

Butterflies (Lepidoptera) of the Republic of the Marshall Islands

By Donald W. Buden* and W. J. Tennent

Abstract

Five butterfly species are reported from the Republic of the Marshall Islands: *Badamia exclamationis*, *Danaus plexippus*, *Hypolimnas bolina*, *Junonia villida*, and *Lampides boeticus*; the last requires corroboration. None is endemic to the Marshalls. All are widely distributed in the Pacific, and some well beyond. *Hypolimnas bolina* is the most common species in the Marshalls. It was recorded, often in large numbers, on all islands surveyed during the present study, and on all islands in the Marshalls where butterflies were previously recorded. Additional surveys of butterflies elsewhere in the Marshall Islands will doubtless result in many new locality records, but few additional species are likely to be added to the present list. Small island size together with limited habitat diversity, limited host-plant availability, and distance from potential source populations contribute to the paucity of species on these remote Pacific islands .

*Corresponding Author E-mail: don_buden@comfsm.fm

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Introduction

The butterfly fauna of the Republic of the Marshall Islands (RMI) has been incompletely studied; many of the atolls and islands have been inadequately sampled, and others not at all. The first record of a butterfly from the Marshall Islands appears to be the description of *Hypolimnas bolina rarik* von Eschscholtz 1821 from Wotje Atoll (see Tennent 2006). Von Eschscholtz visited the Marshalls during a 4-year (1815-1818) circumglobal expedition aboard the vessel *Rurick*, under the command of Otto von Kotzebue and sponsored by the Russian Emperor. His insect collections from various expeditions were deposited in the zoological museums in St. Petersburg and Moscow, Russia, and the natural history museums in Helsinki, Finland and Tartu, Estonia (<http://plants.jstor.org/stable/10.5555/al.ap.person.bm000002424>), but a search of collections by curators at these institutions at our request did not reveal additional butterfly records from the Marshalls.

There are few records of butterflies from the RMI prior to the middle of the 20th century. Seitz (1904) remarked on specimens of *Badamia exclamationis*, *Hypolimnas bolina*, and *Junonia villida* from Jaluit Atoll, and Hirose (1934) reported on collections made during the 1930s, including records of *H. bolina* from Namu, Ailinglaplap, Majuro, Jaluit, Namdrik, and Ebon Atolls, and *J. villida* from Jaluit Atoll. Following WW II, numerous biological studies were conducted throughout the Marshall Islands by visiting American scientists. However, most of the research centered on marine environments, and the terrestrial studies focused largely on birds and plants. Many butterflies collected during the Insects of Micronesia Project outlined by Gressitt (1954), presumably including Marshall Islands material, were apparently lost after being sent on loan overseas (S. E. Miller in Buden and Miller 2003), and no report on the butterflies has ever been published in the Insects of Micronesia series (Buden et al. 2005). New locality

records appeared in a few widely scattered publications mainly during the 1940s and 50s, and sporadically thereafter.

Henry K. Townes, employed by the U. S. Department of Agriculture, conducted an entomological survey of Micronesia during the summer of 1946. In the Marshall Islands, he visited Enewetak Atoll (13-18 May) and Kwajalein, Likiep, Ailinglaplap, Majuro, and Jaluit Atolls (16-30 August). Townes (1946) recorded *B. exclamationis* from Enewetak, and Likiep Atolls, *J. villida* on Enewetak Atoll, and *H. bolina* on all 13 islands that he visited among these six atolls.

Arthur C. Cole, entomologist at the University of Tennessee, was a member of the Bikini Scientific Resurvey team in July and August 1947. The purpose of the visit was to assess insect populations on Bikini Atoll following Operation Crossroads atomic bomb tests. Cole's (1951) brief report on insects of Bikini Atoll included records of *B. exclamationis*, *H. bolina*, and *J. villida*. At approximately the same time, Austin H. Clark, U. S. National Museum, Smithsonian Institution, summarized records of butterflies collected in the northern part of the Marshall Islands during the mid-1940's (Clark 1951). He recorded the same three species listed by Townes (1946) and Cole (1951), but no others. The specimens he reported were obtained by five different collectors who had visited Enewetak, Bikini, Kwajalein, and Likiep Atolls during 1944-1947.

During the summer of 1950, Robert L Usinger, University of California, Berkeley, and Ira La Rivers, University of Nevada, conducted insect surveys on Arno Atoll as part of the Coral Reef Atoll Project of the National Research Council's Pacific Science Board. Their report (Usinger and La Rivers 1953) mentioned only two species of butterflies (*H. bolina* and *Danaus plexippus*) on Arno Atoll; no specific accounts of sightings or specimen records were included.

In January 1958, Typhoon Ophelia struck the southern Marshalls Islands, with Jaluit Atoll receiving a direct hit. The following May, under the joint sponsorship of the Pacific Science

Board of the National Academy of Sciences—National Research Council, the Office of Naval Research, and the Trust Territory of the Pacific Islands, a team of seven scientists that included J. Linsley Gressitt, Chair of the Entomology Department, Bernice P. Bishop Museum, arrived at Jaluit to study the effects of the storm (Blumenstock 1961). Gressitt's (1961) report on the terrestrial fauna noted that *H. bolina* was the only butterfly observed during the study period (24 April-2 May).

Bernard B. Sugerman of the Entomology Program U. S. Army Hawaii, reported on insects and other arthropod allies that he and others collected on Kwajalein Atoll during the mid-to-late 1960's (Sugerman 1972). This report was followed by another (Sugerman 1979) that added new records based on collections Sugerman himself made on Kwajalein during 1971-1974. It included what is still the only known record of a lycaenid ("*Lampides* sp.") from the Marshall Islands. The only other butterflies included in these two published lists are *B. exclamationis* and *H. bolina*.

The 1987 publication of a two-volume treatise on the natural history of Enewetak Atoll (Devaney et al. 1987a,b) summarized the results of research conducted at the Mid-Pacific Research Laboratory during its 30 years of operation (1954-1984) on Enewetak Atoll. G. Allan Samuelson and Gordon Nishida, entomologists at the Bishop Museum, contributed the chapter on insects and other terrestrial arthropods (Samuelson and Nishida 1987). The only butterflies they recorded were the same three species listed by Townes (1951) and Clark (1951)—*B. exclamationis*, *H. bolina*, and *J. villida*.

During 20-30 June, 1989, Donald M. Nafus, entomologist at the University of Guam, conducted an insect survey in the Marshall Islands on Likiep, Majuro, and Jaluit Atolls. He focused mainly on crop pests but provided the first record of *B. exclamationis* from Majuro Atoll (Nafus 1996); no other butterflies were mentioned in his report. Ilse Schreiner, also at the

University of Guam, collaborated with Nafus on a guide to the butterflies of Micronesia, which included records for the Marshall Islands, but without listing specific island (or atoll) localities (Schreiner and Nafus 1997).

Tennent's (2006) annotated check-list of the butterflies of Oceania is hitherto the most recent update of distribution records of Marshall Islands butterflies. It lists locality records by island, but names of atolls are not distinguished from the names of the islands comprising an atoll and, in some cases, inadvertently gives the impression of a more widespread distribution than actually occurs. Of the 27 Marshall Islands localities listed for *H. bolina*, for example, 19 are from Kwajalein Atoll.

In the study reported here, we record butterflies from Rongelap and Mili Atolls, and Kili Island for the first time, along with new island locality records for Namu, Ailinglaplap, Majuro, and Arno Atolls. We summarize and consolidate records gleaned from the scanty and widely scattered literature, include new information furnished by local residents, provide an account of previous studies, and include at least one source (in most cases the primary source) for each locality record.

Study Area

The Pacific island nation of the Republic of the Marshall Islands (RMI) consists of well over 1,000 small, low-lying, coralline islands in the west central Pacific Ocean, between 4 and 15° N and 160 and 173° E. The twenty-nine atolls and five stand-alone, mid-ocean reef islands that make up the Marshall Islands are of relatively recent geological origin having emerged from the sea no more than a few thousand years ago (Dickinson 2003, 2004, 2009). They form a double chain about 1,300 km long (northwest to southeast) and 1,150 km wide—the Ralik Chain in the west and Ratak Chain to the east (Figure 1). Most of the islands are less than 1.0 km² in area (Bryan 1971), and with elevations only about 2-4 m above sea level, the highest point being 10

m on Likiep Atoll (<http://www.peakbagger.com/peak.aspx?pid=11788>). Many are without permanent human habitation, but are frequently visited for farming and fishing, and for collecting crabs, coconuts, firewood, thatch, and other natural resources utilized by islanders from settlements on nearby islands.

Annual rainfall ranges from as little as 635 mm in the northern Marshalls to more than 4,000 mm in the south (National Biodiversity Team of the Republic of the Marshall Islands 2000), and the vegetation correspondingly grades from xerophytic forest and scrub in the north to increasingly more mesic woodlands in the south (Fosberg 1990, Mueller-Dombois and Fosberg 1998). Vegetation in the RMI has been greatly impacted by human activity beginning with the arrival of the first colonists about 2,000 years ago (Kirch 2000, Weisler 2001, Rainbird 2004, Weisler et al. 2012, Harris and Weisler 2016). Coconut (*Cocos nucifera*) plantations supplanted large areas of native forest, often with breadfruit (*Artocarpus* spp.) being codominant on the larger islands, and a wide variety of introduced ornamentals grows in and near the settled areas. Thaman (2006) considered the terrestrial ecosystems of the Marshalls to be among the most disturbed and highly modified in the world.

MATERIALS AND METHODS

Butterflies were collected by D.W.B. on five atolls and one stand-alone island in the Marshall Islands during summer 2016 as part of a study assessing biodiversity in the RMI: Kili Island (28 June), Namdrik Atoll (28 June-5 July), Ailinglaplap Atoll (8-12 July), Mili Atoll (21-28 July), Arno Atoll (1-3 August), and Majuro Atoll (various times totaling about three weeks during 22 June-9 August 2016). Additional specimens were collected by Adam Stratz on Rongelap Atoll during 21 July-4 August 2016. Statistical data for the islands, including the number of islands on each atoll and total land area for each (Table 1) are taken from Bryan (1971), with exceptions as noted in some cases involving more recent studies. Specimens collected were deposited in The

Natural History Museum, London. Scientific names and sequence of species follow Tennent (2006). Place names are those we encountered most frequently during this study—numerous alternative names and variations in spelling appear in the literature. We include the name of the atoll (often repetitively) on which an island is located to avoid confusion when the names are the same (e.g. Mili Island, Mili Atoll) or when the same name (or a minor variant) is used for different islands (e.g., islands named Enewetak or Eniwetak on Enewetak, Kwajalein, and Rongerik Atolls). Additionally, we include alternative names in parentheses when they have been applied differently by different authors. Berlin is given as a primary name for Gugegme (= Gugegwe) Island, Kwajalein Atoll in Clark (1951) and as an alternative for Ningi Island in Sugerman (1972). Bryan (1971) pointed out that confusion between these two islands exists in charts as they form a nearly continuous land mass.

RESULTS
SPECIES ACCOUNTS
Family HesperIIDae

Badamia exclamationis (Fabricius)

This species ranges widely from southern and south-eastern Asia to Indo-Australia and the islands of Oceania (Schreiner and Nafus 1997, Vane-Wright and de Jong 2003, Tennent 2006). It has been recorded in the Marshall Islands on Enewetak Atoll (unspecified localities—Townes 1946), Bikini Atoll (Bikini Island—Clark 1951), Kwajalein Atoll (Loi Island—Clark 1951, Omelek Island—Sugerman 1972), Likiep Atoll (Likiep Island—Townes 1946), and Majuro Atoll (Majuro Island [first observed by D. Nafus in 1989]—Nafus 1991, 1996).

During the present study, D.W.B. frequently observed adult *B. exclamationis* on, or in the vicinity of, a single *Morinda citrifolia* tree on landscaped grounds of Hotel Robert Reimers on Majuro Island; six specimens were collected—one on 23 June, two on 20 July, and three on 31 July. None was seen elsewhere on the island. Seven other specimens collected on Rongelap Atoll

by Adam Stratz (five on Rongelap Island, 22-26 July, and 2 on Naen Island, 2 August 2016) are first records for the atoll; the species was common at both localities (Stratz, pers. comm.).

Family Lycaenidae

Lampides boeticus (Linnaeus)

Sugerman (1979) recorded “*Lampides* sp.” (*L. boeticus*: *Lampides* is a monotypic genus) from Enubuj Island, Kwajalein Atoll, based on material (the number of specimens unstated) that he collected between 1971 and 1974. Identification initially was made by W. D. Field, entomologist at the Smithsonian Institution. Later, Samuelson and Nishida (1987:165) mentioned this record in passing and referred to the species as “probably *L. boeticus* (Linnaeus),” and Tennent (2006) included Kwajalein in the list of locality records for this species. No specimen was found in collections at the National Museum of Natural History (Smithsonian Institution), the Bishop Museum, the University of Hawaii, or the University of Guam, all being places where the material was most likely to have been deposited given the professional affiliations of the principals involved, but we have no reason to doubt the reported presence of this widespread species. Oddly, there are apparently no other records of *L. boeticus* or of any other lycaenid from the Marshall Islands so far as we are aware. The occurrence of *L. boeticus* in the Marshalls is not unexpected given its broad range in the Pacific (Tennent 2006) and elsewhere. However, it remains unrecorded from the Gilbert Islands (now a part of Kiribati) immediately to the south, and from Pohnpei and Kosrae States in the Federated States of Micronesia, the nearest islands to the west (Tennent 2006). Although accepted here by the authors, the Marshall Islands record requires corroboration.

Family Nymphalidae
Subfamily Danainae

Danaus plexippus (Linnaeus)

The monarch ranges widely in tropical and temperate zones throughout most of the world with the exception of Africa, although it was recently recorded from the Cape Verde Islands

(Tennent and Russell 2015). It is widespread among the islands of Oceania (Tennent 2006), but records from the Marshall Islands are scanty, with little or no detail. Seitz (1904) remarked on specimens from Jaluit Atoll, and Tennent (2006) recorded it from Majuro Atoll. Usinger and La Rivers (1953) alluded to its presence on Arno Atoll but did not list any specific records. Pagenstecher (1909), Walker (1920), and Townes (1945, 1946) also recorded it in the Marshalls but without specifying localities. Clark (1951) remarked that Townsend's (1945) citation of its occurrence in the Marshalls was in error, and went on to say, erroneously, that this species does not occur there. Two specimens in the Museum of Comparative Zoology (MCZ 164580 and 164581), both previously unreported in the literature, are the only records of *D. plexippus* from Likiep Atoll. Images of the original specimen labels (and specimens) available online in the MCZbase entomology database indicate that both pupated on 22 January and emerged on 30 January 1900; the collector is not recorded. MCZ 164580 is recorded as from Likiep Atoll and 164581 from Likiep Island, both almost certainly collected on the same island on the atoll of the same name.

During the study reported here, D.W.B. observed *D. plexippus* occasionally (averaging about one sighting every other day) on Majuro Island, Majuro Atoll, and almost always in the vicinity of *Calotropis gigantea* plants. Four specimens were collected on Majuro Island during June-July 2016 and another on Eneko Island, about 11.0 km north of Majuro, on 14 July. Furthermore, Clarence Luther, mayor of Namdrik Atoll, told D.W.B. that monarchs were present on Namdrik Island at least until several decades ago, and that as a boy he had reared some from larval stages, but the species disappeared from the island after their host plants were eliminated by the resident islanders.

Subfamily Nymphalinae

Hypolimnas bolina (Linnaeus)

This species ranges widely from Africa to Southeast Asia, and southward and eastward to New Guinea, Australia, and the Pacific (Tennent 2006). It is the most common butterfly in the Marshall Islands and often the only one recorded on many of the islands (this study). Tennent (2006) included populations from the Marshall Islands, along with those from Wake Island, Kiribati, and Tuvulu in the subspecies *H. b. rarik* von Eschscholtz. However, recent studies have pointed out the lack of uniformity and consistency in geographic variation within many western Pacific populations of this species and suggest that recognition of separate subspecies in this region may be unwarranted (Buden and Tennent 2017).

H. bolina has been recorded in the Marshall Islands from Ujelang Atoll (Nelle Island--National Museum of Natural History, Smithsonian Institution, “many specimens” collected by D. Anderson in 1976 [B. Harris, pers. comm.]), Enewetak Atoll (Enewetak, Igurin, Japtan, Aomon, and Engebi Islands—Townes 1946), Bikini Atoll (Bikini Island—Clark 1951), Utrik Atoll (Eluk Island [reported as “abundant” on *Achyranthes* flowers]—Fosberg 1955:5), Kwajalein Atoll (Roi-Namur, Ennubira, Gagan, Gallinam, Omelek, Kwadack, Enewetak, Meck, Bigej, Gugegwe [= Gugegme], Ningi [= Berlin], Loi, Ebeye, Little Buster, Big Buster, Kwajalein, Enubuj, Ennylabegan, Legan, Illeginni, Enmat, and Eru Islands—Sugerman 1972), Likiep Atoll (Likiep Island—Townes 1946), Wotje Atoll (type locality for *H. b. rarik* von Eschscholtz—see Tennent 2006:82), Namu Atoll (?-island—Hirose 1934, Majkin Island—sight record, J. Niedenthal 1981[see additional remarks below]), Ailinglaplap Atoll (?-island—Hirose 1934, Bigatyeland Island and “near Airek” [= Airok Island?])—Townes 1946), Majuro Atoll (Majuro Island—Townes 1946), Arno Atoll (?-island—Usinger and La Rivers 1953), Jaluit Atoll (?-island—Hirose 1934, Jabor Island and other [unnamed] islets—Gressitt 1961), Namdrik Atoll (probably Namdrik Island—Hirose 1934), and Ebon Atoll (?-island—Hirose 1934).

We present here the first records of *H. bolina* from Rongelap Atoll (Rongelap Island, 8 collected, 28-29 June 2016, A. Stratz), Kili Island (2 collected, 28 June 2016, D.W.B.), and Mili Atoll (Mili Island, 7 collected, 21-26 July 2016, D.W.B.). Additionally, new island locality records (all D. W. B., 2016) from atolls where the species was previously recorded include Buoj Island (4 collected, 9-10 July) and Jeh Island (2 on 11 July) on Ailinglaplap Atoll; Eneko Island (4 collected, 14-15 July), and Koran (1 on 5 August), Anil (2 on 5 August), and Ejit (1 on 5 August) Islands, all on Majuro Atoll); Madmad Island, Namdrik Atoll (sight record only—observed occasionally in weedy areas, 1-2 July 2016); and Ebon Island, Ebon Atoll (sight record only—three or four observed at edge of airstrip during an intermediate stop on 21 July).

This species was observed on all islands visited during the 2016 survey and was especially abundant in open, weedy areas where *Bidens pilosa* and *Melanthera biflora* (formerly in *Wedelia*) were common; adults were also attracted to *Premna serratifolia*. Cumulative encounter rates for five islands during walks along trails and roadsides ranged from 6.7 to 50.3 per hour, with males accounting for 68.3% to 89.8% of the observations (Table 2). The highest single encounter rate was 75.6/hr during a 75 min walk along an unpaved, weed and shrub bordered road through open coconut forest on Arno Island on 2 August 2016; 96.4% were males. Also, during his first year as a Peace Corps Volunteer on Majkin Island, Namu Atoll, in 1981, Jack Niedenthal (pers. comm.) observed swarms of “hundreds” of butterflies matching the description and illustrations of male *H. bolina*. He has not observed any similar occurrences during more than 35 years in residence in the Marshall Islands.

Junonia villida (Fabricius)

This species ranges widely throughout the Indo-Australian Archipelago and Oceania, with a disjunct population in the Chagos Islands (Vane-Wright and Tennent 2011). It has been recorded in the Marshall Islands from Enewetak Atoll (Aomon, Enjebi, and Medren (= Perry)

Islands—Samuelson and Nishida 1987), Bikini Atoll (Bikini Island—Clark 1951) and Jaluit Atoll (?-island--Seitz 1904). None was encountered during the present study.

DISCUSSION

Five species of butterflies are recorded from the Marshall Islands, but one of them (*Lampides boeticus*) needs corroboration. All of the recorded species are widespread in the Pacific and often well beyond (Tennent 2006). Their broad distribution among the small, remote islands of the Pacific is indicative of their vagility and adaptation to limited resources in unstable environments (Buden and Tennent 2017). Of the four well-documented species, *Hypolimnas bolina* is by far the most common, and the one most likely to be encountered on any island at any time.

However, Fosberg (1955) did not encounter it on Bokak Atoll during a week-long visit, 20-27 July 1952. Bokak is the most remote Atoll in the RMI, being at the far northern end of the Ratak Chain, and about 290 km north of the nearest neighboring islands on Bikar Atoll. Fosberg (1990) stated that it is the most arid of the RMI atolls, has a nearly semi-desert aspect, and supports only nine species of flowering plants. He (Fosberg 1955) remarked that except for the large numbers of seabirds, Bokak has a meager land fauna, and commented on the complete absence of butterflies, termites, houseflies, and mosquitoes..

Badamia exclamationis is widespread but locally distributed throughout the Marshalls. Based on albeit meager collection records, it appears to be more numerous in the northern and drier islands. Its larvae feed mainly on *Terminalia* species (Nafus 1996, Schreiner and Nafus 1997, Braby 2004; Tennent 2009). Townes (1946) observed female *B. exclamationis* ovipositing on leaves of *T. littoralis* on Likiep Island, Likiep Atoll, during 29-30 August 1946, and remarked that larvae, almost all of which were being attacked by blood-sucking *Forcipomyia* [biting midges], were common and had nearly defoliated some of the young trees. But most of the *B.*

exclamationis observed on Majuro and Rongelap Atolls during the present study (all adults) were on *Morinda citrifolia*.

Junonia villida is known in the Marshalls from only a few records, and none since the 1940s. Its current status in the Marshalls and adjacent areas of Micronesia is uncertain. It has been recorded from Chuuk and Pohnpei in the Federated States of Micronesia (Schreiner and Nafus 1997, Tennent 2006), but not during more recent surveys (Buden and Miller 2003, Buden et al. 2005, Buden and Tennent 2011 2017). Also, Schreiner and Nafus (1997:27) remarked that “although it is not currently found in the Marianas, an illustration made by the artists of the Freycinet expedition to Guam in 1819 shows a butterfly which appears to be this species.” The reason for a lack of recent records in areas of Micronesia where it was previously recorded is unknown, although this species is known to vary in numbers as a result of local and general migrations. This butterfly utilizes a wide variety of larval host-plants—20 plant genera were noted by Tennent (2002), many of which are widespread in the Pacific .

The only other species of butterfly recorded in the Marshalls, also known from only a few records, is the monarch, *Danaus plexippus*. Here and elsewhere, its presence is closely linked to the availability of milkweed host plants. In the Marshall Islands (this study), and on many islands in the FSM (D.W.B., pers. obs.) the main host plant is the widespread, introduced ornamental, *Calotropis gigantea*. *Asclepias curassavica*, also introduced and widely distributed throughout the Pacific is another favored potential host (Ackery and Vane-Wright 1987, Braby 2004, Tennent 2009). Scudder (1875) was of the opinion that *D. plexippus* was introduced to Micronesia with a shipment of “milkweeds” arriving in Pohnpei from Hawaii in 1857, his opinion being based on information provided in a letter addressed to him from Dr. Luther H. Gulich, who was the recipient of the shipment. In any event, the monarch butterfly is known to

have spread across the Pacific since the mid-1800s, possibly as the result of its migratory tendencies and following the spread of potential host plants (Walker 1914, Vane-Wright 1993).

The paucity of butterfly species in the Marshall Islands may be attributed to limited habitat (including lack of suitable host plants) and distance from potential source populations. Adler and Dudley (1994) reported that isolation was the most important geographic variable explaining variation in species richness in butterflies among Pacific islands, and Miller (1996) cited studies involving at least six different orders of insects showing a reduction in species number progressing from west to east across the Pacific. To what extent butterfly species in the Marshalls arrived in stepping stone fashion from the west via the Caroline Islands or from the south via New Guinea, the Solomons and Kiribati is uncertain. Future molecular studies may resolve some of these biogeographic issues. Few new species are likely to be added to the list of butterflies resident in the Marshall Islands, but additional surveys among the many islands not yet sampled will doubtless yield many new locality records and shed additional light on the biogeography and biodiversity of the RMI.

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TABLE 1

Land Area, Number of Islands, and Distribution of Butterflies for the 29 Atolls and Five Stand-

alone Islands of the Republic of the Marshall Islands; Ex indicates extirpated.

	Land Area (km ²) ^a	No. of Islands ^a	Species ^b				
			B. e.	L. b.	D. p.	H. b.	J. v.
RALIK CHAIN							
Ujelang Atoll	1.75	30				+	
Enewetak Atoll	5.85	44	+			+	+
Bikini Atoll	6.01	22 ^c	+			+	+
Rongelap Atoll	7.95	61	+			+	
Rongerik Atoll	1.68	14					
Ailinginae Atoll	2.80	25					
Wotho Atoll	4.35	18					
Ujae Atoll	1.86	15					
Lae Atoll	1.45	20					
Kwajalein Atoll	16.39	93	+	+?		+	
Lib Island	0.93	1					
Namu Atoll	8.86	58				+	
Jabot Island	0.57	1					
Ailinglaplap Atoll	14.69	56				+	
Jaluit Atoll	11.34	91	+		+	+	+
Kili Island	0.93	1				+	
Namdrik Atoll	2.77	2			Ex?	+	
Ebon Atoll	5.75	22				+	
RATAK CHAIN							
Bokak Atoll	3.24	10					
Bikar Atoll	0.49	7					
Utrik Atoll	2.43	10				+ ^d	
Taka Atoll	0.57	6					
Mejit Island	1.87	1					
Ailuk Atoll	5.36	55					
Jemo Island	0.16	1					
Likiep Atoll	10.26	65	+		+	+	
Wotje Atoll	8.18	75				+	
Erikub Atoll	1.53	16					
Maloelap Atoll	9.82	75					
Aur Atoll	5.62	43					
Majuro Atoll	9.17	64	+		+	+	
Arno Atoll	12.95	103 ^e			+	+	
Mili Atoll	14.91	92 ^f				+	
Nadikdik Atoll	0.90 ^g	28 ^g					

^a From Bryan (1971) unless otherwise indicated.^b B. e., *Badamia exclamationis*; L. b., *Lampides boeticus*; D. p., *Danaus plexippus*; H. b.,*Hypolimnas bolina*; J. v., *Junonia villida*.

^c Bryan (1971) recorded 36 but Fosberg (1985:1) stated “On its roughly rectangular reef were originally 25 islets...reduced to 22 since the atomic bomb tests in 1946-1958.”

^d Sight record only.

^e Other sources (e.g. Kiester 1983, Fosberg 1990) indicate 133 islands.

^f Fosberg (1990:82) states “over 100 islets, well-distributed over the reefs.”

^g From Ford and Kench (2014).

TABLE 2.

Encounter Rates of *Hypolimnas bolina* on Four Atolls in the Marshall Islands During June and

Locality	No. of Survey	Total Time (min)	July 2016 No. of Encounters			Encounter Rate (per hr) ^b
			Males ^a	Females	% Males	
s						
Ailinglaplap Atoll						
Buoj Island	2	135	12	3	80.0	6.7
Jeh Island	3	106	34	11	75.6	25.2
Majuro Atoll						
Majuro Island	5	95	41	19	68.3	37.9
Eneko Island	2	45	26	3	89.7	38.7
Arno Atoll						
Arno Island	2	105	79	9	89.8	50.3
Namdrik Atoll						
Namdrik Island	4	305	112	27	80.6	24.3

^a Identification based on coloration and pattern^b Sexes combined.

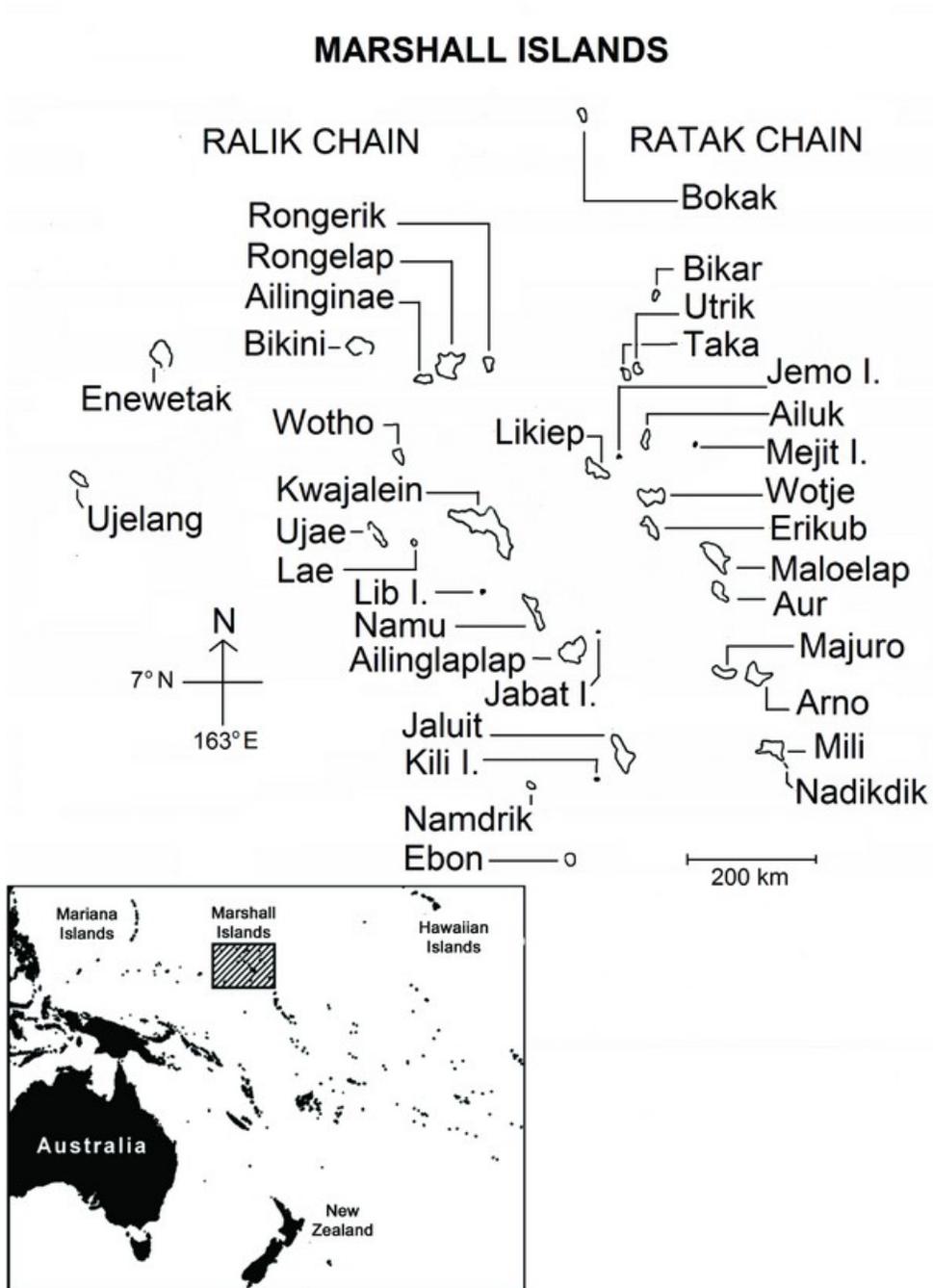


Figure 1. Location map for the Marshall Islands.