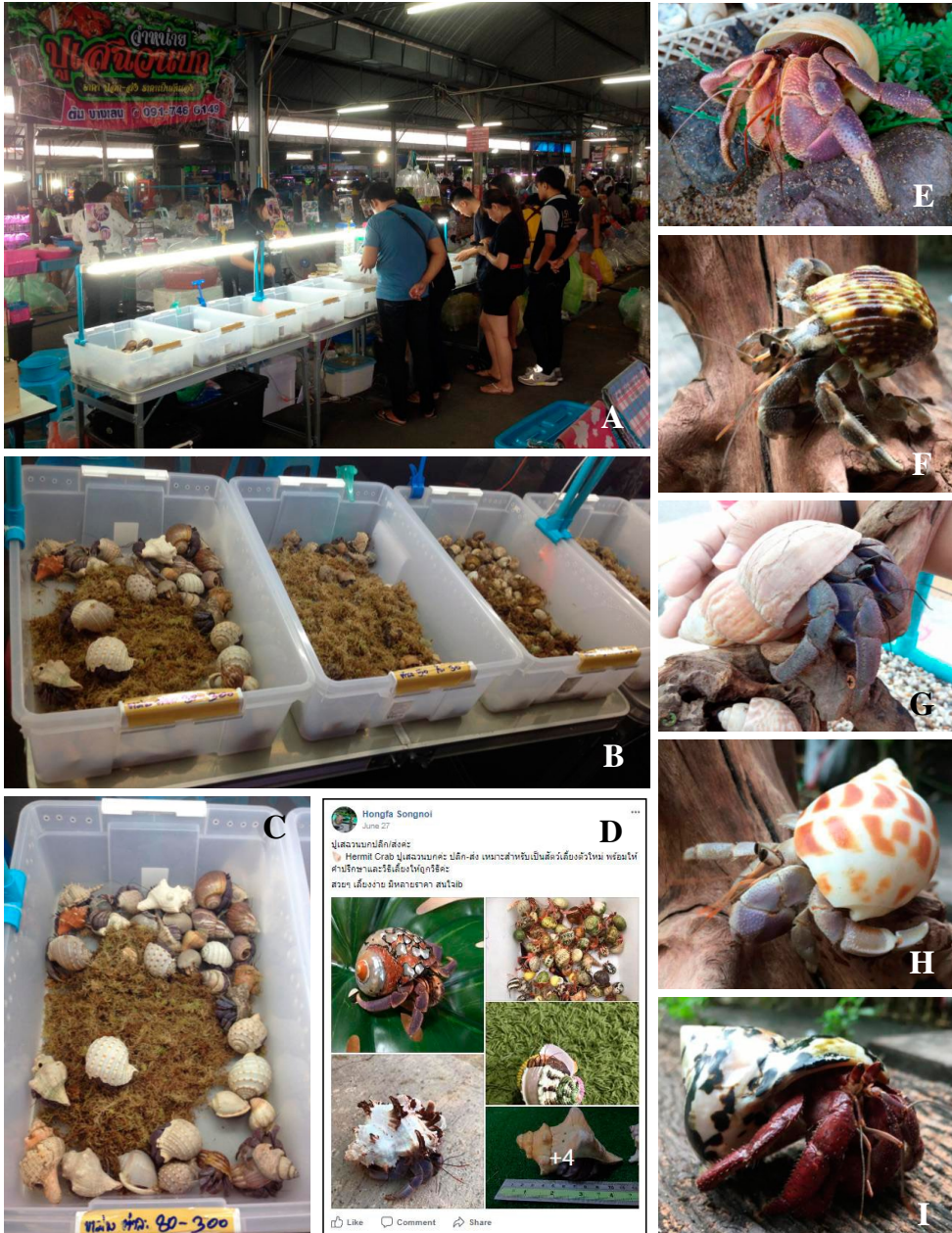


Figure 1. Unregulated trade in land hermit crabs in Thailand. A, The largest wholesale shop at the Chatuchak Weekend Market; B–C, Land hermit crabs sold in the shop of the physical market; D, Land hermit crabs for online sale in the Facebook group; E, *Coenobita brevimanus*; F, *C. rugosus*; G, *C. violascens*; H, *C. lila*; I, *C. clypeatus*. A–C photographed by Thanakhom Bundhitwongrut; D from www.facebook.com; E and G by Kitisuk La-ong; F and H–I by Panthakarn Chawrua.

cardboard mail box, and the package was delivered to the customer. Additionally, selling land hermit crabs as a new career was promoted through both a video clip and a job-finding group in social media. In addition, auctions of land hermit crabs or playing games, such as counting crabs in photos, to get free crab(s) frequently occurred through Facebook groups.

Species and prices in the current trade

Five species of land hermit crabs were found in the current trade in Thailand. Three indigenous species, *Coenobita brevimanus*, *C. rugosus* and *C. violascens*, were observed for sale (Fig. 1E–G). Details on species, size, price and frequency in trade of land hermit crabs found in the current trade in Thailand during July–October 2017, as well as their habitats and distribution, are shown in Table 1. Trade in the initial month, July 2017, started without knowledge of species identification, and prices therefore depended solely on size. With more information for separating species in later months, traders began to set different prices for each species and size. Retail price was about two times the wholesale price. For all three indigenous species, the price of small hermit crabs (quail egg size or smaller) was around 10–40 baht/crab, whereas the price of medium-sized individuals (golf ball size) was about 50–200 baht/crab. Larger species (*C. brevimanus* and *C. violascens*) were sold for 300–500 baht/crab. Extra-large individuals of *C. brevimanus* were sold for prices approaching 1,000–2,000 baht/crab. The most common species in the trade was *C. rugosus*, followed by *C. violascens* and *C. brevimanus*. A recently described species, *C. lila* (Fig. 1H), was also found in the trade, although at lower numbers than the three indigenous species, and sold at 100–200 baht/crab for small size to 350–500 baht/crab for large size. Another species in this trade was *C. clypeatus* (Fig. 1I), which was imported from the USA. Its price five years ago (2012–2016) was around 350–500 baht/crab (personal observation), but its price has increased to 500–950 baht/crab. Furthermore, prices are higher for land hermit crabs changing to new or high-priced shells, offered by sellers after being collected from the wild.

DISCUSSION

Although the current unsustainable trade in land hermit crabs has been featured on television news and on websites (CH7NEWS, 2017; THAIRATH-ONLINE, 2017), it continues unregulated, and is likely causing decreased abundance of these crabs in natural habitats. Land hermit crabs play an important ecological role as generalist scavengers in supralittoral coastal habitats, accelerating the rate of recycling of nutrients and energy transfer in the food chain (LAIDRE, 2013). Thus, any decrease in crab populations caused by human exploitation may have wide disruptive influences on trophic networks. Moreover, shells occupied by crabs, which would otherwise circulate among crab individuals in the population because they usually inhabit old and worn shells rather than new ones (ABRAMS, 1978; LAIDRE, 2012; BUNDHITWONGRUT *ET AL.*, 2015), are also simultaneously removed from habitats in coastal locations. This further decreases shell availability. The current trade in land hermit crabs also induces additional removal of gastropod shells from the wild by collectors for supply as new or substitute shells for crabs in captivity—a positive feedback spiral.

Ovigerous female land hermit crabs are unintentionally and unavoidably collected from their natural habitats. Removal of these gravid females potentially affects population

Table 1. Species, size, price and frequency in trade, habitat and distribution of land hermit crabs found in the current trade in Thailand during July–October 2017. For relative crab size in trade, S = small (quail egg size or smaller); M = medium (golf ball size); L = large (tennis ball size); XL = extra large (larger than tennis ball size). For crab price (in Thai Baht [THB]), the currency exchange rate is approximately 33THB/USD in 2017. For frequency in trade, Less common (LC) = Less than 1,000 individuals/week; Common (C) = Between 1,000 and 2,000 individuals/week; Most common (MC) = More than 2,000 individuals/week.

Species	Size and price in trade				Frequency in trade	Habitat	Distribution	References*
	S	M	L	XL				
<i>C. brevimanus</i>	-	150–200 THB	300–500 THB	1,000–2,000 THB	LC	Forests near beaches and supralittoral zone of sandy beaches	Indo-Pacific, including Thailand	MCLAUGHLIN (2002); MCLAUGHLIN ET AL. (2007)
<i>C. clypeatus</i>	-	500–750 THB	800–950 THB	-	LC	Supralittoral zone from beaches to 15 km inland	Western Atlantic	PROVENZANO (1959); WILDE (1973); HARTNOLL (1988)
<i>C. lita</i>	100–200 THB	350–500 THB	-	-	LC	Supralittoral zone of beaches and reef habitats; sometimes supralittoral zone of mangrove forests and estuarine areas	Malaysia, Singapore and Indonesia; ?Thailand	RAHAYU ET AL. (2016)
<i>C. rugosus</i>	10–40 THB	50–200 THB	-	-	MC	Supralittoral zone of sandy beaches	Indo-Pacific, including Thailand	MCLAUGHLIN (2002); MCLAUGHLIN ET AL. (2007)
<i>C. violascens</i>	10–40 THB	50–200 THB	300–500 THB	-	C	Supralittoral zone of mangrove forests and estuarine habitats; sometimes supralittoral zone of sandy beaches	Indo-Pacific, including Thailand	MCLAUGHLIN (2002); MCLAUGHLIN ET AL. (2007)

* References are for habitat and distribution of each species.

recruitment. Most ovigerous females under stress during transportation and in inappropriate captive conditions ultimately dispose of their eggs to reduce energy consumption and in order to survive. Most pet animals can reproduce in captivity, but land hermit crabs do not. Although, under controlled conditions, land hermit crabs can be nursed from hatching larvae to juveniles living on land, survival rates are low (PROVENZANO, 1962; SHOKITA & YAMASHIRO, 1986; NAKASONE, 1988b; AL-AIDAROOS & WILLIAMSON, 1989; HARVEY, 1992; BRODIE & HARVEY, 2001; HAMASAKI *ET AL.*, 2014, 2015; KATO *ET AL.*, 2015). Effectively, therefore, all crabs sold for pets are collected from their natural habitats; none are captive-bred.

Two coenobitid species as yet unreported in the wild in Thailand were observed in the current trade. *Coenobita lila* was reported from Malaysia, Singapore and Indonesia in its original description (RAHAYU *ET AL.*, 2016). The color and diagnostic characters of *C. lila* found in this investigation were similar to those reported by RAHAYU *ET AL.* (2016). They varied from purple or light purple to violet or pale violet in most individuals, especially larger crabs. Some small individuals were yellowish white or yellowish green in overall color. The diagnostic characters of *C. lila* that distinguish it from its closest relative, *C. violascens*, were paler ocular peduncle color, about one third of the cephalothoracic shield surface anteriorly marked with a dark purple or light brown patch, and the lower outer surface of the palm of the left cheliped covered with tubercles. Due to uncertainty of the provenance of hermit crabs in the current trade, the natural occurrence of *C. lila* in the wild in Thailand still awaits confirmation. The second species referred to above, *C. clypeatus*, has a tropical Western Atlantic distribution and could potentially pose problems as an invasive species if allowed to escape from captivity (BROCKERHOFF & MCLAY, 2011; YEO *ET AL.*, 2011).

Trade in live animals as pets on on-line markets is now widespread (KRISHNASAMY & STONER, 2016; SY, 2018). It poses a major threat to hermit crabs, especially since the emergence of a video clip claiming that hermit crab sellers can reap huge profits (THAIFRANCHISE CENTER, 2017). One Thai Facebook group sought the recruitment of land hermit crab collectors at 10,000–20,000 baht/week (HEALTHY REEFS CLUB, 2017). This advertisement and job recruitment ad possibly attracts new sellers to the trade in land hermit crabs, resulting in more exploitation of wild crabs. In the case of hermit crab delivery in the current trade, transport via closed mail boxes may be harmful to these animals. The sellers do not declare the contents as live crabs as they would be subjected to additional fees.

CONSERVATION SUGGESTIONS

Although the National Park Act punishes those who collect wild animals or plants in protected areas, there is, at present, no other legislation to control the exploitation and trade in land hermit crabs from natural habitats. Related government agencies, such as the Department of Marine and Coastal Resources and Department of National Parks, Wildlife and Plant Conservation (DNP), Ministry of Natural Resources and Environment, and the DOF, should meet to decide on appropriate regulations to control land hermit crab trade and cooperate with other social sectors to preserve these animals before they disappear from natural habitats of this country. Ideally, members of the public should be discouraged from buying hermit crabs. Suggestions for conservation measures are as follows:

All land hermit crabs of the genus *Coenobita* should be announced as species in which collection and trade is regulated. Traders, especially wholesalers and retailers at the Chatuchak

Market, and collectors should be registered by related government agencies. Such regulation of sellers (and aquaculturists) has recently occurred to control trade in alien crayfish which might otherwise escape into the environment (DOF, 2016). The registration of traders in land hermit crabs should be of particular concern because of the increasing trade. A weekly quota should be allotted for each trader as has happened in Australia (DOEE, AUSTRALIAN GOVERNMENT, 2012). Size limits on land hermit crabs captured should also be designated, based on data from research. For example, collection of individuals smaller than the size of the smallest ovigerous female of each coenobitid species should be prohibited. This strategy has been successful for the sustainable fishery of the American lobster *Homarus americanus* in the USA (KING, 2011). Moreover, ovigerous females of all land hermit crabs species should not be collected so as to increase opportunity for recruitment. Such a measure has enhanced sustainable fisheries of the blue swimming crab *Portunus pelagicus* in Thailand (JOHL, 2013) and the American lobster (KING, 2011). In addition, appropriate transport methods should be specified to reduce unintentional deaths of hermit crabs in trade.

Campaigns to prevent collection of empty gastropod shells in nature should be publicized. We should discourage shell collecting, and natural seashells in aquaria should be replaced by artificial shells made with artificial materials such as glass, clay, porcelain, or ceramics as suggested by HYLLEBERG (1992). The natural habitats of land hermit crabs should be rigorously preserved and restored, especially the supralittoral areas covered with vegetation, which are important shelters for land hermit crabs (MORRISON, 2005; BROOK *ET AL.*, 2009; BUNDHITWONGRUT *ET AL.*, 2014). Habitat modification by humans has been shown to adversely influence the abundance of land hermit crabs (NAKAZA *ET AL.*, 1999, 2000). Although national parks and wildlife sanctuaries are already protected by the National Park Act, other areas protected for crab recruitment proposed by researchers should be designated. Simultaneously, the exploited beaches or shorelines inhabited by hermit crabs should be surveyed and monitored to seek evidence for decline in the wild, in order to convince related government agencies such as the DNP to designate these sites as protected areas. Moreover, pollutions in natural habitats of land hermit crabs should be mitigated or eliminated, as pollution can reduce natural densities of crustaceans (WELLS *ET AL.*, 1983). Garbage disposal and littering in hermit crab habitats should be avoided or prohibited.

A handbook and workshops on land hermit crab conservation should be prepared. Younger generations should be educated on the biology of land hermit crabs. Many present Facebook groups that purport to be concerned with the conservation of land hermit crabs are instead established by traders with the goal of convincing members to purchase crabs and accessories. Genuine conservation groups on social media should be set up by concerned government agencies, non-governmental organizations or researchers to teach the public to appreciate these crabs on the beach, not in aquaria. Last but not least, further research on all aspects of land hermit crabs in their natural habitats is needed so as to help us achieve better understanding of their biology and ecology. Implementation of multiple strategies mentioned above could achieve effective conservation of these animals and serve as an exemplar for other cases of endangered and vulnerable, yet under-appreciated, fauna.

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