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The pine sawyer *(Monochamus sutor)*: Distribution and life history in South Norway

Furubukken (Monochamus sutor)*: Utbredelse og levemåte i Syd-Norge*

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Ås 1992

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Abstract

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Monochamus sutor goes through four larval instars. In the southern lowland districts of Norway, they may reach the fourth instar before overwintering and emerge as adults after one year. In higher inland districts, with a shorter summer seasons, the larvae will reach second or third instar before overwintering and will need another summer and winter before they emerge as adults. Geographical populations inbetween these districts may have partly a 1-year and a 2-year life cycle, depending on length of summer or on the annual weather conditions. The species is recorded from pine and spruce forests throughout Norway, but seems to be more abundant in eastern inland districts.

Key words: Pine sawyer, *Monochamus sutor,* life cycle, distribution.

Utdrag

BAKKE, A. & KVAMME, T. 1992. The pine sawyer *Monochamus sutor:* Distribution and life history in South Norway. (Furubukken *Monochamus sutor:* Utbredelse og levemåte i Syd-Norge.) Medd. Skogforsk.44 (13): 1–16.

Monochamus sutor går gjennom fire larvestadier under utviklingen fra egg til utvokst bille. I de sydlige lavlandsdistriktene i Norge kan de nå det fjerde stadiet før overvintringen og klekke som bille året etter. Generasjonstiden blir da 1 år. I høyereliggende innlandsdistrikter, med kortere sommersesong, vil larvene oftest nå det andre eller tredje stadium før overvintringen. De vil da trenge enda en sommer og vinter før de når billestadiet. Generasjonstiden blir da 2 år. I mellomliggende områder vil furubukken ha både 1. årige og 2. årige generasjoner avhengig av sommerens lengde i området og årets værforhold. Furubukken er funnet i furu- og granskogdistrikter over hele Norge, men er mer tallrik i innlandsdistriktene på Østlandet.

Nøkkelord: Furubukk, livssyklus, utbredelse.

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Preface

Lognhorn beetles of the genus *Monochamus* act as vectors for the pinewood nematode *Bursaphelenchus xylophilus*. When this tree-killing nematode, in 1984, was found in coniferous wood chips introduced from North America to Finland, more interest was consentrated on *Monochamus* species in Europe. This paper is the result of a study on life cycle and abundance of the common Nordic species of *Monochamus* in Norway. The authors wish to thank Torfinn Sæther for valuable assistance during the field and laboratory work, Øystein Austaråå, Erik Christiansen and Lawrence Kirkendall for critical manuscript reviews and all those giving us records for the distribution map. Thanks also to Gunnar Fjone for assistance with the computer drawings. The study was funded mainly by Agricultural Research Counsil of Norway.

Ås,March 1992

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Contents

Introduction

Species of the genus *Monochamus* living in coniferous trees are vectors for nematodes of the genus *Bursaphelenchus*. The pine wood nematode *B. xylophilus* (STEINER & BUHRER) Nickle, which occur in North America and East Asia, has caused great damage to pine forests in Japan (KOBAYASHI 1988). Because of the risk of introducing and establising a dangerous pest, an embargo was placed on importation of raw softwood products to the Nordic countries, from all countries where this pine wood nematode occurs.

Some European *Monochamus* species are vectors for the nematode *B. mucronatus,* which is closely related to *B. xylophilus* (MCNAMARA & STØEN 1988, MAGNUSSON & SCHRØDER 1989, TOMMINEN et al. 1989). These beetles may also be potential vectors for the pine wood nematode if the species is accidentally introduced to Europe. More knowledge on the biology, abundance and occurrence of the *Monochamus* species is therefore needed. This paper deals with *Monochamus sutor* (LINNAEUS, 1758), the most common species in Norway.

Few studies have been published in Fennoscandia on the biology of *M. sutor* in recent years. However, some basic data on the biology are known from the papers of TRÄGÅRDH (1919, 1929) and FORSSLUND (1934). Their studies give valuable information particularly on the injury caused by the beetle in pine trees suffering from forest fire. The aim of the present paper is to study life cycle and abundance of *M. sutor* in different climatical zones of Norway.

Material and methods

The uppermost crown sections of both Norway spruce Picea abies and Scots pine *Pinus sylvestris* are usually left in the forest after logging. Many beetles, including *M. sutor* utilize the larger part of these tops for reproduction. Such logging slash seems to be among the most common breeding materials for the beetle. Billets from logging areas were collected in the late autumn of 1989 and 1990 from three climatically different districts of South Norway (Table 1. and Fig.7). Billets with diameter between 5 and 20 cm, from the crown of felled Norway spruce and Scots pine, infested with larvae, were dissected. Infestations are easy to detect because of the frass expelled by the larvae.

Head-capsule width of the larvae were measured across the ventral surface along a line projected through the posteriorlateral angles of the hypostomal sclerites.

The records of *M. sutor* from Norway were mapped. Data of beetles stored in Norwegian museums and other collections were registered. Various districts of the country were invented to evaluate the abundance of the species in logging vaste on clearcuts and in other potential breeding materials.

Table 1. Study districts and material collected for examination.
Undersøkelsesområdene og omfanget av innsamlet materiale.

Locality Municipality Country	Altitude m	Tree species	Time of coll.	Supposed ovipos.	No.of larvae	No.of exit holes
Drevsjø				1987	0	51
Engerdal		Pine		1988	99	0
Hedmark	690		Oct. 1989	1989	79	0
		Pine		1989	122	0
			Sept.1990	1990	118	0
Frysjøberget						
Grue				1988	154	221
Hedmark	310		Oct.1989	1989	94	0
		Spruce				
				1989	159	229
			Oct.1990	1990	216	0
		Pine	Oct.1990	1990	29	0
Kalldalen						
Åmli		Spruce				
Aust-Agder	160		Oct.1989	1989	29	0

Results

Flight period

Field observation indicates that the flight lasts for a long period even in higher inland districts. In 1990 adult beetles were observed in Drevsjø,altitude 700 m, as early as 13. June and as late as 11. September.

Larval behavior

Dissection and examination of infested breeding material at different times during the season gave information on larval behavior. First instar larvae were feeding in the subcortical zone. During the second instar, most of the larvae penetrated into the sapwood (Fig.1). All larvae with a head-capsule indicating that they belong to the third instar, had made their gallery in the sapwood. Like some other relatives in the *Monochamus* genus the larvae return frequently from the gallery to the wood surface to feed. The wood surface are deeply scored, and excess frass from the mines becomes noticable outside the billets. The larvae were always found hibernating in the interior part of the wood gallery.

Number of larval instars

Head-capsule width of all larvae from Engerdal plotted as a frequency histogram give four distributions (Fig.2) which indicate four larval instars. The last peak is wide, may indicate a fifth instar.

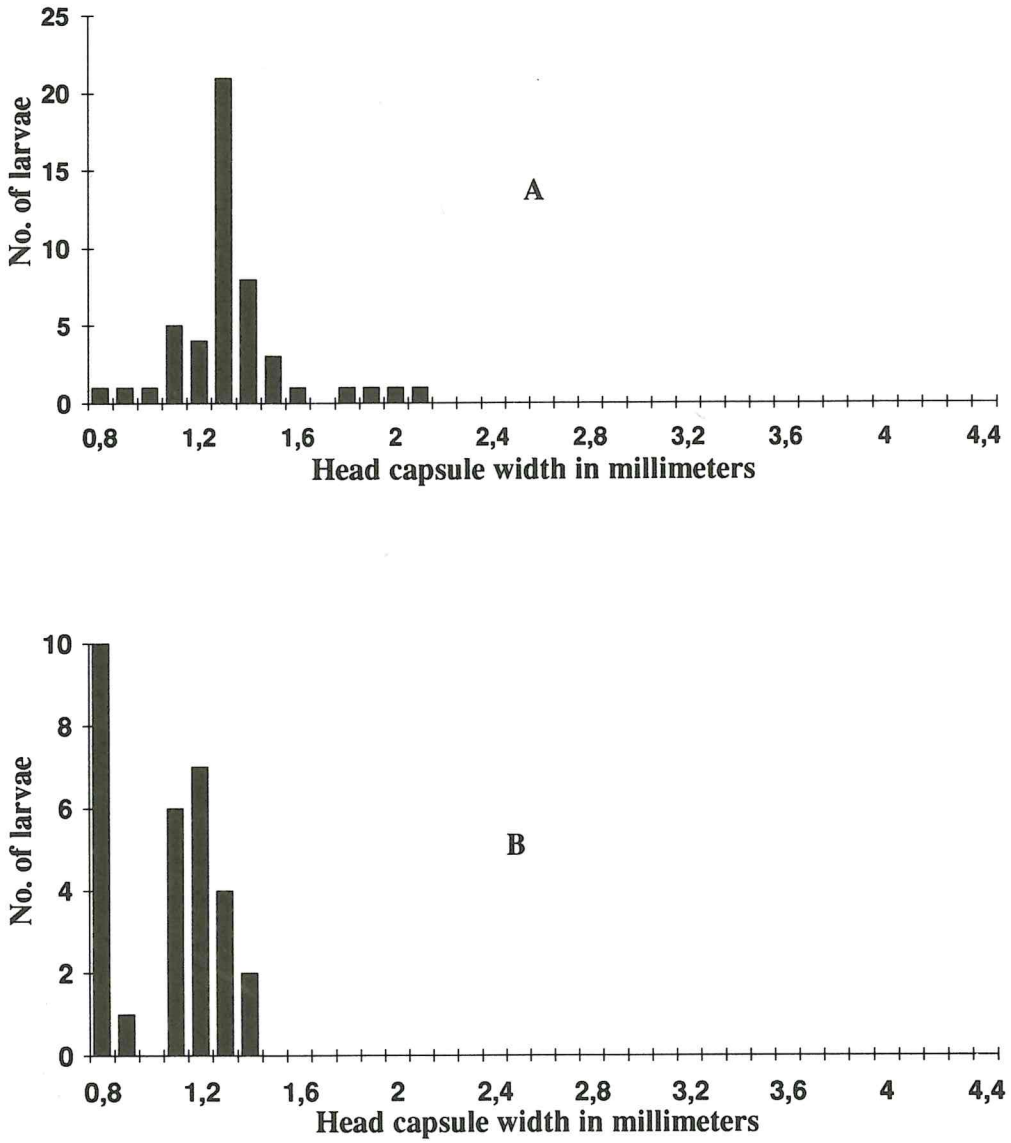

Fig. 1. Head-capsule width of larvae feeding in the subcortical sone with (A) and without (B) the tunnel into the wood. Engerdal 1989.
Hodekapsel-bredde fra larver funnet under barken med (A) og uten (B) en gang inn i veden.

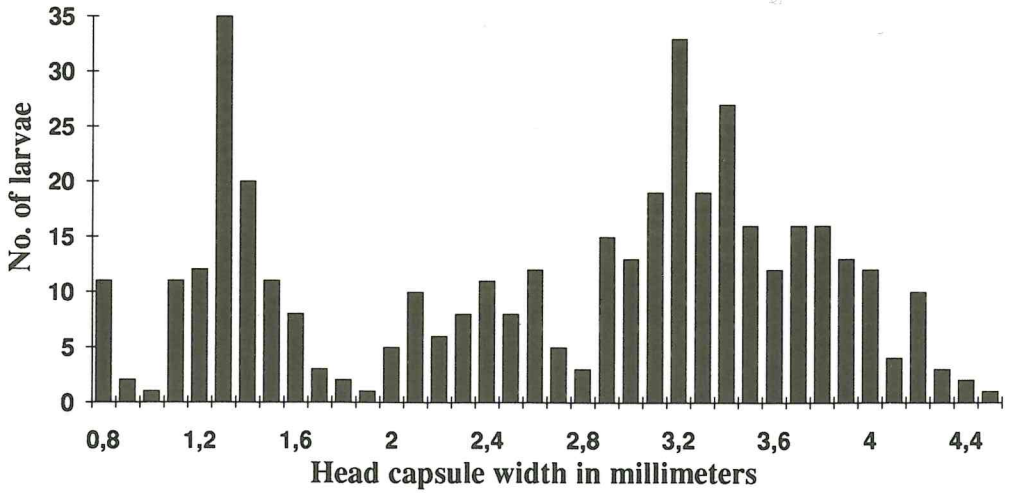

Fig. 2. Head-capsule width of all larvae from Engerdal.
Hodekapsel-bredde av alle larvene fra Engerdal.

Duration of brood development

The period of larval development varies between the three districts selected for this study.

In the southernmost district (Åmli) all larvae collected (n=29) had reached the fourth instar in the autumn of their first summer. They emerged as adult the following spring and hence passed through a univoltine life cycle. The species is rather rare in the southernmost districts of Norway. We found breeding material in one logging area only, most likely from an early summer oviposition. Probably, brood from late summer oviposition will need another summer to complete the life cycle.

In Grue, which represents the lowland forest districts of interior central Scandinavia, most of the larvae hibernated in the third and fourth instars Similar results was obtained both in 1989 and in 1990 (Fig.3). If we assume that larvae with a head-capsule width above 2.5 mm belong to the fourth instar, 65 % in 1989 (n=94) and 66% in 1990 (n=216) had reached the fourth instar before hibernation. By the end of the second summer after oviposition it became evident that about about 60% of the population had a one-year generation (Table 1). This is equal to the percent of the population which had reached the fourth instar before hibernation (Fig.3)

In Engerdal, a higher inland district of central Norway, no fourth instar larvae were found in the late fall of the first season (Fig.4). In 1989, very few had reached the third instar, most were in the second, while some were found as egglarvae. In 1990, most larvae were found in the second instar, but some more in the third and none in the first. After the second season, 95% of the larvae (n=123) had reached the fourth instar (Fig.5). They are supposed to have emerged as adults the following summer. No living larvae were found in slash older than three years. This indicates that the population in that area have a two year life cycle.

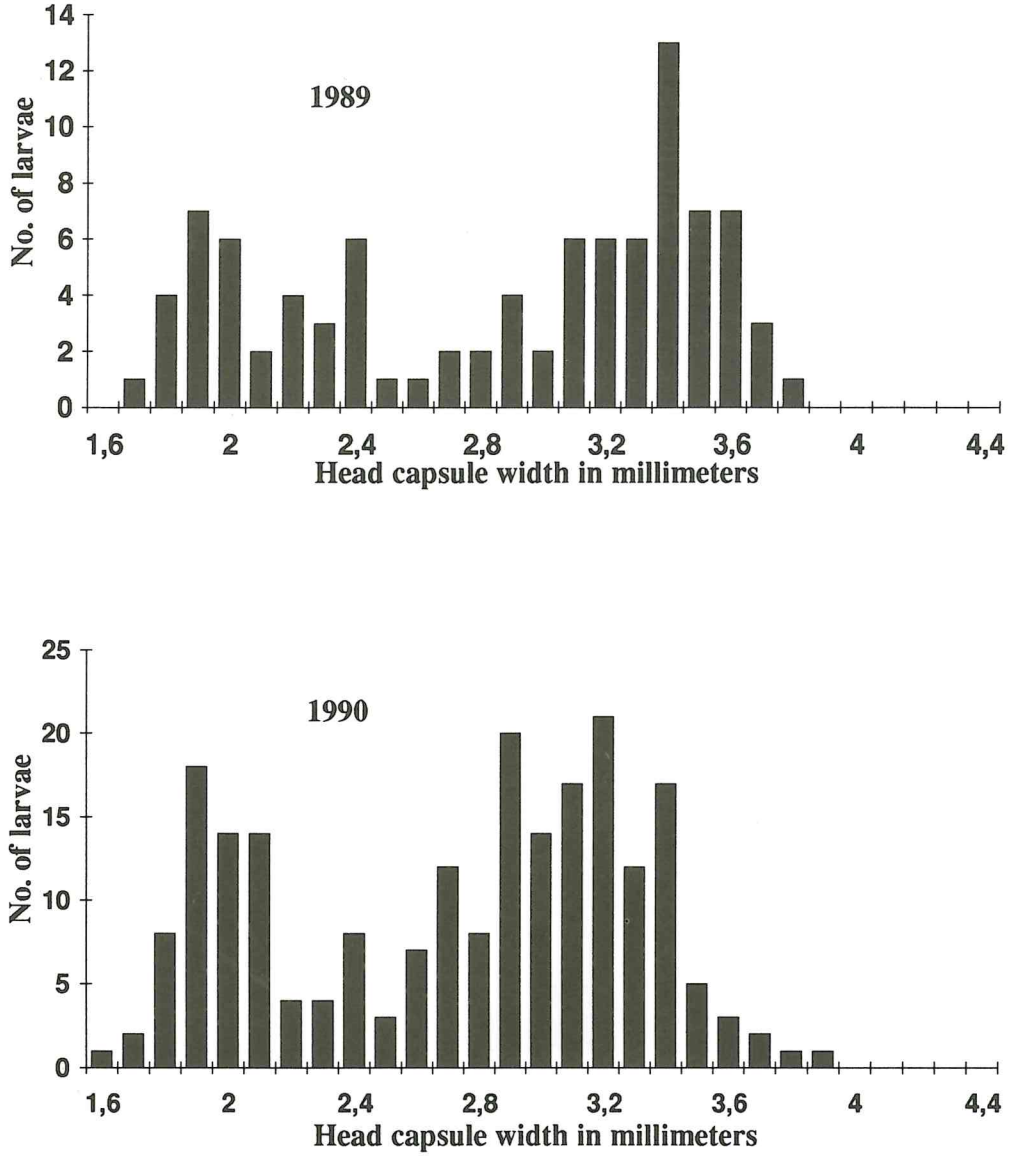

Fig. 3. Head-capsule width of larvae hibernating after the first season in Grue.
Hodekapsel-bredde av larver som overvinteret etter første sommeren i Grue.

Host tree influence on development

The host tree in Engerdal was Scots pine, the only coniferous forest tree in the area where the billets were collected. In Grue all larvae were from pure stands of Norway spruce, the dominant tree in that area. The larvae from Åmli were also collected from Norway spruce. This difference in host tree may have influenced the time of development. To study this, one year

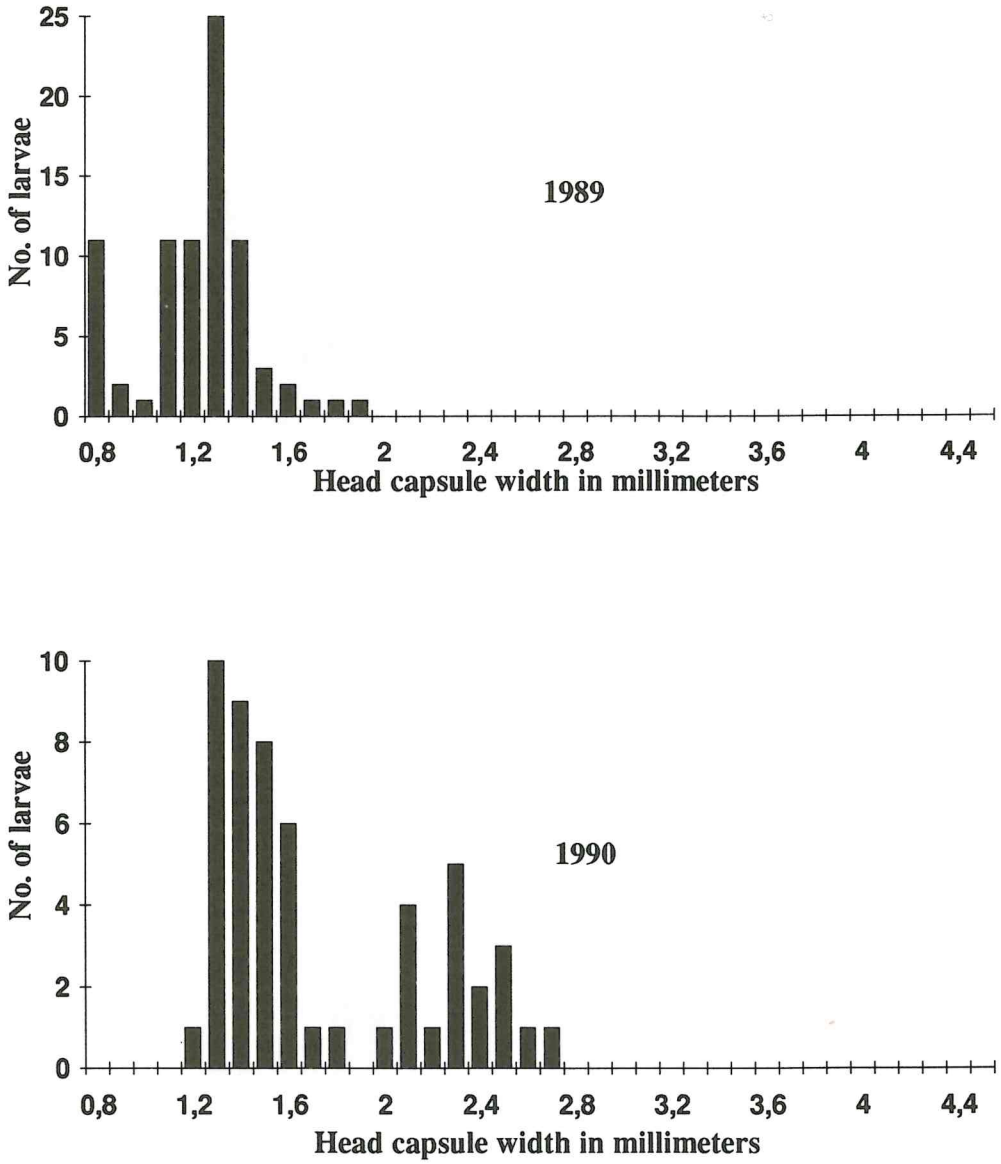

Fig. 4. Head-capsule width of larvae hibernating after the first season in Engerdal.
Hodekapsel-bredde av larver som overvintret etter første sommeren i Engerdal.

old larvae (n=29) were collected in 1990 from a site with Scots pine in Grue and compared with larvae (n=216) of the same age from Norway spruce. Larvae from spruce had a headcapsule width of 2.56 mm and from pine 2.54 mm, which indicate no difference between larvae developed in the two tree species.

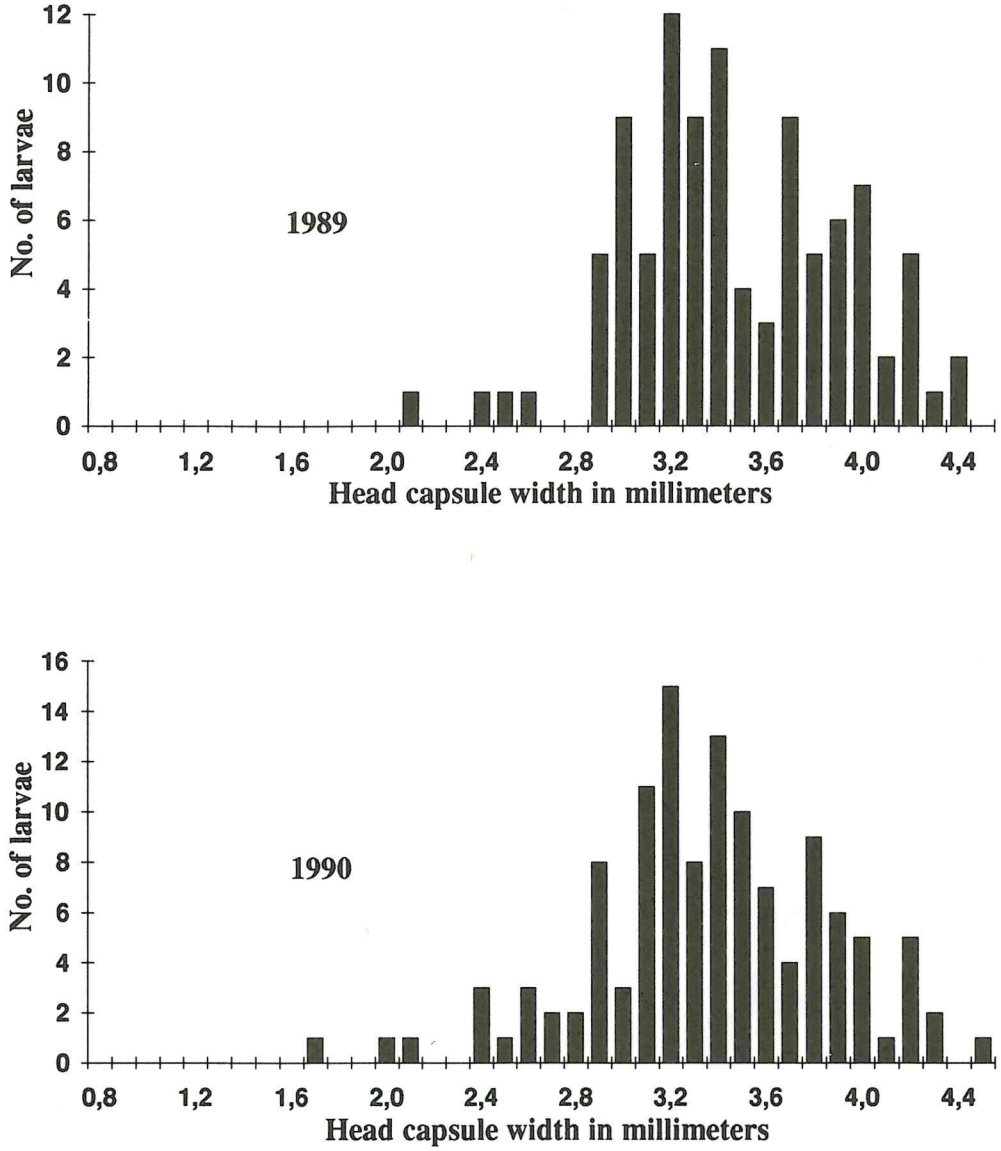

Fig. 5. Head-capsule width of larvae hibernating after two seasons in Engerdal.
Hodekapsel-bredde av larver som overvintret etter to sommre i Engerdal.

Distribution

M. sutor is recorded from coniferous forest areas all over Norway. All available records are plotted on a map (Fig. 6). Inspected sites in south-eastern Norway are depicted on a map (Fig.7) with an indication of the abundance of the species. It is evident from the field inventory that the beetle is abundant particularly in the easternmost districts of South Norway,but more local and rare in the other districts.

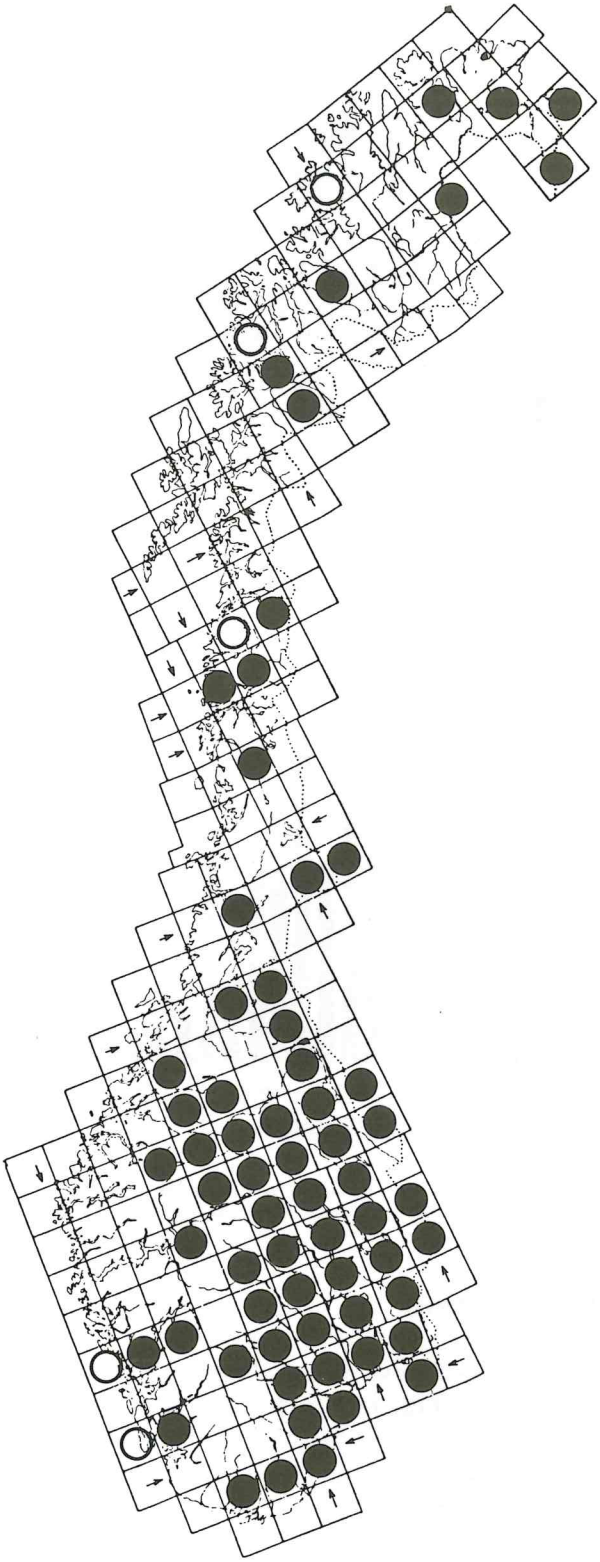

Fig. 6. Records of *Monochamus sutor* in Norway.
Funn av Monochamus sutor *i Norge.*

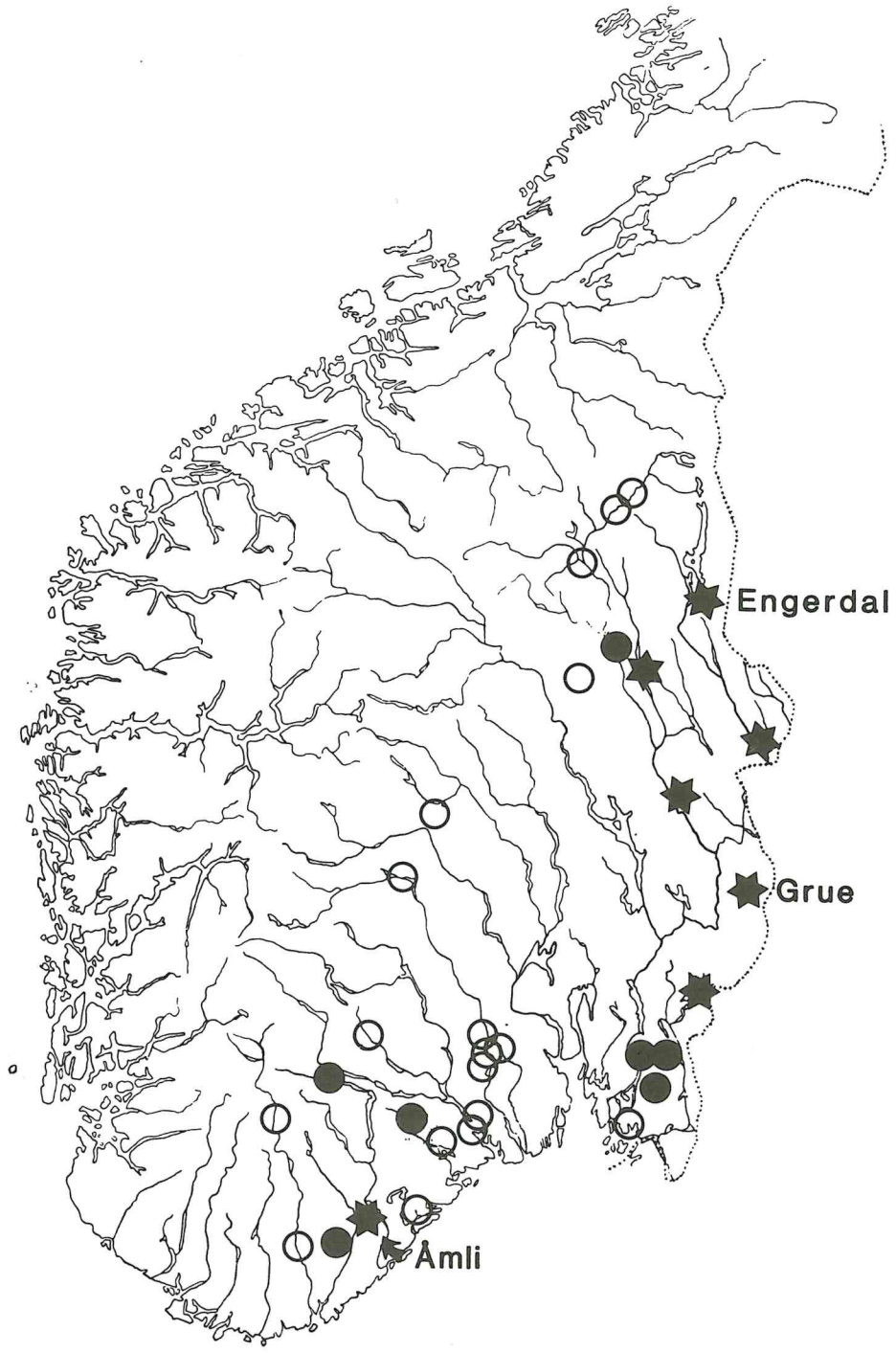

Fig. 7. Observation of abundance of *Monochamus sutor* in some districts of South Norway in 1987–90. Star: abundant, solid circles: single records, open circles: not found.
Observasjoner over forekomst av Monochamus sutor *fra noen distrikter i Syd-Norge i 1987–90. Stjerne: tallrik, sort sirkel: enkelte funn, åpen sirkel: ikke funnet.*

Discussion

This study indicates that *M. sutor* have four instars. The same number of instars is also found in some related *Monochamus* species in other part of the world,e. g. in *M. scutellatus* (Say), the transcontinental species in northern North America (ROSE 1957) and in *M.alternatus* Hope from Japan (KOBAYASHI et al.1984, TOGASHI 1991). ISAEV et al.(1988) described five instars in *M. urossovi* (FISCHER V. VALDHEIM) from Siberia and Hellrigl (1971) mention ten instars in *M. sartor* (Fabricius). When reared under artificial condition, larvae may molt several more times. This has been recorded for *M. carolinensis* (Oliver) (PERSHING & LINIT 1986) and for *M. alternatus* (KOBAYSSHI et al.1984)

The within-tree biology of *M. sutor* larvae has been studied by TRÄGÅRDH (1929). He did not distinguish the instars, but found that the larva starts entering into the wood when the phloem cavity covers 6–8 square cm. *M. carolinensis* in Missouri, U.S.A. (PERSHING & LINIT, 1986) and *M. scuttelatus* in northern Canada (ROSE 1957) began tunnelling in the wood in the third instar, while *M. sutor* in the inland districts of Engerdal penetrate into the wood during the second instar. These differences may be due to either climatical conditions or species differences.

M. sutor has 1 or 2 years life cycle in southern Norway depending on climatical condition and probably on time of oviposition during the summer (Fig. 6). Similar variation in life cycle is found in *M.alternatus* in Japan. According to KOBAYASHI (1988) larvae hatching later than mid-August in northern Japan (Honshu) overwinter as young instar larvae in the sapwood. Those that survive take 2 years to complete their life cycle.

TOGASHI (1989) developed a hypothesis on the regulation of life cycle of *M. alternatus*. He found that larvae overwintering as first and second instars enter diapause at the fourth instar after overwintering. This results in a 2year life cycle. The larvae respond to the physical condition of the second winter. Those overwintering in third or early fourth instar develop without diapause to adult the current summer while those at the fourth instar before overvintering enter diapause, but terminate the diapause during the winter. This results in a 1-year life cycle for all larvae reaching third instar before overwintering.

Our results with *M.sutor* may fit in with the hypothesis of TOGASHI (1989). However, under the climatical condition in inland South Norway the larvae probably have to reach the fourth instar before winter in order to emerge as adult the following year (Fig. 8). ROSE (1957) found similar development in *M.scutellatus* in northwestern Ontario. Here, this beetle genarally has a 2-year life cycle, whereas a 1 year life cycle is common in more southerly localities. The life cycle of *Monochamus* beetles may vary considerably depending on the climat. PERSHING & LINIT (1986) concluded from their studies on the development of *M. carolinensis* in Missouri, U.S.A. that the larvae do not pass through an obligatory diapause and that the species completes two generation per year.

M. sutor was easy to find in the easternmost parts of the surveyed area, whereas it was rather local in the southern and western parts. MCNAMARA

	1. Year		2. Year	3. Year
Engerdal	**Flight**	**2. instar**	**4. instar**	**Adults**
	oviposition	**3. instar**		
Grue	**Flight**	**4. instar (2/3)**	**Adults (2/3)**	
	oviposition	**3. instar (1/3)**	**4. instar (1/3)**	**Adults**
Åmli	**Flight**	**4. instar**	**Adults**	
	oviposition	**3. instar ?**	**4. instar**	**Adults**

Fig. 8. Seasonal life history of *Monochamus sutor* in three climatically different districts of South Norway 1987–1990.
Livsforløpet til Monochamus sutor *i tre klimatisk forskjellige distrikter i Syd-Norge.*

& STØEN (1988) have similar experiences from recent years. One exeption is Åmli where we found several galleries in slash on a clearcut. In several of the surveyed districts the species was commonly found earlier. In Siljan, Telemark county, it was a pest on stored logs and common in logging slash in the late 1950ies (BAKKE 1960), but we failed to find it there during our survey. The records from coastal areas are few and scattered. Thus we will characterize *M. sutor* mainly as an eastern oriented inland species in Norway. In western Norway no survey has been carried out. The true distribution and abundance here are unknown.

The variations in length of larval development in *M. sutor* seem not to influence the distribution of *Bursaphelenchus xylophilus*. The nematode is widespread in Fennoscandia (TOMMINEN et al. 1989) eaven in northern districts. We have records from Åmli (BAKKE et al. 1991) where a 1-year life cycle is common, as well as from Engerdal where the beetle will need 2 years to complete the life cycle.

Furubukken *(Monochamus sutor)*: Utbredelse og levemåte i Syd-Norge.

Trebukker av slekten *Monochamus* overfører furuvednematoden *Bursaphelenchus xylophilus* fra syke til friske trær. Denne nematoden, som har gjort stor skade på furuskog i Japan, er også utbredt i Nord-Amerika. Da nematoden i 1984 ble funnet i Finland, i en båtlast med «flis», ble det besluttet i alle de nordiske landene å forby import av bartrevirke fra alle land hvor furuvednematoden er påvist. Fordi vår nordiske art av furubukker også er potesielle vektorer for nematoden ble det behov for å vite mer om artens utviklingsforhold og forekomst også i Norge.

Undersøkelser av levemåten ble utført på tre steder, Engerdal og Grue i Hedmark og Åmli i Aust-Agder. Artens utbredelse ble dessuten kartlagt på grunnlag av materiale fra museer, forskningsinstitutter og private samlinger. Forekomsten ble også registrert ved reiser til distrikter i Syd-Norge. Undersøkelsene ble utført i perioden 1988–90.

Billen ble påvist i skogen fra midten av juni til ut i september. Målinger av larvenes hodekapselbredde viser at furubukken har fire larvestadier. I nordlige og høyereliggende strøk av Hedmark nådde larven 2. og 3. larvestadium før vinteren. Den fortsatte neste sommer og kom da til 4. stadium på høsten. Den tredje sommeren forpuppet den seg og kom frem som bille. Generasjonstiden blir 2. år. I lavereliggende strøk av Hedmark nådde 2/3 av larvene 4. stadium før første vinter og kom frem som biller neste sommer. De hadde en 1. årig generasjonstid. Resten overvintret på 3.larvestadium og brukte neste sommer til å nå 4. stadium. Larvene overvintret og kom frem som biller etter 2 vintre. Generasjonstiden var 2. år. I Aust-Agder hadde alle de dyrene som ble funnet en 1. åreig generasjonstid.

Furubukken kan utvikle seg både i gran og furu.Det var ikke mulig å påvise forskjeller i utviklingstiden mellom larver fra de to treslagene.

Billen er funnet i barskoger over hele Norge, men den er tallrik på hogstflatene bare i de østlige delene av Syd-Norge. I kyststrøkene er den sjelden men kan finnes på enkelte lokaliteter.

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