

# Ecology and body size of the parthenogenetic *Megabunus diadema* (Fabricius, 1779) (Opiliones: Phalangiidae) at Karmøy, Western Norway

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The presently known distribution of *Megabunus diadema* is summarized and presented as a map. The species is known from Iceland, the Faroe Islands, Western Norway, Great Britain, Western France by the English Channel and Northern Spain. *M. diadema* was studied in 9 localities at the island of **RY** Karmøy, Ryfylke (EIS 13) in Western Norway from 3 different biotopes during the period of 15 June - 10 July 1997. During this period, 261 females and 3 males were collected by hand-picking. *M. diadema* is mainly a parthenogenetic species, and these males are the first reported from Norway. Regarding morphological characters the body length, movable cheliceral finger, pedipalpal tarsus and 1. eye spine were measured. Both the smallest and largest body length were found in specimens from coniferous wood. Compared to Western Europe and Great Britain no geographical differences were detected regarding body length. Regarding movable cheliceral finger length specimens from different coniferous woods were both smallest and largest in size. The length of pedipalpal tarsus was smallest in mixed wood and greatest in coniferous wood. 1. eye spine length was smallest in mixed wood and largest in coniferous wood. The southern distribution limit of *M. diadema* was found to lie close to the county border of **VAY** Vest-Agder. The biotope preference of the species was found to be mixed wood, and the density maximum was in the last week of June.

*Key words:* Opiliones, *Megabunus diadema*, distribution, ecology, size

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## INTRODUCTION

The main aim of the present study was to investigate the preference of *M. diadema* to different biotopes and to study the monthly occurrence of the species. Furthermore, body length, movable cheliceral finger length, pedipalpal tarsus length and 1. eye spine length, were measured. The sizes of movable cheliceral finger, pedipalpal tarsus and 1. eye spine length have not been reported previously for this species.

A survey of the presently known distribution, ecology and size of *Megabunus diadema* (Fabricius, 1779) is presented. The distribution of the species is relatively well-known, with the possibly exception of the northern limits. These, however, may be predictable as one roughly knows the vertical distribution of the species (Stol 2000). *M. diadema* was described from **MRY** Sunnmøre, Norway by Fabricius (1779), although Strøm (1765)

drew the species from the same place without giving it a name. Presently the distribution of *M. diadema* in Norway stretches along the western coast from **STY** Sør-Trøndelag in the north to **VAY** Vest-Agder in the south, Figure 1b. The European distribution includes Iceland, the Faroe Islands, Western Norway, Great Britain and Western France by the English Channel. *M. diadema* is found neither in Belgium nor the Netherlands (Jinze Noordijk pers. comm. and Blick & Komposch 2004). The species also occurs in Northern Spain, (Figure 1b).

Ecological comments have previously been published by Martens (1978), Stol (1982, 1999, 2003), Hillyard & Sankey (1989). Notes on the life cycle and monthly occurrence of *M. diadema* are found in Stol (1982, 1999, 2003).

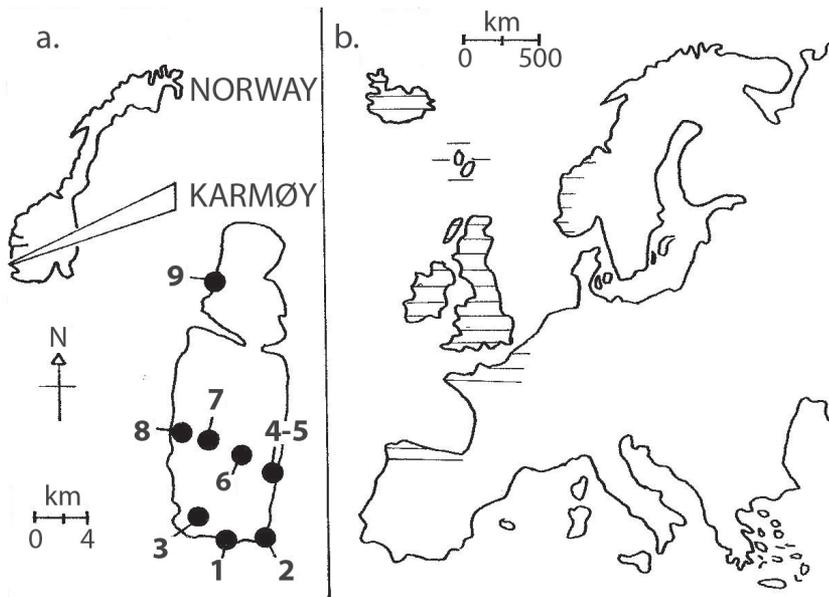


Figure 1. a. The 9 studied localities at Karmøy, Western Norway. See Table 1 for locality numbers. b. The approximate presently known distribution of *Megabunus diadema* in Europe.

Fieldwork was carried out in 1997 by the author on the island of **RY** Karmøy (EIS 13), and also fieldwork that was carried out from **RY** Stavanger (EIS 7) to **VAY** Flekkefjord (EIS 4) in 1998 has given new insight regarding the ecology of *M. diadema*, especially on biotope preferences and temporal occurrences. Furthermore, the southern limit of the species in Norway is better known.

*M. diadema* was proved to be mainly a parthenogenetic species in England by Phillipson (1959), who found 1 male out of 407 individuals. In Norway the first males were taken by the author at **RY** Karmøy (EIS 13) in 1997 (Table 1).

Table 1. A survey of 9 localities visited at Karmøy, Western Norway in 1997. Locality numbers as in Figure 1a. F = females and M = males of *M. diadema*

Loc. no.	Locality	Biotope	No. of individuals	
			F	M
1	Dr. Jensens Minde	Mixed wood	20	0
2	Falnes	Coniferous wood	18	0
3	Risdal	Coniferous wood	16	0
4	Blikshavn	Coniferous wood	37	0
5	Kigavatn	Coniferous wood	16	0
6	Stiklene	Coniferous wood	27	0
7	Sandvatn	Coniferous wood	67	0
8	Hannesskogen	Coniferous wood	24	0
9	Fransahagen	Mixed wood	36	3
Sum			261	3

## MATERIAL AND METHODS

The present study is based on material sampled from 9 localities and three different biotopes in 1997 on the island of **RY** Karmøy (EIS 13) in Western Norway. This rockliving species was collected by hand, and the collection unit was a time period of 30 minutes per day in each locality. A total of 261 FF and 3 MM were collected during the period 15 June - 10 July 1997 (Figure 1a and Table 1). Loc.7 Sandvatn was sampled one time every day in the period, whereas each of the other localities were sampled 3-6 times in the period. Furthermore, on 25 June 1998 material of *M. diadema* was collected along the coast from **RY** Stavanger (EIS 7) to **VAY** Flekkefjord (EIS 4). Each of these localities was sampled for 30 minutes. The material is deposited at the University of Tottori, Japan.

To obtain an index to the biotope preference of *M. diadema* the mean number of individuals collected per 30 minutes was calculated for the following three biotope types investigated in 1997 at the island of **RY** Karmøy (EIS 13); coniferous, deciduous and mixed woods.

The seven localities of coniferous woods (Table 1) was dominated by *Pinus sylvestris* L., *Picea abies* (L.), *Taxus baccata* L., *Juniperus communis* L., *Calluna vulgaris* (L.), *Erica tetralix* L., *Vaccinium vitis-idaea* L. and mosses. In these biotopes the soil was hard with scanty dead organic material and the light intensity was moderate. The two mixed wood localities included mainly *Pinus sylvestris* L., *Picea abies* (L.), *Ulmus glabra* Huds., *Fagus sylvatica* L., *Betula pubescens* Ehrh., *Sorbus aucuparia* L. and mosses. Large amounts of dead organic material were present and the light intensity of this biotope was moderate. One single deciduous wood was also visited, but no *M. diadema* specimens were found. Earlier fieldwork indicate

that the species does not occur in other biotope types, except possibly sometimes in heather.

At Loc.7 Sandvatn, an old well-developed coniferous wood, collecting was performed every day from 15 June to 10 July 1997, indicating the yearly maximum density of *M. diadema*.

Body length was measured dorsally from the frontal edge to the most posterior point. The movable cheliceral finger length (Figure 2) was measured dorsally between the most distant points. Pedipalpal tarsal length includes the claw, and the 1. eye spine length on tuberculum oculorum (Figure 3) is the maximum length of the spine. All measures are in mm.

Means ( $\bar{Y}$ ), upper and lower limits  $L_{1,2}$  (here called ranges with 95 % confidence), standard deviations ( $\pm$  SD), variances, observed sample sizes ( $n_1$ ) and computed sample sizes ( $n_2$ ) needed for a statistical test are presented in Tables 2-5. The statistical formulas applied follow Sokal & Rohlf (1981) and Rohlf & Sokal (1981).

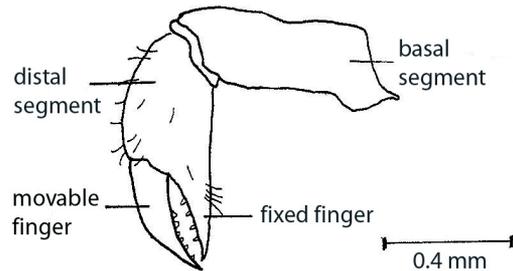


Figure 2. Lateral view of the chelicer of *Megabunus diadema*.

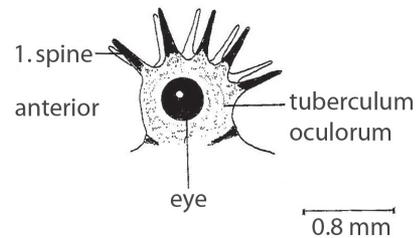


Figure 3. Lateral view of tuberculum oculorum of *Megabunus diadema* showing the long spines.

Table 2. Body length of *M. diadema* with means, standard deviations (SD), ranges, variances and observed sample sizes ( $n_1$ ). Computed sample sizes ( $n_2$ ) > 12. Measures in mm.

Loc. no.	Locality	Females				n1
		Mean	$\pm$ SD	Range	Variance	
8	Hannesskogen	3.16	0.40	2.98 - 3.33	0.159	23
5	Kigavatn	3.31	0.57	3.00 - 3.63	0.327	15
1	Dr. Jensens Minde	3.33	0.51	3.09 - 3.57	0.263	20
3	Risdal	3.34	0.41	3.11 - 3.56	0.167	15
7	Sandvatn	3.37	0.43	3.25 - 3.46	0.181	67
2	Falnes	3.40	0.30	3.24 - 3.55	0.091	17
4	Blikshavn	3.59	0.46	3.44 - 3.75	0.207	37
9	Fransahagen	3.77	0.34	3.65 - 3.88	0.119	36
6	Stiklene	3.79	0.46	3.61 - 3.96	0.208	27

Table 4. Pedipalpal tarsal length of *M. diadema* with the same calculations as in Table 2. Computed sample sizes ( $n_2$ ) > 20. Measures in mm.

Loc. no.	Locality	Females				n1
		Mean	$\pm$ SD	Range	Variance	
1	Dr. Jensens Minde	0.92	0.09	0.89 - 0.95	0.008	40
7	Sandvatn	0.92	0.06	0.91 - 0.93	0.003	134
3	Risdal	0.93	0.05	0.91 - 0.95	0.003	34
2	Falnes	0.94	0.03	0.94 - 0.95	0.002	72
9	Fransahagen	0.94	0.06	0.93 - 0.96	0.003	46
8	Hannesskogen	0.95	0.06	0.93 - 0.97	0.004	30
4	Blikshavn	0.96	0.03	0.95 - 0.96	0.001	74
5	Kigavatn	0.97	0.06	0.94 - 0.99	0.004	30
6	Stiklene	0.98	0.03	0.97 - 0.99	0.001	56

Table 3. Movable cheliceral finger length of *M. diadema* with the same calculations as in Table 2. Computed sample sizes ( $n_2$ ) > 11. Measures in mm.

Loc. no.	Locality	Females				n1
		Mean	$\pm$ SD	Range	Variance	
2	Falnes	0.39	0.03	0.38 - 0.40	0.0008	34
5	Kigavatn	0.39	0.02	0.38 - 0.40	0.0004	30
3	Risdal	0.40	0.03	0.39 - 0.41	0.0009	30
7	Sandvatn	0.40	0.03	0.40 - 0.41	0.0010	134
8	Hannesskogen	0.41	0.03	0.40 - 0.42	0.0010	46
9	Fransahagen	0.41	0.02	0.40 - 0.41	0.0005	72
1	Dr. Jensens Minde	0.41	0.04	0.40 - 0.42	0.0018	40
6	Stiklene	0.42	0.03	0.41 - 0.43	0.0007	56
4	Blikshavn	0.43	0.03	0.42 - 0.44	0.0008	74

Table 5. Length of 1. eye spine of *M. diadema* with the same calculations as in Table 2. Computed sample sizes ( $n_2$ ) > 20. Measures in mm.

Loc. no.	Locality	Females				n1
		Mean	$\pm$ SD	Range	Variance	
1	Dr. Jensens Minde	0.36	0.02	0.35 - 0.37	0.0004	40
7	Sandvatn	0.36	0.03	0.36 - 0.37	0.0006	134
3	Risdal	0.37	0.03	0.36 - 0.38	0.0008	30
2	Falnes	0.38	0.03	0.37 - 0.39	0.0011	34
9	Fransahagen	0.38	0.03	0.37 - 0.39	0.0009	72
8	Hannesskogen	0.38	0.03	0.37 - 0.39	0.0008	46
4	Blikshavn	0.38	0.02	0.38 - 0.39	0.0003	74
5	Kigavatn	0.39	0.02	0.38 - 0.39	0.0004	30
6	Stiklene	0.39	0.02	0.38 - 0.39	0.0005	56

## RESULTS AND DISCUSSION

### Distribution

In addition to localities mentioned in the fieldwork in 1997 and 1998, *M. diadema* has been collected at the following localities, based on material from the Zoological Museum in Bergen. The county divisions follow Økland (1981).

Totally 261 ♀♀ and 3 ♂♂ were taken in 9 localities on the island of **RY** Karmøy (EIS 13) in Western Norway, Table 1 and Figure 1a, in the period 15 June - 10 July 1997. This is the first report of males from Norway.

The material collected from fieldwork along the coast from **RY** Stavanger (EIS 7) to **VAY** Flekkefjord (EIS 4) 25 June 1998 is: **RY** Orre (EIS 7) 5 ♀♀, Oгна (EIS 3) 1 ♀, Mong (EIS 3) 1 ♀, Hauge i Dalane (EIS 3) 2 ♀♀. The presently known southern distribution limit of *M. diadema* in Norway lies at the county border of **VAY** Vest- Agder.

Material at the Zoological Museum, University of Bergen originated from **SFY** Kinn (EIS 48); **SFI** Aurland (EIS 51); **HOY** Bergen (EIS 30), Os (EIS 31), Haus (EIS 40), Meland (EIS 39), Tysnes (EIS 30), Stord (EIS 22), Fantoft (EIS 31); **HOI** Kvinnherad (EIS 23), Granvin (EIS 41), Jondal (EIS 32), Kvam (EIS 32); **RY** Stavanger (EIS 7), Sandnes (EIS 7), Bokn (13), Mosterøy (EIS 14), Rennesøy (EIS 14), Karmøy (EIS 13).

Based on these localities and the literature (Fabricius 1779, Henriksen 1938, Økland 1939, Martens 1978, Kauri 1980, Stol 1982, 1999, 2002, 2003, 2004, Hillyard & Sankey 1989, Agnarsson 1998) the presently known distribution of *M. diadema* in Norway and the rest of Europe is presented in Figure 1b.

### Ecology

A survey of the localities and biotopes studied in 1997 at the island of **RY** Karmøy (EIS 13) is presented in Figure 1a and Table 1.

The mean catch per 30 minutes collection of *M. diadema* in the 9 localities at Karmøy, Western Norway, is shown in Figure 4. The best locality was Loc.9, an old mixed wood surrounding closed copper mines, where 8 individuals were caught. The poorest localities were Loc. 3 and 5, young coniferous woods, with only 2 specimens caught. *M. diadema* was not found in deciduous wood. In England Hillyard & Sankey (1989) also reports *M. diadema* from heathland and moorland. The species spends almost all time on rocks and stones, even in direct sunlight (Stol 1999).

Loc.7 Sandvatn was sampled every day from 15 June - 10 July 1997. The maximum density occurred in the last week of June, Figure 5. 28 June was the best day, when 15 individuals were caught. Hillyard & Sankey (1989) reports from England that *M. diadema* appears from April onwards.

In Norway *M. diadema* is reported from elevations to approximately 400 - 500 m. a. s. l., whereas in Western Europe it reaches an elevation of up to 2000 m. a. s. l. (Martens 1978, Stol 2000).

### Morphology

The mean measures of body length, the movable cheliceral finger, the pedipalpal tarsus and the 1. eye spine and their ranges are presented in Tables 2-5.

Regarding body length (Table 2), specimens from Loc. 8 in coniferous wood were significantly smallest, whereas specimens from Loc. 6, also in coniferous wood, were significantly largest. In Loc. 6 there was a richer vegetation that possibly harbors much food, such as insects, which could explain the large body size of *M. diadema*.

Considering movable cheliceral finger (Table 3 and Figure 2), specimens from Loc. 2 in coniferous wood were the smallest in size, whereas specimens from Loc. 4, also in coniferous wood showed the largest measurements.

The length of pedipalpal tarsus (Table 4) was smallest in mixed wood, Loc. 1, and greatest in coniferous wood, Loc. 6.

The smallest 1. eye spine length (Table 5 and Figure 3) were found in specimens from mixed wood, Loc. 1, whereas the length was largest in specimens from coniferous wood, Loc. 6.

As a general trend almost all characters were largest from Loc.6 in coniferous wood, and in some cases smallest in Loc.1 in mixed wood. It is difficult to explain this, although this is most probably based on individual genetic variation. Body size, however, may be a result of different environmental conditions (Stol 2004).

Measurements of body length of females of *M. diadema* from Western Europe showed ranges of 3.2 - 3.7 mm Martens (1978). Hillyard & Sankey (1989) found ranges of 3.2 - 4.8 mm in Great Britain. Almost all these figures are within the ranges and variation of the present study, suggesting that there are no geographical differences. Certainly some very large individuals may occur in Great Britain

Figure 4. Mean number of *Megabunus diadema* collected by hand per 30 minutes of effort in the 9 localities at Karmøy, Western Norway.

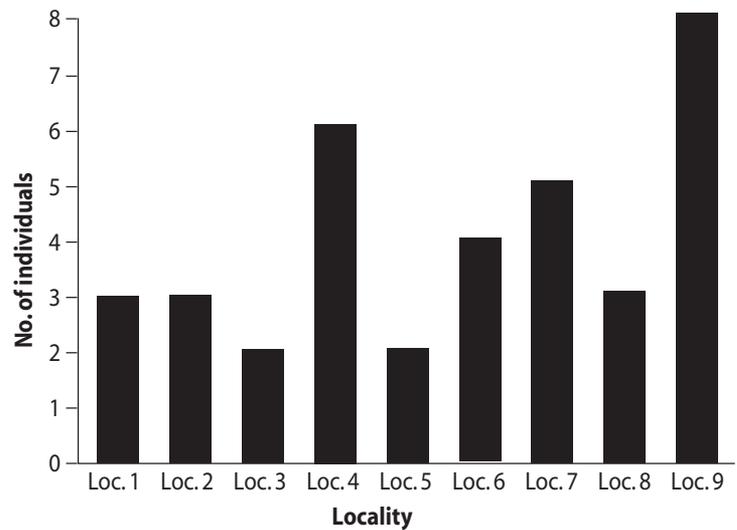
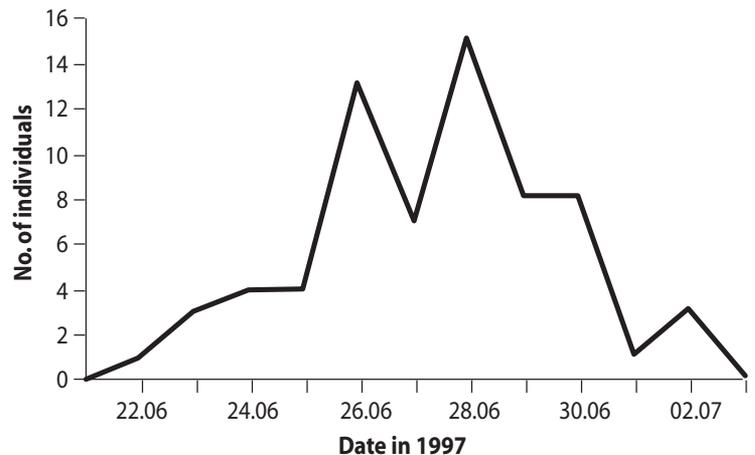


Figure 5. The density maximum of *Megabunus diadema* at Loc.7 Sandvatn, Karmøy, Western Norway in the period 21 June - 03 July.



## Parthenogenesis

As already mentioned *M. diadema* is mainly parthenogenetic, and the present study reveals the first 3 males from Norway out of 264 individuals. The males were found at the island of RY Karmøy (EIS 13) in Western Norway during the period 15 June to 10 July 1997. The locality was an old mixed wood (Loc. 9) (Table 1) surrounding closed copper mines. Parthenogenesis can account for successful spreading over longdistances (Meidell & Stol 1990). Also the species *Megabunus lesserti* Schenkel, 1927, which occurs in Germany, Switzerland and Austria (Blick & Komposch 2004), seems to be parthenogenetic (Komposch 1998, Komposch & Gruber 2004).

## SAMMENDRAG

### Økologi og kroppsstørrelse til den partenogenetiske *Megabunus diadema* (Fabricius, 1779) (Opiliones: Phalangiidae) på Karmøy i Vest-Norge

Den hittil kjente utbredelsen til *M. diadema* er vist på et kart. Arten er kjent fra Island, Færøyene, Vest-Norge, Storbritannia, Vest-Frankrike ved den Engelske kanal og Nord-Spania. *M. diadema* ble studert i 9 lokaliteter på øya Karmøy, Ryfylke (EIS 13), Rogaland i Vest-Norge fra 3 forskjellige biotopyper i perioden 15 juni - 10 juli 1997. I løpet av denne perioden ble det samlet inn 261 hunner og 3 hanner ved handplukking. *M. diadema* er en hovedsakelig partenogenetisk art, og disse hannene er den første rapporten av hanner fra Norge. I 1998 ble også fel-

arbeid utført mellom Stavanger (EIS 7) og Flekkefjord (EIS 4) for å finne den sørlige utbredelsesgrensa til arten. Kommentarer til økologien til *M. diadema* er utførlig gitt. Flest individer ble fanget i en gammel, velutvikla blandingsskog, mens de dårligste lokalitetene var to unge barskoger. I løvskog ble ingen individer funnet. *M. diadema* oppholder seg på berg og steiner slik at fallfeller var ubrukelige til å fange den med. Den årlige tetthetstoppen ligger i siste uka i juni. På den beste dagen ble 15 individer fanget på en halvtime med handplukking. Med hensyn til de morfologiske karakterene ble kroppslengde, bevegelig chelicer finger, pedipalpal tarsus og første øyetaggt målt. Både den minste og største kroppslengden ble funnet hos individer fra barskog. Sammenlignet med Vest-Europa og Storbritannia ble ingen vesentlige geografiske forskjeller funnet angående kroppslengde.

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